ALLEN CAREER INSTITUTE
KOTA (RAJASTHAN)
path to success

JEE (MAIN) 2022

E

TEST PAPERS

Chapter Contents

JEE (MAIN) JUNE 2022 TEST PAPERS

IMPORTANT NOTE

SET # 01

PHYSICS

SECTION-A

1. The bulk modulus of a liquid is 3×10^{10} Nm^{-2}. The pressure required to reduce the volume of liquid by 2% is :

(A) 3×10^8 Nm^{-2} (B) 9×10^8 Nm^{-2}

(C) 6×10^8 Nm^{-2} (D) 12×10^8 Nm^{-2}

2. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : In an uniform magnetic field, speed and energy remains the same for a moving charged particle.

Reason (R) : Moving charged particle experiences magnetic force perpendicular to its direction of motion.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true.

3. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω. A voltmeter connected in the circuit measures 1.2 V. The internal resistance of each cell is

(A) 2.5Ω (B) 4Ω

(C) 5Ω (D) 10Ω

4. Identify the pair of physical quantities which have different dimensions :

(A) Wave number and Rydberg's constant

(B) Stress and Coefficient of elasticity

(C) Coercivity and Magnetisation

(D) Specific heat capacity and Latent heat

5. A projectile is projected with velocity of 25 m/s at an angle θ with the horizontal. After t seconds its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be : [use g = 10 m/s^2]

(A) $\frac{1}{2}\sin^{-1}\left(\frac{5t^2}{4R}\right)$ (B) $\frac{1}{2}\sin^{-1}\left(\frac{4R}{5t^2}\right)$

(C) $\tan^{-1}\left(\frac{4t^2}{5R}\right)$ (D) $\cot^{-1}\left(\frac{R}{20t^2}\right)$

6. A block of mass 10 kg starts sliding on a surface with an initial velocity of 9.8 ms^{-1}. The coefficient of friction between the surface and bock is 0.5. The distance covered by the block before coming to rest is : [use g = 9.8 ms^{-2}]

(A) 4.9 m (B) 9.8 m

(C) 12.5 m (D) 19.6 m

7. A boy ties a stone of mass 100 g to the end of a 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi}$ rev. / min. The value of K is : (Assume the string is massless and unstretchable)

(A) 400 (B) 300

(C) 600 (D) 800

8. A vertical electric field of magnitude 4.9×10^5 N/C just prevents a water droplet of a mass 0.1 g from falling. The value of charge on the droplet will be : (Given g = 9.8 m/s^2)

(A) 1.6×10^{-9} C (B) 2.0×10^{-9} C

(C) 3.2×10^{-9} C (D) 0.5×10^{-9} C

9. A particle experiences a variable force $\vec{F} = (4x\hat{i} + 3y^2\hat{j})$ in a horizontal x-y plane. Assume distance in meters and force is newton. If the particle moves from point (1, 2) to point (2, 3) in the x-y plane, the Kinetic Energy changes by

(A) 50.0 J (B) 12.5 J
(C) 25.0 J (D) 0 J

10. The approximate height from the surface of earth at which the weight of the body becomes $\frac{1}{3}$ of its weight on the surface of earth is : [Radius of earth R = 6400 km and $\sqrt{3} = 1.732$]

(A) 3840 km (B) 4685 km
(C) 2133 km (D) 4267 km

11. A resistance of 40 Ω is connected to a source of alternating current rated 220 V, 50 Hz. Find the time taken by the current to change from its maximum value to rms value :

(A) 2.5 ms (B) 1.25 ms
(C) 2.5 s (D) 0.25 s

12. The equations of two waves are given by :

$$y_1 = 5\sin 2\pi(x - vt)cm$$
$$y_2 = 3\sin 2\pi(x - vt + 1.5)cm$$

These waves are simultaneously passing through a string. The amplitude of the resulting wave is

(A) 2 cm (B) 4 cm
(C) 5.8 cm (D) 8 cm

13. A plane electromagnetic wave travels in a medium of relative permeability 1.61 and relative permittivity 6.44. If magnitude of magnetic intensity is 4.5 × 10^{-2} Am^{-1} at a point, what will be the approximate magnitude of electric field intensity at that point ? (Given : permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}, speed of light in vacuum $c = 3 \times 10^8$ ms^{-1})

(A) 16.96 Vm^{-1}
(B) 2.25 × 10^{-2} Vm^{-1}
(C) 8.48 Vm^{-1}
(D) 6.75 × 10^6 Vm^{-1}

14. Choose the correct option from the following options given below :

(A) In the ground state of Rutherford's model electrons are in stable equilibrium. While in Thomson's model electrons always experience a net-force.

(B) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non-uniform mass distribution in Thomson's model

(C) A classical atom based on Rutherford's model is doomed to collapse.

(D) The positively charged part of the atom possesses most of the mass in Rutherford's model but not in Thomson's model.

15. Nucleus A is having mass number 220 and its binding energy per nucleon is 5.6 MeV. It splits in two fragments 'B' and 'C' of mass numbers 105 and 115. The binding energy of nucleons in 'B' and 'C' is 6.4 MeV per nucleon. The energy Q released per fission will be :

(A) 0.8 MeV (B) 275 MeV
(C) 220 MeV (D) 176 MeV

16. A baseband signal of 3.5 MHz frequency is modulated with a carrier signal of 3.5 GHz frequency using amplitude modulation method. What should be the minimum size of antenna required to transmit the modulated signal ?

(A) 42.8 m (B) 42.8 mm
(C) 21.4 mm (D) 21.4 m

17. A Carnot engine whose heat sinks at 27°C, has an efficiency of 25%. By how many degrees should the temperature of the source be changed to increase the efficiency by 100% of theoriginal efficiency ?

(A) Increases by 18°C
(B) Increase by 200°C
(C) Increase by 120°C
(D) Increase by 73°

18. A parallel plate capacitor is formed by two plates each of area $30\pi\ cm^2$ separated by 1 mm. A material of dielectric strength $3.6 \times 10^7\ Vm^{-1}$ is filled between the plates. If the maximum charge that can be stored on the capacitor without causing any dielectric breakdown is 7×10^{-6} C, the value of dielectric constant of the material is :

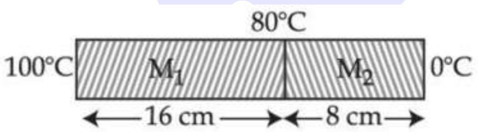
$$\left\{\text{Use} : \frac{1}{4\pi\varepsilon_0} = 9\times10^9\,Nm^2C^{-2}\right\}$$

(A) 1.66 (B) 1.75
(C) 2.25 (D) 2.33

19. The magnetic field at the centre of a circular coil of radius r, due to current I flowing through it, is B. The magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre is :

(A) B/2 (B) 2B
(C) $\left(\frac{2}{\sqrt{5}}\right)^3 B$ (D) $\left(\frac{2}{\sqrt{3}}\right)^3 B$

20. Two metallic blocks M_1 and M_2 of same area of cross-section are connected to each other (as shown in figure). If the thermal conductivity of M_2 is K then the thermal conductivity of M_1 will be : [Assume steady state heat conduction]



(A) 10 K (B) 8 K
(C) 12.5 K (D) 2 K

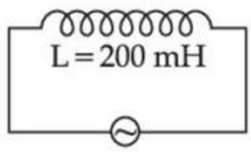
SECTION-B

1. 0.056 kg of Nitrogen is enclosed in a vessel at a temperature of 127°C. The amount of heat required to double the speed of its molecules is _____ k cal.
(Take R = 2 cal $mole^{-1}K^{-1}$)

2. Two identical thin biconvex lenses of focal length 15 cm and refractive index 1.5 are in contact with each other. The space between the lenses is filled with a liquid of refractive index 1.25. The focal length of the combination is ______ cm.

3. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 10 mV is added to the base-emitter voltage, the base current changes by 10 μA and the collector current changes by 1.5 mA. The load resistance is 5 kΩ. The voltage gain of the transistor will be _____ .

4. As shown in the figure an inductor of inductance 200 mH is connected to an AC source of emf 220 V and frequency 50 Hz. The instantaneous voltage of the source is 0 V when the peak value of current is $\frac{\sqrt{a}}{\pi}$ A. The value of a is _______.

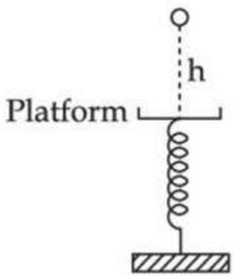


5. Sodium light of wavelengths 650 nm and 655 nm is used to study diffraction at a single slit of aperture 0.5 mm. The distance between the slit and the screen is 2.0 m. The separation between the positions of the first maxima of diffraction pattern obtained in the two cases is _______ $\times 10^{-5}$ m.

6. When light of frequency twice the threshold frequency is incident on the metal plate, the maximum velocity of emitted election is v_1. When the frequency of incident radiation is increased to five times the threshold value, the maximum velocity of emitted electron becomes v_2. If $v_2 = x\ v_1$, the value of x will be ______.

7. From the top of a tower, a ball is thrown vertically upward which reaches the ground in 6 s. A second ball thrown vertically downward from the same position with the same speed reaches the ground in 1.5 s. A third ball released, from the rest from the same location, will reach the ground in ________ s.

8. A ball of mass 100 g is dropped from a height h = 10 cm on a platform fixed at the top of vertical spring (as shown in figure). The ball stays on the platform and the platform is depressed by a distance $\frac{h}{2}$. The spring constant is ________ Nm^{-1}. (Use $g = 10\ ms^{-2}$)



9. In a potentiometer arrangement, a cell gives a balancing point at 75 cm length of wire. This cell is now replaced by another cell of unknown emf. If the ratio of the emf's of two cells respectively is 3 : 2, the difference in the balancing length of the potentiometer wire in above two cases will be ______ cm.

10. A metre scale is balanced on a knife edge at its centre. When two coins, each of mass 10 g are put one on the top of the other at the 10.0 cm mark the scale is found to be balanced at 40.0 cm mark. The mass of the metre scale is found to be $x \times 10^{-2}$ kg. The value of x is

CHEMISTRY

SECTION-A

1. If a rocket runs on a fuel ($C_{15}H_{30}$) and liquid oxygen, the weight of oxygen required and CO_2 released for every litre of fuel respectively are: (Given: density of the fuel is 0.756 g/mL)

(A) 1188 g and 1296 g

(B) 2376 g and 2592 g

(C) 2592g and 2376 g

(D) 3429 g and 3142 g

2. Consider the following pairs of electrons

(A) (a) $n = 3,\ 1 = 1,\ m_1 = 1,\ m_s = +\frac{1}{2}$

(b) $n = 3,\ 1 = 2,\ m_1 = 1,\ m_s = +\frac{1}{2}$

(B) (a) $n = 3,\ 1 = 2,\ m_1 = -2,\ m_s = -\frac{1}{2}$

(b) $n = 3,\ 1 = 2,\ m_1 = -1,\ m_s = -\frac{1}{2}$

(C) (a) $n = 4,\ 1 = 2,\ m_1 = 2,\ m_s = +\frac{1}{2}$

(b) $n = 3,\ 1 = 2,\ m_1 = 2,\ m_s = +\frac{1}{2}$

The pairs of electron present in degenerate orbitals is/are:

(A) Only A (B) Only B

(C) Only C (D) (B) and (C)

3. Match List – I with List - II

List – I		List – II	
(A)	$[PtCl_4]^{2-}$	**(I)**	sp^3d
(B)	BrF_5	**(II)**	d^2sp^3
(C)	PCl_5	**(III)**	dsp^2
(D)	$[Co(NH_3)_6]^{3+}$	**(IV)**	sp^3d^2

(A) (A)→(II), (B)→(IV), (C)→(I), (D)→(III)

(B) (A)→(III), (B)→(IV), (C)→(I), (D)→(II)

(C) (A)→(III), (B)→(I), (C)→(IV), (D)→(II)

(D) (A)→(II), (B)→(I), (C)→(IV), (D)→(III)

4. For a reaction at equilibrium

$$A(g) \rightleftharpoons B(g) + \frac{1}{2}C(g)$$

the relation between dissociation constant (K), degree of dissociation (α) and equilibrium pressure (p) is given by :

(A) $K = \dfrac{\alpha^{\frac{1}{2}} p^{\frac{3}{2}}}{\left(1+\frac{3}{2}\alpha\right)^{\frac{1}{2}}(1-\alpha)}$

(B) $K = \dfrac{\alpha^{\frac{3}{2}} p^{\frac{1}{2}}}{(2+\alpha)^{\frac{1}{2}}(1-\alpha)}$

(C) $K = \dfrac{(\alpha p)^{\frac{3}{2}}}{\left(1+\frac{3}{2}\alpha\right)^{\frac{1}{2}}(1-\alpha)}$

(D) $K = \dfrac{(\alpha p)^{\frac{3}{2}}}{(1+\alpha)(1-\alpha)^{\frac{1}{2}}}$

5. Given below are two statements :

Statement I : Emulsions of oil in water are unstable and sometimes they separate into two layers on standing.

Statement II :For stabilisation of an emulsion, excess of electrolyte is added.

In the light of the above statements, choose the most appropriate answer from the options given below :

(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect.

(C) Statement I is correct but Statement II is incorrect.

(D) Statement I is incorrect but Statement II is correct.

6. Given below are the oxides:

Na_2O, As_2O_3, N_2O, NO and Cl_2O_7

Number of amphoteric oxides is:

(A) 0 (B) 1

(C) 2 (D) 3

7. Match List – I with List – II

	List - I		List - II
(A)	Sphalerite	(I)	$FeCO_3$
(B)	Calamine	(II)	PbS
(C)	Galena	(III)	$ZnCO_3$
(D)	Siderite	(IV)	ZnS

Choose the most appropriate answer from the options given below:

(A) (A) - (IV), (B) – (III), (C) – (II), (D) – (I)

(B) (A) - (IV), (B) – (I), (C) – (II), (D) – (III)

(C) (A) - (II), (B) – (III), (C) – (I), (D) – (IV)

(D) (A) - (III), (B) – (IV), (C) – (II), (D) – (I)

8. The highest industrial consumption of molecular hydrogen is to produce compounds of element:

(A) Carbon (B) Nitrogen

(C) Oxygen (D) Chlorine

9. Which of the following statements are correct?

(A) Both LiCl and $MgCl_2$ are soluble in ethanol.

(B) The oxides Li_2O and MgO combine with excess of oxygen to give superoxide.

(C) LiF is less soluble in water than other alkali metal fluorides.

(D) Li_2O is more soluble in water than other alkali metal oxides.

Choose the most appropriate answer from the options given below:

(A) (A) and (C) only

(B) (A), (C) and (D) only

(C) (B) and (C) only

(D) (A) and (C) only

10. Identify the correct statement for B_2H_6 from those given below.

(A) In B_2H_6, all B-H bonds are equivalent.

(B) In B_2H_6 there are four 3-centre-2-electron bonds.

(C) B_2H_6 is a Lewis acid.

(D) B_2H_6 can be synthesized form both BF_3 and $NaBH_4$.

(E) B_2H_6 is a planar molecule.

Choose the most appropriate answer from the options given below :

(A) (A) and (E) only

(B) (B), (C) and (E) only

(C) (C) and (D) only

(D) (C) and (E) only

11. The most stable trihalide of nitrogen is:

(A) NF_3 (B) NCl_3

(C) NBr_3 (D) NI_3

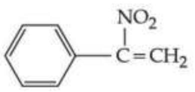
12. Which one of the following elemental forms is not present in the enamel of the teeth?

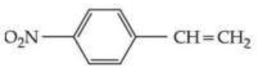
(A) Ca^{2+} (B) P^{3+}

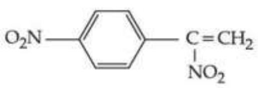
(C) F^- (D) P^{5+}

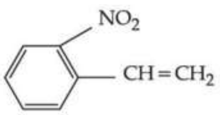
13. In the given reactions sequence, the major product 'C' is :

$$C_8H_{10} \xrightarrow[H_2SO_4]{HNO_3} A \xrightarrow[\Delta]{Br_2} B \xrightarrow[KOH]{\text{alcoholic}} C$$

(A) 

(B) 

(C) 

(D) 

14. Two statements are given below :

Statement I: The melting point of monocarboxylic acid with even number of carbon atoms

is higher than that of with odd number of carbon atoms acid immediately

below and above it in the series.

Statement II : The solubility of monocarboxylic acids in water decreases with increase in molar mass.

Choose the most appropriate option:

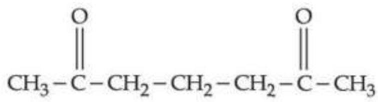
(A) Both Statement I and Statement II are correct.

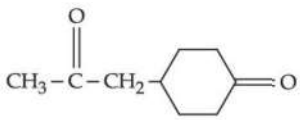
(B) Both Statement I and Statement II are incorrect.

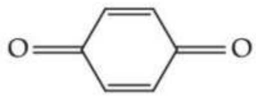
(C) Statement I is correct but Statement II is incorrect.

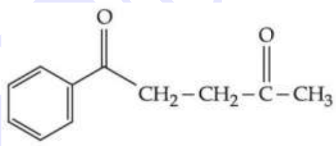
(D) Statement I is incorrect but Statement II is correct.

15. Which of the following is an example of conjugated diketone?

(A) 

(B) 

(C) 

(D) 

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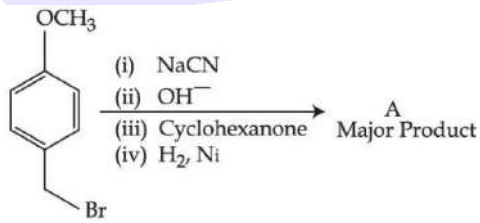
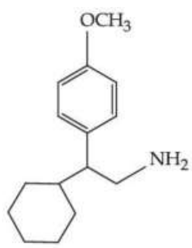
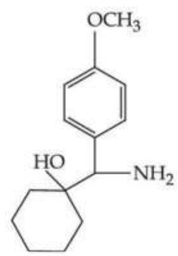
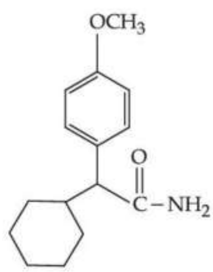
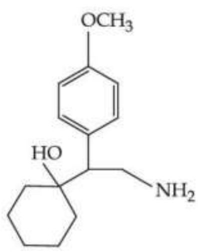


The major product of the above reaction is

(A) 

(B) 

(C) 

(D) 

17. Which of the following is an example of polyester?

(A) Butadiene-styrene copolymer

(B) Melamine polymer

(C) Neoprene

(D) Poly-β-hydroxybutyrate-co-β-hydroxy valerate

18. A polysaccharide 'X' on boiling with dil H_2SO_4 at 393 K under 2-3 atm pressure yields 'Y'.
'Y' on treatment with bromine water gives gluconic acid. 'X' contains β-glycosidic linkages only. Compound 'X' is :
(A) starch (B) cellulose
(C) amylose (D) amylopectin

19. Which of the following is not a broad spectrum antibiotic?
(A) Vancomycin (B) Ampicillin
(C) Ofloxacin (D) Penicillin G

20. During the qualitative analysis of salt with cation y^{2+} , addition of a reagent (X) to alkaline solution of the salt gives a bright red precipitate. The reagent (X) and the cation (y^{2+}) present respectively are:
(A) Dimethylglyoxime and Ni^{2+}
(B) Dimethylglyoxime and Co^{2+}
(C) Nessler's reagent and Hg^{2+}
(D) Nessler's reagent and Ni^{2+}

SECTION-B

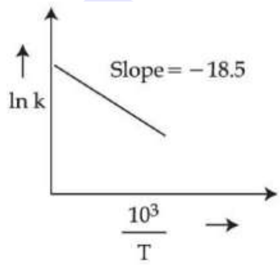
1. Atoms of element X form hcp lattice and those of element Y occupy $\frac{2}{3}$ of its tetrahedral voids. The percentage of element X in the lattice is_________ (Nearest integer)

2. $2O_3(g) \rightleftharpoons 3O_2(g)$
At 300 K, ozone is fifty percent dissociated. The standard free energy change at this temperature and 1 atm pressure is (–) __J mol^{-1} (Nearest integer)
[Given: ln 1.35 = 0.3 and R = 8.3 J K^{-1} mol^{-1}]

3. The osmotic pressure of blood is 7.47 bar at 300 K. To inject glucose to a patient intravenously, it has to be isotonic with blood. The concentration of glucose solution in gL^{-1} is _____ (Molar mass of glucose = 180 g mol^{-1}
R = 0.083 L bar K^{-1} mol^{-1}) (Nearest integer)

4. The cell potential for the following cell
$Pt|H_2(g)|H^+(aq)||Cu^{2+}(0.01M)|Cu(s)$
is 0.576 V at 298 K. The pH of the solution is ___. (Nearest integer)

5. The rate constants for decomposition of acetaldehyde have been measured over the temperature range 700 –1000 K. The data has been analysed by plotting In k vs $\frac{10^3}{T}$ graph.The value of activation energy for the reaction is___ kJ mol^{-1}. (Nearest integer) (Given : R = 8.31 J K^{-1} mol^{-1})

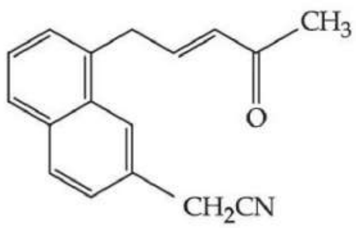


6. The difference in oxidation state of chromium in chromate and dichromate salts is _______

7. In the cobalt-carbonyl complex: $[Co_2(CO)_8]$, number of Co-Co bonds is "X" and terminal CO ligands is "Y". X + Y =____

8. A 0.166 g sample of an organic compound was digested with cone. H_2SO_4 and then distilled with NaOH. The ammonia gas evolved was passed through 50.0 mL of 0.5 N H_2SO_4. The used acid required 30.0 mL of 0.25 N NaOH for complete neutralization. The mass percentage of nitrogen in the organic compound is____.

9. Number of electrophilic centre in the given compound is ____



10. The major product 'A' of the following given reaction has _____ sp^2 hybridized carbon atoms.
2,7 – Dimethyl1 – 2, 6 – octadiene
$\xrightarrow{H^+}$ $\underset{\text{Mojor Product}}{A}$

MATHEMATICS

SECTION-A

1. Let $A=\{z\in C:1\le|z-(1+i)|\le 2\}$ and $B=\{z\in A:|z-(1-i)|=1\}$. Then, B :

(A) is an empty set
(B) contains exactly two elements
(C) contains exactly three elements
(D) is an infinite set

2. The remainder when 3^{2022} is divided by 5 is

(A) 1 (B) 2
(C) 3 (D) 4

3. The surface area of a balloon of spherical shape being inflated, increases at a constant rate. Ifinitially, the radius of balloon is 3 units and after 5 seconds,, it becomes 7 units, then its radius after 9 seconds is :

(A) 9 (B) 10
(C) 11 (D) 12

4. Bag A contains 2 white, 1 black and 3 red balls and bag B contains 3 black, 2 red and n white balls. One bag is chosen at random and 2 balls drawn from it at random, are found to be 1 red and 1 black. If the probability that both balls come from Bag A is $\frac{6}{11}$, then n is equal to _____ .

(A) 13 (B) 6
(C) 4 (D) 3

5. Let $x^2 + y^2 + Ax + By + C = 0$ be a circle passing through (0, 6) and touching the parabola $y = x^2$ at (2, 4). Then A + C is equal to_______ .

(A) 16 (B) 88/5
(C) 72 (D) –8

6. The number of values of α for which the system of equations :

$x + y + z = \alpha$
$\alpha x + 2\alpha y + 3z = -1$
$x + 3\alpha y + 5z = 4$

is inconsistent, is

(A) 0 (B) 1
(C) 2 (D) 3

7. If the sum of the squares of the reciprocals of the roots α and β of the equation $3x^2 + \lambda x - 1 = 0$ is 15, then $6(\alpha^3 + \beta^3)^2$ is equal to :

(A) 18 (B) 24
(C) 36 (D) 96

8. The set of all values of k for which $(\tan^{-1}x)^3+(\cot^{-1}x)^3=k\pi^3, x\in R,$ is the interval :

(A) $\left[\frac{1}{32},\frac{7}{8}\right)$ (B) $\left(\frac{1}{24},\frac{13}{16}\right)$

(C) $\left[\frac{1}{48},\frac{13}{16}\right]$ (D) $\left[\frac{1}{32},\frac{9}{8}\right)$

9. Let $S=\{\sqrt{n}:1\le n\le 50 \text{ and n is odd}\}$

Let $a\in S$ and $A=\begin{bmatrix}1 & 0 & a\\ -1 & 1 & 0\\ -a & 0 & 1\end{bmatrix}$

If $\sum_{a\in S}\det(\text{adj}A)=100\lambda$, then λ is equal to

(A) 218 (B) 221
(C) 663 (D) 1717

10. $f(x) = 4\log_e(x-1) - 2x^2 + 4x + 5$, $x > 1$, which one of the following is NOT correct ?

(A) f is increasing in (1, 2) and decreasing in $(2, \infty)$
(B) f(x)= –1 has exactly two solutions
(C) f'(e) –f'' (2) < 0
(D) f(x) = 0 has a root in the interval (e, e +1)

11. the tangent at the point (x_1, y_1) on the curve $y = x^3 + 3x^2 + 5$ passes through the origin, then (x_1, y_1) does NOT lie on the curve :

(A) $x^2+\frac{y^2}{81}=2$ (B) $\frac{y^2}{9}-x^2=8$

(C) $y=4x^2+5$ (D) $\frac{x}{3}-y^2=2$

12. The sum of absolute maximum and absolute minimum values of the function $f(x) = |2x^2 + 3x - 2| + \sin x \cos x$ in the interval [0, 1] is :

(A) $3 + \frac{\sin(1)\cos^2(1/2)}{2}$

(B) $3 + \frac{1}{2}(1 + 2\cos(1))\sin(1)$

(C) $5 + \frac{1}{2}(\sin(1) + \sin(2))$

(D) $2 + \sin\left(\frac{1}{2}\right)\cos\left(\frac{1}{2}\right)$

13. If $\{a_i\}_{i=1}^{n}$ where n is an even integer , is an arithmetic progression with common difference 1, and $\sum_{i=1}^{n} a_i = 192$, $\sum_{i=1}^{n/2} a_{2i} = 120$, then n is equal to:

(A) 48 (B) 96
(C) 92 (D) 104

14. If $x = x(y)$ is the solution of the differential equation $y\frac{dx}{dy} = 2x + y^3(y+1)e^y, x(1) = 0$; then x(e) is equal to :

(A) $e^3(e^e - 1)$ (B) $e^e(e^3 - 1)$
(C) $e^2(e^e + 1)$ (D) $e^e(e^2 - 1)$

15. Let $\lambda x - 2y = \mu$ be a tangent to the hyperbola $a^2x^2 - y^2 = b^2$. Then $\left(\frac{\lambda}{a}\right)^2 - \left(\frac{\mu}{b}\right)^2$ is equal to:

(A) –2 (B) –4
(C) 2 (D) 4

16. Let $\hat{a}, \hat{b}$ be unit vectors. If $\vec{c}$ be a vector such that the angle between $\hat{a}$ and $\vec{c}$ is $\frac{\pi}{12}$, and $\hat{b} = \vec{c} + 2(\vec{c} \times \hat{a})$, then $|6\vec{c}|^2$ is equal to

(A) $6(3-\sqrt{3})$ (B) $3+\sqrt{3}$
(C) $6(3+\sqrt{3})$ (D) $6(\sqrt{3}+1)$

17. If a random variable X follows the Binomial distribution B (33, p) such that $3P(X = 0) = P(X = 1)$, then the value of $\frac{P(X=15)}{P(X=18)} - \frac{P(X=16)}{P(X=17)}$ is equal to

(A) 1320 (B) 1088
(C) $\frac{120}{1331}$ (D) $\frac{1088}{1089}$

18. The domain of the function

$$f(x) = \frac{\cos^{-1}\left(\frac{x^2 - 5x + 6}{x^2 - 9}\right)}{\log_e(x^2 - 3x + 2)}$$ is

(A) $(-\infty, 1) \cup (2, \infty)$

(B) $(2, \infty)$

(C) $\left[-\frac{1}{2}, 1\right) \cup (2, \infty)$

(D) $\left[-\frac{1}{2}, 1\right) \cup (2, \infty) - \left\{\frac{3+\sqrt{5}}{2}, \frac{3-\sqrt{5}}{2}\right\}$

19. Let

$$S = \left\{\theta \in [-\pi, \pi] - \left\{\pm\frac{\pi}{2}\right\} : \sin\theta\tan\theta + \tan\theta = \sin 2\theta\right\}.$$

If $T = \sum_{\theta \in S} \cos 2\theta$, then $T + n(S)$ is equal

(A) $7+\sqrt{3}$ (B) 9
(C) $8+\sqrt{3}$ (D) 10

20. The number of choices of $\Delta \in \{\wedge, \vee, \Rightarrow, \Leftrightarrow\}$, such that $(p\Delta q) \Rightarrow ((p\Delta \sim q) \vee ((\sim p)\Delta q))$ is a tautology, is

(A) 1 (B) 2
(C) 3 (D) 4

SECTION-B

1. The number of one-one function $f : \{a, b, c, d\} \to \{0, 1, 2, \ldots, 10\}$ such that $2f(a) - f(b) + 3f(c) + f(d) = 0$ is _____ .

2. In an examination, there are 5 multiple choice questions with 3 choices, out of which exactly one is correct There are 3 marks for each correct answer, -2 marks for each wrong answer and 0 mark if the question is not attempted. Then, the number of ways a student appearing in the examination gets 5 marks is_.

3. Let $A\left(\frac{3}{\sqrt{a}},\sqrt{a}\right) a>0$, be a fixed point in the xy-plane. The image of A in y-axis be B and the image of B in x-axis be C. If D(3 cos θ, a sin θ) is a point in the fourth quadrant such that the maximum area of ΔACD is 12 square units, then a is equal to _______ .

4. Let a line having direction ratios 1, -4, 2 intersect the lines $\frac{x-7}{3}=\frac{y-1}{-1}=\frac{z+2}{1}$ and $\frac{x}{2}=\frac{y-7}{3}=\frac{z}{1}$ at the point A and B. Then $(AB)^2$ is equal to ____ .

5. The number of points where the function

$$f(x)=\begin{cases}|2x^2-3x-7| & \text{if} \quad x\le -1\\ [4x^2-1] & \text{if} \quad -1<x<1\\ |x+1|+|x-2| & \text{if} \quad x\ge 1\end{cases}$$

[t] denotes the greatest integer $\le t$, is discontinuous is _______ .

6. Let $f(\theta)=\sin\theta+\int_{-\pi/2}^{\pi/2}(\sin\theta+t\cos\theta)f(t)dt.$

Then the value of $\left|\int_0^{\pi/2} f(\theta)d\theta\right|$ is _______ .

7. Let $\underset{0\le x\le 2}{\text{Max}}\left\{\frac{9-x^2}{5-x}\right\}=\alpha$ and $\underset{0\le x\le 2}{\text{Min}}\left\{\frac{9-x^2}{5-x}\right\}=\beta$

If

$$\int_{\beta-\frac{8}{3}}^{2\alpha-1}\text{Max}\left\{\frac{9-x^2}{5-x},x\right\}dx=\alpha_1+\alpha_2\log_e\left(\frac{8}{15}\right)$$

then $\alpha_1+\alpha_2$ is equal to _______

8. If two tangents drawn from a point (α, β) lying on the ellipse $25x^2 + 4y^2 = 1$ to the parabola $y^2 = 4x$ are such that the slope of one tangent is four times the other, then the value of $(10\alpha+5)^2+(16\beta^2+50)^2$ equals __________

9. Let S be the region bounded by the curves $y = x^3$ and $y^2 = x$. The curve $y = 2|x|$ divides S into two regions of areas R_1 and R_2.

If $\max\{R_1,R_2\}=R_2$, then $\frac{R_2}{R_1}$ is equal to ____ .

10. If the shortest distance between the line

$\vec{r}=\left(-\hat{i}+3\hat{k}\right)+\lambda\left(\hat{i}-a\hat{j}\right)$ and

$\vec{r}=\left(-\hat{j}+2\hat{k}\right)+\mu\left(\hat{i}-\hat{j}+\hat{k}\right)$ is $\sqrt{\frac{2}{3}}$, then the integral value of a is equal to

SET # 02

PHYSICS

SECTION-A

1. Identify the pair of physical quantities that have same dimensions :

(A) velocity gradient and decay constant

(B) wien's constant and Stefan constant

(C)angular frequency and angular momentum

(D) wave number and Avogadro number

2. The distance between Sun and Earth is R. The duration of year if the distance between Sun and Earth becomes 3R will be :

(A) $\sqrt{3}$ years (B) 3 years

(C) 9 years (D) $3\sqrt{3}$ years

3. A stone of mass m, tied to a string is being whirled in a vertical circle with a uniform speed. The tension in the string is :

(A) the same throughout the motion

(B) minimum at the highest position of the circular path

(C) minimum at the lowest position of the circular path

(D) minimum when the rope is in the horizontal position

4. Two identical charged particles each having a mass 10 g and charge 2.0×10^{-7} C area placed on a horizontal table with a separation of L between then such that they stay in limited equilibrium. If the coefficient of friction between each particle and the table is 0.25, find the value of L. [Use g = 10 ms^{-2}]

(A) 12 cm (B) 10 cm

(C) 8 cm (D) 5 cm

5. A Carnot engine take 5000 kcal of heat from a reservoir at 727°C and gives heat to a sink at 127°C. The work done by the engine is :

(A) 3×10^6 J (B) Zero

(C) 12.6×10^6 J (D) 8.4×10^6 J

6. Two massless springs with spring constants 2 k and 2 k, carry 50 g and 100 g masses at their free ends. These two masses oscillate vertically such that their maximum velocities are equal. Then, the ratio of their respective amplitudes will be :

(A) 1 : 2 (B) 3 : 2

(C) 3 : 1 (D) 2 : 3

7. What will be the most suitable combination of three resistors A = 2Ω, B = 4Ω, C = 6 Ω so that $\left(\frac{22}{3}\right)\Omega$ is equivalent resistance of combination?

(A) Parallel combination of A and C connected in series with B.

(B) Parallel combination of A and B connected in series with C.

(C) Series combination of A and C connected in parallel with B.

(D) Series combination of B and C connected in parallel with A.

8. The soft-iron is a suitable material for making an electromagnet. This is because soft-iron has :

(A) low coercively and high retentively

(B) low coercively and low permeability

(C) high permeability and low retentively

(D) high permeability and high retentively

9. A proton, a deuteron and an α-particle with same kinetic energy enter into a uniform magnetic field at right angle to magnetic field. The ratio of the radii of their respective circular paths is :

(A) $1:\sqrt{2}:\sqrt{2}$ (B) $1:1:\sqrt{2}$

(C) $\sqrt{2}:1:1$ (D) $1:\sqrt{2}:1$

10. Given below are two statements :

Statement-I : The reactance of an ac circuit is zero. It is possible that the circuit contains a capacitor and an inductor.

Statement-II : In ac circuit, the average poser delivered by the source never becomes zero.

In the light of the above statements, choose the correct answer from the options given below :

(A) Both Statement I and Statement II are true.

(B) Both Statement I and Statement II are false.

(C) Statement I is true but Statement II in false.

(D) Statement I is false but Statement II is true.

11. Potential energy as a function of r is given by $U = \frac{A}{r^{10}} - \frac{B}{r^5}$, where r is the interatomic distance, A and B are positive constants. The equilibrium distance between the two atoms will be :

(A) $\left(\frac{A}{B}\right)^{\frac{1}{5}}$ (B) $\left(\frac{B}{A}\right)^{\frac{1}{5}}$

(C) $\left(\frac{2A}{B}\right)^{\frac{1}{5}}$ (D) $\left(\frac{B}{2A}\right)^{\frac{1}{5}}$

12. An object of mass 5 kg is thrown vertically upwards from the ground. The air resistance produces a constant retarding force of 10 N throughout the motion. The ratio of time of ascent to the time of descent will be equal to : [Use $g = 10\ ms^{-2}$]

(A) 1 : 1 (B) $\sqrt{2} : \sqrt{3}$

(C) $\sqrt{3} : \sqrt{2}$ (D) 2 : 3

13. A fly wheel is accelerated uniformly from rest and rotates through 5 rad in the first second. The angle rotated by the fly wheel in the next second, will be :

(A) 7.5 rad (B) 15 rad

(C) 20 rad (D) 30 rad

14. A 100 g of iron nail is hit by a 1.5 kg hammer striking at a velocity of 60 ms^{-1}. What will be the rise in the temperature of the nail if one fourth of energy of the hammer goes into heating the nail? [Specific heat capacity of iron = 0.42 $Jg^{-1}\ °C^{-1}$]

(A) 675°C (B) 1600°C

(C) 160.7°C (D) 6.75°C

15. If the charge on a capacitor is increased by 2 C, the energy stored in it increases by 44%. The original charge on the capacitor is (in C):

(A) 10 (B) 20

(C) 30 (D) 40

16. A long cylindrical volume contains a uniformly distributed charge of density ρ. The radius of cylindrical volume is R. A charge particle (q) revolves around the cylinder in a circular path. The kinetic of the particle is :

(A) $\frac{\rho q R^2}{4\varepsilon_0}$ (B) $\frac{\rho q R^2}{2\varepsilon_0}$

(C) $\frac{q\rho}{4\varepsilon_0 R^2}$ (D) $\frac{4\varepsilon_0 R^2}{q\rho}$

17. An electric bulb is rated as 200 W. What will be the peak magnetic field at 4 m distance produced by the radiations coming from this bulb? Consider this bulb as a point source with 3.5% efficiency.

(A) 1.19×10^{-8} T (B) 1.71×10^{-8} T

(C) 0.84×10^{-8} T (D) 3.36×10^{-8} T

18. The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speeds of emitted electrons for the two
frequencies respectivly will be :

(A) 1 : 1 (B) 2 : 1

(C) 4 : 1 (D) 1 : 4

19. Two light beams of intensities in the ratio of 9 : 4 are allowed to interfere. The .ratio of the intensity of maxima and minima will be :

(A) 2 : 3 (B) 16 : 81

(C) 25 : 169 (D) 25 : 1

20. In Bohr's atomic model of hydrogen, let K. P and E are the kinetic energy, potential energy and total energy of the electron respectively. Choose the correct option when the electron undergoes transitions to a higher level :

(A) All K. P and E increase.

(B) K decreases. P and E increase.

(C) P decreases. K and E increase.

(D) K increases. P and E decrease.

SECTION-B

1. A body is projected from the ground at an angle of 45° with the horizontal. Its velocity after 2s is 20 ms^{-1}. The maximum height reached by the body during its motion is _______m. (use $g = 10ms^{-2}$)

2. An antenna is placed in a dielectric medium of dielectric constant 6.25. If the maximum size of that antenna is 5.0 mm. it can radiate a signal of minimum frequency of ______GHz. (Given $\mu_r = 1$ for dielectric medium)

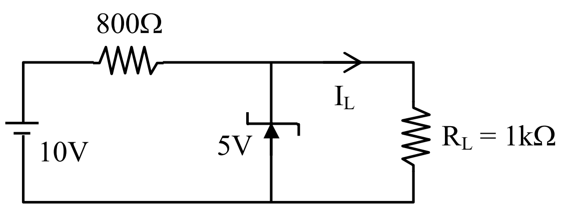
3. A potentiometer wire of length 10 m and resistance 20 Ω is connected in series with a 25 V battery and an external resistance 30 Ω . A cell of emf E in secondary circuit is balanced by 250 cm long potentiometer wire. The value of E (in volt) is $\frac{x}{10}$. The value of x is _______.

4. Two travelling waves of equal amplitudes and equal frequencies move in opposite directions along a string. They interfere to produce a stationary wave whose equation is given by

$$y = (10 \cos \pi x \sin \frac{2\pi t}{T})\ \text{cm}$$

The amplitude of the particle at $x = \frac{4}{3}$ cm will be _______ cm.

5. In the given circuit- the value of current I_L will be ______ mA.
(When $R_L = 1k\Omega$)



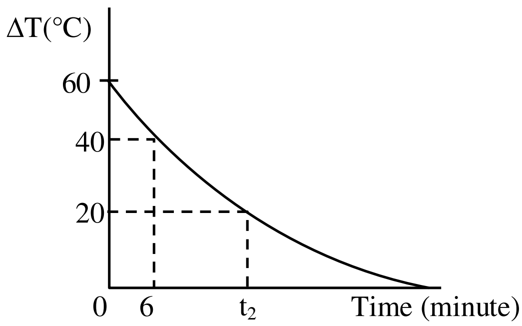
6. A sample contains 10^{-2} kg each of two substances A and B with half lives 4 s and 8 s respectively. The ratio of then atomic weights is 1 : 2. The ratio of the amounts of A and B after 16 s is $\frac{x}{100}$. the value of x is _______.

7. A ray of ligh is incident at an angle of incidence 60° on the glass slab of refractive index $\sqrt{3}$. After refraction, the light ray emerges out from other parallel faces and lateral shift between incident ray and emergent ray is $4\sqrt{3}$ cm. The thickness of the glass slab is _______ cm.

8. A circular coil of 1000 turns each with area $1m^2$ is rotated about its vertical diameter at the rate of one revolution per second in a uniform horizontal magnetic field of 0.07T. The maximum voltage generation will be _______V.

9. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be ________R during this transformation.
Where R is the gas constant.

10. In an experment ot verify Newton's law of cooling, a graph is plotted between, the temperature difference (ΔT) of the water and surroundings and time as shown in figure. The initial temperature of water is taken as 80°C. The value of t_2 as mentioned in the graph will be _______.



CHEMISTRY

SECTION-A

1. 120 of an organic compound that contains only carbon and hydrogen gives 330g of CO_2 and 270g of water on complete combustion. The percentage of carbon and hydrogen, respectively are.

(A) 25 and 75 (B) 40 and 60

(C) 60 and 40 (D) 75 and 25

2. The energy of one mole of photons of radiation of wavelength 300 nm is

(Given : $h = 6.63 \times 10^{-34}$ Js,

$N_A = 6.02 \times 10^{23} mol^{-1}$, $c = 3 \times 10^8 ms^{-1}$)

(A) 235 kJ mol^{-1} (B) 325 kJ mol^{-1}

(C) 399 kJ mol^{-1} (D) 435 kJ mol^{-1}

3. The correct order of bound orders of C_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively.

(A) $C_2^{2-} < N_2^{2-} < O_2^{2-}$

(B) $O_2^{2-} < N_2^{2-} < C_2^{2-}$

(C) $C_2^{2-} < O_2^{2-} < N_2^{2-}$

(D) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

4. At 25°C and 1 atm pressure, the enthalpies of combustion are as given below:

Substance	H_2	C (graphite)	$C_2H_6(g)$
$\frac{\Delta_C H^{\ominus}}{kJmol^{-1}}$	–286.0	–394.0	–1560.0

The enthalpy of formation of ethane is

(A) +54.0 kJ mol^{-1} (B) –68.0 kJ mol^{-1}

(C) –86.0 kJ mol^{-1} (D) +97.0 kJ mol^{-1}

5. For a first order reaction, the time required for completion of 90% reaction is 'x' times the half life of the reaction. The value of 'x' is

(Given: ln 10 = 2.303 and log 2 = 0.3010)

(A) 1.12 (B) 2.43

(C) 3.32 (D) 33.31

6. Metals generally melt at very high temperature. Amongst the following, the metal with the highest melting point will be

(A) Hg (B) Ag

(C) Ga (D) Cs

7. Which of the following chemical reactions represents Hall-Heroult Process?

(A) $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$

(B) $2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$

(C) $FeO + CO \rightarrow Fe + CO_2$

(D) $2[Au(CN)_2]^-_{(aq)} + Zn(s) \rightarrow 2Au(s) + [Zn(CN_4)]^{2-}$

8. In the industrial production of which of the following, molecular hydrogen is obtained as a byproduct?

(A) NaOH (B) NaCl

(C) Na metal (D) Na_2CO_3

9. Which one of the following compounds is used as a chemical in certain type of fire extinguishers?

(A) Baking Soda (B) Soda ash

(C) Washing Soda (D) Caustic Soda

10. PCl_5 is well known. but NCl_5 is not. Because.

(A) nitrogen is less reactive than phosphorous.

(B) nitrogen doesn't have d-orbitals in its valence shell.

(C) catenation tendency is weaker in nitrogen than phosphorous.

(D) size of phosphorous is larger than nitrogen.

11. Transition metal complex with highest value of crystal field splitting (Δ_0) will be

(A) $[Cr(H_2O)_6]^{3+}$ (B) $[Mo(H_2O)_6]^{3+}$

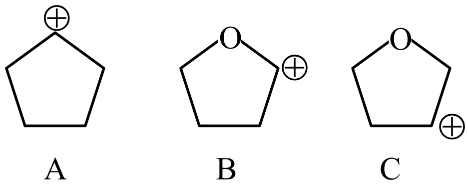
(C) $[Fe(H_2O)_6]^{3+}$ (D) $[Os(H_2O)_6]^{3+}$

12. Some gases are responsible for heating of atmosphere (green house effect). Identify from the following the gaseous species which does not cause it.

(A) CH_4 (B) O_3

(C) H_2O (D) N_2

13. Arrange the following carbocations in decreasing order of stability.



(A) A > C > B (B) A > B > C
(C) C > B > A (D) C > A > B

14. Given below are two statements.

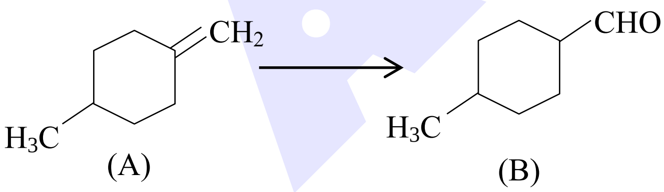
Statement I : The presence of weaker π-bonds make alkenes less stable than alkanes.

Statement II : The strength of the double bond is greater than that of carbon-carbon single bond.

In the light of the above statements, choose the *correct* answer from the options given below.

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

15. Which of the following reagents/ reactions will convert 'A' to 'B'?



(A) PCC oxidation
(B) Ozonolysis
(C) $BH_3, H_2O_2 / {}^{-}OH$ followed by PCC oxidation
(D) HBr, hydrolysis followed by oxidation by $K_2Cr_2O_7$.

16. Hex-4-ene-2-ol on treatment with PCC gives 'A'. 'A' on reaction with sodium hypoiodite gives 'B', which on further heating with soda lime gives 'C'. The compound 'C' is

(A) 2- pentene
(B) proponaldehyde
(C) 2-butene
(D) 4-methylpent-2-ene

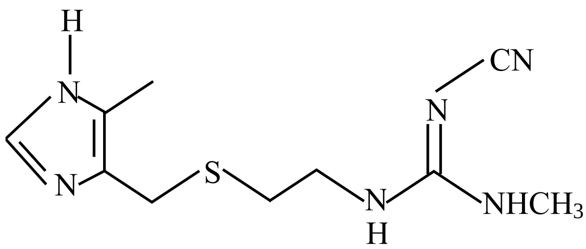
17. The conversion of propan-1-ol to n-butylamine involves the sequential addition of reagents. The correct sequential order of reagents is.

(A) (i) $SOCl_2$ (ii) KCN
(iii) H_2/Ni,Na(Hg)/C_2H_5OH
(B) (i) HCl (ii) H_2/Ni, Na(Hg)/C_2H_5OH
(C) (i) $SOCl_2$ (ii) KCN (iii) CH_3NH_2
(D) (i) HCl (ii) CH_3NH_2

18. Which of the following is **not** an example of a condensation polymer?

(A) Nylon 6,6 (B) Decron
(C) Buna-N (D) Silicone

19. The structure shown below is of which well-known drug molecule?



(A) Ranitidine (B) Seldane
(C) Cimetidine (D) Codeine

20. In the flame test of a mixture of salts, a green flame with blue centre was observed. Which one of the following cations may be present?

(A) Cu^{2+} (B) Sr^{2+}
(C) Ba^{2+} (D) Ca^{2+}

SECTION-B

1. At 300 K, a sample of 3.0 g of gas A occupies the same volume as 0.2 g of hydrogen at 200 K at the same pressure. The molar mass of gas A is____ g mol^{-1} (nearest integer) Assume that the behaviour of gases as ideal. (Given: The molar mass of hydrogen (H_2) gas is 2.0 g mol^{-1})

2. A company dissolves 'X' amount of CO_2 at 298 K in 1 litre of water to prepare soda water X =____ × 10^{-3}g. (nearest integer)
(Given: partial pressure of CO_2 at 298 K= 0.835 bar. Henry's law constant for CO_2 at 298 K = 1.67 kbar. Atomic mass of H,C and O is 1, 12 and 6 g mol^{-1}, respectively)

3. PCl_5 dissociates as

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

5 moles of PCl_5 are placed in a 200 litre vessel which contains 2 moles of N_2 and is maintained at 600 K. The equilibrium pressure is 2.46 atm. The equilibrium constant K_p for the dissociation of PCl_5 is_____ × 10^{-3}. (nearest integer)
(Given: R = 0.082 L atm K^{-1} mol^{-1} : Assume ideal gas behaviour)

4. The resistance of conductivity cell containing 0.01 M KCl solution at 298 K is 1750 Ω. If the conductively of 0.01 M KCl solution at 298 K is 0.152 × 10^{-3} S cm^{-1}, then the cell constant of the conductivity cell is _______× 10^{-3} cm^{-1}.

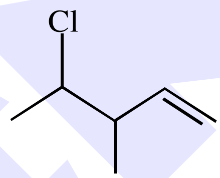
5. When 200 mL of 0.2 M acetic acid is shaken with 0.6 g of wood charcoal, the final concentration of acetic after adsorption is 0.1 M. The mass of acetic acid adsorbed per garm of carbon is_____ g.

6. (a) Baryte, (b) Galena, (c) Zinc blende and (d) Copper pyrites. How many of these minerals are sulphide based?

7. Manganese (VI) has ability to disproportionate in acidic solution. The difference in oxidation states of two ions it forms in acidic solution is______

8. 0.2 g of an organic compound was subjected to estimation of nitrogen by Dumas method in which volume of N_2 evolved (at STP) was found to be 22.400 mL. The percentage of nitrogen in the compound is____.[nearest integer]
(Given: Molar mass of N_2 is 28 mol^{-1}. Molar volume of N_2 at STP : 22.4 L)

9.



$\xrightarrow[H_2O]{NaOH}$ P (Major Product)

Consider the above reaction. The number of π electrons present in the product 'P' is____.

10. In alanylglycylleucylalanylvaline, the number of peptide linkages is______.

MATHEMATICS

SECTION-A

1. Let $x*y = x^2 + y^3$ and $(x*1)*1 = x*(1*1)$.

Then a value of $2\sin^{-1}\left(\frac{x^4+x^2-2}{x^4+x^2+2}\right)$ is

(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{2}$ (D) $\frac{\pi}{6}$

2. The sum of all the real roots of the equation $(e^{2x} - 4)(6e^{2x} - 5e^x + 1) = 0$ is

(A) $\log_e 3$ (B) $-\log_e 3$

(C) $\log_e 6$ (D) $-\log_e 6$

3. Let the system of linear equations

$x + y + \alpha z = 2$

$3x + y + z = 4$

$x + 2z = 1$

have a unique solution (x^*, y^*, z^*). If (α, x^*), (y^*, α) and $(x^*, -y^*)$ are collinear points, then the sum of absolute values of all possible values of α is :

(A) 4 (B) 3

(C) 2 (D) 1

4. Let $x, y > 0$. If $x^3y^2 = 2^{15}$, then the least value of $3x + 2y$ is

(A) 30 (B) 32

(C) 36 (D) 40

5. Let

$$f(x)=\begin{cases}\dfrac{\sin(x-[x])}{x-[x]} & , \quad x\in(-2,-1)\\ \max\{2x,3[|x|]\} & , \quad |x|<1\\ 1 & , \quad \text{otherwise}\end{cases}$$

where $[t]$ denotes greatest integer $\le t$. If m is the number of points where f is not continuous and n is the number of points where f is not differentiable, then the ordered pair (m, n) is :

(A) (3, 3) (B) (2, 4)

(C) (2, 3) (D) (3, 4)

6. The value of the integral

$$\int_{-\pi/2}^{\pi/2}\frac{dx}{(1+e^x)(\sin^6 x+\cos^6 x)}$$ is equal to

(A) 2π (B) 0

(C) π (D) $\dfrac{\pi}{2}$

7. $$\lim_{n\to\infty}\left(\frac{n^2}{(n^2+1)(n+1)}+\frac{n^2}{(n^2+4)(n+2)}+\frac{n^2}{(n^2+9)(n+3)}+\ldots+\frac{n^2}{(n^2+n^2)(n+n)}\right)$$

is equal to

(A) $\dfrac{\pi}{8}+\dfrac{1}{4}\log_e 2$ (B) $\dfrac{\pi}{4}+\dfrac{1}{8}\log_e 2$

(C) $\dfrac{\pi}{4}-\dfrac{1}{8}\log_e 2$ (D) $\dfrac{\pi}{8}+\log_e\sqrt{2}$

8. A particle is moving in the xy-plane along a curve C passing through the point (3, 3). The tangent to the curve C at the point P meets the x-axis at Q. If the y-axis bisects the segment PQ, then C is a parabola with

(A) length of latus rectum 3

(B) length of latus rectum 6

(C) focus $\left(\dfrac{4}{3},0\right)$

(D) focus $\left(0,\dfrac{3}{4}\right)$

9. Let the maximum area of the triangle that can be inscribed in the ellipse $\dfrac{x^2}{a^2}+\dfrac{y^2}{4}=1$, $a > 2$, having one of its vertices at one end of the major axis of the ellipse and one of its sides parallel to the y-axis, be $6\sqrt{3}$. Then the eccentricity of the ellipse is :

(A) $\dfrac{\sqrt{3}}{2}$ (B) $\dfrac{1}{2}$

(C) $\dfrac{1}{\sqrt{2}}$ (D) $\dfrac{\sqrt{3}}{4}$

10. Let the area of the triangle with vertices $A(1, \alpha)$, $B(\alpha, 0)$ and $C(0, \alpha)$ be 4 sq. units. If the point $(\alpha, -\alpha)$, $(-\alpha, \alpha)$ and (α^2, β) are collinear, then β is equal to

(A) 64 (B) –8

(C) –64 (D) 512

11. The number of distinct real roots of the equation $x^7 - 7x - 2 = 0$ is

(A) 5 (B) 7

(C) 1 (D) 3

12. A random variable X has the following probability distribution :

X	0	1	2	3	4
P(X)	k	2k	4k	6k	86

The value of $P(1 < X < 4 \mid X \le 2)$ is equal to :

(A) $\frac{4}{7}$ (B) $\frac{2}{3}$

(C) $\frac{3}{7}$ (D) $\frac{4}{5}$

13. The number of solutions of the equation $\cos\left(x+\frac{\pi}{3}\right)\cos\left(\frac{\pi}{3}-x\right)=\frac{1}{4}\cos^2 2x$,

$x \in [-3\pi, 3\pi]$ is :

(A) 8 (B) 5

(C) 6 (D) 7

14. If the shortest distance between the lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{\lambda}$ and $\frac{x-2}{1}=\frac{y-4}{4}=\frac{z-5}{5}$ is $\frac{1}{\sqrt{3}}$, then the sum of all possible values of λ is :

(A) 16 (B) 6

(C) 12 (D) 15

15. Let the points on the plane P be equidistant from the points (–4, 2, 1) and (2, –2, 3). Then the acute angle between the plane P and the plane $2x + y + 3z = 1$ is

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{4}$

(C) $\frac{\pi}{3}$ (D) $\frac{5\pi}{12}$

16. Let $\hat{a}$ and $\hat{b}$ be two unit vectors such that $\left|\left(\hat{a}+\hat{b}\right)+2\left(\hat{a}\times\hat{b}\right)\right|=2$. If $\theta \in (0, \pi)$ is the angle between $\hat{a}$ and $\hat{b}$, then among the statements :

(S1) : $2\left|\hat{a}\times\hat{b}\right|=\left|\hat{a}-\hat{b}\right|$

(S2) : The projection of $\hat{a}$ on $\left(\hat{a}+\hat{b}\right)$ is $\frac{1}{2}$

(A) Only (S1) is true

(B) Only (S2) is true

(C) Both (S1) and (S2) are true

(D) Both (S1) and (S2) are false

17. If $y = \tan^{-1}(\sec x^3 - \tan x^3)$, $\frac{\pi}{2} < x^3 < \frac{3\pi}{2}$, then

(A) $xy'' + 2y' = 0$

(B) $x^2y'' - 6y + \frac{3\pi}{2} = 0$

(C) $x^2y'' - 6y + 3\pi = 0$

(D) $xy'' - 4y' = 0$

18. Consider the following statements :

A : Rishi is a judge.

B : Rishi is honest.

C : Rishi is not arrogant.

The negation of the statement "if Rishi is a judge and he is not arrogant, then he is honest" is

(A) $B \rightarrow (A \vee C)$

(B) $(\sim B) \wedge (A \wedge C)$

(C) $B \rightarrow ((\sim A) \vee (\sim C))$

(D) $B \rightarrow (A \wedge C)$

19. The slope of normal at any point (x, y), x > 0, y > 0 on the curve y = y(x) is given by $\frac{x^2}{xy - x^2y^2 - 1}$.

If the curve passes through the point (1, 1), then e.y(e) is equal to

(A) $\frac{1-\tan(1)}{1+\tan(1)}$ (B) tan(1)

(C) 1 (D) $\frac{1+\tan(1)}{1-\tan(1)}$

20. Let λ^* be the largest value of λ for which the function $f_\lambda(x) = 4\lambda x^3 - 36\lambda x^2 + 36x + 48$ is increasing for all $x \in \mathbb{R}$.

Then $f_{\lambda^*}(1) + f_{\lambda^*}(-1)$ is equal to :

(A) 36 (B) 48

(C) 64 (D) 72

SECTION-B

1. Let

$S = \{z \in \mathbb{C} : |z-3| \le 1 \text{ and } z(4+3i) + \bar{z}(4-3i) \le 24\}$.

If $\alpha + i\beta$ is the point in S which is closest to 4i, then $25(\alpha + \beta)$ is equal to _____.

2. Let $S = \left\{\begin{pmatrix} -1 & a \\ 0 & b \end{pmatrix}; a, b \in \{1, 2, 3, \ldots 100\}\right\}$ and let $T_n = \{A \in S : A^{n(n+1)} = I\}$. Then the number of elements in $\bigcap_{n=1}^{100} T_n$ is _____.

3. The number of 7-digit numbers which are multiples of 11 and are formed using all the digits 1, 2, 3, 4, 5, 7 and 9 is _____.

4. The sum of all the elements of the set $\{\alpha \in \{1, 2, \ldots, 100\} : \text{HCF}(\alpha, 24) = 1\}$ is _____.

5. The remainder on dividing $1 + 3 + 3^2 + 3^3 + \ldots + 3^{2021}$ by 50 is _____.

6. The area (in sq. units) of the region enclosed between the parabola $y^2 = 2x$ and the line $x + y = 4$ is _____.

7. Let a circle $C : (x - h)^2 + (y - k)^2 = r^2$, $k > 0$, touch the x-axis at (1, 0). If the line $x + y = 0$ intersects the circle C at P and Q such that the length of the chord PQ is 2, then the value of $h + k + r$ is equal to _____.

8. In an examination, there are 10 true-false type questions. Out of 10, a student can guess the answer of 4 questions correctly with probability $\frac{3}{4}$ and the remaining 6 questions correctly with probability $\frac{1}{4}$. If the probability that the student guesses the answers of exactly 8 questions correctly out of 10 is $\frac{27k}{4^{10}}$, then k is equal to _____.

9. Let the hyperbola $H : \frac{x^2}{a^2} - y^2 = 1$ and the ellipse $E : 3x^2 + 4y^2 = 12$ be such that the length of latus rectum of H is equal to the length of latus rectum of E. If e_H and e_E are the eccentricities of H and E respectively, then the value of $12\left(e_H^2 + e_E^2\right)$ is equal to _____.

10. Let P_1 be a parabola with vertex (3, 2) and focus (4, 4) and P_2 be its mirror image with respect to the line $x + 2y = 6$. Then the directrix of P_2 is $x + 2y =$ _____.

SET # 03

PHYSICS
SECTION-A

1. If $Z = \frac{A^2B^3}{C^4}$, then the relative error in Z will be :

(A) $\frac{\Delta A}{A} + \frac{\Delta B}{B} + \frac{\Delta C}{C}$

(B) $\frac{2\Delta A}{A} + \frac{3\Delta B}{B} - \frac{4\Delta C}{C}$

(C) $\frac{2\Delta A}{A} + \frac{3\Delta B}{B} + \frac{4\Delta C}{C}$

(D) $\frac{\Delta A}{A} + \frac{\Delta B}{B} - \frac{\Delta C}{C}$

2. $\vec{A}$ is a vector quantity such that $|\vec{A}|$ = non-zero constant. Which of the following expressions is true for $\vec{A}$?

(A) $\vec{A}.\vec{A} = 0$

(B) $\vec{A} \times \vec{A} < 0$

(C) $\vec{A} \times \vec{A} = 0$

(D) $\vec{A} \times \vec{A} > 0$

3. Which of the following relations is true for two unit vectors $\hat{A}$ and $\hat{B}$ making an angle θ to each other?

(A) $|\hat{A} + \hat{B}| = |\hat{A} - \hat{B}| \tan\frac{\theta}{2}$

(B) $|\hat{A} - \hat{B}| = |\hat{A} + \hat{B}| \tan\frac{\theta}{2}$

(C) $|\hat{A} + \hat{B}| = |\hat{A} - \hat{B}| \cos\frac{\theta}{2}$

(D) $|\hat{A} - \hat{B}| = |\hat{A} + \hat{B}| \cos\frac{\theta}{2}$

4. If force $\vec{F} = 3\hat{i} + 4\hat{j} - 2\hat{k}$ acts on a particle having position vector $2\hat{i} + \hat{j} + 2\hat{k}$ then, the torque about the origin will be :-

(A) $3\hat{i} + 4\hat{j} - 2\hat{k}$ (B) $-10\hat{i} + 10\hat{j} + 5\hat{k}$

(C) $10\hat{i} + 5\hat{j} - 10\hat{k}$ (D) $10\hat{i} + \hat{j} - 5\hat{k}$

5. The height of any point P above the surface of earth is equal to diameter of earth. The value of acceleration due to gravity at point P will be : (Given g = acceleration due to gravity at the surface of earth)

(A) g/2 (B) g/4

(C) g/3 (D) g/9

6. The terminal velocity (v_t) of the spherical rain drop depends on the radius (r) of the spherical rain drop as:-

(A) $r^{1/2}$ (B) r

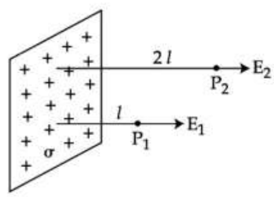
(C) r^2 (D) r^3

7. The relation between root mean square speed (v_{rms}) and most probable speed (v_p) for the molar mass M of oxygen gas molecule at the temperature of 300 K will be :-

(A) $v_{rms} = \sqrt{\frac{2}{3}} v_p$ (B) $v_{rms} = \sqrt{\frac{3}{2}} v_p$

(C) $v_{rms} = v_p$ (D) $v_{rms} = \sqrt{\frac{1}{3}} v_p$

8. In the figure, a very large plane sheet of positive charge is shown. P_1 and P_2 are two points at distance l and $2l$ from the charge distribution. If σ is the surface charge density, then the magnitude of electric fields E_1 and E_2 at P_1 and P_2 respectively are :



(A) $E_1 = \sigma/\varepsilon_0, E_2 = \sigma/2\varepsilon_0$

(B) $E_1 = 2\sigma/\varepsilon_0, E_2 = \sigma/\varepsilon_0$

(C) $E_1 = E_2 = \sigma/2\varepsilon_0$

(D) $E_1 = E_2 = \sigma/\varepsilon_0$

9. Match List-I with List-II

List-I		**List-II**
(A) AC generator	(I)	Detects the presence of current in the circuit
(B) Galvanometer	(II)	Converts mechanical energy into electrical energy
(C) Transformer	(III)	Works on the principle of resonance in AC circuit
(D) Metal detector	(IV)	Changes an alternating voltage for smaller or greater value

Choose the **correct answer** from the options given below :-

(A) (A)–(II), B–(I), (C)–(IV), (D)–(III)

(B) (A)–(II), B–(I), (C)–(III), (D)–(IV)

(C) (A)–(III), B–(IV), (C)–(II), (D)–(I)

(D) (A)–(III), B–(I), (C)–(II), (D)–(IV)

10. A long straight wire with a circular cross-section having radius R, is carrying a steady current I. The current I is uniformly distributed across this cross-section. Then the variation of magnetic field due to current I with distance r (r < R) from its centre will be:-

(A) $B \propto r^2$ (B) $B \propto r$

(C) $B \propto \frac{1}{r^2}$ (D) $B \propto \frac{1}{r}$

11. If wattless current flows in the AC circuit, then the circuit is

(A) Purely Resistive circuit

(B) Purely Inductive circuit

(C) LCR series circuit

(D) RC series circuit only

12. The electric field in an electromagnetic wave is given by $E = 56.5 \sin \omega(t - x/c) NC^{-1}$. Find the intensity of the wave if it is propagating along x-axis in the free space. (Given $\varepsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$)

(A) $5.65\ Wm^{-2}$ (B) $4.24\ Wm^{-2}$

(C) $1.9 \times 10^{-7}\ Wm^{-2}$ (D) $56.5\ Wm^{-2}$

13. The two light beams having intensities I and 9I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\frac{\pi}{2}$ at point P and π at point Q. Then the difference between the resultant intensities at P and Q will be:

(A) 2 I (B) 6 I

(C) 5 I (D) 7 I

14. A light wave travelling linearly in a medium of dielectric constant 4, incident on the horizontal interface separating medium with air. The angle of incidence for which the total intensity of incident wave will be reflected back into the same medium will be (Given : relative permeability of medium $\mu_r = 1$)

(A) 10° (B) 20°

(C) 30° (D) 60°

15. Given below are two statements :-

Statement I : Davisson-Germer experiment establishes the wave nature of electrons.

Statement II : If electrons have wave nature, they can interfere and show diffraction.

In the light of the above statements choose the **correct answer** from the options given below:-

(A) Both **Statement I** and **Statement II** are true

(B) Both **Statement I** and **Statement II** are false

(C) **Statement I** is true but **Statement II** is false

(D) **Statement I** is false but **Statement II** is true

16. The ratio for the speed of the electron in the 3rd orbit of He^+ to the speed of the electron in the 3rd orbit of hydrogen atom will be :-

(A) 1 : 1 (B) 1 : 2

(C) 4 : 1 (D) 2 : 1

17. The photodiode is used to detect the optical signals. These diodes are preferably operated in reverse biased mode because.

(A) fractional change in majority carriers produce higher forward bias current

(B) fractional change in majority carriers produce higher reverse bias current

(C) fractional change in minority carriers produce higher forward bias current

(D) fractional change in minority carriers produce higher reverse bias current

18. A signal of 100 THz frequency can be transmitted with maximum efficiency by :

(A) Coaxial cable

(B) Optical fibre

(C) Twisted pair of copper wires

(D) Water

19. The difference of speed of light in the two media A and B ($v_A - v_B$) is 2.6×10^7 m/s. If the refractive index of medium B is 1.47, then the ratio of refractive index of medium B to medium A is : (Given : speed of light in vacuum $c = 3 \times 10^8$ ms^{-1})

(A) 1.303 (B) 1.318

(C) 1.13 (D) 0.12

20. A teacher in his physics laboratory allotted an experiment to determine the resistance (G) of a galvanometer. Students took the observations for $\frac{1}{3}$ deflection in the galvanometer. Which of the below is **true** for measuring value of G?

(A) $\frac{1}{3}$ deflection method cannot be used for determining the resistance of the galvanometer.

(B) $\frac{1}{3}$ deflection method can be used and in this case the G equals to twice the value of shunt resistance(s).

(C) $\frac{1}{3}$ deflection method can be used and in this case, the G equals to three times the value of shunt resistance(s)

(D) $\frac{1}{3}$ deflection method can be used and in this case the G value equals to the shunt resistance(s).

SECTION-B

1. A uniform chain of 6 m length is placed on a table such that a part of its length is hanging over the edge of the table. The system is at rest. The co-efficient of static friction between the chain and the surface of the table is 0.5, the maximum length of the chain hanging from the table is __________m.

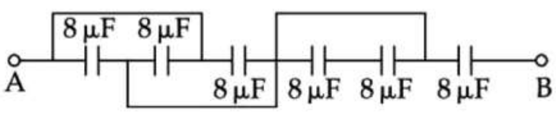
2. A 0.5 kg block moving at a speed of 12 ms^{-1} compresses a spring through a distance 30 cm when its speed is halved. The spring constant of the spring will be ___________ Nm^{-1}.

3. The velocity of upper layer of water in a river is 36 kmh^{-1}. Shearing stress between horizontal layers of water is 10^{-3} Nm^{-2}. Depth of the river is __________m. (Co-efficiency of viscosity of water is 10^{-2} Pa.s)

4. A steam engine intakes 50g of steam at 100°C per minute and cools it down to 20°C. If latent heat of vaporization of steam is 540 cal g^{-1}, then the heat rejected by the steam engine per minute is ______ $\times 10^3$ cal.

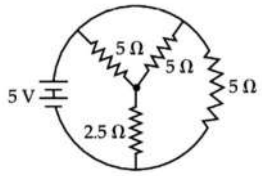
5. The first overtone frequency of an open organ pipe is equal to the fundamental frequency of a closed organ pipe. If the length of the closed organ pipe is 20 cm. The length of the open organ pipe is _____ cm.

6. The equivalent capacitance between points A and B in below shown figure will be _____μF.



7. A resistor develops 300 J of thermal energy in 15s, when a current of 2A is passed through it. If the current increases to 3A, the energy developed in 10s is _________ J.

8. The total current supplied to the circuit as shown in figure by the 5V battery is __________A



9. The current in a coil of self-inductance 2.0 H is increasing according to I = 2sin(t^2)A. The amount of energy spent during the period when current changes from 0 to 2A is _______ J.

10. A force on an object of mass 100g is $(10\hat{i}+5\hat{j})$ N. The position of that object at t = 2s is $(a\hat{i}+b\hat{j})$ m after starting from rest. The value of $\frac{a}{b}$ will be __________.

CHEMISTRY

SECTION-A

1. Bonding in which of the following diatomic molecule(s) become(s) stronger, on the basis of MO Theory, by removal of an electron ?

(A) NO
(B) N_2
(C) O_2
(D) C_2
(E) B_2

Choose the most appropriate answer from the options given below :-

(A) (A), (B), (C) only
(B) (B), (C), (E) only
(C) (A), (C) only
(D) (D) only

2. Incorrect statement for Tyndall effect is :-

(A) The refractive indices of the dispersed phase and the dispersion medium differ greatly in magnitude.
(B) The diameter of the dispersed particles is much smaller than the wavelength of the light used.
(C) During projection of movies in the cinemas hall, Tyndall effect is noticed.
(D) It is used to distinguish a true solution from a colloidal solution.

3. The pair, in which ions are isoelectronic with Al^{3+} is :-

(A) Br^- and Be^{2+}
(B) Cl^- and Li^+
(C) S^{2-} and K^+
(D) O^{2-} and Mg^{2+}

4. Leaching of gold with dilute aqueous solution of NaCN in presence of oxygen gives complex [A], which on reaction with zinc forms the elemental gold and another complex [B]. [A] and [B], respectively are :-

(A) $[Au(CN)_4]^-$ and $[Zn(CN)_2(OH)_2]^{2-}$
(B) $[Au(CN)_2]^-$ and $[Zn(OH)_4]^{2-}$
(C) $[Au(CN)_2]^-$ and $[Zn(CN)_4]^{2-}$
(D) $[Au(CN)_4]^{2-}$ and $[Zn(CN)_6]^{4-}$

5. Number of electron deficient molecules among the following

PH_3, B_2H_6, CCl_4, NH_3, LiH and BCl_3 is

(A) 0
(B) 1
(C) 2
(D) 3

6. Which one of the following alkaline earth metal ions has the highest ionic mobility in its aqueous solution?

(A) Be^{2+}
(B) Mg^{2+}
(C) Ca^{2+}
(D) Sr^{2+}

7. White precipitate of AgCl dissolves in aqueous ammonia solution due to formation of :

(A) $[Ag(NH_3)_4]Cl_2$
(B) $[Ag(Cl)_2(NH_3)_2]$
(C) $[Ag(NH_3)_2]Cl$
(D) $[Ag(NH_3)Cl]Cl$

8. Cerium (IV) has a noble gas configuration. Which of the following is correct statement about it?

(A) It will not prefer to undergo redox reactions.
(B) It will prefer to gain electron and act as an oxidizing agent
(C) It will prefer to give away an electron and behave as reducing agent
(D) It acts as both, oxidizing and reducing agent.

9. Among the following, which is the strongest oxidizing agent ?

(A) Mn^{3+} (B) Fe^{3+}

(C) Ti^{3+} (D) Cr^{3+}

10. The eutrophication of water body results in :

(A) loss of Biodiversity

(B) breakdown of organic matter

(C) increase in biodiversity

(D) decrease in BOD.

11. Phenol on reaction with dilute nitric acid, gives two products. Which method will be most effective for large scale separation ?

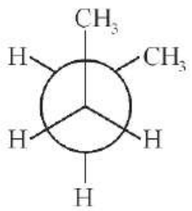
(A) Chromatographic separation

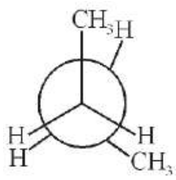
(B) Fractional Crystallisation

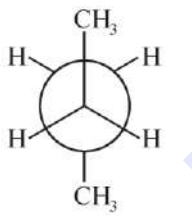
(C) Steam distillation

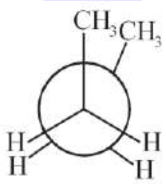
(D) Sublimation

12. In the following structures, which one is having staggered conformation with maximum dihedral angle?

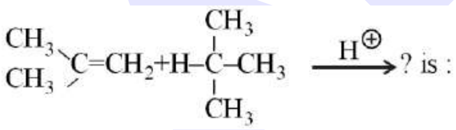
(A) 

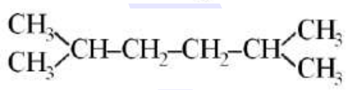
(B) 

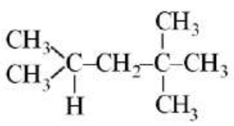
(C) 

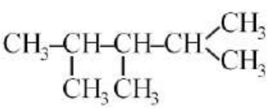
(D) 

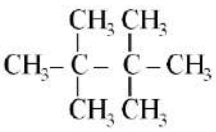
13. The products formed in the following reaction.



(A) 

(B) 

(C) 

(D) 

14. The IUPAC name of ethylidene chloride is :-

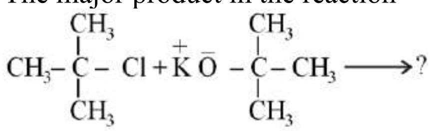
(A) 1-Chloroethene

(B) 1-Chloroethyne

(C) 1,2-Dichloroethane

(D) 1,1-Dichloroethane

15. The major product in the reaction



is

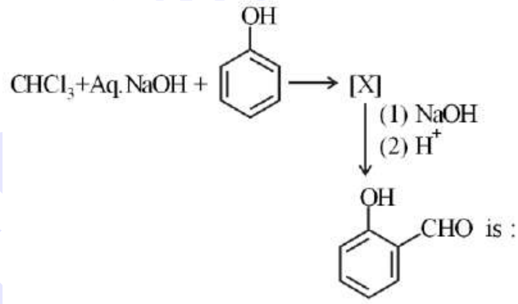
(A) t-Butyl ethyl ether

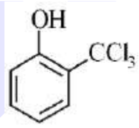
(B) 2,2-Dimethyl butane

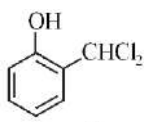
(C) 2-Methyl pent-1-ene

(D) 2-Methyl prop-1-ene

16. The intermediate X, in the reaction



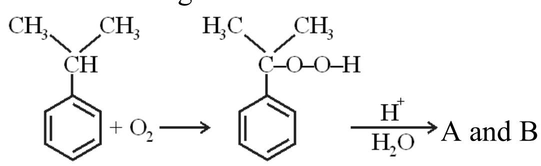
(A) 

(B) 

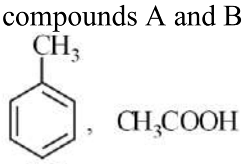
(C) 

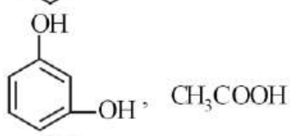
(D) 

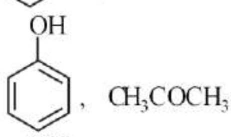
17. In the following reaction :

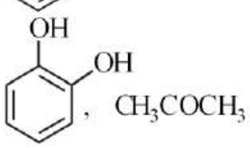


The compounds A and B respectively are :-

(A) 

(B) 

(C) 

(D) 

18. The reaction of $R-\underset{\underset{O}{\|}}{C}-NH_2$ with bromine and KOH gives RNH_2 as the end product. Which one of the following is the intermediate product formed in this reaction ?

(A) $R-\underset{\underset{O}{\|}}{C}-NH-Br$ (B) $R-NH-Br$

(C) $R-N=C=O$ (D) $R-\underset{\underset{O}{\|}}{C}-NBr_2$

19. Using very little soap while washing clothes, does not serve the purpose of cleaning of clothes because

(A) soap particles remain floating in water as ions

(B) the hydrophobic part of soap is not able to take away grease

(C) the micelles are not formed due to concentration of soap, below its CMC value

(D) colloidal structure of soap in water is completely disturbed.

20. Which one of the following is an example of artificial sweetner ?

(A) Bithional   (B) Alitame

(C) Salvarsan   (D) Lactose

SECTION-B

1. The number of N atoms is 681 g of $C_7H_5N_3O_6$ is $x \times 10^{21}$. The value of x is _____ ($N_A = 6.02 \times 10^{23}$ mol^{-1}) (Nearest Integer)

2. The distance between Na^+ and Cl^- ions in solid NaCl of density 43.1 g cm^{-3} is ________ $\times 10^{-10}$m. (Nearest Integer)

(Given : $N_A = 6.02 \times 10^{23}$ mol^{-1})

3. The longest wavelength of light that can be used for the ionisation of lithium atom (Li) in its ground state is $x \times 10^{-8}$ m. The value of x is ____________. (Nearest Integer)

(Given : Energy of the electron in the first shell of the hydrogen atom is -2.2×10^{-18} J; $h = 6.63 \times 10^{-34}$ Js and $c = 3 \times 10^8$ ms^{-1})

4. The standard entropy change for the reaction $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ is -550 JK^{-1} at 298 K.

[Given : The standard enthalpy change for the reaction is -165 kJ mol^{-1}]. The temperature in K at which the reaction attains equilibrium is _________. (Nearest Integer)

5. 1 L aqueous solution of H_2SO_4 contains 0.02 m mol H_2SO_4. 50% of this solution is diluted with deionized water to give 1 L solution (A). In solution (A), 0.01 m mol of H_2SO_4 are added. Total m mols of H_2SO_4 in the final solution is ___________ $\times 10^3$ m mols.

6. The standard free energy change ($\Delta G°$) for 50% dissociation of N_2O_4 into NO_2 at 27°C and 1 atm pressure is $-x$ J mol^{-1}. The value of x is _________. (Nearest Integer)

[Given : $R = 8.31$ J K^{-1} mol^{-1},

log 1.33 = 0.1239 ln 10 = 2.3]

7. In a cell, the following reactions take place

$Fe^{2+} \rightarrow Fe^{3+} e^-$ $E^o_{Fe^{3+}/Fe^{2+}} = 0.77$ V

$2I^- \rightarrow I_2 + 2e^-$ $E^o_{I_2/I^-} = 0.54$ V

The standard electrode potential for the spontaneous reaction in the cell is $x \times 10^{-2}$V 298 K. The value of x is __________ (Nearest Integer)

8. For a given chemical reaction

$$\gamma_1 A + \gamma_2 B \rightarrow \gamma_3 C + \gamma_4 D$$

Concentration of C changes from 10 mmol dm^{-3} to 20 mmol dm^{-3} in 10 seconds. Rate of appearance of D is 1.5 times the rate of disappearance of B which is twice the rate of disappearance A. The rate of appearance of D has been experimentally determined to be 9 mmol dm^{-3} s^{-1}. Therefore the rate of reaction is________mmol dm^{-3} s^{-1}. (Nearest Integer)

9. If $[Cu(H_2O)_4]^{2+}$ absorbs a light of wavelength 600 nm for d–d transition, then the value of octahedral crystal field splitting energy for $[Cu(H_2O)_6]^{2+}$ will be__________ $\times 10^{-21}$ J. (Nearest Integer)
(Given : $h = 6.63 \times 10^{-34}$ Js
and $c = 3.08 \times 10^8$ ms^{-1})

10. Number of grams of bromine that will completely react with 5.0g of pent-1-ene is _______ $\times 10^{-2}$g. (Atomic mass of Br = 80 g/mol) [Nearest Integer]

MATHEMATICS
SECTION-A

1. Let a circle C touch the lines
$L_1 : 4x - 3y + K_1 = 0$ and
$L_2 : 4x - 3y + K_2 = 0$,
$K_1, K_2 \in R$. If a line passing through the centre of the circle C intersects L_1 at $(-1, 2)$ and L_2 at $(3, -6)$, then the equation of the circle C is
(A) $(x - 1)^2 + (y - 2)^2 = 4$
(B) $(x + 1)^2 + (y - 2)^2 = 4$
(C) $(x - 1)^2 + (y + 2)^2 = 16$
(D) $(x - 1)^2 + (y - 2)^2 = 16$

2. The value of $\int_0^{\pi} \frac{e^{\cos x} \sin x}{(1+\cos^2 x)(e^{\cos x} + e^{-\cos x})} dx$ is equal to
(A) $\frac{\pi^2}{4}$
(B) $\frac{\pi^2}{2}$
(C) $\frac{\pi}{4}$
(D) $\frac{\pi}{2}$

3. Let a, b and c be the length of sides of a triangle ABC such that $\frac{a+b}{7} = \frac{b+c}{8} = \frac{c+a}{9}$.
If r and R are the radius of incircle and radius of circumcircle of the triangle ABC, respectively, then the value of $\frac{R}{r}$ is equal to
(A) $\frac{5}{2}$
(B) 2
(C) $\frac{3}{2}$
(D) 1

4. Let $f : N \to R$ be a function such that $f(x+y)=2f(x)f(y)$ for natural numbers x and y. If $f(1) = 2$, then the value of α for which

$$\sum_{k=1}^{10} f(\alpha + k) = \frac{512}{3}(2^{20} - 1)$$

holds, is
(A) 2
(B) 3
(C) 4
(D) 6

5. Let A be a 3×3 real matrix such that
$A\begin{pmatrix}1\\1\\0\end{pmatrix} = \begin{pmatrix}1\\1\\0\end{pmatrix}; A\begin{pmatrix}1\\0\\1\end{pmatrix} = \begin{pmatrix}-1\\0\\1\end{pmatrix}$ and $A\begin{pmatrix}0\\0\\1\end{pmatrix} = \begin{pmatrix}1\\1\\2\end{pmatrix}$.
If $X = (x_1, x_2, x_3)^T$ and I is an identity matrix of order 3, then the system

$(A - 2I)X = \begin{pmatrix}4\\1\\1\end{pmatrix}$ has

(A) no solution
(B) infinitely many solutions
(C) unique solution
(D) exactly two solutions

6. Let $f : R \to R$ be defined as
$f(x) = x^3 + x - 5$.
If g (x) is a function such that $f(g(x)) = x$, $\forall x \in R$, then $g'(63)$ is equal to ______.
(A) $\frac{1}{49}$
(B) $\frac{3}{49}$
(C) $\frac{43}{49}$
(D) $\frac{91}{49}$

7. Consider the following two propositions:
P1 : $\sim(p \to \sim q)$
P2 : $(p \wedge \sim q)((\sim p) \wedge q)$
If the proposition $p \to ((\sim p) \wedge q)$ is evaluated as FALSE, then:
(A) P1 is TRUE and P2 is FALSE
(B) P1 is FALSE and P2 is TRUE
(C) Both P1 and P2 are FALSE
(D) Both P1 and P2 are TRUE

8. If $\frac{1}{2 \cdot 3^{10}} + \frac{1}{2^2 \cdot 3^9} + \ldots \frac{1}{2^{10} \cdot 3} = \frac{K}{2^{10} \cdot 3^{10}}$, then the remainder when K is divided by 6 is
(A) 1
(B) 2
(C) 3
(D) 5

9. Let f (x) be a polynomial function such that $f(x) + f'(x) + f''(x) = x^5 + 64$. Then, the value of $\lim_{x\to 1}\frac{f(x)}{x-1}$

(A) – 15 (B) – 60
(C) 60 (D) 15

10. Let E_1 and E_2 be two events such that the conditional probabilities $P(E_1|E_2)=\frac{1}{2}$, $P(E_2|E_1)=\frac{3}{4}$ and $P(E_1\cap E_2)=\frac{1}{8}$. Then:

(A) $P(E_1\cap E_2)=P(E_1)\cdot P(E_2)$
(B) $P(E'_1\cap E'_2)=P(E'_1)\cdot P(E_2)$
(C) $P(E_1\cap E'_2)=P(E_1)\cdot P(E_2)$
(D) $P(E'_1\cap E_2)=P(E_1)\cdot P(E_2)$

11. Let A = $\begin{bmatrix}0 & -2\\ 2 & 0\end{bmatrix}$. If M and N are two matrices given by M = $\sum_{k=1}^{10}A^{2k}$ and $N=\sum_{k=1}^{10}A^{2k-1}$ then MN^2 is

(A) a non-identity symmetric matrix
(B) a skew-symmetric matrix
(C) neither symmetric nor skew-symmetric matrix
(D) an identify matrix

12. Let g : $(0, \infty) \to R$ be a differentiable function such that

$$\int\left(\frac{x(\cos x-\sin x)}{e^x+1}+\frac{g(x)(e^x+1-xe^x)}{(e^x+1)^2}\right)dx=\frac{xg(x)}{e^x+1}+c$$
,

for all x > 0, where c is an arbitrary constant. Then.

(A) g is decreasing in $\left(0,\frac{\pi}{4}\right)$

(B) g' is increasing in $\left(0,\frac{\pi}{4}\right)$

(C) g + g' is increasing in $\left(0,\frac{\pi}{2}\right)$

(D) g – g' is increasing in $\left(0,\frac{\pi}{2}\right)$

13. Let f : R → R and g : R → R be two functions defined by $f(x) = \log_e(x^2 + 1) - e^{-x} + 1$ and $g(x)=\frac{1-2e^{2x}}{e^x}$. Then, for which of the following range of α, the inequality $f\left(g\left(\frac{(\alpha-1)^2}{3}\right)\right)>f\left(g\left(\alpha-\frac{5}{3}\right)\right)$ holds?

(A) (2, 3) (B) (–2, – 1)
(C) (1, 2) (D) (–1, 1)

14. Let $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$, $a_i > 0$, i = 1, 2, 3 be a vector which makes equal angles with the coordinates axes OX, OY and OZ. Also, let the projection of $\vec{a}$ on the vector $3\hat{i}+4\hat{j}$ be 7. Let $\vec{b}$ be a vector obtained by rotating $\vec{a}$ with 90°. If $\vec{a}, \vec{b}$ and x-axis are coplanar, then projection of a vector $\vec{b}$ on $3\hat{i}+4\hat{j}$ is equal to

(A) $\sqrt{7}$ (B) $\sqrt{2}$
(C) 2 (D) 7

15. Let y = y(x) be the solution of the differential equation $(x + 1)y' - y = e^{3x}(x + 1)^2$, with $y(0) = \frac{1}{3}$. Then, the point $x = -\frac{4}{3}$ for the curve y = y(x) is:

(A) not a critical point
(B) a point of local minima
(C) a point of local maxima
(D) a point of inflection

16. If $y = m_1x + c_1$ and $y = m_2x + c_2$, $m_1 \neq m_2$ are two common tangents of circle $x^2 + y^2 = 2$ and parabola $y^2 = x$, then the value of $8|m_1m_2|$ is equal to

(A) $3+4\sqrt{2}$ (B) $-5+6\sqrt{2}$
(C) $-4+3\sqrt{2}$ (D) $7+6\sqrt{2}$

17. Let Q be the mirror image of the point P(1, 0, 1) with respect to the plane S : x + y + z = 5. If a line L passing through (1, –1, –1), parallel to the line PQ meets the plane S at R, then QR^2 is equal to:

(A) 2 (B) 5
(C) 7 (D) 11

18. If the solution curve y = y(x) of the differential equation $y^2dx + (x^2 - xy + y^2)dy = 0$, which passes through the point (1, 1) and intersects the line $y = \sqrt{3}x$ at the point $(\alpha, \sqrt{3}\alpha)$, then value of $\log_e(\sqrt{3}\alpha)$ is equal to

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{2}$
(C) $\frac{\pi}{12}$ (D) $\frac{\pi}{6}$

19. Let x = 2t, $y = \frac{t^2}{3}$ be a conic. Let S be the focus and B be the point on the axis of the conic such that SA ⊥ BA, where A is any point on the conic. If k is the ordinate of the centroid of ΔSAB, then $\lim_{t\to 1} k$ is equal to

(A) $\frac{17}{18}$ (B) $\frac{19}{18}$
(C) $\frac{11}{18}$ (D) $\frac{13}{18}$

20. Let a circle C in complex plane pass through the points $z_1 = 3 + 4i$, $z_2 = 4 + 3i$ and $z_3 = 5i$. If $z(\neq z_1)$ is a point on C such that the line through z and z_1 is perpendicular to the line through z_2 and z_3, then arg(z) is equal to :

(A) $\tan^{-1}\left(\frac{2}{\sqrt{5}}\right) - \pi$ (B) $\tan^{-1}\left(\frac{24}{7}\right) - \pi$
(C) $\tan^{-1}(3) - \pi$ (D) $\tan^{-1}\left(\frac{3}{4}\right) - \pi$

SECTION-B

1. Let C_r denote the binomial coefficient of x^r in the expansion of $(1 + x)^{10}$. If α, β ∈ R. $C_1 + 3\cdot2C_2 + 5\cdot3C_3 + ...$ upto 10 terms

$$= \frac{\alpha \times 2^{11}}{2^\beta - 1}\left(C_0 + \frac{C_1}{2} + \frac{C_2}{3} + ...\text{upto 10 terms}\right)$$

then the value of α + β is equal to

2. The number of 3-digit odd numbers, whose sum of digits is a multiple of 7, is ______.

3. Let θ be the angle between the vectors $\vec{a}$ and $\vec{b}$, where $|\vec{a}| = 4$, $|\vec{b}| = 3$ $\theta \in \left(\frac{\pi}{4}, \frac{\pi}{3}\right)$.

Then

$\left|\left(\vec{a} - \vec{b}\right) \times \left(\vec{a} + \vec{b}\right)\right|^2 + 4\left(\vec{a}\cdot\vec{b}\right)^2$ is equal to ____

4. Let the abscissae of the two points P and Q be the roots of $2x^2 - rx + p = 0$ and the ordinates of P and Q be the roots of $x^2 - sx - q = 0$. If the equation of the circle described on PQ as diameter is $2(x^2 + y^2) - 11x - 14y - 22 = 0$, then $2r + s - 2q + p$ is equal to

5. The number of values of x in the interval $\left(\frac{\pi}{4}, \frac{7\pi}{4}\right)$ for which $14\text{cosec}^2x - 2\sin^2x = 21 - 4\cos^2x$ holds, is ________

6. For a natural number n, let $a_n = 19^n - 12^n$. Then, the value of $\frac{31\alpha_9 - \alpha_{10}}{57\alpha_8}$ is

7. Let f : R → R be a function defined by $f(x) = \left(2\left(1 - \frac{x^{25}}{2}\right)\left(2 + x^{25}\right)\right)^{\frac{1}{50}}$. If the function $g(x) = f(f(f(x))) + f(f(x))$, the the greatest integer less than or equal to g (1) is ______

8. Let the lines

$L_1 : \vec{r} = \lambda(\hat{i} + 2\hat{j} + 3\hat{k}),\ \lambda \in R$

$L_2 : \vec{r} = (\hat{i} + 3\hat{j} + \hat{k}) + \mu(\hat{i} + \hat{j} + 5\hat{k});\ \mu \in R$

intersect at the point S. If a plane ax + by – z + d = 0 passes through S and is parallel to both the lines L_1 and L_2, then the value of a + b + d is equal to _______.

9. Let A be a 3 × 3 matrix having entries from. the set {–1, 0, 1}. The number of all such matrices A having sum of all the entries equal to 5, is _______

10. The greatest integer less than or equal to the sum of first 100 terms of the sequence $\frac{1}{3}, \frac{5}{9}, \frac{19}{27}, \frac{65}{81}, ...$ is equal to

SET # 04

PHYSICS

SECTION-A

1. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : Two identical balls A and B thrown with same velocity 'u' at two different angles with horizontal attained the same range R. If A and B reached the maximum height h_1 and h_2 respectively, then $R = 4\sqrt{h_1 h_2}$

Reason R: Product of said heights.

$$h_1 h_2 = \left(\frac{u^2 \sin^2\theta}{2g}\right).\left(\frac{u^2 \cos^2\theta}{2g}\right)$$

Choose the CORRECT answer :

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false

(D) A is false but R is true

2. Two buses P and Q start from a point at the same time and move in a straight line and their positions are represented by $X_P(t) = \alpha t + \beta t^2$ and $X_Q(t) = ft - t^2$. At what time, both the buses have same velocity?

(A) $\dfrac{\alpha - f}{1+\beta}$ (B) $\dfrac{\alpha + f}{2(\beta - 1)}$

(C) $\dfrac{\alpha + f}{2(1+\beta)}$ (D) $\dfrac{f - \alpha}{2(1+\beta)}$

3. A disc with a flat small bottom beaker placed on it at a distance R from its center is revolving about an axis passing through the center and perpendicular to its plane with an angular velocity ω. The coefficient of static friction between the bottom of the beaker and the surface of the disc is μ. The beaker will revolve with the disc if :

(A) $R \le \dfrac{\mu g}{2\omega^2}$ (B) $R \le \dfrac{\mu g}{\omega^2}$

(C) $R \ge \dfrac{\mu g}{2\omega^2}$ (D) $R \ge \dfrac{\mu g}{\omega^2}$

4. A solid metallic cube having total surface area 24 m^2 is uniformly heated. If its temperature is increased by 10°C, calculate the increase in volume of the cube $\left(\text{Given}: \alpha = 5.0\times10^{-4}\,°C^{-1}\right)$

(A) 2.4×10^6 cm^3 (B) 1.2×10^5 cm^3

(C) 6.0×10^4 cm^3 (D) 4.8×10^5 cm^3

5. A copper block of mass 5.0 kg is heated to a temperature of 500°C and is placed on a large ice block. What is the maximum amount of ice that can melt? [Specific heat of copper: $0.39\,J\,g^{-1}\,°C^{-1}$ and latent heat of fusion of water : 335 J g^{-1}]

(A) 1.5 kg (B) 5.8 kg

(C) 2.9 kg (D) 3.8 kg

6. The ratio of specific heats $\left(\dfrac{C_P}{C_V}\right)$ in terms of degree of freedom (f) is given by:

(A) $\left(1+\dfrac{f}{3}\right)$ (B) $\left(1+\dfrac{2}{f}\right)$

(C) $\left(1+\dfrac{f}{2}\right)$ (D) $\left(1+\dfrac{1}{f}\right)$

7. For a particle in uniform circular motion, the acceleration $\vec{a}$ at any point P(R,θ) on the circular path of radius R is (when θ is measured from the positive x –axis and v is uniform speed) :

(A) $-\frac{v^2}{R}\sin\theta\hat{i}+\frac{v^2}{R}\cos\theta\hat{j}$

(B) $-\frac{v^2}{R}\cos\theta\hat{i}+\frac{v^2}{R}\sin\theta\hat{j}$

(C) $-\frac{v^2}{R}\cos\theta\hat{i}-\frac{v^2}{R}\sin\theta\hat{j}$

(D) $-\frac{v^2}{R}\hat{i}+\frac{v^2}{R}\hat{j}$

8. Two metallic plates form a parallel plate capacitor. The distance between the plates is 'd'. A metal sheet of thickness $\frac{d}{2}$ and of area equal to area of each plate is introduced between the plates. What will be the ratio of the new capacitance to the original capacitance of the capacitor ?

(A) 2 : 1 (B) 1 : 2

(C) 1 : 4 (D) 4 : 1

9. Two cells of same emf but different internal resistances r_1 and r_2 are connected in series with a resistance R. The value of resistance R, for which the potential difference across second cell is zero, is

(A) $r_2 - r_1$ (B) $r_1 - r_2$

(C) r_1 (D) r_2

10. Given below are two statements:

Statement – I : Susceptibilities of paramagnetic and ferromagnetic substances increase with decrease in temperature.

Statement – II: Diamagnetism is a result of orbital motions of electrons developing magnetic moments opposite to the applied magnetic field.

Choose the **CORRECT** answer from the options given below : -

(A) Both statement – I and statement -II are true.

(B) Both statement – I and Statement – II are false.

(C) Statement – I is true but statement – II is false.

(D) Statement-I is false but Statement-II is true.

11. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of magnetic field will be equal to

(A) B (B) 2 B

(C) 4 B (D) $\frac{B}{2}$

12. A sinusoidal voltage V(t) = 210 sin 3000t volt is applied to a series LCR circuit in which L = 10 mH, C = 25 μF and R = 100Ω. The phase difference (Φ) between the applied voltage and resultant current will be :

(A) $\tan^{-1}(0.17)$ (B) $\tan^{-1}(9.46)$

(C) $\tan^{-1}(0.30)$ (D) $\tan^{-1}(13.33)$

13. The electromagnetic waves travel in a medium at a speed of 2.0×10^8 m/s. The relative permeability of the medium is 1.0. The relative permittivity of the medium will be:

(A) 2.25 (B) 4.25

(C) 6.25 (D) 8.25

14. The interference pattern is obtained with two coherent light sources of intensity ratio 4 :1. And the ratio $\frac{I_{max}+I_{min}}{I_{max}-I_{min}}$ is $\frac{5}{x}$. Then, the value of x will be equal to :

(A) 3 (B) 4

(C) 2 (D) 1

15. A light whose electric field vectors are completely removed by using a good Polaroid, allowed to incident on the surface of the prism at Brewster's angle. Choose the most suitable option for the phenomenon related to the prism.

(A) Reflected and refracted rays will be perpendicular to each other

(B) Wave will propagate along the surface of prism

(C) No refraction, and there will be total reflection of light.

(D) No reflection and there will be total transmission of light.

16. A proton, a neutron, an electron and an α-particle have same energy. If $\lambda_p, \lambda_n, \lambda_e$ and λ_α are the de Broglie's wavelengths of proton, neutron, electron and α particle respectively, then choose the correct relation from the following :

(A) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$

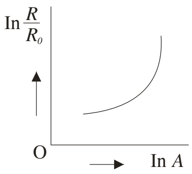
(B) $\lambda_\alpha < \lambda_n < \lambda_p < \lambda_e$

(C) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$

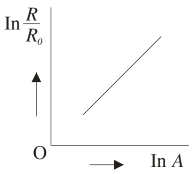
(D) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

17. Which of the following figure represents the variation of $\ln\left(\frac{R}{R_0}\right)$ with ln A(If R = radius of a nucleus and A = its mass number)

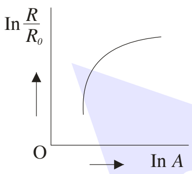
(A)



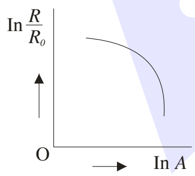
(B)



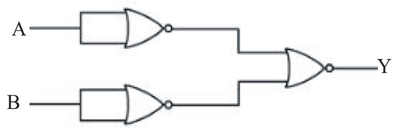
(C)



(D)



18. Identify the logic operation performed by the given circuit :



(A) AND gate (B) OR gate

(C) NOR gate (D) NAND gate

19. Match List-I with List-II

List-I		List-II	
A	Facsimile	I.	Static Document Image
B.	Guided media Channel	II.	Local Broadcast Radio
C.	Frequency Modulation	III.	Rectangular wave
D.	Digital Signal	IV.	Optical Fiber

Choose the correct answer from the following options :

(A) A –IV, B-III, C-II, D-I

(B) A-I, B-IV, C-II, D-III

(C) A –IV, B-II, C-III, D-I

(D) A-I, B-II, C-III, D-IV

20. If n represents the actual number of deflections in a converted galvanometer of resistance G and shunt resistance S. Then the total current I when its figure of merit is K will be :

(A) $\frac{KS}{(S+G)}$ (B) $\frac{(G+S)}{nKS}$

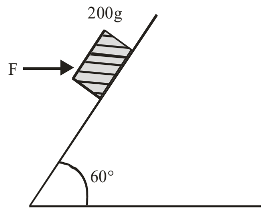
(C) $\frac{nKS}{(G+S)}$ (D) $\frac{nK(G+S)}{S}$

SECTION-B

1. For $z = a^2x^3y^{\frac{1}{2}}$, where 'a' is a constant. If percentage error in measurement of 'x' and 'y' are 4% and 12%, respectively, then the percentage error for 'z' will be %.

2. A curved in a level road has a radius 75m. The maximum speed of a car turning this curved road can be 30 m/s without skidding. If radius of curved road is changed to 48 m and the coefficient of friction between the tyres and the road remains same, then maximum allowed speed would be__ m/s.

3. A block of mass 200 g is kept stationary on a smooth inclined plane by applying a minimum horizontal force $F = \sqrt{x}N$ as shown in figure. The value of x = ________.



4. Moment of Inertia (M.I.) of four bodies having same mass 'M' and radius '2R' are as follows:

I_1= M.I. of solid sphere about its diameter

I_2 = M.I. of solid cylinder about its axis

I_3 = M.I. of solid circular disc about its diameter

I_4 = M.I. of thin circular ring about its diameter

If $2(I_2 + I_3) + I_4 = x.\ I_1$ then the value of x will be _____

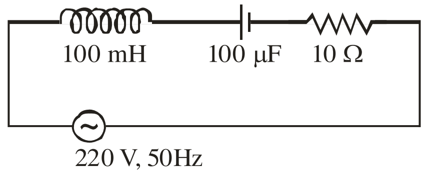
5. Two satellites S_1 and S_2 are revolving in circular orbits around a planet with radius R_1 = 3200 km and R_2 = 800 km respectively. The ratio of speed of satellite S_1 to the speed of satellite S_2 in their respective orbits would be $\frac{1}{x}$ where x =

6. When a gas filled in a closed vessel is heated by raising the temperature by 1°C, its pressure increase by 0.4%. The initial temperature of the gas is______ K.

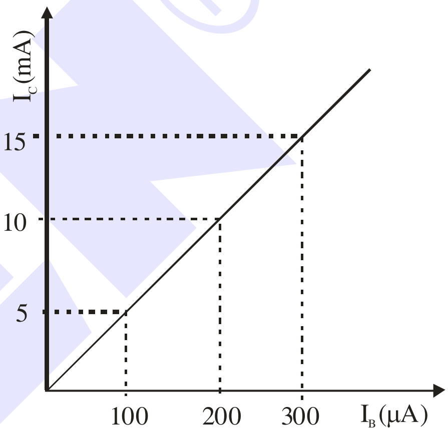
7. 27 identical drops are charged at 22V each. They combine to form a bigger drop. The potential of the bigger drop will be _____ V.

8. The length of a given cylindrical wire is increased to double of its original length. The percentage increase in the resistance of the wire will be ____%.

9. In a series LCR circuit, the inductance, capacitance and resistance are L = 100mH, C = 100μF and R = 10Ω respectively. They are connected to an AC source of voltage 220V and frequency of 50 Hz. The approximate value of current in the circuit will be____ A.



10. In an experiment of CE configuration of n-p-n transistor, the transfer characteristics are observed as given in figure.



If the input resistance is 200Ω and output resistance is 60 Ω the voltage gain in this experiment will be _____

CHEMISTRY

SECTION-A

1. The minimum energy that must be possessed by photons in order to produce the photoelectric effect with platinum metal is:

[Given: The threshold frequency of platinum is $1.3 \times 10^{15}\ s^{-1}$ and $h = 6.6 \times 10^{-34}$ J s.]

(A) 3.21×10^{-14} J (B) 6.24×10^{-16} J

(C) 8.58×10^{-19} J (D) 9.76×10^{-20} J

2. At 25°C and 1 atm pressure, the enthalpy of combustion of benzene (1) and acetylene (g) are –3268 kJ mol^{-1} and –1300 kJ mol^{-1}, respectively. The change in enthalpy for the reaction

$3\ C_2H_2(g) \rightarrow C_6H_6(l)$, is

(A) + 324 kJ mol^{-1} (B) +632 kJ mol^{-1}

(C) – 632 kJ mol^{-1} (D) – 732 kJ mol^{-1}

3. Solute A associates in water. When 0.7 g of solute A is dissolved in 42.0 g of water, it depresses the freezing point by 0.2°C. The percentage association of solute A in water, is [Given : Molar mass of A = 93 g mol^{-1}. Molal depression constant of water is 1.86 K kg mol^{-1}]

(A) 50 % (B) 60 %
(C) 70 % (D) 80 %

4. The K_{sp} for bismuth sulphide (Bi_2S_3) is 1.08×10^{-73}. The solubility of Bi_2S_3 in mol L^{-1} at 298 K is

(A) 1.0×10^{-15} (B) 2.7×10^{-12}
(C) 3.2×10^{-10} (D) 4.2×10^{-8}

5. Match List I with List II.

List I	List II
A. Zymase	I. Stomach
B. Diastase	II. Yeast
C. Urease	III. Malt
D. Pepsin	IV. Soyabean

Choose the correct answer from the options given below:

(A) A-II, B-III, C-I, D-IV
(B) A-II, B-III, C-IV, D-I
(C) A-III, B-II, C-IV, D-I
(D) A-III, B-II, C-I, D-IV

6. The correct order of electron gain enthalpies of Cl, F, Te and Po is

(A) F < Cl < Te < Po
(B) Po < Te < F < Cl
(C) Te < Po < Cl < F
(D) Cl < F < Te < Po

7. Given below are two statements.

Statement I: During electrolytic refining, blister copper deposits precious metals

Statement II: In the process of obtaining pure copper by electrolysis method, copper blister is used to make the anode.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

8. Given below are two statements one is labelled as **Assertion A** and the other is labelled as **Reason R:**

Assertion A : The amphoteric nature of water is explained by using Lewis acid/base concept.

Reason R : Water acts as an acid with NH_3 and as a base with H_2S.

In the light of the above statements choose the correct answer from the options given below :

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

9. The correct order of reduction potentials of the following pairs is

A. Cl_2/Cl^- B. I_2/I^-
C. Ag^+/Ag D. Na^+/Na
E. Li^+/Li

Choose the correct answer from the options given below.

(A) A > C > B > D > E
(B) A > B > C > D > E
(C) A > C > B > E > D
(D) A > B > C > E > D

10. The number of bridged oxygen atoms present in compound B formed from the following reactions is

$$Pb(NO_3)_2 \xrightarrow{673\text{ K}} A + PbO + O_2$$

$$A \xrightarrow{\text{Dimerise}} B$$

(A) 0 (B) 1
(C) 2 (D) 3

11. The metal ion (in gaseous state) with lowest spin-only magnetic moment value is

(A) V^{2+} (B) Ni^{2+}
(C) Cr^{2+} (D) Fe^{2+}

12. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A: Polluted water may have a value of BOD of the order of 17 ppm.

Reason R: BOD is a measure of oxygen required to oxidise both the biodegradable and non-biodegradable organic material in water.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both A and R are correct and R is the correct explanation of A.

(B) Both A and R are correct but R is NOT the correct explanation of A.

(C) A is correct but R is not correct.

(D) A is not correct but R is correct.

13. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A: A mixture contains benzoic acid and napthalene. The pure benzoic acid can be separated out by the use of benzene.

Reason R: Benzoic acid is soluble in hot water.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

14. During halogen test, sodium fusion extract is boiled with concentrated HNO_3 to

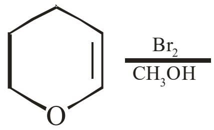
(A) remove unreacted sodium

(B) decompose cyanide or sulphide of sodium

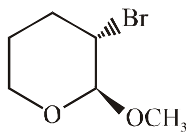
(C) extract halogen from organic compound

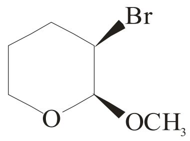
(D) maintain the pH of extract

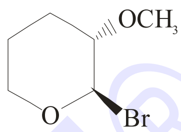
15. Amongst the following, the major product of the given chemical reaction is

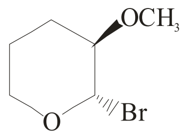


Major Product

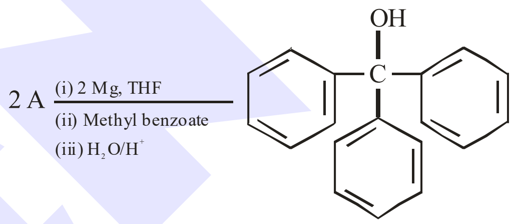
(A) 

(B) 

(C) 

(D) 

16. In the given reaction

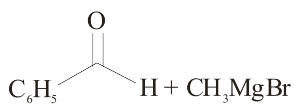


'A' can be

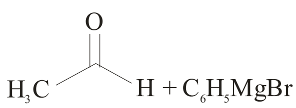
(A) benzyl bromide (B) bromobenzene

(C) cyclohexyl bromide (D) methyl bromide

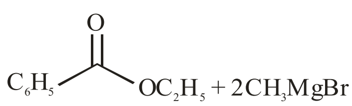
17. Which of the following conditions or reaction sequence will NOT give acetophenone as the major product ?

(A) (a) 

(b) $Na_2Cr_2O_7$, H^+

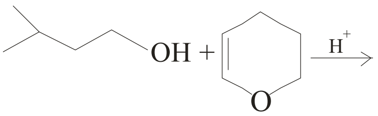
(B) (a) 

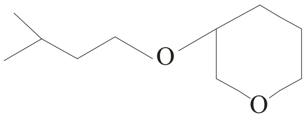
(b) PCC, DCM

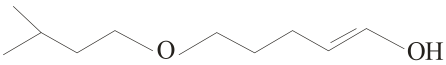
(C) 

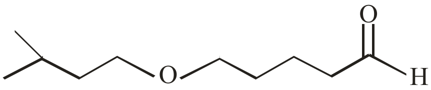
(D) 

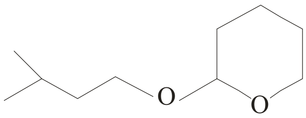
18. The major product formed in the following reaction, is



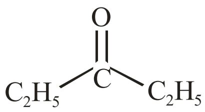
(A) 

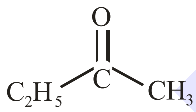
(B) 

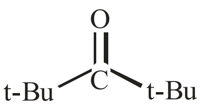
(C) 

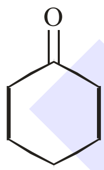
(D) 

19. Which of the following ketone will NOT give enamine on treatment with secondary amines? [where t-Bu is $-C(CH_3)_3$]

(A) 

(B) 

(C) 

(D) 

20. An antiseptic dettol is a mixture of two compounds 'A' and 'B' where A has 6π electrons and B has 2π electrons. What is 'B'?

(A) Bithionol

(B) Terpineol

(C) Chloroxylenol

(D) Chloramphenicol

SECTION-B

1. A protein 'A' contains 0.30% of glycine (molecular weight 75). The minimum molar mass of the protein 'A' is________ $\times 10^3$ g mol^{-1} [nearest integer]

2. A rigid nitrogen tank stored inside a laboratory has a pressure of 30 atm at 06:00 am when the temperature is 27 °C. At 03:00 pm, when the temperature is 45°C, the pressure in the tank will be ____________atm. [nearest integer]

3. Amongst BeF_2, BF_3, H_2O, NH_3, CCl_4 and HCl, the number of molecules with non-zero net dipole moment is __________.

4. At 345 K, the half life for the decomposition of a sample of a gaseous compound initially at 55.5 kPa was 340 s. When the pressure was 27.8 kPa, the half life was fund to be 170 s. The order of the reaction is________. [integer answer]

5. A solution of $Fe_2(SO_4)_3$ is electrolyzed for 'x' min with a current of 1.5 A to deposit 0.3482 g of Fe. The value of x is______. [nearest integer]

Given : 1 F = 96500 C mol^{-1}

Atomic mass of Fe = 56 g mol^{-1}

6. Consider the following reactions :

$PCl_3 + H_2O \longrightarrow A + HCl$

$A + H_2O \longrightarrow B + HCl$

number of ionisable protons present in the product B________.

7. Amongst $FeCl_3.3H_2O$, $K_3[Fe(CN)_6]$ and $[Co(NH_3)_6]Cl_3$, the spin-only magnetic moment value of the inner-orbital complex that absorbs light at shortest wavelength is________ B.M. [nearest integer]

8. The Novolac polymer has mass of 963 g. The number of monomer units present in it are

9. How many of the given compounds will give a positive Biuret test ______ ? Glycine, Glycylalanine, Tripeptide, Biuret

10. The neutralization occurs when 10 mL of 0.1 M acid 'A' is allowed to react with 30 mL of 0.05 M base $M(OH)_2$. The basicity of the acid 'A' is______. [M is a metal]

MATHEMATICS

SECTION-A

1. Let $A=\{x\in R:|x+1|<2\}$ and $B=\{x\in R:|x-1|\ge 2\}$. Then which one of the following statements is **NOT** true ?

(A) $A-B=(-1,1)$

(B) $B-A=R-(-3,1)$

(C) $A\cap B=(-3,-1]$

(D) $A\cup B=R-[1,3)$

2. Let $a,b\in R$ be such that the equation $ax^2-2bx+15=0$ has a repeated root α. If α and β are the roots of the equation $x^2-2bx+21=0$, then $\alpha^2+\beta^2$ is equal to:

(A) 37 (B) 58

(C) 68 (D) 92

3. Let z_1 and z_2 be two complex numbers such that $\overline{z}_1=i\overline{z}_2$ and $\arg\left(\frac{z_1}{\overline{z}_2}\right)=\pi$. Then

(A) $\arg z_2=\frac{\pi}{4}$ (B) $\arg z_2=-\frac{3\pi}{4}$

(C) $\arg z_1=\frac{\pi}{4}$ (D) $\arg z_1=-\frac{3\pi}{4}$

4. The system of equations

$-kx+3y-14z=25$

$-15x+4y-kz=3$

$-4x+y+3z=4$

is consistent for all k in the set

(A) R (B) $R-\{-11,13\}$

(C) $R-\{13\}$ (D) $R-\{-11,11\}$

5. $\lim\limits_{x\to\frac{\pi}{2}}\left(\tan^2 x\left(\left(2\sin^2 x+3\sin x+4\right)^{\frac{1}{2}}-\left(\sin^2 x+6\sin x+2\right)^{\frac{1}{2}}\right)\right)$ is equal to

(A) $\frac{1}{12}$ (B) $-\frac{1}{18}$

(C) $-\frac{1}{12}$ (D) $-\frac{1}{6}$

6. The area of the region enclosed between the parabolas $y^2=2x-1$ and $y^2=4x-3$ is

(A) $\frac{1}{3}$ (B) $\frac{1}{6}$

(C) $\frac{2}{3}$ (D) $\frac{3}{4}$

7. The coefficient of x^{101} in the expression $(5+x)^{500}+x(5+x)^{499}+x^2(5+x)^{498}+.....x^{500}$, $x>0$, is

(A) ${}^{501}C_{101}(5)^{399}$ (B) ${}^{501}C_{101}(5)^{400}$

(C) ${}^{501}C_{100}(5)^{400}$ (D) ${}^{500}C_{101}(5)^{399}$

8. The sum $1+2\cdot 3+3\cdot 3^2+.....+10\cdot 3^9$ is equal to

(A) $\frac{2\cdot 3^{12}+10}{4}$ (B) $\frac{19\cdot 3^{10}+1}{4}$

(C) $5\cdot 3^{10}-2$ (D) $\frac{9\cdot 3^{10}+1}{2}$

9. Let P be the plane passing through the intersection of the planes $\vec{r}\cdot\left(\hat{i}+3\hat{j}-\hat{k}\right)=5$ and $\vec{r}\cdot\left(2\hat{i}-\hat{j}+\hat{k}\right)=3$, and the point $(2,1,-2)$. Let the position vectors of the points X and Y be $\hat{i}-2\hat{j}+4\hat{k}$ and $5\hat{i}-\hat{j}+2\hat{k}$ respectively. Then the points

(A) X and X + Y are on the same side of P

(B) Y and Y – X are on the opposite sides of P

(C) X and Y are on the opposite sides of P

(D) X + Y and X – Y are on the same side of P

10. A circle touches both the y-axis and the line x + y = 0. Then the locus of its center is

(A) $y=\sqrt{2}x$ (B) $x=\sqrt{2}y$

(C) $y^2-x^2=2xy$ (D) $x^2-y^2=2xy$

11. Water is being filled at the rate of $1\ cm^3/sec$ in a right circular conical vessel (vertex downwards) of height 35 cm and diameter 14 cm. When the height of the water level is 10 cm, the rate (in cm^2/sec) at which the wet conical surface area of the vessel increases is

(A) 5 (B) $\frac{\sqrt{21}}{5}$

(C) $\frac{\sqrt{26}}{5}$ (D) $\frac{\sqrt{26}}{10}$

12. If $b_n = \int_0^{\frac{\pi}{2}} \frac{\cos^2 nx}{\sin x} dx,\ n \in N$, then

(A) $b_3 - b_2, b_4 - b_3, b_5 - b_4$ are in an A.P. with common difference –2

(B) $\frac{1}{b_3 - b_2}, \frac{1}{b_4 - b_3}, \frac{1}{b_5 - b_4}$ are in an A.P. with common difference 2

(C) $b_3 - b_2, b_4 - b_3, b_5 - b_4$ are in a G.P.

(D) $\frac{1}{b_3 - b_2}, \frac{1}{b_4 - b_3}, \frac{1}{b_5 - b_4}$ are in an A.P. with common difference –2

13. If y = y(x) is the solution of the differential equation $2x^2\frac{dy}{dx} - 2xy + 3y^2 = 0$ such that $y(e) = \frac{e}{3}$, then y(1) is equal to

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$

(C) $\frac{3}{2}$ (D) 3

14. If the angle made by the tangent at the point (x_0, y_0) on the curve x = 12(t + sin t cos t), $y = 12(1+\sin t)^2, 0 < t < \frac{\pi}{2}$, with the positive x-axis is $\frac{\pi}{3}$, then y_0 is equal to

(A) $6(3+2\sqrt{2})$ (B) $3(7+4\sqrt{3})$

(C) 27 (D) 48

15. The value of 2sin(12°) – sin(72°) is :

(A) $\frac{\sqrt{5}(1-\sqrt{3})}{4}$ (B) $\frac{1-\sqrt{5}}{8}$

(C) $\frac{\sqrt{3}(1-\sqrt{5})}{2}$ (D) $\frac{\sqrt{3}(1-\sqrt{5})}{4}$

16. A biased die is marked with numbers 2,4, 8, 16, 32, 32 on its faces and the probability of getting a face with mark n is $\frac{1}{n}$. If the die is thrown thrice, then the probability, that the sum of the numbers obtained is 48, is

(A) $\frac{7}{2^{11}}$ (B) $\frac{7}{2^{12}}$

(C) $\frac{3}{2^{10}}$ (D) $\frac{13}{2^{12}}$

17. The negation of the Boolean expression $((\sim q) \wedge p) \Rightarrow ((\sim p) \vee q)$ is logically equivalent to

(A) $p \Rightarrow q$ (B) $q \Rightarrow p$

(C) $\sim(p \Rightarrow q)$ (D) $\sim(q \Rightarrow p)$

18. If the line $y = 4 + kx$, k > 0, is the tangent to the parabola $y = x - x^2$ at the point P and V is the vertex of the parabola, then the slope of the line through P and V is :

(A) $\frac{3}{2}$ (B) $\frac{26}{9}$

(C) $\frac{5}{2}$ (D) $\frac{23}{6}$

19. The value of $\tan^{-1}\left(\frac{\cos\left(\frac{15\pi}{4}\right) - 1}{\sin\left(\frac{\pi}{4}\right)}\right)$ is equal to

(A) $-\frac{\pi}{4}$ (B) $-\frac{\pi}{8}$

(C) $-\frac{5\pi}{12}$ (D) $-\frac{4\pi}{9}$

20. The line $y = x + 1$ meets the ellipse $\frac{x^2}{4} + \frac{y^2}{2} = 1$ at two points P and Q. If r is the radius of the circle with PQ as diameter then $(3r)^2$ is equal to

(A) 20 (B) 12

(C) 11 (D) 8

SECTION-B

1. Let $A = \begin{pmatrix} 2 & -2 \\ 1 & -1 \end{pmatrix}$ and $B = \begin{pmatrix} -1 & 2 \\ -1 & 2 \end{pmatrix}$. Then the number of elements in the set $\{(n, m) : n, m \in \{1, 2, ..., 10\}$ and $nA^n + mB^m = I\}$ is _____

2. Let $f(x) = [2x^2 + 1]$ and $g(x) = \begin{cases} 2x - 3, & x < 0 \\ 2x + 3, & x \geq 0 \end{cases}$, where $[t]$ is the greatest integer $\leq t$. Then, in the open interval (–1, 1), the number of points where fog is discontinuous is equal to ______

3. The value of $b > 3$ for which $12\int_3^b \frac{1}{(x^2-1)(x^2-4)}dx = \log_e\left(\frac{49}{40}\right)$, is equal to

4. If the sum of the coefficients of all the positive even powers of x in the binomial expansion of $\left(2x^3 + \frac{3}{x}\right)^{10}$ is $5^{10} - \beta \cdot 3^9$, then β is equal to ______

5. If the mean deviation about the mean of the numbers 1, 2, 3, ..., n, where n is odd, is $\frac{5(n+1)}{n}$, then n is equal to ______

6. Let $\vec{b} = \hat{i} + \hat{j} + \lambda\hat{k}, \lambda \in R$. If $\vec{a}$ is a vector such that $\vec{a} \times \vec{b} = 13\hat{i} - \hat{j} - 4\hat{k}$ and $\vec{a} \cdot \vec{b} + 21 = 0$, then $(\vec{b} - \vec{a}) \cdot (\hat{k} - \hat{j}) + (\vec{b} + \vec{a}) \cdot (\hat{i} - \hat{k})$ is equal to

7. The total number of three-digit numbers, with one digit repeated exactly two times, is

8. Let $f(x) = |(x-1)(x^2 - 2x - 3)| + x - 3,\ x \in R$. If m and M are respectively the number of points of local minimum and local maximum of f in the interval (0, 4), then m + M is equal to _____

9. Let the eccentricity of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ be $\frac{5}{4}$. If the equation of the normal at the point $\left(\frac{8}{\sqrt{5}}, \frac{12}{5}\right)$ on the hyperbola is $8\sqrt{5}x + \beta y = \lambda$, then $\lambda - \beta$ is equal to

10. Let l_1 be the line in xy-plane with x and y intercepts $\frac{1}{8}$ and $\frac{1}{4\sqrt{2}}$ respectively, and l_2 be the line in zx-plane with x and z intercepts $-\frac{1}{8}$ and $-\frac{1}{6\sqrt{3}}$ respectively. If d is the shortest distance between the line l_1 and l_2, then d^{-2} is equal to

SET # 05

PHYSICS

SECTION-A

1. An expression for a dimensionless quantity P is given by $P = \frac{\alpha}{\beta}\log_e\left(\frac{kt}{\beta x}\right)$; where α and β are constants, x is distance ; k is Boltzmann constant and t is the temperature. Then the dimensions of α will be :

(A) $[M^0L^{-1}T^0]$ (B) $[ML^0T^{-2}]$

(C) $[MLT^{-2}]$ (D) $[ML^2T^{-2}]$

2. A person is standing in an elevator. In which situation, he experiences weight loss ?

(A) When the elevator moves upward with constant acceleration

(B) When the elevator moves downward with constant acceleration

(C) When the elevator moves upward with uniform velocity

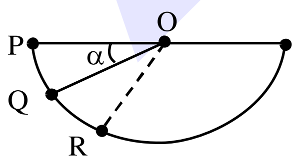
(D) When the elevator moves downward with uniform velocity

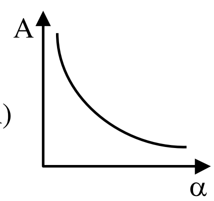
3. An object is thrown vertically upwards. At its maximum height, which of the following quantity becomes zero ?

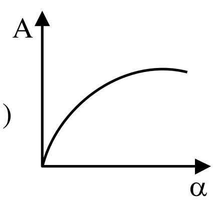
(A) Momentum (B) Potential energy

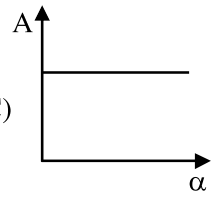
(C) Acceleration (D) Force

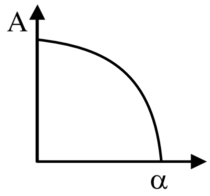
4. A ball is released from rest from point P of a smooth semi-spherical vessel as shown in figure. The ratio of the centripetal force and normal reaction on the ball at point Q is A while angular position of point Q is α with respect to point P. Which of the following graphs represent the correct relation between A and α when ball goes from Q to R ?



(A) 

(B) 

(C) 

(D) 

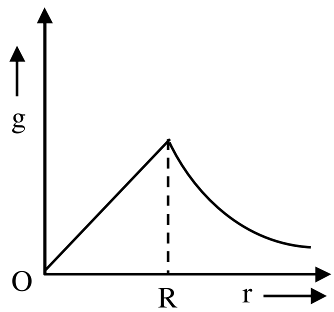
5. A thin circular ring of mass M and radius R is rotating with a constant angular velocity 2 rads^{-1} in a horizontal plane about an axis vertical to its plane and passing through the center of the ring. If two objects each of mass m be attached gently to the opposite ends of a diameter of ring, the ring will then rotate with an angular velocity (in rads^{-1}).

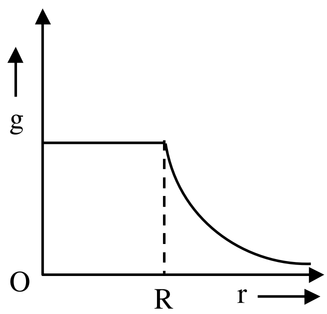
(A) $\frac{M}{(M+m)}$ (B) $\frac{(M+2m)}{2M}$

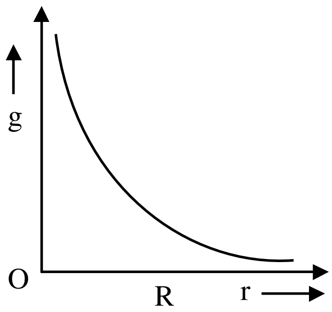
(C) $\frac{2M}{(M+2m)}$ (D) $\frac{2(M+2m)}{M}$

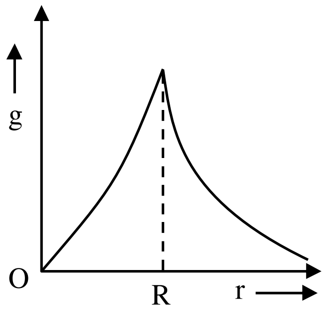
6. The variation of acceleration due to gravity (g) with distance (r) from the center of the earth is correctly represented by :

(Given R = radius of earth)

(A) 

(B) 

(C) 

(D) 

7. The efficiency of a Carnot's engine, working between steam point and ice point, will be :

(A) 26.81% (B) 37.81%

(C) 47.81% (D) 57.81%

8. Time period of a simple pendulum in a stationary lift is 'T'. If the lift accelerates with $\frac{g}{6}$ vertically upwards then the time period will be :

(where g = acceleration due to gravity)

(A) $\sqrt{\frac{6}{5}}T$ (B) $\sqrt{\frac{5}{6}}T$

(C) $\sqrt{\frac{6}{7}}T$ (D) $\sqrt{\frac{7}{6}}T$

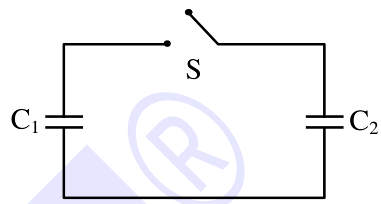
9. A thermally insulated vessel contains an ideal gas of molecular mass M and ratio of specific heats 1.4. Vessel is moving with speed v and is suddenly brought to rest. Assuming no heat is lost to the surrounding and vessel temperature of the gas increases by :

(R = universal gas constant)

(A) $\frac{Mv^2}{7R}$ (B) $\frac{Mv^2}{5R}$

(C) $2\frac{Mv^2}{7R}$ (D) $7\frac{Mv^2}{5R}$

10. Two capacitors having capacitance C_1 and C_2 respectively are connected as shown in figure. Initially, capacitor C_1 is charged to a potential difference V volt by a battery. The battery is then removed and the charged capacitor C_1 is now connected to uncharged capacitor C_2 by closing the switch S. The amount of charge on the capacitor C_2, after equilibrium is :



(A) $\frac{C_1C_2}{(C_1+C_2)}V$ (B) $\frac{(C_1+C_2)}{C_1C_2}V$

(C) $(C_1 + C_2)V$ (D) $(C_1 - C_2)V$

11. **Assertion (A) :** Non-polar amterials do not have my permanent dipole moment.

Reason (R) : When an non-polar material is placed in a electric field. the centre of the positive charge distribution of it's individual atom or molecule coinsides with the centre of the negative charge distribution.

In the light of above statements, choose the most appropriate answer from the options given below.

(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).

(B) Both (A) and (R) are correct and (R) is not the correct explanation of (A).

(C) (A) is correct but (R) is not correct.

(D) (A) is not correct but (R) is correct.

12. The magnetic flux through a coil perpendicular to its plane is varying according to the relation $\phi = (5t^3 + 4t + 2t - 5)$ Weber. If the resistant of the coil is 5 ohm, then the induced current through the coil at t = 2 sec will be:

(A) 15.6 A (B) 16.6 A

(C) 17.6 A (D) 18.6 A

13. An aluminium wire is stretched to make its length, 04% larger. Then percentage change in resistance is:
(A) 0.4 % (B) 0.2 %
(C) 0.8 % (D) 0.6 %

14. A proton and an alpha particle of the same enter in a uniform magnetic field which is acting perpendicular to their direction of motion. The ratio of the circular paths described by the alpha particle and proton is:
(A) 1 : 4 (B) 4 : 1
(C) 2 : 1 (D) 1 : 2

15. If electric field intensity of a uniform plane electro magnetic wave is given as
$E = -301.6\sin(kz-\omega t)\,\hat{a}_x +$

$$452.4\sin(kz-\omega t)\,\hat{a}_y\,\frac{V}{m}$$

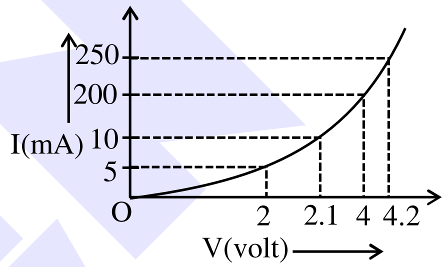
Then, magnetic intensity H of this wave in Am^{-1} will be:'
[Given: Speed of light in vacuum $c = 3\times10^{8}\ ms^{-1}$, permeability of vacuum $\mu_0 = 4\pi\times10^{-7}\ NA^{-2}$]
(A) $+0.8\sin(kz-\omega t)\hat{a}_y + 0.8\sin(kz-\omega t)\hat{a}_x$
(B) $+1.0\times10^{-6}\sin(kz-\omega t)\hat{a}_y + 1.5\times10^{-6}(kz-\omega t)\hat{a}_x$
(C) $-0.8\sin(kz-\omega t)\hat{a}_y - 1.2\sin(kz-\omega t)\hat{a}_x$
(D) $-1.0\times10^{-6}\sin(kz-\omega t)\hat{a}_y - 1.5\times10^{-6}\sin(kz-\omega t)\hat{a}_x$

16. In free space, an electromagnetic wave of 3 GHz of 3 GHz frequency strikes over the edge of an object of size $\frac{\lambda}{100}$, where λ is the wavelength of the wave in free space. The phenomenon, which happens there will be:
(A) Reflection (B) Refraction
(C) Diffraction (D) Scattering

17. An electron with speed v and a photon with speed c have the same de-Broglie wavelength. If the kinetic energy and momentum of electron are E_e and p_e and that of photon are E_{ph} and p_{ph} respectively. Which of the following is correct?
(A) $\frac{E_e}{E_{ph}} = \frac{2c}{v}$ (B) $\frac{E_e}{E_{ph}} = \frac{v}{2c}$
(C) $\frac{p_e}{p_{ph}} = \frac{2c}{v}$ (D) $\frac{p_e}{p_{ph}} = \frac{v}{2c}$

18. How many alpha and beta particles are emitted when Uranium $_{92}U^{238}$ decays to lead $_{82}Pb^{206}$?
(A) 3 alpha particles and 5 beta particles
(B) 6 alpha particles and 4 beta particles
(C) 4 alpha particles and 5 beta particles
(D) 8 alpha particles and 6 beta particles

19. The I-V characteristics of a p-n junction diode in forward bias is shown in the figure. The ratio of dynamic resistance, corresponding to forward bias voltages of 2V and 4V respectively, is :



(A) 1 : 2 (B) 5 : 1
(C) 1 : 40 (D) 20 : 1

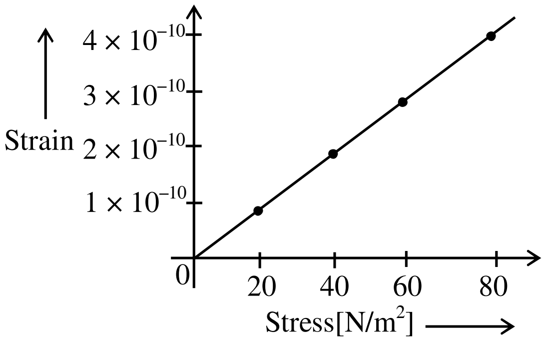
20. Choose the correct statement for amplitude modulation:
(A) Amplitude of modulating is varied in accordance with the information signal.
(B) Amplitude of modulated is varied in accordance with the information signal.
(C) Amplitude of carrier signal is varied in accordance with the information signal.
(D) Amplitude of modulated is varied in accordance with the modulating signal.

SECTION-B

1. A fighter jet is flying horizontally at a certain altitude with a speed of 200 ms^{-1}. When it passes directly overhead an anti-aircraft gun, bullet is fired from the gun, at an angle θ with the horizontal, to hit the jet. If the bullet speed is 400 m/s, the value of θ will be .... °.

2. A ball of mass 0.5 kg is dropped from the height of 10m. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is .... m. (Use $g = 10\ m/s^2$).

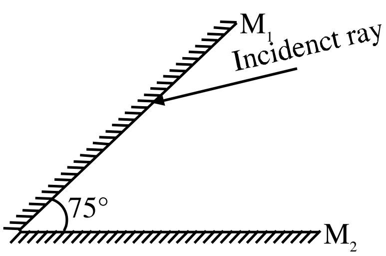
3. The elastic behaviour of material for linear streass and linear strain, is shown in the figure. The energy density for a linear strain of 5×10^{-4} is .... kJ/m^3. Assume that material is elastic upto the linear strain of 5×10^{-4}.



4. The elongation of a wire on the surface of the earth is 10^{-4} m. The same wire of same dimensions is elongated by 6×10^{-5}m on another planet. The acceleration due to gravity on the planet will be .... ms^{-2}. (Take acceleration due to gravity on the surface of earth = $10\ m/s^{-2}$)

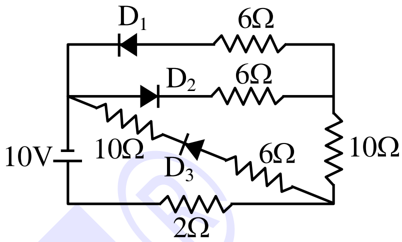
5. A 10Ω, 20 mH coil carrying constant current is connected to a battery of 20 V through a switch is opened current becomes zero in 100μs. The average emf induced in the coil is .... V.

6. A light ray is incident, at an incident angle θ_1, on the system of two plane mirrors M_1 and M_2 having an inclination angle 75° between them (as shown in figure). After reflecting from mirror M_1 it gets reflected back by the mirror M_2 with an angle of reflection 30°. The total deviation of the ray will be .... degree.

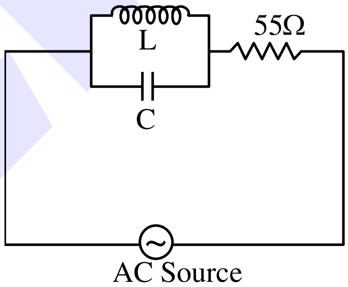


7. In a vernier callipers, each cm on the main scale is divided into 20 equal parts. If tenth vernier scale division coincides with nineth main scale division. Then the value of vernier constant will be .... $\times 10^{-2}$ mm.

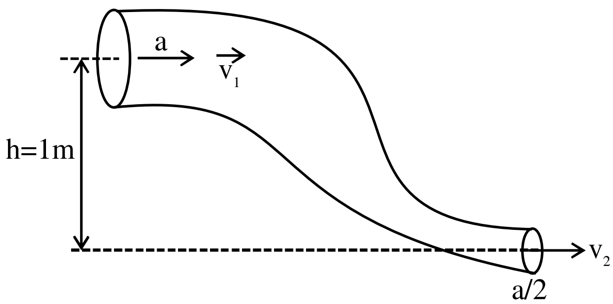
8. As per the given circuit, the value of current through the battery will be .... A.



9. A 110 V , 50 Hz, AC source is connected in the circuit (as shown in figure). The current through the resistance 55 Ω, at resonance in the circuit, will be .... A.



10. An ideal fluid of density 800 kgm^{-3}, flows smoothly through a bent pipe (as shown in figure) that tapers in cross-sectional area from a to $\frac{a}{2}$. The pressure difference between the wide and narrow sections of pipe is 4100 Pa. At wider section, the velocity of fluid is $\frac{\sqrt{x}}{6} ms^{-1}$ for x = ... (Given g = 10 m^{-2})



CHEMISTRY
SECTION-A

1. A commercially sold conc. HCl is 35% HCl by mass. If the density of this commercial acid is 1.46 g/mL, the molarity of this solution is :
(Atomic mass : Cl = 35.5 amu, H = 1 amu)
(A) 10.2 M (B) 12.5 M
(C) 14.0 M (D) 18.2 M

2. An evacuated glass vessel weighs 40.0 g when empty, 135.0 g when filled with a liquid of density 0.95 g mL^{-1} and 40.5 g when filled with an ideal gas at 0.82 atm at 250 K. The molar mass of the gas in g mol^{-1} is :
(Given : R = 0.082 L atm K^{-1} mol^{-1})
(A) 35 (B) 50
(C) 75 (D) 125

3. If the radius of the 3rd Bohr's orbit of hydrogen atom is r_3 and the radius of 4th Bohr's orbit is r_4. Then :
(A) $r_4 = \frac{9}{16} r_3$ (B) $r_4 = \frac{16}{9} r_3$
(C) $r_4 = \frac{3}{4} r_3$ (D) $r_4 = \frac{4}{3} r_3$

4. Consider the ions/molecule
$O_2^+, O_2, O_2^-, O_2^{2-}$
For increasing bond order the correct option is :
(A) $O_2^{2-} < O_2^- < O_2 < O_2^+$
(B) $O_2^- < O_2^{2-} < O_2 < O_2^+$
(C) $O_2^- < O_2^{2-} < O_2^+ < O_2$
(D) $O_2^- < O_2^+ < O_2^{2-} < O_2$

5. The $\left(\frac{\partial E}{\partial T}\right)_P$ of different types of half cells are as follows :

A	B	C	D
1×10^{-4}	2×10^{-4}	0.1×10^{-4}	0.2×10^{-4}

(Where E is the electromotive force)
Which of the above half cells would be preferred to be used as reference electrode ?
(A) A (B) B
(C) C (D) D

6. Choose the correct stability order of group 13 elements in their +1 oxidation state.
(A) Al < Ga < In < Tl
(B) Tl < In < Ga < Al
(C) Al < Ga < Tl < In
(D) Al < Tl < Ga < In

7. Given below are two statements :
Statement I : According to the Ellingham diagram, any metal oxide with higher ΔG° is more stable than the one with lower ΔG°.
Statement II : The metal involved in the formation of oxide placed lower in the Ellingham diagram can reduce the oxide of a metal placed higher in the diagram.
In the light of the above statements, choose the **most appropriate** answer from the options given below :
(A) Both **Statement I** and **Statement II** are correct.
(B) Both **Statement I** and **Statement II** are incorrect.
(C) **Statement I** is correct but **Statement II** is incorrect.
(D) **Statement I** is incorrect but **Statement II** is correct.

8. Consider the following reaction :
$$2HSO_4^-(aq) \xrightarrow[\text{(2) Hydrolysis}]{\text{(1) Electrolysis}} 2HSO_4^- + 2H^+ + \mathbf{A}$$
The dihedral angle in product **A** in its solid phase at 110 K is :
(A) 104° (B) 111.5°
(C) 90.2° (D) 111.0°

9. The correct order of melting point is :
(A) Be > Mg > Ca > Sr
(B) Sr > Ca > Mg > Be
(C) Be > Ca > Mg > Sr
(D) Be > Ca > Sr > Mg

10. The correct order of melting points of hydrides of group 16 elements is :
(A) $H_2S < H_2Se < H_2Te < H_2O$
(B) $H_2O < H_2S < H_2Se < H_2Te$
(C) $H_2S < H_2Te < H_2Se < H_2O$
(D) $H_2Se < H_2S < H_2Te < H_2O$

11. Consider the following reaction :

A + alkali $\rightarrow$ B (Major Product)

If B is an oxoacid of phosphorus with no P–H bond, then A is :

(A) White P_4 (B) Red P_4

(C) P_2O_3 (D) H_3PO_3

12. Polar stratospheric clouds facilitate the formation of :

(A) $ClONO_2$ (B) HOCl

(C) ClO (D) CH_4

13. Given below are two statements :

Statement I : In 'Lassaigne's Test, when both nitrogen and sulphur are present in an organic compound, sodium thiocyanate is formed.

Statement II : If both nitrogen and sulphur are present in an organic compound, then the excess of sodium used in sodium fusion will decompose the sodium thiocyanate formed to give NaCN and Na_2S.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(A) Both **Statement I** and **Statement II** are correct.

(B) Both **Statement I** and **Statement II** are incorrect.

(C) **Statement I** is correct but **Statement II** is incorrect.

(D) **Statement I** is incorrect but **Statement II** is correct.

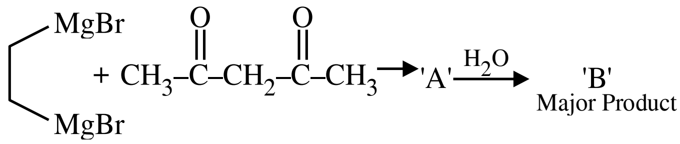
14. $(C_7H_5O_2)_2 \xrightarrow{hv} [X] + 2\dot{C}_6H_5 + 2CO_2$

Consider the above reaction and identify the intermediate 'X'

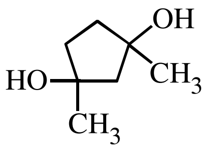
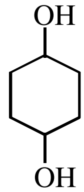
(A) $C_6H_5-\overset{\overset{O}{\|}}{C}{}^{\oplus}$ (B) $C_6H_5-\overset{\overset{O}{\|}}{C}-O^{\ominus}$

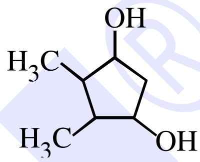
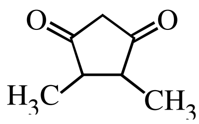
(C) $C_6H_5-\overset{\overset{O}{\|}}{C}-\ddot{\underset{\cdot\cdot}{O}}$ (D) $C_6H_5-\overset{\overset{O}{\|}}{C}-\ddot{\underset{\cdot\cdot}{O}}\cdot$

15.

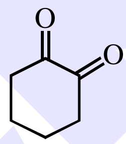
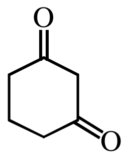


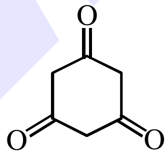
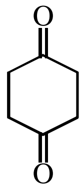
Consider the above reaction sequence and identify the product **B.**

(A)  (B) 

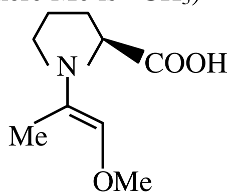
(C)  (D) 

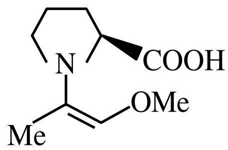
16. Which will have the highest enol content ?

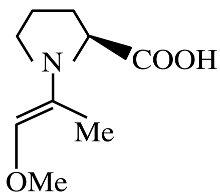
(A)  (B) 

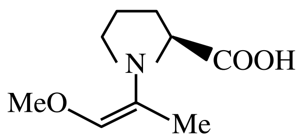
(C)  (D) 

17. Among the following structures, which will show the most stable enamine formation ? (Where Me is $-CH_3$)

(A) 

(B) 

(C) 

(D) 

18. Which of the following sets are **correct** regarding polymer ?
(A) Copolymer : Buna–S
(B) Condensation polymer : Nylon–6,6
(C) Fibre : Nylon–6,6
(D) Thermosetting polymer : Terylene
(E) Homopolymer : Buna–N
Choose the **correct** answer from given options below:
(A) (A), (B) and (C) are correct
(B) (B), (C) and (D) are correct
(C) (A), (C) and (E) are correct
(D) (A), (B) and (D) are correct

19. A chemical which stimulates the secretion of pepsin is :
(A) Anti histamine (B) Cimetidine
(C) Histamine (D) Zantac

20. Which statement is **not** true with respect to nitrate ion test ?
(A) A dark brown ring is formed at the junction of two solutions.
(B) Ring is formed due to nitroferrous sulphate complex.
(C) The brown complex is $[Fe(H_2O)_5(NO)]SO_4$.
(D) Heating the nitrate salt with conc. H_2SO_4, light brown fumes are evolved.

SECTION–B

1. For complete combustion of methanol

$$CH_3OH(l)+\frac{3}{2}O_2(g)\rightarrow CO_2(g)+2H_2O(l)$$

the amount of heat produced as measured by bomb calorimeter is 726 kJ mol^{-1} at 27°C. The enthalpy of combustion for the reaction is –x kJ mol^{-1}, where x is ______. (Nearest integer)
(Given : R = 8.3 JK^{-1} mol^{-1})

2. A 0.5 percent solution of potassium chloride was found to freeze at –0.24°C. The percentage dissociation of potassium chloride is ________. (Nearest integer)
(Molal depression constant for water is 1.80 K kg mol^{-1} and molar mass of KCl is 74.6 g mol^{-1})

3. 50 mL of 0.1 M CH_3COOH is being titrated against 0.1 M NaOH. When 25 mL of NaOH has been added, the pH of the solution will be ________ $\times 10^{-2}$. (Nearest integer)
(Given : pK_a (CH_3COOH) = 4.76)
log 2 = 0.30
log 3 = 0.48
log 5 = 0.69
log 7 = 0.84
log 11 = 1.04

4. A flask is filled with equal moles of A and B. The half lives of A and B are 100 s and 50 s respectively and are independent of the initial concentration. The time required for the concentration of A to be four times that of B is ________s.
(Given : ln 2 = 0.693)

5. 2.0 g of H_2 gas is adsorbed on 2.5 g of platinum powder at 300 K and 1 bar pressure. The volume of the gas adsorbed per gram of the adsorbent is ________ mL.
(Given : R = 0.083 L bar K^{-1} mol^{-1})

6. The spin–only magnetic moment value of the most basic oxide of vanadium among V_2O_3, V_2O_4 and V_2O_5 is ________ B.M. (Nearest Integer)

7. The spin–only magnetic moment value of an octahedral complex among $CoCl_3.4NH_3$, $NiCl_2.6H_2O$ and $PtCl_4.2HCl$, which upon reaction with excess of $AgNO_3$ gives 2 moles of AgCl is ________ B.M. (Nearest Integer)

8. On complete combustion 0.30 g of an organic compound gave 0.20 g of carbon dioxide and 0.10 g of water. The percentage of carbon in the given organic compound is ________ (Nearest Integer)

9. Compound 'P' on nitration with dil. HNO_3 yields two isomers (A) and (B). These isomers can be separated by steam distillation. Isomers (A) and (B) show the intramolecular and intermolecular hydrogen bonding respectively. Compound (P) on reaction with conc. HNO_3 yields a yellow compound 'C', a strong acid. The number of oxygen atoms is present in compound 'C' ________.

10. The number of oxygens present in a nucleotide formed from a base, that is present only in RNA is ________.

MATHEMATICS
SECTION-A

1. Let $f(x)=\dfrac{x-1}{x+1}, x \in R-\{0,-1,1\}$.

If $f^{n+1}(x)=f(f^{n}(x))$ for all $n \in N$, then $f^{6}(6)+f^{7}(7)$ is equal to:

(A) $\dfrac{7}{6}$ (B) $-\dfrac{3}{2}$

(C) $\dfrac{7}{12}$ (D) $-\dfrac{11}{12}$

2. Let $A=\left\{z\in C:\left|\dfrac{z+1}{z-1}<1\right|\right\}$

and $B=\left\{z \in C: \arg\left(\dfrac{z-1}{z+1}\right)=\dfrac{2\pi}{3}\right\}$.

Then $A \cap B$ is :

(A) a portion of a circle centred at $\left(0,-\dfrac{1}{\sqrt{3}}\right)$ that lies in the second and third quadrants only

(B) a portion of a circle centred at $\left(0,-\dfrac{1}{\sqrt{3}}\right)$ that lies in the second quadrant only

(C) an empty set

(D) a portion of a circle of radius $\dfrac{2}{\sqrt{3}}$ that lies in the third quadrant only

3. Let A be a 3 × 3 invertible matrix. If $|\text{adj}(24A)| = |\text{adj}(3\text{adj}(2A))|$, then $|A|^2$ is equal to :

(A) 6^6 (B) 2^{12} (C) 2^6 (D) 1

4. The ordered pair (a, b), for which the system of linear equations

$3x - 2y + z = b$

$5x - 8y + 9z = 3$

$2x + y + az = -1$

has no solution, is :

(A) $\left(3,\dfrac{1}{3}\right)$ (B) $\left(-3,\dfrac{1}{3}\right)$

(C) $\left(-3,-\dfrac{1}{3}\right)$ (D) $\left(3,-\dfrac{1}{3}\right)$

5. The remainder when $(2021)^{2023}$ is divided by 7 is :

(A) 1 (B) 2 (C) 5 (D) 6

6. $\lim\limits_{x\to\frac{1}{\sqrt{2}}}\dfrac{\sin(\cos^{-1}x)-x}{1-\tan(\cos^{-1}x)}$ is equal to :

(A) $\sqrt{2}$ (B) $-\sqrt{2}$

(C) $\dfrac{1}{\sqrt{2}}$ (D) $-\dfrac{1}{\sqrt{2}}$

7. Let f, g : R → R be two real valued functions defined as $f(x)=\begin{cases}-|x+3| & , \quad x<0 \\ e^{x} & , \quad x\ge 0\end{cases}$ and

$g(x)=\begin{cases}x^2+k_1x & , \quad x<0 \\ 4x+k_2 & , \quad x\ge 0\end{cases}$, where k_1 and k_2 are real constants. If (gof) is differentiable at x = 0, then (gof) (–4) + (gof) (4) is equal to:

(A) $4(e^4 + 1)$ (B) $2(2e^4 + 1)$

(C) $4e^4$ (D) $2(2e^4 - 1)$

8. The sum of the absolute minimum and the absolute maximum values of the function $f(x) = |3x - x^2 + 2| - x$ in the interval $[-1, 2]$ is :

(A) $\dfrac{\sqrt{17}+3}{2}$ (B) $\dfrac{\sqrt{17}+5}{2}$

(C) 5 (D) $\dfrac{9-\sqrt{17}}{2}$

9. Let S be the set of all the natural numbers, for which the line $\dfrac{x}{a}+\dfrac{y}{b}=2$ is a tangent to the curve $\left(\dfrac{x}{a}\right)^n+\left(\dfrac{y}{b}\right)^n=2$ at the point (a, b), $ab \neq 0$. Then:

(A) $S = \phi$ (B) n(S) = 1

(C) $S = \{2k : k \in N\}$ (D) S = N

10. The area bounded by the curve $y = |x^2 - 9|$ and the line y = 3 is :

(A) $4\left(2\sqrt{3}+\sqrt{6}-4\right)$

(B) $4\left(4\sqrt{3}+\sqrt{6}-4\right)$

(C) $8\left(4\sqrt{3}+3\sqrt{6}-9\right)$

(D) $8\left(4\sqrt{3}+\sqrt{6}-9\right)$

11. Let R be the point (3, 7) and let P and Q be two points on the line x + y = 5 such that PQR is an equilateral triangle. Then the area of ΔPQR is :

(A) $\frac{25}{4\sqrt{3}}$ (B) $\frac{25\sqrt{3}}{2}$

(C) $\frac{25}{\sqrt{3}}$ (D) $\frac{25}{2\sqrt{3}}$

12. Let C be a circle passing through the points A(2, –1) and B(3, 4). The line segment AB is not a diameter of C. If r is the radius of C and its centre lies on the circle

$(x-5)^2 + (y-1)^2 = \frac{13}{2}$, then r^2 is equal to :

(A) 32 (B) $\frac{65}{2}$

(C) $\frac{61}{2}$ (D) 30

13. Let the normal at the point P on the parabola $y^2 = 6x$ pass through the point (5, –8). If the tangent at P to the parabola intersects its directrix at the point Q, then the ordinate of the point Q is :

(A) –3 (B) $-\frac{9}{4}$ (C) $-\frac{5}{2}$ (D) –2

14. If the two lines $l_1 : \frac{x-2}{3} = \frac{y+1}{-2}$, z = 2 and $l_2 : \frac{x-1}{1} = \frac{2y+3}{\alpha} = \frac{z+5}{2}$ perpendicular, then an angle between the lines l_2 and $l_3 : \frac{1-x}{3} = \frac{2y-1}{-4} = \frac{z}{4}$ is :

(A) $\cos^{-1}\left(\frac{29}{4}\right)$ (B) $\sec^{-1}\left(\frac{29}{4}\right)$

(C) $\cos^{-1}\left(\frac{2}{29}\right)$ (D) $\cos^{-1}\left(\frac{2}{\sqrt{29}}\right)$

15. Let the plane 2x + 3y + z + 20 = 0 be rotated through a right angle about its line of intersection with the plane x – 3y + 5z = 8. If the mirror image of the point $\left(2, -\frac{1}{2}, 2\right)$ in the rotated plane is B(a, b, c), then :

(A) $\frac{a}{8} = \frac{b}{5} = \frac{c}{-4}$ (B) $\frac{a}{4} = \frac{b}{5} = \frac{c}{-2}$

(C) $\frac{a}{8} = \frac{b}{-5} = \frac{c}{4}$ (D) $\frac{a}{4} = \frac{b}{5} = \frac{c}{2}$

16. If $\vec{a}\cdot\vec{b} = 1$, $\vec{b}\cdot\vec{c} = 2$ and $\vec{c}\cdot\vec{a} = 3$, then the value of $\left[\vec{a}\times\left(\vec{b}\times\vec{c}\right), \vec{b}\times\left(\vec{c}\times\vec{a}\right), \vec{c}\times\left(\vec{b}\times\vec{a}\right)\right]$ is :

(A) 0 (B) $-6\vec{a}\cdot\left(\vec{b}\times\vec{c}\right)$

(C) $12\vec{c}\cdot\left(\vec{a}\times\vec{b}\right)$ (D) $-12\vec{b}\cdot\left(\vec{c}\times\vec{a}\right)$

17. Let a biased coin be tossed 5 times. If the probability of getting 4 heads is equal to the probability of getting 5 heads, then the probability of getting atmost two heads is:

(A) $\frac{275}{6^5}$ (B) $\frac{36}{5^4}$

(C) $\frac{181}{5^5}$ (D) $\frac{46}{6^4}$

18. The mean of the numbers a, b, 8, 5, 10 is 6 and their variance is 6.8. If M is the mean deviation of the numbers about the mean, then 25 M is equal to:

(A) 60 (B) 55 (C) 50 (D) 45

19. Let $f(x) = 2\cos^{-1}x + 4\cot^{-1}x - 3x^2 - 2x + 10$, $x \in [-1, 1]$. If [a, b] is the range of the function then 4a – b is equal to:

(A) 11 (B) 11 – π

(C) 11 + π (D) 15 – π

20. Let Δ, ∇ ∈ $\{\wedge, \vee\}$ be such that p ∇ q ⇒ ((p Δ q) ∇ r) is a tautology. Then (p ∇ q) Δ r is logically equivalent to :

(A) (p Δ r) ∨ q (B) (p Δ r) ∧ q

(C) (p ∧ r) Δ q (D) (p ∇ r) ∧ q

SECTION-B

1. The sum of the cubes of all the roots of the equation $x^4 - 3x^3 - 2x^2 + 3x + 1 = 10$ is ______.

2. There are ten boys $B_1, B_2, ..., B_{10}$ and five girls $G_1, G_2, ..., G_5$ in a class. Then the number of ways of forming a group consisting of three boys and three girls, if both B_1 and B_2 together should not be the members of a group, is__________.

3. Let the common tangents to the curves $4(x^2 + y^2) = 9$ and $y^2 = 4x$ intersect at the point Q. Let an ellipse, centered at the origin O, has lengths of semi-minor and semi-major axes equal to OQ and 6, respectively. If e and l respectively denote the eccentricity and the length of the latus rectum of this ellipse, then $\frac{l}{e^2}$ is equal to___________.

4. Let $f(x) = \max\{|x + 1|, |x + 2|, ..., |x + 5|\}$. Then $\int_{-6}^{0} f(x)dx$ is equal to _____________.

5. Let the solution curve $y = y(x)$ of the differential equation $(4 + x^2)dy - 2x(x^2 + 3y + 4)dx = 0$ pass through the origin. Then y(2) is equal to________.

6. If $\sin^2(10°)\sin(20°)\sin(40°)\sin(50°)\sin(70°) = \alpha - \frac{1}{16}\sin(10°)$, then $16 + \alpha^{-1}$ is equal to __________.

7. Let $A = \{n \in N : \text{H.C.F.}(n, 45) = 1\}$ and Let $B = \{2k : k \in \{1, 2, ..., 100\}\}$. Then the sum of all the elements of $A \cap B$ is __________.

8. The value of the integral $\frac{48}{\pi^4}\int_0^{\pi}\left(\frac{3\pi x^2}{2} - x^3\right)\frac{\sin x}{1+\cos^2 x}dx$ is equal to _______.

9. Let $A = \sum_{i=1}^{10}\sum_{j=1}^{10}\min\{i, j\}$ and $B = \sum_{i=1}^{10}\sum_{j=1}^{10}\max\{i, j\}$. Then A + B is equal to ________.

10. Let $S = (0, 2\pi) - \left\{\frac{\pi}{2}, \frac{3\pi}{4}, \frac{3\pi}{2}, \frac{7\pi}{4}\right\}$. Let $y = y(x)$, $x \in S$, be the solution curve of the differential equation $\frac{dy}{dx} = \frac{1}{1+\sin 2x}$, $y\left(\frac{\pi}{4}\right) = \frac{1}{2}$. if the sum of abscissas of all the points of intersection of the curve $y = y(x)$ with the curve $y = \sqrt{2}\sin x$ is $\frac{k\pi}{12}$, then k is equal to _________.

SET # 06

PHYSICS

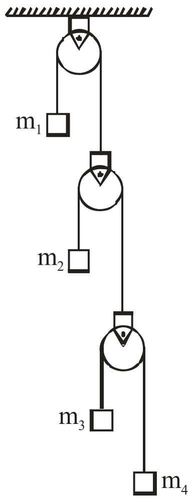
SECTION-A

1. The dimension of mutual inductance is :

(A) $[ML^2 T^{-2} A^{-1}]$ (B) $[ML^2T^{-3}A^{-1}]$

(C) $[ML^2T^{-2}A^{-2}]$ (D) $[ML^2T^{-3}A^{-2}]$

2. In the arrangement shown in figure a_1, a_2, a_3 and a_4 are the accelerations of masses m_1, m_2, m_3 and m_4 respectively. Which of the following relation is true for this arrangement?



(A) $4a_1 + 2a_2 + a_3 + a_4 = 0$

(B) $a_1 + 4a_2 + 3a_3 + a_4 = 0$

(C) $a_1 + 4a_2 + 3a_3 + 2a_4 = 0$

(D) $2a_1 + 2a_2 + 3a_3 + a_4 = 0$

3. Arrange the four graphs in descending order of total work done; where W_1, W_2, W_3 and W_4 are the work done corresponding to figure a, b, c and d respectively.

Figure-a

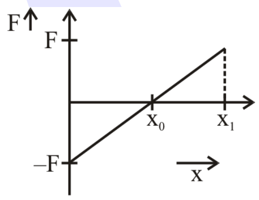


Figure-b

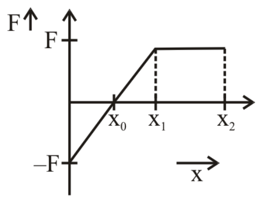


Figure-c

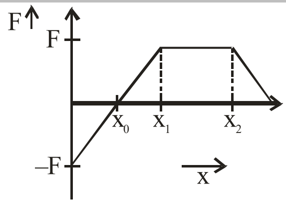
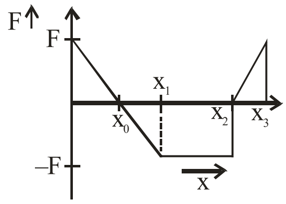


Figure-d



(A) $W_3 > W_2 > W_1 > W_4$

(B) $W_3 > W_2 > W_4 > W_1$

(C) $W_2 > W_3 > W_4 > W_1$

(D) $W_2 > W_3 > W_1 > W_4$

4. Solid spherical ball is rolling on a frictionless horizontal plane surface about its axis of symmetry. The ratio of rotational kinetic energy of the ball to its total kinetic energy is :-

(A) $\frac{2}{5}$ (B) $\frac{2}{7}$ (C) $\frac{1}{5}$ (D) $\frac{7}{10}$

5. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : If we move from poles to equator, the direction of acceleration due to gravity of earth always points towards the center of earth without any variation in its magnitude.

Reason R : At equator, the direction of acceleration due to the gravity is towards the center of earth.

In the light of above statements, choose the correct answer from the options given below :

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false

(D) A is false but R is true

6. If ρ is the density and η is coefficient of viscosity of fluid which flows with a speed v in the pipe of diameter d, the correct formula for Reynolds number R_e is :

(A) $R_e = \frac{\eta d}{\rho v}$ (B) $R_e = \frac{\rho v}{\eta d}$

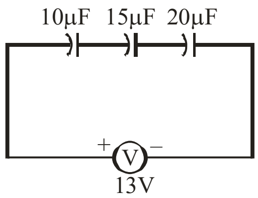
(C) $R_e = \frac{\rho v d}{\eta}$ (D) $R_e = \frac{\eta}{\rho v d}$

7. A flask contains argon and oxygen in the ratio of 3 : 2 in mass and the mixture is kept at 27°C. The ratio of their average kinetic energy per molecule respectively will be :

(A) 3 : 2 (B) 9 : 4

(C) 2 : 3 (D) 1 : 1

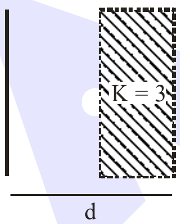
8. The charge on capacitor of capacitance 15μF in the figure given below is :



(A) 60μc (B) 130μc

(C) 260 μc (D) 585 μc

9. A parallel plate capacitor with plate area A and plate separation d=2 m has a capacitance of 4 μF. The new capacitance of the system if half of the space between them is filled with a dielectric material of dielectric constant K=3 (as shown in figure) will be :



(A) 2μF (B) 32μF

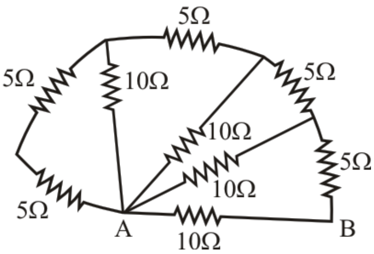
(C) 6μF (D) 8μF

10. Sixty four conducting drops each of radius 0.02 m and each carrying a charge of 5 μC are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be :

(A) 1 : 4 (B) 4 : 1

(C) 1 : 8 (D) 8 : 1

11. The equivalent resistance between points A and B in the given network is :



(A) 65Ω (B) 20Ω

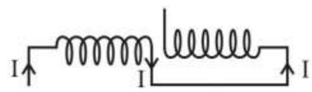
(C) 5Ω (D) 2Ω

12. A bar magnet having a magnetic moment of 2.0×10^5 JT^{-1}, is placed along the direction of uniform magnetic field of magnitude $B = 14 \times 10^{-5}$ T. The work done in rotating the magnet slowly through 60° from the direction of field is :

(A) 14 J (B) 8.4 J

(C) 4 J (D) 1.4 J

13. Two coils of self inductance L_1 and L_2 are connected in series combination having mutual inductance of the coils as M. The equivalent self inductance of the combination will be :



(A) $\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{M}$ (B) $L_1 + L_2 + M$

(C) $L_1 + L_2 + 2M$ (D) $L_1 + L_2 - 2M$

14. A metallic conductor of length 1m rotates in a vertical plane parallel to east-west direction about one of its end with angular velocity 5 rad/s. If the horizontal component of earth's magnetic field is 0.2×10^{-4} T, then emf induced between the two ends of the conductor is :

(A) 5μV (B) 50μV

(C) 5mV (D) 50mV

15. Which is the correct ascending order of wavelengths?

(A) $\lambda_{visible} < \lambda_{X-ray} < \lambda_{gamma\text{-}ray} < \lambda_{microwave}$

(B) $\lambda_{gamma\text{-}ray} < \lambda_{X-ray} < \lambda_{visible} < \lambda_{microwave}$

(C) $\lambda_{X\text{-}ray} < \lambda_{gamma\text{-}ray} < \lambda_{visible} < \lambda_{microwave}$

(D) $\lambda_{microwave} < \lambda_{visible} < \lambda_{gamma\text{-}ray} < \lambda_{X\text{-}ray}$

16. For a specific wavelength 670 nm of light coming from a galaxy moving with velocity v, the observed wavelength is 670.7 nm.

The value of v is :

(A) 3×10^8 ms^{-1} (B) 3×10^{10} ms^{-1}

(C) 3.13×10^5 ms^{-1} (D) 4.48×10^5 ms^{-1}

17. A metal surface is illuminated by a radiation of wavelength 4500 Å. The ejected photo-electron enters a constant magnetic field of 2 mT making an angle of 90° with the magnetic field. If it starts revolving in a circular path of radius 2 mm, the work function of the metal is approximately :

(A) 1.36 eV (B) 1.69 eV

(C) 2.78 eV (D) 2.23 eV

18. A radioactive nucleus can decay by two different processes. Half-life for the first process is 3.0 hours while it is 4.5 hours for the second process. The effective half- life of the nucleus will be :

(A) 3.75 hours (B) 0.56 hours

(C) 0.26 hours (D) 1.80 hours

19. The positive feedback is required by an amplifier to act an oscillator. The feedback here means :

(A) External input is necessary to sustain ac signal in output.

(B) A portion of the output power is returned back to the input.

(C) Feedback can be achieved by LR network.

(D) The base-collector junction must be forward biased.

20. A sinusoidal wave $y(t) = 40\sin(10 \times 10^6 \pi t)$ is amplitude modulated by another sinusoidal wave $x(t) = 20\sin(1000\pi t)$. The amplitude of minimum frequency component of modulated signal is :

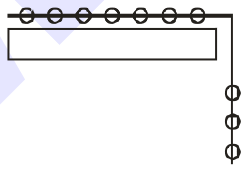
(A) 0.5 (B) 0.25 (C) 20 (D) 10

SECTION-B

1. A ball is projected vertically upward with an initial velocity of 50 ms^{-1} at t = 0s. At t = 2s. another ball is projected vertically upward with same velocity. At t =________s, second ball will meet the first ball (g =10 ms^{-2}).

2. A batsman hits back a ball of mass 0.4 kg straight in the direction of the bowler without changing its initial speed of 15 ms^{-1}. The impulse imparted to the ball is ________________Ns.

3. A system to 10 balls each of mass 2 kg are connected via massless and unstretchable string. The system is allowed to slip over the edge of a smooth table as shown in figure. Tension on the string between the 7th and 8th ball is______________N when 6th ball just leaves the table.



4. A geyser heats water flowing at a rate of 2.0 kg per minute from 30°C to 70°C. If geyser operates on a gas burner, the rate of combustion of fuel will be _____________g min^{-1}

[Heat of combustion = 8×10^3 Jg^{-1}

Specific heat of water = 4.2 Jg^{-1} °C^{-1}]

5. A heat engine operates with the cold reservoir at temperature 324 K.

The minimum temperature of the hot reservoir, if the heat engine takes 300 J heat from the hot reservoir and delivers 180 J heat to the cold reservoir per cycle, is ____________K.

6. A set of 20 tuning forks is arranged in a series of increasing frequencies. If each fork gives 4 beats with respect to the preceding fork and the frequency of the last fork is twice the frequency of the first, then the frequency of last fork is_____Hz.

7. Two 10 cm long, straight wires, each carrying a current of 5A are kept parallel to each other. If each wire experienced a force of 10^{-5} N, then separation between the wires is _________cm.

8. A small bulb is placed at the bottom of a tank containing water to a depth of $\sqrt{7}$ m. The refractive index of water is $\frac{4}{3}$. The area of the surface of water through which light from the bulb can emerge out is $x\pi$ m^2. The value of x is_______.

9. A travelling microscope is used to determine the refractive index of a glass slab. If 40 divisions are there in 1 cm on main scale and 50 Vernier scale divisions are equal to 49 main scale divisions, then least count of the travelling microscope is ______$\times 10^{-6}$ m.

10. The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 6630 Å is 0.42 V. If the threshold frequency is $x \times 10^{13}$/s, where x is ______ (nearest integer).
(Given, speed light = 3×10^8 m/s, Planck's constant = 6.63×10^{-34} Js)

CHEMISTRY
SECTION-A

1. The number of radial and angular nodes in 4d orbital are. respectively
(A) 1 and 2 (B) 3 and 2
(C) 1 and 0 (D) 2 and 1

2. Match List I with List II.

List I Enzyme	List II Conversion of
A. Invertase	I. Starch into maltose
B. Zymase	II. Maltose into glucose
C. Diastase	III. Glucose into ethanol
D. Maltase	IV. Cane sugar into glucose

Choose the most appropriate answer from the options given below :
(A) A-III, B-IV. C-II. D-I
(B) A-III. B-II. C-I. D-IV
(C) A-IV, B-IIL C-I. D-II
(D) A-IV, B-II. C-III. D-I

3. Which of the following elements in considered as a metalloid?
(A) Sc (B) Pb (C) Bi (D) Te

4. The role of depressants in Froth Flotation method* is to
(A) selectively prevent one component of the ore from coming to the froth.
(B) reduce the consumption of oil for froth formation.
(C) stabilize the froth.
(D) enhance non-wettability of the mineral particles.

5. Boiling of hard water is helpful in removing the temporary hardness by converting calcium hydrogen carbonate and magnesium hydrogen carbonate to
(A) $CaCO_3$ and $Mg(OH)_2$
(B) $CaCO_3$ and M_2CO_3
(C) $Ca(OH)_2$ and $MgCO_3$
(D) $Ca(OH)_2$ and $Mg(OH)_2$

6. s-block element which cannot be qualitatively confirmed by the flame test is
(A) Li (B) Na (C) Rb (D) Be

7. The oxide which contains an odd electron at the nitrogen atom is
(A) N_2O (B) NO_2
(C) N_2O_3 (D) N_2O_5

8. Which one of the following is an example of disproportionation reaction?
(A) $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$
(B) $MnO_4^{2-} + 4H^+ + 4e^- \rightarrow MnO_2 + 2H_2O$
(C) $10I^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5I_2$
(D) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

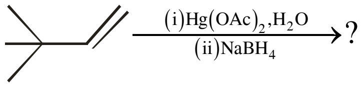
9. The most common oxidation state of Lanthanoid elements is +3. Which of the following is likely to deviate easily from +3 oxidation state?
(A) Ce (At. No. 58) (B) La (At. No. 57)
(C) Lu (At. No. 71) (D) Gd (At. No. 64)

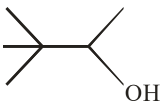
10. The measured BOD values for four different water samples (A-D) are as follows:
A = 3 ppm: B = 18 ppm: C-21 ppm: D = 4 ppm. The water samples which can be called as highly polluted with organic wastes, are
(A) A and B (B) A and D
(C) B and C (D) B and D

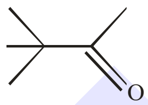
11. The correct order of nucleophilicity is
(A) $F^- > OH^-$ (B) $H_2\ddot{\underset{..}{O}} > OH^-$
(C) $R\ddot{\underset{..}{O}}H > RO^-$ (D) $NH_2^- > NH_3$

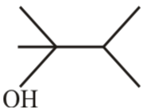
12. Oxidation of toluene to Benzaldehyde can be easily carried out with which of the following reagents?
(A) CrO_3/acetic acid, H_3O^+
(B) CrO_3/acetic anhydride, H_3O^+
(C) $KMnO_4$/HCl, H_3O^+
(D) CO/HCl, anhydrous $AlCl_3$

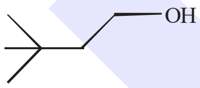
13. The major product in the following reaction

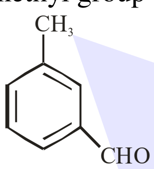


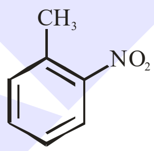
(A) 

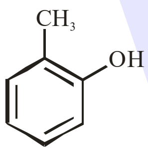
(B) 

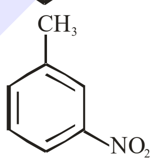
(C) 

(D) 

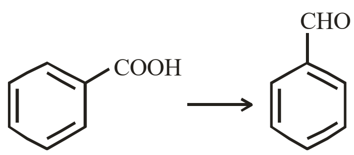
14. Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product?
(A) 

(B) 

(C) 

(D) 

15. The reagent, from the following, which converts benzoic acid to benzaldehyde in one step is



(A) $LiAlH_4$ (B) $KMnO_4$
(C) MnO (D) $NaBH_4$

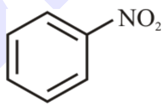
16. The final product 'A' in the following reaction sequence

$$CH_3CH_2-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow{HCN} ? \xrightarrow[\text{Heat}]{95\%\ H_2SO_4} A$$

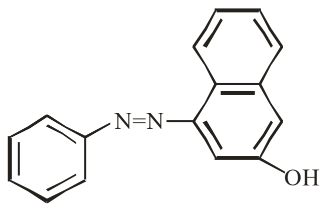
(A) $CH_3-CH=\overset{\overset{CH_3}{|}}{C}-COOH$
(B) $CH_3-CH=\underset{\underset{CH_3}{|}}{C}-CN$
(C) $CH_3-CH-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-COOH$
(D) $CH_3-CH=\underset{\underset{CH_3}{|}}{C}-CONH_2$

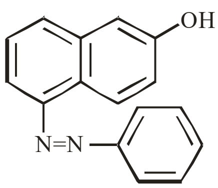
17. Which statement is NOT correct for p-toluenesulphonyl chloride?
(A) It is known as Hinsberg's reagent.
(B) It is used to distinguish primary and secondary amines.
(C) On treatment with secondary amine, it leads to a product, that is soluble in alkali.
(D) It doesn't react with tertiary amines.

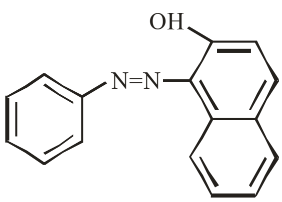
18. The final product 'C' is the following series series of reactions

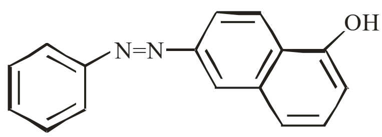


$\xrightarrow{Sn/HCl} A \xrightarrow[HCl]{NaNO_2} B \xrightarrow[NaOH]{\beta-\text{Naphthol}} C$ is

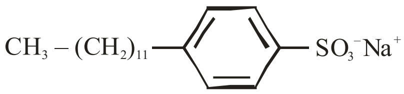
(A) 

(B) 

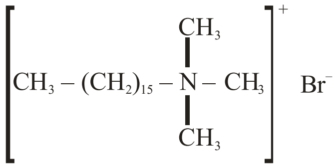
(C) 

(D) 

19. Which of the following is NOT an example of synthetic detergent?

(A) 

(B) $CH_3-(CH_2)_{16}-COO^-Na^+$

(C) 

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$

20. Which one of the following is a water soluble vitamin, that is not excreted easily?

(A) Vitamin B_2 (B) Vitamin B_1

(C) Vitamin B_6 (D) Vitamin B_{12}

SECTION-B

1. CNG is an important transportation fuel. When 100 g CNG is mixed with 208 oxygen in vehicles, it leads to the formation of CO_2 and H_2O and produces large quantity of heat during this combustion, then the amount of carbon dioxide, produced in grams is________. [nearest integer]

[Assume CNG to be methane]

2. In a solid AB. A atoms are in ccp arrangement and B atoms occupy all the octahedral sites. If two atoms from the opposite faces are removed, then the resultant stoichiometry of the compound is A_xB_y. The value of x is________. [nearest integer]

3. Amongst SF_4, XeF_4, CF_4 and H_2O, the number of species with two lone pairs of electrons _______ .

4. A fish swimming in water body when taken out from the water body is covered with a film of water of weight 36 g. When it is subjected to cooking at 100°C, then the internal energy for vaporization in kJ mol^{-1} is ________.

[nearest integer]

[Assume steam to be an ideal gas. Given $A_{vap}H^{\ominus}$ for water at 373 K and 1 bar is 41.1 kJ mol^{-1} ; R = 8.31 $JK^{-1}mol^{-1}$]

5. The osmotic pressure exerted by a solution prepared by dissolving 2.0 g of protein of molar mass 60 kg mol^{-1} in 200 mL of water at 27°C is _______ Pa. [integer value]

(use R = 0.083 L bar mol^{-1} K^{-1})

6. 40% of HI undergoes decomposition to H_2 and I_2 at 300 K. $\Delta G^{\ominus}$ for this decompostion reaction at one atmosphere pressure is________ J mol^{-1}. [nearest integer]

(Use R = 8.31 J K^{-1} mol^{-1}; log 2 = 0.3010. In 10 = 2.3, log 3 = 0.477)

7. $Cu(s) + Sn^{2+}(0.001M) \rightarrow Cu^{2+}(0.01M) + Sn(s)$

The Gibbs free energy change for the above reaction at 298 K is $x \times 10^{-1}$ kJ mol^{-1};

The value of x is______. [nearest integer]

$\left[\text{Given}: E^{\ominus}_{Cu^{2+}/Cu} = 0.34V; E^{\ominus}_{Sn^{2+}/Sn} = -0.14V; F = 96500C\ mol^{-1}\right]$

8. Catalyst A reduces the activation energy for a reaction by 10 kJ mol^{-1} at 300 K. The ratio of rate constants, $\frac{^{k}T,\text{Catalysed}}{^{k}T,\text{Uncatalysed}}$ is e^x. The value of x is _______. [nearest integer]

[Assume theat the pre-exponential factor is same in both the cases.

Given R = 8.31 J K^{-1} mol^{-1}]

9. Reaction of $[Co(H_2O)_6]^{2+}$ with excess ammonia and in the presence of oxygen results into a diamagnetic product. Number of electrons present in t_{2g}–orbitals of the product is _______ .

10. The moles of methane required to produce 81 g of water after complete combustion is ______ $\times 10^{-2}$ mol. [nearest integer]

MATHEMATICS
SECTION-A

1. Let $f: \mathbb{R} \to \mathbb{R}$ be defined as f(x) = x-1 and $g: \mathbb{R} - \{1, -1\} \to \mathbb{R}$ be defined as $g(x) = \frac{x^2}{x^2-1}$.

Then the function fog is :

(A) one-one but not onto function

(B) onto but not one-one function

(C) both one-one and onto function

(D) neither one-one nor onto function

2. If the system of equations $\alpha x + y + z = 5$, $x + 2y + 3z = 4$, $x + 3y + 5z = \beta$, has infinitely many solutions, then the ordered pair (α, β) is equal to :

(A) (1,–3) (B) (–1, 3)

(C) (1, 3) (D) (–1, –3)

3. If $A = \sum_{n=1}^{\infty} \frac{1}{\left(3+(-1)^n\right)^n}$ and $B = \sum_{n=1}^{\infty} \frac{(-1)^n}{\left(3+(-1)^n\right)^n}$, then $\frac{A}{B}$ is equal to :

(A) $\frac{11}{9}$ (B) 1

(C) $-\frac{11}{9}$ (D) $-\frac{11}{3}$

4. $\lim_{x \to 0} \frac{\cos(\sin x) - \cos x}{x^4}$ is equal to :

(A) $\frac{1}{3}$ (B) $\frac{1}{4}$

(C) $\frac{1}{6}$ (D) $\frac{1}{12}$

5. Let f (x) = min {1, 1 + x sin x}, $0 \le x \le 2\pi$. If m is the number of points, where f is not differentiable and n is the number of points, where f is not continuous, then the ordered pair (m, n) is equal to

(A) (2, 0) (B) (1, 0)

(C) (1, 1) (D) (2, 1)

6. Consider a cuboid of sides 2x, 4x and 5x and a closed hemisphere of radius r. If the sum of their surface areas is a constant k, then the ratio x : r, for which the sum of their volumes is maximum, is :

(A) 2 : 5 (B) 19:45

(C) 3 : 8 (D) 19 : 15

7. The area of the region bounded by $y^2 = 8x$ and $y^2 = 16(3 - x)$ is equal to :-

(A) $\frac{32}{3}$ (B) $\frac{40}{3}$

(C) 16 (D) 19

8. If $\int \frac{1}{x}\sqrt{\frac{1-x}{1+x}}dx = g(x) + c, g(1) = 0$, then $g\left(\frac{1}{2}\right)$ is equal to :

(A) $\log_e\left(\frac{\sqrt{3}-1}{\sqrt{3}+1}\right) + \frac{\pi}{3}$

(B) $\log_e\left(\frac{\sqrt{3}+1}{\sqrt{3}-1}\right) + \frac{\pi}{3}$

(C) $\log_e\left(\frac{\sqrt{3}+1}{\sqrt{3}-1}\right) - \frac{\pi}{3}$

(D) $\frac{1}{2}\log_e\left(\frac{\sqrt{3}-1}{\sqrt{3}+1}\right) - \frac{\pi}{6}$

9. If y = y(x) is the solution of the differential equation $x\frac{dy}{dx} + 2y = xe^x, y(1) = 0$, then the local maximum value of the function $z(x) = x^2y(x) - e^x$, $x \in R$ is :

(A) 1 – e (B) 0

(C) $\frac{1}{2}$ (D) $\frac{4}{e} - e$

10. If the solution of the differential equation

$$\frac{dy}{dx} + e^x\left(x^2-2\right)y = \left(x^2-2x\right)\left(x^2-2\right)e^{2x}$$

satisfies

y(0) = 0, then the value of y(2) is _______ .

(A) –1 (B) 1

(C) 0 (D) e

11. If m is the slope of a common tangent to the curves $\frac{x^2}{16} + \frac{y^2}{9} = 1$ and $x^2+y^2 = 12$, then $12m^2$ is equal to :

(A) 6 (B) 9

(C) 10 (D) 12

12. The locus of the mid point of the line segment joining the point (4, 3) and the points on the ellipse $x^2 + 2y^2 = 4$ is an ellipse with eccentricity :

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{1}{2\sqrt{2}}$

(C) $\frac{1}{\sqrt{2}}$ (D) $\frac{1}{2}$

13. The normal to the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{9}=1$ at the point $(8,3\sqrt{3})$ on it passes through the point :

(A) $(15,-2\sqrt{3})$ (B) $(9,2\sqrt{3})$

(C) $(-1,9\sqrt{3})$ (D) $(-1,6\sqrt{3})$

14. If the plane $2x + y - 5z = 0$ is rotated about its line of intersection with the plane $3x - y + 4z - 7 = 0$ by an angle of $\frac{\pi}{2}$, then the plane after the rotation passes through the point :

(A) (2, –2, 0) (B) (–2, 2, 0)

(C) (1, 0, 2) (D) (–1, 0, –2)

15. If the lines $\vec{r}=(\hat{i}-\hat{j}+\hat{k})+\lambda(3\hat{j}-\hat{k})$ and $\vec{r}=(\alpha\hat{i}-\hat{j})+\mu(2\hat{i}-3\hat{k})$ are co-planar, then distance of the plane containing these two lines from the point (α, 0, 0) is :

(A) $\frac{2}{9}$ (B) $\frac{2}{11}$

(C) $\frac{4}{11}$ (D) 2

16. Let $\vec{a}=\hat{i}+\hat{j}+2\hat{k}, \vec{b}=2\hat{i}-3\hat{j}+\hat{k}$ and $\vec{c}=\hat{i}-\hat{j}+\hat{k}$ be three given vectors. Let $\vec{v}$ be a vector in the plane of $\vec{a}$ and $\vec{b}$ whose projection on $\vec{c}$ is $\frac{2}{\sqrt{3}}$. If $\vec{v}.\hat{j}=7$, then $\vec{v}.(\hat{i}+\hat{k})$ is equal to :

(A) 6 (B) 7 (C) 8 (D) 9

17. The mean and standard deviation of 50 observations are 15 and 2 respectively. It was found that one incorrect observation was taken such that the sum of correct and incorrect observations is 70. If the correct mean is 16, then the correct variance is equal to :

(A) 10 (B) 36

(C) 43 (D) 60

18. 16 sin (20°) sin (40°) sin (80°) is equal to :

(A) $\sqrt{3}$ (B) $2\sqrt{3}$

(C) 3 (D) $4\sqrt{3}$

19. If the inverse trigonometric functions take principal values, then $\cos^{-1}\left(\frac{3}{10}\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right)+\frac{2}{5}\sin\left(\tan^{-1}\left(\frac{4}{3}\right)\right)\right)$ is equal to :

(A) 0 (B) $\frac{\pi}{4}$

(C) $\frac{\pi}{3}$ (D) $\frac{\pi}{6}$

20. Let r ∈ {p, q, ~p, ~q} be such that the logical statement $r\vee(\sim p)\Rightarrow(p\wedge q)\vee r$ is a tautology. Then 'r' is equal to :

(A) p (B) q (C) ~p (D) ~q

SECTION-B

1. Let $f:\mathbb{R}\to\mathbb{R}$ satisfy $f(x + y) = 2^x f(y) + 4^y f(x), \forall x, y \in \mathbb{R}$.

If f(2) = 3, then $14.\frac{f'(4)}{f'(2)}$ is equal to _____.

2. Let p and q be two real numbers such that p + q = 3 and $p^4 + q^4 = 369$. Then $\left(\frac{1}{p}+\frac{1}{q}\right)^{-2}$ is equal to _______.

3. If $z^2 + z + 1 = 0$, $z \in \mathbb{C}$, then $\left|\sum_{n=1}^{15}\left(Z^n+(-1)^n\frac{1}{Z^n}\right)^2\right|$ is equal to ______ .

4. Let $X = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}, Y = \alpha I + \beta X + \gamma X^2$ and $Z = \alpha^2 I - \alpha\beta X + \left(\beta^2 - \alpha\gamma\right)X^2, \alpha, \beta, \gamma \in \mathbb{R}$. If $Y^{-1} = \begin{bmatrix} \frac{1}{5} & \frac{-2}{5} & \frac{1}{5} \\ 0 & \frac{1}{5} & \frac{-2}{5} \\ 0 & 0 & \frac{1}{5} \end{bmatrix}$, then $(\alpha - \beta + \gamma)^2$ is equal to _____ .

5. The total number of 3–digit numbers, whose greatest common divisor with 36 is 2, is ______ .

6. If $\left({}^{40}C_0\right) + \left({}^{41}C_1\right) + \left({}^{42}C_2\right) + ... + \left({}^{60}C_{20}\right) = \frac{m}{n}\, {}^{60}C_{20}$, m and n are coprime, then m + n is equal to ____ .

7. If $a_1 (> 0)$, a_2, a_3, a_4, a_5 are in a G.P., $a_2 + a_4 = 2a_3 + 1$ and $3a_2 + a_3 = 2a_4$, then $a_2 + a_4 + 2a_5$ is equal to ____.

8. The integral $\frac{24}{\pi}\int_0^{\sqrt{2}} \frac{\left(2 - x^2\right)dx}{\left(2 + x^2\right)\sqrt{4 + x^4}}$ is equal to ___.

9. Let a line L_1 be tangent to the hyperbola $\frac{x^2}{16} - \frac{y^2}{4} = 1$ and let L_2 be the line passing through the origin and perpendicular to L_1. If the locus of the point of intersection of L_1 and L_2 is $(x^2 + y^2)^2 = \alpha x^2 + \beta y^2$, then $\alpha + \beta$ is equal to ______ .

10. If the probability that a randomly chosen 6-digit number formed by using digits 1 and 8 only is a multiple of 21 is p, then 96 p is equal to _____ .

SET # 07

PHYSICS
SECTION-A

1. A projectile is launched at an angle 'α' with the horizontal with a velocity 20 ms^{-1} . After 10 s, its inclination with horizontal is 'β'. The value of tanβ will be : (g = 10 ms^{-2})

(A) $\tan\alpha + 5\sec\alpha$
(B) $\tan\alpha - 5\sec\alpha$
(C) $2\tan\alpha - 5\sec\alpha$
(D) $2\tan\alpha + 5\sec\alpha$

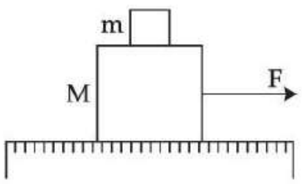
2. A girl standing on road holds her umbrella at 45° with the vertical to keep the rain away. If she starts running without umbrella with a speed of $15\sqrt{2}\,kmh^{-1}$, the rain drops hit her head vertically. The speed of rain drops with respect to the moving girl is :

(A) $30\,kmh^{-1}$ (B) $\frac{25}{\sqrt{2}}kmh^{-1}$
(C) $\frac{30}{\sqrt{2}}kmh^{-1}$ (D) $25\,kmh^{-1}$

3. A sliver wire has mass (0.6 ± 0.006) g, radius (0.5 ± 0.005) mm and length (4 ± 0.04) cm. The maximum percentage error in the measurement of its density will be :

(A) 4% (B) 3%
(C) 6% (D) 7%

4. A system of two blocks of masses m = 2 kg and M = 8 kg is placed on a smooth table as shown in figure. The coefficient of static friction between two blocks is 0.5. The maximum horizontal force F that can be applied to the block of mass M so that the blocks move together will be :



(A) 9.8 N (B) 39.2 N
(C) 49 N (D) 78.4 N

5. Two blocks of masses 10 kg and 30 kg are placed on the same straight line with coordinates (0, 0) cm and (x, 0) cm respectively. The block of 10 kg is moved on the same line through a distance of 6 cm towards the other block. The distance through which the block of 30 kg must be moved to keep the position of centre of mass of the system unchanged is :

(A) 4 cm towards the 10 kg block
(B) 2 cm away from the 10 kg block
(C) 2 cm towards the 10 kg block
(D) 4 cm away from the 10 kg block

6. A 72 Ω galvanometer is shunted by a resistance of 8 Ω. The percentage of the total current which passes through the galvanometer is :

(A) 0.1% (B) 10 %
(C) 25% (D) 0.25%

7. Given below are two statements :

Statement I : The law of gravitation holds good for any pair of bodies in the universe.

Statement II : The weight of any person becomes zero when the person is at the centre of the earth.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both statement I and Statement II are true
(B) Both statement I and Statement II are false
(C) Statement I is true but Statement II are false
(D) Statement I is false but Statement II is true

8. What percentage of kinetic energy of a moving particle is transferred to a stationary particle when it strikes the stationary particle of 5 times its mass? (Assume the collision to be head-on elastic collision)

(A) 50.0% (B) 66.6%
(C) 55.5% (D) 33.3%

9. The velocity of a small ball of mass 'm' and density d_1, when dropped in a container filled with glycerine, becomes constant after some time. If the density of glycerine is d_2, then the viscous force acting on the ball, will be :

(A) $mg\left(1-\frac{d_1}{d_2}\right)$ (B) $mg\left(1-\frac{d_2}{d_1}\right)$

(C) $mg\left(\frac{d_1}{d_2}-1\right)$ (D) $mg\left(\frac{d_2}{d_1}-1\right)$

10. The susceptibility of a paramagnetic material is 99. The permeability of the material in Wb/A-m is :

[Permeability of free space $\mu_0 = 4\pi \times 10^{-7} Wb/A-m$]

(A) $4\pi\times10^{-7}$ (B) $4\pi\times10^{-4}$

(C) $4\pi\times10^{-5}$ (D) $4\pi\times10^{-6}$

11. The current flowing through an ac circuit is given by

$$I = 5\sin(120\pi t)A$$

How long will the current take to reach the peak value starting from zero?

(A) $\frac{1}{60}s$ (B) 60s

(C) $\frac{1}{120}s$ (D) $\frac{1}{240}s$

12. Mach List-I with List – II :

	List-I		List-II
(a)	Ultraviolet rays	(i)	Study crystal structure
(b)	Microwaves	(ii)	Greenhouse effect
(c)	Infrared waves	(iii)	Sterilizing surgical instrument
(d)	X-rays	(iv)	Radar system

Choose the correct answer from the options given below :

(A) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)
(B) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)
(C) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

13. An α particle and a carbon 12 atom has same kinetic energy K. The ratio of their de-Broglie wavelength $(\lambda_\alpha : \lambda_{C12})$ is :

(A) $1:\sqrt{3}$ (B) $\sqrt{3}:1$

(C) 3 : 1 (D) $2:\sqrt{3}$

14. A force of 10N acts on a charged particle placed between two plates of a charged capacitor. If one plate of capacitor is removed, then the force acting on that particle will be :

(A) 5 N (B) 10 N

(C) 20 N (D) Zero

15. The displacement of simple harmonic oscillator after 3 seconds starting from its mean position is equal to half of its amplitude. The time period of harmonic motion is :

(A) 6 s (B) 8 s

(C) 12s (D) 36 s

16. An observer moves towards a stationary source of sound with a velocity equal to one-fifth of the velocity of sound. The percentage change in the frequency will be :

(A) 20% (B) 10%

(C) 5% (D) 0%

17. Consider a light ray travelling in air is incident into a medium of refractive index $\sqrt{2n}$. The incident angle is twice that of refracting angle. Then, the angle of incidence will be :

(A) $\sin^{-1}(\sqrt{n})$ (B) $\cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$

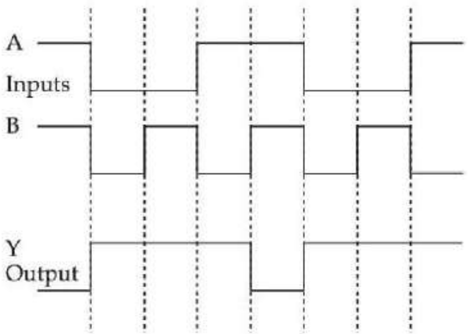
(C) $\sin^{-1}(\sqrt{2n})$ (D) $2\cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$

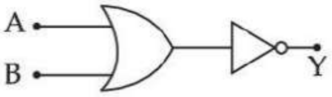
18. A hydrogen atom in is ground state absorbs 10.2 eV of energy. The angular momentum of electron of the hydrogen atom will increase by the value of : (Given, Plank's constant $= 6.6 \times 10^{-34}$ Js)

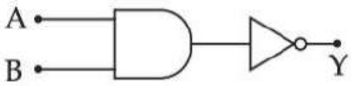
(A) $2.10\times10^{-34} Js$ (B) $1.05\times10^{-34} Js$

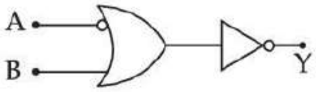
(C) $3.15\times10^{-34} Js$ (D) $4.2\times10^{-34} Js$

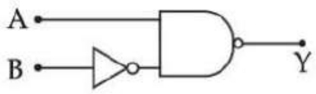
19. Identify the correct Logic Gate for the following output (Y) of two inputs A and B.



(A) 

(B) 

(C) 

(D) 

20. A mixture of hydrogen and oxygen has volume 2000 cm^3, temperature 300 K, pressure 100 kPa and mass 0.76 g The ratio of number of moles of hydrogen to number of moles of oxygen in the mixture will be :

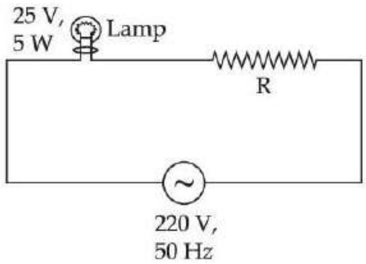
(A) $\frac{1}{3}$ (B) $\frac{3}{1}$

(C) $\frac{1}{16}$ (D) $\frac{16}{1}$

SECTION-B

1. In a carnot engine, the temperature of reservoir is 527ºC and that of sink is 200 K. If the workdone by the engine when it transfers heat from reservoir to sink is 12000 kJ, the quantity of heat absorbed by the engine from reservoir is _______ $\times 10^6$ J.

2. A 220 V, 50 Hz AC source is connected to a 25 V, 5 W lamp and an additional resistance R in series (as shown in figure) to run the lamp at its peak brightness, then the value of R (in ohm) will be ______ .



3. In Young's double slit experiment the two slits are 0.6 mm distance apart. Interference pattern is observed on a screen at a distance 80 cm from the slits. The first dark fringe is observed on the screen directly opposite to one of the slits. The wavelength of light will be _____ nm.

4. A beam of monochromatic light is used to excite the electron in Li^{++} from the first orbit to the third orbit. The wavelength of monochromatic light is found to be $x \times 10^{-10} m$. The value of x is ______ .

[Given hc = 1242 eV nm]

5. A cell, shunted by a 8 Ω resistance, is balanced across a potentiometer wire of length 3m. The balancing length is 2 m when the cell is shunted by 4Ω resistance. The value of internal resistance of the cell will be _____ Ω.

6. The current density in a cylindrical wire of radius 4 mm is $4 \times 10^6 Am^{-2}$. The current through the outer portion of the wire between radial distance $\frac{R}{2}$ and R is ____ π A.

7. A capacitor of capacitance 50 pF is charged by 100 V source. It is then connected to another uncharged identical capacitor. Electrostatic energy loss in the process is ____ nJ.

8. The height of a transmitting antenna at the top of a tower is 25 m and that of receiving antenna is, 49 m. The maximum distance between them, for satisfactory communication in LOS (Line-Of-Sight) is $K\sqrt{5} \times 10^2 m$. The value of K is ______ .

[Assume radius of Earth is $64 \times 10^{+5} m$]

(Calculate upto nearest integer value)

9. The area of cross-section of a large tank is $0.5 \ m^2$. It has a narrow opening near the bottom having area of cross-section $1 \ cm^2$. A load of 25 kg is applied on the water at the top in the tank. Neglecting the speed of water in the tank, the velocity of the water, coming out of the opening at the time when the height of water level in the tank is 40 cm above the bottom, will be ___ cms^{-1}. [Take $g = 10 \ ms^{-2}$]

10. A pendulum of length 2 m consists of a wooden bob of mass 50 g. A bullet of mass 75 g is fired towards the stationary bob with a speed v. The bullet emerges out of the bob with a speed $\frac{v}{3}$ and the bob just completes the vertical circle. The value of v is ________ ms^{-1}. (if $g = 10 \ m/s^2$)

CHEMISTRY
SECTION-A

1. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**

Assertion (A) : At 10°C, the density of a 5M solution of KCl [atomic masses of K and Cl are 39 & 35.5 g mol^{-1}]. The solution is cooled to -21°C. The molality of the solution will remain unchanged.

Reason (R) : The molality of a solution does not change with temperature as mass remains unaffected with temperature.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**

(B) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**

(C) **(A)** is true but **(R)** is false

(D) **(A)** is false but **(R)** is true

2. Based upon VSEPR theory, match the shape (geometry) of the molecules in List-I with the molecules in List-II and select the most appropriate option

List-I (Shape)	**List-II (Molecules)**
(A) T-shaped	(I) XeF_4
(B) Trigonal planar	(II) SF_4
(C) Square planar	(III) ClF_3
(D) See-saw	(IV) BF_3

(A) (A) – I, (B) – (II), (C) – (III), (D) – (IV)
(B) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)
(C) (A) – (III), (B) – (IV), (C) – (II), (D) – (I)
(D) (A) – (IV), (B) – (III), (C) – (I), (D) – (II)

3. Match List-I with List-II

	List-I	List-II
(A)	Spontaneous process	(I) $\Delta H < 0$
(B)	Process with $\Delta P = 0, \Delta T = 0$	(II) $\Delta G_{T,P} < 0$
(C)	$\Delta H_{reaction}$	(III) Isothermal and isobaric process
(D)	Exothermic process	(IV) [Bond energies of molecules in reactants] - [Bond energies of product molecules

Choose the correct answer from the options given below:
(A) (A) – (III), (B) – (II), (C) – (IV), (D) – (I)
(B) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)
(C) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)
(D) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

4. Match List-I with List-II

List-I	**List-II**
(A) Lyophilic colloid	(I) Liquid-liquid colloid
(B) Emulsion	(II) protective colloid
(C) Positively charged	(III) $FeCl_3$ + NaOH
(D) Negatively charged	(IV) $FeCl_3$ + hot water colloid

Choose the correct answer from the options given below:
(A) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)
(B) (A) – (III), (B) – (I), (C) – (IV), (D) – (II)
(C) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)
(D) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

5. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason(R)

Assertion (A): The ionic radii of O^{2-} and Mg^{2+} are same.

Reason (R) : Both O^{2-} and Mg^{2+} are isoelectronic species

In the light of the above statements, choose the correct answer from the options given below

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true

6. Match List-I with List-II

List-I	**List-II**
(A) Concentration of gold ore	(I) Aniline
(B) Leaching of alumina	(II) NaOH
(C) Froth stabiliser	(III) SO_2
(D) Blister copper	(IV) NaCN

Choose the correct answer from the options given below.

(A) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)

(B) (A) – (IV), (B) – (II), (C) – (I), (D) – (III)

(C) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

(D) (A) – (II), (B) – (IV), (C) – (III), (D) – (I)

7. Addition of H_2SO_4 to BaO_2 produces:

(A) BaO, SO_2 and H_2O

(B)$BaHSO_4$ and O_2

(C) $BaSO_4$, H_2 and O_2

(D) $BaSO_4$ and H_2O_2

8. $BeCl_2$ reacts with $LiAlH_4$ to give

(A) Be + Li[$AlCl_4$] + H_2

(B) Be + AlH_3 + LiCl + HCl

(C) BeH_2 + LiCl + $AlCl_3$

(D) BeH_2 + Li[$AlCl_4$]

9. Match List-I with List-II

List-I	List-II
(Si-Compounds) Polymeric/other	**(Si-products)**
(A) $(CH_3)_4Si$	(I) Chain silicone
(B) $(CH_3)Si(OH)_3$	(II)Dimeric silicone
(C) $(CH_3)_2Si(OH)_2$	(III) Silane
(D) $(CH_3)_3Si(OH)$	(IV) 2D – Silicone

Choose the correct answer from the options given below:

(A) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

(B) (A) – (IV), (B) – (I), (C) – (II), (D) – (III)

(C) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

(D) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

10. Heating white phosphorus with conc. NaOH solution gives mainly

(A) Na_3P and H_2O

(B) H_3PO and NaH

(C) $P(OH)_3$ and NaH_2PO_4

(D) PH_3 and NaH_2PO_2

11. Which of the following will have maximum stabilization due to crystal field?

(A) $[Ti(H_2O)_6]^{3+}$ (B) $[Co(H_2O)_6]^{2+}$

(C) $[Co(CN)_6]^{3-}$ (D) $[Cu(NH_3)_4]^{2+}$

12. Given below are two statements:

Statement I: Classical smog occurs in cool humid climate. It is a reducing mixture of smoke, fog and sulphur dioxide

Statement II: Photochemical smog (B) has components, ozone, nitric oxide, acrolein, formaldehyde, PAN etc.

In the light of above statements, choose the **most appropriate** answer from the options give below

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

13. Which of the following is structure of a separating funnel?

(A) 

(B) 

(C) 

(D) 

14. '**A**' and '**B**' respectively are:

A $\xrightarrow[(2)\,Zn-H_2O]{(1)\,O_3}$ Ethane-1,2-dicarbaldehyde

\+

Glyoxal/Oxaldehyde

B $\xrightarrow[(2)\,Zn-H_2O]{(1)\,O_3}$ 5-oxohexanal

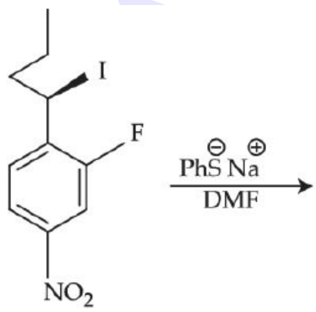
(A) 1-methylcyclohex-1, 3-diene & cyclopentene

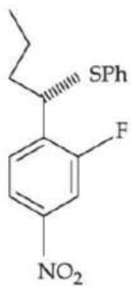
(B) Cyclohex-1, 3-diene & cyclopentene

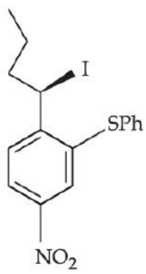
(C) 1-methylcyclohex-1,4-diene & 1-methylcyclopent-1-ene

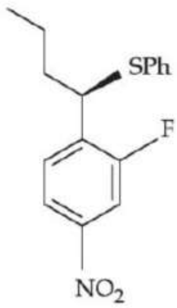
(D) Cyclohex-1,3-diene & 1-methylcyclopent-1-ene

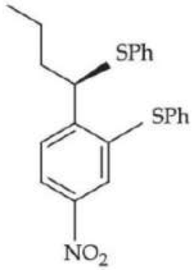
15. The major product of the following reaction is:



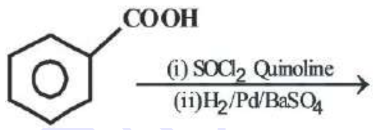
(A) 

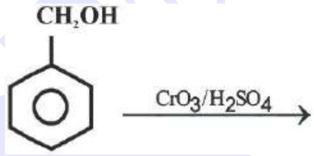
(B) 

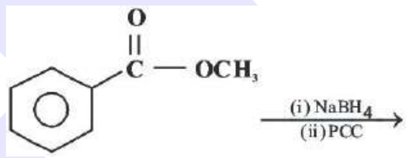
(C) 

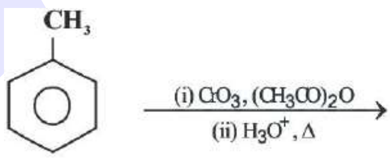
(D) 

16. Which of the following reactions will yield benzaldehyde as a product?

(A) 

(B) 

(C) 

(D) 

(A) (B) and (C)
(B) (C) and (D)
(C) (A) and (D)
(D) (A) and (C)

17. Given below are two statements:

Statements-I : In Hofmann degradation reaction, the migration of only an alkyl group takes place from carbonyl carbon of the amide to the nitrogen atom.

Statement-II : The group is migrated in Hofmann degradation reaction to electron deficient atom.

In the light of the above statement, choose the **most appropriate** answer from the options given below:

(A) Both **Statement-I** and **Statement-II** are correct

(B) Both **Statement-I** and **Statement-II** are incorrect

(C) **Statement-I** is correct but **Statement-II** is incorrect

(D) **Statement-I** is incorrect but **Statement-II** is correct

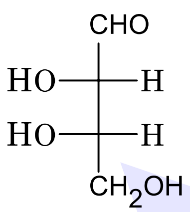
18. Match List-I with List-II

List-I	List-II
(Polymer)	**(Used in)**
(A) Bakelite	(I) Radio and television Cabinets
(B) Glyptal	(II) Electrical switches
(C) PVC	(III) Paints and Lacquers
(D) Polystyrene	(IV) Water pipes

Choose the correct answer from the options given below:

(A) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)
(B) (A) – (I), (B) – (II), (C) – (III), (D) – (IV)
(C) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)
(D) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

19. L-isomer of a compound 'A' ($C_4H_8O_4$) gives a positive test with $[Ag(NH_3)_2]^+$. Treatment of 'A' with acetic anhydride yield triacetate derivative. Compound 'A' produces an optically active compound (B) and an optically inactive compound (C) on treatment with bromine water and HNO_3 respectively, compound (A) is:

(A)


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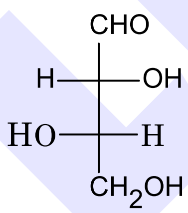

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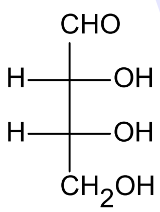
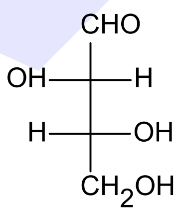
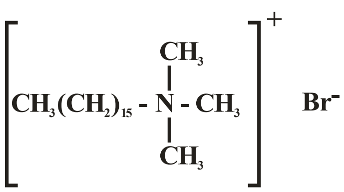
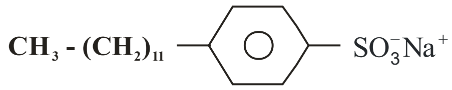


(D)


20. Match List-I with List-II

List-I

(A) 

(B) 

(C) $C_{17}H_{35}COO^-Na^+ + Na_2CO_3 + \text{Rosinate}$

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$

List-II

(I) Dishwashing powder
(II) Toothpaste
(III) Laundry soap
(IV) Hair conditioner

(A) (A) – (III), (B) – (II), (C) – (IV), (D) – (I)
(B) (A) – (IV), (B) – (II), (C) – (III), (D) – (I)
(C) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)
(D) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

SECTION-B

1. Metal deficiency defect is shown by $Fe_{0.93}O$. In the crystal, some Fe^{2+} cations are missing and loss of positive charge is compensated by the presence of Fe^{3+} ions. The percentage of Fe^{2+} ions in the $Fe_{0.93}O$ crystals is _________. (Nearest integer)

2. If the uncertainty in velocity and position of a minute particle in space are, 2.4×10^{-26} (ms^{-1}) and 10^{-7}(m) respectively. The mass of the particle in g is _________ (Nearest integer)
(Given : $h = 6.626 \times 10^{-34}$ Js)

3. 2g of a non-volatile non-electrolyte solute is dissolved in 200 g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 8. The elevation in boiling points of A and B are in the ratio $\frac{x}{y}$ (x : y). The value of y is_________ (Nearest integer)

4. $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$
In an experiment, 2.0 moles of NOCl was placed in a one-litre flask and the concentration of NO after equilibrium established, was found to be 0.4 mol/L. The equilibrium constant at 30°C is _____ $\times 10^{-4}$.

5. The limiting molar conductivities of NaI, $NaNO_3$ and $AgNO_3$ are 12.7, 12.0 and 13.3 mS m^2 mol^{-1}, respectively (all at 25°C). The limiting molar conductivity of AgI at this temperature is _____ mS m^2 mol^{-1}

6. The rate constant for a first order reaction is given by the following equation:

$$\ln k = 33.24 - \frac{2.0\times10^4 K}{T}$$

The Activation energy for the reaction is given by ______ kJ mol^{-1}. (In Nearest integer)

(Given: R = 8.3 J K^{-1} mol^{-1})

7. The number of statement(s) correct from the following for copper (at no. 29) is/are ______

(A) Cu(II) complexes are always paramagnetic

(B) Cu(I) complexes are generally colourless

(C) Cu(I) is easily oxidized

(D) In Fehling solution, the active reagent has Cu(I)

8. Acidified potassium permanganate solution oxidises oxalic acid. The spin-only magnetic moment of the manganese product formed from the above reaction is ______ B.M. (Nearest Integer)

9. Two elements A and B which form 0.15 moles of A_2B and AB_3 type compounds. If both A_2B and AB_3 weigh equally, then the atomic weight of A is _____ times of atomic weight of B.

10. Total number of possible stereoisomers of dimethyl cyclopentane is ___________

MATHEMATICS

SECTION-A

1. The area of the polygon, whose vertices are the non-real roots of the equation $\bar{z} = iz^2$ is :

(A) $\frac{3\sqrt{3}}{4}$ (B) $\frac{3\sqrt{3}}{2}$

(C) $\frac{3}{2}$ (D) $\frac{3}{4}$

2. Let the system of linear equations $x + 2y + z = 2$, $\alpha x + 3y - z = \alpha$, $-\alpha x + y + 2z = -\alpha$ be inconsistent. Then α is equal to :

(A) $\frac{5}{2}$ (B) $-\frac{5}{2}$

(C) $\frac{7}{2}$ (D) $-\frac{7}{2}$

3. If $x = \sum_{n=0}^{\infty} a^n, y = \sum_{n=0}^{\infty} b^n, z = \sum_{n=0}^{\infty} c^n$, where a, b, c are in A.P. and $|a| < 1$, $|b| < 1$, $|c| < 1$, $abc \neq 0$, then

(A) x, y, z are in A.P.

(B) x, y, z are in G.P.

(C) $\frac{1}{x}, \frac{1}{y}, \frac{1}{z}$ are in A.P.

(D) $\frac{1}{x}+\frac{1}{y}+\frac{1}{z} = 1-(a+b+c)$

4. Let $\frac{dy}{dx} = \frac{ax-by+a}{bx+cy+a}$, where a, b, c are constants, represent a circle passing through the point (2, 5). Then the shortest distance of the point (11, 6) from this circle is :

(A) 10 (B) 8

(C) 7 (D) 5

5. Let a be an integer such that $\lim_{x\to7}\frac{18-[1-x]}{[x-3a]}$ exists, where [t] is greatest integer $\leq$ t. Then a is equal to :

(A) -6 (B) -2

(C) 2 (D) 6

6. The number of distinct real roots of $x^4 - 4x + 1 = 0$ is :

(A) 4 (B) 2

(C) 1 (D) 0

7. The lengths of the sides of a triangle are $10 + x^2$, $10 + x^2$ and $20 - 2x^2$. If for x = k, the area of the triangle is maximum, then $3k^2$ is equal to :

(A) 5 (B) 8

(C) 10 (D) 12

8. If $\cos^{-1}\left(\frac{y}{2}\right) = \log_e\left(\frac{x}{5}\right)^5, |y| < 2$, then :

(A) $x^2y'' + xy' - 25y = 0$

(B) $x^2y'' - xy' - 25y = 0$

(C) $x^2y'' - xy' + 25y = 0$

(D) $x^2y'' + xy' + 25y = 0$

9. $\int \frac{(x^2+1)e^x}{(x+1)^2}dx = f(x)e^x + C$, Where C is a constant, then $\frac{d^3f}{dx^3}$ at x = 1 is equal to :

(A) $-\frac{3}{4}$ (B) $\frac{3}{4}$

(C) $-\frac{3}{2}$ (D) $\frac{3}{2}$

10. The value of the integral $\int_{-2}^{2} \frac{|x^3 + x|}{\left(e^{x|x|} + 1\right)}dx$ is equal to :

(A) $5e^2$ (B) $3e^{-2}$

(C) 4 (D) 6

11. If $\frac{dy}{dx} + \frac{2^{x-y}(2^y - 1)}{2^x - 1} = 0, x, y > 0, y(1) = 1$, then y(2) is equal to :

(A) $2 + \log_2 3$ (B) $2 + \log_2 2$

(C) $2 - \log_2 3$ (D) $2 - \log_2 3$

12. In an isosceles triangle ABC, the vertex A is (6, 1) and the equation of the base BC is 2x + y = 4. Let the point B lie on the line x + 3y = 7. If (α, β) is the centroid ΔABC, then $15(\alpha + \beta)$ is equal to :

(A) 39 (B) 41

(C) 51 (D) 63

13. Let the eccentricity of an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b$, be $\frac{1}{4}$. If this ellipse passes through the point $\left(-4\sqrt{\frac{2}{5}}, 3\right)$, then $a^2 + b^2$ is equal to :

(A) 29 (B) 31

(C) 32 (D) 34

14. If two straight lines whose direction cosines are given by the relations l + m – n = 0, $3l^2 + m^2 + cnl = 0$ are parallel, then the positive value of c is :

(A) 6 (B) 4

(C) 3 (D) 2

15. Let $\vec{a} = \hat{i} + \hat{j} - \hat{k}$ and $\vec{c} = 2\hat{i} - 3\hat{j} + 2\hat{k}$. Then the number of vectors $\vec{b}$ such that $\vec{b} \times \vec{c} = \vec{a}$ and $|\vec{b}| \in \{1, 2, \ldots, 10\}$ is :

(A) 0 (B) 1

(C) 2 (D) 3

16. Five numbers x_1, x_2, x_3, x_4, x_5 are randomly selected from the numbers 1, 2, 3,……, 18 and are arranged in the increasing order ($x_1 < x_2 < x_3 < x_4 < x_5$). The probability that $x_2 = 7$ and $x_4 = 11$ is :

(A) $\frac{1}{136}$ (B) $\frac{1}{72}$

(C) $\frac{1}{68}$ (D) $\frac{1}{34}$

17. Let X be a random variable having binomial distribution B(7, p). If P(X = 3) = 5P(X = 4), then the sum of the mean and the variance of X is :

(A) $\frac{105}{16}$ (B) $\frac{7}{16}$

(C) $\frac{77}{36}$ (D) $\frac{49}{16}$

18. The value of

$$\cos\left(\frac{2\pi}{7}\right)+\cos\left(\frac{4\pi}{7}\right)+\cos\left(\frac{6\pi}{7}\right)$$ is equal to :

(A) -1 (B) $-\frac{1}{2}$

(C) $-\frac{1}{3}$ (D) $-\frac{1}{4}$

19. $\sin^{-1}\left(\sin\frac{2\pi}{3}\right)+\cos^{-1}\left(\cos\frac{7\pi}{6}\right)+\tan^{-1}\left(\tan\frac{3\pi}{4}\right)$ is equal to :

(A) $\frac{11\pi}{12}$ (B) $\frac{17\pi}{12}$

(C) $\frac{31\pi}{12}$ (D) $-\frac{3\pi}{4}$

20. The Boolean expression $\left(\sim\left(p\wedge q\right)\right)\vee q$ is equivalent to :

(A) $q\to\left(p\wedge q\right)$ (B) $p\to q$

(C) $p\to\left(p\to q\right)$ (D) $p\to\left(p\vee q\right)$

SECTION-B

1. Let $f:R\to R$ be a function defined $f(x)=\frac{2e^{2x}}{e^{2x}+e}$. Then

$$f\left(\frac{1}{100}\right)+f\left(\frac{2}{100}\right)+f\left(\frac{3}{100}\right)+.....+f\left(\frac{99}{100}\right)$$

is equal to____________.

2. If the sum of all the roots of the equation $e^{2x}-11e^{x}-45e^{-x}+\frac{81}{2}=0$ is $\log_e$ P, then p is equal to _______.

3. The positive value of the determinant of the matrix A, whose

$$Adj\left(Adj\left(A\right)\right)=\begin{pmatrix}14 & 28 & -14\\ -14 & 14 & 28\\ 28 & -14 & 14\end{pmatrix},$$

is __________.

4. The number of ways, 16 identical cubes, of which 11 are blue and rest are red, can be placed in a row so that between any two red cubes there should be at least 2 blue cubes, is _______.

5. If the coefficient of x^{10} in the binomial expansion of $\left(\frac{\sqrt{x}}{5^{\frac{1}{4}}}+\frac{\sqrt{5}}{x^{\frac{1}{3}}}\right)^{60}$ is $5^k l$, where l, k $\in$ N and l is co-prime to 5, then k is equal to _____.

6. Let

$$A_1=\left\{(x,y):|x|\le y^2,|x|+2y\le 8\right\}$$ and

$$A_2=\left\{(x,y):|x|+|y|\le k\right\}.$$

If 27 (Area A_1) = 5 (Area A_2), then k is equal to :

7. If the sum of the first ten terms of the series

$$\frac{1}{5}+\frac{2}{65}+\frac{3}{325}+\frac{4}{1025}+\frac{5}{2501}+....$$ is $\frac{m}{n}$,

where m and n are co-prime numbers, then m + n is equal to __________.

8. A rectangle R with end points of the one of its dies as (1, 2) and (3, 6) is inscribed in a circle. If the equation of a diameter of the circle is 2x – y + 4 = 0, then the area of R is ________.

9. A circle of radius 2 unit passes through the vertex and the focus of the parabola y^2 = 2x and touches the parabola $y=\left(x-\frac{1}{4}\right)^2+\alpha$, where $\alpha>0$. Then $(4\alpha-8)^2$ is equal to ___________.

10. Let the mirror image of the point (a, b, c) with respect to the plane 3x – 4y + 12z + 19 = 0 be (a- 6, β, γ). If a + b + c = 5, then 7 β - 9 γ is equal to ____________.

SET # 08

PHYSICS

SECTION-A

1. The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be

(A) $[ML^{-1}T^{-1}]$ (B) $[ML^{-1}T^{-2}]$

(C) $[ML^{2}T^{-1}]$ (D) $[M^{-1}L^{3}T^{0}]$

2. The distance of the Sun from earth is 1.5×10^{11} m and its angular diameter is (2000) s when observed from the earth. The diameter of the Sun will be :

(A) 2.45×10^{10} m (B) 1.45×10^{10} m

(C) 1.45×10^{9} m (D) 0.14×10^{9} m

3. When a ball is dropped into a lake from a height 4.9 m above the water level, it hits the water with a velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 4.0 s after it is dropped. The approximate depth of the lake is :

(A) 19.6 m (B) 29.4 m

(C) 39.2 m (D) 73.5 m

4. One end of a massless spring of spring constant k and natural length l_0 is fixed while the other end is connected to a small object of mass m lying on a frictionless table. The spring remains horizontal on the table. If the object is made to rotate at an angular velocity ω about an axis passing through fixed end, then the elongation of the spring will be:

(A) $\dfrac{k - m\omega^2 l_0}{m\omega^2}$ (B) $\dfrac{m\omega^2 l_0}{k + m\omega^2}$

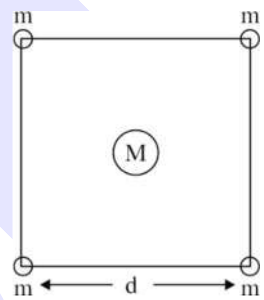
(C) $\dfrac{m\omega^2 l_0}{k - m\omega^2}$ (D) $\dfrac{k + m\omega^2 l_0}{m\omega^2}$

5. A stone tide to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of change in its velocity, as it reaches a position where the string is horizontal, is $\sqrt{x(u^2 - gL)}$. The value of x is

(A) 3 (B) 2

(C) 1 (D) 5

6. Four spheres each of mass m form a square of side d (as shown in figure). A fifth sphere of mass M is situated at the centre of square. The total gravitational potential energy of the system is :



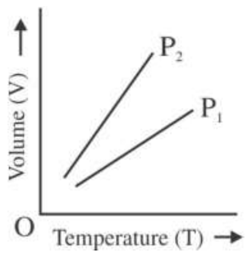
(A) $-\dfrac{Gm}{d}\left[(4+\sqrt{2})m + 4\sqrt{2}M\right]$

(B) $-\dfrac{Gm}{d}\left[(4+\sqrt{2})M + 4\sqrt{2}m\right]$

(C) $-\dfrac{Gm}{d}\left[3m^2 + 4\sqrt{2}M\right]$

(D) $-\dfrac{Gm}{d}\left[6m^2 + 4\sqrt{2}M\right]$

7. For a perfect gas, two pressures P_1 and P_2 are shown in figure. The graph shows:



(A) $P_1 > P_2$

(B) $P_1 < P_2$

(C) $P_1 = P_2$

(D) Insufficient data to draw any conclusion

8. According to kinetic theory of gases,

A. The motion of the gas molecules freezes at 0°C

B. The mean free path of gas molecules decreases if the density of molecules is increased.

C. The mean free path of gas molecules increases if temperature is increased keeping pressure constant.

D. Average kinetic energy per molecule per degree of freedom is $\frac{3}{2}k_BT$ (for monoatomic gases)

Choose the most appropriate answer from the options given below:

(A) A and C only (B) B and C only

(C) A and B only (D) C and D only

9. A lead bullet penetrates into a solid object and melts. Assuming that 40% of its kinetic energy is used to heat it, the initial speed of bullet is:

(Given, initial temperature of the bullet = 127°C, Melting point of the bullet = 327°C, Latent heat of fusion of lead = 2.5×10^4 J Kg^{-1},

Specific heat capacity of lead = 125J/kg K)

(A) 125 ms^{-1} (B) 500 ms^{-1}

(C) 250 ms^{-1} (D) 600 ms^{-1}

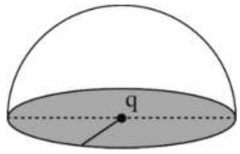
10. The equation of a particle executing simple harmonic motion is given by $x = \sin\pi\left(t + \frac{1}{3}\right)$ m. At t = 1s, the speed of particle will be

(Given : $\pi = 3.14$)

(A) 0 cm s^{-1} (B) 157 cm s^{-1}

(C) 272 cm s^{-1} (D) 314 cm s^{-1}

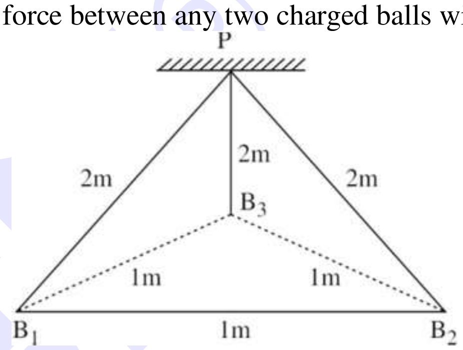
11. If a charge q is placed at the centre of a closed hemispherical non-conducting surface, the total flux passing through the flat surface would be :



(A) $\frac{q}{\varepsilon_0}$ (B) $\frac{q}{2\varepsilon_0}$

(C) $\frac{q}{4\varepsilon_0}$ (D) $\frac{q}{2\pi\varepsilon_0}$

12. Three identical charged balls each of charge 2C are suspended from a common point P by silk threads of 2m each (as shown in figure). They form an equilateral triangle of side 1m. The ratio of net force on a charged ball to the force between any two charged balls will be :



(A) 1 : 1 (B) 1 : 4

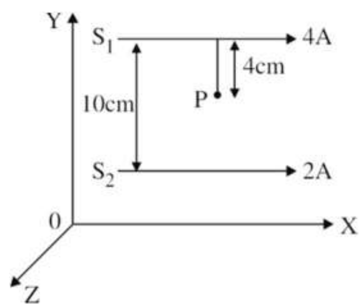
(C) $\sqrt{3} : 2$ (D) $\sqrt{3} : 1$

13. Two long parallel conductors S_1 and S_2 are separated by a distance 10 cm and carrying currents of 4A and 2A respectively. The conductors are placed along x-axis in X-Y plane. There is a point P located between the conductors (as shown in figure).

A charge particle of 3π coulomb is passing through the point P with velocity

$\vec{v} = (2\hat{i} + 3\hat{j})m/s$; where $\hat{i}$ & $\hat{j}$ represents unit vector along x & y axis respectively.

The force acting on the charge particle is $4\pi \times 10^{-5}(-x\hat{i} + 2\hat{j})N$. The value of x is :



(A) 2 (B) 1

(C) 3 (D) –3

14. If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time ?

(A) RC (B) $\frac{L}{R}$

(C) $\sqrt{LC}$ (D) $\frac{L}{C}$

15. Given below are two statements:

Statement I : A time varying electric field is a source of changing magnetic field and vice-versa. Thus a disturbance in electric or magnetic field creates EM waves.

Statement II : In a material medium. The EM wave travels with speed $v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$.

In the light of the above statements, choose the correct answer from the options given below:

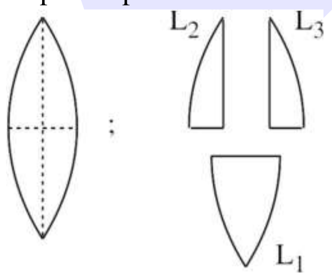
(A) Both statement I and statement II are true.

(B) Both statement I and statement II are false.

(C) Statement I is correct but statement II is false.

(D) Statement I is incorrect but statement II is true.

16. A convex lens has power P. It is cut into two halves along its principal axis. Further one piece (out of the two halves) is cut into two halves perpendicular to the principal axis (as shown in figure). Choose the incorrect option for the reported pieces.



(A) Power of $L_1 = \frac{P}{2}$

(B) Power of $L_2 = \frac{P}{2}$

(C) Power of $L_3 = \frac{P}{2}$

(D) Power of $L_1 = P$

17. If a wave gets refracted into a denser medium, then which of the following is true?

(A) wavelength speed and frequency decreases.

(B) wavelength increases, speed decreases and frequency remains constant.

(C) wavelength and speed decreases but frequency remains constant.

(D) wavelength, speed and frequency increases.

18. Given below are two statements:

Statement I : In hydrogen atom, the frequency of radiation emitted when an electron jumps from lower energy orbit (E_1) to higher energy orbit (E_2), is given as $hf = E_1 - E_2$.

Statement-II : The jumping of electron from higher energy orbit (E_2) to lower energy orbit (E_1) is associated with frequency of radiation given as $f = (E_2 - E_1)/h$

This condition is Bohr's frequency condition.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both statement I and statement II are true.

(B) Both statement I and statement II are false

(C) Statement I is correct but statement II is false

(D) Statement I is incorrect but statement II is true.

19. For a transistor to act as a switch, it must be operated in

(A) Active region

(B) Saturation state only

(C) Cut-off state only

(D) Saturation and cut-off state

20. We do not transmit low frequency signal to long distances because

(a) The size of the antenna should be comparable to signal wavelength which is unreal solution for a signal of longer wavelength.

(b) Effective power radiated by a long wavelength baseband signal would be high.

(c) We want to avoid mixing up signals transmitted by different transmitter simultaneously.

(d) Low frequency signal can be sent to long distances by superimposing with a high frequency wave as well.

Therefore, the most suitable options will be :

(A) All statements are true

(B) (a), (b) and (c) are true only

(C) (a), (c) and (d) are true only

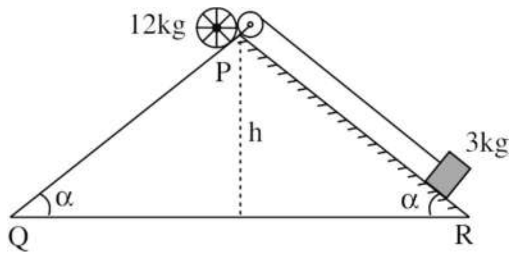
(D) (b), (c) and (d) are true only

SECTION-B

1. A mass of 10 kg is suspended vertically by a rope of length 5m from the roof. A force of 30 N is applied at the middle point of rope in horizontal direction. The angle made by upper half of the rope with vertical is $\theta = \tan^{-1}(x \times 10^{-1})$. The value of x is ______.
(Given $g = 10\ m/s^2$)

2. A rolling wheel of 12 kg is on an inclined plane at position P and connected to a mass of 3 kg through a string of fixed length and pulley as shown in figure. Consider PR as friction free surface.

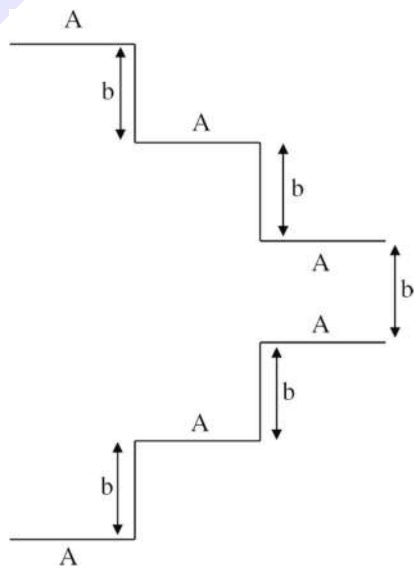
The velocity of centre of mass of the wheel when it reaches at the bottom Q of the inclined plane PQ will be $\frac{1}{2}\sqrt{xgh}$ m/s. The value of x is ______ .



3. A diatomic gas ($\gamma = 1.4$) does 400 J of work when it is expanded isobarically. The heat given to the gas in the process is _______ J.

4. A particle executes simple harmonic motion. Its amplitude is 8 cm and time period is 6s. The time it will take to travel from its position of maximum displacement to the point corresponding to half of its amplitude, is ________ s.

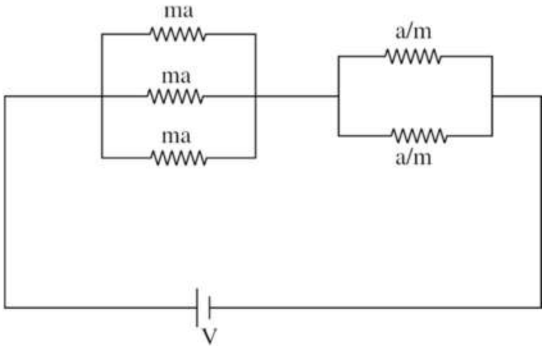
5. A paralle plate capacitor is made up of stair like structure with a palte area A of each stair and that is connected with a wire of length b, as shown in the figure. The capacitance of the arrangement is $\frac{x}{15}\frac{\varepsilon_0 A}{b}$. The value of x is _______ .



6. The current density in a cylindrical wire of radius r = 4.0 mm is $1.0 \times 10^{6}\ A/m^2$. The current through the outer portion of the wire between radial distances r/2 and r is $x\pi$ A; where x is _______ .

7. In the given circuit 'a' is an arbitrary constant. The value of m for which the equivalent circuit resistance is minimum, will be $\sqrt{\frac{x}{2}}$.

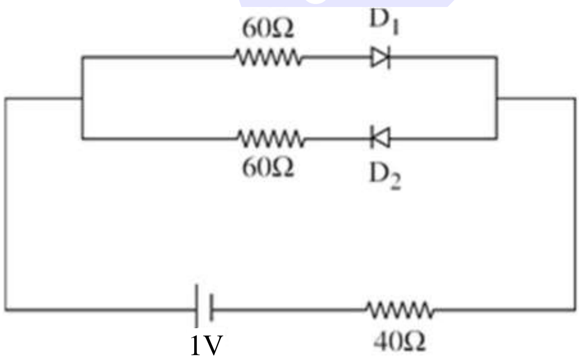
The value of x is _____ .



8. A deuteron and a proton moving with equal kinetic energy enter into to a uniform magnetic field at right angle to the field. If r_d and r_p are the radii of their circular paths respectively, then the ratio $\frac{r_d}{r_p}$ will be $\sqrt{x}:1$ where x is ______ .

9. A metallic rod of length 20 cm is palced in North-South direction and is moved at a constant speed of 20 m/s towards East. The horizontal component of the Earth's magnetic field at that place is 4×10^{-3} T and the angle of dip is 45°. The emf induced in the rod is _______ mV.

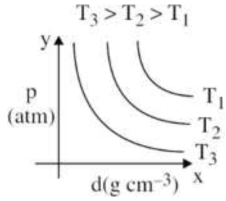
10. The cut-off voltage of the diodes (shown in figure) in forward bias is 0.6 V. The current through the resister of 40 Ω is _______ mA.

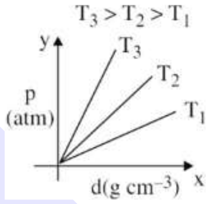


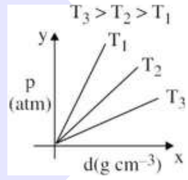
CHEMISTRY

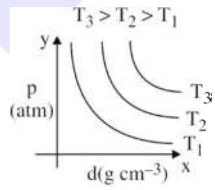
SECTION-A

1. Which amongst the given plots is the correct plot for pressure (p) vs density (d) for an ideal gas ?

(A) 

(B) 

(C) 

(D) 

2. Identify the **incorrect** statement for PCl_5 from the following.

(A) In this molecule, orbitals of phosphorous are assumed to undergo sp^3d hybridization.

(B) The geometry of PCl_5 is trigonal bipyramidal.

(C) PCl_5 has two axial bonds stronger than three equatorial bonds.

(D) The three equatorial bonds of PCl_5 lie in a plane.

3. **Statement I : Leaching of gold** with cyanide ion in absence of air / O_2 leads to cyano complex of Au(III).

Statement II : Zinc is oxidized during the displacement reaction carried out for gold extraction.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both Statement I and Statement II are correct

(B) Both Statement I and Statement II are incorrect

(C) Statement I is correct but Statement II is incorrect

(D) Statement I is incorrect but Statement II is correct

4. The correct order of increasing intermolecular hydrogen bond strength is

(A) $HCN < H_2O < NH_3$

(B) $HCN < CH_4 < NH_3$

(C) $CH_4 < HCN < NH_3$

(D) $CH_4 < NH_3 < HCN$

5. The correct order of increasing ionic radii is

(A) $Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

(B) $N^{3-} < O^{2-} < F^- < Na^+ < Mg^{2+}$

(C) $F^- < Na^+ < O^{2-} < Mg^{2+} < N^{3-}$

(D) $Na^+ < F^- < Mg^{2+} < O^{2-} < N^{3-}$

6. The gas produced by treating an aqueous solution of ammonium chloride with sodium nitrite is

(A) NH_3 (B) N_2

(C) N_2O (D) Cl_2

7. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Flourine forms one oxoacid.

Reason R : Flourine has smallest size amongst all halogens and is highly electronegative

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both A and R are correct and R is the correct explanation of A.

(B) Both A and R are correct but R is NOT the correct explanation of A.

(C) A is correct but R is not correct.

(D) A is not correct but R is correct

8. In 3d series, the metal having the highest M^{2+}/M standard electrode potential is

(A) Cr (B) Fe

(C) Cu (D) Zn

9. The 'f' orbitals are half and completely filled, respectively in lanthanide ions

(Given: Atomic no. Eu, 63; Sm, 62; Tm, 69; Tb, 65; Yb, 70; Dy, 66]

(A) Eu^{2+} and Tm^{2+} (B) Sm^{2+} and Tm^{3+}

(C) Tb^{4+} and Yb^{2+} (D) Dy^{3+} and Yb^{3+}

10. Arrange the following coordination compounds in the increasing order of magnetic moments. (Atomic numbers : Mn = 25; Fe = 26)

(A) $[FeF_6]^{3-}$

(B) $[Fe(CN)_6]^{3-}$

(C) $[MnCl_6]^{3-}$ (high spin)

(D) $[Mn(CN)_6]^{3-}$

(A) A < B < D < C (B) B < D < C < A

(C) A < C < D < B (D) B < D < A < C

11. On the surface of polar stratospheric clouds, hydrolysis of chlorine nitrate gives A and B while its reaction with HCl produces B and C. A, B and C are, respectively

(A) $HOCl, HNO_3, Cl_2$

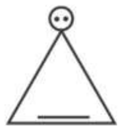
(B) $Cl_2, HNO_3, HOCl$

(C) $HClO_2, HNO_2, HOCl$

(D) $HOCl, HNO_2, Cl_2O$

12. Which of the following is most stable?

(A) 

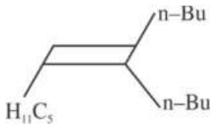
(B) 

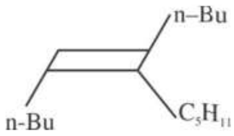
(C) 

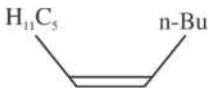
(D) 

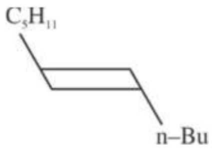
13. What will be the major product of following sequence of reactions?

$$n-Bu-\equiv \xrightarrow[\text{(ii) Lindlar cat, } H_2]{\text{(i) } n-BuLi,\ n-C_5H_{11}Cl}$$

(A) 

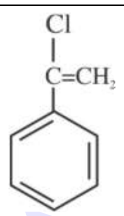
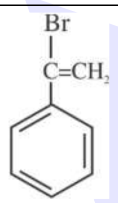
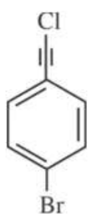
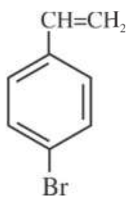
(B) 

(C) 

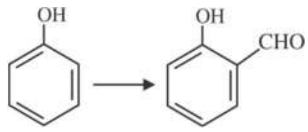
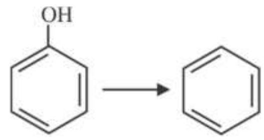
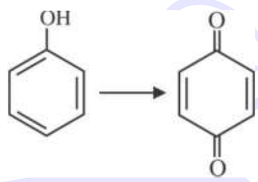
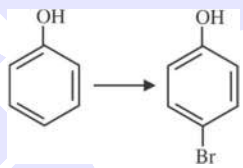
(D) 

14. Product 'A' of following sequence of reactions is

$$\text{Ethylbenzene} \xrightarrow[\substack{(b)\ Cl_2,\ \Delta \\ (c)\ alc.\ KOH}]{(a)\ Br_2.Fe} \text{'A'(Major product)}$$

(A)	
(B)	
(C)	
(D)	

15. Match List I with List II

List I	List II
A. 	I. Br_2 in CS_2
B. 	II. $Na_2Cr_2O_7/H_2SO_4$
C. 	III. Zn
D. 	IV. $CHCl_3/NaOH$

Choose the correct answer from the options given below:

(A) A-IV, B-III, C-II, D-I

(B) A-IV, B-III, C-I, D-II

(C) A-II, B-III, C-I, D-IV

(D) A-IV, B-II, C-III, D-I

16. Decarboxylation of all six possible forms of diaminobenzoic acids $C_6H_3(NH_2)_2COOH$ yields three products A, B and C. Three acids give a product 'A', two acids gives a product 'B' and one acid give a product 'C'. The melting point of product 'C' is

(A) 63ºC (B) 90ºC

(C) 104ºC (D) 142ºC

17. Which is true about Buna-N?

(A) It is a linear polymer of 1, 3-butadiene.

(B) It is obtained by copolymerization of 1, 3-butadiene and styrene.

(C) It is obtained by copolymerization of 1, 3-butadiene and acrylonitrile.

(D) The suffix N in Buna-N stands for its natural occurrence

18. Given below are two statements.

Statments I: Maltose has two α-D-glucose units linked at C_1 and C_4 and is a reducing sugar.

Statement II: Maltose has two monosaccharides: α-D-glucose and β-D-glucose linked at C_1 and C_6 and it is a non-reducing sugar.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both Statement I and Statement II are true
(B) Both Statement I and Statement II are false
(C) Statement I is true but Statement II is false
(D) Statement I is false but Statement II is true

19. Match List I with List II

List I	List II
A. Antipyretic	I. Reduces pain
B. Analgesic	II. Reduces stress
C. Tranquilizer	III. Reduces fever
D. Antacid	IV. Reduces acidity (Stomach)

Choose the correct answer from the options given below:

(A) A-III, B-I, C-II, D-IV
(B) A-III, B-I, C-IV, D-II
(C) A-I, B-IV, C-II, D-III
(D) A-I, B-III, C-II, D-IV

20. Match List I with List II

List I (Anion)	List II (Gas evolved on reaction with dil. H_2SO_4)
A. CO_3^{2-}	I. Colourless gas which turns lead acetate paper black
B. S^{2-}	II. Colourless gas which turns acidified potassium dichromate solution green.
C. SO_3^{2-}	III. Brown fumes which turns acidified KI solution containing starch blue.
D. NO_2^-	IV. Colourless gas evolved with brisk effervescence, which turns lime water milky.

Choose the correct answer from the options given below:

(A) A-III, B-I, C-II, D-IV
(B) A-II, B-I, C-IV, D-III
(C) A-IV, B-I, C-III, D-II
(D) A-IV, B-I, C-II, D-III

SECTION-B

1. 116 g of a substance upon dissociation reaction, yields 7.5 g of hydrogen, 60g of oxygen and 48.5 g of carbon. Given that the atomic masses of H, O and C are 1, 16 and 12 respectively. The data agrees with how many formulae of the following?

(A) CH_3COOH (B) HCHO
(C) CH_3OOCH_3 (D) CH_3CHO

2. Consider the following set of quantum numbers

	n	l	m_l
A.	3	3	-3
B.	3	2	-2
C.	2	1	+1
D.	2	2	+2

The number of correct sets of quantum numbers is _______

3. BeO reacts with HF in presence of ammonia to give [A] which on thermal decomposition produces [B] and ammonium fluoride. Oxidation state of Be in [A] is_______

4. When 5 moles of He gas expand isothermally and reversibly at 300 K from 10 litre to 20 litre, the magnitude of the maximum work obtained is ____ J. [nearest integer] (Given: $R = 8.3\ J\ K^{-1}mol^{-1}$ and log 2 = 0.3010)

5. A solution containing 2.5×10^{-3} kg of a solute dissolved in 75×10^{-3} kg of water boils at 373.535 K. The molar mass of the solute is ______ g mol^{-1}. [nearest integer] (Given: K_b (H_2O) = 0.52 K Kg mol^{-1} , boiling point of water = 373.15K)

6. pH value of 0.001 M NaOH solution is______.

7. For the reaction taking place in the cell:

$Pt(s) \mid H_2(g) \mid H^+(aq) \parallel Ag^+(aq) \mid Ag(s)$

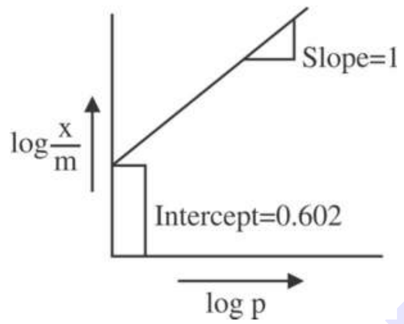
$E^o_{Cell} = +0.5332$ V.

The value of $\Delta_f G^0$ is ________ kJ mol^{-1}. (in nearest integer)

8. It has been found that for a chemical reaction with rise in temperature by 9K the rate constant gets doubled. Assuming a reaction to be occurring at 300 K, the value of activation energy is found to be ______ kJ mol^{-1}. [nearest integer]

(Given ln 10 = 2.3, R = 8.3 JK^{-1}mol^{-1}, log2 = 0.30)

9.



If the initial pressure of a gas is 0.03 atm, the mass of the gas adsorbed per gram of the adsorbent is _______ × 10^{-2}g.

10. 0.25 g of an organic compound containing chlorine gave 0.40 g of silver chloride in Carius estimation. The percentage of chlorine present in the compound is ______. [in nearest integer]

(Given: Molar mass of Ag is 108 g mol^{-1} and that of Cl is 35.5 g mol^{-1})

MATHEMATICS

SECTION-A

1. The number of points of intersection of $|z-(4+3i)|=2$ and $|z|+|z-4|=6$, $z \in C$ is:

(A) 0 (B) 1

(C) 2 (D) 3

2. Let $f(x)=\begin{vmatrix} a & -1 & 0 \\ ax & a & -1 \\ ax^2 & ax & a \end{vmatrix}$, $a \in R$. Then the sum of which the squares of all the values of a for $2f'(10)-f'(5)+100=0$ is :

(A) 117 (B) 106

(C) 125 (D) 136

3. Let for some real numbers α and β, a = α –iβ. If the system of equations $4ix+(1+i)y=0$ and $8\left(\cos\frac{2\pi}{3}+i\sin\frac{2\pi}{3}\right)x+\bar{a}y=0$ has more than one solution then $\frac{\alpha}{\beta}$ is equal to :

(A) $-2+\sqrt{3}$ (B) $2-\sqrt{3}$

(C) $2+\sqrt{3}$ (D) $-2-\sqrt{3}$

4. Let A and B be two 3 × 3 matrices such that AB= I and $|A|=\frac{1}{8}$ then $|adj(B\,adj(2A))|$ is equal to

(A) 16 (B) 32

(C) 64 (D) 128

5. Let $S=2+\frac{6}{7}+\frac{12}{7^2}+\frac{20}{7^3}+\frac{30}{7^4}+.....$ then 4S is equal to

(A) $\left(\frac{7}{3}\right)^2$ (B) $\frac{7^3}{3^2}$

(C) $\left(\frac{7}{3}\right)^3$ (D) $\frac{7^2}{3^3}$

6. If $a_1, a_2, a_3 ....$ and $b_1, b_2, b_3 ....$ are A.P. and $a_1 = 2$, $a_{10} = 3$, $a_1b_1 = 1 = a_{10}b_{10}$ then a_4b_4 is equal to

(A) $\frac{35}{27}$ (B) 1

(C) $\frac{27}{28}$ (D) $\frac{28}{27}$

7. If m and n respectively are the number of local maximum and local minimum points of the function $f(x)=\int_0^{x^2}\frac{t^2-5t+4}{2+e^t}dt$, then the ordered pair (m, n) is equal to
(A) (3, 2) (B) (2, 3)
(C) (2, 2) (D) (3, 4)

8. Let f be a differentiable function in $\left(0,\frac{\pi}{2}\right)$. If $\int_{\cos x}^{1} t^2 f(t)\,dt=\sin^3 x+\cos x$ then $\frac{1}{\sqrt{3}}f'\left(\frac{1}{\sqrt{3}}\right)$ is equal to :
(A) $6-9\sqrt{2}$ (B) $6-\frac{9}{\sqrt{2}}$
(C) $\frac{9}{2}-6\sqrt{2}$ (D) $\frac{9}{\sqrt{2}}-6$

9. The integral $\int_0^1 \frac{1}{7^{\left[\frac{1}{x}\right]}}dx$, where [.] denotes the greatest integer function is equal to
(A) $1+6\log_e\left(\frac{6}{7}\right)$ (B) $1-6\log_e\left(\frac{6}{7}\right)$
(C) $\log_e\left(\frac{7}{6}\right)$ (D) $1-7\log_e\left(\frac{6}{7}\right)$

10. If the solution curve of the differential equation $\left((\tan^{-1}y)-x\right)dy=(1+y^2)dx$ passes through the point (1, 0) then the abscissa of the point on the curve whose ordinate is tan (1) is :
(A) 2e (B) $\frac{2}{e}$
(C) 2 (D) $\frac{1}{e}$

11. If the equation of the parabola, whose vertex is at (5, 4) and the directrix is $3x+y-29=0$, is $x^2+ay^2+bxy+cx+dy+k=0$ then a + b + c +d + k is equal to
(A) 575 (B) –575
(C) 576 (D) –576

12. The set of values of k for which the circle C : $4x^2+4y^2-12x+8y+k=0$ lies inside the fourth quadrant and the point $\left(1,-\frac{1}{3}\right)$ lies on or inside the circle C is :
(A) An empty set (B) $\left(6,\frac{95}{9}\right]$
(C) $\left[\frac{80}{9},10\right)$ (D) $\left(9,\frac{92}{9}\right]$

13. Let the foot of the perpendicular from the point (1, 2, 4) on the line $\frac{x+2}{4}=\frac{y-1}{2}=\frac{z+1}{3}$ be P. Then the distance of P from the plane $3x+4y+12z+23=0$
(A) 5 (B) $\frac{50}{13}$
(C) 4 (D) $\frac{63}{13}$

14. The shortest distance between the lines $\frac{x-3}{2}=\frac{y-2}{3}=\frac{z-1}{-1}$ and $\frac{x+3}{2}=\frac{y-6}{1}=\frac{z-5}{3}$ is :
(A) $\frac{18}{\sqrt{5}}$ (B) $\frac{22}{3\sqrt{5}}$
(C) $\frac{46}{3\sqrt{5}}$ (D) $6\sqrt{3}$

15. Let $\vec{a}$ and $\vec{b}$ be the vectors along the diagonal of a parallelogram having area $2\sqrt{2}$. Let the angle between $\vec{a}$ and $\vec{b}$ be acute. $|\vec{a}|=1$ and $|\vec{a}.\vec{b}|=|\vec{a}\times\vec{b}|$. If $\vec{c}=2\sqrt{2}\left(\vec{a}\times\vec{b}\right)-2\vec{b}$, then an angle between $\vec{b}$ and $\vec{c}$ is :
(A) $\frac{\pi}{4}$ (B) $-\frac{\pi}{4}$
(C) $\frac{5\pi}{6}$ (D) $\frac{3\pi}{4}$

16. The mean and variance of the data4, 5, 6, 6, 7, 8, x, y where x < y are 6, and $\frac{9}{4}$ respectively. Then x^4+y^2 is equal to
(A) 162 (B) 320
(C) 674 (D) 420

17. If a point A(x, y) lies in the region bounded by the y-axis, straight lines 2y + x = 6 and 5x – 6y = 30, then the probability that y < 1 is:

(A) $\frac{1}{6}$ (B) $\frac{5}{6}$ (C) $\frac{2}{3}$ (D) $\frac{6}{7}$

18. The value of $\cot\left(\sum_{n=1}^{50}\tan^{-1}\left(\frac{1}{1+n+n^2}\right)\right)$ is

(A) $\frac{26}{25}$ (B) $\frac{25}{26}$ (C) $\frac{50}{51}$ (D) $\frac{52}{51}$

19. α = sin 36° is a root of which of the following equation

(A) $10x^4-10x^2-5=0$

(B) $16x^4+20x^2-5=0$

(C) $16x^4-20x^2+5=0$

(D) $16x^4-10x^2+5=0$

20. Which of the following statement is a tautology?

(A) $((\sim q)\wedge p)\wedge q$

(B) $((\sim q)\wedge p)\wedge(p\wedge(\sim p))$

(C) $((\sim q)\wedge p)\vee(p\vee(\sim p))$

(D) $(p\wedge q)\wedge(\sim(p\wedge q))$

SECTION-B

1. Let S = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}. Define

$f:S\to S$ as $f(n)=\begin{cases}2n, & \text{if } n=1,2,3,4,5\\ 2n-11 & \text{if } n=6,7,8,9,10\end{cases}$

Let g : S → S be a function such that $fog(n)=\begin{cases}n+1 & \text{,if n is odd}\\ n-1 & \text{,if n is even}\end{cases}$, then

g(10) ((g(1) + g(2) + g(3) + g(4) + g(5)) is equal to:

2. Let α, β be the roots of the equation $x^2-4\lambda x+5=0$ and α, γ be the roots of the equation $x^2-\left(3\sqrt{2}+2\sqrt{3}\right)x+7+3\lambda\sqrt{3}=0$.

If $\beta+\gamma=3\sqrt{2}$, then $(\alpha+2\beta+\gamma)^2$ is equal to :

3. Let A be a matrix of order 2 × 2, whose entries are from the set {0, 1, 2, 3, 4, 5}. If the sum of all the entries of A is a prime number p, 2 < p < 8, then the number of such matrices A is :

4. If the sum of the coefficients of all the positive powers of x, in the binomial expansion of $\left(x^n+\frac{2}{x^5}\right)^7$ is 939, then the sum of all the possible integral values of n is :

5. Let [t] denote the greatest integer ≤ t and {t} denote the fractional part of t. Then integral value of α for which the left hand limit of the function $f(x)=[1+x]+\frac{\alpha^{2[x]+\{x\}}+[x]-1}{2[x]+\{x\}}$ at x = 0 is equal to $\alpha-\frac{4}{3}$ is ____

6. If $y(x)=(x^{x^x}),\ x>0$ then $\frac{d^2x}{dy^2}+20$ at x = 1 is equal to:

7. If the area of the region $\left\{(x,y):x^{\frac{2}{3}}+y^{\frac{2}{3}}\le 1 x+y\ge 0,\ y\ge 0\right\}$ is A, then $\frac{256A}{\pi}$ is

8. Let v be the solution of the differential equation $(1-x^2)dy=\left(xy+(x^3+2)\sqrt{1-x^2}\right)dx,\ -1<x<1$

and y (0) = 0 if $\int_{-\frac{1}{2}}^{\frac{1}{2}}\sqrt{1-x^2}\,y(x)dx=k$ then k^{-1} is equal to :

9. Let a circle C of radius 5 lie below the x-axis. The line $L_1=4x+3y-2$ passes through the centre P of the circle C and intersects the line $L_2:3x-4y-11=0$ at Q. The line L_2 touches C at the point Q. Then the distance of P from the line $5x-12y+51=0$ is

10. Let $S=\{E,E_2....E_8\}$ be a sample space of random experiment such that $P(E_n)=\frac{n}{36}$ for every n = 1, 2….8. Then the number of elements in the set $\left\{A\subset S:P(A)\ge\frac{4}{5}\right\}$ is ______

SET # 09

PHYSICS

SECTION-A

1. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Product of Pressure (P) and time (t) has the same dimension as that of coefficient of viscosity.

Reason R:

Coefficient of viscosity = $\frac{\text{Force}}{\text{Velocity gradient}}$

Question: Choose the correct answer from the options given below :

(A) Both A and R true, and R is correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

2. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration (a) is varying with time t as $a = k^2rt^2$. where k is a constant. The power delivered to the particle by the force acting on it is given as

(A) zero (B) $mk^2r^2t^2$

(C) mk^2r^2t (D) mk^2rt

3. Motion of a particle in x-y plane is described by a set of following equations $x = 4\sin\left(\frac{\pi}{2} - \omega t\right)m$ and $y = 4\sin(\omega t)m$.

The path of particle will be –

(A) circular (B) helical

(C) parabolic (D) elliptical

4. Match List-I with List-II

	List-I		List-II
A	Moment of inertia of solid sphere of radius R about any tangent	I	$\frac{5}{3}MR^2$
B	Moment of inertia of hollow sphere of radius (R) about any tangent	II	$\frac{7}{5}MR^2$
C	Moment of inertia of circular ring of radius (R) about its diameter.	III	$\frac{1}{4}MR^2$
D	Moment of inertia of circular disc of radius (R) about any diameter.	IV	$\frac{1}{2}MR^2$

Question: Choose the correct answer from the options given below

(A) A-II, B-II, C-IV, D-III

(B) A-I, B-II, C-IV, D-III

(C) A-II, B-I, C-III, D-IV

(D) A-I, B-II, C-III, D-IV

5. Two planets A and B of equal mass are having their period of revolutions T_A and T_B such that $T_A = 2T_B$. These planets are revolving in the circular orbits of radii r_A and r_B respectively. Which out of the following would be the correct relationship of their orbits?

(A) $2r_A^2 = r_B^2$

(B) $r_A^3 = 2r_B^3$

(C) $r_A^3 = 3r_B^3$

(D) $T_A^2 - T_B^2 = \frac{\pi^2}{GM}(r_B^3 - 4r_A^3)$

6. A water drop of diameter cm is broken into 64 equal droplets. The surface tension of water is 0.075 N/m. In this process the gain in surface energy will be :

(A) 2.8×10^{-4} J (B) 1.5×10^{-3} J

(C) 1.9×10^{-4} J (D) 9.4×10^{-5} J

7. Given below are two statement :

Statement – I : What μ amount of an ideal gas undergoes adiabatic change from state (P_1, V_1, T_1) to state (P_2, V_2, T_2), the work done

is $W = \dfrac{1R(T_2 - T_1)}{1-\gamma}$, where $\gamma = \dfrac{C_P}{C_V}$ and

R = universal gas constant,

Statement — II: In the above case. when work is done on the gas. the temperature of the gas would rise.

Choose the correct answer from the options given below:

(A) Both statement—I and statement-II are true.

(B) Both statement—I and statement-II are false.

(C) Statement-I is true but statement-II is false.

(D) Statement-I is false but statement-II is true.

8. Given below are two statements :

Statement-I : A point charge is brought in an electric field. The value of electric field at a point near to the charge may increase if the charge is positive.

Statement-II : An electric dipole is placed in a non-uniform electric field. The net electric force on the dipole will not be zero.

Choose the correct answer from the options given below :

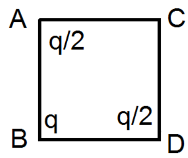
(A) Both statement—I and statement-II are true.

(B) Both statement—I and statement-II are false.

(C) Statement-I is true but statement-II is false.

(D) Statement-I is false but statement-II is true.

9. The three charges q/2, q and q/2 are placed at the corners A, B and C of a square of side 'a' as shown in figure. The magnitude of electric field (E) at the comer D of the square, is :



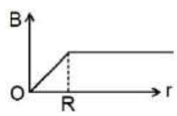
(A) $\dfrac{q}{4\pi\epsilon_0 a^2}\left(\dfrac{1}{\sqrt{2}} + \dfrac{1}{2}\right)$

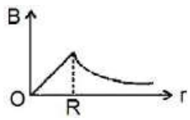
(B) $\dfrac{q}{4\pi\epsilon_0 a^2}\left(1 + \dfrac{1}{\sqrt{2}}\right)$

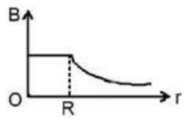
(C) $\dfrac{q}{4\pi\epsilon_0 a^2}\left(1 - \dfrac{1}{\sqrt{2}}\right)$

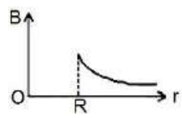
(D) $\dfrac{q}{4\pi\epsilon_0 a^2}\left(\dfrac{1}{\sqrt{2}} - \dfrac{1}{2}\right)$

10. An infinitely long hollow conducting cylinder with radius R carries a uniform current along its surface.
Choose the correct representation of magnetic field (B) as a function of radial distance (r) from the axis of cylinder.

(A) 

(B) 

(C) 

(D) 

11. A radar sends an electromagnetic signal of electric field (E_0) = 2.25 V/m and magnetic field (B_0) = 1.5 x 10^{-8} T which strikes a target on line of sight at a distance of 3 km in a medium. After that, a pail of signal (echo) reflects back towards the radar with same velocity and by same path. If the signal was transmitted at time t_0 from radar. then after how much time echo will reach to the radar?

(A) 2.0×10^{-5} s (B) 4.0×10^{-5} s

(C) 1.0×10^{-5} s (D) 8.0×10^{-5} s

12. The refracting angle of a prism is A and refractive index of the material of the prism is cot (A/2). Then the angle of minimum deviation will be -

(A) 180 – 2A (B) 90 – A

(C) 180 + 2A (D) 180 – 3A

13. The aperture of the objective is 24.4 cm. The resolving power of this telescope. If a light of wavelength 2440 Å is used to see the object will be

(A) 8.1×10^{6} (B) 10.0×10^{7}

(C) 8.2×10^{5} (D) 1.0×10^{-8}

14. The de Brogue wavelengths for an electron and a photon are λ_e and λ_p respectively.

For the same kinetic energy of electron and photon. which of the following presents the correct relation between the de Brogue wavelengths of two ?

(A) $\lambda_p \propto \lambda_e^2$ (B) $\lambda_p \propto \lambda_e$

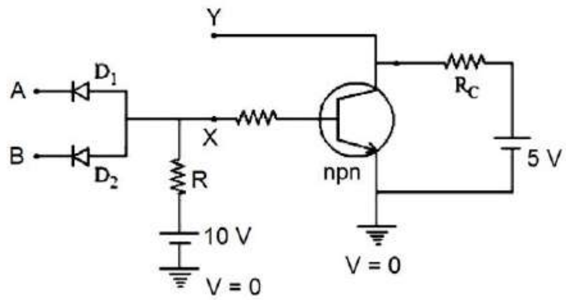
(C) $\lambda_p \propto \sqrt{\lambda_e}$ (D) $\lambda_p \propto \sqrt{\frac{1}{\lambda_e}}$

15. The Q-value of a nuclear reaction and kinetic energy of the projectile particle, K_p are related as :

(A) $Q = K_p$ (B) $(K_p + Q) < O$

(C) $Q < K_p$ (D) $(K_p + Q) > 0$

16. In the following circuit, the correct relation between output (Y) and inputs A and B will be :



(A) $Y = AB$ (B) $Y = A + B$

(C) $Y = \overline{AB}$ (D) $Y = \overline{A + B}$

17. For using a multimeter to identify diode from electrical components. choose the correct statement out of the following about the diode :

(A) It is two terminal device which conducts current in both directions.

(B) It is two terminal device which conducts current in one direction only

(C) It does not conduct current gives an initial deflection which decays to zero.

(D) It is three terminal device which conducts current in ne direction only between central terminal and either of the remaining two terminals

18. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : n-p-n transistor permits more current than a p-n-p transistor.

Reason R : Electrons have greater mobility as a charge carrier.

Choose the correct answer from the options given below :

(A) Both A and R true. and R is correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

19. Match List-I with List-II

	List-I		List-II
A	Television signal	I	03 KHz
B	Radio signal	II	20 KHz
C	High Quality Music	III	02 MHz
D	Human speech	IV	06 MHz

Choose the correct answer from the options given below :

(A) A-I, B-II, C-III, D-IV

(B) A-IV, B-III, C-I, D-II

(C) A-IV, B-III, C-II, D-I

(D) A-I, B-II, C-IV, D-III

20. The velocity of sound in a gas. in which two wavelengths 4.08m and 4.16m produce 40 beats in 12s, will be :

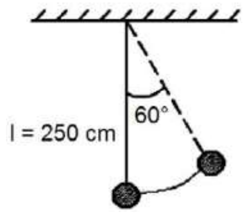
(A)2.82.8 ms^{-1} (B) 175.5 ms^{-1}

(C) 353.6 ms^{-1} (D) 707.2 ms^{-1}

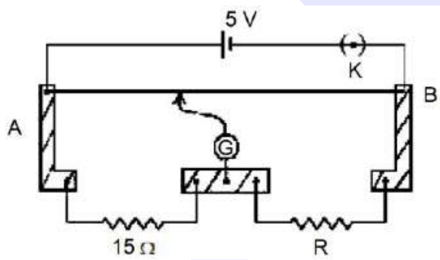
SECTION - B

1. A pendulum is suspended by a string of length 250 cm. The mass of the bob of the pendulum is 200 g. The bob is pulled aside until the string is at 60° with vertical as shown in the figure. After releasing the bob. the maximum velocity attained by the bob will be ____________ ms^{-1}.

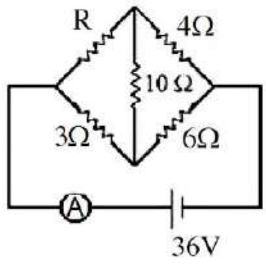
(if $g = 10\ m/s^2$)



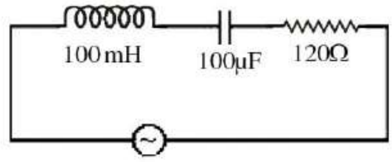
2. A meter bridge setup is shown in the figure. It is used to determine an unknown resistance R using a given resistor of 1 5 Ω. The galvanometer (G) shows null deflection when tapping key is at 43 cm mark from end A. If the end correction for end A is 2 cm. then the determined value of R will be _______ Ω.



3. Current measured by the ammeter (A) in the reported circuit when no current flows through 10 Ω resistance. will be _______ A.



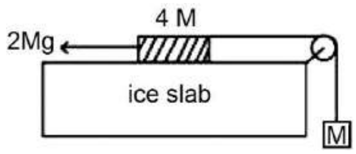
4. An AC source is connected to an inductance of 100 mH, a capacitance of 100 μ F and a resistance of 120 Ω as shown in figure. The time in which the resistance having a thermal capacity 2 J°/C will get heated by 16°C is _______s.



5. The position vector of 1 kg object is $\vec{r} = \left(3\hat{i} - \hat{j}\right)m$ and its velocity $\vec{v} = \left(3\hat{j} + \hat{k}\right)ms^{-1}$. The magnitude of its angular momentum is $\sqrt{x}$ Nm where x is ______ .

6. A man of 60 kg is running on the road and suddenly jumps into a stationary trolly car of mass 120 kg. Then. the trolly car starts moving with velocity 2 ms^{-1}. The velocity of the running man was _____________ ms^{-1}. when he jumps into the car.

7. A hanging mass M is connected to a four times bigger mass by using a string-pulley arrangement. as shown in the figure. The bigger mass is placed on a horizontal ice-slab and being pulled by 2 Mg force. In this situation. tension in the string is $\frac{x}{5}$Mg for x = ________. Neglect mass of the string and friction of the block (bigger mass) with ice slab. (Given g = acceleration due to gravity)



8. The total internal energy of two mole monoatomic ideal gas at temperature T = 300 K will be J. (Given R = 8.31 J/mol.K)

9. A singly ionized magnesium atom (A24) ion is accelerated to kinetic energy 5 keV and is projected perpendicularly into a magnetic field B of the magnitude 0.5 T. The radius of path formed will be ____________ cm.

10. A telegraph line of length 100 km has a capacity of 0.01 μF/km and it carries an alternating current at 0.5 kilo cycle per second. If minimum impedance is required, then the value of the inductance that needs to be introduced in series is ________ mH. $\left(\text{if } \pi = \sqrt{10}\right)$

CHEMISTRY

SECTION-A

1. The incorrect statement about the imperfections in solids is :

(A) Schottky defect decreases the density of the substance.

(B) Interstitial defect increases the density of the substance.

(C) Frenkel defect does not alter the density of the substance.

(D) Vacancy defect increases the density of the substance.

2. The Zeta potential is related to which property of colloids"

(A) Colour

(B) Tyndall effect

(C) Charge on the surface of colloidal particles

(D) Brownian movement

3. Element "E" belongs to the period 4 and group 16 of the periodic table. The valence shell electron configuration of the element, which is just above 'E' in the group is

(A) $3s^2. 3p^4$ (B) $3d^{10}. 4s^2, 4p^4$

(C) $4d^{10}. 5s^2, 5p^4$ (D) $2s^2$, p4

4. Given are two statements one is labelled as Assertion A and other is labelled as Reason R.

Assertion A :Magnesium can reduce Al_2O_3 at a temperature below 1350°C, while above 1350°C aluminium can reduce MgO.

Reason R : The melting and boiling points of magnesium are lower than those of aluminium.

In light of the above statements. choose most appropriate answer from the options given below:

(A) Both A and R are correct. and R is correct explanation of A.

(B) Both A and R are correct. but R is NOT the correct explanation of A.

(C) A is correct R is not correct.

(D) A is not correct. R is correct.

5. Dihydrogen reacts with CuO to give

(A) CuH_2 (B) Cu

(C) Cu_2O (D) $Cu(OH)_2$

6. Nitrogen gas is obtained by thermal decomposition of

(A) $Ba(NO_3)_2$ (B) $Ba(N_3)_2$

(C) $NaNO_2$ (D) $NaNO_3$

7. Given below are two statements :

Statement -I :The pentavalent oxide of group-15 element. E_2O_5. is less acidic than trivalent oxide. E_2O_3. of the same element.

Statement -II :The acidic character of trivalent oxide of group 15 elements. E_2O_3. decreases down the group.

In light of the above statements. choose most appropriate answer from the options given below:

(A) Both Statement I and Statement II are true.

(B) Both Statement I and Statement II are false.

(C) Statement I true. but statement II is false.

(D) Statement I is false but statement II is true.

8. Which one of the lanthanoids given below is the most stable in divalent form?

(A) Ce (Atomic Number 58)

(B) Sm (Atomic Number 62)

(C) Eu (Atomic Number 63)

(D) Yb (Atomic Number 70)

9. Given below are two statements :

Statement I : $[Ni(CN)4]^{2-}$ is square planar and diamagnetic complex. with dsp^2 hybridization for Ni but $[Ni(CO)_4]$ is tetrahedral. paramagnetic and with sp^3-hybridication for Ni.

Statement II: $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ both have same d-electron configuration have same geometry and are paramagnetic.

In light the above statements. choose the correct answer form the options given below:

(A) Both Statement I and Statement II are true.

(B) Both Statement I and Statement II are false.

(C) Statement I is correct but statement II is false.

(D) Statement I is incorrect but statement II is true.

10. Which amongst the following is not a pesticide ?

(A) DDT

(B) Organophosphates

(C) Dieldrin

(D) Sodium arsenite

11. Which one of the following techniques is not used to spot components of a mixture separated on thin layer chromatographic plate?

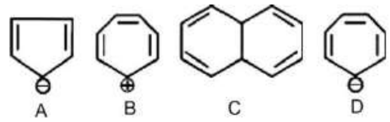
(A) I_2 (Solid)

(B) U.V. Light

(C) Visualisation agent as a component of mobile phase

(D) Spraying of an appropriate reagent

12. Which of the following structures are aromatic in nature?



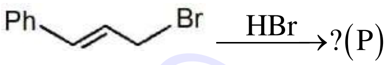
(A) A,B,C and D

(B) Only A and B

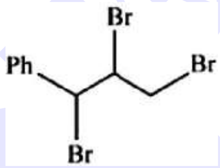
(C) Only A and C

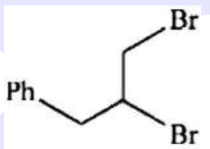
(D) Only B, C and D

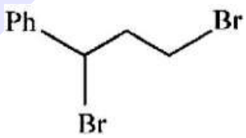
13. The major product (P) in the reaction

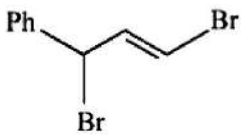


[Ph is – C_6H_5] is

(A) 

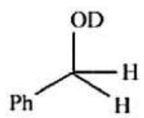
(B) 

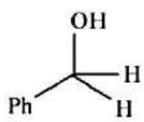
(C) 

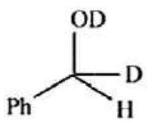
(D) 

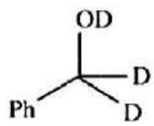
14. The correct structure of product 'A' formed in the following reaction.

$$PhCHO + Ph\cdot CHO \xrightarrow[\text{in } D_2O]{NaOD} A + Ph-\overset{O}{\overset{\|}{C}}-O^- \quad (Ph\text{ is} -C_6H_5)$$

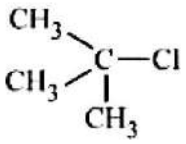
(A) 

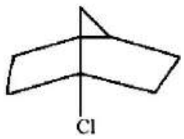
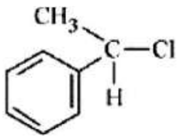
(B) 

(C) 

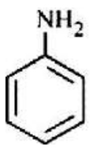
(D) 

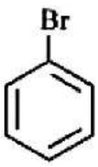
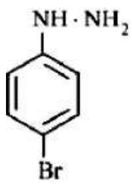
15. Which one of the following compounds is inactive towards S_N1 reaction?

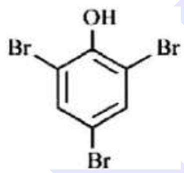
(A)  (B) 

(C)  (D) 

16. Identify the major product formed in the following sequence of reactions :



(A)  (B) 

(C)  (D) 

17. A primary aliphatic amine on reaction with nitrous acid in cold (273 K) and there after raising temperature of reaction mixture to room temperature (298 K). Gives a/an

(A) nitrile (B) alcohol

(C) diazonium salt (D) secondary amine

18. Which one of the following is **NOT** a copolymer ?

(A) Buna-S

(B) Neoprene

(C) PHBV

(D) Butadiene-styrene

19. Stability of α- Helix structure of proteins depends upon

(A) dipolar interaction

(B) H-bonding interaction

(C) van der Waals forces

(D) π-stacking interaction

20. The formula of the purple colour formed in Laissaigne's test for sulphur using sodium nitroprusside is

(A) $NaFe[Fe(CN)_6]$

(B) $Na[Cr(NH_3)_2(NCS)_4]$

(C) $Na_2[Fe(CN)_5(NO)]$

(D) $Na_4[Fe(CN)_5(NOS)]$

SECTION-B

1. A 2.0 g sample containing MnO_2 is treated with HCl liberating Cl_2. The Cl_2 gas is passed into a solution of KI and 60.0 mL of 0.1 M $Na_2S_2O_3$ is required to titrate the liberated iodine. The percentage of MnO_2 in the sample is ___________. (Nearest integer)

[Atomic masses (in u) Mn = 55; Cl = 35.5; O = 16, I = 127, Na = 23, K = 39, S = 32]

2. If the work function of a metal is 6.63×10^{-19} J, the maximum wavelength of the photon required to remove a photoelectron from the metal is ________ nm. (Nearest integer)

[Given : $h = 6.63 \times 10^{-34}$ J s, and $c = 3 \times 10^{8}$ m s^{-1}]

3. The hybridization of P exhibited in PF_5 is $sp^x d^y$. The value of y is ___________.

4. 4.0 L of an ideal gas is allowed to expand isothermally into vacuum until the total volume is 20 L. The amount of heat absorbed in this expansion is ____________ L atm.

5. The vapour pressures of two volatile liquids A and B at 25°C are 50 Torr and 100 Torr, respectively. If the liquid mixture contains 0.3 mole fraction of A, then the mole fraction of liquid B in the vapour phase is $\frac{x}{17}$. The value of x is _________.

6. The solubility product of a sparingly soluble salt A_2X_3 is 1.1×10^{-23}. If specific conductance of the solution is 3×10^{-5} S m^{-1}, the limiting molar conductivity of the solution is $x \times 10^{-3}$ S m^2 mol^{-1}. The value of x is ___________.

7. The quantity of electricity in Faraday needed to reduce 1 mol of $Cr_2O_7^{2-}$ to Cr^{3+} is _____.

8. For a first order reaction $A \to B$, the rate constant, $k = 5.5 \times 10^{-14} s^{-1}$. The time required for 67% completion of reaction is x × 10^{-1} times the half life of reaction. The value of x is ________ (Nearest integer)

(Given : log 3 = 0.4771)

9. Number of complexes which will exhibit synergic bonding amongst, $[Cr(CO)_6]$, $[Mn(CO)_5]$ and $[Mn_2(CO)_{10}]$ is ________.

10. In the estimation of bromine, 0.5 g of an organic compound gave 0.40 g of silver bromide. The percentage of bromine in the given compound is _________% (nearest integer)

(Relative atomic masses of Ag and Br are 108u and 80u, respectively).

MATHEMATICS

SECTION-A

1. If

$$\sum_{k=1}^{31}\left({}^{31}C_k\right)\left({}^{31}C_{k-1}\right)-\sum_{k=1}^{30}\left({}^{30}C_k\right)\left({}^{30}C_{k-1}\right)=\frac{\alpha(60!)}{(30!)(31!)}$$

,

Where $\alpha \in R$, then the value of 16α is equal to

(A) 1411 (B) 1320

(C) 1615 (D) 1855

2. Let a function $f : \mathbb{N} \to \mathbb{N}$ be defined by

$$f(n)=\begin{bmatrix} 2n, & n=2,4,6,8,..... \\ n-1, & n=3,7,11,15,..... \\ \frac{n+1}{2}, & n=1,5,9,13,..... \end{bmatrix}$$

then, f is

(A) one-one but not onto

(B) onto but not one-one

(C) neither one-one nor onto

(D) one-one and onto

3. If the system of linear equations

$2x + 3y - z = -2$

$x + y + z = 4$

$x - y + |\lambda| z = 4\lambda - 4$

where $\lambda \in \mathbb{R}$, has no solution, then

(A) $\lambda = 7$ (B) $\lambda = -7$

(C) $\lambda = 8$ (D) $\lambda^2 = 1$

4. Let A be a matrix of order 3 × 3 and det (A) = 2. Then det (det (A) adj (5 adj (A^3))) is equal to ____.

(A) 512×10^6 (B) 256×10^6

(C) 1024×10^6 (D) 256×10^{11}

5. The total number of 5-digit numbers, formed by using the digits 1, 2, 3, 5, 6, 7 without repetition, which are multiple of 6, is

(A) 36 (B) 48

(C) 60 (D) 72

6. Let A_1, A_2, A_3, …… be an increasing geometric progression of positive real numbers. If $A_1A_3A_5A_7 = \frac{1}{1296}$ and $A_2 + A_4 = \frac{7}{36}$, then, the value of $A_6 + A_8 + A_{10}$ is equal to

(A) 33 (B) 37

(C) 43 (D) 47

7. Let [t] denote the greatest integer less than or equal to t. Then, the value of the integral $\int_0^1 [-8x^2 + 6x - 1]dx$ is equal to

(A) -1 (B) $-\frac{5}{4}$

(C) $\frac{\sqrt{17}-13}{8}$ (D) $\frac{\sqrt{17}-16}{8}$

8. Let $f : \mathbb{R} \to \mathbb{R}$ be defined as

$$f(x)=\begin{bmatrix} [e^x], & x<0 \\ ae^x+[x-1], & 0\le x<1 \\ b+[\sin(\pi x)], & 1\le x<2 \\ [e^{-x}]-c, & x\ge 2 \end{bmatrix}$$

where $a, b, c \in \mathbb{R}$ and [t] denotes greatest integer less than or equal to t. Then, which of the following statements is true ?

(A) There exists $a, b, c \in \mathbb{R}$ such that f is continuous of $\mathbb{R}$.

(B) If f is discontinuous at exactly one point, then $a + b + c = 1$.

(C) If f is discontinuous at exactly one point, then $a+b+c \neq 1$.

(D) f is discontinuous at atleast two points, for any values of a, b and c.

9. The area of the region

$S = \{(x,y) : y^2 \leq 8x, y \geq \sqrt{2}x, x \geq 1\}$ is

(A) $\frac{13\sqrt{2}}{6}$ (B) $\frac{11\sqrt{2}}{6}$

(C) $\frac{5\sqrt{2}}{6}$ (D) $\frac{19\sqrt{2}}{6}$

10. Let the solution curve y = y(x) of the differential equation,

$$\left[\frac{x}{\sqrt{x^2-y^2}} + e^{\frac{y}{x}}\right] x\frac{dy}{dx} = x + \left[\frac{x}{\sqrt{x^2-y^2}} + e^{\frac{y}{x}}\right] y$$

pass through the points (1, 0) and $(2\alpha, \alpha), \alpha > 0$. Then α is equal to

(A) $\frac{1}{2}\exp\left(\frac{\pi}{6} + \sqrt{e} - 1\right)$

(B) $\frac{1}{2}\exp\left(\frac{\pi}{3} + \sqrt{e} - 1\right)$

(C) $\exp\left(\frac{\pi}{6} + \sqrt{e} + 1\right)$

(D) $2\exp\left(\frac{\pi}{3} + \sqrt{e} - 1\right)$

11. Let y = y(x) be the solution of the differential equation

$$x\left(1-x^2\right)\frac{dy}{dx} + \left(3x^2y - y - 4x^3\right) = 0, x > 1,$$

with y(2) = –2. Then y(3) is equal to

(A) –18 (B) –12

(C) –6 (D) –3

12. The number of real solutions of $x^7 + 5x^3 + 3x + 1 = 0$ is equal to ________.

(A) 0 (B) 1

(C) 3 (D) 5

13. Let the eccentricity of the hyperbola $H : \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ be $\sqrt{\frac{5}{2}}$ and length of its latus rectum be $6\sqrt{2}$, If y = 2x + c is a tangent to the hyperbola H, then the value of c^2 is equal to

(A) 18 (B) 20

(C) 24 (D) 32

14. If the tangents drawn at the point O(0, 0) and $P\left(1+\sqrt{5}, 2\right)$ on the circle $x^2 + y^2 - 2x - 4y = 0$ intersect at the point Q, then the area of the triangle OPQ is equal to

(A) $\frac{3+\sqrt{5}}{2}$ (B) $\frac{4+2\sqrt{5}}{2}$

(C) $\frac{5+3\sqrt{5}}{2}$ (D) $\frac{7+3\sqrt{5}}{2}$

15. If two distinct point Q, R lie on the line of intersection of the planes –x + 2y – z = 0 and $3x - 5y + 2z = 0$ and $PQ = PR = \sqrt{18}$ where the point P is (1, –2, 3), then the area of the triangle PQR is equal to

(A) $\frac{2}{3}\sqrt{38}$ (B) $\frac{4}{3}\sqrt{38}$

(C) $\frac{8}{3}\sqrt{38}$ (D) $\sqrt{\frac{152}{3}}$

16. The acute angle between the planes P_1 and P_2, when P_1 and P_2 are the planes passing through the intersection of the planes 5x + 8y + 13z – 29 = 0 and 8x – 7y + z – 20 = 0 and the points (2, 1, 3) and (0, 1, 2), respectively, is

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{4}$

(C) $\frac{\pi}{6}$ (D) $\frac{\pi}{12}$

17. Let the plane $P:\vec{r}\cdot\vec{a}=d$ contain the line of intersection of two planes $\vec{r}\cdot(\hat{i}+3\hat{j}-\hat{k})=6$ and $\vec{r}\cdot(-6\hat{i}+5\hat{j}-\hat{k})=7$. If the plane P passes through the point $\left(2, 3, \frac{1}{2}\right)$, then the value of $\frac{|13\vec{a}|^2}{d^2}$ is equal to

(A) 90 (B) 93

(C) 95 (D) 97

18. The probability, that in a randomly selected 3-digit number at least two digits are odd, is

(A) $\frac{19}{36}$ (B) $\frac{15}{36}$

(C) $\frac{13}{36}$ (D) $\frac{23}{36}$

19. Let AB and PQ be two vertical poles, 160 m apart from each other. Let C be the middle point of B and Q, which are feet of these two poles. Let $\frac{\pi}{8}$ and θ be the angles of elevation from C to P and A, respectively. If the height of pole PQ is twice the height of pole AB, then $\tan^2\theta$ is equal to

(A) $\frac{3-2\sqrt{2}}{2}$ (B) $\frac{3+\sqrt{2}}{2}$

(C) $\frac{3-2\sqrt{2}}{4}$ (D) $\frac{3-\sqrt{2}}{4}$

20. Let p, q, r be three logical statements. Consider the compound statements

$S_1:((\sim p)\vee q)\vee((\sim p)\vee r)$ and

$S_2:p\rightarrow(q\vee r)$

Then, which of the following is **NOT** true ?

(A) If S_2 is True, then S_1 is True

(B) If S_2 is False, then S_1 is False

(C) If S_2 is False, then S_1 is True

(D) If S_1 is False, then S_2 is False

SECTION-B

1. Let R_1 and R_2 be relations on the set $\{1, 2, \ldots, 50\}$ such that

$R_1=\{(p, p^n): p \text{ is a prime and } n\geq 0 \text{ is an integer}\}$

and $R_2=\{(p, p^n): p \text{ is a prime and } n=0 \text{ or } 1\}$.

Then, the number of elements in $R_1 - R_2$ is ______.

2. The number of real solutions of the equation $e^{4x}+4e^{3x}-58e^{2x}+4e^x+1=0$ is ______.

3. The mean and standard deviation of 15 observations are found to be 8 and 3 respectively. On rechecking it was found that, in the observations, 20 was misread as 5. Then, the correct variance is equal to _______.

4. If $\vec{a}=2\hat{i}+\hat{j}+3\hat{k}$, $\vec{b}=3\hat{i}+3\hat{j}+\hat{k}$ and $\vec{c}=c_1\hat{i}+c_2\hat{j}+c_3\hat{k}$ are coplanar vectors and $\vec{a}\cdot\vec{c}=5$, $\vec{b}\perp\vec{c}$, then 122 $(c_1 + c_2 + c_3)$ is equal to _______.

5. A ray of light passing through the point P(2, 3) reflects on the x-axis at point A and the reflected ray passes through the point Q(5, 4). Let R be the point that divides the line segment AQ internally into the ratio 2 : 1. Let the co-ordinates of the foot of the perpendicular M from R on the bisector of the angle PAQ be (α, β). Then, the value of $7\alpha+3\beta$ is equal to _______.

6. Let ℓ be a line which is normal to the curve $y=2x^2+x+2$ at a point P on the curve. If the point Q(6, 4) lies on the line ℓ and O is origin, then the area of the triangle OPQ is equal to _____.

7. Let A = $\{1, a_1, a_2 \ldots\ldots a_{18}, 77\}$ be a set of integers with $1 < a_1 < a_2 < \ldots\ldots < a_{18} < 77$. Let the set $A+A=\{x+y: x, y\in A\}$ contain exactly 39 elements. Then, the value of $a_1 + a_2 + \ldots\ldots + a_{18}$ is equal to ________.

8. The number of positive integers k such that the constant term in the binomial expansion of $\left(2x^3+\frac{3}{x^k}\right)^{12}$, $x \neq 0$ is $2^8 \cdot \ell$, where ℓ is an odd integer, is ________.

9. The number of elements in the set $\{z = a + ib \in \mathbb{C} : a, b \in \mathbb{Z} \text{ and } 1 < |z - 3 + 2i| < 4\}$ is ________.

10. Let the lines $y + 2x = \sqrt{11} + 7\sqrt{7}$ and $2y + x = 2\sqrt{11} + 6\sqrt{7}$ be normal to a circle $C : (x-h)^2 + (y-k)^2 = r^2$. If the line $\sqrt{11}y - 3x = \frac{5\sqrt{77}}{3} + 11$ is tangent to the circle C, then the value of $(5h - 8k)^2 + 5r^2$ is equal to ____.

SET # 10

PHYSICS

SECTION-A

1. Velocity (v) and acceleration (a) in two systems of units 1 and 2 are related as $v_2 = \frac{n}{m^2}v_1$ and $a_2 = \frac{a_1}{mn}$ respectively. Here m and n are constants. The relations for distance and time in two systems respectively are:

(A) $\frac{n^3}{m^3}L_1 = L_2$ and $\frac{n^2}{m}T_1 = T_2$

(B) $L_1 = \frac{n^4}{m^2}L_2$ and $T_1 = \frac{n^2}{m}T_2$

(C) $L_1 = \frac{n^2}{m}L_2$ and $T_1 = \frac{n^4}{m^2}T_2$

(D) $\frac{n^2}{m}L_1 = L_2$ and $\frac{n^4}{m^2}T_1 = T_2$

2. A ball is spun with angular acceleration $\alpha = 6t^2 - 2t$ where t is in second and α is in rads^{-2}. At t = 0, the ball has angular velocity of 10 rads^{-1} and angular position of 4 rad. The most appropriate expression for the angular position of the ball is:

(A) $\frac{3}{2}t^4 - t^2 + 10t$

(B) $\frac{t^4}{2} - \frac{t^3}{3} + 10t + 4$

(C) $\frac{2t^4}{3} - \frac{t^3}{6} + 10t + 12$

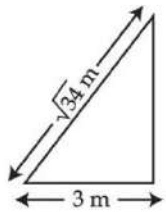
(D) $2t^4 - \frac{t^3}{2} + 5t + 4$

3. A block of mass 2 kg moving on a horizontal surface with speed of 4 ms^{-1} enters a rough surface ranging from x = 0.5 m to x = 1.5 m. The retarding force in this range of rough surface is related to distance by $F = -kx$ where k = 12 Nm^{-1}. The speed of the block as it just crosses the rough surface will be:

(A) Zero (B) 1.5 ms^{-1}

(C) 2.0 ms^{-1} (D) 2.5 ms^{-1}

4. A $\sqrt{34}$ m long ladder weighing 10 kg leans on a frictionless wall. Its feet rest on the floor 3 m away from the wall as shown in the figure. If F_f and F_w are the reaction forces of the floor and the wall, then ratio of F_w/F_f will be : (Use g = 10 m/s^2)



(A) $\frac{6}{\sqrt{110}}$ (B) $\frac{3}{\sqrt{113}}$

(C) $\frac{3}{\sqrt{109}}$ (D) $\frac{2}{\sqrt{109}}$

5. Water fall from a 40 m high dam at the rate of 9×10^4 kg per hour. Fifty percentage of gravitational potential energy can be converted into electrical energy. Using this hydroelectric energy number of 100W lamps, that can be lit, is:
(Take g = 10 ms^{-2})

(A) 25 (B) 50 (C) 100 (D) 18

6. Two objects of equal masses placed at certain distance from each other attracts each other with a force of F. If one-third mass of one object is transferred to the other object, then the new force will be :

(A) $\frac{2}{9}F$ (B) $\frac{16}{9}F$ (C) $\frac{8}{9}F$ (D) F

7. A water drop of radius $1\mu m$ falls in a situation where the effect of buoyant force is negligible. Co-efficient of viscosity of air is 1.8×10^{-5} Nsm^{-2} and its density is negligible as compared to that of water 10^6 gm^{-3}. Terminal velocity of the water drop is:
(Take acceleration due to gravity = 10 ms^{-2})

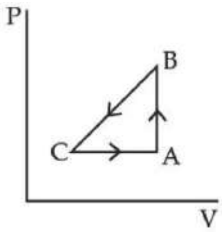
(A) 145.4×10^{-6} ms^{-1}

(B) 118.0×10^{-6} ms^{-1}

(C) 132.6×10^{-6} ms^{-1}

(D) 123.4×10^{-6} ms^{-1}

8. A sample of an ideal gas is taken through the cyclic process ABCA as shown in figure. It absorbs, 40 J of heat during the part AB, no heat during BC and rejects 60J of heat during CA. A work 50J is done on the gas during the part BC. The internal energy of the gas at A is 1560J. The work done by the gas during the part CA is:



(A) 20 J (B) 30 J
(C) –30J (D) –60 J

9. What will be the effect on the root mean square velocity of oxygen molecules if the temperature is doubled and oxygen molecule dissociates into atomic oxygen?

(A) The velocity of atomic oxygen remains same
(B) The velocity of atomic oxygen doubles
(C) The velocity of atomic oxygen becomes half
(D) The velocity of atomic oxygen becomes four times

10. Two point charges A and B of magnitude $+8\times10^{-6}C$ and $-8\times10^{-6}C$ respectively are placed at a distance d apart. The electric field at the middle point O between the charges is $6.4\times10^{4}NC^{-1}$. The distance 'd' between the point charges A and B is:

(A) 2.0 m (B) 3.0 m
(C) 1.0 m (D) 4.0 m

11. Resistance of the wire is measured as 2Ω and 3Ω at 10°C and 30°C respectively. Temperature co–coefficient of resistance of the material of the wire is :

(A) $0.033°C^{-1}$ (B) $-0.033°C^{-1}$
(C) $0.011°C^{-1}$ (D) $0.055°C^{-1}$

12. The space inside a straight current carrying solenoid is filled with a magnetic material having magnetic susceptibility equal to 1.2×10^{-5}. What is fractional increase in the magnetic field inside solenoid with respect to air as medium inside the solenoid?

(A) 1.2×10^{-5} (B) 1.2×10^{-3}
(C) 1.8×10^{-3} (D) 2.4×10^{-5}

13. Two parallel, long wires are kept 0.20 m apart in vacuum, each carrying current of x A in the same direction. If the force of attraction per meter of each wire is $2\times10^{-6}N$, then the value of x is approximately:

(A) 1 (B) 2.4
(C) 1.4 (D) 2

14. A coil is placed in a time varying magnetic field. If the number of turns in the coil were to be halved and the radius of wire doubled, the electrical power dissipated due to the current induced in the coil would be:
(Assume the coil to be short circuited.)

(A) Halved (B) Quadrupled
(C) The same (D) Doubled

15. An EM wave propagating in x-direction has a wavelength of 8 mm. The electric field vibrating y-direction has maximum magnitude of 60 Vm^{-1}. Choose the correct equations for electric and magnetic fields if the EM wave is propagating in vacuum :

(A) $E_y = 60\sin\left[\frac{\pi}{4}\times10^{3}\left(x-3\times10^{8}t\right)\right]\hat{j}Vm^{-1}$

$B_z = 2\sin\left[\frac{\pi}{4}\times10^{3}\left(x-3\times10^{8}t\right)\right]\hat{k}T$

(B) $E_y = 60\sin\left[\frac{\pi}{4}\times10^{3}\left(x-3\times10^{8}t\right)\right]\hat{j}Vm^{-1}$

$B_z = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^{3}\left(x-3\times10^{8}t\right)\right]\hat{k}T$

(C) $E_y = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^{3}\left(x-3\times10^{8}t\right)\right]\hat{j}Vm^{-1}$

$B_z = 60\sin\left[\frac{\pi}{4}\times10^{3}\left(x-3\times10^{8}t\right)\right]\hat{k}T$

(D) $E_y = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^{4}\left(x-4\times10^{8}t\right)\right]\hat{j}Vm^{-1}$

$B_z = 60\sin\left[\frac{\pi}{4}\times10^{4}\left(x-4\times10^{8}t\right)\right]\hat{k}T$

16. In young's double slit experiment performed using a monochromatic light of wavelength λ, when a glass plate $(\mu = 1.5)$ of thickness $x\lambda$ is introduced in the path of the one of the interfering beams, the intensity at the position where the central maximum occurred previously remains unchanged. The value of x will be:

(A) 3 (B) 2

(C) 1.5 (D) 0.5

17. Let K_1 and K_2 be the maximum kinetic energies of photo–electrons emitted when two monochromatic beams of wavelength λ_1 and λ_2, respectively are incident on a metallic surface. If $\lambda_1 = 3\lambda_2$ then:

(A) $K_1 > \frac{K_2}{3}$ (B) $K_1 < \frac{K_2}{3}$

(C) $K_1 = \frac{K_2}{3}$ (D) $K_2 = \frac{K_1}{3}$

18. Following statements related to radioactivity are given below:

(A) Radioactivity is a random and spontaneous process and is dependent on physical and chemical conditions.

(B) The number of un–decayed nuclei in the radioactive sample decays exponentially with time.

(C) Slope of the graph of $\log_e$(no. of undecayed nuclei) Vs. time represents the reciprocal of mean life time (τ).

(D) Product of decay constant (λ) and half–life time $(T_{1/2})$ is not constant.

Choose the most appropriate answer from the options given below:

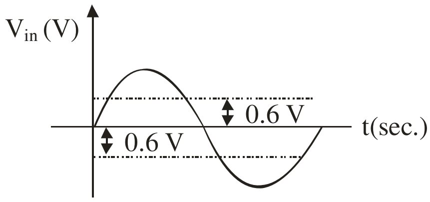
(A) (A) and (B) only

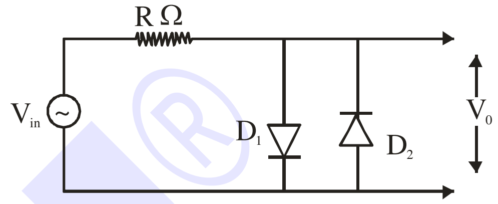
(B) (B) and (D) only

(C) (B) and (C) only

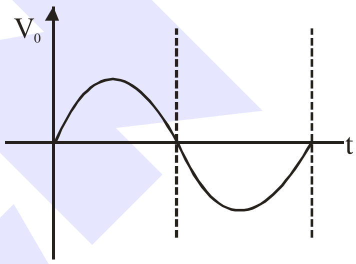
(D) (C) and (D) only

19. In the given circuit the input voltage V_{in} is shown in figure. The cut–in voltage of p–n junction diode (D_1 or D_2) is 0.6 V. Which of the following output voltage (V_0) waveform across the diode is correct?

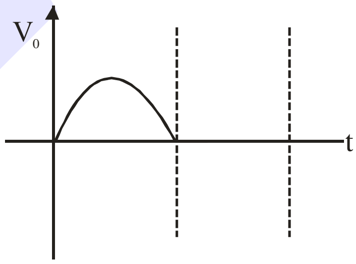




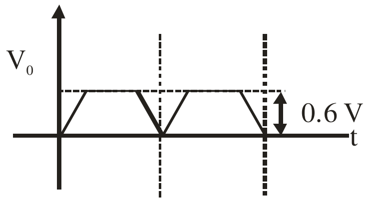
(A)



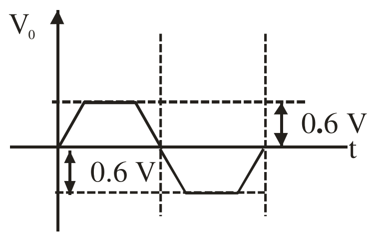
(B)



(C)



(D)



20. Amplitude modulated wave is represented by $V_{AM} = 10\left[1 + 0.4\cos\left(2\pi\times10^4 t\right)\right]\cos\left(2\pi\times10^7 t\right)$.

The total bandwidth of the amplitude modulated wave is :

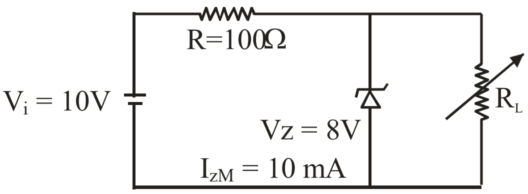
(A) 10 kHz (B) 20 MHz

(C) 20 kHz (D) 10 MHz

SECTION-B

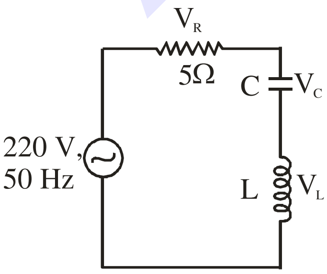
1. A student in the laboratory measures thickness of a wire using screw gauge. The readings are 1.22 mm, 1.23 mm, 1.19 mm and 1.20 mm. The percentage error is $\frac{x}{121}\%$. The value of x is ___

2. A Zener of breakdown voltage $V_Z = 8V$ and maximum zener current, $I_{ZM} = 10$ mA is subjected to an input voltage $V_i = 10V$ with series resistance $R = 100\Omega$. In the given circuit R_L represents the variable load resistance. The ratio of maximum and minimum value of R_L is ______

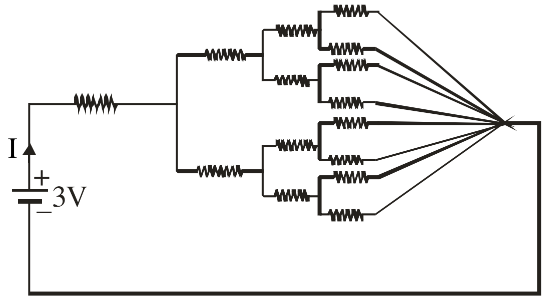


3. In a Young's double slit experiment, an angular width of the fringe is 0.35° on a screen placed at 2 m away for particular wavelength of 450 nm. The angular width of the fringe, when whole system is immersed in a medium of refractive index 7/5, is $\frac{1}{\alpha}$. The value of α is _______

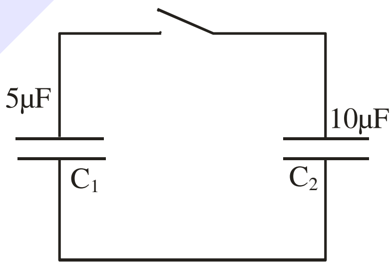
4. In the given circuit, the magnitude of V_L and V_C are twice that of V_R. Given that f = 50 Hz, the inductance of the coil is $\frac{1}{K\pi}$ mH. The value of K is ______



5. All resistances in figure are 1Ω each. The value of current 'I' is $\frac{a}{5}$A. The value of a is ______



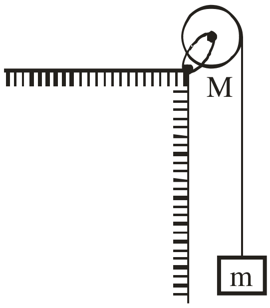
6. A capacitor C_1 of capacitance $5\mu F$ is charged to a potential of 30 V using a battery. The battery is then removed and the charged capacitor is connected to an uncharged capacitor C_2 of capacitance $10\mu F$ as shown in figure. When the switch is closed charge flows between the capacitors. At equilibrium, the charge on the capacitor C_2 is ________ μC.



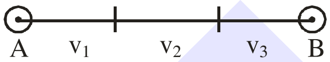
7. A tuning fork of frequency 340 Hz resonates in the fundamental mode with an air column of length 125 cm in a cylindrical tube closed at one end. When water is slowly poured in it, the minimum height of water required for observing resonance once again is ______cm. (Velocity of sound in air is 340 ms^{-1})

8. A liquid of density 750 kgm^{-3} flows smoothly through a horizontal pipe that tapers in cross–sectional area from $A_1 = 1.2\times10^{-2}m^2$ to $A_2 = \frac{A_1}{2}$. The pressure difference between the wide and narrow sections of the pipe is 4500 Pa. The rate of flow of liquid is ______ $\times10^{-3}m^3s^{-1}$.

9. A uniform disc with mass M = 4 kg and radius R = 10 cm is mounted on a fixed horizontal axle as shown in figure. A block with mass m = 2 kg hangs from a massless cord that is wrapped around the rim of the disc. During the fall of the block, the cord does not slip and there is no friction at the axle. The tension in the cord is ________N. (Take $g = 10\ ms^{-2}$)



10. A car covers AB distance with first one–third at velocity $v_1\ ms^{-1}$, second one–third at $v_2\ ms^{-1}$ and last one–third at $v_3\ ms^{-1}$. If $v_3 = 3v_1$, $v_2 = 2v_1$ and $v_1 = 11\ ms^{-1}$ then the average velocity of the car is ________ ms^{-1}.



CHEMISTRY

SECTION-A

1. Compound A contains 8.7% Hydrogen, 74% Carbon and 17.3% Nitrogen. The molecular formula of the compound is,

Given : Atomic masses of C, H and N are 12, 1 and 14 amu respectively.

The molar mass of the compound A is $162\ g\ mol^{-1}$.

(A) $C_4H_6N_2$ (B) C_2H_3N

(C) C_5H_7N (D) $C_{10}H_{14}N_2$

2. Consider the following statements :

(A) The principal quantum number 'n' is a positive integer with values of 'n' = 1, 2, 3, ….

(B) The azimuthal quantum number 'l' for a given 'n' (principal quantum number) can have values as 'l' = 0, 1, 2, …. n

(C) Magnetic orbital quantum number 'm_l' for a particular 'l' (azimuthal quantum number) has $(2l + 1)$ values.

(D) ±1/2 are the two possible orientations of electron spin.

(E) For $l = 5$, there will be a total of 9 orbital.

Which of the above statements are **correct**?

(A) (A), (B) and (C)

(B) (A), (C), (D) and (E)

(C) (A), (C) and (D)

(D) (A), (B), (C) and (D)

3. In the structure of SF_4, the lone pair of electrons on S is in.

(A) equatorial position and there are two lone pair-bond pair repulsions at 90°

(B) equatorial position and there are three lone pair-bond pair repulsions at 90°

(C) axial position and there are three lone pair – bond pair repulsion at 90°.

(D) axial position and there are two lone pair – bond pair repulsion at 90°.

4. A student needs to prepare a buffer solution of propanoic acid and its sodium salt with pH 4. The ratio of $\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$ required to make buffer is ……….

Given : $K_a(CH_3CH_2COOH) = 1.3 \times 10^{-5}$

(A) 0.03 (B) 0.13

(C) 0.23 (D) 0.33

5. Match List-I with List-II.

List-I		List-II	
(A)	Negatively charged sol	(I)	$Fe_2O_3 \cdot xH_2O$
(B)	Macromolecular colloid	(II)	CdS sol
(C)	Positively charged sol	(III)	Starch
(D)	Cheese	(IV)	a gel

Choose the correct answer from the options given below :

(A) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)
(B) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)
(C) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)
(D) (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

6. Match List-I with List-II.

List-I (Oxide)		List-II (Nature)	
(A)	Cl_2O_7	(I)	Amphoteric
(B)	Na_2O	(II)	Basic
(C)	Al_2O_3	(III)	Neutral
(D)	N_2O	(IV)	Acidic

Choose the **correct** answer from the options given below :

(A) (A) – (IV), (B) – (III), (C) – (I), (D) – (II)
(B) (A) – (IV), (B) – (II), (C) – (I), (D) – (III)
(C) (A) – (II), (B) – (IV), (C) – (III), (D) – (I)
(D) (A) – (I), (B) – (II), (C) – (IIII), (D) – (IV)

7. In the metallurgical extraction of copper, following reaction is used :

$FeO + SiO_2 \rightarrow FeSiO_3$

FeO and $FeSiO_3$ respectively are.

(A) gangue and flux (B) flux and slag
(C) slag and flux (D) gangue and slag

8. Hydrogen has three isotopes : protium (^1H), deuterium (^2H or D) and tritium (^3H or T). They have nearly same chemical properties but different physical properties. They differ in

(A) number of protons
(B) atomic number
(C) electronic configuration
(D) atomic mass

9. Among the following basic oxide is :

(A) SO_3 (B) SiO_2
(C) CaO (D) Al_2O_3

10. Among the given oxides of nitrogen; N_2O, N_2O_3, N_2O_4 and N_2O_5, the number of compound/(s) having N–N bond is :

(A) 1 (B) 2
(C) 3 (D) 4

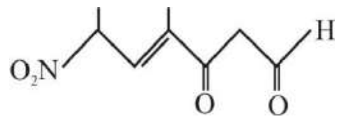
11. Which of the following oxoacids of sulphur contains "S" in two different oxidation states?

(A) $H_2S_2O_3$ (B) $H_2S_2O_6$
(C) $H_2S_2O_7$ (D) $H_2S_2O_8$

12. Correct statement about photo-chemical smog is :

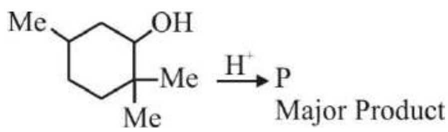
(A) It occurs in humid climate.
(B) It is a mixture of smoke, fog and SO_2
(C) It is reducing smog.
(D) It results from reaction of unsaturated hydrocarbons.

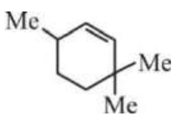
13. The correct IUPAC name of the following compound is :

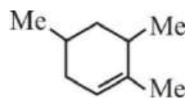


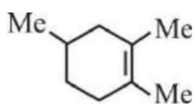
(A) 4-methyl-2-nitro-5-oxohept-3-enal
(B) 4-methyl-5-oxo-2-nitrohept-3-enal
(C) 4-methyl-6-nitro-3-oxohept-4-enal
(D) 6-formyl-4-methyl-2-nitrohex-3-enal

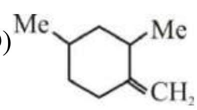
14. The major product (P) of the given reaction is (where, Me is $-CH_3$)



(A)


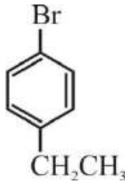
(B)


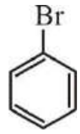
(C)


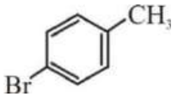
(D)


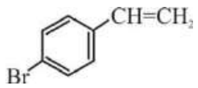
15. A $\xrightarrow[\text{(ii) } CN^- \text{ (iii) } H_2O/H^+]{\text{(i) } Cl_2,\Delta}$ 4-Bromophenyl acetic acid.

In the above reaction 'A' is

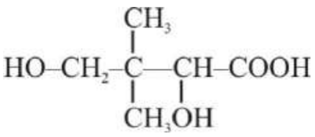
(A) 

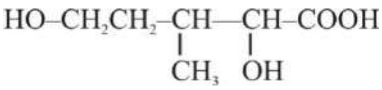
(B) 

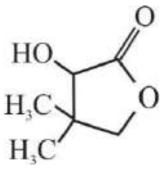
(C) 

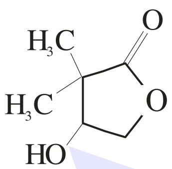
(D) 

16. Isobutyraldehyde on reaction with formaldehyde and K_2CO_3 gives compound 'A'. Compound 'A' reacts with KCN and yields compound 'B', which on hydrolysis gives a stable compound 'C'. The compound 'C' is :

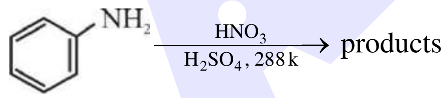
(A) 

(B) 

(C) 

(D) 

17. With respect to the following reaction, consider the given statements :



(A) o-Nitroaniline and p-nitroaniline are the predominant products

(B) p-Nitroaniline and m-nitroaniline are the predominant products

(C) HNO_3 acts as an acid

(D) H_2SO_4 acts as an acid

(A) (A) and (C) are correct statements.

(B) (A) and (D) are correct statements.

(C) (B) and (D) are correct statements.

(D) (B) and (C) are correct statements.

18. Given below are two statements, one is Assertion (A) and other is Reason (R).

Assertion (A) : Natural rubber is a linear polymer of isoprene called cis-polyisoprene with elastic properties.

Reason (R) : The cis-polyisoprene molecules consist of various chains held together by strong polar interactions with coiled structure.

In the light of the above statements, choose the **correct** one from the options given below:

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) (A) is true but (R) is false.

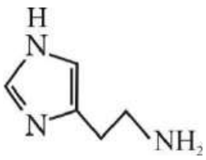
(D) (A) is false but (R) is true.

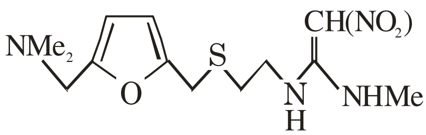
19. When sugar 'X' is boiled with dilute H_2SO_4 in alcoholic solution, two isomers 'A' and 'B' are formed. 'A' on oxidation with HNO_3 yields saccharic acid where as 'B' is laevorotatory. The compound 'X' is :

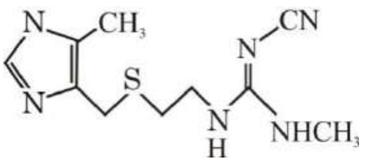
(A) Maltose (B) Sucrose

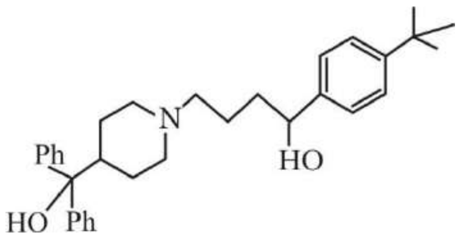
(C) Lactose (D) Strach

20. The drug tegamet is :

(A) 

(B) 

(C) 

(D) 

SECTION-B

1. 100 g of an ideal gas is kept in a cylinder of 416 L volume at 27°C under 1.5 bar pressure. The molar mass of the gas is ______ g mol^{-1}. (Nearest integer) (Given : R = 0.083 L bar K^{-1} mol^{-1})

2. For combustion of one mole of magnesium in an open container at 300 K and 1 bar pressure, $\Delta_C H^{\ominus}$ = –601.70 kJ mol^{-1}, the magnitude of change in internal energy for the reaction is _____ kJ. (Nearest integer) (Given : R = 8.3 J K^{-1} mol^{-1})

3. 2.5 g of protein containing only glycine ($C_2H_5NO_2$) is dissolved in water to make 500 mL of solution. The osmotic pressure of this solution at 300 K is found to be 5.03×10^{-3} bar. The total number of glycine units present in the protein is ____ (Given : R = 0.083 L bar K^{-1} mol^{-1})

4. For the given reactions

$Sn^{2+} + 2e^- \rightarrow Sn$

$Sn^{4+} + 4e^- \rightarrow Sn$

The electrode potentials are; $E^o_{Sn^{2+}/Sn}$ = –0.140V and $E^o_{Sn^{4+}/Sn}$ = 0.010 V. The magnitude of standard electrode potential for Sn^{4+}/Sn^{2+} i.e. $E^o_{Sn^{4+}/Sn^{2+}}$ is ______ $\times 10^{-2}$ V. (Nearest integer)

5. A radioactive element has a half life of 200 days. The percentage of original activity remaining after 83 days is ______. (Nearest integer) (Given : antilog 0.125 = 1.333, antilog 0.693 = 4.93)

6. $[Fe(CN)_6]^{4-}$

$[Fe(CN)_6]^{3-}$

$[Ti(CN)_6]^{3-}$

$[Ni(CN)_4]^{2-}$

$[Co(CN)_6]^{3-}$

Among the given complexes, number of paramagnetic complexes is _____.

7. (a) $CoCl_3 \cdot 4\ NH_3$

(b) $CoCl_3 \cdot 5NH_3$

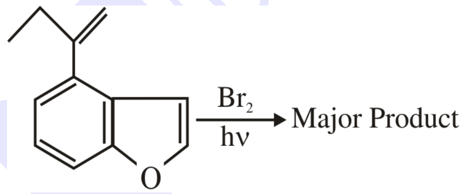
(c) $CoCl_3 \cdot .6NH_3$ and

(d) $CoCl(NO_3)_2 \cdot 5NH_3$

Number of complex(es) which will exist in cis-trans is/are

8. The complete combustion of 0.492 g of an organic compound containing 'C', 'H' and 'O' gives 0.793g of CO_2 and 0.442 g of H_2O. The percentage of oxygen composition in the organic compound is ___________. (nearest integer)

9. The major product of the following reaction contains _______ bromine atom(s).



10. 0.01 M $KMnO_4$ solution was added to 20.0 mL of 0.05 M Mohr's salt solution through a burette. The initial reading of 50 mL burette is zero. The volume of $KMnO_4$ solution left in the burette after the end point is _______ mL. (nearest integer)

MATHEMATICS

SECTION-A

1. Let $R_1 = \{(a,b) \in N \times N : |a-b| \le 13\}$ and $R_2 = \{(a,b) \in N \times N : |a-b| \ne 13\}$.

Then on N:

(A) Both R_1 and R_2 are equivalence relations

(B) Neither R_1 nor R_2 is an equivalence relation

(C) R_1 is an equivalence relation but R_2 is not

(D) R_2 is an equivalence relation but R_1 is not

2. Let f(x) be a quadratic polynomial such that f(–2) + f(3) = 0. If one of the roots of f(x) = 0 is –1, then the sum of the roots of f(x) = 0 is equal to :

(A) $\frac{11}{3}$ (B) $\frac{7}{3}$

(C) $\frac{13}{3}$ (D) $\frac{14}{3}$

3. The number of ways to distribute 30 identical candies among four children C_1, C_2, C_3 and C_4 so that C_2 receives atleast 4 and atmost 7 candies, C_3 receives atleast 2 and atmost 6 candies, is equal to

(A) 205 (B) 615
(C) 510 (D) 430

4. The term independent of x in the expression of $\left(1-x^2+3x^3\right)\left(\frac{5}{2}x^3-\frac{1}{5x^2}\right)^{11}, x \neq 0$ is

(A) $\frac{7}{40}$ (B) $\frac{33}{200}$ (C) $\frac{39}{200}$ (D) $\frac{11}{50}$

5. If n arithmetic means are inserted between a and 100 such that the ratio of the first mean to the last mean is 1 : 7 and a + n = 33, then the value of n is

(A) 21 (B) 22
(C) 23 (D) 24

6. Let $f, g : \mathbf{R} \rightarrow \mathbf{R}$ be functions defined by

$$f(x)=\begin{cases}[x] & , x<0 \\ |1-x| & , x \geq 0\end{cases} \text{ and}$$

$$g(x)=\begin{cases}e^x-x & , x<0 \\ (x-1)^2-1 & , x \geq 0\end{cases}$$

where [x] denote the greatest integer less than or equal to x. Then, the function fog is discontinuous at exactly :

(A) one point (B) two points
(C) three points (D) four points

7. Let $f : \mathbf{R} \rightarrow \mathbf{R}$ be a differentiable function such that $f\left(\frac{\pi}{4}\right)=\sqrt{2}, f\left(\frac{\pi}{2}\right)=0$ and $f'\left(\frac{\pi}{2}\right)=1$ and let

$$g(x)=\int_x^{\pi/4}\left(f'(t)\sec t+\tan t \sec t\, f(t)\right)dt$$

for $x \in \left[\frac{\pi}{4}, \frac{\pi}{2}\right)$. Then $\lim_{x \to \left(\frac{\pi}{2}\right)^-} g(x)$ is equal to

(A) 2 (B) 3 (C) 4 (D) –3

8. Let $f : \mathbf{R} \rightarrow \mathbf{R}$ be continuous function satisfying f(x) + f(x + k) = n, for all $x \in \mathbf{R}$ where k > 0 and n is a positive integer. If $I_1=\int_0^{4nk} f(x)dx$ and $I_2=\int_{-k}^{3k} f(x)dx$, then

(A) $I_1+2I_2=4nk$

(B) $I_1+2I_2=2nk$

(C) $I_1+nI_2=4n^2k$

(D) $I_1+nI_2=6n^2k$

9. The area of the bounded region enclosed by the curve $y=3-\left|x-\frac{1}{2}\right|-|x+1|$ and the x-axis is

(A) $\frac{9}{4}$ (B) $\frac{45}{16}$

(C) $\frac{27}{8}$ (D) $\frac{63}{16}$

10. Let x = x(y) be the solution of the differential equation

$$2y e^{x/y^2}dx+\left(y^2-4xe^{x/y^2}\right)dy=0$$

such that x(1) = 0. Then, x(e) is equal to

(A) $e\log_e(2)$ (B) $-e\log_e(2)$

(C) $e^2\log_e(2)$ (D) $-e^2\log_e(2)$

11. Let the slope of the tangent to a curve y = f(x) at (x, y) be given by 2 tanx (cosx – y). if the curve passes through the point $\left(\pi/4, 0\right)$, then the value of $\int_0^{\pi/2} y\,dx$ is equal to

(A) $\left(2-\sqrt{2}\right)+\frac{\pi}{\sqrt{2}}$ (B) $2-\frac{\pi}{\sqrt{2}}$

(C) $\left(2+\sqrt{2}\right)+\frac{\pi}{\sqrt{2}}$ (D) $2+\frac{\pi}{\sqrt{2}}$

12. Let a triangle be bounded by the lines $L_1 : 2x + 5y = 10$; $L_2 : -4x + 3y = 12$ and the line L_3, which passes through the point P(2, 3), intersect L_2 at A and L_1 at B. If the point P divides the line-segment AB, internally in the ratio 1 : 3, then the area of the triangle is equal to

(A) $\frac{110}{13}$ (B) $\frac{132}{13}$

(C) $\frac{142}{13}$ (D) $\frac{151}{13}$

13. Let a > 0, b > 0. Let e and ℓ respectively be the eccentricity and length of the latus rectum of the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$. Let e' and ℓ' respectively the eccentricity and length of the latus rectum of its conjugate hyperbola. If $e^2=\frac{11}{14}\ell$ and $(e')^2=\frac{11}{8}\ell'$, then the value of $77a+44b$ is equal to

(A) 100 (B) 110

(C) 120 (D) 130

14. Let $\vec{a}=\alpha\hat{i}+2\hat{j}-\hat{k}$ and $\vec{b}=-2\hat{i}+\alpha\hat{j}+\hat{k}$, where $\alpha\in\mathbf{R}$. If the area of the parallelogram whose adjacent sides are represented by the vectors $\vec{a}$ and $\vec{b}$ is $\sqrt{15(\alpha^2+4)}$, then the value of $2|\vec{a}|^2+(\vec{a}\cdot\vec{b})|\vec{b}|^2$ is equal to

(A) 10 (B) 7

(C) 9 (D) 14

15. If vertex of a parabola is (2, – 1) and the equation of its directrix is 4x – 3y = 21, then the length of its latus rectum is

(A) 2 (B) 8

(C) 12 (D) 16

16. Let the plane ax + by + cz = d pass through (2, 3, –5) and is perpendicular to the planes 2x + y – 5z = 10 and 3x + 5y – 7z = 12.
If a, b, c, d are integers d > 0 and gcd (|a|, |b|, |c|, d) = 1, then the value of a + 7b + c + 20d is equal to

(A) 18 (B) 20

(C) 24 (D) 22

17. The probability that a randomly chosen one-one function from the set {a, b, c, d} to the set {1, 2, 3, 4, 5} satisfies f(a) + 2f(b) – f(c) = f(d) is :

(A) $\frac{1}{24}$ (B) $\frac{1}{40}$

(C) $\frac{1}{30}$ (D) $\frac{1}{20}$

18. The value of

$$\lim_{n\to\infty} 6\tan\left\{\sum_{r=1}^{n}\tan^{-1}\left(\frac{1}{r^2+3r+3}\right)\right\}$$ is equal to

(A) 1 (B) 2

(C) 3 (D) 6

19. Let $\vec{a}$ be a vector which is perpendicular to the vector $3\hat{i}+\frac{1}{2}\hat{j}+2\hat{k}$. If

$\vec{a}\times(2\hat{i}+\hat{k})=2\hat{i}-13\hat{j}-4\hat{k}$,

then the projection of the vector $\vec{a}$ non the vector $2\hat{i}+2\hat{j}+\hat{k}$ is

(A) $\frac{1}{3}$ (B) 1 (C) $\frac{5}{3}$ (D) $\frac{7}{3}$

20. If $\cot\alpha=1$ and $\sec\beta=-\frac{5}{3}$, where $\pi<\alpha<\frac{3\pi}{2}$ and $\frac{\pi}{2}<\beta<\pi$, then the value of $\tan(\alpha+\beta)$ and the quadrant in which $\alpha+\beta$ lies, respectively are

(A) $-\frac{1}{7}$ and IVth quadrant

(B) 7 and Ist quadrant

(C) – 7 and IVth quadrant

(D) $\frac{1}{7}$ and Ist quadrant

SECTION-B

1. Let the image of the point P(1, 2, 3) in the line $L:\frac{x-6}{3}=\frac{y-1}{2}=\frac{z-2}{3}$ be Q. let $R(\alpha,\beta,\gamma)$ be a point that divides internally the line segment PQ in the ratio 1 : 3. Then the value of $22(\alpha+\beta+\gamma)$ is equal to

2. Suppose a class has 7 students. The average marks of these students in the mathematics examination is 62, and their variance is 20. A student fails in the examination if he/she gets less than 50 marks, then in worst case, the number of students can fail is

3. If one of the diameters of the circle $x^2+y^2-2\sqrt{2}x-6\sqrt{2}y+14=0$ is a chord of the circle $(x-2\sqrt{2})^2+(y-2\sqrt{2})^2=r^2$, then the value of r^2 is equal to

4. If $\lim\limits_{x\to1}\frac{\sin(3x^2-4x+1)-x^2+1}{2x^3-7x^2+ax+b}=-2$, then the value of (a – b) is equal to

5. Let for n = 1, 2, ….., 50, S_n be the sum of the infinite geometric progression whose first term is n^2 and whose common ratio is $\frac{1}{(n+1)^2}$. Then the value of $\frac{1}{26}+\sum_{n=1}^{50}\left(S_n+\frac{2}{n+1}-n-1\right)$ is equal to

6. If the system of linear equations

$2x-3y=\gamma+5,$

$\alpha x+5y=\beta+1,$ where $\alpha,\beta,\gamma\in\mathbf{R}$ has infinitely many solutions, then the value of $|9\alpha+3\beta+5\gamma|$ is equal to

7. Let $A=\begin{pmatrix}1+i & 1\\ -i & 0\end{pmatrix}$ where $i=\sqrt{-1}$.

Then, the number of elements in the set $\{n\in\{1,2,....,100\}:A^n=A\}$ is

8. Sum of squares of modulus of all the complex numbers z satisfying $\bar{z}=iz^2+z^2-z$ is equal to

9. Let S = {1, 2, 3, 4}. Then the number of elements in the set $\{f:S\times S\to S : f \text{ is onto and } f(a,b)=f(b,a)\geq a\ \forall (a,b)\in S\times S\}$ is

10. The maximum number of compound propositions, out of

$p\vee r\vee s,\ p\vee r\vee\sim s,\ p\vee\sim q\vee s,$
$\sim p\vee\sim r\vee s,\ \sim p\vee\sim r\vee\sim s,\ \sim p\vee q\vee\sim s,$
$q\vee r\vee\sim s,\ q\vee\sim r\vee\sim s,\ \sim p\vee\sim q\vee\sim s$

that can be made simultaneously true by an assignment of the truth values to p, q, r and s, is equal to

SET # 11

PHYSICS
SECTION-A

1. Two balls A and B are placed at the top of 180 m tall tower. Ball A is released from the top at t = 0 s. Ball B is thrown vertically down with an initial velocity 'u' at t = 2 s. After a certain time, both balls meet 100 m above the ground. Find the value of 'u' in ms^{-1}. [use $g = 10\ ms^{-2}$] :

(A) 10 (B) 15
(C) 20 (D) 30

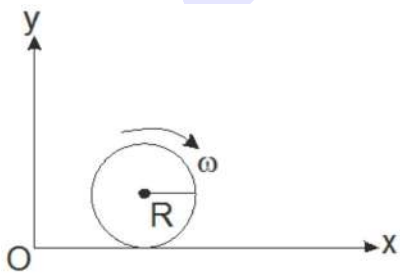
2. A body of mass M at rest explodes into three pieces, in the ratio of masses 1 : 1 : 2. Two smaller pieces fly off perpendicular to each other with velocities of 30 ms^{-1} and 40 ms^{-1} respectively. The velocity of the third piece will be :

(A) 15 ms^{-1} (B) 25 ms^{-1}
(C) 35 ms^{-1} (D) 50 ms^{-1}

3. The activity of a radioactive material is 2.56×10^{-3} Ci. If the half life of the material is 5 days, after how many days the activity will become 2×10^{-5} Ci?

(A) 30 days (B) 35 days
(C) 40 days (D) 25 days

4. A spherical shell of 1 kg mass and radius R is rolling with angular speed ω on horizontal plane (as shown in figure). The magnitude of angular momentum of the shell about the origin O is $\frac{a}{3}R^2\omega$. The value of a will be :



(A) 2 (B) 3
(C) 5 (D) 4

5. A cylinder of fixed capacity of 44.8 litres contains helium gas at standard temperature and pressure. The amount of heat needed to raise the temperature of gas in the cylinder by 20.0°C will be :
(Given gas constant $R = 8.3\ JK^{-1}\text{-}mol^{-1}$)

(A) 249 J (B) 415 J
(C) 498 J (D) 830 J

6. A wire of length L is hanging from a fixed support. The length changes to L_1 and L_2 when masses 1kg and 2 kg are suspended respectively from its free end. Then the value of L is equal to :

(A) $\sqrt{L_1L_2}$ (B) $\frac{L_1+L_2}{2}$
(C) $2L_1 - L_2$ (D) $3L_1 - 2L_2$

7. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : The photoelectric effect does not take place, if the energy of the incident radiation is less than the work function of a metal.

Reason R : Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal.

In the light of the above statements, choose the **most appropriate** answer from the options given below.

(A) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(B) Both **A** and **R** are correct but **R** is not the correct explanation of **A**
(C) **A** is correct but **R** is not correct
(D) **A** is not correct but **R** is correct

8. A particle of mass 500 gm is moving in a straight line with velocity $\upsilon = b\ x^{5/2}$. The work done by the net force during its displacement from x = 0 to x = 4 m is :
(Take $b = 0.25\ m^{-3/2}\ s^{-1}$).

(A) 2 J (B) 4 J
(C) 8 J (D) 16 J

9. A charged particle moves along circular path in a uniform magnetic field in a cyclotron. The kinetic energy of the charged particle increases to 4 times its initial value. What will be the ratio of new radius to the original radius of circular path of the charged particle:

(A) 1 : 1 (B) 1 : 2
(C) 2 : 1 (D) 1 : 4

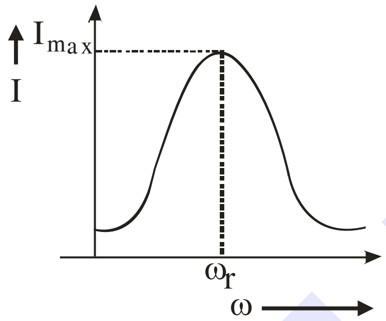
10. For a series LCR circuit, I vs ω curve is shown :

(a) To the left of ω_r, the circuit is mainly capacitive.

(b) To the left of ω_r, the circuit is mainly inductive.

(c) At ω_r, impedance of the circuit is equal to the resistance of the circuit.

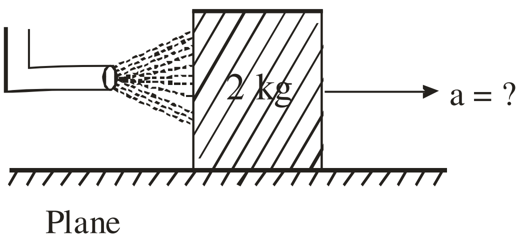
(d) At ω_r, impedance of the circuit is 0.



Choose the **most appropriate** answer from the options given below :

(A) (a) and (d) only (B) (b) and (d) only
(C) (a) and (c) only (D) (b) and (c) only

11. A block of metal weighing 2 kg is resting on a frictionless plane (as shown in figure). It is struck by a jet releasing water at a rate of 1 kgs^{-1} and at a speed of 10 ms^{-1}. Then, the initial acceleration of the block, in ms^{-2}, will be :



(A) 3 (B) 6
(C) 5 (D) 4

12. In Vander Waals equation $\left[P+\frac{a}{V^2}\right][V-b]=RT$; P is pressure, V is volume, R is universal gas constant and T is temperature. The ratio of constants $\frac{a}{b}$ is dimensionally equal to :

(A) $\frac{P}{V}$ (B) $\frac{V}{P}$
(C) PV (D) PV^3

13. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If magnitude of $\vec{A}+\vec{B}$ is equal to two times the magnitude of $\vec{A}-\vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ will be :

(A) $\sin^{-1}\left(\frac{3}{5}\right)$ (B) $\sin^{-1}\left(\frac{1}{3}\right)$
(C) $\cos^{-1}\left(\frac{3}{5}\right)$ (D) $\cos^{-1}\left(\frac{1}{3}\right)$

14. The escape velocity of a body on a planet 'A' is 12 kms^{-1}. The escape velocity of the body on another planet 'B', whose density is four times and radius is half of the planet 'A', is :

(A) 12 kms^{-1} (B) 24 kms^{-1}
(C) 36 kms^{-1} (D) 6 kms^{-1}

15. At a certain place the angle of dip is 30° and the horizontal component of earth's magnetic field is 0.5 G. The earth's total magnetic field (in G), at that certain place, is :

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{2}$
(C) $\sqrt{3}$ (D) 1

16. A longitudinal wave is represented by $x = 10\sin 2\pi\left(nt-\frac{x}{\lambda}\right)$ cm. The maximum particle velocity will be four times the wave velocity if the determined value of wavelength is equal to :

(A) 2π (B) 5π
(C) π (D) $\frac{5\pi}{2}$

17. A parallel plate capacitor filled with a medium of dielectric constant 10, is connected across a battery and is charged. The dielectric slab is replaced by another slab of dielectric constant 15. Then the energy of capacitor will :

(A) increase by 50%

(B) decrease by 15%

(C) increase by 25%

(D) increase by 33%

18. A positive charge particle of 100 mg is thrown in opposite direction to a uniform electric field of strength 1×10^5 NC^{-1}. If the charge on the particle is 40 μC and the initial velocity is 200 ms^{-1}, how much distance it will travel before coming to the rest momentarily :

(A) 1 m (B) 5 m

(C) 10 m (D) 0.5 m

19. Using Young's double slit experiment, a monochromatic light of wavelength 5000 Å produces fringes of fringe width 0.5 mm. If another monochromatic light of wavelength 6000Å is used and the separation between the slits is doubled, then the new fringe width will be :

(A) 0.5 mm (B) 1.0 mm

(C) 0.6 mm (D) 0.3 mm

20. Only 2% of the optical source frequency is the available channel bandwidth for an optical communicating system operating at 1000 nm. If an audio signal requires a bandwidth of 8 kHz, how many channels can be accommodated for transmission :

(A) 375×10^7 (B) 75×10^7

(C) 375×10^8 (D) 75×10^9

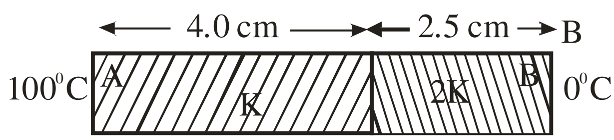
SECTION-B

1. Two coils require 20 minutes and 60 minutes respectively to produce same amount of heat energy when connected separately to the same source. If they are connected in parallel arrangement to the same source; the time required to produce same amount of heat by the combination of coils, will be__________min.

2. The intensity of the light from a bulb incident on a surface is 0.22 W/m^2. The amplitude of the magnetic field in this light-wave is______$\times 10^{-9}$ T.

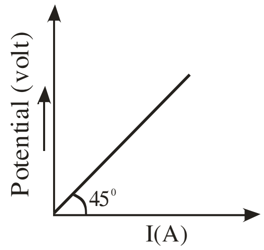
(Given : Permittivity of vacuum $\epsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$, speed of light in vacuum $c = 3 \times 10^8$ ms^{-1})

3. As per the given figure, two plates A and B of thermal conductivity K and 2 K are joined together to form a compound plate. The thickness of plates are 4.0 cm and 2.5 cm respectively and the area of cross-section is 120 cm^2 for each plate. The equivalent thermal conductivity of the compound plate is $\left(1+\frac{5}{\alpha}\right)$K, then the value of α will be __________.



4. A body is performing simple harmonic with an amplitude of 10 cm. The velocity of the body was tripled by air Jet when it is at 5 cm from its mean position. The new amplitude of vibration is $\sqrt{x}$ cm. The value of x is__________.

5. The variation of applied potential and current flowing through a given wire is shown in figure. The length of wire is 31.4 cm. The diameter of wire is measured as 2.4 cm. The resistivity of the given wire is measured as x $\times 10^{-3}$ Ω cm. The value of x is __________.
[Take $\pi = 3.14$]



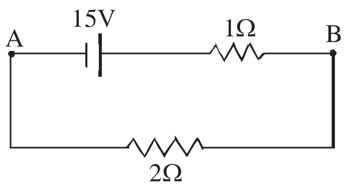
6. 300 cal. of heat is given to a heat engine and it rejects 225 cal. of heat. If source temperature is 227°C, then the temperature of sink will be __ ^{0}C.

7. $\sqrt{d_1}$ and $\sqrt{d_2}$ are the impact parameters corresponding to scattering angles 60° and 90° respectively, when an α particle is approaching a gold nucleus. For $d_1 = x\ d_2$, the value of x will be_______.

8. A transistor is used in an amplifier circuit in common emitter mode. If the base current changes by 100 μA, it brings a change of 10 mA in collector current. If the load resistance is 2 kΩ and input resistance is 1 kΩ, the value of power gain is $x \times 10^4$. The value of x is _______.

9. A parallel beam of light is allowed to fall on a transparent spherical globe of diameter 30 cm and refractive index 1.5. The distance from the centre of the globe at which the beam of light can converge is _______ mm.

10. For the network shown below, the value $V_B - V_A$ is ________V.



CHEMISTRY

SECTION-A

1. Production of iron in blast furnace follows the following equation
$Fe_3O_4(s) + 4CO(g) \rightarrow 3Fe(l) + 4CO_2(g)$
when 4.640 kg of Fe_3O_4 and 2.520 kg of CO are allowed to react then the amount of iron (in g) produced is :
[Given : Molar Atomic mass (g mol $^{-1}$): Fe = 56 Molar Atomic mass (g mol^{-1}) : 0 = 16
Molar Atomic mass (g mol^{-1}): = C = 12

(A) 1400 (B) 2200
(C) 3360 (D) 4200

2. Which of the following statements are **correct** ?
(A) The electronic configuration of Cr is [Ar] $3d^5\ 4s^1$.
(B) The magnetic quantum number may have a negative value.
(C) In the ground state of an atom, the orbitals are filled in order of their increasing energies.
(D) The total number of nodes are given by n – 2 .

Choose the **most appropriate** answer from the options given below :
(A) (A), (C) and (D) only
(B) (A) and (B) only
(C) (A) and (C) only
(D) (A), (B) and (C) only

3. Arrange the following in the decreasing order of their covalent character :
(A) LiCl (B) NaCl
(C) KCl (D) CsCl

Question: Choose the **most appropriate** answer from the options given below :
(A) (A)> (C) > (B)> (D)
(B) (B) > (A) > (C) > (D)
(C) (A) > (B) > (C) > (D)
(D) (A) > (B) > (D) > (C)

4. The solubility of AgCl will be maximum in which of the following ?

(A) 0.01 M KCl

(B) 0.01 M HC1

(C) 0.01 M $AgNO_3$

(D) Deionised water

5. Which of the following is a **correct** statement?

(A) Brownian motion destabilises sols.

(B) Any amount of dispersed phase can be added to emulsion without destabilising it.

(C) Mixing two oppositely charged sols in equal amount neutralises charges and stabilises colloids.

(D) Presence of equal and similar charges on colloidal particles provides stability to the colloidal solution.

6. The electronic configuration of Pt (atomic number 78) is:

(A) $[Xe]\ 4f^{14}\ 5d^{9}\ 6s^{1}$

(B) $[Kr]\ 4f^{14}\ 5d^{10}$

(C) $[Xe]\ 4f^{14}\ 5d^{10}$

(D) $[Xe]\ 4f^{14}\ 5d^{8}\ 6s^{2}$

7. In isolation of which one of the following metals from their ores, the use of cyanide salt is not commonly involved ?

(A) Zinc

(B) Gold

(C) Silver

(D) Copper

8. Which one of the following reactions indicates the reducing ability of hydrogen peroxide in basic medium ?

(A) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

(B) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

(C) $2MnO_4^- + 3H_2O_2 \rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$

(D) $Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$

9. Match the **List-I** with **List- II.**

List-I (Metal)	**List-II (Emitted light wavelength (nm))**
(A) Li	(I) 670.8
(B) Na	(II) 589.2
(C) Rb	(III) 780.0
(D) Cs	(IV) 455.5

Choose the **most appropriate** answer from the options given below:

(A) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(B) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(C) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)

(D) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

10. Match the **List-I** with **List- II.**

List-I (Metal)	**List-II Application**
(A) Cs	(I) High temperature thermometer
(B) Ga	(II) Water repellent sprays
(C) B	(III) Photoelectric cells
(D) Si	(IV) Bullet proof vest

Choose the most appropriate answer from the option given below:

(A) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(B) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(C) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(D) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

11. The oxoacid of phosphorus that is easily obtained from a reaction of alkali and white phosphorus and has two P-H bonds, is :

(A) Phosphonic acid

(B) Phosphinic acid

(C) Pyrophosphorus acid

(D) Hypophosphoric acid

12. The acid that is believed to be mainly responsible for the damage of Taj Mahal is

(A) Sulfuric acid

(B) Hydrofluoric acid

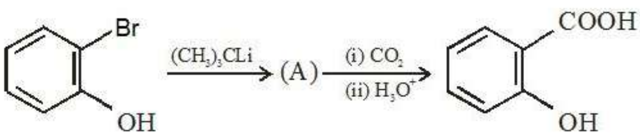
(C) Phosphoric acid

(D) Hydrochloric acid

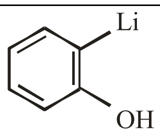
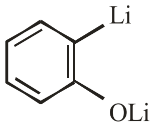
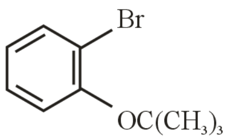
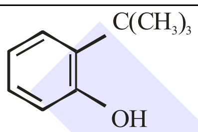
13. Two isomers 'A' and 'B' with molecular formula C_4H_8 give different products on oxidation with $KMnO_4$ in acidic medium. Isomer 'A' on reaction with $KMnO_4/H^+$ results in effervescence of a gas and gives ketone. The compound 'A' is

(A) But-1-ene
(B) cis-But-2-ene
(C) trans-But-2ene
(D) 2-methyl propene

14.



In the given conversion the compound A is:

(A)	
(B)	
(C)	
(D)	

15. Given below are two statements :

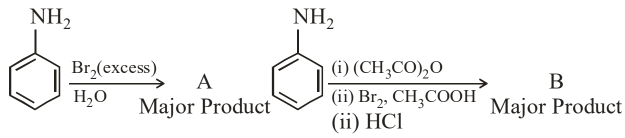
Statement I : The esterification of carboxylic acid with an alcohol is a nucleophilic acyl substitution.

Statement II : Electron withdrawing groups in the carboxylic acid will increase the rate of esterification reaction.

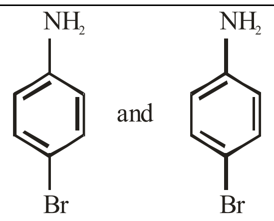
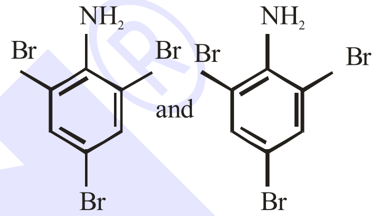
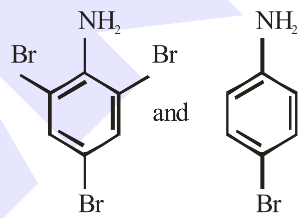
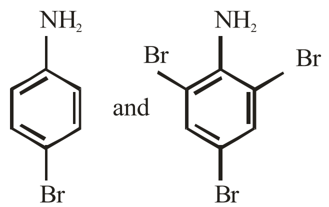
Choose the **most appropriate** option :

(A) Both **Statement I** and **Statement II** are correct.
(B) Both **Statement I** and **Statement II** are incorrect.
(C) **Statement I** is correct but **Statement II** is incorrect.
(D) **Statement I** is incorrect but **Statement II** is correct.

16.



Consider the above reaction, the product A and product B respectively are

(A)	
(B)	
(C)	
(D)	

17. The polymer, which can be stretched and retains its original status on releasing the force is

(A) Bakelite (B) Nylon 6,6
(C) Buna-N (D) Terylene

18. Sugar moiety in DNA and RNA molecules respectively are

(A) β-D-2-deoxyribose, β -D-deoxyribose
(B) β-D-2-deoxyribose, β -D-ribose
(C) β-D-ribose, β -D-2-deoxyribose
(D) β-D-deoxyribose, β -D-2-deoxyribose

19. Which of the following compound **does not** contain sulphur atom ?

(A) Cimetidine (B) Ranitidine
(C) Histamine (D) Saccharin

20. Given below are two statements.

Statement I : Phenols are weakly acidic.

Statement II : Therefore they are freely soluble in NaOH solution and are weaker acids than alcohols and water.

Choose the **most appropriate** option:

(A) Both **Statement I** and **Statement II** are correct.

(B) Both **Statement I** and **Statement II** are incorrect.

(C) **Statement I** is correct but **Statement II** is incorrect.

(D) **Statement I** is incorrect but **Statement II** is correct.

SECTION-B

1. Geraniol, a volatile organic compound, is a component of rose oil. The density of the vapour is 0.46 gL^{-1} at 257°C and 100 mm Hg. The molar mass of geraniol is ____________ (Nearest Integer)

[Given R = 0.082 L atm K^{-1} mol^{-1}]

2. 17.0 g of NH_3 completely vapourises at –33.42°C and 1 bar pressure and the enthalpy change in the process is 23.4 kJ mol^{-1}. The enthalpy change for the vapourisation of 85 g of NH_3 under the same conditions is ________ kJ.

3. 1.2 mL of acetic acid is dissolved in water to make 2.0 L of solution. The depression in freezing point observed for this strength of acid is 0.0198°C. The percentage of dissociation of the acid is ________ . (Nearest integer)

[Given : Density of acetic acid is 1.02 g mL^{-1}

Molar mass of acetic acid is 60 g mol^{-1}

K_f (H_2O) =1.85 K kg $mo1^{-1}$]

4. A dilute solution of sulphuric acid is electrolysed using a current of 0.10 A for 2 hours to produce hydrogen and oxygen gas. The total volume of gases produced at STP is ________ cm^3. (Nearest integer)

[Given : Faraday constant F = 96500 C $mo1^{-1}$ at STP, molar volume of an ideal gas is 22.7 L $mo1^{-1}$]

5. The activation energy of one of the reactions in a biochemical process is 532611 J $mo1^{-1}$. When the temperature falls from 310 K to 300 K, the change in rate constant observed is $k_{300} = x \times 10^{-3}\ k_{310}$. The value of x is __________.

[Given: 1n10 = 2.3, R=8.3 J K^{-1} $mo1^{-1}$]

6. The number of terminal oxygen atoms present in the product B obtained from the following reaction is ________.

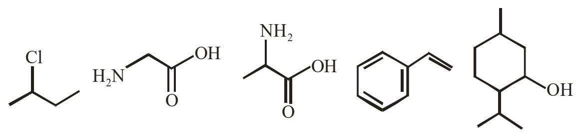
$FeCr_2O_4 + Na_2CO_3 + O_2 \rightarrow A + Fe_2O_3 + CO_2$

$A + H^+ \rightarrow B + H_2O + Na^+$

7. An acidified manganate solution undergoes disproportionation reaction. The spin-only magnetic moment value of the product having manganese in higher oxidation state is __________ B.M. (Nearest integer)

8. Kjeldahl's method was used for the estimation of nitrogen in an organic compound. The ammonia evolved from 0.55 g of the compound neutralised 12.5 mL of 1 M H_2SO_4 solution. The percentage of nitrogen in the compound is __________. (Nearest integer)

9. Observe structures of the following compounds



The total number of structures/compounds which possess asymmetric carbon atoms is ___________.

10. $C_6H_{12}O_6 \xrightarrow{\text{Zymase}} A \xrightarrow[\Delta]{\text{NaOI}} B + CHI_3$

The number of carbon atoms present in the product B is __________.

MATHEMATICS
SECTION-A

1. The probability that a randomly chosen 2×2 matrix with all the entries from the set of first 10 primes, is singular, is equal to :

(A) $\frac{133}{10^4}$ (B) $\frac{18}{10^3}$

(C) $\frac{19}{10^3}$ (D) $\frac{271}{10^4}$

2. Let the solution curve of the differential equation $x\frac{dy}{dx} - y = \sqrt{y^2 + 16x^2}$, $y(1) = 3$ be $y = y(x)$. Then $y(2)$ is equal to :

(A) 15 (B) 11

(C) 13 (D) 17

3. If the mirror image of the point (2, 4, 7) in the plane $3x - y + 4z = 2$ is (a, b, c), the $2a + b + 2c$ is equal to :

(A) 54 (B) 50

(C) −6 (D) −42

4. Let $f : R \to R$ be a function defined by :

$$f(x) = \begin{cases} \max\limits_{t \le x}\{t^3 - 3t\}; x \le 2 \\ x^2 + 2x - 6; 2 < x < 3 \\ [x-3] + 9 \;; 3 \le x \le 5 \\ 2x + 1 \;;\; x > 5 \end{cases}$$

Where [t] is the greatest integer less than or equal to t. Let m be the number of points where f is not differentiable and $I = \int_{-2}^{2} f(x)dx$. Then the ordered pair (m, I) is equal to :

(A) $\left(3, \frac{27}{4}\right)$ (B) $\left(3, \frac{23}{4}\right)$

(C) $\left(4, \frac{27}{4}\right)$ (D) $\left(4, \frac{23}{4}\right)$

5. Let $\vec{a} = \alpha\hat{i} + 3\hat{j} - \hat{k}, \vec{b} = 3\hat{i} - \beta\hat{j} + 4\hat{k}$ and $\vec{c} = \hat{i} + 2\hat{j} - 2\hat{k}$ where α, β ∈ R, be three vectors. If the projection of $\vec{a}$ on $\vec{c}$ is $\frac{10}{3}$ and $\vec{b} \times \vec{c} = -6\hat{i} + 10\hat{j} + 7\hat{k}$, then the value of $\alpha + \beta$ equal to :

(A) 3 (B) 4

(C) 5 (D) 6

6. The area enclosed by $y^2 = 8x$ and $y = \sqrt{2}\,x$ that lies outside the triangle formed by $y = \sqrt{2}x, x = 1, y = 2\sqrt{2}$, is equal to :

(A) $\frac{16\sqrt{2}}{6}$ (B) $\frac{11\sqrt{2}}{6}$

(C) $\frac{13\sqrt{2}}{6}$ (D) $\frac{5\sqrt{2}}{6}$

7. If the system of linear equations

$2x + y - z = 7$

$x - 3y + 2z = 1$

$x + 4y + \delta z = k$, where $\delta, k \in R$

has infinitely many solutions, then $\delta + k$ is equal to:

(A) −3 (B) 3 (C) 6 (D) 9

8. Let α and β be the roots of the equation $x^2 + (2i - 1) = 0$. Then, the value of $|\alpha^8 + \beta^8|$ is equal to :

(A) 50 (B) 250

(C) 1250 (D) 1500

9. Let $\Delta \in \{\wedge, \vee, \Rightarrow, \Leftrightarrow\}$ be such that $(p \wedge q)\Delta((p \vee q) \Rightarrow q)$ is a tautology. Then Δ is equal to :

(A) $\wedge$ (B) $\vee$

(C) $\Rightarrow$ (D) $\Leftrightarrow$

10. Let $A = [a_{ij}]$ be a square matrix of order 3 such that $a_{ij} = 2^{j-i}$, for all i, j = 1, 2, 3. Then, the matrix $A^2 + A^3 + \ldots + A^{10}$ is equal to :

(A) $\left(\frac{3^{10}-3}{2}\right)A$ (B) $\left(\frac{3^{10}-1}{2}\right)A$

(C) $\left(\frac{3^{10}+1}{2}\right)A$ (D) $\left(\frac{3^{10}+3}{2}\right)A$

11. Let a set $A = A_1 \cup A_2 \cup \ldots \cup A_k$, where $A_i \cap A_j = \phi$ for $i \ne j$ $1 \le i, j \le k$. Define the relation R from A to A by $R = \{(x, y) : y \in A_i$ if and only if $x \in A_i, 1 \le i \le k\}$. Then, R is :

(A) reflexive, symmetric but not transitive

(B) reflexive, transitive but not symmetric

(C) reflexive but not symmetric and transitive

(D) an equivalence relation

12. Let $\{a_n\}_{n=0}^{\infty}$ be a sequence such that $a_0 = a_1 = 0$ and $a_{n+2} = 2a_{n+1} - a_n + 1$ for all $n \geq 0$. Then, $\sum_{n=2}^{\infty} \frac{a_n}{7^n}$ is equal to

(A) $\frac{6}{343}$ (B) $\frac{7}{216}$

(C) $\frac{8}{343}$ (D) $\frac{49}{216}$

13. The distance between the two points A and A' which lie on y = 2 such that both the line segments AB and A' B (where B is the point (2, 3)) subtend angle $\frac{\pi}{4}$ at the origin, is equal to :

(A) 10 (B) $\frac{48}{5}$

(C) $\frac{52}{5}$ (D) 3

14. A wire of length 22 m is to be cut into two pieces. One of the pieces is to be made into a square and the other into an equilateral triangle. Then, the length of the side of the equilateral triangle, so that the combined area of the square and the equilateral triangle is minimum, is :

(A) $\frac{22}{9+4\sqrt{3}}$ (B) $\frac{66}{9+4\sqrt{3}}$

(C) $\frac{22}{4+9\sqrt{3}}$ (D) $\frac{66}{4+9\sqrt{3}}$

15. The domain of the function

$\cos^{-1}\left(\frac{2\sin^{-1}\left(\frac{1}{4x^2-1}\right)}{\pi}\right)$ is :

(A) $R - \left\{-\frac{1}{2}, \frac{1}{2}\right\}$

(B) $(-\infty, -1] \cup [1, \infty) \cup \{0\}$

(C) $\left(-\infty, \frac{-1}{2}\right) \cup \left(\frac{1}{2}, \infty\right) \cup \{0\}$

(D) $\left(-\infty, \frac{-1}{\sqrt{2}}\right] \cup \left[\frac{1}{\sqrt{2}}, \infty\right) \cup \{0\}$

16. If the constant term in the expansion of $\left(3x^3 - 2x^2 + \frac{5}{x^5}\right)^{10}$ is $2^k . l$, where l is an odd integer, then the value of k is equal to :

(A) 6 (B) 7

(C) 8 (D) 9

17. $\int_0^5 \cos\left(\pi\left(x - \left[\frac{x}{2}\right]\right)\right) dx$,

Where [t] denotes greatest integer less than or equal to t, is equal to :

(A) -3 (B) -2

(C) 2 (D) 0

18. Let PQ be a focal chord of the parabola $y^2 = 4x$ such that it subtends an angle of $\frac{\pi}{2}$ at the point (3, 0). Let the line segment PQ be also a focal chord of the ellipse

E: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,\ a^2 > b^2$.

If e is the eccentricity of the ellipse E, then the value of $\frac{1}{e^2}$ is equal to :

(A) $1 + \sqrt{2}$ (B) $3 + 2\sqrt{2}$

(C) $1 + 2\sqrt{3}$ (D) $4 + 5\sqrt{3}$

19. Let the tangent to the circle $C_1 : x^2 + y^2 = 2$ at the point $M(-1, 1)$ intersect the circle $C_2 : (x-3)^2 + (y-2)^2 = 5$, at two distinct points A and B. If the tangents to C_2 at the points A and B intersect at N, then the area of the triangle ANB is equal to :

(A) $\frac{1}{2}$ (B) $\frac{2}{3}$

(C) $\frac{1}{6}$ (D) $\frac{5}{3}$

20. Let the mean and the variance of 5 observations x_1, x_2, x_3, x_4, x_5 be $\frac{24}{5}$ and $\frac{194}{25}$ respectively.

If the mean and variance of the first 4 observation are $\frac{7}{2}$ and a respectively, then $(4a + x_5)$ is equal to:

(A) 13 (B) 15

(C) 17 (D) 18

SECTION-B

1. Let $S = \{z \in C : |z-2| \leq 1, z(1+i) + \bar{z}(1-i) \leq 2\}$. Let $|z - 4i|$ attains minimum and maximum values, respectively, at $z_1 \in S$ and $z_2 \in S$. If $5(|z_1|^2 + |z_2|^2) = \alpha + \beta\sqrt{5}$, where α and β are integers, then the value of α + β is equal to _____.

2. Let y = y(x) be the solution of the differential equation

$\frac{dy}{dx} + \frac{\sqrt{2}y}{2\cos^4 x - \cos 2x} = xe^{\tan^{-1}(\sqrt{2}\cot 2x)}$,

$0 < x < \pi/2$ with $y\left(\frac{\pi}{4}\right) = \frac{\pi^2}{32}$.

If $y\left(\frac{\pi}{3}\right) = \frac{\pi^2}{18}e^{-\tan^{-1}(\alpha)}$, then the value of $3\alpha^2$ is equal to _____.

3. Let d be the distance between the foot of perpendiculars of the points P(1, 2 – 1) and Q(2, – 1, 3) on the plane – x + y + z = 1. Then d^2 is equal to _______.

4. The number of elements in the set $S = \{\theta \epsilon [-4\pi, 4\pi] : 3\cos^2 2\theta + 6\cos 2\theta - 10\cos^2\theta + 5 = 0\}$ is ________.

5. The number of solutions of the equation $2\theta - \cos^2\theta + \sqrt{2} = 0$ is R is equal to ______.

6. $50\tan\left(3\tan^{-1}\left(\frac{1}{2}\right) + 2\cos^{-1}\left(\frac{1}{\sqrt{5}}\right)\right) + 4\sqrt{2}\tan\left(\frac{1}{2}\tan^{-1}(2\sqrt{2})\right)$ is equal to _____.

7. Let c, k ∈ R. If $f(x) = (c + 1)x^2 + (1 - c^2)x + 2k$ and f(x + y) = f(x) + f(y) – xy, for all x, y ∈ R, then the value of |2(f(1) + f(2) + f(3) + ……+f(20))| is equal to _______.

8. Let $H: \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, a > 0, b > 0, be a hyperbola such that the sum of lengths of the transverse and the conjugate axes is $4\left(2\sqrt{2} + \sqrt{14}\right)$. If the eccentricity H is $\frac{\sqrt{11}}{2}$, then value of $a^2 + b^2$ is equal to __________.

9. Let $P_1 : \vec{r}.(2\hat{i} + \hat{j} - 3\hat{k}) = 4$ be a plane. Let P_2 be another plane which passes through the points (2, - 3, 2) (2, − 2, − 3) and (1, −4, 2). If the direction ratios of the line of intersection of P_1 and P_2 be 16, α, β, then the value of α + β is equal to _____.

10. Let $b_1b_2b_3b_4$ be a 4-element permutation with $b_i \in \{1, 2, 3, \ldots, 100\}$ for $1 \le i \le 4$ and $b_i \ne b_j$ for $i \ne j$, such that either b_1, b_2, b_3 are consecutive integers or b_2, b_3, b_4 are consecutive integers.

Then the number of such permutations $b_1b_2b_3b_4$ is equal to ________.

SET # 12

PHYSICS

SECTION-A

1. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in t s,. the distance travelled by the toy in the next t s will be :

(A) 10m (B) 20m

(C) 30m (D) 40m

2. At what temperature a gold ring of diameter 6.230 cm be heated so that it can be fitted on a wooden bangle of diameter 6.241 cm? Both the diameters have been measured at room temperature (27ºC).

(Given: coefficient of linear thermal expansion of gold $\alpha_L = 1.4 \times 10^{-5}\ K^{-1}$)

(A) 125.7ºC (B) 91.7ºC

(C) 425.7º (D) 152.7ºC

3. Two point charges Q each are placed at a distance d apart. A third point charge q is placed at a distance x from mid-point on the perpendicular bisector. The value of x at which charge q will experience the maximum Coulomb's force is :

(A) $x = d$ (B) $x = \frac{d}{2}$

(C) $x = \frac{d}{\sqrt{2}}$ (D) $x = \frac{d}{2\sqrt{2}}$

4. The speed of light in media 'A' and 'B' are 2.0×10^{10} cm/s and 1.5×10^{10} chm/s respectively. A ray of light enters from the medium B to A at an incident angle 'θ'. If the ray suffers total internal reflection, then

(A) $\theta = \sin^{-1}\left(\frac{3}{4}\right)$ (B) $\theta > \sin^{-1}\left(\frac{2}{3}\right)$

(C) $\theta < \sin^{-1}\left(\frac{3}{4}\right)$ (D) $\theta > \sin^{-1}\left(\frac{3}{4}\right)$

5. In the following nuclear rection,

$$D \xrightarrow{\alpha} D_1 \xrightarrow{\beta^-} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\gamma} D_4$$

Mass number of D is 182 and atomic number is 74. Mass number and atomic number of D_4 respectively will be___.

(A) 174 and 71 (B) 174 and 69

(C) 172 and 69 (D) 172 and 71

6. The electric field at the point associated with a light wave is given by

$E = 200\ [\sin(6 \times 10^{15})\ t + \sin(9 \times 10^{15})\ t]\ Vm^{-1}$

Given : $h = 4.14 \times 10^{-15}$ eVs

If this light falls on a metal surface having a work function of 2.50 eV, the maximum kinetic energy of the photoelectrons will be :

(A) 1.90 eV (B) 3.27 eV

(C) 3.60 eV (D) 3.42 eV

7. A capacitor is discharging through a resistor R. Consider in time t_1, the energy stored in the capacitor reduces to half of its initial value and in time t_2, the charge stored reduces to one eighth of its initial value. The ratio t_1/t_2 will be :

(A) 1/2 (B) 1/3

(C) 1/4 (D) 1/6

8. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal. W_2. if the process is purely adiabatic and W_3 if the process is purely isobaric. Then, choose the coned option

(A) $W_1 < W_2 < W_3$

(B) $W_2 < W_3 < W_1$

(C) $W_3 < W_1 < W_2$

(D) $W_2 < W_1 < W_3$

9. Two long current carrying conductors are placed parallel to each other at a distance of 8 cm between them. The magnitude of magnetic field produced at mid-point between the two conductors due to current flowing in them is 300 μT. The equal current flowing in the two conductors is :

(A) 30A in the same direction.

(B) 30A in the opposite direction.

(C) 60A in the opposite direction.

(D) 300A in the opposite direction.

10. The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to three times its previous value, then approximate new time period of the satellite will be :

(A) 40 hours (B) 36 hours

(C) 30 hours (D) 25 hours

11. The TV transmission tower at a particular station has a height of 125 m. For dubling the coverage of its range, the height of the tower should be increased by :

(A)125 m (B) 250 m

(C) 375 (D) 500 m

12. The motion of a simple pendulum excuting S.H.M. is represented by following equation.

$Y = A \sin(\pi t + \phi)$, where time is measured in second. The length of pendulum is :

(A) 97.23 cm (B) 25.3 cm

(C) 99.4 cm (D) 406.1 cm

13. A vessel contains 16g of hydrogen and 128 g of oxygen at standard temperature and pressure. The volume of the vessel in cm^3 is :

(A) 72×10^5 (B) 32×10^5

(C) 27×10^4 (D) 54×10^4

14. Given below are two statements :

Statement I: The electric force changes the speed of the charged particle and hence changes its kinetic energy: whereas the magnetic force does not change the kinetic energy of the charged particle.

Statement II: The electric force accelerates the positively charged particle perpendicular to the direction of electric field. The magnetic force accelerates the moving charged particle along the direction of magnetic field. In the light of the above statements, choose the most appropriate answer from the options given below:

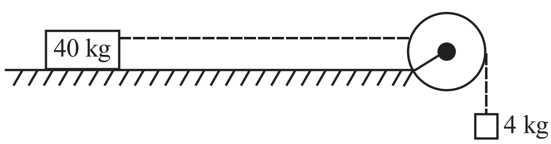
(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect.

(C) Statement I is correct but Statement II is incorrect.

(D) Statement I is incorrect but Statement II is correct.

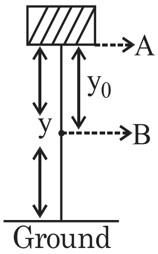
15. A block of mass 40 kg slides over a surface, when a mass of 4 kg is suspended through an inextensible massless string passing over frictionless pulley as shown below. The coefficient of kinetic friction between the surface and block is 0.02. The acceleration of block is. (Given g = 10 ms^{-2}.)



(A) 1 ms^{-2} (B) 1/5 ms^{-2}

(C) 4/5 ms^{-2} (D) 8/11 ms^{-2}

16. In the given figure, the block of mass m is dropped from the point 'A'. The expression for kinetic energy of block when it reaches point 'B' is :



(A) $\frac{1}{2}mg y_0^2$
(B) $\frac{1}{2}mg y^2$
(C) $mg(y - y_0)$
(D) mgy_0

17. A block of mass M placed inside a box descends vertically with acceleration 'a'. The block exerts a force equal to one-fourth of its weight on the floor of the box. The value of 'a' will be :

(A) $\frac{g}{4}$
(B) $\frac{g}{2}$
(C) $\frac{3g}{4}$
(D) g

18. If the electric potential at any point (x, y, z)m in space is given by $V = 3x^2$ volt. The electric field at the point (1, 0, 3) m will be :

(A) 3 Vm^{-1}, directed along positive x-axis.
(B) 3 Vm^{-1}, directed along negative x-axis.
(C) 6 Vm^{-1}, directed along positive x-axis.
(D) 6 Vm^{-1}, directed along negative x-axis.

19. The combination of two identical cells, whether connected in series or parallel combination provides the same current through an external resistance of 2Ω. The value of internal resistance of each cell is :

(A) 2Ω
(B) 4Ω
(C) 6Ω
(D) 8Ω

20. A person can throw a ball upto a maximum range of 100 m. How high above the ground he can throw the same ball?

(A) 25 m
(B) 50 m
(C) 100 m
(D) 200 m

SECTION-B

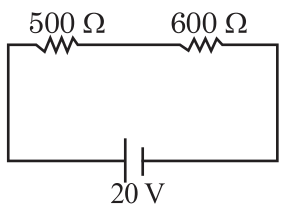
1. The vernier constant of Vernier callipers is 0.1 mm and it has zero error of (–0.05) cm. While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5. The corrected diameter will be_____ $\times 10^{-2}$ cm.

2. A small spherical ball of radius 0.1 mm and density 10^4 kg m^{-3} falls freely under gravity through a a distance h before entering a tank of water. If after entering the water the velocity of ball does not change and it continue to fall with same constant velocity inside water, then the value of h wil be_____m.

(Given g = 10 ms^{-2}, viscosity of water $= 1.0 \times 10^{-5}$ N-sm^{-2}).

3. In an experiment to determine the velocity of sound in air at room temperature using a resonance is observed when the air column has a length of 20.0 cm for a tuning fork of frequency 400 Hz is used. The velocity of the sound at room temperature is 336 ms^{-1}. The third resonance is observed when the air column has a length of ____cm.

4. Two resistors are connected in series across a battery as shown in figure. If a voltmeter of resistance 2000 Ω is used to measure the potential difference across 500 Ω resister, the reading of the voltmeter will be____V.



5. A potential barrier of 0.4 V exists across a p-n junction. An electron enters the junction from the n-side with a speed of 6.0×10^5 ms^{-1}. The speed with which electron enters the p side will be $\frac{x}{3} \times 10^5 \, ms^{-1}$ the value of x is _______.

(Given mass of electron $= 9 \times 10^{-31}$ kg, charge on electron $= 1.6 \times 10^{-19}$C.)

6. The displacement current of 4.425 μA is developed in the space between the plates of parallel plate capacitor when voltage is changing at a rate of 10^6 Vs^{-1}. The area of each plate of the capacitor is 40 cm^2. The distance between each plate of the capacitor is x × 10^{-3}m. The value of x is,

(Permittivity of free space, $E_0 = 8.85 \times 10^{-12}\ C^2 N^{-1} m^{-2}$)

7. The moment of inertia of a uniform thin rod about a perpendicular axis passing through one end is I_1. The same rod is bent into a ring and its moment of inertia about a diameter is I_2. If $\frac{I_1}{I_2}$ is $\frac{x\pi^2}{3}$, then the value of x will be_______.

8. The half life of a radioactive substance is 5 years. After x years a given sample of the radioactive substance gest reduced to 6.25% of its initial value of x is _______.

9. In a double slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5 × 10^{-2} m towards the slits, the change in fringe width is 3 × 10^{-3} cm. If the distance between the slits is 1 mm, then the wavelength of the light will be _______nm.

10. An inductor of 0.5 mH, a capacitor of 200 μF and a resistor of 2 Ω are connected in series with a 220 V ac source. If the current is in phase with the emf, the frequency of ac source will be___× 10^2 Hz.

CHEMISTRY

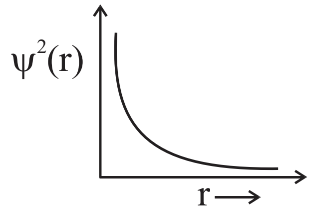
SECTION-A

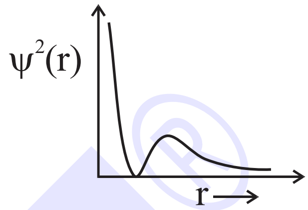
1. Using the rules for significant figures, the correct answer for the expression $\frac{0.02858 \times 0.112}{0.5702}$ will be:

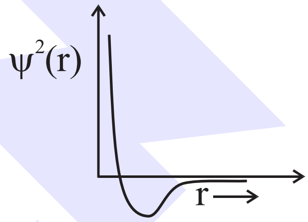
(A) 0.005613 (B) 0.00561

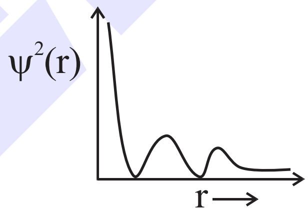
(C) 0.0056 (D) 0.006

2. Which of the following is the correct plot for the probability density $\psi^2(r)$ as a function of distance 'r' of the electron form the nucleus for 2s orbital?

(A)


(B)


(C)


(D)


3. Consider the species CH_4, NH_4^+ and BH_4^-. Choose the correct option with respect to the there species:

(A) They are isoelectronic and only two have tetrahedral structures

(B) They are isoelectronic and all have tetrahedral structures

(C) Only two are isoelectronic and all have tetrahedral structures

(D) Only two are isoelectronic and only two have tetrahedral structures

4. 4.0 moles of argon and 5.0 moles of PCl_5 are introduced into an evacuated flask of 100 litre capacity at 610 K. The system is allowed to equilibrate. At equilibrium, the total pressure of mixture was found to be 6.0 atm. The K_p for the reaction is [Given : R = 0.082L atm K^{-1} mol^{-1}]

(A) 2.25 (B) 6.24

(C) 12.13 (D) 15.24

5. A 42.12% (w/v) solution of NaCl causes precipitation of a certain sol in 10 hours. The coagulating value of NaCl for the sol is
[Given : Molar mass : Na = 23.0 g mol^{-1}; Cl = 35.5 g mol^{-1}]
(A) 36 mmol L^{-1}
(B) 36 mol L^{-1}
(C) 1440 mol L^{-1}
(D) 1440 mmol L^{-1}

6. Given below are two statements. One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : The first ionization enthalpy for oxygen is lower than that of nitrogen.
Reason R : The four electrons in 2p orbitals of oxygen experience more electron-electron repulsion.
In the light of the above statements, choose the correct answer from the options given below.
(A) Both A and R are correct and R is the correct explanation of A.
(B) Both A and R are correct but R is NOT the correct explanation of A.
(C) A is correct but R is not correct.
(D) A is not correct but R is correct

7. Match List I with List II.

List I Ore	List II Composition
A. Siderite	I. Fe CO_3
B. Malachite	II. $CuCO_3.Cu(OH)_2$
C. Sphalerite	III. ZnS
D. Calamine	IV. $ZnCO_3$

Choose the correct answer from the options given below:
(A) A-I, B-II, C-III, D-IV
(B) A-III, B-IV, C-II, D-I
(C) A-IV, B-III, C-I, D-II
(D) A-I, B-II, C-IV, D-III

8. Given below are two statements .
Statement I : In $CuSO_4.5H_2O$, Cu–O bonds are present.
Statement II : In $CuSO_4.5H_2O$, ligands coordinating with Cu(II) ion are O-and S-based ligands.
In the light of the above statements, choose the correct answer from the options given below
(A) Both Statement I and Statement II are correct (B) Both Statement I and Statement II are incorrect
(C) Statement I is correct but Statement II is incorrect
(D) Statement I is incorrect but Statement II is correct

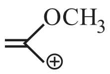
9. Amongst baking soda, caustic soda and washing soda carbonate anion is present in :
(A) washing soda only.
(B) washing soda and caustic soda only.
(C) washing soda and baking soda only.
(D) baking soda, caustic soda and washing soda.

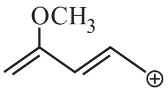
10. Number of lone pair (s) of electrons on central atom and the shape of BrF_3 molecule respectively, are :
(A) 0, triangular planar.
(B) 1, pyramidal.
(C) 2, bent T-shape.
(D) 1, bent T-shape

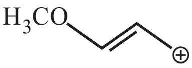
11. Aqueous solution of which of the following boron compounds will be strongly basic in nature?
(A) $NaBH_4$ (B) $LiBH_4$
(C) B_2H_6 (D) $Na_2B_4O_7$

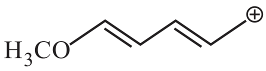
12. Sulphur dioxide is one of the components of polluted air. SO_2 is also a major contributor to acid rain. The correct and complete reaction to represent acid rain caused by SO_2 is :
(A) $2\ SO_2 + O_2 \rightarrow 2\ SO_3$
(B) $SO_2 + O_3 \rightarrow SO_3 + O_2$
(C) $SO_2 + H_2O_2 \rightarrow H_2SO_4$
(D) $2\ SO_2 + O_2 + 2\ H_2O \rightarrow 2\ H_2SO_4$

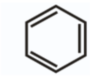
13. Which of the following carbocations is most stable :

(A) 

(B) 

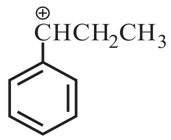
(C) 

(D) 

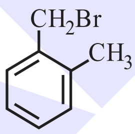
14.  $+ CH_3CH_2CH_2Cl \xrightarrow{\text{Anhydrous, } AlCl_3}$ 'A' Major Product

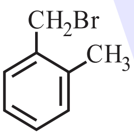
The stable carbocation formed in the above reaction is :

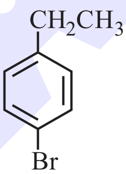
(A) $CH_3CH_2\overset{\oplus}{C}H_2$ (B) $CH_3\overset{\oplus}{C}H_2$

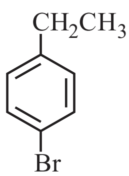
(C) $CH_3-\overset{\oplus}{C}H-CH_3$ (D) 

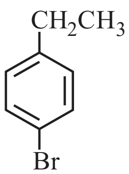
15. Two isomers (A) and (B) with Molar mass 184 g/mol and elemental composition C, 52.2%; H, 4.9% and Br 42.9% gave benzoic acid and p-bromobenzoic acid, respectively on oxidation with $KMnO_4$. Isomer 'A' is optically active and gives a pale yellow precipitate when warmed with alcoholic $AgNO_3$. Isomer 'A' and 'B' are, respectively :

(A) $H_3C–CHBr–C_6H_5$ and 

(B) 

and 

(C) $H_3C–CHBr–C_6H_5$ and 

(D) 

and $H_3C–CHBr–C_6H_5$

16. In Friedel-Crafts alkylation of aniline, one gets:

(A) alkylated product with ortho and para substitution.

(B) secondary amine after acidic treatment.

(C) an amide product.

(D) positively charged nitrogen at benzene ring.

17. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: Dacron is an example of polyester polymer.

Reason R: Dacron is made up of ethylene glycol and terephthalic acid monomers.

In the light of the above statements, choose the ***most appropriate*** answer from the options given below.

(A) Both **A** and **B** are correct and **R** is the correct explanation of **A**.

(B) Both **A** and **B** are correct but **R** is NOT the correct explanation of **A**.

(C) **A** is correct but **R** is not correct.

(D) **A** is not correct but **R** is correct.

18. The structure of protein that is unaffected by heating is :

(A) secondary structure

(B) tertiary structure

(C) primary structure

(D) quaternary structure

19. The mixture of chloroxylenol and terpineol is an example of :

(A) antiseptic (B) pesticide

(C) disinfectant (D) narcotic analgesic

20. A white precipitate was formed when $BaCl_2$ was added to water extract of an inorganic salt. Further, a gas 'X' with characteristic odour was released when the formed white precipitate was dissolved in dilute HCl. The anion present in the inorganic salt is :

(A) I^- (B) SO_3^{2-}

(C) S^{2-} (D) NO_2^-

SECTION-B

1. A box contains 0.90 g of liquid water in equilibrium with water vapour at 27°C. The equilibrium vapour pressure of water at 27°C 32.0 Torr. When the volume of the box is increased, some of the liquid water evaporates to maintain the equilibrium pressure. If all the liquid water evaporates, then the volume of the box must be____ litre. [nearest integer]

(Given: $R = 0.082$ L atm K^{-1} mol^{-1})

(Ignore the volume of the liquid water and assume water vapours behave as an ideal gas.)

2. 2.2 g of nitrous oxide (N_2O) gas is cooled at a constant pressure of 1 atm from 310 K to 270 K causing the compression of the gas from 217.1 mL to 167.75 mL. The change in internal energy of the process, ΔU is '–x' J. The value of 'x' is __. [nearest integer]

(Given: atomic mass of N = 14 g mol^{-1} and of O = 16 g mol^{-1}. Molar heat capacity of N_2O is 100 JK^{-1} mol^{-1})

3. Elevation in boiling point for 1.5 molal solution of glucose in water is 4K. The depression in freezing point for 4.5 molal solution of glucose in water is 4K. The ratio of molal elevation constant to molal depression constant (K_b/K_f) is____.

4. The cell potential for the given cell at 298 K

$Pt \mid H_2(g, 1\ bar) \mid H^+(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

is 0.31V. The pH of the acidic solution is found to be 3, whereas the concentration of Cu^{2+} is 10^{-x} M. The value of x is _____.

(Given: $E^{\ominus}_{Cu^{2+}/Cu} = 0.34$ V and

$\dfrac{2.303RT}{F} = 0.06V$)

5. The equation

$k = (6.5 \times 10^{12}\ s^{-1})\ e^{-26000K/T}$

is followed for the decomposition of compound A. The activation energy for the reaction is ____ kJ mol^{-1}. [nearest integer]

(Given: $R = 8.314$ J K^{-1} mol^{-1})

6. Spin only magnetic moment of $[MnBr_6]^{4-}$ is____ B.M. (round off to the closest integer)

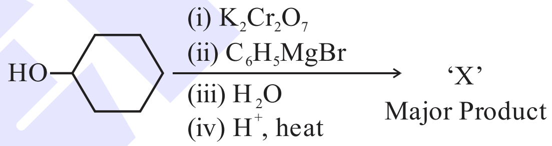
7. For the reaction given below:

$CoCl_3 \cdot xNH_3 + AgNO_3(aq) \rightarrow$

If two equivalents of AgCl precipitate out, then the value of x will be _____.

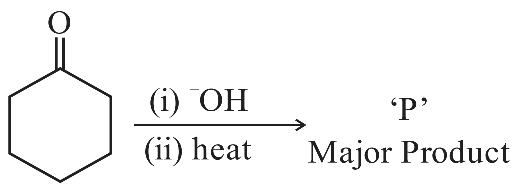
8. The number of chiral alcohol(s) with molecular formula $C_4H_{10}O$ is______.

9. In the given reaction



the number of sp^2 hybridised carbon (s) in compound 'X' is_____.

10. In the given reaction,



The number of π electrons present in the product 'P' is _____.

MATHEMATICS

SECTION-A

1. Let α be a root of the equation $1 + x^2 + x^4 = 0$. Then the value of $\alpha^{1011} + \alpha^{2022} - \alpha^{3033}$ is equal to:

(A) 1
(B) α
(C) $1 + \alpha$
(D) $1 + 2\alpha$

2. Let arg (z) represent the principal argument of the complex number z. The, $|z| = 3$ and $\arg(z-1) - \arg(z+1) = \frac{\pi}{4}$ intersect:

(A) Exactly at one point
(B) Exactly at two points
(C) Nowhere
(D) At infinitely many points.

3. Let $A = \begin{pmatrix} 2 & -1 \\ 0 & 2 \end{pmatrix}$. If $B = I - {}^5C_1 (\text{adj}A) + {}^5C_2 (\text{adj}A)^2 - \ldots - {}^5C_5 (\text{adj}A)^5$, then the sum of all elements of the matrix B is:

(A) –5 (B) –6
(C) –7 (D) –8

4. The sum of the infinite series $1 + \frac{5}{6} + \frac{12}{6^2} + \frac{22}{6^3} + \frac{35}{6^4} + \frac{51}{6^5} + \frac{70}{6^6} + \ldots$ is equal to:

(A) $\frac{425}{216}$ (B) $\frac{429}{216}$
(C) $\frac{288}{125}$ (D) $\frac{280}{125}$

5. The value of $\lim\limits_{x\to 1} \frac{(x^2-1)\sin^2(\pi x)}{x^4 - 2x^3 + 2x - 1}$ is equal to:

(A) $\frac{\pi^2}{6}$ (B) $\frac{\pi^2}{3}$
(C) $\frac{\pi^2}{2}$ (D) π^2

6. Let $f : \mathbb{R} \to \mathbb{R}$ be a function defined by $f(x) = (x-3)^{n_1}(x-5)^{n_2}$, $n_1, n_2 \in N$. The, which of the following is <u>NOT</u> true?

(A) For $n_1 = 3$, $n_2 = 4$, there exists $\alpha \in (3,5)$ where f attains local maxima.
(B) For $n_1 = 4$, $n_2 = 3$, there exists $\alpha \in (3,5)$ where f attains local manima.
(C) For $n_1 = 3$, $n_2 = 5$, there exists $\alpha \in (3,5)$ where f attains local maxima.
(D) For $n_1 = 4$, $n_2 = 6$, there exists $\alpha \in (3,5)$ where f attains local maxima.

7. Let f be a real valued continuous function on [0,1] and $f(x) = x + \int_0^1 (x-t)f(t)dt$. Then which of the following points (x,y) lies on the curve $y = f(x)$?

(A) (2, 4) (B) (1, 2)
(C) (4, 17) (D) (6, 8)

8. If $\int_0^2 \left(\sqrt{2x} - \sqrt{2x - x^2}\right)dx = \int_0^1 \left(1 - \sqrt{1-y^2} - \frac{y^2}{2}\right)dy + \int_1^2 \left(2 - \frac{y^2}{2}\right)dy + I$

(A) $\int_0^1 \left(1 + \sqrt{1-y^2}\right)dy$

(B) $\int_0^1 \left(\frac{y^2}{2} - \sqrt{1-y^2} + 1\right)dy$

(C) $\int_0^1 \left(1 - \sqrt{1-y^2}\right)dy$

(D) $\int_0^1 \left(\frac{y^2}{2} + \sqrt{1-y^2} + 1\right)dy$

9. If y = y (x) is the solution of the differential equation $(1 + e^{2x})\frac{dy}{dx} + 2(1 + y^2)e^x = 0$ and $y(0) = 0$, then $6\left(y'(0) + \left(y\left(\log_e \sqrt{3}\right)\right)^2\right)$ is equal to:

(A) 2 (B) –2
(C) –4 (D) –1

10. Let P : $y^2 = 4ax$, $a > 0$ be a parabola with focus S.Let the tangents to the parabola P make an angle of $\frac{\pi}{4}$ with the line $y = 3x + 5$ touch the parabola P at A and B. Then the value of a for which A,B and S are collinear is:

(A) 8 only (B) 2 only
(C) $\frac{1}{4}$ only (D) any a > 0

11. Let a triangle *ABC* be inscribed in the circle $x^2 - \sqrt{2}(x+y)+y^2 = 0$ such that $\angle BAC = \frac{\pi}{2}$. If the length of side AB is $\sqrt{2}$, then the area of the ΔABC is equal to:

(A) $\left(\sqrt{2}+\sqrt{6}\right)/3$ (B) $\left(\sqrt{6}+\sqrt{3}\right)/2$

(C) $\left(3+\sqrt{3}\right)/4$ (D) $\left(\sqrt{6}+2\sqrt{3}\right)/4$

12. Let $\frac{x-2}{3}=\frac{y+1}{-2}=\frac{z+3}{-1}$ lie on the plane $px - qy + z = 5$, for some $p, q \in \mathbb{R}$. The shortest distance of the plane from the origin is:

(A) $\sqrt{\frac{3}{109}}$ (B) $\sqrt{\frac{5}{142}}$

(C) $\sqrt{\frac{5}{71}}$ (D) $\sqrt{\frac{1}{142}}$

13. The distance of the origin from the centroid of the triangle whose two sides have the equations $x - 2y + 1 = 0$ and $2x - y - 1 = 0$ and whose orthocenter is $\left(\frac{7}{3},\frac{7}{3}\right)$ is:

(A) $\sqrt{2}$ (B) 2

(C) $2\sqrt{2}$ (D) 4

14. Let Q be the mirror image of the point P(1, 2, 1) with respect to the plane $x + 2y + 2z = 16$. Let T be a plane passing through the point Q and contains the line $\vec{r} = -\hat{k}+\lambda\left(\hat{i}+\hat{j}+2\hat{k}\right), \lambda \in \mathbb{R}$.

Then, which of the following points lies on T?

(A) (2, 1, 0) (B) (1, 2, 1)

(C) (1, 2, 2) (D) (1, 3, 2)

15. Let A, B, C be three points whose position vectors respectively are:

$\vec{a} = \hat{i}+4\hat{j}+3\hat{k}$

$\vec{b} = 2\hat{i}+\alpha\hat{j}+4\hat{k}, \alpha \in \mathbb{R}$

$\vec{c} = 3\hat{i}-2\hat{j}+5\hat{k}$

If α is the smallest positive integer for which $\vec{a}, \vec{b}, \vec{c}$ are non-collinear, then the length of the median, in ΔABC, through A is:

(A) $\frac{\sqrt{82}}{2}$ (B) $\frac{\sqrt{62}}{2}$

(C) $\frac{\sqrt{69}}{2}$ (D) $\frac{\sqrt{66}}{2}$

16. The probability that a relation R from {x,y} to {x,y} is both symmetric and transitive, is equal to:

(A) $\frac{5}{16}$ (B) $\frac{9}{16}$

(C) $\frac{11}{16}$ (D) $\frac{13}{16}$

17. The number of values of $a \in \mathbb{N}$ such that the variance of 3, 7, 12 a, 43 – a is a natural number is:

(A) 0 (B) 2

(C) 5 (D) infinite

18. From the base of a pole of height 20 meter, the angle of elevation of the top of a tower is 60°. The pole subtends an angle 30° at the top of the tower. Then the height of the tower is:

(A) $15\sqrt{3}$ (B) $20\sqrt{3}$

(C) $20+10\sqrt{3}$ (D) 30

19. Negation of the Boolean statement $(p \vee q) \Rightarrow \left((\sim r) \vee p\right)$ is equivalent to:

(A) $p \wedge (\sim q) \wedge r$

(B) $(\sim p) \wedge (\sim q) \wedge r$

(C) $(\sim p) \wedge q \wedge r$

(D) $p \wedge q \wedge (\sim r)$

20. Let $n \geq 5$ be an integer. If $9^n - 8n - 1 = 64\alpha$ and $6^n - 5n - 1 = 25\beta$, then $\alpha - \beta$ is equal to:

(A) $1 + {}^nC_2\,(8-5) + {}^nC_3\,(8^2 - 5^2) + \ldots + {}^nC_n\,(8^{n-1} - 5^{n-1})$

(B) $1 + {}^nC_3\,(8-5) + {}^nC_4\,(8^2 - 5^2) + \ldots + {}^nC_n\,(8^{n-2} - 5^{n-2})$

(C) ${}^nC_3\,(8-5) + {}^nC_4\,(8^2 - 5^2) + \ldots + {}^nC_n\,(8^{n-2} - 5^{n-2})$

(D) ${}^nC_4\,(8-5) + {}^nC_5\,(8^2 - 5^2) + \ldots + {}^nC_n\,(8^{n-3} - 5^{n-3})$

SECTION-B

1. Let $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}, \vec{b} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{c}$ be a vector such that $\vec{a} + \left(\vec{b} \times \vec{c}\right) = \vec{0}$ and $\vec{b}.\vec{c} = 5$. Then, the value of $3\left(\vec{c}.\vec{a}\right)$ is equal to_____.

2. Let y = y(x), x > 1, be the solution of the differential equation $(x-1)\frac{dy}{dx} + 2xy = \frac{1}{x-1}$, with $y(2) = \frac{1+e^4}{2e^4}$. If $y(3) = \frac{e^\alpha + 1}{\beta e^\alpha}$. then the value of $\alpha + \beta$ is equal to______.

3. Let 3, 6, 9, 12,... upto 78 terms and 5, 9, 13, 17,... upto 59 terms be two series. Then, the sum of the terms common to both the series is equal to____.

4. The number of solutions of the equation sin x = $\cos^2$ x in the interval (0,10) is___.

5. For real numbers a,b (a > b > 0), let

$$Area\left\{(x,y): x^2 + y^2 \le a^2 \text{and } \frac{x^2}{a^2} + \frac{y^2}{b^2} \ge 1\right\} = 30\pi$$

and

$$Area\left\{(x,y): x^2 + y^2 \ge b^2 \text{and } \frac{x^2}{a^2} + \frac{y^2}{b^2} \le 1\right\} = 18\pi$$

Then the value of $(a-b)^2$ is equal to___.

6. Let f and g be twice differentiable even functions on (–2, 2) such that $f\left(\frac{1}{4}\right) = 0, f\left(\frac{1}{2}\right) = 0, f(1) = 1$ and $g\left(\frac{3}{4}\right) = 0, g(1) = 2$ Then, the minimum number of solutions of $f(x)g''(x) + f'(x)g'(x) = 0$ in (–2,2) is equal to___.

7. Let the coefficients of x^{-1} and x^{-3} in the expansion of $\left(2x^{\frac{1}{5}} - \frac{1}{x^{\frac{1}{5}}}\right)^{15}$, x > 0, be m and n respectively. If r is a positive integer such $mn^2 = {}^{15}C_r . 2^r$, then the value of r is equal to___.

8. The total number of four digit numbers such that each of the first three digits is divisible by the last digit, is equal to_______.

9. Let $M = \begin{bmatrix} 0 & -\alpha \\ \alpha & 0 \end{bmatrix}$, where α is a non-zero real number an $N = \sum_{k=1}^{49} M^{2k}$. If $(I - M^2)N = -2I$, then the positive integral value of α is _____.

10. Let f(x) and g(x) be two real polynomials of degree 2 and 1 respectively.

If $f(g(x)) = 8x^2 - 2x$, and $g(f(x)) = 4x^2 + 6x + 1$, then the value of f(2) + g(2) is______.

SET-01

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	A	C	D	D	B	C	B	C	B	A	A	NTA-C Allen-Bonus	C	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	D	C	B	12	10	750	242	3	2	3	120	25	6

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	B	B	C	B	A	B	A	C	A	B	B	A	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	B	D	A	43	747	54	5	154	0	7	NTA-63 Allen-Bonus	3	2

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	D	A	C	A	B	B	A	B	C	D	B	B	A	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	D	B	B	31	40	8	84	7	1	34	2929	19	2

SET-02

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	D	B	A	C	B	B	C	D	C	C	B	B	C	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	B	D	B	20	6	25	5	5	NTA-25 Allen-50	12	440	2	16

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	C	B	C	C	B	B	A	A	B	D	D	NTA-A Allen-Bonus	A	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	C	C	A	45	NTA-1221 Allen-1222 & 1223	1107	266	2	3	3	14	2	4

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	D	C	C	A	A	A	C	D	A	D	A	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	B	D	D	80	100	576	1633	4	18	7	479	42	10

SET-03

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	B	B	D	C	B	C	A	B	B	B	B	D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	B	C	B	2	600	100	31	80	6	450	2	4	2

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	D	C	C	D	C	B	A	A	C	C	B	D	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	C	NTA-C Allen-A & C	C	B	5418	1	NTA-4 Allen-Bonus	300	NTA-15 Allen-0	710	23	1	NTA-745 Allen-766	NTA-1136 Allen-1143

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	A	C	B	A	C	D	A	C	A	D	A	B	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	C	D	B	NTA-286 Allen-BONUS	63	576	7	4	4	2	5	414	98

SET-04

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	D	B	B	C	B	C	A	A	A	A	A	A	D	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	A	B	D	18	24	12	5	2	250	198	300	22	15

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	D	A	B	NTA-B Allen-D	A	D	A	A	B	C	D	B	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	C	D	C	B	25	32	3	0	20	2	2	9	2	3

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	D	A	A	A	B	C	D	C	D	B	C	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	C	B	A	1	62	6	83	21	14	243	3	85	51

SET-05

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	A	C	C	A	A	C	B	A	C	A	C	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	B	D	B	C	60	5	25	6	400	210	5	1	0	363

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	D	B	A	C	A	D	C	D	A	B	B	A	D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	C	NTA-A Allen-A,B,C	C	B	727	99 or 98	476	200	9960	3	3	18	7	9

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	C	C	D	D	A	D	NTA-D Allen-Bonus	D	B	B	B	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	D	A	B	A	36	1120	4	21	12	80	5264	6	1100	42

SET-06

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	A	A	B	D	C	NTA-D Allen-Bonus	A	C	B	C	A	D	B	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	D	B	D	6	12	36	42	540	152	5	9	5	35

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	D	A	A	D	B	A	A	C	D	B	A	C	NTA-C Allen-D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	C	NTA-C Allen-D	B	D	143	3	NTA-3 Allen-1	38	415	2735	983	4	6	225

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	C	C	C	B	B	C	A	D	C	B	C	C	C	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	B	C	C	248	4	2	100	150	102	40	3	12	33

SET-07

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	C	A	C	C	B	A	C	B	C	D	A	B	A	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	D	B	B	B	16	975	450	114	8	48	125	192	300	10

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	B	B	A	D	B	D	C	D	D	C	A	A	D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	D	A	A	B	85	22	8	125	14	166	3	6	2	NTA-5 Allen-6

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	D	C	B	A	B	C	D	B	D	D	C	B	A	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	C	B	A	D	99	45	14	56	5	6	276	16	63	137

SET-08

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	B	C	B	A	A	B	B	B	B	D	C	D	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	C	D	D	C	3	3	1400	1	23	12	3	2	16	4

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	C	D	C	A	B	A	C	C	B	A	A	C	D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	C	A	D	2	2	2	8630	45	11	NTA-51 Allen-51 or 103	59	12	40

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	B	C	C	D	B	NTA-B Allen-Bonus	A	B	D	D	A	A	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	A	C	C	190	98	180	57	3	16	36	320	11	19

SET-09

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	A	A	C	A	A	NTA-A Allen-C	A	D	B	A	C	A	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	A	C	D	5	19	10	15	91	6	6	7479	10	100

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	C	A	B	B	B	D	C	B	D	C	B	C	A	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	B	B	D	13	300	1	0	14	3	6	16	3	34

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	D	B	A	D	C	C	C	B	A	A	B	B	C	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	A	C	C	8	2	17	150	31	13	702	2	40	816

SET-10

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	B	C	C	B	C	D	B	B	B	A	A	C	NTA-B Allen-D	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	C	D	C	150	2	4	0	8	100	50	24	10	18

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	C	A	B	C	B	D	D	C	C	A	D	C	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	C	C	B	C	4	600	330	16	75	2	1	46	1	30

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	D	B	C	B	B	C	C	D	B	B	D	D	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	C	C	A	125	0	10	11	41651	58	25	2	37	9

SET-11

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	B	C	C	C	B	D	C	C	C	C	C	A	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	A	D	D	B	15	43	21	700	144	102	3	2	225	10

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	D	C	D	D	A	D	C	A	A	B	A	D	B	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	C	B	C	C	152	117	5	127	1	6	0	64	3	1

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	A	C	C	A	C	B	A	C	A	D	B	C	B	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	B	C	B	26	2	26	32	1	29	3395	88	28	18915

SET-12

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	D	D	D	A	D	D	D	B	B	C	C	C	C	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	D	A	B	180	20	104	8	14	8	8	20	600	5

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	B	A	NTA-D Allen-Bonus	A	A	C	A	C	D	D	D	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	A	C	A	B	29	195	3	7	216	6	5	NTA-1 Allen-2	8	4

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	C	C	D	C	D	C	C	D	Dropped	B	C	B	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	A	D	C	C	NTA-10 Allen-Bonus	14	2223	4	12	4	5	1086	1	18

Chapter Contents

JEE (MAIN) JULY 2022 TEST PAPERS

IMPORTANT NOTE

SET # 01

PHYSICS
SECTION-A

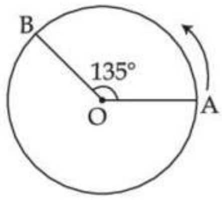
1. If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is :

(A) $[P A^{-1} T^0]$ (B) $[P A T^{-1}]$
(C) $[P A^{-1} T]$ (D) $[P A^{-1} T^{-1}]$

2. Which of the following physical quantities have the same dimensions ?

(A) Electric displacement $(\vec{D})$ and surface charge density
(B) Displacement current and electric field
(C) Current density and surface charge density
(D) Electric potential and energy

3. A person moved from A to B on a circular path as shown in figure. If the distance travelled by him is 60 m, then the magnitude of displacement would be :
(Given cos135° = - 0.7)



(A) 42 m (B) 47 m
(C) 19 m (D) 40 m

4. A body of mass 0.5 kg travels on straight line path with velocity $v = (3x^2 + 4)$ m/s. The net workdone by the force during its displacement from x = 0 to x = 2 m is :

(A) 64 J (B) 60 J
(C) 120 J (D) 128 J

5. A solid cylinder and a solid sphere, having same mass M and radius R, roll down the same inclined plane from top without slipping. They start from rest. The ratio of velocity of the solid cylinder to that of the solid sphere, with which they reach the ground, will be :

(A) $\sqrt{\frac{5}{3}}$ (B) $\sqrt{\frac{4}{5}}$
(C) $\sqrt{\frac{3}{5}}$ (D) $\sqrt{\frac{14}{15}}$

6. Three identical particle A, B and C of mass 100 kg each are placed in a straight line with AB = BC = 13 m. The gravitational force on a fourth particle P of the same mass is F, when placed at a distance 13 m from the particle B on the perpendicular bisector of the line AC. The value of F will be approximately :

(A) 21 G (B) 100 G
(C) 59 G (D) 42 G

7. A certain amount of gas of volume V at 27°C temperature and pressure 2×10^7 Nm^{-2} expands isothermally until its volume gets doubled. Later it expands adiabatically until its volume gets redoubled. The final pressure of the gas will be (Use $\gamma = 1.5$)

(A) 3.536×10^5 Pa (B) 3.536×10^6 Pa
(C) 1.25×10^6 Pa (D) 1.25×10^5 Pa

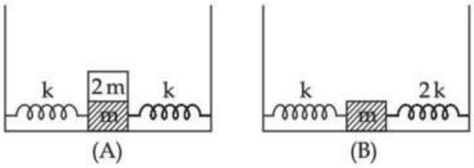
8. Following statements are given :

(1) The average kinetic energy of a gas molecule decreases when the temperature is reduced.
(2) The average kinetic energy of a gas molecule increases with increase in pressure at constant temperature.
(3) The average kinetic energy of a gas molecule decreases with increases in volume
(4) Pressure of a gas increases with increase in temperature at constant pressure.
(5) The volume of gas decreases with increase in temperature.

Choose the correct answer from the options given below :

(A) (1) and (4) only
(B) (1), (2) and (4) only
(C) (2) and (4) only
(D) (1), (2) and (5) only

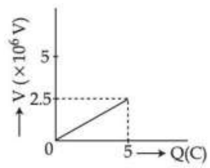
9. In figure (A), mass '2 m' is fixed on mass 'm' which is attached to two springs of spring constant k. In figure (B), mass 'm' is attached to two spring of spring constant 'k' and '2k'. If mass 'm' in (A) and (B) are displaced by distance 'x' horizontally and then released, then time period T_1 and T_2 corresponding to (A) and (B) respectively follow the relation.

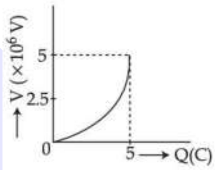


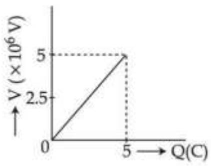
(A) $\frac{T_1}{T_2} = \frac{3}{\sqrt{2}}$ (B) $\frac{T_1}{T_2} = \sqrt{\frac{3}{2}}$

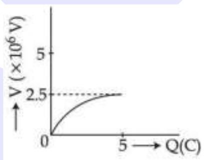
(C) $\frac{T_1}{T_2} = \sqrt{\frac{2}{3}}$ (D) $\frac{T_1}{T_2} = \frac{\sqrt{2}}{3}$

10. A condenser of 2 μF capacitance is charged steadily from 0 to 5C. Which of the following graph represents correctly the variation of potential difference (V) across it's plates with respect to the charge (Q) on the condenser ?

(A) 

(B) 

(C) 

(D) 

11. Two charged particles, having same kinetic energy, are allowed to pass through a uniform magnetic field perpendicular to the direction of motion. If the ratio of radii of their circular paths is 6 : 5 and their respective masses ratio is 9 : 4. Then, the ratio of their charges will be :

(A) 8 : 5 (B) 5 : 4

(C) 5 : 3 (D) 8 : 7

12. To increase the resonant frequency in series LCR circuit,

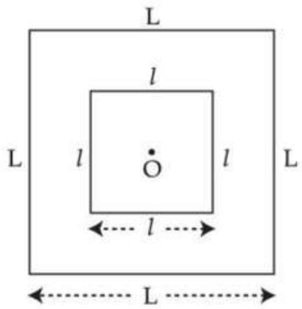
(A) Source frequency should be increased

(B) Another resistance should be added in series with the first resistance.

(C) Another capacitor should be added in series with the first capacitor

(D) The source frequency should be decreased

13. A small square loop of wire of side l is placed inside a large square loop of wire L (L >> l). Both loops are coplanar and their centres coincide at point O as shown in figure. The mutual inductance of the system is :



(A) $\frac{2\sqrt{2}\mu_0 L^2}{\pi\ell}$ (B) $\frac{\mu_0 \ell^2}{2\sqrt{2}\pi L}$

(C) $\frac{2\sqrt{2}\mu_0 \ell^2}{\pi L}$ (D) $\frac{\mu_0 L^2}{2\sqrt{2}\pi\ell}$

14. The rms value of conduction current in a parallel plate capacitor is 6.9 μA. The capacity of this capacitor, if it is connected to 230 V ac supply with an angular frequency of 600 rad/s, will be :

(A) 5 pF (B) 50 pF

(C) 100 pF (D) 200 pF

15. Which of the following statement is correct ?

(A) In primary rainbow, observer sees red colour on the top and violet on the bottom

(B) In primary rainbow, observer sees violet colour on the top and red on the bottom

(C) In primary rainbow, light wave suffers total internal reflection twice before coming out of water drops

(D) Primary rainbow is less bright than secondary rainbow.

16. Time taken by light to travel in two different materials A and B of refractive indices μ_A and μ_B of same thickness is t_1 and t_2 respectively. If $t_2 - t_1 = 5 \times 10^{-10}$ s and the ratio of μ_A to μ_B is 1 : 2. Then the thickness of material, in meter is : (Given v_A and v_B are velocities of light in A and B materials respectively).

(A) $5 \times 10^{-10}\ v_a$ m
(B) 5×10^{-10} m
(C) 1.5×10^{-10} m
(D) $5 \times 10^{-10}\ v_B$ m

17. A metal exposed to light of wavelength 800 nm and emits photoelectrons with a certain kinetic energy. The maximum kinetic energy of photo-electron doubles when light of wavelength 500 nm is used. The work function of the metal is (Take hc = 1230 eV-nm).

(A) 1.537 eV
(B) 2.46 eV
(C) 0.615 eV
(D) 1.23 eV

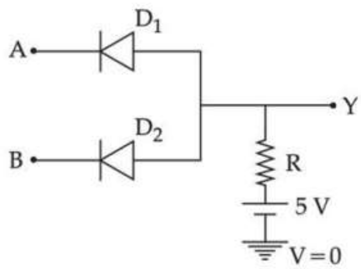
18. The momentum of an electron revolving in n^{th} orbit is given by : (Symbols have their usual meanings)

(A) $\frac{nh}{2\pi r}$
(B) $\frac{nh}{2r}$
(C) $\frac{nh}{2\pi}$
(D) $\frac{2\pi r}{nh}$

19. The magnetic moment of an electron (e) revolving in an orbit around nucleus with an orbital angular momentum is given by :

(A) $\vec{\mu}_L = \frac{e\vec{L}}{2m}$
(B) $\vec{\mu}_L = -\frac{e\vec{L}}{2m}$
(C) $\vec{\mu}_l = -\frac{e\vec{L}}{m}$
(D) $\vec{\mu}_l = \frac{2e\vec{L}}{m}$

20. In the circuit, the logical value of A = 1 or B = 1 when potential at A or B is 5V and the logical value of A = 0 or B = 0 when potential at A or B is 0 V.



The truth table of the given circuit will be :

(A)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

(B)

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

(C)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	0

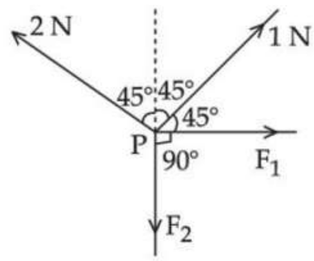
(D)

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

SECTION-B

1. A car is moving with speed of 150 km/h and after applying the brake it will move 27 m before it stops. If the same car is moving with a speed of one third the reported speed then it will stop after travelling ________ m distance.

2. Four forces are acting at a point P in equilibrium as shown in figure. The ratio of force F_1 to F_2 is 1 : x where x = _____ .



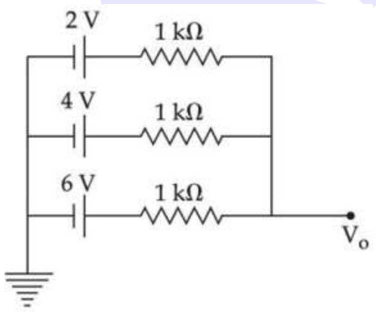
3. A wire of length L and radius r is clamped rigidly at one end. When the other end of the wire is pulled by a force F, its length increases by 5 cm. Another wire of the same material of length 4L and radius 4r is pulled by a force 4F under same conditions. The increase in length of this wire is ______ cm.

4. A unit scale is to be prepared whose length does not change with temperature and remains 20 cm, using a bimetallic strip made of brass and iron each of different length. The length of both components would change in such a way that difference between their lengths remains constant. If length of brass is 40 cm and length of iron will be ______cm.
($\alpha_{iron} = 1.2 \times 10^{-5}\ K^{-1}$ and $\alpha_{brass} = 1.8 \times 10^{-5}\ K^{-1}$).

5. An observer is riding on a bicycle and moving towards a hill at 18 kmh^{-1}. He hears a sound from a source at some distance behind him directly as well as after its reflection from the hill. If the original frequency of the sound as emitted by source is 640 Hz and velocity of the sound in air is 320 m/s, the beat frequency between the two sounds heard by observer will be _____ Hz.

6. The volume charge density of a sphere of radius 6 m is 2 $\mu C\ cm^{-3}$. The number of lines of force per unit surface area coming out from the surface of the sphere is _______ $\times 10^{10}\ NC^{-1}$.
[Given : Permittivity of vacuum
$\in_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1} - m^{-2}$]

7. In the given figure, the value of V_0 will be ____ V.



8. Eight copper wire of length l and diameter d are joined in parallel to form a single composite conductor of resistance R. If a single copper wire of length $2l$ have the same resistance (R) then its diameter will be _________ d.

9. The energy band gap of semiconducting material to produce violet (wavelength = 4000 Å) LED is _____ eV. (Round off to the nearest integer).

10. The required height of a TV tower which can cover the population of 6.03 lakh is h. If the average population density is 100 per square km and the radius of earth is 6400 km, then the value of h will be ______ m.

CHEMISTRY

SECTION-A

1. SO_2Cl_2 on reaction with excess of water results into acidic mixture
$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$
16 moles of NaOH is required for the complete neutralisation of the resultant acidic mixture. The number of moles of SO_2Cl_2 used is :
(A) 16 (B) 8
(C) 4 (D) 2

2. Which of the following sets of quantum numbers is not allowed ?
(A) $n = 3, l = 2, m_l = 0, s = +\frac{1}{2}$
(B) $n = 3, l = 2, m_l = -2, s = +\frac{1}{2}$
(C) $n = 3, l = 3, m_l = -3, s = -\frac{1}{2}$
(D) $n = 3, l = 0, m_l = 0, s = -\frac{1}{2}$

3. The depression in freezing point observed for a formic acid solution of concentration 0.5 mL L^{-1} is 0.0405°C. Density of formic acid is 1.05 g mL^{-1}. The Van't Hoff factor of the formic acid solution is nearly : (Given for water k_f= 1.86 K kg mol^{-1})
(A) 0.8 (B) 1.1
(C) 1.9 (D) 2.4

4. 20 mL of 0.1 M NH_4OH is mixed with 40 mL of 0.05 M HCl. The pH of the mixture is nearest to:
(Given: $K_b(NH_4OH) = 1 \times 10^{-5}$, log 2 = 0.30, log 3 = 0.48, log 5 = 0.69, log 7 = 0.84, log 11 =1.04)
(A) 3.2 (B) 4.2
(C) 5.2 (D) 6.2

5.
Match List - I with List - II

	List - I		List - II
(A)	$N_2(g)+3H_2(g) \rightarrow 2NH_3(g)$	(I)	Cu
(B)	$CO(g)+3H_2(g) \rightarrow CH_4(g)+H_2O(g)$	(II)	$Cu/ZnO-Cr_2O_3$
(C)	$CO(g)+H_2(g) \rightarrow HCHO(g)$	(III)	$Fe_xO_y+K_2O+Al_2O_3$
(D)	$CO(g)+2H_2(g) \rightarrow CH_3OH(g)$	(IV)	Ni

Choose the correct answer from the options given below :
(A) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
(B) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
(C) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
(D) (A) - (III), (B) - (I), (C) - (IV), (D) - (II)

6. The IUPAC nomenclature of an element with electronic configuration $[Rn]5f^{14}6d^17s^2$ is :
(A) Unnilbium (B) Unnilunium
(C) Unnilquadium (D) Unniltrium

7. The compound(s) that is(are) removed as slag during the extraction of copper is :
(1) CaO (2) FeO
(3) Al_2O_3 (4) ZnO
(5) NiO
Choose the correct answer from the options given below :
(A) (3) (4) Only
(B) (1), (2), (5) Only
(C) (1), (2) Only
(D) (2) Only

8. The reaction of H_2O_2 with potassium permanganate in acidic medium leads to the formation of mainly:
(A) Mn^{2+} (B) Mn^{4+}
(C) Mn^{3+} (D) Mn^{6+}

9. Choose the correct order of density of the alkali metals :
(A) Li < K < Na < Rb < Cs
(B) Li < Na < K < Rb < Cs
(C) Cs < Rb < K < Na < Li
(D) Li < Na < K < Cs < Rb

10. The geometry around boron in the product 'B' formed from the following reaction is

$$BF_3 + NaH \xrightarrow{450\,K} A + NaF$$

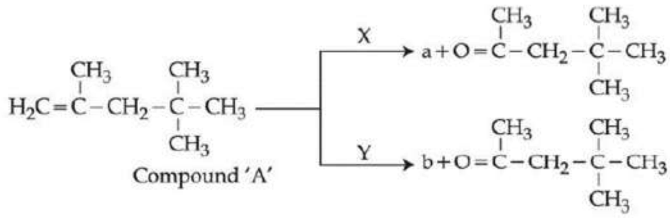
$$A + NMe_3 \rightarrow B$$

(A) trigonal planar (B) tetrahedral
(C) pyramidal (D) square planar

11. The interhalogen compound formed from the reaction of bromine with excess of fluorine is a :
(A) hypohalite (B) halate
(C) perhalate (D) halite

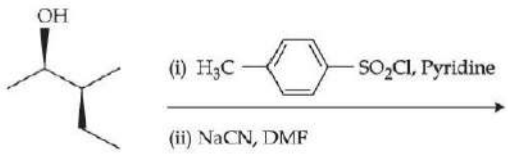
12. The photochemical smog does not generally contain :
(A) NO (B) NO_2
(C) SO_2 (D) HCHO

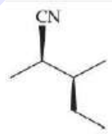
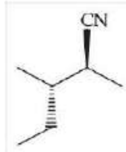
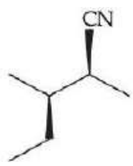
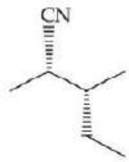
13. A compound 'A' on reaction with 'X' and 'Y produces the same major product but different by product 'a' and 'b'. Oxidation of 'a' gives a substance produced by ants.



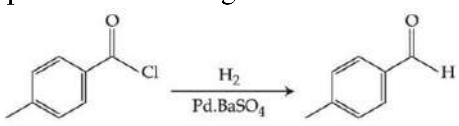
'X' and 'Y' respectively are :
(A) $KMnO_4/H^+$ and dil. $KMnO_4$, 273 K
(B) $KMnO_4$,(dilute), 273 K and $KMnO_4/H^+$
(C) $KMnO_4/H^+$ and O_3, H_2O/Zn
(D) O_3, H_2O/Zn and $KMnO_4/H^+$

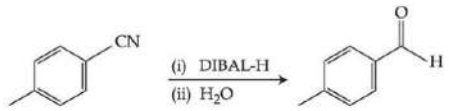
14. Most stable product of the following reaction is:

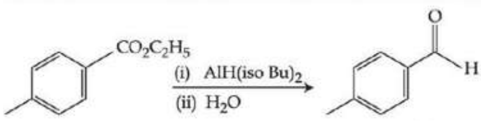


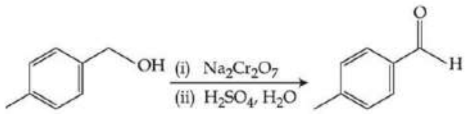
(A) 
(B) 
(C) 
(D) 

15. Which one of the following reactions does not represent correct combination of substrate and product under the given conditions ?

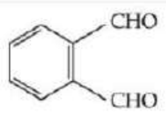
(A) 

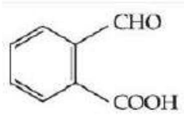
(B) 

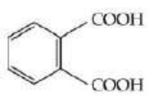
(C) 

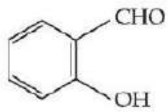
(D) 

16. An organic compound 'A' on reaction with NH_3 followed by heating gives compound B. Which on further strong heating gives compound C ($C_8H_5NO_2$). Compound C on sequential reaction with ethanolic KOH, alkyl chloride and hydrolysis with alkali gives a primary amine. The compound A is :

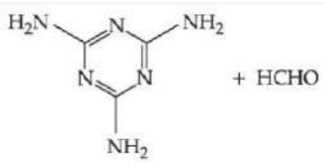
(A) 

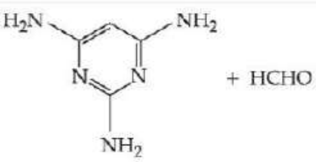
(B) 

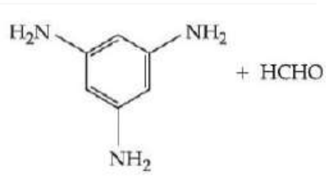
(C) 

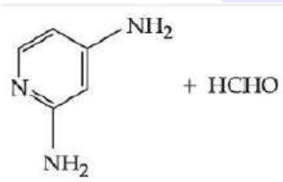
(D) 

17. Melamine polymer is formed by the condensation of :

(A) 

(B) 

(C) 

(D) 

18. During the denaturation of proteins, which of these structures will remain intact ?

(A) Primary

(B) Secondary

(C) Tertiary

(D) Quaternary

19. Drugs used to bind to receptors, inhibiting its natural function and blocking a message are called :

(A) Agonists

(B) Antagonists

(C) Allosterists

(D) Anti histaminists

20. Given below are two statements :

Statement I : On heating with $KHSO_4$, glycerol is dehydrated and acrolein is formed.

Statement II : Acrolein has fruity odour and can be used to test glycerol's presence.

Choose the correct option.

(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect

(C) Statement I is correct but Statement II is incorrect.

(D) Statement I is incorrect but Statement II is correct.

SECTION-B

1. Among the following species

N_2, N_2^+, N_2^- , N_2^{2-}, O_2, O_2^+, O_2^-, O_2^{2-}

the number of species showing diamagnetism is

2. The enthalpy of combustion of propane, graphite and dihydrogen at 298 K are: –2220.0 kJ mol^{-1}, –393.5 kJ mol^{-1} and –285.8 kJ mol^{-1} respectively. The magnitude enthalpy of formation of propane (C_3H_8) is........kJ mol^{-1}. (Nearest integer)

3. The pressure of a moist gas at 27°C is 4 atm. The volume of the container is doubled at the same temperature. The new pressure of the moist gas is .... $\times 10^{-1}$ atm. (Nearest integer)

(Given : The vapour pressure of water at 27°C is 0.4 atm)

4. The cell potential for $Zn|Zn^{2+}(aq)||Sn^{x+}|Sn$ is 0.801 V at 298 K. The reaction quotient for the above reaction is 10^{-2}. The number of electrons involved in the given electrochemical cell reaction is. . . . . .

(Given $E^0_{Zn^{2+}|Zn} = -0.763V$,

$E^0_{Sn^{x+}|Sn} = +0.008V$ and

$\frac{2.303RT}{F} = 0.06V$)

5. The half life for the decomposition of gaseous compound A is 240 s when the gaseous pressure was 500 Torr initially. When the pressure was 250 Torr, the half life was found to be 4.0 min. The order of the reaction is……. (Nearest integer)

6. Consider the following metal complexes :

$[Co(NH_3)]^{3+}$

$[CoCl(NH_3)_5]^{2+}$

$[Co(CN)_6]^{3-}$

$[Co(NH_3)_5(H_2O)]^{3+}$

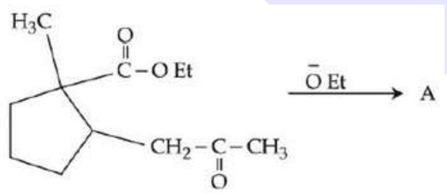
The spin-only magnetic moment value of the complex that absorbs light with shortest wavelength is B.M. (Nearest integer)

7. Among Co^{3+}, Ti^{2+}, V^{2+} and Cr^{2+}ions, one if used as a reagent cannot liberate H_2 from dilute mineral acid solution, its spin-only magnetic moment in gaseous state is ……B.M. (Nearest integer)

8. While estimating the nitrogen present in an organic compound by Kjeldahl's method, the ammonia evolved from 0.25 g of the compound neutralized 2.5 mL of 2 M H_2SO_4. The percentage of nitrogen present in organic compound is ....

9. The number of sp^3 hybridised carbons in an acyclic neutral compound with molecular formula C_4H_5N is :

10. In the given reaction



(Where Et is $-C_2H_5$)

The number of chiral carbon/s in product A is

2 chiral carbons

MATHEMATICS

SECTION-A

1. The total number of functions,

$f : \{1, 2, 3, 4\} \to \{1, 2, 3, 4, 5, 6\}$

such that $f(1) + f(2) = f(3)$, is equal to :

(A) 60 (B) 90

(C) 108 (D) 126

2. If $\alpha, \beta, \gamma, \delta$ are the roots of the equation $x^4 + x^3 + x^2 + x + 1 = 0$, then $\alpha^{2021} + \beta^{2021} + \gamma^{2021} + \delta^{2021}$ is equal to .

(A) –4 (B) –1

(C) 1 (D) 4

3. For $n \in N$, let $S_n = \left\{z \in C : |z - 3 + 2i| = \frac{n}{4}\right\}$

and $T_n = \left\{z \in C : |z - 2 + 3i| = \frac{1}{n}\right\}$.

Then the number of elements in the set $\{n \in N : S_n \cap T_n = \phi\}$ is :

(A) 0 (B) 2

(C) 3 (D) 4

4. The number of $\theta \in (0, 4\pi)$ for which the system of linear equations

$3 (\sin 3\theta)\, x - y + z = 2$

$3 (\cos 2\theta)\, x + 4y + 3z = 3$

$6x + 7y + 7z = 9$

has no solution is :

(A) 6 (B) 7

(C) 8 (D) 9

5. If $\lim_{n\to\infty}\left(\sqrt{n^2 - n - 1} + n\alpha + \beta\right) = 0$ then $8(\alpha + \beta)$ is equal to :

(A) 4 (B) –8

(C) –4 (D) 8

6. If the absolute maximum value of the function $f(x) = (x^2 - 2x + 7)\, e^{(4x^3 - 12x^2 - 180x + 31)}$ in the interval $[-3, 0]$ is $f(\alpha)$, then :

(A) $\alpha = 0$ (B) $\alpha = -3$

(C) $\alpha \in (-1, 0)$ (D) $\alpha \in (-3, -1)$

7. The curve $y(x) = ax^3 + bx^2 + cx + 5$ touches the x-axis at the point P(–2, 0) and cuts the y-axis at the point Q, where y' is equal to 3. Then the local maximum value of y(x) is :

(A) $\frac{27}{4}$ (B) $\frac{29}{4}$

(C) $\frac{37}{4}$ (D) $\frac{9}{2}$

8. The area of the region given by
$A=\{(x, y) : x^2 \le y \le \min\{x + 2, 4 - 3x\}\}$ is :

(A) $\frac{31}{8}$ (B) $\frac{17}{6}$

(C) $\frac{19}{6}$ (D) $\frac{27}{8}$

9. For any real number x, let [x] denote the largest integer less than equal to x. Let f be a real valued function defined on the interval [–10,10] by

$$f(x)=\begin{cases} x-[x], & \text{if}(x) \text{ is odd} \\ 1+[x]-x & \text{if}(x) \text{ is even}\end{cases}$$

Then the value of $\frac{\pi^2}{10}\int_{-10}^{10} f(x)\cos \pi x dx$ is :

(A) 4 (B) 2

(C) 1 (D) 0

10. The slope of the tangent to a curve C : y =y(x) at any point [x, y) on it is $\frac{2e^{2x}-6e^{-x}+9}{2+9e^{-2x}}$. If C passes through the points $\left(0, \frac{1}{2}+\frac{\pi}{2\sqrt{2}}\right)$ and $\left(\alpha, \frac{1}{2}e^{2\alpha}\right)$ then e^{α} is equal to :

(A) $\frac{3+\sqrt{2}}{3-\sqrt{2}}$ (B) $\frac{3}{\sqrt{2}}\left(\frac{3+\sqrt{2}}{3-\sqrt{2}}\right)$

(C) $\frac{1}{\sqrt{2}}\left(\frac{\sqrt{2}+1}{\sqrt{2}-1}\right)$ (D) $\frac{\sqrt{2}+1}{\sqrt{2}-1}$

11. The general solution of the differential equation
$(x - y^2)dx + y(5x + y^2)dy = 0$ is :

(A) $(y^2 + x)^4 = C|(y^2 + 2x)^3|$

(B) $(y^2 + 2x)^4 = C|(y^2 + x)^3|$

(C) $|(y^2 + x)^3| = C(2y^2 + x)^4$

(D) $|(y^2 + 2x)^3| = C(2y^2 + x)^4$

12. A line, with the slope greater than one, passes through the point A(4, 3) and intersects the line $x - y - 2 = 0$ at the point B. If the length of the line segment AB is $\frac{\sqrt{29}}{3}$, then B also lies on the line :

(A) $2x + y = 9$ (B) $3x - 2y = 7$

(C) $x + 2y = 6$ (D) $2x - 3y = 3$

13. Let the locus of the centre (α, β), $\beta > 0$, of the circle which touches the circle $x^2 + (y - 1)^2 = 1$ externally and also touches the x-axis be L. Then the area bounded by L and the line y = 4 is :

(A) $\frac{32\sqrt{2}}{3}$ (B) $\frac{40\sqrt{2}}{3}$

(C) $\frac{64}{3}$ (D) $\frac{32}{3}$

14. Let P be the plane containing the straight line $\frac{x-3}{9}=\frac{y+4}{-1}=\frac{z-7}{-5}$ and perpendicular to the plane containing the straight lines $\frac{x}{2}=\frac{y}{3}=\frac{z}{5}$ and $\frac{x}{3}=\frac{y}{7}=\frac{z}{8}$. If d is the distance of P from the point (2, –5, 11), then d^2 is equal to :

(A) $\frac{147}{2}$ (B) 96 (C) $\frac{32}{3}$ (D) 54

15. Let ABC be a triangle such that $\overrightarrow{BC}=\vec{a}$, $\overrightarrow{CA}=\vec{b}$, $\overrightarrow{AB}=\vec{c}$, $|\vec{a}|=6\sqrt{2}$, $|\vec{b}|=2\sqrt{3}$ and $\vec{b}\cdot\vec{c}=12$ Consider the statements :

(S1) : $|(\vec{a}\times\vec{b})+(\vec{c}\times\vec{b})|-|\vec{c}|=6(2\sqrt{2}-1)$

(S2) : $\angle ABC=\cos^{-1}\left(\sqrt{\frac{2}{3}}\right)$. Then

(A) both (S1) and (S2) are true

(B) only (S1) is true

(C) only (S2) is true

(D) both (S1) and (S2) are false

16. If the sum and the product of mean and variance of a binomial distribution are 24 and 128 respectively, then the probability of one or two successes is :

(A) $\frac{33}{2^{32}}$ (B) $\frac{33}{2^{29}}$

(C) $\frac{33}{2^{28}}$ (D) $\frac{33}{2^{27}}$

17. If the numbers appeared on the two throws of a fair six faced die are α and β, then the probability that $x^2 + \alpha x + \beta > 0$, for all $x \in R$, is :

(A) $\frac{17}{36}$ (B) $\frac{4}{9}$

(C) $\frac{1}{2}$ (D) $\frac{19}{36}$

18. The number of solutions of $|\cos x| = \sin x$, such that $-4\pi \le x \le 4\pi$ is :

(A) 4 (B) 6 (C) 8 (D) 12

19. A tower PQ stands on a horizontal ground with base Q on the ground. The point R divides the tower in two parts such that QR = 15 m. If from a point A on the ground the angle of elevation of R is 60° and the part PR of the tower subtends an angle of 15° at A, then the height of the tower is :

(A) $5(2\sqrt{3}+3)$ m (B) $5(\sqrt{3}+3)$ m

(C) $10(\sqrt{3}+1)$ m (D) $10(2\sqrt{3}+1)$ m

20. Which of the following statements is a tautology ?

(A) $((\sim p) \vee q) \Rightarrow p$ (B) $p \Rightarrow ((\sim p) \vee q)$

(C) $((\sim p) \vee q) \Rightarrow q$ (D) $q \Rightarrow ((\sim p) \vee q)$

SECTION-B

1. Let $A = \begin{bmatrix} 2 & -1 & -1 \\ 1 & 0 & -1 \\ 1 & -1 & 0 \end{bmatrix}$ and $B = A - I$. If $\omega = \frac{\sqrt{3}i - 1}{2}$, then the number of elements in the set $\{n \in \{1, 2, \ldots, 100\} : A^n + (\omega B)^n = A + B\}$ is equal to _______.

2. The letters of the word 'MANKIND' are written in all possible orders and arranged in serial order as in an English dictionary. Then the serial number of the word 'MANKIND' is _______.

3. If the maximum value of the term independent of t in the expansion of $\left(t^2 x^{\frac{1}{5}} + \frac{(1-x)^{\frac{1}{10}}}{t}\right)^{15}$, $x \ge 0$, is K, then 8K is equal to _______.

4. Let a, b be two non-zero real numbers. If p and r are the roots of the equation $x^2 - 8ax + 2a = 0$ and q and s are the roots of the equation $x^2 + 12bx + 6b = 0$, such that $\frac{1}{p}, \frac{1}{q}, \frac{1}{r}, \frac{1}{s}$ are in A.P., then $a^{-1} - b^{-1}$ is equal to _______.

5. Let $a_1 = b_1 = 1$, $a_n = a_{n-1} + 2$ and $b_n = a_n + b_{n-1}$ for every natural number $n \ge 2$. Then $\sum_{n=1}^{15} a_n \cdot b_n$ is equal to _______.

6. Let

$$f(x) = \begin{cases} |4x^2 - 8x + 5|, & \text{if } 8x^2 - 6x + 1 \ge 0 \\ [4x^2 - 8x + 5], & \text{if } 8x^2 - 6x + 1 < 0 \end{cases},$$

where $[\alpha]$ denotes the greatest integer less than or equal to α. Then the number of points in R where f is not differentiable is _______.

7. If $\lim_{n\to\infty} \frac{(n+1)^{k-1}}{n^{k+1}} [(nk + 1) + (nk + 2) + \ldots + (nk + n)] = 33.$

$\lim_{n\to\infty} \frac{1}{n^{k+1}} \cdot [1^k + 2^k + 3^k + \ldots + n^k]$, then the integral value of k is equal to _______.

8. Let the equation of two diameters of a circle $x^2 + y^2 - 2x + 2fy + 1 = 0$ be $2px - y = 1$ and $2x + py = 4p$. Then the slope $m \in (0, \infty)$ of the tangent to the hyperbola $3x^2 - y^2 = 3$ passing through the centre of the circle is equal to _______.

9. The sum of diameters of the circles that touch (i) the parabola $75x^2 = 64(5y - 3)$ at the point $\left(\frac{8}{5}, \frac{6}{5}\right)$ and (ii) the y-axis, is equal to _______.

10. The line of shortest distance between the lines $\frac{x-2}{0} = \frac{y-1}{1} = \frac{z}{1}$ and $\frac{x-3}{2} = \frac{y-5}{2} = \frac{z-1}{1}$ makes an angle of $\cos^{-1}\left(\sqrt{\frac{2}{27}}\right)$ with the plane P : $ax - y - z = 0$, $(a > 0)$. If the image of the point (1, 1, –5) in the plane P is (α, β, γ), then $\alpha + \beta - \gamma$ is equal to ______.

SET # 02

PHYSICS

SECTION-A

1. In AM modulation, a signal is modulated on a carrier wave such that maximum and minimum amplitude are found to be 6V and 2V respectively. The modulation index is

(A) 100% (B) 80%

(C) 60% (D) 50%

2. The electric current in a circular coil of 2 turns produces a magnetic induction B_1 at its centre. The coil is unwound and is rewound into a circular coil of 5 turns and the same current produces a magnetic induction B_2 at its centre. The ratio of $\frac{B_2}{B_1}$ is :

(A) $\frac{5}{2}$ (B) $\frac{25}{4}$

(C) $\frac{5}{4}$ (D) $\frac{25}{2}$

3. A drop of liquid of density ρ is floating half immersed in a liquid of density σ and surface tension 7.5×10^{-4} Ncm^{-1}. The radius of drop in cm will be : (Take : $g = 10\ m/s^2$)

(A) $\frac{15}{\sqrt{2\rho-\sigma}}$ (B) $\frac{15}{\sqrt{\rho-\sigma}}$

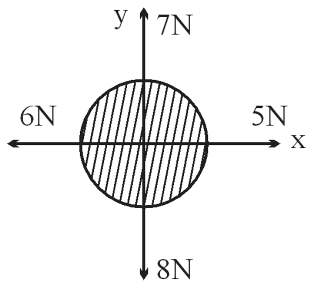
(C) $\frac{3}{2\sqrt{\rho-\sigma}}$ (D) $\frac{3}{20\sqrt{2\rho-\sigma}}$

4. Two billiard balls of mass 0.05 kg each moving in opposite directions with 10 ms^{-1} collide and rebound with the same speed. If the time duration of contact is t = 0.005 s, then what is the force exerted on the ball due to each other?

(A) 100 N (B) 200 N

(C) 300 N (D) 400 N

5. For a free body diagram shown in the figure, the four forces are applied in the 'x' and 'y' directions. What additional force must be applied and at what angle with positive x-axis so that the net acceleration of body is zero?



(A) $\sqrt{2}$ N, 45° (B) $\sqrt{2}$ N, 135°

(C) $\frac{2}{\sqrt{3}}$ N, 30° (D) 2N, 45°

6. Capacitance of an isolated conducting sphere of radius R_1 becomes n times when it is enclosed by a concentric conducting sphere of radius R_2 connected to earth. The ratio of their radii $\left(\frac{R_2}{R_1}\right)$ is:

(A) $\frac{n}{n-1}$ (B) $\frac{2n}{2n+1}$

(C) $\frac{n+1}{n}$ (D) $\frac{2n+1}{n}$

7. The ratio of wavelengths of proton and deuteron accelerated by potential V_p and V_d is $1:\sqrt{2}$. Then, the ratio of V_p to V_d will be

(A) 1 : 1 (B) $\sqrt{2}:1$

(C) 2 : 1 (D) 4 : 1

8. For an object placed at a distance 2.4 m from a lens, a sharp focused image is observed on a screen placed at a distance 12 cm from the lens. A glass plate of refractive index 1.5 and thickness 1 cm is introduced between lens and screen such that the glass plate plane faces parallel to the screen. By what distance should the object be shifted so that a sharp focused image is observed again on the screen?

(A) 0.8 m (B) 3.2 m

(C) 1.2 m (D) 5.6 m

9. Light wave travelling in air along x-direction is given by $E_y = 540 \sin \pi \times 10^4(x - ct)\ Vm^{-1}$. Then, the peak value of magnetic field of wave will be (Given $c = 3 \times 10^8\ ms^{-1}$)

(A) 18×10^{-7} T (B) 54×10^{-7} T
(C) 54×10^{-8} T (D) 18×10^{-8} T

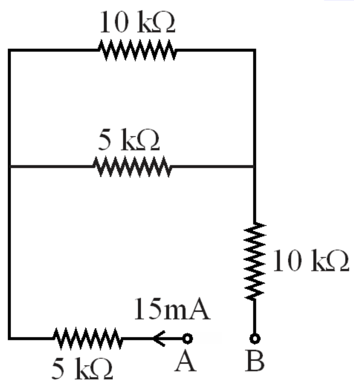
10. When you walk through a metal detector carrying a metal object in your pocket, it raises an alarm. This phenomenon works on

(A) Electromagnetic induction
(B) Resonance in ac circuits
(C) Mutual induction in ac circuits
(D) interference of electromagnetic waves

11. An electron with energy 0.1 keV moves at right angle to the earth's magnetic field of $1 \times 10^{-4}\ Wbm^{-2}$. The frequency of revolution of the electron will be
(Take mass of electron $= 9.0 \times 10^{-31}$ kg)

(A) 1.6×10^5 Hz
(B) 5.6×10^5 Hz
(C) 2.8×10^6 Hz
(D) 1.8×10^6 Hz

12. A current of 15 mA flows in the circuit as shown in figure. The value of potential difference between the points A and B will be



(A) 50 V (B) 75 V
(C) 150 V (D) 275 V

13. The length of a seconds pendulum at a height h = 2R from earth surface will be :
(Given : R = Radius of earth and acceleration due to gravity at the surface of earth $g = \pi^2 ms^{-2}$)

(A) $\frac{2}{9}$m (B) $\frac{4}{9}$m
(C) $\frac{8}{9}$m (D) $\frac{1}{9}$m

14. Sound travels in a mixture of two moles of helium and n moles of hydrogen. If rms speed of gas molecules in the mixture is $\sqrt{2}$ times the speed of sound, then the value of n will be

(A) 1 (B) 2
(C) 3 (D) 4

15. Let η_1 is the efficiency of an engine at $T_1 = 447°C$ and $T_2 = 147°C$ while η_2 is the efficiency at $T_1 = 947°C$ and $T_2 = 47°C$. The ratio $\frac{\eta_1}{\eta_2}$ will be :

(A) 0.41 (B) 0.56
(C) 0.73 (D) 0.70

16. An object is taken to a height above the surface of earth at a distance $\frac{5}{4}R$ from the centre of the earth. Where radius of earth, R = 6400 km. The percentage decrease in the weight of the object will be

(A) 36% (B) 50%
(C) 64% (D) 25%

17. A bag of sand of mass 9.8 kg is suspended by a rope. A bullet of 200 g travelling with speed $10\ ms^{-1}$ gets embedded in it, then loss of kinetic energy will be

(A) 4.9 J (B) 9.8 J
(C) 14.7 J (D) 19.6 J

18. A ball is projected from the ground with a speed $15\ ms^{-1}$ at an angle θ with horizontal so that its range and maximum height are equal, then'tan θ' will be equal to

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$
(C) 2 (D) 4

19. The maximum error in the measurement of resistance, current and time for which current flows in an electrical circuit are 1%, 2% and 3% respectively. The maximum percentage error in the detection of the dissipated heat will be:

(A) 2 (B) 4
(C) 6 (D) 8

20. Hydrogen atom from excited state comes to the ground by emitting a photon of wavelength λ. The value of principal quantum number 'n' of the excited state will be :
(R : Rydberg constant)

(A) $\sqrt{\frac{\lambda R}{\lambda - 1}}$ (B) $\sqrt{\frac{\lambda R}{\lambda R - 1}}$

(C) $\sqrt{\frac{\lambda}{\lambda R - 1}}$ (D) $\sqrt{\frac{\lambda R^2}{\lambda R - 1}}$

SECTION-B

1. A particle is moving in a straight line such that its velocity is increasing at 5 ms^{-1} per meter. The acceleration of the particle is _____ ms^{-2} at a point where its velocity is 20 ms^{-1}.

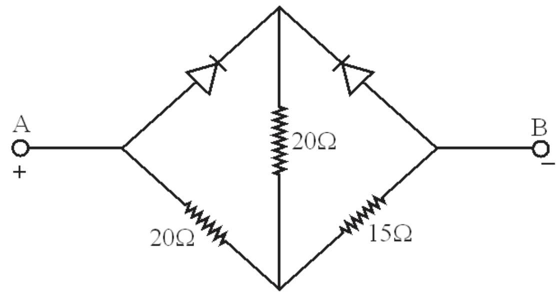
2. Three identical spheres each of mass M are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 3 m each. Taking point of intersection of mutually perpendicular sides as origin, the magnitude of position vector of centre of mass of the system will be $\sqrt{x}$ m. The value of x is

3. A block of ice of mass 120 g at temperature 0°C is put in 300 gm of water at 25°C. The xg of ice melts as the temperature of the water reaches 0°C. The value of x is
[Use: Specific heat capacity of water = 4200 $Jkg^{-1}K^{-1}$, Latent heat of ice = 3.5×10^5 Jkg^{-1}]

4. $\frac{x}{x+4}$ is the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its
(i) third permitted energy level to the second level and
(ii) the highest permitted energy level to the second permitted level.
The value of x will be

5. In a potentiometer arrangement, a cell of emf 1.20 V gives a balance point at 36 cm length of wire. This cell is now replaced by another cell of emf 1.80 V. The difference in balancing length of potentiometer wire in above conditions will be ________ cm.

6. Two ideal diodes are connected in the network as shown in figure. The equivalent resistance between A and B is ______Ω.



7. Two waves executing simple harmonic motion travelling in the same direction with same amplitude and frequency are superimposed. The resultant amplitude is equal to the $\sqrt{3}$ times of amplitude of individual motions. The phase difference between the two motions is _____ (degree)

8. Two parallel plate capacitors of capacity C and 3C are connected in parallel combination and charged to a potential difference 18V. The battery is then disconnected and the space between the plates of the capacitor of capacity C is completely filled with a material of dielectric constant 9. The final potential difference across the combination of capacitors will be _______ V

9. A convex lens of focal length 20 cm is placed in front of convex mirror with principal axis coinciding each other. The distance between the lens and mirror is 10 cm. A point object is placed on principal axis at a distance of 60 cm from the convex lens. The image formed by combination coincides the object itself. The focal length of the convex mirror is _____ cm.

10. Magnetic flux (in weber) in a closed circuit of resistance 20 Ω varies with time t(s) as $\phi = 8t^2 - 9t + 5$. The magnitude of the induced current at t = 0.25 s will be ______ mA

CHEMISTRY
SECTION-A

1. Match **List I** with **List II** :

List-I (molecule)	List-II (hybridization; shape)
A. XeO_3	I. sp^3d ; linear
B. XeF_2	II. sp^3; pyramidal
C. $XeOF_4$	III. sp^3d^3; distorted octahedral
D. XeF_6	IV. sp^3d^2 ;square pyramidal

Choose the correct answer from the options given below:

(A) A-II, B-I, C-IV, D-III
(B) A-II, B-IV, C-III, D-I
(C) A-IV, B-II, C-III, D-I
(D) A-IV, B-II, C-I, D-III

2. Two solutions A and B are prepared by dissolving 1 g of non-volatile solutes X and Y. respectively in 1 kg of water. The ratio of depression in freezing points for A and B is found to be 1 : 4. The ratio of molar masses of X and Y is :

(A) 1 : 4 (B) 1 : 0.25
(C) 1 : 0.20 (D) 1 : 5

3. Ka_1, Ka_2 and Ka_3 are the respective ionization constants for the following reactions (a), (b) and (c).

(a) $H_2C_2O_4 \rightleftharpoons H^+ + HC_2O_4^-$

(b) $HC_2O_4^- \rightleftharpoons H^+ + HC_2O_4^{2-}$

(c) $H_2C_2O_4 \rightleftharpoons 2H^+ + C_2O_4^{2-}$

The relationship between K_{a_1}, K_{a_2} and K_{a_3} is given as

(A) $K_{a_3} = K_{a_1} + K_{a_2}$ (B) $K_{a_3} = K_{a_1} - K_{a_2}$
(C) $K_{a_3} = K_{a_1} / K_{a_2}$ (D) $K_{a_3} = K_{a_1} \times K_{a_2}$

4. The molar conductivity of a conductivity cell filled with 10 moles of 20 mL NaCl solution is Λ_{m1} and that of 20 moles another identical cell heaving 80 mL NaCl solution is Λ_{m2}, The conductivities exhibited by these two cells are same. The relationship between Λ_{m2} and Λ_{m1} is

(A) $\Lambda_{m2} = 2\Lambda_{m1}$ (B) $\Lambda_{m2} = \Lambda_{m1}/2$
(C) $\Lambda_{m2} = \Lambda_{m1}$ (D) $\Lambda_{m2} = 4\Lambda_{m1}$

5. For micelle formation, which of the following statements are correct?

(A) Micelle formation is an exothermic process.
(B) Micelle formation is an endothermic process.
(C) The entropy change is positive.
(D) The entropy change is negative.

(A) A and D only (B) A and C only
(C) B and C only (D) B and D only

6. The first ionization enthalpies of Be, B, N and O follow the order

(A) O < N < B < Be (B) Be < B < N < O
(C) B < Be < N < O (D) B < Be < O < N

7. Given below are two statements.

Statement I : Pig iron is obtained by heating cast iron with scrap iron.

Statement II: Pig iron has a relatively lower carbon content than that of cast iron. In the light of the above statements, choose the correct answer from the options given below.

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are not correct.
(C) Statement I is correct but Statement II is not correct
(D) Statement I is not correct but Statement II is correct.

8. High purity (>99.95%) dihydrogen is obtained by

(A) reaction of zinc with aqueous alkali.
(B) electrolysis of acidified water using platinum electrodes.
(C) electrolysis of warm aqueous barium hydroxide solution between nickel electrodes.
(D) reaction of zinc with dilute acid.

9. The correct order of density is

(A) Be > Mg > Ca > Sr
(B) Sr > Ca > Mg > Be
(C) Sr > Be > Mg > Ca
(D) Be > Sr > Mg > Ca

10. The total number of acidic oxides from the following list is : NO, N_2O, B_2O_3, N_2O_5, CO, SO_3, P_4O_{10}

(A) 3 (B) 4

(C) 5 (D) 6

11. The correct order of energy of absorption for the following metal complexes is

A: $[Ni(en)_3]^{2+}$, B: $[Ni(NH_3)_6]^{2+}$,

C: $[Ni(H_2O)_6]^{2+}$

(A) C < B < A (B) B < C < A

(C) C < A < B (D) A < C < B

12. Match List I with List II.

List–I		List–II	
A.	Sulphate	I.	Pesticide
B.	Fluoride	II.	Bending of bones
C.	Nicotine	III.	Laxative effect
D.	Sodium arsinite	IV.	Herbicide

Choose the correct answer from the options given below:

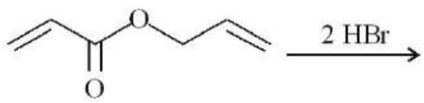
(A) A-II, B-III. C-IV, D-I

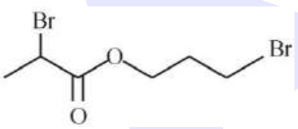
(B) A-IV, B-III, C-II, D-I

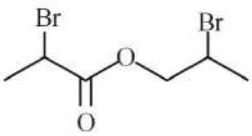
(C) A-III, B-II, C-I, D-IV

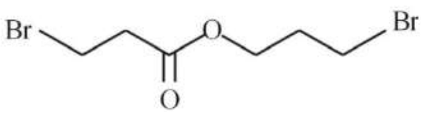
(D) A-III, B-II, C-IV, D-I

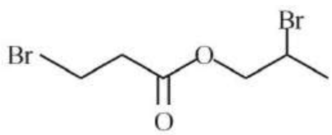
13. Major product of the following reaction is



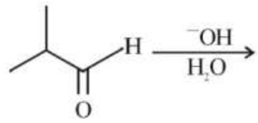
(A) 

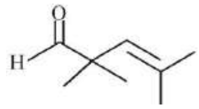
(B) 

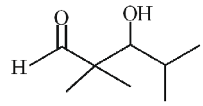
(C) 

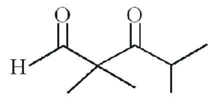
(D) 

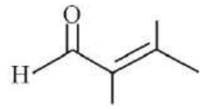
14. What is the major product of the following reaction?



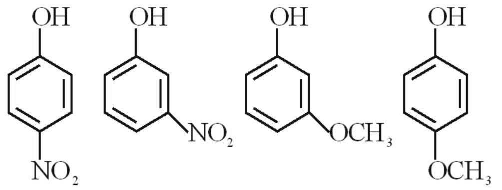
(A) 

(B) 

(C) 

(D) 

15. Arrange the following in decreasing acidic strength.



(A) (B) (C) (D)

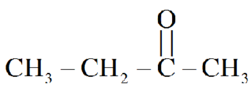
(A) A > B > C > D (B) B > A > C > D

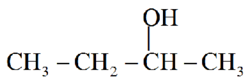
(C) D > C > A > B (D) D > C > B > A

16. $CH_3-CH_2-CN \xrightarrow[\text{Ether}]{CH_3MgBr} A \xrightarrow{H_3O^+} B \xrightarrow[\text{HCl}]{\text{Zn-Hg}} C$

The correct structure of C is

(A) $CH_3—CH_2—CH_2—CH_3$

(B) 

(C) 

(D) $CH_3—CH_2—CH = CH_2$

17. Match List I with List II :

List-I Polymer	List-II used for items
A. Nylon 6,6	I. Buckets
B. Low density polythene	II. Non-stick utensils
C. High density polythene	III. Bristles of brushes
D. Teflon	IV. Toys

Choose the correct answer from the options given below:

(A) A–III, B-I, C-IV, D-II

(B) A–III, B-IV, C-I, D-II

(C) A–II, B-I, C-IV, D-III

(D) A–II, B-IV, C-I, D-III

18. Glycosidic linkage between C_1 of α-glucose and C_2 of β-fructose is found in

(A) maltose (B) sucrose
(C) lactose (D) amylose

19. Some drugs bind to a site other than, the active site of an enzyme. This site is known as

(A) non-active site (B) allosteric site
(C) competitive site (D) therapeutic site

20. In base vs. Acid titration, at the end point methyl orange is present as

(A) quinonoid form (B) heterocyclic form
(C) phenolic form (D) benzenoid form

SECTION-B

1. 56.0 L of nitrogen gas is mixed with excess of hydrogen gas and it is found that 20 L of ammonia gas is produced. The volume of unused nitrogen gas is found to be____ L.

2. A sealed flask with a capacity of 2 dm^3 contains 11 g of propane gas. The flask is so weak that it will burst if the pressure becomes 2 MPa. The minimum temperature at which the flask will burst is _______ °C. [Nearest integer]

(Given: R = 8.3 J K^{-1} mol^{-1}. Atomic masses of C and H are 12u and 1u respectively.) (Assume that propane behaves as an ideal gas.)

3. When the excited electron of a H atom from n = 5 drops to the ground state, the maximum number of emission lines observed are _____.

4. While performing a thermodynamics experiment, a student made the following observations,

$HCl + NaOH \rightarrow NaCl + H_2O$

$\Delta H = -57.3$ kJ mol^{-1}

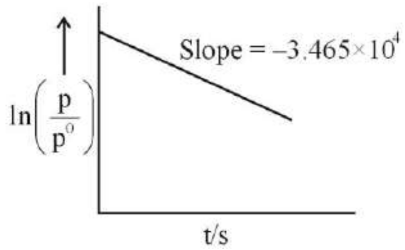
$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

$\Delta H = -55.3$ kJ mol^{-1}.

The enthalpy of ionization of CH_3COOH as calculated by the student is ______ kJ mol^{-1}. (nearest integer)

5. For the decomposition of azomethane.

$CH_3N_2CH_3(g) \rightarrow CH_3CH_3(g)+N_2(g)$ a first order reaction, the variation in partial pressure with time at 600 K is given as



The half life of the reaction is _____ × 10^{-5}s. [Nearest integer]

6. The sum of number of lone pairs of electrons present on the central atoms of XeO_3, $XeOF_4$ and XeF_6 is _____________

7. The spin-only magnetic moment value of M^{3+} ion (in gaseous state) from the pairs Cr^{3+}/Cr^{2+}, Mn^{3+}/Mn^{2}, Fe^{3+}/Fe^{2+} and Co^{3+}/Co^{2+} that has negative standard electrode potential, is B.M. [Nearest integer]

8. A sample of 4.5 mg of an unknown monohydric alcohol, R–OH was added to methylmagnesium iodide. A gas is evolved and is collected and its volume measured to be 3.1 mL. The molecular weight of the unknown alcohol is ____ g/mol. [Nearest integer]

9. The separation of two coloured substances was done by paper chromatography. The distances travelled by solvent front, substance A and substance B from the base line are 3.25 cm. 2.08 cm and 1.05 cm. respectively. The ratio of R_f values of A to B is _______

10. The total number of monobromo derivatives formed by the alkanes with molecular formula C_5H_{12} is (excluding stereo isomers)_____

MATHEMATICS

SECTION-A

1. For $z \in \mathbb{C}$ if the minimum value of $\left(|z-3\sqrt{2}|+|z-p\sqrt{2}i|\right)$ is $5\sqrt{2}$, then a value of p is ______________

(A) 3 (B) $\frac{7}{2}$

(C) 4 (D) $\frac{9}{2}$

2. The number of real values λ, such that the system of linear equations

$2x - 3y + 5z = 9$

$x + 3y - z = -18$

$3x - y + (\lambda^2 - |\lambda|)z = 16$

has no solution, is :-

(A) 0 (B) 1

(C) 2 (D) 4

3. The number of bijective functions $f : \{1, 3, 5, 7, ...99\} \rightarrow \{2, 4, 6, 8, ..., 100\}$, such that $f(3) \geq f(9) \geq f(15) \geq f(21) \geq ..... \geq f(99)$, is ______

(A) ${}^{50}P_{17}$ (B) ${}^{50}P_{33}$

(C) $33! \times 17!$ (D) $\frac{50!}{2}$

4. The remainder when $(11)^{1011} + (1011)^{11}$ is divided by 9 is

(A) 1 (B) 4

(C) 6 (D) 8

5. The sum $\sum_{n=1}^{21} \frac{3}{(4n-1)(4n+3)}$ is equal to

(A) $\frac{7}{87}$ (B) $\frac{7}{29}$

(C) $\frac{14}{87}$ (D) $\frac{21}{29}$

6. $\lim_{x \to \frac{\pi}{4}} \frac{8\sqrt{2}-(\cos x+\sin x)^7}{\sqrt{2}-\sqrt{2}\sin 2x}$ is equal to

(A) 14 (B) 7

(C) $14\sqrt{2}$ (D) $7\sqrt{2}$

7. $\lim_{n\to\infty} \frac{1}{2^n}\left(\frac{1}{\sqrt{1-\frac{1}{2^n}}}+\frac{1}{\sqrt{1-\frac{2}{2^n}}}+\frac{1}{\sqrt{1-\frac{3}{2^n}}}+......+\frac{1}{\sqrt{1-\frac{2^n-1}{2^n}}}\right)$

is equal to

(A) $\frac{1}{2}$ (B) 1

(C) 2 (D) –2

8. If A and B are two events such that $P(A)=\frac{1}{3}, P(B)=\frac{1}{5}$ and $P(A \cup B)=\frac{1}{2}$, then $P(A|B')+P(B|A')$ is equal to

(A) $\frac{3}{4}$ (B) $\frac{5}{8}$

(C) $\frac{5}{4}$ (D) $\frac{7}{8}$

9. Let [t] denote the greatest integer less than or equal to t. Then the value of the integral $\int_{-3}^{101}\left([\sin(\pi x)]+e^{[\cos(2\pi x)]}\right)dx$ is equal to

(A) $\frac{52(1-e)}{e}$ (B) $\frac{52}{e}$

(C) $\frac{52(2+e)}{e}$ (D) $\frac{104}{e}$

10. Let the point P (α, β) be at a unit distance from each of the two lines $L_1 : 3x - 4y + 12 = 0$, and $L_2 : 8x + 6y + 11 = 0$. If P lies below L_1 and above L_2, then $100(\alpha + \beta)$ is equal to

(A) –14 (B) 42

(C) –22 (D) 14

11. Let a smooth curve y = f(x) be such that the slope of the tangent at any point (x, y) on it is directly proportional to $\left(\frac{-y}{x}\right)$. If the curve passes through the point (1, 2) and (8, 1), then $\left|y\left(\frac{1}{8}\right)\right|$ is equal to

(A) $2\log_e 2$ (B) 4

(C) 1 (D) $4\log_e 2$

12. If the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ meets the line $\frac{x}{7}+\frac{y}{2\sqrt{6}}=1$ on the x-axis and the line $\frac{x}{7}-\frac{y}{2\sqrt{6}}=1$ on the y-axis, then the eccentricity of the ellipse is

(A) $\frac{5}{7}$ (B) $\frac{2\sqrt{6}}{7}$

(C) $\frac{3}{7}$ (D) $\frac{2\sqrt{5}}{7}$

13. The tangents at the point A(1, 3) and B(1, –1) on the parabola $y^2 - 2x - 2y = 1$ meet at the point P. Then the area (in unit^2) of the triangle PAB is :-

(A) 4 (B) 6

(C) 7 (D) 8

14. Let the foci of the ellipse $\frac{x^2}{16}+\frac{y^2}{7}=1$ and the hyperbola $\frac{x^2}{144}-\frac{y^2}{\alpha}=\frac{1}{25}$ coincide. Then the length of the latus rectum of the hyperbola is:-

(A) $\frac{32}{9}$ (B) $\frac{18}{5}$

(C) $\frac{27}{4}$ (D) $\frac{27}{10}$

15. A plane E is perpendicular to the two planes $2x - 2y + z = 0$ and $x - y + 2z = 4$, and passes through the point P(1, –1, 1). If the distance of the plane E from the point Q(a, a, 2) is $3\sqrt{2}$, then $(PQ)^2$ is equal to

(A) 9 (B) 12

(C) 21 (D) 33

16. The shortest distance between the lines $\frac{x+7}{-6}=\frac{y-6}{7}=z$ and $\frac{7-x}{2}=y-2=z-6$ is

(A) $2\sqrt{29}$ (B) 1

(C) $\sqrt{\frac{37}{29}}$ (D) $\frac{\sqrt{29}}{2}$

17. Let $\vec{a}=\hat{i}-\hat{j}+2\hat{k}$ and $\vec{b}$ be a vector such that $\vec{a}\times\vec{b}=2\hat{i}-\hat{k}$ and $\vec{a}.\vec{b}=3$. Then the projection of $\vec{b}$ on the vector $\vec{a}-\vec{b}$ is :-

(A) $\frac{2}{\sqrt{21}}$ (B) $2\sqrt{\frac{3}{7}}$

(C) $\frac{2}{3}\sqrt{\frac{7}{3}}$ (D) $\frac{2}{3}$

18. If the mean deviation about median for the number 3, 5, 7, 2k, 12, 16, 21, 24 arranged in the ascending order, is 6 then the median is

(A) 11.5 (B) 10.5

(C) 12 (D) 11

19. $2\sin\left(\frac{\pi}{22}\right)\sin\left(\frac{3\pi}{22}\right)\sin\left(\frac{5\pi}{22}\right)\sin\left(\frac{7\pi}{22}\right)\sin\left(\frac{9\pi}{22}\right)$ is equal to

(A) $\frac{3}{16}$ (B) $\frac{1}{16}$

(C) $\frac{1}{32}$ (D) $\frac{9}{32}$

20. Consider the following statements :

P : Ramu is intelligent
Q : Ramu is rich
R : Ramu is not honest

The negation of the statement "Ramu is intelligent and honest if and only if Ramu is not rich" can be expressed as :

(A) $((P \wedge (\sim R)) \wedge Q) \wedge ((\sim Q) \wedge ((\sim P) \vee R))$

(B) $((P \wedge R) \wedge Q) \vee ((\sim Q) \wedge ((\sim P) \vee (\sim R)))$

(C) $((P \wedge R) \wedge Q) \wedge ((\sim Q) \wedge ((\sim P) \vee (\sim R)))$

(D) $((P \wedge (\sim R)) \wedge Q) \vee ((\sim Q) \wedge ((\sim P) \vee R))$

SECTION-B

1. Let A : {1, 2, 3, 4, 5, 6, 7}. Define B = {T $\subseteq$ A : either $1 \not\subset T$ or $2 \in T$} and C = T $\subseteq$ A : T the sum of all the elements of T is a prime number}. Then the number of elements in the set $B \cup C$ is ______________

2. Let f(x) be a quadratic polynomial with leading coefficient 1 such that $f(0) = p,\ p \neq 0$ and $f(1)=\frac{1}{3}$. If the equation f(x) = 0 and fofofof(x) = 0 have a common real root, then f(–3) is equal to......................

3. Let $A=\begin{bmatrix}1 & a & a\\ 0 & 1 & b\\ 0 & 0 & 1\end{bmatrix}, a,b\in\mathbb{R}$. If for some $n\in N$, $A^n=\begin{bmatrix}1 & 48 & 2160\\ 0 & 1 & 96\\ 0 & 0 & 1\end{bmatrix}$ then n + a + b is equal to ____________

4. The sum of the maximum and minimum values of the function $f(x) = |5x - 7| + [x^2 + 2x]$ is the interval $\left[\frac{5}{4},2\right]$, where [t] is the greatest integer $\leq t$ is _____________

5. Let y = y(x) be the solution of the differential equation $\frac{dy}{dx}=\frac{4y^3+2yx^2}{3xy^2+x^3}, y(1)=1$. If for some $n\in N, y(2)\in[n-1,n)$, then n is equal to ________

6. Let f be a twice differentiable function on R. If $f'(0)=4$ and

$$f(x)+\int_0^x (x-t)f'(t)dt=(e^{2x}+e^{-2x})\cos 2x+\frac{2}{a}x,$$

then $(2a + 1)^5 a^2$ is equal to _________

7. Let $a_n=\int_{-1}^{n}\left(1+\frac{x}{2}+\frac{x^2}{2}+\frac{x^3}{3}+.......+\frac{x^{n-1}}{n}\right)dx$ for $n\in N$. Then the sum of all the elements of the set $\{n\in N : a_n\in(2,30)\}$ is ______

8. If the circles $x^2 + y^2 + 6x + 8y + 16 = 0$ and $x^2+y^2+2(3-\sqrt{3})x+x+2(4-\sqrt{6})y$ $=k+6\sqrt{3}+8\sqrt{6}, k>0$ touch internally at the point P(α, β), then $(\alpha+\sqrt{3})^2+(\beta+\sqrt{6})^2$ is equal to ___________

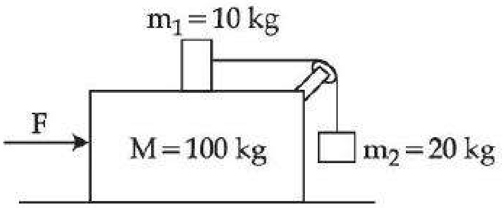
9. Let the area enclosed by the x-axis, and the tangent and normal drawn to the curve $4x^3 - 3xy^2 + 6x^2 - 5xy - 8y^2 + 9x + 14 = 0$ at the point (–2, 3) be A. Then 8A is equal to _____

10. Let $x=\sin(2\tan^{-1}\alpha)$ and $y=\sin\left(\frac{1}{2}\tan^{-1}\frac{4}{3}\right)$. If $S=\{\alpha\in R : y^2=1-x\}$, then $\sum_{\alpha\in S}16\alpha^3$ is equal to ________

SET # 03

SECTION-A

1. Three masses M = 100 kg, m_1 = 10 kg and m_2=20 kg are arranged in a system as shown in figure. All the surfaces are frictionless and strings are inextensible and weightless. The pulleys are also weightless and frictionless. A force F is applied on the system so that the mass m_2 moves upward with an acceleration of 2 ms^{-2}. The value of F is :
(Take g = 10 ms^{-2})



(A) 3360 N (B) 3380 N
(C) 3120 N (D) 3240 N

2. A radio can tune to any station in 6 MHz to 10 MHz band. The value of corresponding wavelength bandwidth will be :
(A) 4 m (B) 20 m
(C) 30 m (D) 50 m

3. The disintegration rate of a certain radioactive sample at any instant is 4250 disintegrations per minute. 10 minutes later, the rate becomes 2250 disintegrations per minute. The approximate decay constant is :
(Take $\log_{10}1.88 = 0.274$)
(A) 0.02 min^{-1} (B) 2.7 min^{-1}
(C) 0.063 min^{-1} (D) 6.3 min^{-1}

4. A parallel beam of light of wavelength 900 nm and intensity 100 Wm^{-2} is incident on a surface perpendicular to the beam. Tire number of photons crossing 1 cm^2 area perpendicular to the beam in one second is :
(A) 3×10^{16} (B) 4.5×10^{16}
(C) 4.5×10^{17} (D) 4.5×10^{20}

5. In young's double slit experiment, the fringe width is 12mm. If the entire arrangement is placed in water of refractive index $\frac{4}{3}$, then the fringe width becomes (in mm)
(A) 16 (B) 9
(C) 48 (D) 12

6. The magnetic field of a plane electromagnetic wave is given by

$$\vec{B} = 2\times10^{-8}\sin\left(0.5\times10^{3}x + 1.5\times10^{11}t\right)\hat{j}\,T$$

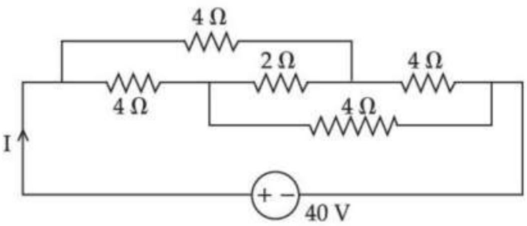
The amplitude of the electric field would be
(A) $6Vm^{-1}$ along x-axis
(B) $3Vm^{-1}$ along z-axis
(C) $6Vm^{-1}$ along z-axis
(D) $2\times10^{-8}Vm^{-1}$ along z-axis

7. In a series LR circuit $X_L = R$ and power factor of the circuit is P_1. When capacitor with capacitance C such that $X_L = X_C$ is put in series, the power factor becomes P_2. The ratio $\frac{P_1}{P_2}$ is
(A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$
(C) $\frac{\sqrt{3}}{\sqrt{2}}$ (D) 2 : 1

8. A charge particle is moving in a uniform magnetic field $\left(2\hat{i}+3\hat{j}\right)T$. If it has an acceleration of $\left(\alpha\hat{i}-4\hat{j}\right)m/s^2$, then the value of α will be
(A) 3 (B) 6
(C) 12 (D) 2

9. B_X and B_Y are the magnetic field at the centre of two coils of two coils X and Y respectively, each carrying equal current. If coil X has 200 turns and 20 cm radius and coil Y has 400 turns and 20 cm radius, the ratio of B_X and B_Y is
(A) 1 : 1 (B) 1 : 2
(C) 2 : 1 (D) 4 : 1

10. The current I in the given circuit will be :



(A) 10A (B) 20 A

(C) 4A (D) 40A

11. The total charge on the system of capacitance $C_1 = 1\mu F,\ C_2 = 2\mu F, C_3 = 4\mu F$ and $C_4 = 3\mu F$ connected in parallel is

(Assume a battery of 20V is connected to the combination)

(A) $200\mu C$ (B) 200C

(C) $10\mu C$ (D) 10C

12. When a particle executes simple Harmonic motion, the nature of graph of velocity as function of displacement will be :

(A) Circular (B) Ellipitical

(C) Sinusoidal (D) Straight line

13. 7 mole of certain monoatomic ideal gas undergoes a temperature increase of 40K at constant pressure. The increase in the internal energy of the gas in this process is (Given R = $8.3\ JK^{-1}mol^{-1}$)

(A) 5810 J (B) 3486 J

(C) 11620J (D) 6972 J

14. A monoatomic gas at pressure P and volume V is suddenly compressed to one eighth of its original volume. The final pressure at constant entropy will be:

(A) P (B) 8P

(C) 32P (D) 64 P

15. A water drop of radius 1cm is broken into 729 equal droplets. If surface tension of water is 75 dyne/cm, then the gain in surface energy upto first decimal place will be :

[Given $\pi = 3.14$]

(A) 8.5×10^{-4} J (B) 8.2×10^{-4} J

(C) 7.5×10^{-4} J (D) 5.3×10^{-4} J

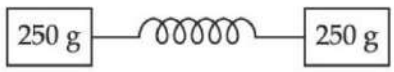
16. The percentage decrease in the weight of a rocket, when taken to a height of 32 km above the surface of earth will, be :

(Radius of earth = 6400km)

(A) 1 % (B) 3%

(C) 4% (D) 0.5%

17. As per the given figure, two blocks each of mass 250g are connected to a spring of spring constant $2Nm^{-1}$. If both are given velocity v in opposite directions, then maximum elongation of the spring is :



(A) $\frac{v}{2\sqrt{2}}$ (B) $\frac{v}{2}$

(C) $\frac{v}{4}$ (D) $\frac{v}{\sqrt{2}}$

18. A monkey of mass 50kg climbs on a rope which can withstand the tension (T) of 350N. If monkey initially climbs down with an acceleration of $4m/s^2$ and then climbs up with an acceleration of $5m/s^2$. Choose the correct option $\left(g = 10m/s^2\right)$

(A) T = 700N while climbing upward

(B) T = 350 N while going downward

(C) Rope will break while climbing upward

(D) Rope will break while going downward

19. Two projectile thrown at 30^0 and 45^0 with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is

(A) $1:\sqrt{2}$ (B) 2 : 1

(C) $\sqrt{2}:1$ (D) $1:2$

20. A screw gauge of pitch 0.5mm is used to measure the diameter of uniform wire of length 6.8cm, the main scale reading is 1.5 mm and circular scale reading is 7. The calculated curved surface area of wire to appropriate significant figures is :

[Screw gauge has 50 divisions on the circular scale]

(A) $6.8cm^2$ (B) $3.4cm^2$

(C) $3.9cm^2$ (D) $2.4cm^2$

SECTION-B

1. If the initial velocity in horizontal direction of a projectile is unit vector $\hat{i}$ and the equation of trajectory is $y = 5x(1-x)$. The y component vector of the initial velocity is _____ $\hat{j}$ (Take $g = 10 m/s^2$)

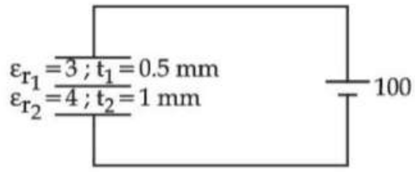
2. A disc of mass 1 kg and radius R is free of rotate about a horizontal axis passing through its centre and perpendicular to the plane of disc. A body of same mass as that of disc is fixed at the highest point of the disc. Now the system is released, when the body comes to the lowest position, its angular speed will be $4\sqrt{\frac{x}{3R}}\ rad\,s^{-1}$ where x = _____ $(g = 10ms^{-2})$

3. In an experiment of determine the Young's modulus of wire of a length exactly 1m, the extension in the length of the wire is measured as 0.4mm with an uncertainty of ± 0.02 mm when a load of 1kg is applied. The diameter of the wire is measured as 0.4mm with an uncertainty of ± 0.01 mm. The error in the measurement of Young's modulus (ΔY) is found to be $x \times 10^{10} Nm^{-2}$. The value of x is _____

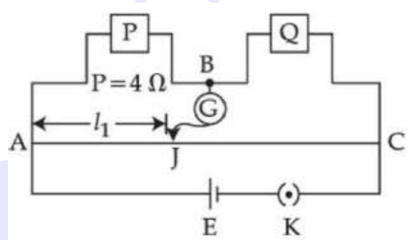
[Take $g = 10m/s^2$]

4. When a car is approaching the observer, the frequency of horn is 100Hz. After passing the observer, it is 50Hz. If the observer moves with the car, the frequency will be $\frac{x}{3}$ Hz where x = ___

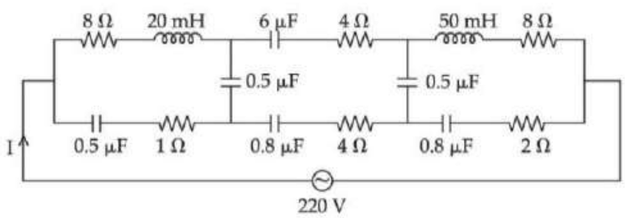
5. A composite parallel plate capacitor is made up of two different dielectric materials with different thickness $(t_1 \text{ and } t_2)$ as shown in figure. The two different dielectric material are separated by a conducting foil F. The voltage of the conducting foil is ____V.



6. Resistance are connected in a meter bridge circuit as shown in the figure. The balancing length l_1 is 40cm. Now an unknown resistance x is connected in series with P and new balancing length is found to be 80cm measured from the same end. Then the value of x will be _____Ω

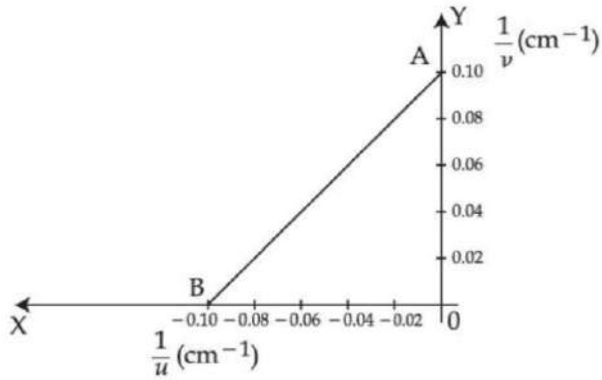


7. The effective current I in the given circuit at very high frequencies will be ____A



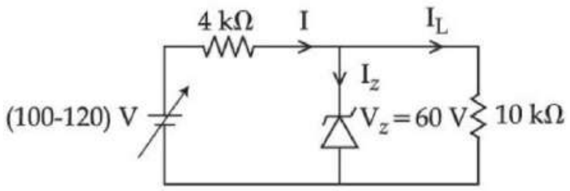
8. The graph between $\frac{1}{u}$ and $\frac{1}{v}$ for a thin convex lens in order to determine its focal length is plotted as shown in the figure. The refractive index of length is 1.5 and its both the surfaces have same radius of curvatures R. The value of R will be ____cm.

(Where u = object distance , v = image distance)



9. In a hydrogen spectrum, λ be the wavelength of first transition line of Lyman series. The wavelength difference will be "$a\lambda$" between the wavelength of 3rd transition line of Paschen series and that of 2nd transition line of Balmer Series where a = ________

10. In the circuit shown below, maximum zener diode current will be ____Ma



CHEMISTRY

SECTION-A

1. Match **List - I** with **List - II**.

List - I (Compound)	**List – II (Shape)**
(A) BrF_5	(I) bent
(B) $[CrF_6]^{3-}$	(II) square pyramidal
(C) O_3	(III) trigonal bipyramidal
(D) PCl_5	(IV) octahedral

Choose the **correct** answer from the options given below :

(A) (A) – (I), (B) - (II), (C) - (III), (D) - (IV)
(B) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
(C) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
(D) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)

2. Match **List - I** with **List - II.**

List –I (Processes/Reactions)	**List – II (Catalyst)**
(A) $2SO_2(g)+O_2(g)\rightarrow 2SO_3(g)$	(I) Fe(s)
(B) $4NH_3(g)+5O_2(g)\rightarrow 4NO(g)+6H_2O(g)$	(II) Pt(s)-Rh(s)
(C) $N_2(g)+3H_2(g)\rightarrow 2NH_3(g)$	(III) V_2O_5
(D) Vegetable oil(l)+$H_2\rightarrow$ Vegetable ghee(s)	(IV) Ni(s)

Choose the correct answer from the options given below :

(A) (A) - (III), (B) - (I), (C) - (II), (D) - (IV)
(B) (A) - (III), (B) - (II), (C) - (I), (D) - (IV)
(C) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
(D) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)

3. Given two statements below :

Statement I : In Cl_2 molecule the covalent radius is double of the atomic radius of chlorine.

Statement II : Radius of anionic species is always greater than their parent atomic radius.

Choose the **most appropriate** answer from options given below :

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

4. Refining using liquation method is the most suitable for metals with :

(A) Low melting point
(B) High boiling point
(C) High electrical conductivity
(D) Less tendency to be soluble in melts than impurities

5. Which of the following can be used to prevent the decomposition of H_2O_2?

(A) Urea
(B) Formaldehyde
(C) Formic acid
(D) Ethanol

6. Reaction of $BeCl_2$ with $LiAlH_4$ gives :

(A) $AlCl_3$ (B) BeH_2
(C) LiH (D) LiCl
(E) $BeAlH_4$

Choose the **correct** answer from options given below :

(A) (A), (D) and (E)
(B) (A) , (B) and (D)
(C) (D) and (E)
(D) (B) , (C) and (D)

7. Borazine, also known as inorganic benzene, can be prepared by the reaction of 3-equivalents of "X" with 6-equivalents of "Y". "X" and "Y", respectively are :

(A) $B(OH)_3$ and NH_3 (B) B_2H_6 and NH_3

(C) B_2H_6 and HN_3 (D) NH_3 and B_2O_3

8. Which of the given reactions is not an example of disproportionation reaction ?

(A) $2H_2O_2 \rightarrow 2H_2O + O_2$

(B) $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

(C) $MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$

(D) $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

9. The dark purple colour of $KMnO_4$ disappears in the titration with oxalic acid in acidic medium.

The overall change in the oxidation number of manganese in the reaction is :

(A) 5 (B) 1

(C) 7 (D) 2

10. $\dot{C}l + CH_4 \rightarrow A + B$

A and B in the above atmospheric reaction step are

(A) C_2H_6 and Cl_2 (B) $\dot{C}HCl_2$ and H_2

(C) $\dot{C}H_3$ and HCl (D) C_2H_6 and HCl

11. Which technique among the following, is most appropriate in separation of a mixture of 100 mg of p-nitrophenol and picric acid ?

(A) Steam distillation

(B) 2-5 ft long column of silica gel

(C) Sublimation

(D) Preparative TLC (Thin Layer Chromatography)

12. The difference in the reaction of phenol with bromine in chloroform and bromine in water medium is due to :

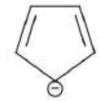
(A) Hyperconjugation in substrate

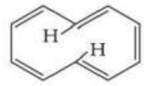
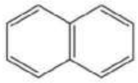
(B) Polarity of solvent

(C) Free radical formation

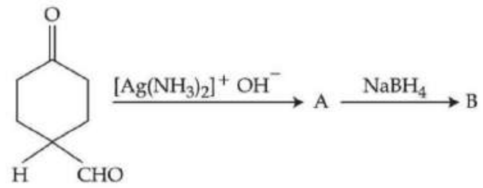
(D) Electromeric effect of the substrate

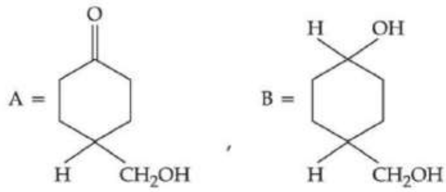
13. Which of the following compounds is **not** aromatic?

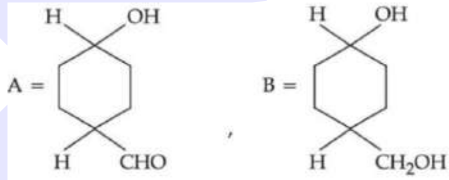
(A)  (B) 

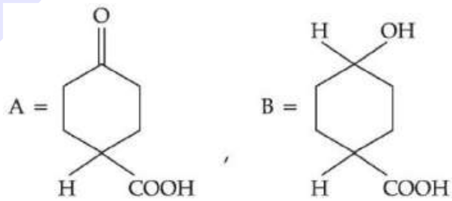
(C)  (D) 

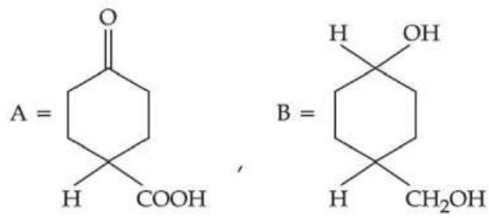
14. The products formed in the following reaction, A and B are



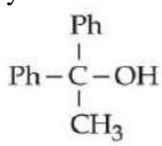
(A) 

(B) 

(C) 

(D) 

15. Which reactant will give the following alcohol on reaction with one mole of phenyl magnesium bromide (PhMgBr) followed by acidic hydrolysis ?



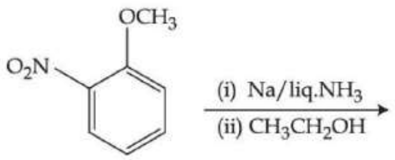
(A) $CH_3 - C \equiv N$

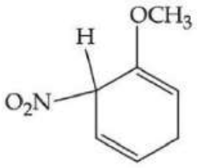
(B) $Ph - C \equiv N$

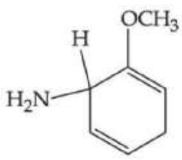
(C) $CH_3 - \overset{O}{\overset{\|}{C}} - O - Ph$

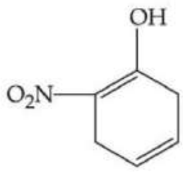
(D) $Ph - \underset{O}{\underset{\|}{C}} - CH_3$

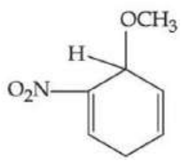
16. The major product of the following reaction is



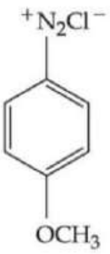
(A) 

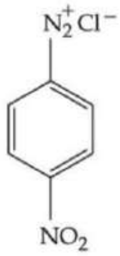
(B) 

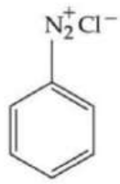
(C) 

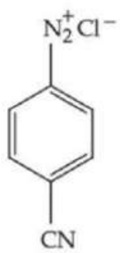
(D) 

17. The correct stability order of the following diazonium salt is

(A) 

(B) 

(C) 

(D) 

(A) (A) > (B) > (C) > (D)

(B) (A) > (C) > (D) > (B)

(C) (C) > (A) > (D) > (B)

(D) (C) > (D) > (B) > (A)

18. Stearic acid and polyethylene glycol react to form which one of the following soap/s detergents ?

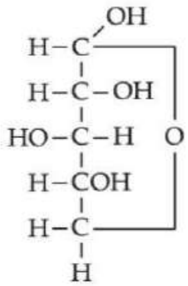
(A) Cationic detergent

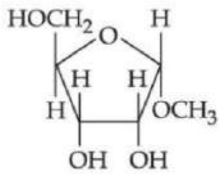
(B) Soap

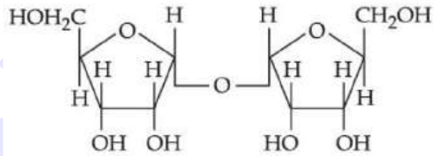
(C) Anionic detergent

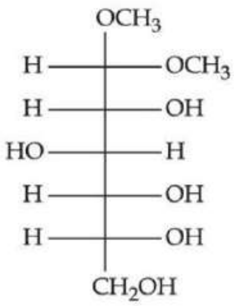
(D) Non-ionic detergent

19. Which of the following is reducing sugar?

(A) 

(B) 

(C) 

(D) 

20. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A) : Experimental reaction of CH_3Cl with aniline and anhydrous $AlCl_3$ does **not** give o and p-methylaniline.

Reason (R) : The — NH_2 group of aniline becomes deactivating because of salt formation with anhydrous $AlCl_3$ and hence yields *m*-methyl aniline as the product.

In the light of the above statements, choose the most appropriate answer from the options given below :

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) (A) is true, but (R) is false.

(D) (A) is false, but (R) is true.

SECTION-B

1. Chlorophyll extracted from the crushed green leaves was dissolved in water to make 2 L solution of Mg of concentration 48 ppm. The number of atoms of Mg in this solution is $x \times 10^{20}$ atoms. The value of x is________. (Nearest Integer)
(Given : Atomic mass of Mg is 24 g mol^{-1}, $N_A = 6.02 \times 10^{23}$ mol^{-1})

2. A mixture of hydrogen and oxygen contains 40% hydrogen by mass when the pressure is 2.2 bar. The partial pressure of hydrogen is bar.
(Nearest Integer)

3. The wavelength of an electron and a neutron will become equal when the velocity of the electron is x times the velocity of neutron. The value of x is__________. (Nearest Integer)
(Mass of electron is 9.1×10^{-31} kg and mass of neutron is 1.6×10^{-27} kg)

4. 2.4 g coal is burnt in a bomb calorimeter in excess of oxygen at 298 K and 1 atm pressure.
The temperature of the calorimeter rises from 298 K to 300 K. The enthalpy change during the combustion of coal is – x kJ mol^{-1}. The value of x is___________. (Nearest Integer)
(Given : Heat capacity of bomb calorimeter 20.0 kJ K^{-1} . Assume coal to be pure carbon)

5. When 800 mL of 0.5 M nitric acid is heated in a beaker, its volume is reduced to half and 11.5 g of nitric acid is evaporated. The molarity of the remaining nitric acid solution is $x \times 10^{-2}$ M. (Nearest Integer)
(Molar mass of nitric acid is 63 g mol^{-1})

6. At 298 K, the equilibrium constant is 2×10^{15} for the reaction :

$$Cu(s) + 2Ag^+(aq) \rightleftharpoons Cu^{2+}(aq) + 2Ag(s)$$

The equilibrium constant for the reaction

$$\frac{1}{2}Cu^{2+}(aq) + Ag(s) \rightleftharpoons \frac{1}{2}Cu(s) + Ag^+(aq)$$

is $x \times 10^{-8}$. The value of x is_______.
(Nearest Integer)

7. The amount of charge in F (Faraday) required to obtain one mole of iron from Fe_3O_4 is _____. (Nearest Integer)

8. For a reaction $A \rightarrow 2B + C$ the half lives are 100 s and 50 s when the concentration of reactant A is 0.5 and 1.0 mol L^{-1} respectively. The order of the reaction is___ _____. (Nearest Integer)

9. The difference between spin only magnetic moment values of $[Co(H_2O)_6]Cl_2$ and $[Cr(H_2O)_6]Cl_3$ is___________.

10. In the presence of sunlight, benzene reacts with Cl_2 to give product, X. The number of hydrogens in X is_________.

MATHEMATICS

SECTION-A

1. Let f: R → R be a continuous function such that
f (3x) – f (x) = x. If f (8) = 7, then f (14) is equal
to :

(A) 4 (B) 10
(C) 11 (D) 16

2. Let O be the origin and A be the point $z_1 = 1 + 2i$. If B is the point z_2, $Re(z_2) < 0$, such that OAB is a right angled isosceles triangle with OB as hypotenuse, then which of the following is NOT true ?

(A) $\arg z_2 = \pi - \tan^{-1} 3$

(B) $\arg (z_1 - 2z_2) = -\tan^{-1} \frac{4}{3}$

(C) $|z_2| = \sqrt{10}$

(D) $|2z_1 - z_2| = 5$

3. If the system of linear equations.
$8x + y + 4z = -2$
$x + y + z = 0$
$\lambda x - 3y = \mu$
has infinitely many solutions, then the distance of the point $\left(\lambda, \mu, -\frac{1}{2}\right)$ from the plane $8x + y + 4z + 2 = 0$ is :

(A) $3\sqrt{5}$ (B) 4

(C) $\frac{26}{9}$ (D) $\frac{10}{3}$

4. Let A be a 2 × 2 matrix with det (A) = –1 and det ((A + I) (Adj (A) + I)) = 4. Then the sum of the diagonal elements of A can be :

(A) –1 (B) 2

(C) 1 (D) $-\sqrt{2}$

5. The odd natural number a, such that the area of the region bounded by y= 1, y = 3, x = 0, $x = y^a$ is $\frac{364}{3}$, equal to :

(A) 3 (B) 5

(C) 7 (D) 9

6. Consider two G.Ps. 2, 2^2, 2^3, ... and 4, 4^2, 4^3,.... of 60 and n terms respectively. If the geometric mean of all the 60 + n terms is $(2)^{\frac{225}{8}}$, then $\sum_{k=1}^{n} k(n-k)$ is equal to :

(A) 560 (B) 1540

(C) 1330 (D) 2600

7. If the function

$$f(x)=\begin{cases}\dfrac{\log_e(1-x+x^2)+\log_e(1+x+x^2)}{\sec x-\cos x}, & x\in\left(\dfrac{-\pi}{2},\dfrac{\pi}{2}\right)-\{0\}\\ k & ,x=0\end{cases}$$

is continuous at x = 0, then k is equal to :

(A) 1 (B) –1

(C) e (D) 0

8. If f(x) = $\begin{cases} x+a, & x\le 0\\ |x-4|, & x>0\end{cases}$ and

g(x) = $\begin{cases} x+1, & x<0\\ (x-4)^2+b, & x\ge 0\end{cases}$

are continuous on R, then

(gof) (2) + (fog) (–2) is equal to :

(A) –10 (B) 10

(C) 8 (D) –8

9. Let f(x) = $\begin{cases} x^3-x^2+10x-7, & x\le 1\\ -2x+\log_2(b^2-4), & x>1\end{cases}$

Then the set of all values of b, for which f(x) has maximum value at x = 1, is :

(A) (–6, –2)

(B) (2, 6)

(C) [–6, –2) ∪ (2, 6]

(D) $[-\sqrt{6}, -2) \cup (2, \sqrt{6}]$

10. If $a = \lim_{n\to\infty}\sum_{k=1}^{n}\frac{2n}{n^2+k^2}$ and

$f(x) = \sqrt{\frac{1-\cos x}{1+\cos x}}, x\in(0,1)$, then :

(A) $2\sqrt{2}f\left(\frac{a}{2}\right)=f'\left(\frac{a}{2}\right)$

(B) $f\left(\frac{a}{2}\right)f'\left(\frac{a}{2}\right)=\sqrt{2}$

(C) $\sqrt{2}f\left(\frac{a}{2}\right)=f'\left(\frac{a}{2}\right)$

(D) $f\left(\frac{a}{2}\right)=\sqrt{2}f'\left(\frac{a}{2}\right)$

11. If $\frac{dy}{dx}$ + 2y tan x = sin x, $0 < x < \frac{\pi}{2}$ and $y\left(\frac{\pi}{3}\right)$ = 0, then the maximum value of y(x) is

(A) $\frac{1}{8}$ (B) $\frac{3}{4}$

(C) $\frac{1}{4}$ (D) $\frac{3}{8}$

12. A point P moves so that the sum of squares of its distances from the points (1, 2) and (–2, 1) is 14. Let f(x, y) = 0 be the locus of P, which intersects the x-axis at the points A, B and the y-axis at the point C, D . Then the area of the quadrilateral ACBD is equal to

(A) $\frac{9}{2}$ (B) $\frac{3\sqrt{17}}{2}$

(C) $\frac{3\sqrt{17}}{4}$ (D) 9

13. Let the tangent drawn to the parabola $y^2 = 24x$ at the point (α, β) is perpendicular to the line 2x +2y = 5. Then the normal to the hyperbola $\frac{x^2}{\alpha^2}-\frac{y^2}{\beta^2}=1$ at the point $(\alpha+4, \beta+4)$ does NOT pass through the point :

(A) (25, 10) (B) (20, 12)

(C) (30, 8) (D) (15, 13)

14. The length of the perpendicular from the point (1, –2, 5) on the line passing through (1, 2, 4) and parallel to the line $x + y - z = 0 = x - 2y + 3z - 5$ is :

(A) $\sqrt{\frac{21}{2}}$ (B) $\sqrt{\frac{9}{2}}$

(C) $\sqrt{\frac{73}{2}}$ (D) 1

15. Let $\vec{a} = \alpha\hat{i} + \hat{j} - \hat{k}$ and $\vec{b} = 2\hat{i} + \hat{j} - \alpha\hat{k}, \alpha > 0$. If the projection of $\vec{a} \times \vec{b}$ on the vector $-\hat{i} + 2\hat{j} - 2\hat{k}$ is 30, then α is equal to

(A) $\frac{15}{2}$ (B) 8

(C) $\frac{13}{2}$ (D) 7

16. The mean and variance of a binomial distribution are α and $\frac{\alpha}{3}$ respectively. If $P(X=1) = \frac{4}{243}$, then P(X = 4 or 5) is equal to :

(A) $\frac{5}{9}$ (B) $\frac{64}{81}$

(C) $\frac{16}{27}$ (D) $\frac{145}{243}$

17. Let E_1, E_2, E_3 be three mutually exclusive events such that $P(E_1) = \frac{2+3p}{6}$, $P(E_2) = \frac{2-p}{8}$ and $P(E_3) = \frac{1-p}{2}$. If the maximum and minimum values of p are p_1 and p_2, then $(p_1 + p_2)$ is equal to :

(A) $\frac{2}{3}$ (B) $\frac{5}{3}$

(C) $\frac{5}{4}$ (D) 1

18. Let $S = \{\theta \in [0, 2\pi] : 8^{2\sin^2\theta} + 8^{2\cos^2\theta} = 16\}$. Then

$$n(S) + \sum_{\theta \in S}\left(\sec\left(\frac{\pi}{4} + 2\theta\right)\operatorname{cosec}\left(\frac{\pi}{4} + 2\theta\right)\right)$$

is equal to :

(A) 0 (B) –2

(C) –4 (D) 12

19. $\tan\left(2\tan^{-1}\frac{1}{5} + \sec^{-1}\frac{\sqrt{5}}{2} + 2\tan^{-1}\frac{1}{8}\right)$ is equal to:

(A) 1 (B) 2

(C) $\frac{1}{4}$ (D) $\frac{5}{4}$

20. The statement $(\sim(p \Leftrightarrow \sim q)) \wedge q$ is :

(A) a tautology

(B) a contradiction

(C) equivalent to $(p \Rightarrow q) \wedge q$

(D) equivalent to $(p \Rightarrow q) \wedge p$

SECTION-B

1. If for some p, q, r $\in$ R, not all have same sign, one of the roots of the equation $(p^2 + q^2)x^2 - 2q(p + r)x + q^2 + r^2 = 0$ is also a root of the equation $x^2 + 2x - 8 = 0$, then $\frac{q^2 + r^2}{p^2}$ is equal to-

2. The number of 5-digit natural numbers, such that the product of their digits is 36, is

3. The series of positive multiples of 3 is divided into sets : {3}, {6, 9,12}, {15, 18, 21, 24, 27},... Then the sum of the elements in the 11^{th} set is equal to__________,

4. The number of distinct real roots of the equation

$$x^5(x^3 - x^2 - x + 1) + x(3x^3 - 4x^2 - 2x + 4) - 1 = 0 \text{ is}$$

5. If the coefficients of x and x^2 in the expansion of $(1 + x)^p(1 - x)^q$, p, q $\le$ 15, are –3 and –5 respectively, then the coefficient of x^3 is equal to______________.

6. If

$$n(2n+1)\int_0^1 (1-x^n)^{2n}dx = 1177\int_0^1 (1-x^n)^{2n+1}dx,$$

then $n \in N$ is equal to _______

7. Let a curve $y = y(x)$ pass through the point (3, 3) and the area of the region under this curve, above the x-axis and between the abscissae 3 and x(>3) be $\left(\frac{y}{x}\right)^3$. If this curve also passes through the point $\left(\alpha, 6\sqrt{10}\right)$ in the first quadrant, then α is equal to ________

8. The equations of the sides AB, BC and CA of a triangle ABC are 2x + y = 0, x + py = 15a and
x – y = 3 respectively. If its orthocentre is (2, a), $-\frac{1}{2} < a < 2$, then p is equal to

9. Let the function f(x) = $2x^2 - \log_e x$, x > 0, be decreasing in (0, a) and increasing in (a, 4). A tangent to the parabola $y^2 = 4ax$ at a point P on it passes through the point (8a, 8a – 1) but does not pass through the point $\left(-\frac{1}{a}, 0\right)$. If the equation of the normal at P is $\frac{x}{\alpha} + \frac{y}{\beta} = 1$, then $\alpha + \beta$ is equal to-

10. Let Q and R be two points on the line $\frac{x+1}{2} = \frac{y+2}{3} = \frac{z-1}{2}$ at a distance $\sqrt{26}$ from the point P(4, 2, 7). Then the square of the area of the triangle PQR is______________.

SET # 04

PHYSICS

SECTION-A

1. Two projectiles are thrown with same initial velocity making an angle of 45° and 30° with the horizontal respectively. The ratio of their respective ranges will be

(A) $1:\sqrt{2}$ (B) $\sqrt{2}:1$

(C) $2:\sqrt{3}$ (D) $\sqrt{3}:2$

2. In a Vernier Calipers. 10 divisions of Vernier scale is equal to the 9 divisions of main scale. When both jaws of Vernier calipers touch each other, the zero of the Vernier scale is shifted to the left of zero of the main scale and 4^{th} Vernier scale division exactly coincides with the main scale reading. One main scale division is equal to 1 mm. While measuring diameter of a spherical body, the body is held between two jaws. It is now observed that zero of the Vernier scale lies between 30 and 31 divisions of main scale reading and 6^{th} Vernier scale division exactly. coincides with the main scale reading. The diameter of the spherical body will be :

(A) 3.02 cm (B) 3.06 cm

(C) 3.10 cm (D) 3.20 cm

3. A ball of mass 0.15 kg hits the wall with its initial speed of 12 ms^{-1} and bounces back without changing its initial speed. If the force applied by the wall on the ball during the contact is 100 N. calculate the time duration of the contact of ball with the wall.

(A) 0.018 s (B) 0.036 s

(C) 0.009 s (D) 0.072 s

4. A body of mass 8 kg and another of mass 2 kg are moving with equal kinetic energy. The ratio of their respective momenta will be:

(A) 1 : 1 (B) 2 : 1

(C) 1 : 4 (D) 4 : 1

5. Two uniformly charged spherical conductors A and B of radii 5 mm and 10 mm are separated by a distance of 2 cm. If the spheres are connected by a conducting wire, then in equilibrium condition, the ratio of the magnitudes of the electric fields at the surface of the sphere A and B will be :

(A) 1 : 2 (B) 2 : 1

(C) 1 : 1 (D) 1 : 4

6. The oscillating magnetic field in a plane electromagnetic wave is given by $B_y = 5 \times 10^{-6} \sin 1000\pi\ (5x - 4 \times 10^8\ t)$T. The amplitude of electric field will be :

(A) 15×10^2 Vm^{-1} (B) 5×10^{-6} Vm^{-1}

(C) 16×10^{12} Vm^{-1} (D) 4×10^2 Vm^{-1}

7. Light travels in two media M_1 and M_2 with speeds 1.5×10^8 ms^{-1} and 2.0×10^8 ms^{-1} respectively. The critical angle between them is:

(A) $\tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$ (B) $\tan^{-1}\left(\frac{2}{3}\right)$

(C) $\cos^{-1}\left(\frac{3}{4}\right)$ (D) $\sin^{-1}\left(\frac{2}{3}\right)$

8. A body is projected vertically upwards from the surface of earth with a velocity equal to one third of escape velocity. The maximum height attained by the body will be:

(Take radius of earth = 6400 km and $g=10\ ms^{-2}$)

(A) 800 km (B) 1600 km

(C) 2133 km (D) 4800 km

9. The maximum and minimum voltage of an amplitude modulated signal are 60 V and 20 V respectively. The percentage modulation index will be :

(A) 0.5% (B) 50%

(C) 2% (D) 30%

10. A nucleus of mass M at rest splits into two parts having masses $\frac{M'}{3}$ and $\frac{2M'}{3}(M' < M)$. The ratio of de Broglie wavelength of two parts will be :

(A) 1 : 2 (B) 2 : 1

(C) 1 : 1 (D) 2 : 3

11. An ice cube of dimensions 60 cm × 50 cm × 20 cm is placed in an insulation box of wall thickness 1 cm. The box keeping the ice cube at 0°C of temperature is brought to a room of temperature 40°C. The rate of melting of ice is approximately: (Latent heat of fusion of ice is 3.4×10^5 J kg^{-1} and thermal conducting of insulation wall is 0.05 $Wm^{-1}°C^{-1}$)

(A) 61×10^{-1} kg s^{-1}

(B) 61×10^{-5} kg s^{-1}

(C) 208 kg s^{-1}

(D) 30×10^{-5} kg s^{-1}

12. A gas has n degrees of freedom. The ratio of specific heat of gas at constant volume to the specific heat of gas at constant pressure will be :

(A) $\frac{n}{n+2}$ (B) $\frac{n+2}{n}$

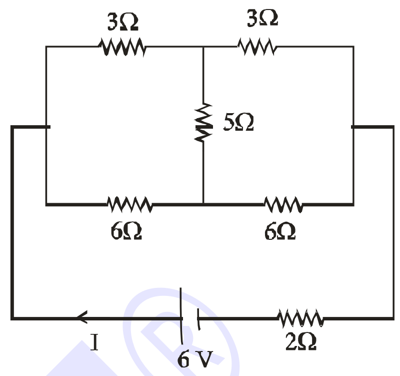
(C) $\frac{n}{2n+2}$ (D) $\frac{n}{n-2}$

13. A transverse wave is represented by $y = 2\sin(\omega t - kx)$ cm. The value of wavelength (in cm) for which the wave velocity becomes equal to the maximum particle velocity, will be ;

(A) 4π (B) 2π

(C) π (D) 2

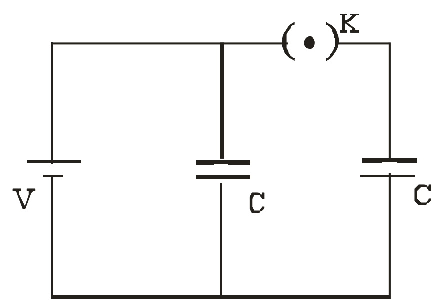
14. A battery of 6 V is connected to the circuit as shown below. The current I drawn from the battery is :



(A) 1A (B) 2A

(C) $\frac{6}{11}$A (D) $\frac{4}{3}$A

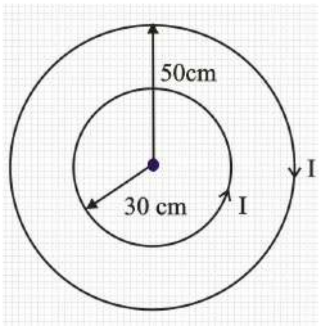
15. A source of potential difference V is connected to the combination of two identical capacitors as shown in the figure. When key 'K' is closed, the total energy stored across the combination is E_1. Now key 'K' is opened and dielectric of dielectric constant 5 is introduced between the plates of the capacitors. The total energy stored across the combination is now E_2. The ratio E_1/E_2 will be :



(A) $\frac{1}{10}$ (B) $\frac{2}{5}$

(C) $\frac{5}{13}$ (D) $\frac{5}{26}$

16. Two concentric circular loops of radii r_1=30 cm and r_2=50 cm are placed in X-Y plane as shown in the figure. A current I = 7A is flowing through them in the direction as shown in figure. The net magnetic moment of this system of two circular loops is approximately :



(A) $\frac{7}{2}\hat{k}\ Am^2$ (B) $-\frac{7}{2}\hat{k}\ Am^2$

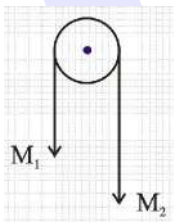
(C) $7\hat{k}\ Am^2$ (D) $-7\hat{k}\ Am^2$

17. A velocity selector consists of electric field $\vec{E} = E\hat{k}$ and magnetic field $\vec{B} = B\hat{j}$ with B=12 mT. The value E required for an electron of energy 728 eV moving along the positive x-axis to pass undeflected is :
(Given, mass of electron = 9.1×10^{-31}kg)

(A) 192 kVm^{-1} (B) 192 m Vm^{-1}

(C) 9600 kVm^{-1} (D) 16 kVm^{-1}

18. Two masses M_1 and .M_2 are tied together at the two ends of a light inextensible string that passes over a frictionless pulley. When the mass M_2 is twice that of M_1. the acceleration of the system is a_1. When the mass M_2 is thrice that of M_1. The acceleration of The system is a_2. The ratio $\frac{a_1}{a_2}$ will be:



(A) $\frac{1}{3}$ (B) $\frac{2}{3}$

(C) $\frac{3}{2}$ (D) $\frac{1}{2}$

19. Mass numbers of two nuclei are in the ratio of 4:3. Their nuclear densities will be in the ratio of

(A) 4:3 (B) $\left(\frac{3}{4}\right)^{\frac{1}{3}}$

(C) 1 : 1 (D) $\left(\frac{4}{3}\right)^{\frac{1}{3}}$

20. The area of cross section of the rope used to lift a load by a crane is $2.5 \times 10^{-4}m^2$. The maximum lifting capacity of the crane is 10 metric tons. To increase the lifting capacity of the crane to 25 metric tons, the required area of cross section of the rope should be :
(take g =10 ms^{-2})

(A) $6.25 \times 10^{-4}m^2$ (B) $10 \times 10^{-4}m^2$

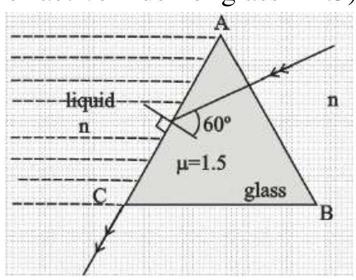
(C) $1 \times 10^{-4}m^2$ (D) $1.67 \times 10^{-4}m^2$

SECTION-B

1. If $\vec{A} = (2\hat{i} + 3\hat{j} - \hat{k})$ m and $\vec{B} = (\hat{i} + 2\hat{j} + 2\hat{k})$ m. The magnitude of component of vector $\vec{A}$ along vector $\vec{B}$ will be________ m.

2. The radius of gyration of a cylindrical rod about an axis of rotation perpendicular to its length and passing through the center will be_______ m. Given, the length of the rod is $10\sqrt{3}$ m.

3. In the given figure, the face AC of the equilateral prism is immersed in a liquid of refractive index 'n'. For incident angle 60° at the side AC, the refracted light beam just grazes along face AC. The refractive index of the liquid $n = \frac{\sqrt{x}}{4}$. The value of x is_________ .
(Given refractive index of glass = 1.5)



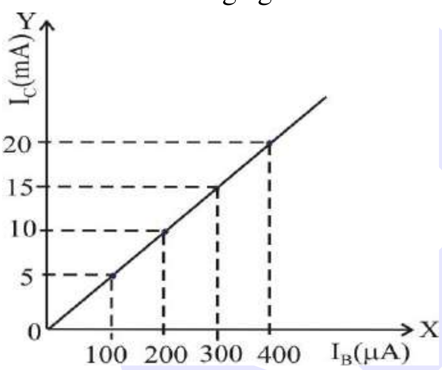
4. Two lighter nuclei combine to form a comparatively heavier nucleus by the relation given below :

$${}_{1}^{2}X + {}_{1}^{2}X = {}_{2}^{4}Y$$

The binding energies per nucleon ${}_{1}^{2}X$ and ${}_{2}^{4}Y$ are 1.1 MeV and 7.6 MeV respectively. The energy released in this process is_______ . MeV.

5. A uniform heavy rod of mass 20 kg. Cross sectional area 0.4 m^2 and length 20 m is hanging from a fixed support. Neglecting the lateral contraction, the elongation in the rod due to its own weight is $x \times 10^{-9}$ m. The value of x is_____.
(Given : Young's modulus $Y = 2 \times 10^{11}$ Nm^{-2} and $g = 10$ ms^{-2})

6. The typical transfer characteristic of a transistor in CE configuration is shown in figure. A load resistor of 2 $k\Omega$ is connected in the collector branch of the circuit used. The input resistance of the transistor is 0.50 $k\Omega$. The voltage gain of the transistor is



7. Three point charges of magnitude 5μC, 0.16μC and 0.3μC are located at the vertices A, B, C of a right angled triangle whose sides are AB = 3cm, $BC = 3\sqrt{2}$ cm and CA=3 cm and point A is the right angle corner. Charge at point A experiences _______ N of electrostatic force due to the other two charges.

8. In a coil of resistance 8Ω, the magnetic flux due to an external magnetic field varies with time as $\phi = \frac{2}{3}(9 - t^2)$. The value of total heat produced in the coil, till the flux becomes zero, will be_______J.

9. A potentiometer wire of length 300 cm is connected in series with a resistance 780 Ω and a standard cell of emf 4V. A constant current flows through potentiometer wire. The length of the null point for cell of emf 20 mV is found to be 60 cm. The resistance of the potentiometer wire is____Ω.

10. As per given figures, two springs of spring constants K and 2K are connected to mass m. If the period of oscillation in figure (a) is 3s, then the period of oscillation in figure (b) will be $\sqrt{x}$ s. The value of x is_________.

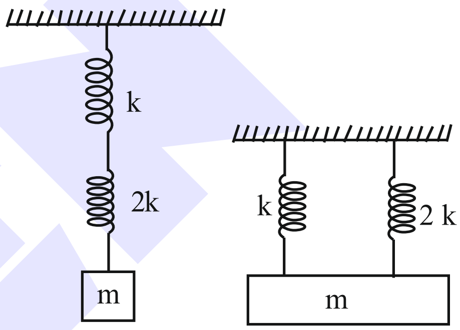


figure (a) figure (b)

CHEMISTRY
SECTION-A

1. Hemoglobin contains 0.34% of iron by mass. The number of Fe atoms in 3.3 g of hemoglobin is : (Given : Atomic mass of Fe is 56 u, N_A in 6.022×10^{23} mol^{-1})

(A) 1.21×10^5 (B) 12.0×10^{16}
(C) 1.21×10^{20} (D) 3.4×10^{22}

2. Arrange the following in increasing order of their covalent character.

(A) CaF_2 (B) $CaCl_2$
(C) $CaBr_2$ (D) CaI_2

Choose the correct answer from the options given below.

(A) B < A < C < D (B) A < B < C < D
(C) A < B < D < C (D) A < C < B < D

3. Class XII students were asked to prepare one litre of buffer solution of pH 8.26 by their chemistry teacher. The amount of ammonium chloride to be dissolved by the student in 0.2 M ammonia solution to make one litre of the buffer is (Given pK_b (NH_3) = 4.74; Molar mass of NH_3 = 17 g mol^{-1}; Molar mass of NH_4Cl = 53.5 g mol^{-1})

(A) 53.5 g (B) 72.3 g
(C) 107.0 g (D) 126.0 g

4. At 30°C, the half life for the decomposition of AB_2 is 200 s and is independent of the initial concentration of AB_2. The time required for 80% of the AB_2 to decompose is (Given: log 2 = 0.30; log 3 = 0.48)

(A) 200 s (B) 323 s
(C) 467 s (D) 532 s

5. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Finest gold is red in colour, as the size of the particles increases, it appears purple then blue and finally gold.

Assertion R : The colour of the colloidal solution depends on the wavelength of light scattered by the dispersed particles.

In the light of the above statements, choose the most appropriate answer from the options given below;

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is NOT the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

6. The metal that has very low melting point and its periodic position is closer to a metalloid is :

(A) Al (B) Ga
(C) Se (D) In

7. The metal that is not extracted from its sulphide ore is :

(A) Aluminium (B) Iron
(C) Lead (D) Zinc

8. The products obtained from a reaction of hydrogen peroxide and acidified potassium permanganate are

(A) Mn^{4+}, H_2O only
(B) Mn^{2+}, H_2O only
(C) Mn^{4+}, H_2O, O_2 only
(D) Mn^{2+}, H_2O, O_2 only

9. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : LiF is sparingly soluble in water.

Reason R : The ionic radius of Li^+ ion is smallest among its group members, hence has least hydration enthalpy.

In the light of the above statements, choose the most appropriate answer from the options given below .

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is NOT the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

10. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Boric acid is a weak acid

Reason R : Boric acid is not able to release H^+ ion on its own. It receives OH^- ion from water and releases H^+ ion.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both A and R are correct and R is the correct explanation of A
(B) Both A and R are correct but R is NOT the correct explanation of A
(C) A is correct but R is not correct
(D) A is not correct but R is correct

11. The metal complex that is diamagnetic is

(Atomic number : Fe, 26; Cu, 29)

(A) $K_3[Cu(CN)_4]$ (B) $K_2[Cu(CN)_4]$

(C) $K_3[Fe(CN)_4]$ (D) $K_4[FeCl_6]$

12. Match List I with List II

List I Pollutant	List II Source
A. Microorganisms	I. Strip mining
B. Plant nutrients	II. Domestic sewage
C. Toxic heavy metals	III. Chemical fertilizer
D. Sediment	IV. Chemical factory

Choose the correct answer from the options given below :

(A) A-II, B-III, C-IV, D-I

(B) A-II, B-I, C-IV, D-III

(C) A-I, B-IV, C-II, D-III

(D) A-I, B-IV, C-III, D-II

13. The correct decreasing order of priority of functional groups in naming an organic compound as per IUPAC system of nomenclature is :

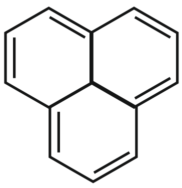
(A) —COOH > —$CONH_2$ > —COCl > —CHO

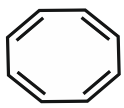
(B) —SO_3H > —COCl > —$CONH_2$ > —CN

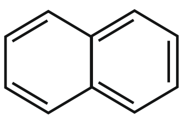
(C) —COOR > —COCl > —NH_2 > >C = o

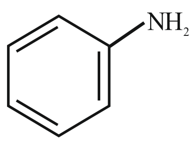
(D) —COOH > —COOR > —$CONH_2$ > —COCl

14. Which of the following is not an example of benzenoid compound ?

(A) 

(B) 

(C) 

(D) 

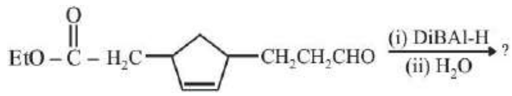
15. Hydrolysis of which compound will give carbolic acid ?

(A) Cumene

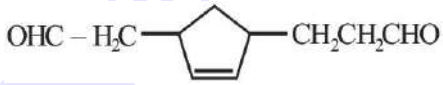
(B) Benzenediazonium chloride

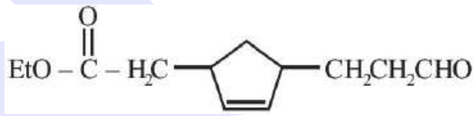
(C) Benzal chloride

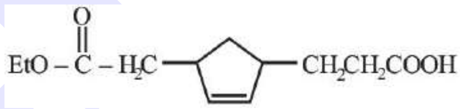
(D) Ethylene glycol ketal

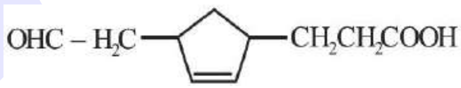
16. 

Consider the above reaction and predict the major product.

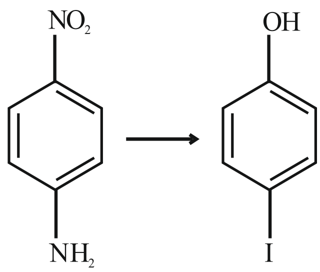
(A) 

(B) 

(C) 

(D) 

17. The correct sequential order of the reagents for the given reaction is :



(A) HNO_2, Fe/H^+, HNO_2, KI, H_2O/H^+

(B) HNO_2, KI, Fe/H^+, HNO_2, H_2O/warm

(C) HNO_2, KI, HNO_2, Fe/H^+, H_2O/H^+

(D) HNO_2, Fe/H^+, KI, HNO_2, H_2O/warm

18. Vulcanization of rubber is carried out by heating a mixture of :

(A) isoprene and styrene

(B) neoprene and sulphur

(C) isoprene and sulphur

(D) neoprene and styrene

19. Animal starch is the other name of :

(A) amylose (B) maltose

(C) glycogen (D) amylopectin

20. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Phenolphthalein is a pH dependent indicator, remains colourless in acidic solution and gives pink colour in basic medium

Reason R : Phenolphthalein is a weak acid. It doesn't dissociate in basic medium.

In the light of the above statements, choose the most appropriate answer from the options given below :

(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false

(D) A is false but R is true

SECTION-B

1. A 10 g mixture of hydrogen and helium is contained in a vessel of capacity 0.0125 m^3 at 6 bar and 27°C. The mass of helium in the mixture is _______ g. (nearest integer)

Given : R = 8.3 $JK^{-1}mol^{-1}$ (Atomic masses of H and He are 1u and 4u, respectively)

2. Consider an imaginary ion $^{48}_{22}X^{3-}$. The nucleus contains 'a'% more neutrons than the number of electrons in the ion. The value of 'a' is _____. [nearest integer]

3. For the reaction

$H_2F_2(g) \rightarrow H_2(g) + F_2(g)$

$\Delta U = -59.6$ kJ mol^{-1} at 27°C.

The enthalpy change for the above reaction is (–) ___ kJ mol^{-1} [nearest integer]

Given : R = 8.314 JK^{-1} mol^{-1}.

4. The elevation in boiling point for 1 molal solution of non-volatile solute A is 3K. The depression in freezing point for 2 molal solution of A in the same solvent is 6 K. The ratio of K_b and K_f i.e., K_b/K_f is 1 : X. The value of X is [nearest integer]

5. 20 mL of 0.02 M hypo solution is used for the titration of 10 mL of copper sulphate solution, in the presence of excess of KI using starch as an indicator. The molarity of Cu^{2+} is found to be _____ $\times 10^{-2}$ M [nearest integer]

Given : $2Cu^{2+} + 4I^- \rightarrow Cu_2I_2 + I_2$

$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$

6. The number of non-ionisable protons present in the product B obtained from the following reaction is ___. $C_2H_5OH + PCl_3 \rightarrow C_2H_5Cl + A$

$A + PCl_3 \rightarrow B$

7. The spin-only magnetic moment value of the compound with strongest oxidizing ability among MnF_4, MnF_3 and MnF_2 is ______ B.M. [nearest integer]

8. Total number of isomers (including stereoisomers) obtained on monochlorination of methylcyclohexane is ________.

9. A 100 mL solution of CH_3CH_2MgBr on treatment with methanol produces 2.24 mL of a gas at STP. The weight of gas produced is _______ mg. [nearest integer]

10. How many of the following drugs is/are example(s) of broad spectrum antibiotic ? Ofloxacin, Penicillin G, Terpineol, Salvarsan

MATHEMATICS
SECTION-A

1. The minimum value of the sum of the squares of the roots of $x^2+(3-a)x+1=2a$ is:

(A) 4 (B) 5

(C) 6 (D) 8

2. If z = x + iy satisfies |z| - 2 = 0 and |z-i|-|z+5i|=0, then

(A) $x + 2y - 4 = 0$ (B) $x^2 + y - 4 = 0$

(C) $x + 2y + 4 = 0$ (D) $x^2 - y + 3 = 0$

3. Let $A=\begin{bmatrix}1\\1\\1\end{bmatrix}$ and $B=\begin{bmatrix}9^2 & -10^2 & 11^2\\12^2 & 13^2 & -14^2\\-15^2 & 16^2 & 17^2\end{bmatrix}$,

then the value of $A'BA$ is:

(A) 1224 (B) 1042

(C) 540 (D) 539

4. $\sum_{\substack{i,j=0\\i\neq j}}^{n} {}^nC_i\ {}^nC_j$ is equal to

(A) $2^{2n}-{}^{2n}C_n$ (B) $2^{2n-1}-{}^{2n-1}C_{n-1}$

(C) $2^{2n}-\frac{1}{2}\,{}^{2n}C_n$ (D) $2^{n-1}+{}^{2n-1}C_n$

5. Let P and Q be any points on the curves $(x-1)^2+(y+1)^2=1$ and $y = x^2$, respectively. The distance between P and Q is minimum for some value of the abscissa of P in the interval

(A) $\left(0,\frac{1}{4}\right)$ (B) $\left(\frac{1}{2},\frac{3}{4}\right)$

(C) $\left(\frac{1}{4},\frac{1}{2}\right)$ (D) $\left(\frac{3}{4},1\right)$

6. If the maximum value of a, for which the function $f_a(x)=\tan^{-1}2x-3ax+7$ is non-decreasing in $\left(-\frac{\pi}{6},\frac{\pi}{6}\right)$, is $\bar{a}$, then $f_{\bar{a}}\left(\frac{\pi}{8}\right)$ is equal to

(A) $8-\frac{9\pi}{4\left(9+\pi^2\right)}$ (B) $8-\frac{4\pi}{9\left(4+\pi^2\right)}$

(C) $8\left(\frac{1+\pi^2}{9+\pi^2}\right)$ (D) $8-\frac{\pi}{4}$

7. Let $\beta=\lim_{x\to0}\frac{\alpha x-\left(e^{3x}-1\right)}{\alpha x\left(e^{3x}-1\right)}$ for some $\alpha\in\mathbb{R}$.

Then the value of $\alpha+\beta$ is :

(A) $\frac{14}{5}$ (B) $\frac{3}{2}$ (C) $\frac{5}{2}$ (D) $\frac{7}{2}$

8. The value of $\log_e 2\,\frac{d}{dx}(\log_{\cos x}\operatorname{cosec}x)$ at $x=\frac{\pi}{4}$ is

(A) $-2\sqrt{2}$ (B) $2\sqrt{2}$ (C) -4 (D) 4

9. $\int_0^{20\pi}\left(|\sin x|+|\cos x|\right)^2dx$ is equal to :-

(A) $10(\pi+4)$ (B) $10(\pi+2)$

(C) $20(\pi-2)$ (D) $20(\pi+2)$

10. Let the solution curve y = f(x) of the differential equation $\frac{dy}{dx}+\frac{xy}{x^2-1}=\frac{x^4+2x}{\sqrt{1-x^2}},x\in(-1,1)$ pass through the origin. Then $\int_{-\frac{\sqrt{3}}{2}}^{\frac{\sqrt{3}}{2}}f(x)dx$ is equal to

(A) $\frac{\pi}{3}-\frac{1}{4}$ (B) $\frac{\pi}{3}-\frac{\sqrt{3}}{4}$

(C) $\frac{\pi}{6}-\frac{\sqrt{3}}{4}$ (D) $\frac{\pi}{6}-\frac{\sqrt{3}}{2}$

11. The acute angle between the pair of tangents drawn to the ellipse $2x^2 + 3y^2 = 5$ from the point (1,3) is

(A) $\tan^{-1}\left(\frac{16}{7\sqrt{5}}\right)$ (B) $\tan^{-1}\left(\frac{24}{7\sqrt{5}}\right)$

(C) $\tan^{-1}\left(\frac{32}{7\sqrt{5}}\right)$ (D) $\tan^{-1}\left(\frac{3+8\sqrt{5}}{35}\right)$

12. The equation of a common tangent to the parabolas $y = x^2$ and $y = -(x-2)^2$ is

(A) y = 4(x-2) (B) y = 4 (x-1)

(C) y = 4 (x+1) (D) y = 4 (x+2)

13. Let the abscissae of the two points P and Q on a circle be the roots of $x^2 - 4x - 6 = 0$ and the ordinates of P and Q be the roots of $y^2 + 2y - 7 = 0$.If PQ is a diameter of the circle $x^2 + y^2 + 2ax + 2by + c= 0$, then the value of (a+b-c) is

(A) 12 (B) 13 (C) 14 (D) 16

14. If the line x-1 = 0, is a directrix of the hyperbola $kx^2 - y^2=6$, then the hyperbola passes through the point

(A) $\left(-2\sqrt{5},6\right)$ (B) $\left(-\sqrt{5},3\right)$

(C) $\left(\sqrt{5},-2\right)$ (D) $\left(2\sqrt{5},3\sqrt{6}\right)$

15. A vector $\vec{a}$ is parallel to the line of intersection of the plane determined by the vectors $\hat{i}, \hat{i}+\hat{j}$ and the plane determined by the vectors $\hat{i}-\hat{j}, \hat{i}+\hat{k}$. The obtuse angle between $\vec{a}$ and the vector $\vec{b}=\hat{i}-2\hat{j}+2\hat{k}$ is

(A) $\frac{3\pi}{4}$ (B) $\frac{2\pi}{3}$

(C) $\frac{4\pi}{5}$ (D) $\frac{5\pi}{6}$

16. If $0<x<\frac{1}{\sqrt{2}}$ and $\frac{\sin^{-1}x}{\alpha}=\frac{\cos^{-1}x}{\beta}$, then a value of $\sin\left(\frac{2\pi\alpha}{\alpha+\beta}\right)$ is

(A) $4\sqrt{\left(1-x^2\right)}\left(1-2x^2\right)$

(B) $4x\sqrt{\left(1-x^2\right)}\left(1-2x^2\right)$

(C) $2x\sqrt{\left(1-x^2\right)}\left(1-4x^2\right)$

(D) $4\sqrt{\left(1-x^2\right)}\left(1-4x^2\right)$

17. Negation of the Boolean expression $p \Leftrightarrow (q \Rightarrow p)$ is

(A) $(\sim p)\wedge q$

(B) $p\wedge(\sim q)$

(C) $(\sim p)\vee(\sim q)$

(D) $(\sim p)\wedge(\sim q)$

18. Let X be a binomially distributed random variable with mean 4 and variance $\frac{4}{3}$. Then $54\,P(X\le 2)$ is equal to

(A) $\frac{73}{27}$ (B) $\frac{146}{27}$

(C) $\frac{146}{81}$ (D) $\frac{126}{81}$

19. The integral $\int \frac{\left(1-\frac{1}{\sqrt{3}}\right)(\cos x-\sin x)}{\left(1+\frac{2}{\sqrt{3}}\sin 2x\right)}dx$ is equal to

(A) $\frac{1}{2}\log_e\left|\frac{\tan\left(\frac{x}{2}+\frac{\pi}{12}\right)}{\left(\frac{x}{2}+\frac{\pi}{6}\right)}\right|+C$

(B) $\frac{1}{2}\log_e\left|\frac{\tan\left(\frac{x}{2}+\frac{\pi}{6}\right)}{\left(\frac{x}{2}+\frac{\pi}{3}\right)}\right|+C$

(C) $\log_e\left|\frac{\tan\left(\frac{x}{2}+\frac{\pi}{6}\right)}{\tan\left(\frac{x}{2}+\frac{\pi}{12}\right)}\right|+C$

(D) $\frac{1}{2}\log_e\left|\frac{\tan\left(\frac{x}{2}-\frac{\pi}{12}\right)}{\tan\left(\frac{x}{2}-\frac{\pi}{6}\right)}\right|+C$

20. The area bounded by the curves $y = |x^2-1|$ and $y = 1$ is

(A) $\frac{2}{3}\left(\sqrt{2}+1\right)$ (B) $\frac{4}{3}\left(\sqrt{2}-1\right)$

(C) $2\left(\sqrt{2}-1\right)$ (D) $\frac{8}{3}\left(\sqrt{2}-1\right)$

SECTION-B

1. Let A = {1,2,3,4,5,6,7} and B = {3,6,7,9}. Then the number of elements in the set $\{C\subseteq A : C\cap B\neq\phi\}$ is_______

2. The largest value of a, for which the perpendicular distance of the plane containing the lines $\vec{r}=\left(\hat{i}+\hat{j}\right)+\lambda\left(\hat{i}+a\hat{j}-\hat{k}\right)$ and $\vec{r}=\left(\hat{i}+\hat{j}\right)+\mu\left(-\hat{i}+\hat{j}-a\hat{k}\right)$ from the point (2,1,4) is $\sqrt{3}$, is_________.

3. Numbers are to be formed between 1000 and 3000, which are divisible by 4, using the digits 1,2,3,4,5 and 6 without repetition of digits. Then the total number of such numbers is _____________.

4. If $\sum_{k=1}^{10}\frac{k}{k^4+k^2+1}=\frac{m}{n}$, where m and n are co-prime, then m + n is equal to

5. If the sum of solutions of the system of equations $2\sin^2\theta - \cos 2\theta = 0$ and $2\cos^2\theta + 3\sin\theta = 0$ in the interval $[0, 2\pi]$ is $k\pi$, then k is equal to _______.

6. The mean and standard deviation of 40 observations are 30 and 5 respectively. It was noticed that two of these observations 12 and 10 were wrongly recorded. If σ is the standard deviation of the data after omitting the two wrong observations from the data, then $38\sigma^2$ is equal to__________.

7. The plane passing through the line L: ℓ x-y+3(1-ℓ) z = 1, x+2y - z = 2 and perpendicular to the plane 3x+2y+z = 6 is 3x-8y+7z=4. If θ is the acute angle between the line L and the y-axis, then 415 $\cos^2\theta$ is equal to_____.

8. Suppose y = y(x) be the solution curve to the differential equation $\frac{dy}{dx} - y = 2 - e^{-x}$ such that $\lim_{x\to\infty} y(x)$ is finite. If a and b are respectively the x-and y- intercepts of the tangent to the curve at x=0, then the value of a-4b is equal to _________.

9. Different A.P.'s are constructed with the first term 100, the last term 199, And integral common differences. The sum of the common differences of all such, A.P's having at least 3 terms and at most 33 terms is.

10. The number of matrices $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, where $a,b,c,d \in \{-1,0,1,2,3,\ldots\ldots,10\}$, such that A = A^{-1}, is______.

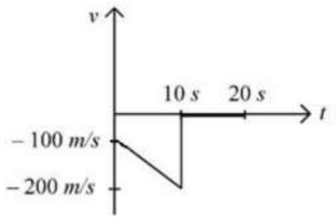
SET # 05

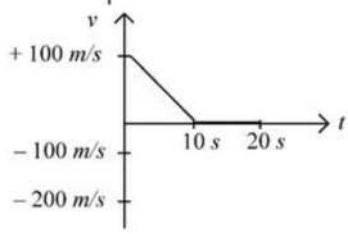
PHYSICS
SECTION-A

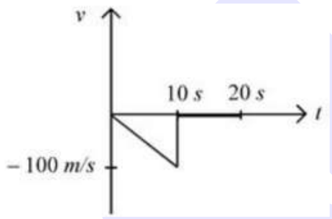
1. A torque meter is calibrated to reference standards of mass, length and time each with 5% accuracy. After calibration, the measured torque with this torque meter will have net accuracy of :

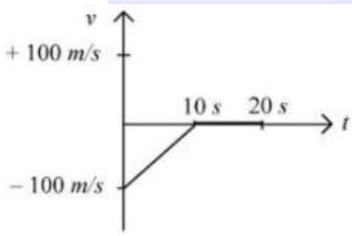
(A) 15% (B) 25% (C) 75% (D) 5%

2. A bullet is shot vertically downwards with an initial velocity of 100 m/s from a certain height. Within 10 s, the bullet reaches the ground and instantaneously comes to rest due to the perfectly inelastic collision. The velocity-time curve for total time t = 20 s will be : (Take $g = 10\ m/s^2$)

(A)


(B)


(C)


(D)


3. Sand is being dropped from a stationary dropper at a rate of $0.5\ kgs^{-1}$ on a conveyor belt moving with a velocity of $5\ ms^{-1}$. The power needed to keep belt moving with the same velocity will be :

(A) 1.25 W (B) 2.5 W
(C) 6.25 W (D) 12.5 W

4. A bag is gently dropped on a conveyor belt moving at a speed of 2 m/s. The coefficient of friction between the conveyor belt and bag is 0.4 Initially, the bag slips on the belt before it stops due to friction. The distance travelled by the bag on the belt during slipping motion is : [Take $g = 10\ m/s^{-2}$]

(A) 2 m (B) 0.5 m
(C) 3.2 m (D) 0.8 ms

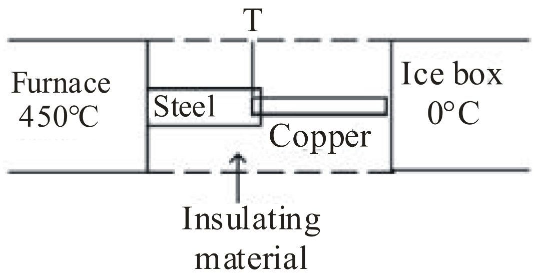
5. Two cylindrical vessels of equal cross-sectional area $16\ cm^2$ contain water upto heights 100 cm and 150 cm respectively. The vessels are interconnected so that the water levels in them become equal. The work done by the force of gravity during the process, is [Take density of water = $10^3\ kg/m^3$ and $g = 10\ ms^{-2}$]

(A) 0.25 J (B) 1 J
(C) 8 J (D) 12 J

6. Two satellites A and B having masses in the ratio 4:3 are revolving in circular orbits of radii 3r and 4 r respectively around the earth. The ratio of total mechanical energy of A to B is :

(A) 9 : 16 (B) 16 : 9
(C) 1 : 1 (D) 4 : 3

7. If K_1 and K_2 are the thermal conductivities L_1 and L_2 are the lengths and A_1 and A_2 are the cross sectional areas of steel and copper rods respectively such that $\frac{K_2}{K_1} = 9, \frac{A_1}{A_2} = 2, \frac{L_1}{L_2} = 2$. Then, for the arrangement as shown in the figure. The value of temperature T of the steel – copper junction in the steady state will be :



(A) 18°C (B) 14 °C
(C) 45 °C (D) 150 °C

8. Read the following statements :

A. When small temperature difference between a liquid and its surrounding is doubled the rate of loss of heat of the liquid becomes twice.

B. Two bodies P and Q having equal surface areas are maintained at temperature 10ºC and 20 ºC. The thermal radiation emitted in a given time by P and Q are in the ratio 1 : 1.15

C. A carnot Engine working between 100 K and 400 K has an efficiency of 75%

D. When small temperature difference between a liquid and its surrounding is quadrupled, the rate of loss of heat of the liquid becomes twice.

Choose the correct answer from the options given below :

(A) A, B, C only (B) A, B only

(C) A, C only (D) B, C, D only

9. Same gas is filled in two vessels of the same volume at the same temperature. If the ratio of the number of molecules is 1:4, then

A. The r.m.s. velocity of gas molecules in two vessels will be the same.

B. The ratio of pressure in these vessels will be 1 : 4

C. The ratio of pressure will be 1 : 1

D. The r.m.s. velocity of gas molecules in two vessels will be in the ratio of 1 : 4

(A) A and C only (B) B and D only

(C) A and B only (D) C and D only

10. Two identical positive charges Q each are fixed at a distance of '2a' apart from each other. Another point charge q_0 with mass 'm' is placed at midpoint between two fixed charges. For a small displacement along the line joining the fixed charges, the charge q_0 executes SHM. The time period of oscillation of charge q_0 will be :

(A) $\sqrt{\dfrac{4\pi^3\varepsilon_0 ma^3}{q_0 Q}}$ (B) $\sqrt{\dfrac{q_0 Q}{4\pi^3\varepsilon_0 ma^3}}$

(C) $\sqrt{\dfrac{2\pi^2\varepsilon_0 ma^3}{q_0 Q}}$ (D) $\sqrt{\dfrac{8\pi^3\varepsilon_0 ma^3}{q_0 Q}}$

11. Two sources of equal emfs are connected in series. This combination is connected to an external resistance R. The internal resistances of the two sources are r_1 and r_2 ($r_1 > r_2$). If the potential difference across the source of internal resistance r_1 is zero then the value of R will be

(A) $r_1 - r_2$ (B) $\dfrac{r_1 r_2}{r_1 + r_2}$

(C) $\dfrac{r_1 + r_2}{2}$ (D) $r_2 - r_1$

12. Two bar magnets oscillate in a horizontal plane in earth's magnetic field with time periods of 3 s and 4 s respectively. If their moments of inertia are in the ratio of 3 : 2 then the ratio of their magnetic moments will be :

(A) 2 : 1 (B) 8 : 3

(C) 1 : 3 (D) 27 : 16

13. A magnet hung at 45º with magnetic meridian makes an angle of 60º with the horizontal. The actual value of the angle of dip is

(A) $\tan^{-1}\left(\sqrt{\dfrac{3}{2}}\right)$ (B) $\tan^{-1}\left(\sqrt{6}\right)$

(C) $\tan^{-1}\left(\sqrt{\dfrac{2}{3}}\right)$ (D) $\tan^{-1}\left(\sqrt{\dfrac{1}{2}}\right)$

14. A direct current of 4 A and an alternating current of peak value 4 A flow through resistance of 3 Ω and 2 Ω respectively. The ratio of heat produced in the two resistances in same interval of time will be :

(A) 3 : 2 (B) 3 : 1

(C) 3 : 4 (D) 4 : 3

15. A beam of light travelling along X-axis is described by the electric field $E_y = 900 \sin \omega(t - x/c)$. The ratio of electric force to magnetic force on a charge q moving along Y-axis with a speed of 3×10^7 ms^{-1} will be :

[Given speed of light = 3×10^8 ms^{-1}]

(A) 1 : 1 (B) 1 : 10

(C) 10 : 1 (D) 1 : 2

16. A microscope was initially placed in air (refractive index 1). It is then immersed in oil (refractive index 2). For a light whose wavelength in air is λ, calculate the change of microscope's resolving power due to oil and choose the correct option

(A) Resolving power will be $\frac{1}{4}$ in the oil than it was in the air

(B) Resolving power will be twice in the oil than it was in the air.

(C) Resolving power will be four times in the oil than it was in the air.

(D) Resolving power will be $\frac{1}{2}$ in the oil than it was in the air.

17. An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}(v_0 > 0)$ is moving in an electric field $\vec{E} = -E_0\hat{i}(E_0 > 0)$ where E_0 is constant. If at t = 0 de Broglie wavelength is $\lambda_0 = \frac{h}{mv_0}$, then its de Broglie wavelength after time t is given by

(A) λ_0 (B) $\lambda_0\left(1+\frac{eE_0t}{mv_0}\right)$

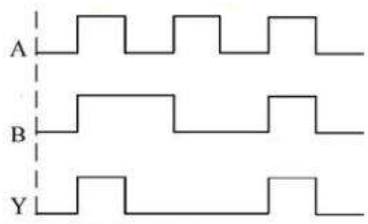
(C) $\lambda_0 t$ (D) $\frac{\lambda_0}{\left(1+\frac{eE_0t}{mv_0}\right)}$

18. What is the half-life period of a radioactive material if its activity drops to 1/16th of its initial value of 30 years ?

(A) 9.5 years (B) 8.5 years

(C) 7.5 years (D) 10.5 years

19. A logic gate circuit has two inputs A and B and output Y. The voltage waveforms of A, B and Y are shown below



The logic gate circuit is

(A) AND gate (B) OR gate

(C) NOR gate (D) NAND gate

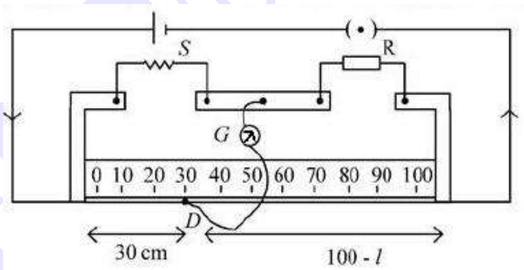
20. At a particular station, the TV transmission tower has a height of 100 m. To triple its coverage range, height of the tower should be increased to

(A) 200 m (B) 300 m

(C) 600 m (D) 900 m

SECTION-B

1. In meter bridge experiment for measuring unknown resistance 'S', the null point is obtained at a distance 30 cm from the left side as shown at point D. If R is 5.6 kΩ, then the value of unknown resistance 'S' will be ______ Ω.



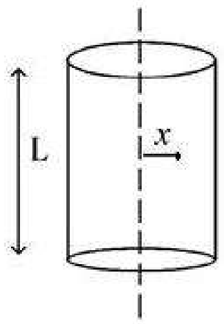
2. The one division of main scale of vernier callipers reads 1 mm and 10 divisions of Vernier scale is equal to the 9 divisions on main scale. When the two jaws of the instrument touch each other the zero of the Vernier lies to the right of zero of the main scale and its fourth division coincides with a main scale division. When a spherical bob is tightly placed between the two jaws, the zero of the Vernier scale lies in between 4.1 cm and 4.2 cm and 6th Vernier division coincides with a main scale division. The diameter of the bob will be_____ 10^{-2} cm

3. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the two beams are $\pi/2$ and $\pi/3$ at points A and B respectively. The difference between the resultant intensities at the two points is xI. The value of x will be _____ .

4. To light, a 50 W, 100 V lamp is connected, in series with a capacitor of capacitance $\frac{50}{\pi\sqrt{x}}\mu F$, with 200 V, 50Hz AC source. The value of x will be ____ .

5. A 1 m long copper wire carries a current of 1 A. If the cross section of the wire is 2.0 mm^2 and the resistivity of copper is 1.7×10^{-8} Ωm. the force experienced by moving electron in the wire is ______ $\times 10^{-23}$ N. (charge on electron = 1.6×10^{-19} C)

6. A long cylindrical volume contains a uniformly distributed charge of density ρ Cm^{-3}. The electric field inside the cylindrical volume at a distance $x = \frac{2\varepsilon_0}{\rho}$ m from its axis is ______ Vm^{-1}



7. A mass 0.9 kg, attached to a horizontal spring, executes SHM with an amplitude A_1. When this mass passes through its mean position, then a smaller mass of 124 g is placed over it and both masses move together with amplitude A_2. If the ratio $\frac{A_1}{A_2}$ is $\frac{\alpha}{\alpha - 1}$, then the value of α will be ____ .

8. A square aluminium (shear modulus is 25×10^9 Nm^{-2}) slab of side 60 cm and thickness 15 cm is subjected to a shearing force (on its narrow face) of 18.0×10^4 N. The lower edge is riveted to the floor. The displacement of the upper edge is ____ μ m.

9. A pulley of radius 1.5 m is rotated about its axis by a force $F = (12t - 3t^2)$ N applied tangentially (while t is measured in seconds). If moment of inertia of the pulley about its axis of rotation is 4.5 kg m^2, the number of rotations made by the pulley before its direction of motion is reversed, will be $\frac{K}{\pi}$. The value of K is ____ .

10. A ball of mass m is thrown vertically upward. Another ball of mass 2 m is thrown an angle θ with the vertical. Both the balls stay in air for the same period of time. The ratio of the heights attained by the two balls respectively is $\frac{1}{x}$. The value of x is _____ .

CHEMISTRY

SECTION-A

1. 250 g solution of D-glucose in water contains 10.8% of carbon by weight. The molality of the solution is nearest to

(Given: Atomic Weights are H, 1u ; C, 12u ; O, 16u)

(A) 1.03 (B) 2.06

(C) 3.09 (D) 5.40

2. Given below are two statements.

Statement I : O_2 , Cu^{2+} and Fe^{3+} are weakly attracted by magnetic field and are magnetized in the same direction as magnetic field.

Statement II : NaCl and H_2O are weakly magnetized in opposite direction to magnetic field.

In the light of the above statements, choose the ***most appropriate*** answer form the options given below :

(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect.

(C) Statement I is correct but Statement II is incorrect.

(D) Statement I is incorrect but Statement II is correct.

3. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : Energy of 2s orbital of hydrogen atom is greater than that of 2s orbital of lithium.

Reason R : Energies of the orbitals in the same subshell decrease with increase in the atomic number.

In the light of the above statements, choose the ***correct*** answer from the options given below.

(A) Both **A** and **R** are true and **R** is the correct explanation of **A.**

(B) Both **A** and **R** are true but **R** is NOT the correct explanation of **A.**

(C) **A** is true but **R** is false.

(D) **A** is false but **R** is true.

4. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R. Assertion A :** Activated charcoal adsorbs SO_2 more efficiently than CH_4.

Reason R : Gases with lower critical temperatures are readily adsorbed by activated charcoal.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both **A** and **R** are correct and **R** is the correct explanation of **A.**

(B) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A.**

(C) **A** is correct but **R** is not correct.

(D) **A** is not correct but **R** is correct.

5. Boiling point of a 2% aqueous solution of a non-volatile solute A is equal to the boiling point of 8% aqueous solution of a non-volatile solute B. The relation between molecular weights of A and B is.

(A) $M_A = 4M_B$ (B) $M_B = 4M_A$

(C) $M_A = 8M_B$ (D) $M_B = 8M_A$

6. The **incorrect** statement is

(A) The first ionization enthalpy of K is less than that of Na and Li

(B) Xe does not have the lowest first ionization enthalpy in its group

(C) The first ionization enthalpy of element with atomic number 37 is lower than that of the element with atomic number 38.

(D) The first ionization enthalpy of Ga is higher than that of the d-block element with atomic number 30.

7. Which of the following methods are not used to refine any metal?

(A) Liquation (B) Calcination

(C) Electrolysis (D) Leaching

(E) Distillation

Choose the **correct** answer from the options given below:

(A) B and D only

(B) A, B, D and E only

(C) B, D and E only

(D) A, C and E only

8. Given below are two statements:

Statement I : Hydrogen peroxide can act as an oxidizing agent in both acidic and basic conditions.

Statement II: Density of hydrogen peroxide at 298 K is lower than that of D_2O.

In the light of the above statements. Choose the ***correct*** answer from the options.

(A) Both statement I and Statement II are ture

(B) Both statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

9. Given below are two statements:

Statement I : The chlorides of Be and Al have Cl-bridged structure. Both are soluble in organic solvents and act as Lewis bases.

Statement II: Hydroxides of Be and Al dissolve in excess alkali to give beryllate and aluminate ions.

In the light of the above statements. Choose the correct answer from the options given below.

(A) Both statement I and Statement II are true

(B) Both statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

10. Which oxoacid of phosphorous has the highest number of oxygen atoms present in its chemical formula?

(A) Pyrophosphorous acid

(B) Hypophosphoric acid

(C) Phosphoric acid

(D) Pyrophosphoric acid

11. Given below are two statements:

Statement I : Iron (III) catalyst, acidified $K_2Cr_2O_7$ and neutral $KMnO_4$ have the ability to oxidise I^- to I_2 independently.

Statement II : Manganate ion is paramagnetic in nature and involves $p\pi - p\pi$ bonding.

In the light of the above statements, choose the ***correct*** answer from the options.

(A) Both statement I and Statement II are ture

(B) Both statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

12. The total number of Mn = O bonds in Mn_2O_7 is _____

(A) 4 (B) 5

(C) 6 (D) 3

13. Match List I with List II

List I Pollutant	List II Disease /sickness
A. Sulphate (>500 ppm)	I. Methemoglobinemia
B. Nitrate (>50 ppm)	II. Brown mottling of teeth
C. Lead (> 50 ppb)	III. Laxative effect
D. Fluoride (>2 ppm)	IV. Kidney damage

Choose the correct answer from the options given below:

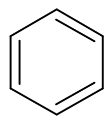
(A) A-IV, B –I, C-II, D-III

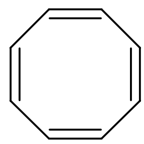
(B) A-III, B –I, C-IV, D-II

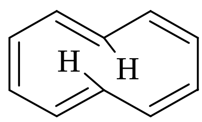
(C) A-II, B –IV, C-I, D-III

(D) A-II, B –IV, C-III, D-I

14. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R. Assertion A :** [6] Annulene. [8] Annulene and cis –[10] Annulene, are respectively aromatic, not-aromatic and aromatic.

[6] Annulene 

[8] Annulene 

Cis-[10] Annulene 

Reason R : Planarity is one of the requirements of aromatic systems.

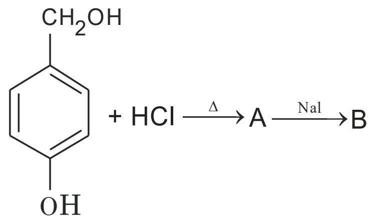
In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both **A** and **R** are correct and **R** is the correct explanation of **A.**

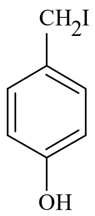
(B) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A.**

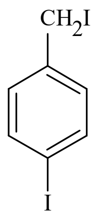
(C) **A** is correct but **R** is not correct.

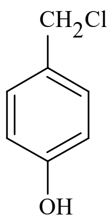
(D) **A** is not correct but **R** is correct.

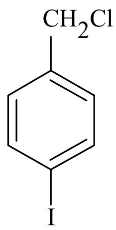
15. 

In the above reaction product B is:

(A) 

(B) 

(C) 

(D) 

16. Match **List I** with **List II**

List I **Polymers**	**List II** **Commenrcial names**
A. Phenol-formaldehyde resin	I. Glyptal
B. Copolymer of 1,3-butadiene and styrene	II. Novolac
C. Polyester of glycol and phthalic acid	III. Buna-S
D. Polyester of glycol and terephthalic acid	IV. Dacron

Choose the correct answer from the options given below:

(A) A-II, B –III, C-IV, D-I

(B) A-II, B –III, C-I, D-IV

(C) A-II, B –I, C-III, D-IV

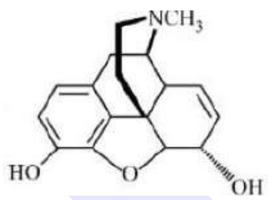
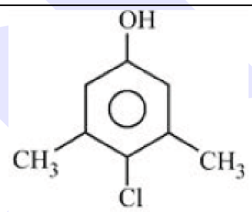
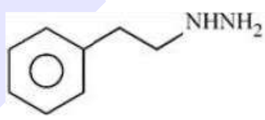
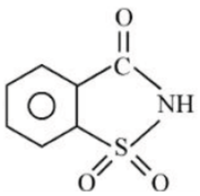
(D) A-III, B –II, C-IV, D-I

17. A sugar 'X' dehydrates very slowly under acidic condition to give furfural which on further reaction with resorcinol gives the coloured product after sometime. Sugar 'X' is

(A) Aldopentose (B) Aldotetrose

(C) Oxalic acid (D) Ketotetrose

18. Match **List I** with **List II**

List I	**List II**
A. 	I. Anti-depressant
B. 	II. 550 times sweeter than cane sugar
C. 	III. Narcotic analgesic
D. 	IV. Antiseptic

Choose the correct answer from the options given below:

(A) A-IV, B –III, C-II, D-I

(B) A-III, B –I, C-II, D-IV

(C) A-III, B –IV, C-I, D-II

(D) A-III, B –I, C-IV, D-II

19. In Carius method of estimation of halogen. 0.45 g of an organic compound gave 0.36 g of AgBr. Find out the percentage of bromine in the compound.

(Molar masses : AgBr = 188 g mol^{-1}:

Br = 80 g mol^{-1})

(A) 34.04% (B) 40.04%

(C) 36.03% (D) 38.04%

20. Match **List I** with **List II**

List I	List II
A. Benzenesulphonyl chloride	I. Test for primary amines
B. Hoffmann bromamide reaction	II. Anti Saytzeff
C. Carbylamine reaction	III. Hinsberg reagent
D. Hoffmann orientation	IV. Known reaction of Isocyanates.

Choose the correct answer from the options given below:

(A) A-IV, B –III, C-II, D-I

(B) A-IV, B –II, C-I, D-III

(C) A-III, B –IV, C-I, D-II

(D) A-IV, B –III, C-I, D-II

SECTION-B

1. 20 mL of 0.02 M $K_2Cr_2O_7$ solution is used for the titration of 10 mL of Fe^{2+} solution in the acidic medium.

The molarity of Fe^{2+} solution is ______ $\times 10^{-2}$ M. (Nearest Integer)

2. $2NO + 2H_2 \rightarrow N_2 + 2H_2O$

The above reaction has been studied at 800°C. The related data are given in the table below

Reaction serial number	Initial pressure of H_2 / kPa	Initial Pressure of NO/ kPa	Initial rate $\left(\frac{-dp}{dt}\right)/(kPa/s)$
1	65.6	40.0	0.135
2	65.6	20.1	0.033
3	38.6	65.6	0.214
4	19.2	65.6	0.106

The order of the reaction with respect to NO is____

3. Amongst the following the number of oxide(s) which are paramagnetic in nature is

Na_2O, KO_2, NO_2, N_2O, ClO_2, NO, SO_2, Cl_2O

4. The molar heat capacity for an ideal gas at constant pressure is 20.785 J $K^{-1}mol^{-1}$. The change in internal energy is 5000 J upon heating it from 300K to 500K. The number of moles of the gas at constant volume is ___ [Nearest integer]

(Given: R = 8.314 J K^{-1} mol^{-1})

5. According to MO theory, number of species/ions from the following having identical bond order is_____:

$CN^-, NO^+, O_2, O_2^+, O_2^{2+}$

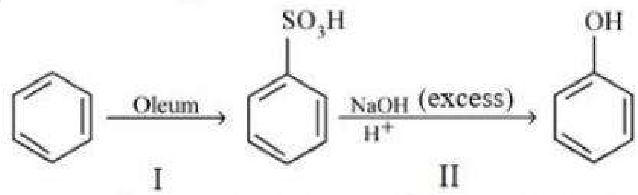
6. At 310 K, the solubility of CaF_2 in water is 2.34×10^{-3}g /100 mL. The solubility product of CaF_2 is ___ $\times 10^{-8}$ $(mol/L)^3$. (Given molar mass : CaF_2 = 78 g mol^{-1})

7. The conductivity of a solution of complex with formula $CoCl_3(NH_3)_4$ corresponds to 1 : 1 electrolyte, then the primary valency of central metal ion is______

8. In the titration of $KMnO_4$ and oxalic acid in acidic medium, the change in oxidation number of carbon at the end point is_____

9. Optical activity of an enantiomeric mixture is +12.6° and the specific rotation of (+) isomer is +30°. The optical purity is____%

10. In the following reaction



The % yield for reaction I is 60% and that of reaction II is 50%. The overall yield of the complete reaction is ___% [nearest integer]

MATHEMATICS
SECTION-A

1. Let R_1 and R_2 be two relations defined on $\mathbb{R}$ by

$a R_1 b \Leftrightarrow ab \geq 0$ and $a R_2 b \Leftrightarrow a \geq b$, then

(A) R_1 is an equivalence relation but not R_2

(B) R_2 is an equivalence relation but not R_1

(C) both R_1 and R_2 are equivalence relations

(D) neither R_1 nor R_2 is an equivalence relation

2. Let $f, g : \mathbb{N} - \{1\} \to \mathbb{N}$ be functions defined by f(a) = α, where α is the maximum of the powers of those primes p such that p^{α} divides a, and $g(a) = a + 1$, for all $a \in \mathbb{N} - \{1\}$. Then, the function f + g is

(A) one-one but not onto
(B) onto but not one-one
(C) both one-one and onto
(D) neither one-one nor onto

3. Let the minimum value v_0 of $v = |z|^2 + |z-3|^2 + |z-6i|^2$, $z \in \mathbb{C}$ is attained at z = z_0. Then $\left|2z_0^2 - \bar{z}_0^3 + 3\right|^2 + v_0^2$ is equal to

(A) 1000 (B) 1024
(C) 1105 (D) 1196

4. Let $A = \begin{pmatrix} 1 & 2 \\ -2 & -5 \end{pmatrix}$. Let $\alpha, \beta \in \mathbb{R}$ be such that $\alpha A^2 + \beta A = 2I$. Then $\alpha + \beta$ is equal to -

(A) -10 (B) -6
(C) 6 (D) 10

5. The remainder when $(2021)^{2022} + (2022)^{2021}$ is divided by 7 is

(A) 0 (B) 1
(C) 2 (D) 6

6. Suppose $a_1, a_2, \ldots, a_n, \ldots$ be an arithmetic progression of natural numbers. If the ratio of the sum of the first five terms of the sum of first nine terms of the progression is 5 : 17 and 110 < a_{15} < 120, then the sum of the first ten terms of the progression is equal to -

(A) 290 (B) 380
(C) 460 (D) 510

7. Let $f : \mathbb{R} \to \mathbb{R}$ be a function defined as

$$f(x) = a\sin\left(\frac{\pi[x]}{2}\right) + [2-x], \qquad a \in \mathbb{R},$$

where [t] is the greatest integer less than or equal to t. If $\lim_{x \to -1} f(x)$ exists, then the value of $\int_0^4 f(x)\,dx$ is equal to :

(A) -1 (B) -2
(C) 1 (D) 2

8. $I = \int_{\pi/4}^{\pi/3} \left(\frac{8\sin x - \sin 2x}{x}\right) dx$. Then

(A) $\frac{\pi}{2} < I < \frac{3\pi}{4}$

(B) $\frac{\pi}{5} < I < \frac{5\pi}{12}$

(C) $\frac{5\pi}{12} < I < \frac{\sqrt{2}}{3}\pi$

(D) $\frac{3\pi}{4} < I < \pi$

9. The area of the smaller region enclosed by the curves $y^2 = 8x + 4$ and $x^2 + y^2 + 4\sqrt{3}x - 4 = 0$ is equal to

(A) $\frac{1}{3}\left(2 - 12\sqrt{3} + 8\pi\right)$

(B) $\frac{1}{3}\left(2 - 12\sqrt{3} + 6\pi\right)$

(C) $\frac{1}{3}\left(4 - 12\sqrt{3} + 8\pi\right)$

(D) $\frac{1}{3}\left(4 - 12\sqrt{3} + 6\pi\right)$

10. Let y = y_1 (x) and y = y_2(x) be two distinct solutions of the differential equation $\frac{dy}{dx} = x + y$, with y_1 (0) = 0 and y_2 (0) = 1 respectively. Then, the number of points of intersection of y = y_1 (x) and y = y_2(x) is

(A) 0 (B) 1
(C) 2 (D) 3

11. Let P (a, b) be a point on the parabola $y^2 = 8x$ such that the tangent at P passes through the centre of the circle $x^2 + y^2 - 10x - 14y + 65 = 0$. Let A be the product of all possible values of a and B be the product of all possible values of b. Then the value of A + B is equal to :

(A) 0 (B) 25
(C) 40 (D) 65

12. Let $\vec{a} = \alpha\hat{i} + \hat{j} + \beta\hat{k}$ and $\vec{b} = 3\hat{i} - 5\hat{j} + 4\hat{k}$ be two vectors, such that $\vec{a} \times \vec{b} = -\hat{i} + 9\hat{i} + 12k$. Then the projection of $\vec{b} - 2\vec{a}$ on $\vec{b} + \vec{a}$ is equal to

(A) 2 (B) $\frac{39}{5}$

(C) 9 (D) $\frac{46}{5}$

13. Let $\vec{a} = 2\hat{i} - \hat{j} + 5\hat{k}$ and $\vec{b} = \alpha\hat{i} + \beta\hat{j} + 2\hat{k}$. If $\left(\left(\vec{a} \times \vec{b}\right) \times \hat{i}\right).\hat{k} = \frac{23}{2}$, then $\left|\vec{b} \times 2\hat{j}\right|$ is equal to

(A) 4 (B) 5

(C) $\sqrt{21}$ (D) $\sqrt{17}$

14. Let S be the sample space of all five digit numbers. If p is the probability that a randomly selected number from S, is a multiple of 7 but not divisible by 5, then $9p$ is equal to

(A) 1.0146 (B) 1.2085

(C) 1.0285 (D) 1.1521

15. Let a vertical tower AB of height $2h$ stands on a horizontal ground. Let from a point P on the ground a man can see upto height h of the tower with an angle of elevation 2α. When from P, he moves a distance d in the direction of $\overrightarrow{AP}$, he can see the top B of the tower with an angle of elevation α. If $d = \sqrt{7}h$, then tan α is equal to

(A) $\sqrt{5} - 2$ (B) $\sqrt{3} - 1$

(C) $\sqrt{7} - 2$ (D) $\sqrt{7} - \sqrt{3}$

16. $(p \wedge r) \Leftrightarrow (p \wedge (\sim q))$ is equivalent to $(\sim p)$ when r is

(A) p (B) $\sim p$

(C) q (D) $\sim q$

17. If the plane P passes through the intersection of two mutually perpendicular planes 2x + ky – 5z = 1 and 3kx – ky + z = 5, k < 3 and intercepts a unit length on positive x-axis, then the intercept made by the plane P on the y-axis is

(A) $\frac{1}{11}$ (B) $\frac{5}{11}$

(C) 6 (D) 7

18. Let A(1, 1), B(-4, 3) C(-2, -5) be vertices of a triangle ABC, P be a point on side BC, and Δ_1 and Δ_2 be the areas of triangle APB and ABC. Respectively.

If $\Delta_1 : \Delta_2 = 4 : 7$, then the area enclosed by the lines AP, AC and the x-axis is

(A) $\frac{1}{4}$ (B) $\frac{3}{4}$

(C) $\frac{1}{2}$ (D) 1

19. If the circle $x^2 + y^2 - 2gx + 6y - 19c = 0$, g, $c \in \mathbb{R}$ passes through the point (6, 1) and its centre lies on the line x – 2cy = 8, then the length of intercept made by the circle on x-axis is

(A) $\sqrt{11}$ (B) 4

(C) 3 (D) $2\sqrt{23}$

20. Let a function $f : \mathbb{R} \to \mathbb{R}$ be defined as :

$$f(x) = \begin{cases} \int_0^x \left(5 - |t - 3|\right) dt, & x > 4 \\ x^2 + bx \quad , & x \le 4 \end{cases}$$

where $b \in \mathbb{R}$. If f is continuous at x = 4, then which of the following statements is NOT true ?

(A) f is not differentiable at x = 4

(B) $f'(3) + f'(5) = \frac{35}{4}$

(C) f is increasing in $\left(-\infty, \frac{1}{8}\right) \cup (8, \infty)$

(D) f has a local minima at $x = \frac{1}{8}$

SECTION-B

1. For $k \in \mathbb{R}$, let the solutions of the equation $\cos\left(\sin^{-1}\left(x\cot\left(\tan^{-1}\left(\cos\left(\sin^{-1} x\right)\right)\right)\right)\right) = k, 0 < |x| < \frac{1}{\sqrt{2}}$ be α and β, where the inverse trigonometric functions take only principal values. If the solutions of the equation $x^2 - bx - 5 = 0$ are $\frac{1}{\alpha^2} + \frac{1}{\beta^2}$ and $\frac{\alpha}{\beta}$, then $\frac{b}{k^2}$ is equal to ______.

2. The mean and variance of 10 observations were calculated as 15 and 15 respectively by a student who took by mistake 25 instead of 15 for one observation. Then, the correct standard deviation is __________.

3. Let the line $\frac{x-3}{7}=\frac{y-2}{-1}=\frac{z-3}{-4}$ intersect the plane containing the lines $\frac{x-4}{1}=\frac{y+1}{-2}=\frac{z}{1}$ and $4ax-y+5z-7a=0 = 2x-5y-z-3$, $a \in \mathbb{R}$ at the point $P(\alpha,\beta,\gamma)$. Then the value of $\alpha+\beta+\gamma$ equals _______.

4. An ellipse $E:\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ passes through the vertices of the hyperbola $H:\frac{x^2}{49}-\frac{y^2}{64}=-1$. Let the major and minor axes of the ellipse E coincide with the transverse and conjugate axes of the hyperbola H. Let the product of the eccentricities of E and H be $\frac{1}{2}$. If l is the length of the latus rectum of the ellipse E, then the value of $113l$ *is* equal to _______.

5. Let y = y(x) be the solution curve of the differential equation

$$\sin(2x^2)\log_e(\tan x^2)dy+\left(4xy-4\sqrt{2}x\sin\left(x^2-\frac{\pi}{4}\right)\right)dx=0,$$

$0<x<\sqrt{\frac{\pi}{2}}$, which passes through the point $\left(\sqrt{\frac{\pi}{6}},1\right)$. Then $\left|y\left(\sqrt{\frac{\pi}{3}}\right)\right|$ is equal to _______.

6. Let M and N be the number of points on the curve $y^5 - 9xy + 2x = 0$, where the tangents to the curve are parallel to x-axis and y-axis, respectively. Then the value of M + N equals ________.

7. Let $f(x)=2x^2-x-1$ and $S=\{n\in\mathbb{Z}:|f(n)|\le 800\}$. Then, the value of $\sum_{n\in S} f(n)$ is equal to _________.

8. Let S be the set containing all 3 × 3 matrices with entries from {-1, 0, 1}. The total number of matrices A $\in S$ such that the sum of all the diagonal elements of $A^T A$ is 6 is __________.

9. If the length of the latus rectum of the ellipse $x^2 + 4y^2 + 2x + 8y - \lambda = 0$ is 4, and l is the length of its major axis, then $\lambda+l$ is equal to _______.

10. Let $S=\{z\in\mathbb{C}:z^2+\bar{z}=0\}$. Then $\sum_{z\in S}(\mathrm{Re}(z)+\mathrm{Im}(z))$ is equal to ______.

SET # 06

PHYSICS

SECTION-A

1. An expression of energy density is given by $u=\frac{\alpha}{\beta}\sin\left(\frac{\alpha x}{kt}\right)$, where α, β are constants, x is displacement, k is Boltzmann constant and t is the temperature. The dimensions of β will be :

(A) $[ML^2T^{-2}\theta^{-1}]$ (B) $[M^0L^2T^{-2}]$

(C) $[M^0L^0T^0]$ (D) $[M^0L^2T^0]$

2. A body of mass 10 kg is projected at an angle of 45° with the horizontal. The trajectory of the body is observed to pass through a point (20, 10). If T is the time of flight, then its momentum vector, at time $t=\frac{T}{\sqrt{2}}$, is ________

[Take $g = 10\ m/s^2$]

(A) $100\hat{i}+(100\sqrt{2}-200)\hat{j}$

(B) $100\sqrt{2}\ \hat{i}+(100-200\sqrt{2})\hat{j}$

(C) $100\ \hat{i}+(100-200\sqrt{2})\hat{j}$

(D) $100\sqrt{2}\ \hat{i}+(100\sqrt{2}-200)\hat{j}$

3. A block of mass M slides down on a rough inclined plane with constant velocity. The angle made by the incline plane with horizontal is θ. The magnitude of the contact force will be :

(A) Mg

(B) Mg cos θ

(C) $\sqrt{Mg\sin\theta+Mg\cos\theta}$

(D) $Mg\sin\theta\sqrt{1+\mu}$

4. A block 'A' takes 2 s to slide down a frictionless incline of 30° and length '*l*', kept inside a lift going up with uniform velocity '*v*'. If the incline is changed to 45°, the time taken by the block, to slide down the incline, will be approximately:

(A) 2.66 s (B) 0.83 s

(C) 1.68 s (D) 0.70 s

5. The velocity of the bullet becomes one third after it penetrates 4 cm in a wooden block. Assuming that bullet is facing a constant resistance during its motion in the block. The bullet stops completely after travelling at (4 + x) cm inside the block. The value of x is:

(A) 2.0 (B) 1.0

(C) 0. 5 (D) 1.5

6. A body of mass m is projected with velocity λv_e in vertically upward direction from the surface of the earth into space. It is given that v_e is escape velocity and λ < 1. If air resistance is considered to the negligible, then the maximum height from the centre of earth, to which the body can go, will be

(R : radius of earth)

(A) $\frac{R}{1+\lambda^2}$ (B) $\frac{R}{1-\lambda^2}$

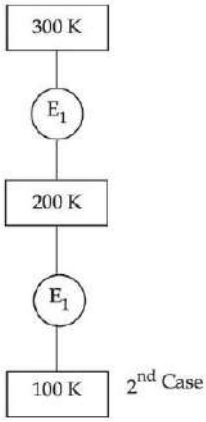
(C) $\frac{R}{1-\lambda}$ (D) $\frac{\lambda^2 R}{1-\lambda^2}$

7. A steel wire of length 3.2 m ($Y_S = 2.0\times10^{11}\ Nm^{-2}$) and a copper wire of length 4.4 M ($Y_C = 1.1\times10^{11}\ Nm^{-2}$), both of radius 1.4 mm are connected end to end. When stretched by a load, the net elongation is found to be 1.4 mm. The load applied, in Newton, will be: (Given $\pi=\frac{22}{7}$)

(A) 360 (B) 180

(C) 1080 (D) 154

8. In 1st case, Carnot engine operates between temperatures 300 K and 100 K. In 2nd case, as shown in the figure, a combination of two engines is used. The efficiency of this combination (in 2nd case) will be :



(A) same as the 1st case
(B) always greater than the 1st case
(C) always less than the 1st case
(D) may increase or decrease with respect to the 1st case

9. Which statements are correct about degrees of freedom?

A. A molecule with n degrees of freedom has n^2 different ways of storing energy.
B. Each degree of freedom is associated with $\frac{1}{2}RT$ average energy per mole.
C. A monoatomic gas molecule has 1 rotational degree of freedom where as diatomic molecule has 2 rotational degrees of freedom
D. CH_4 has a total to 6 degrees of freedom

Choose the correct answer from the option given below:

(A) B and C only (B) B and D only
(C) A and B only (D) C and D only

10. A charge of 4 μC is to be divided into two. The distance between the two divided charges is constant. The magnitude of the divided charges so that the force between them is maximum, will be:

(A) 1 μC and 3 μC
(B) 2 μC and 2 μC
(C) 0 and 4 μC
(D) 1.5 μC and 2.5 μC

11. A. The drift velocity of electrons decreases with the increase in the temperature of conductor.
B. The drift velocity is inversely proportional to the area of cross-section of given conductor.
C. The drift velocity does not depend on the applied potential difference to the conductor.
D. The drift velocity of electron is inversely proportional to the length of the conductor.
E. The drift velocity increases with the increase in the temperature of conductor.

Choose the correct answer from the options given below:

(A) A and B only (B) A and D only
(C) B and E only (D) B and C only

12. A compass needle of oscillation magnetometer oscillates 20 times per minute at a place P of dip 30°. The number of oscillations per minute become 10 at another place Q of 60° dip. The ratio of the total magnetic field at the two places ($B_Q : B_P$) is:

(A) $\sqrt{3}:4$ (B) $4:\sqrt{3}$
(C) $\sqrt{3}:2$ (D) $2:\sqrt{3}$

13. A cyclotron is used to accelerate protons. If the operating magnetic field is 1.0 T and the radius of the cyclotron 'dees' is 60 cm, the kinetic energy of the accelerated protons in MeV will be :

[use m_p = 1.6×10^{-27} kg, $e = 1.6 \times 10^{-19}$ C]

(A) 12 (B) 18
(C) 16 (D) 32

14. A series LCR circuit has L = 0.01 H, R = 10 Ω and C = 1 μF and it is connected to ac voltage of amplitude (V_m) 50 V. At frequency 60% lower than resonant frequency, the amplitude of current will be approximately :

(A) 466 mA (B) 312 mA
(C) 238 mA (D) 196 mA

15. Identify the correct statements from the following descriptions of various properties of electromagnetic waves.

A. In a plane electromagnetic wave electric field and magnetic field must be perpendicular to each other and direction of propagation of wave should be along electric field or magnetic field.

B. The energy in electromagnetic wave is divided equally between electric and magnetic fields.

C. Both electric field and magnetic field are parallel to each other and perpendicular to the direction of propagation of wave.

D. The electric field, magnetic field and direction of propagation of wave must be perpendicular to each other.

E. The ratio of amplitude of magnetic field to the amplitude of electric field is equal to speed of light.

Choose the most appropriate answer from the options given below:

(A) D only

(B) B and D only

(C) B, C and E only

(D) A, B and E only

16. Two coherent sources of light interfere. The intensity ratio of two sources is 1 : 4. For this interference pattern if the value of $\frac{I_{max}+I_{min}}{I_{max}-I_{min}}$ is equal to $\frac{2\alpha+1}{\beta+3}$, then $\frac{\alpha}{\beta}$ will be :

(A) 1.5 (B) 2 (C) 0.5 (D) 1

17. With reference to the observations in photo-electric effect, identify the correct statements from below:

A. The square of maximum velocity of photoelectrons varies linearly with frequency of incident light.

B. The value of saturation current increases on moving the source of light away from the metal surface.

C. The maximum kinetic energy of photo-electrons decreases on decreasing the power of LED (light emitting diode) source of light.

D. The immediate emission of photo-electrons out of metal surface can not be explained by particle nature of light/electromagnetic waves.

E. Existence of threshold wavelength can not be explained by wave nature of light/electromagnetic waves.

Choose the correct answer from the options given below:

(A) A and B only (B) A and E only

(C) C and E only (D) D and E only

18. The activity of a radioactive material is 6.4×10^{-4} curie. Its half life is 5 days. The activity will become 5×10^{-6} curie after :

(A) 7 days (B) 15 days

(C) 25 days (D) 35 days

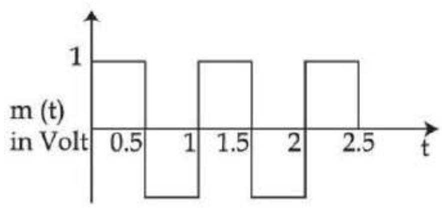
19. For a constant collector-emitter voltage of 8V, the collector current of a transistor reached to the value of 6 mA from 4 mA, whereas base current changed from 20 μA to 25 μA value. If transistor is in active state, small signal current gain (current amplification factor) will be :

(A) 240 (B) 400

(C) 0.0025 (D) 200

20. A square wave of the modulating signal is shown in the figure. The carrier wave is given by

$C(t) = 5 \sin (8\pi t)$ Volt. The modulation index is :

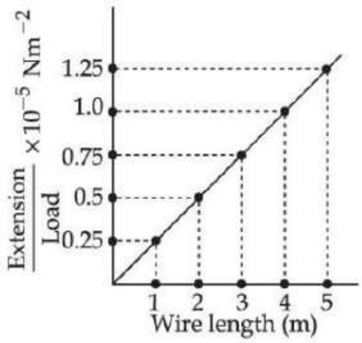


(A) 0.2 (B) 0.1

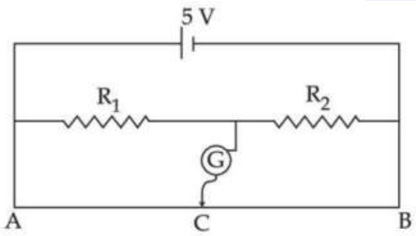
(C) 0.3 (D) 0.4

SECTION-B

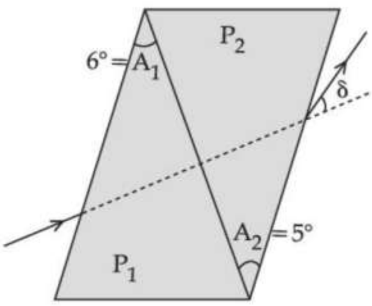
1. In an experiment to determine the Young's modulus, steel wires of five different lengths (1, 2, 3, 4 and 5 m) but of same cross section ($2\ mm^2$) were taken and curves between extension and load were obtained. The slope (extension/load) of the curves were plotted with the wire length and the following graph is obtained. If the Young's modulus of given steel wires is $x \times 10^{11}\ Nm^{-2}$, then the value of x is ________ .



2. In the given figure of meter bridge experiment, the balancing length AC corresponding to null deflection of the galvanometer is 40 cm. The balancing length, if the radius of the wire AB is doubled, will be……….cm.

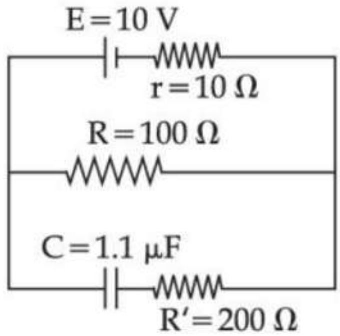


3. A thin prism of angle 6° and refractive index for yellow light (n_Y)1.5 is combined with another prism of angle 5° and n_Y = 1.55. The combination produces no dispersion. The net average deviation (δ) produced by the combination is $\left(\frac{1}{x}\right)^{\circ}$. The value of x is…….



4. A conducting circular loop is placed in X – Y plane in presence of magnetic field $\vec{B} = \left(3t^3\hat{j} + 3t^2\hat{k}\right)$ in SI unit. If the radius of the loop is 1m, the induced emf in the loop, at time, t = 2s is nπV. The value of n is……..

5. As show in the figure, in steady state, the charge stored in the capacitor is ……. × 10^{-6}C.



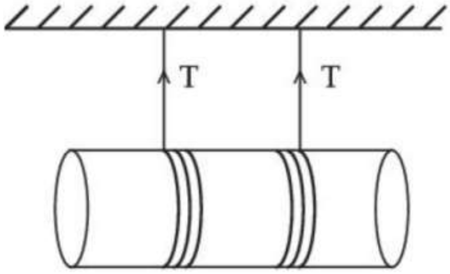
6. A parallel plate capacitor with width 4 cm, length 8 cm and separation between the plates of 4mm is connected to a battery of 20 V. A dielectric slab of dielectric constant 5 having length 1cm, width 4 cm and thickness 4 mm is inserted between the plates of parallel plate capacitor. The electrostatic energy of this system will be………ϵ_0 J. (Where ϵ_0 is the permittivity of free space)

7. A wire of length 30 cm, stretched between rigid supports, has it's n^{th} and $(n + 1)^{th}$ harmonics at 400 Hz and 450 Hz, respectively. If tension in the string is 2700 N, it's linear mass density is……..kg/m.

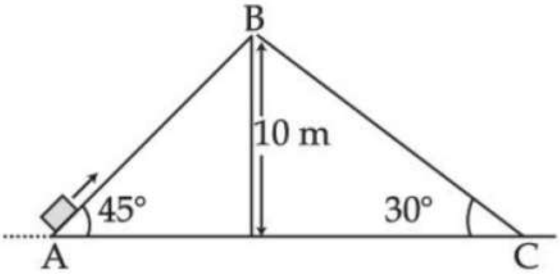
8. A spherical soap bubble of radius 3 cm is formed inside another spherical soap bubble of radius 6 cm. If the internal pressure of the smaller bubble of radius 3 cm in the above system is equal to the internal pressure of the another single soap bubble of radius r cm. The value of r is…….

9. A solid cylinder length is suspended symmetrically through two massless strings, as shown in the figure. The distance from the initial rest position, the cylinder should by unbinding the strings to achieve a speed of 4 ms^{-1}, is.......cm.

(take g = 10 ms^{-2})



10. Two inclined planes are placed as shown in figure. A block is projected from the Point A of inclined plane AB along its surface with a velocity just sufficient to carry it to the top Point B at a height 10 m. After reaching the Point B the block slides down on inclined plane BC. Time it takes to reach to the point C from point A is $t(\sqrt{2}+1)$s. The value of t is........(use g = 10 m/s^2)



CHEMISTRY
SECTION-A

1. The correct decreasing order of energy, for the orbitals having, following set of quantum numbers:

(A) n = 3, l = 0, m = 0

(B) n = 4, l = 0, m = 0

(C) n = 3, l = 1, m = 0

(D) n = 3, l = 2, m = 1

(A) (D) > (B) > (C) > (A)

(B) (B) > (D) > (C) > (A)

(C) (C) > (B) > (D) > (A)

(D) (B) > (C) > (D) > (A)

2. Match List-I with List-II

List-I	List-II
(A) $\Psi_{MO} = \Psi_A - \Psi_B$	(I) Dipole moment
(B) $\mu = Q \times r$	(II) Bonding molecular orbital
(C) $\frac{N_b - N_a}{2}$	(III) Anti-bonding molecular orbital
(D) $\Psi_{MO} = \Psi_A + \Psi_B$	(IV) Bond order

(A) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

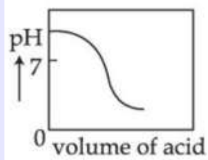
(B) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(C) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

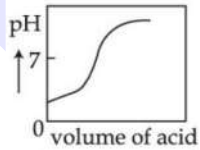
(D) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

3. The Plot of pH-metric titration of weak base NH_4OH vs strong acid HCl looks like:

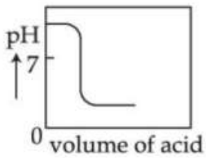
(A)



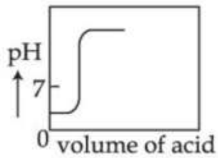
(B)



(C)



(D)



4. Given below are two statements:

Statement I: For KI, molar conductivity increases steeply with dilution.

Statement II: For carbonic acid, molar conductivity increases slowly with dilution.

In the light of the above statements, choose the **correct** answer from the options given below:

(A) Both **Statement I** and **Statement II** are true

(B) Both **Statement I** and **Statement II** are false

(C) **Statement I** is true but **Statement II** is false

(D) **Statement I** is false but **Statement II** is true

5. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**

Assertion (A) : Dissolved substances can be removed from a colloidal solution by diffusion through a parchment paper.

Reason (R) : Particles in a true solution cannot pass through parchment paper but the collodial particles can pass through the parchment paper.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

(B) Both **(A)** and **(R)** are correct but **(R)** is not the correct explanation of **(A)**

(C) **(A)** is correct but **(R)** is not correct

(D) **(A)** is not correct but **(R)** is correct

6. Outermost electronic configurations of four elements A, B, C, D are given below:

(A) $3s^2$ (B) $3s^2 3p^1$

(C) $3s^2 3p^3$ (D) $3s^2 3p^4$

The **correct** order of first ionization enthalpy for them is:

(A) (A) < (B) < (C) < (D)

(B) (B) < (A) < (D) < (C)

(C) (B) < (D) < (A) < (C)

(D) (B) < (A) < (C) < (D)

7. An element A of group 1 shows similarity to an element B belonging to group 2. If A has maximum hydration enthalpy in group 1 then B is:

(A) Mg (B) Be

(C) Ca (D) Sr

8. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**

Assertion (A) : Boron is unable to form BF_6^{3-}

Reason (R) : Size of B is very small.

In the light of the above statements, choose the **correct** answer from the options given below:

(A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**

(B) Both **(A)** and **(R)** are true but **(R)** is **not** the correct explanation of **(A)**

(C) **(A)** is true but **(R)** is false

(D) **(A)** is false but **(R)** is true

9. In neutral or alkaline solution, MnO_4^- oxidises thiosulphate to:

(A) $S_2O_7^{2-}$ (B) $S_2O_8^{2-}$

(C) SO_3^{2-} (D) SO_4^{2-}

10. Low oxidation state of metals in their complexes are common when ligands:

(A) have good π -accepting character

(B) have good σ -donor character

(C) are havind good π -donating ability

(D) are havind poor σ -donating ability

11. Given below are two statements:

Statement I : The non bio-degradable fly ash and slag from steel industry can be used by cement industry.

Statement II : The fuel obtained from plastic waste is lead free.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

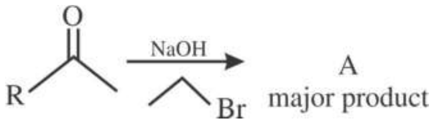
(A) Both **Statement I** and **Statement II** are correct

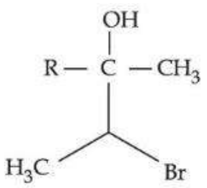
(B) Both **Statement I** and **Statement II** are incorrect

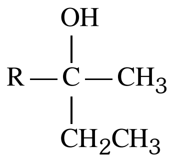
(C) **Statement I** is correct but **Statement II** is incorrect

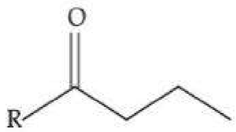
(D) **Statement I** is incorrect but **Statement II** is correct

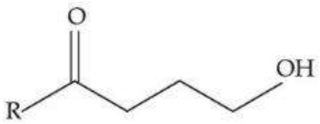
12. The structure of A in the given reaction is:



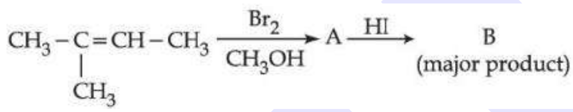
(A) 

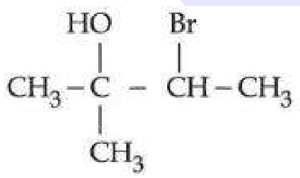
(B) 

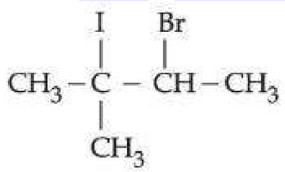
(C) 

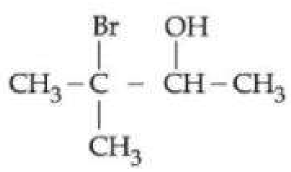
(D) 

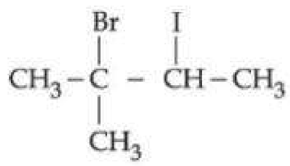
13. Major product 'B' of the following reaction sequence is:



(A) 

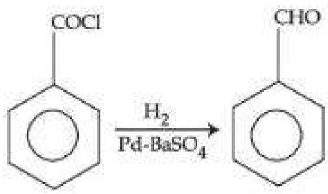
(B) 

(C) 

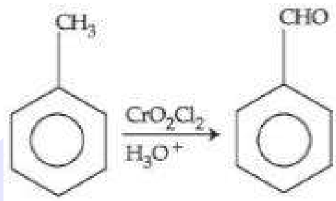
(D) 

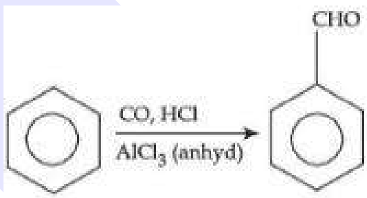
14. Match List-I with List-II.

List-I

(A) 

(B) $CH_3-CN \xrightarrow[H_3O^+]{SnCl_2/HCl} CH_3-CHO$

(C) 

(D) 

Lits-II

(I) Gatterman Koch reaction

(II) Etard reaction

(III) Stephen reaction

(IV) Rosenmund reaction

Choose the **correct** answer from the options given below:

(A) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(B) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(C) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(D) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

15. Match List-I with List-II.

List-I **(Polymer)**	**List-II** **(Monomer)**
(A) Neoprene	(I) Acrylonitrile
(B) Teflon	(II) Chloroprene
(C) Acrilan	(III) Tetrafluoroethene
(D) Natural rubber	(IV) Isoprene

Choose the correct answer from the option given below:

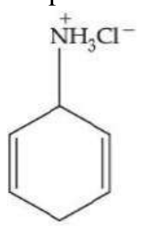
(A) (A)-(II), (B)-(III), (C)-(I), (D-(IV)

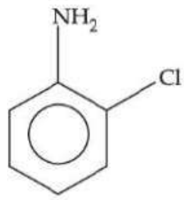
(B) (A)-(II), (B)-(I), (C)-(III), (D-(IV)

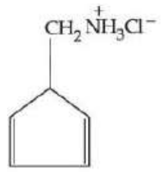
(C) (A)-(II), (B)-(I), (C)-(IV), (D-(III)

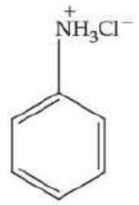
(D) (A)-(I), (B)-(II), (C)-(III), (D-(IV)

16. An organic compound 'A' contains nitrogen and chlorine. It dissolves readily in water to give a solution that turns litmus red. Titration of compound 'A' with standard base indicates that the molecular weight of 'A' is 131 ± 2. When a sample of 'A' is treated with aq. NaOH, a liquid separates which contains N but not Cl. Treatment of the obtained liquid with nitrous acid followed by phenol gives orange precipitate. The compound 'A' is :

(A) 

(B) 

(C) 

(D) 

17. Match List-I with List-II

List-I

(A) Glucose + HI

(B) Glucose + Br_2 water

(C) Glucose + acetic anhydride

(D) Glucose + HNO_3

List-II

(I) Gluconic acid

(II) Glucose pentacetate

(III) Saccharic acid

(IV) Hexane

Choose the correct answer from the options given below:

(A) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

(B) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(C) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(D) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)

18. Which of the following enhances the lathering property of soap?

(A) Sodium stearate

(B) Sodium carbonate

(C) Sodium rosinate

(D) Trisodium phosphate

19. Match List-I with List-II

List-I (Mixture)

(A) Chloroform & Aniline

(B) Benzoic acid & Napthalene

(C) Water & Aniline

(D) Napthalene & Sodium chloride

List-II (Purification Process)

(I) Steam distillation

(II) Sublimation

(III) Distillation

(IV) Crystallisation

(A) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

(B) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(C) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

(D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

20. Fe^{3+} cation gives a prussian blue precipitate on addition of potassium ferrocyanide solution due to the formation of:

(A) $[Fe(H_2O)_6]_2\,[Fe(CN)_6]$

(B) $Fe_2[Fe(CN)_6]_2$

(C) $Fe_3[Fe(OH)_2(CN)_4]_2$

(D) $Fe_4[Fe(CN)_6]_3$

SECTION-B

1. The normality of H_2SO_4 in the solution obtained on mixing 100 mL of 0.1 M H_2SO_4 with 50 mL of 0.1 M NaOH is_______ $\times 10^{-1}$ N. (Nearest Integer)

2. for a real gas at 25°C temperature and high pressure (99 bar) the value of compressibility factor is 2, so the value of Vander Waal's constant 'b' should be________ $\times 10^{-2}$ L mol^{-1} (Nearest integer)

(Given R = 0.083 L bar K^{-1} mol^{-1})

3. A gas (Molar mass = 280 g mol^{-1}) was burnt in excess O_2 in a constant volume calorimeter and during combustion the temperature of calorimeter increased from 298.0 K to 298.45 K. If the heat capacity of calorimeter is 2.5 kJ K^{-1} and enthalpy of combustion of gas is 9 kJ mol^{-1} then amount of gas burnt is_______g. (Nearest Integer)

4. When a certain amount of solid A is dissolved in 100 g of water at 25°C to make a dilute solution, the vapour pressure of the solution is reduced to one-half of that of pure water. The vapour pressure of pure water is 23.76 mmHg. The number of moles of solute A added is________. (Nearest Integer)

5. [A] $\rightarrow$ [B]

Reactant Product

If formation of compound [B] follows the first order of kinetics and after 70 minutes the concentration of [A] was found to be half of its initial concentration. Then the rate constant of the reaction is $x \times 10^{-6}\ s^{-1}$. The value of x is______. (Nearest Integer)

6. Among the following ores Bauxite, Siderite, Cuprite, Calamine, Haematite, Kaolinite, Malachite, Magnetite, Sphalerite, Limonite, Cryolite, the number of principal ores if (of) iron is_______.

7. The oxidation state of manganese in the product obtained in a reaction of potassium permanganate and hydrogen peroxide in basic medium is______.

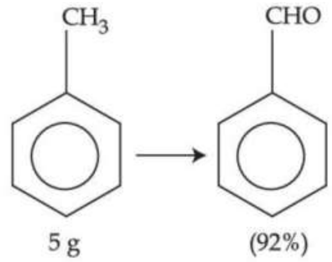
8. The number of molecule(s) or ion(s) from the following having non-planar structure is______.

$NO_3^-, H_2O_2, BF_3, PCl_3, XeF_4,$

$SF_4, XeO_3, PH_4^+, SO_3, [Al(OH)_4]^-$

9. The spin only magnetic moment of the complex present in Fehling's reagent is______ B.M. (Nearest integer).

10.



In the above reaction, 5 g of toluene is converted into benzaldehyde with 92% yield. The amount of benzaldehyde produced is______$\times 10^{-2}$ g. (Nearest integer)

MATHEMATICS

SECTION-A

1. The domain of the function

$$f(x) = \sin^{-1}[2x^2 - 3] + \log_2\left(\log_{\frac{1}{2}}\left(x^2 - 5x + 5\right)\right),$$

where [t] is the greatest integer function, is :

(A) $\left(-\sqrt{\frac{5}{2}}, \frac{5-\sqrt{5}}{2}\right)$

(B) $\left(\frac{5-\sqrt{5}}{2}, \frac{5+\sqrt{5}}{2}\right)$

(C) $\left(1, \frac{5-\sqrt{5}}{2}\right)$

(D) $\left[1, \frac{5+\sqrt{5}}{2}\right)$

2. Let S be the set of all (α, β), $\pi < \alpha, \beta < 2\pi$, for which the complex number $\frac{1 - i\sin\alpha}{1 + 2i\sin\alpha}$ is purely imaginary and $\frac{1 + i\cos\beta}{1 - 2i\cos\beta}$ is purely real. Let $Z_{\alpha\beta} = \sin 2\alpha + i\cos 2\beta, (\alpha, \beta) \in S$.

Then $\sum_{(\alpha,\beta)\in S}\left(iZ_{\alpha\beta} + \frac{1}{i\overline{Z}_{\alpha\beta}}\right)$ is equal to :

(A) 3 (B) 3 i

(C) 1 (D) 2 – i

3. If α, β are the roots of the equation

$$x^2 - \left(5 + 3^{\sqrt{\log_3 5}} - 5^{\sqrt{\log_5 3}}\right) + 3\left(3^{(\log_3 5)^{\frac{1}{3}}} - 5^{(\log_5 3)^{\frac{2}{3}}} - 1\right) = 0$$

then the equation, whose roots are

$\alpha + \frac{1}{\beta}$ and $\beta + \frac{1}{\alpha}$,

(A) $3x^2 - 20x - 12 = 0$
(B) $3x^2 - 10x - 4 = 0$
(C) $3x^2 - 10x + 2 = 0$
(D) $3x^2 - 20x + 16 = 0$

4. Let $A = \begin{pmatrix} 4 & -2 \\ \alpha & \beta \end{pmatrix}$

If $A^2 + \gamma A + 18I = O$, then det (A) is equal to ____________.

(A) –18 (B) 18 (C) –50 (D) 50

5. If for $p \neq q \neq 0$, then function

$f(x) = \dfrac{\sqrt[7]{p(729+x)} - 3}{\sqrt[3]{729+qx} - 9}$ is continuous at x = 0,

then:

(A) $7pq\, f(0) - 1 = 0$ (B) $63q\, f(0) - p^2 = 0$
(C) $21q\, f(0) - p^2 = 0$ (D) $7pq\, f(0) - 9 = 0$

6. Let $f(x) = 2 + |x| - |x - 1| + |x + 1|$, $x \in \mathbf{R}$.
Consider

$(S1): f'\left(-\frac{3}{2}\right) + f'\left(-\frac{1}{2}\right) + f'\left(\frac{1}{2}\right) + f'\left(\frac{3}{2}\right) = 2$

$(S2): \int_{-2}^{2} f(x)dx = 12$

Then,
(A) both (S1) and (S2) are correct
(B) both (S1) and (S2) are wrong
(C) only (S1) is correct
(D) only (S2) is correct

7. Let the sum of an infinite G.P., whose first term is a and the common ratio is r, be 5. Let the sum of its first five terms be $\frac{98}{25}$. Then the sum of the first 21 terms of an AP, whose first term is 10ar, n^{th} term is a_n and the common difference is $10ar^2$, is equal to :

(A) $21\, a_{11}$ (B) $22\, a_{11}$
(C) $15\, a_{16}$ (D) $14\, a_{16}$

8. The area of the region enclosed by $y \leq 4x^2, x^2 \leq 9y$ and $y \leq 4$, is equal to :

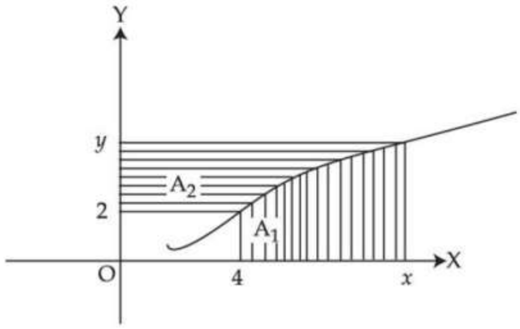
(A) $\frac{40}{3}$ (B) $\frac{56}{3}$
(C) $\frac{112}{3}$ (D) $\frac{80}{3}$

9. $\int_0^2 \left(\left|2x^2 - 3x\right| + \left[x - \frac{1}{2}\right]\right) dx$,

where [t] is the greatest integer function, is equal to:

(A) $\frac{7}{6}$ (B) $\frac{19}{12}$ (C) $\frac{31}{12}$ (D) $\frac{3}{2}$

10. Consider a curve y = y(x) in the first quadrant as shown in the figure. Let the area A_1 is twice the area A_2. Then the normal to the curve perpendicular to the line 2x – 12y = 15 does **NOT** pass through the point.



(1) (6, 21) (2) (8, 9)
(3) (10, –4) (4) (12, –15)

11. The equations of the sides AB, BC and CA of a triangle ABC are 2x + y = 0, x + py = 39 and x – y = 3 respectively and P(2, 3) is its circumcentre. Then which of the following is NOT true :

(A) $(AC)^2 = 9p$
(B) $(AC)^2 + p^2 = 136$
(C) $32 < \text{area}(\Delta ABC) < 36$
(D) $34 < \text{area}(\Delta ABC) < 38$

12. A circle C_1 passes through the origin O and has diameter 4 on the positive x-axis. The line y = 2x gives a chord OA of a circle C_1. Let C_2 be the circle with OA as a diameter. If the tangent to C_2 at the point A meets the x-axis at P and y-axis at Q, then QA : AP is equal to :

(A) 1 : 4 (B) 1 : 5
(C) 2 : 5 (D) 1 : 3

13. If the length of the latus rectum of a parabola, whose focus is (a, a) and the tangent at its vertex is x + y = a, is 16, then |a| is equal to :

(A) $2\sqrt{2}$ (B) $2\sqrt{3}$

(C) $4\sqrt{2}$ (D) 4

14. If the length of the perpendicular drawn from the point P(a, 4, 2), a > 0 on the line $\frac{x+1}{2}=\frac{y-3}{3}=\frac{z-1}{-1}$ is $2\sqrt{6}$ units and $Q(\alpha_1, \alpha_2, \alpha_3)$ is the image of the point P in this line, then $a+\sum_{i=1}^{3}\alpha_i$ is equal to :

(A) 7 (B) 8

(C) 12 (D) 14

15. If the line of intersection of the planes $ax+by=3$ and $ax+by+cz=0$, a > 0 makes an angle 30° with the plane $y-z+2=0$, then the direction cosines of the line are :

(A) $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0$ (B) $\frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}, 0$

(C) $\frac{1}{\sqrt{5}}, -\frac{2}{\sqrt{5}}, 0$ (D) $\frac{1}{2}, -\frac{\sqrt{3}}{2}, 0$

16. Let X have a binomial distribution B(n, p) such that the sum and the product of the mean and variance of X are 24 and 128 respectively. If $P(X > n-3)=\frac{k}{2^n}$, then k is equal to

(A) 528 (B) 529

(C) 629 (D) 630

17. A six faced die is biased such that 3 × P(a prime number) = 6 × P(a composite number) = 2 × P(1). Let X be a random variable that counts the number of times one gets a perfect square on some throws of this die. If the die is thrown twice, then the mean of X is :

(A) $\frac{3}{11}$ (B) $\frac{5}{11}$

(C) $\frac{7}{11}$ (D) $\frac{8}{11}$

18. The angle of elevation of the top P of a vertical tower PQ of height 10 from a point A on the horizontal ground is 45°. Let R be a point on AQ and from a point B, vertically above R, the angle of elevation of P is 60°. If ∠BAQ = 30°, AB = d and the area of the trapezium PQRB is α, then the ordered pair (d, α) is :

(A) $\left(10\left(\sqrt{3}-1\right), 25\right)$

(B) $\left(10\left(\sqrt{3}-1\right), \frac{25}{2}\right)$

(C) $\left(10\left(\sqrt{3}+1\right), 25\right)$

(D) $\left(10\left(\sqrt{3}+1\right), \frac{25}{2}\right)$

19. Let

$$S=\left\{\theta \in \left(0,\frac{\pi}{2}\right) : \sum_{m=1}^{9} \sec\left(\theta+(m-1)\frac{\pi}{6}\right)\sec\left(\theta+\frac{m\pi}{6}\right)=-\frac{8}{\sqrt{3}}\right\}$$

Then

(A) $S=\left\{\frac{\pi}{12}\right\}$ (B) $S=\left\{\frac{2\pi}{3}\right\}$

(C) $\sum_{\theta \in S}\theta=\frac{\pi}{2}$ (D) $\sum_{\theta \in S}\theta=\frac{3\pi}{4}$

20. If the truth value of the statement $\left(P \wedge (\sim R)\right) \rightarrow \left((\sim R) \wedge Q\right)$ is F, then the truth value of which of the following is F ?

(A) $P \vee Q \rightarrow \sim R$ (B) $R \vee Q \rightarrow \sim P$

(C) $\sim(P \vee Q) \rightarrow \sim R$ (D) $\sim(R \vee Q) \rightarrow \sim P$

SECTION-B

1. Consider a matrix

$$A=\begin{bmatrix} \alpha & \beta & \gamma \\ \alpha^2 & \beta^2 & \gamma^2 \\ \beta+\gamma & \gamma+\alpha & \alpha+\beta \end{bmatrix}$$, where α, β, γ are three distinct natural numbers.

If $\frac{\det\left(\operatorname{adj}\left(\operatorname{adj}\left(\operatorname{adj}\left(\operatorname{adj}A\right)\right)\right)\right)}{(\alpha-\beta)^{16}(\beta-\gamma)^{16}(\gamma-\alpha)^{16}}=2^{32}\times 3^{16}$,

then the number of such 3 – tuples (α, β, γ) is ________ .

2. The number of functions f, from the set $A = \{x \in N : x^2 - 10x + 9 \le 0\}$ to the set $B = \{n^2 : n \in N\}$ such that $f(x) \le (x-3)^2 + 1$, for every $x \in A$, is ________ .

3. Let for the 9^{th} term in the binomial expansion of $(3 + 6x)^n$, in the increasing powers of 6x, to be the greatest for $x = \frac{3}{2}$, the least value of n is n_0. If k is the ratio of the coefficient of x^6 to the coefficient of x^3, then $k + n_0$ is equal to:

4. $\frac{2^3 - 1^3}{1 \times 7} + \frac{4^3 - 3^3 + 2^3 - 1^3}{2 \times 11} + \frac{6^3 - 5^3 + 4^3 - 3^3 + 2^3 - 1^3}{3 \times 15} + ... + \frac{30^3 - 29^3 + 28^3 - 27^3 + ... + 2^3 - 1^3}{15 \times 63}$ is equal to _____.

5. A water tank has the shape of a right circular cone with axis vertical and vertex downwards. Its semi-vertical angle is $\tan^{-1}\frac{3}{4}$. Water is poured in it at a constant rate of 6 cubic meter per hour. The rate (in square meter per hour), at which the wet curved surface area of the tank is increasing, when the depth of water in the tank is 4 meters, is ________.

6. For the curve C : $(x^2 + y^2 - 3) + (x^2 - y^2 - 1)^5 = 0$, the value of $3y' - y^3y''$, at the point (α, α), $\alpha > 0$, on C, is equal to ________.

7. Let $f(x) = \min\{[x - 1], [x - 2], \ldots, [x - 10]\}$ where [t] denotes the greatest integer $\le$ t. Then $\int_0^{10} f(x)dx + \int_0^{10} (f(x))^2 dx + \int_0^{10} |f(x)|dx$ is equal to ___.

8. Let f be a differentiable function satisfying $f(x) = \frac{2}{\sqrt{3}}\int_0^{\sqrt{3}} f\left(\frac{\lambda^2 x}{3}\right)d\lambda$, $x > 0$ and $f(1) = \sqrt{3}$. If y=f(x) passes through the point $(\alpha, 6)$, then α is equal to ______.

9. A common tangent T to the curves $C_1 : \frac{x^2}{4} + \frac{y^2}{9} = 1$ and $C_2 : \frac{x^2}{42} - \frac{y^2}{143} = 1$ does not pass through the fourth quadrant. If T touches C_1 at (x_1, y_1) and C_2 at (x_2, y_2), then $|2x_1 + x_2|$ is equal to _______.

10. Let $\vec{a}, \vec{b}, \vec{c}$ be three non-coplanar vectors such that $\vec{a} \times \vec{b} = 4\vec{c}$, $\vec{b} \times \vec{c} = 9\vec{a}$ and $\vec{c} \times \vec{a} = \alpha\vec{b}$, $\alpha > 0$. If $|\vec{a}| + |\vec{b}| + |\vec{c}| = \frac{1}{36}$, then α is equal to ______.

SET # 07

PHYSICS
SECTION-A

1. The dimensions of $\left(\dfrac{B^2}{\mu_0}\right)$ will be :

(if μ_0 : permeability of free space and

B : magnetic field)

(A) $[M L^2 T^{-2}]$ (B) $[M L T^{-2}]$

(C) $[M L^{-1} T^{-2}]$ (D) $[M L^2 T^{-2} A^{-1}]$

2. A NCC parade is going at a uniform speed of 9 km/h under a mango tree on which a monkey is sitting at a height of 19.6 m. At any particular instant, the monkey drops a mango. A cadet will receive the mango whose distance from the tree at time of drop is : (Given $g = 9.8\ m/s^2$)

(A) 5 m (B) 10 m

(C) 19.8 m (D) 24.5 m

3. In two different experiments, an object of mass 5 kg moving with a speed of 25 ms^{-1} hits two different walls and comes to rest within

(i) 3 second, (ii) 5 seconds, respectively.

Choose the correct option out of the following :

(A) Impulse and average force acting on the object will be same for both the cases.

(B) Impulse will be same for both the cases but the average force will be different.

(C) Average force will be same for both the cases but the impulse will be different.

(D) Average force and impulse will be different for both the cases.

4. A balloon has mass of 10 g in air. The air escapes from the balloon at a uniform rate with velocity 4.5 cm/s. If the balloon shrinks in 5 s completely. Then, the average force acting on that balloon will be (in dyne).

(A) 3 (B) 9

(C) 12 (D) 18

5. If the radius of earth shrinks by 2% while its mass remains same. The acceleration due to gravity on the earth's surface will approximately :

(A) decrease by 2% (B) decrease by 4%

(C) increase by 2% (D) increase by 4%

6. The force required to stretch a wire of cross-section 1 cm^2 to double its length will be :

(Given Yong's modulus of the wire $= 2 \times 10^{11}\ N/m^2$)

(A) 1×10^7 N (B) 1.5×10^7 N

(C) 2×10^7 N (D) 2.5×10^7 N

7. A Carnot engine has efficiency of 50%. If the temperature of sink is reduced by 40°C, its efficiency increases by 30%. The temperature of the source will be :

(A) 166.7 K (B) 255.1 K

(C) 266.7 K (D) 367.7 K

8. Given below are two statements :

Statement I : The average momentum of a molecule in a sample of an ideal gas depends on temperature.

Statement II : The rms speed of oxygen molecules in a gas is v. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become 2v.

In the light of the above statements, choose the correct answer from the options given below :

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

9. In the wave equation

$$y = 0.5\sin\frac{2\pi}{\lambda}(400t - x)\,m$$

the velocity of the wave will be :

(A) 200 m/s (B) $200\sqrt{2}$ m/s

(C) 400 m/s (D) $400\sqrt{2}$ m/s

10. Two capacitors, each having capacitance $40\ \mu F$ are connected in series. The space between one of the capacitors is filled with dielectric material of dielectric constant K such that the equivalence capacitance of the system became $24\ \mu F$. The value of K will be :

(A) 1.5 (B) 2.5
(C) 1.2 (D) 3

11. A wire of resistance R_1 is drawn out so that its length is increased by twice of its original length. The ratio of new resistance to original resistance is:

(A) 9 : 1 (B) 1 : 9
(C) 4 : 1 (D) 3 : 1

12. The current sensitivity of a galvanometer can be increased by :

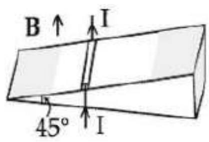
(A) decreasing the number of turns
(B) increasing the magnetic field
(C) decreasing the area of the coil
(D) decreasing the torsional constant of the spring

Choose the most appropriate answer from the options given below :

(A) (B) and (C) only
(B) (C) and (D) only
(C) (A) and (C) only
(D) (B) and (D) only

13. As shown in the figure, a metallic rod of linear density $0.45\ kg\ m^{-1}$ is lying horizontally on a smooth incline plane which makes an angle of 45° with the horizontal. The minimum current flowing in the rod required to keep it stationary, when 0.15 T magnetic field is acting on it in the vertical upward direction, will be :

{Use $g = 10\ m/s^2$}



(A) 30 A (B) 15 A
(C) 10 A (D) 3 A

14. The equation of current in a purely inductive circuit is $5\sin(49\pi t - 30°)$. If the inductance is 30 mH then the equation for the voltage across the inductor, will be :

$\left\{\text{Let } \pi = \frac{22}{7}\right\}$

(A) $1.47\sin(49\pi t - 30°)$

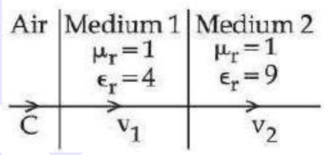
(B) $1.47\sin(49\pi t + 60°)$

(C) $23.1\sin(49\pi t - 30°)$

(D) $23.1\sin(49\pi t + 60°)$

15. As shown in the figure, after passing through the medium 1. The speed of light v_2 in medium 2 will be :

(Given $c = 3 \times 10^8\ ms^{-1}$)



(A) $1.0 \times 10^8\ ms^{-1}$ (B) $0.5 \times 10^8\ ms^{-1}$

(C) $1.5 \times 10^8\ ms^{-1}$ (D) $3.0 \times 10^8\ ms^{-1}$

16. In normal adjustment, for a refracting telescope, the distance between objective and eye piece is 30 cm. The focal length of the objective, when the angular magnification of the telescope is 2, will be:

(A) 20 cm (B) 30 cm
(C) 10 cm (D) 15 cm

17. The equation $\lambda = \frac{1.227}{x}$ nm can be used to find the de-Brogli wavelength of an electron. In this equation x stands for :

Where,

m = mass of electron

P = momentum of electron

K = Kinetic energy of electron

V = Accelerating potential in volts for electron

(A) $\sqrt{mK}$ (B) $\sqrt{P}$

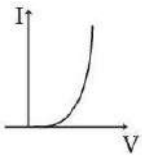
(C) $\sqrt{K}$ (D) $\sqrt{V}$

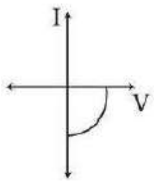
18. The half life period of a radioactive substance is 60 days. The time taken for $\frac{7}{8}$th of its original mass to disintegrate will be :

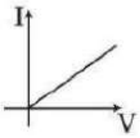
(A) 120 days (B) 130 days

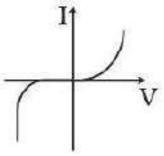
(C) 180 days (D) 20 days

19. Identify the solar cell characteristics from the following options :

(A) 

(B) 

(C) 

(D) 

20. In the case of amplitude modulation to avoid distortion the modulation index (μ) should be :

(A) $\mu \le 1$ (B) $\mu \ge 1$

(C) $\mu = 2$ (D) $\mu = 0$

SECTION-B

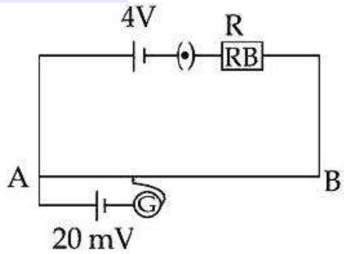
1. If the projection of $2\hat{i}+4\hat{j}-2\hat{k}$ on $\hat{i}+2\hat{j}+\alpha\hat{k}$ is zero. Then, the value of α will be

2. A freshly prepared radioactive source of half life 2 hours 30 minutes emits radiation which is 64 times the permissible safe level. The minimum time, after which it would be possible to work safely with source, will be ________ hours.

3. In a Young's double slit experiment, a laser light of 560 nm produces an interference pattern with consecutive bright fringes' separation of 7.2 mm. Now another light is used to produce an interference pattern with consecutive bright fringes' separation of 8.1 mm. The wavelength of second light is _________ nm.

4. The frequencies at which the current amplitude in an LCR series circuit becomes $\frac{1}{\sqrt{2}}$ times its maximum value, are 212 rad s^{-1} and 232 rad s^{-1}. The value of resistance in the circuit is $R = 5\Omega$. The self inductance in the circuit is ________ mH.

5. As shown in the figure, a potentiometer wire of resistance 20Ω and length 300 cm is connected with resistance box (R.B.) and a standard cell of emf 4 V. For a resistance 'R' of resistance box introduced into the circuit, the null point for a cell of 20 mV is found to be 60 cm. The value of 'R' is __________Ω.



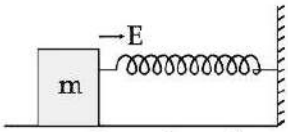
6. Two electric dipoles of dipole moments 1.2×10^{-30} cm and 2.4×10^{-30} cm are placed in two difference uniform electric fields of strengths 5×10^4 NC^{-1} and 15×10^4 NC^{-1} respectively. The ratio of maximum torque experienced by the electric dipoles will be $\frac{1}{x}$.

The value of x is _______.

7. The frequency of echo will be _________ Hz if the train blowing a whistle of frequency 320 Hz is moving with a velocity of 36 km/h towards a hill from which an echo is heard by the train driver. Velocity of sound in air is 330 m/s.

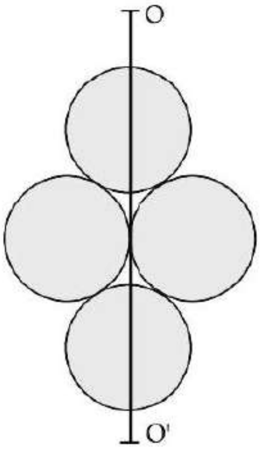
8. The diameter of an air bubble which was initially 2 mm, rises steadily through a solution of density 1750 kg m^{-3} at the rate of 0.35 cms^{-1}. The coefficient of viscosity of the solution is _______ poise (in nearest integer). (the density of air is negligible).

9. A block of mass 'm' (as shown in figure) moving with kinetic energy E compresses a spring through a distance 25 cm when, its speed is halved. The value of spring constant of used spring will be nE Nm^{-1} for n = ___________.



Smooth surface

10. Four identical discs each of mass 'M' and diameter 'a' are arranged in a small plane as shown in figure. If the moment of inertia of the system about OO' is $\frac{x}{4}Ma^2$. Then, the value of x will be _____.



CHEMISTRY
SECTION-A

1. Identify the incorrect statement from the following.

(A) A circular path around the nucleus in which an electron moves is proposed as Bohr's orbit.

(B) An orbital is the one electron wave function (Ψ) in an atom.

(C) The existence of Bohr's orbits is supported by hydrogen spectrum.

(D) Atomic orbital is characterised by the quantum numbers n and l only

2. Which of the following relation is not correct?

(A) $\Delta H = \Delta U - P\Delta V$ (B) $\Delta U = q + W$

(C) $\Delta S_{sys} + \Delta S_{surr} \geq 0$ (D) $\Delta G = \Delta H - T\Delta S$

3. Match List-I with List-II.

	List-I		List-II
(A)	$Cd(s) + 2Ni(OH)_3(s) \rightarrow CdO(s) + 2Ni(OH)_2(s) + H_2O(l)$	(I)	Primary battery
(B)	$Zn(Hg) + HgO(s) \rightarrow ZnO(s) + Hg(l)$	(II)	Discharging of secondary battery
(C)	$2PbSO_4(s) + 2H_2O(l) \rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4(aq)$	(III)	Fuel cell
(D)	$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	(IV)	Charging of secondary battery

Choose the correct answer from the options given below :

(A) (A) – (I), (B) – (II), (C) – (III), (D) – (IV)

(B) (A) – (IV), (B) – (I), (C) – (II), (D) – (III)

(C) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

(D) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

4. Match List-I with List-II.

	List-I Reaction		List-II Catalyst
(A)	$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$	(I)	NO(g)
(B)	$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(II)	$H_2SO_4(l)$
(C)	$C_{12}H_{22}O_{11}(aq) + H_2O(l) \rightarrow C_6H_{12}O_6$ (Glucose) + $C_6H_{12}O_6$ (Fructose)	(III)	Pt(s)
(D)	$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$	(IV)	Fe(s)

Choose the correct answer from the options given below :

(A) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

(B) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

(C) (A) – (III), (B) – (IV), (C) – (II), (D) – (I)

(D) (A) – (III), (B) – (II), (C) – (IV), (D) – (I)

5. In which of the following pairs, electron gain enthalpies of constituent elements are nearly the same or identical ?

(A) Rb and Cs (B) Na and K

(C) Ar and Kr (D) I and At

Choose the correct answer from the options given below :

(A) (A) and (B) only

(B) (B) and (C) only

(C) (A) and (C) only

(D) (C) and (D) only

6. Which of the reaction is suitable for concentrating ore by leaching process ?

(A) $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$

(B) $Fe_3O_4 + CO \rightarrow 3FeO + CO_2$

(C) $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2Na[Al(OH)_4]$

(D) $Al_2O_3 + 6Mg \rightarrow 6MgO + 4Al$

7. The metal salts formed during softening of hardwater using Clark's method are :

(A) $Ca(OH)_2$ and $Mg(OH)_2$

(B) $CaCO_3$ and $Mg(OH)_2$

(C) $Ca(OH)_2$ and $MgCO_3$

(D) $CaCO_3$ and $MgCO_3$

8. Which of the following statement is incorrect?

(A) Low solubility of LiF in water is due to its small hydration enthalpy.

(B) KO_2 is paramagnetic.

(C) Solution of sodium in liquid ammonia is conducting in nature.

(D) Sodium metal has higher density than potassium metal

9. Match List-I with List-II, match the gas evolved during each reaction.

	List-I		List-II
(A)	$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta}$	(I)	H_2
(B)	$KMnO_4 + HCl \rightarrow$	(II)	N_2
(C)	$Al + NaOH + H_2O \rightarrow$	(III)	O_2
(D)	$NaNO_3 \xrightarrow{\Delta}$	(IV)	Cl_2

Choose the correct answer from the options given below :

(A) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

(B) (A) – (III), (B) – (I), (C) – (IV), (D) – (II)

(C) (A) – (II), (B) – (IV), (C) – (I), (D) – (III)

(D) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

10. Which of the following has least tendency to liberate H_2 from mineral acids ?

(A) Cu (B) Mn

(C) Ni (D) Zn

11. Given below are two statements :

Statement I : In polluted water values of both dissolved oxygen and BOD are very low.

Statement II : Eutrophication results in decrease in the amount of dissolved oxygen.

In the light of the above statements, choose the most appropriate answer from the options given below :

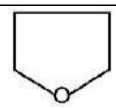
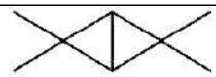
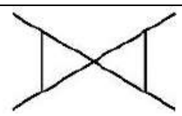
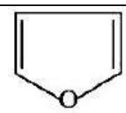
(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

12. Match List-I with List-II.

	List-I		List-II
(A)		(I)	Spiro compound
(B)		(II)	Aromatic compound
(C)		(III)	Non-planar Heterocyclic compound
(D)		(IV)	Bicyclo compound

Choose the correct answer from the options given below :

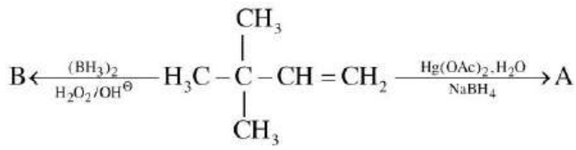
(A) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

(B) (A) – (IV), (B) – (III), (C) – (I), (D) – (II)

(C) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

(D) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)

13. Choose the correct option for the following reactions.



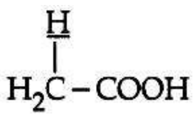
(A) 'A' and 'B' are both Markovnikov addition products.

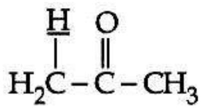
(B) 'A' is Markovnikov product and 'B' is anti-Markovnikov product.

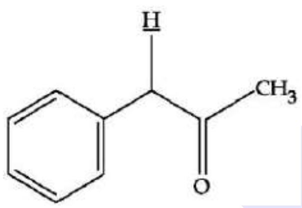
(C) 'A' and 'B' are both anti-Markovnikov products.

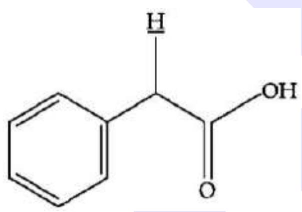
(D) 'B' is Markovnikov and 'A' is anti-Markovnikov product.

14. Among the following marked proton of which compound shows lowest pK_a value ?

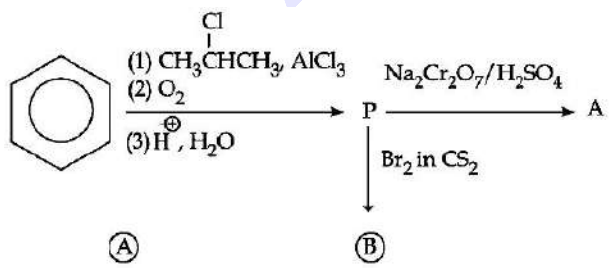
(A) 

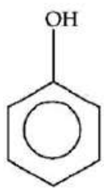
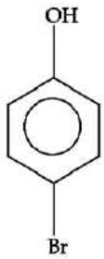
(B) 

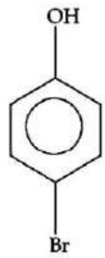
(C) 

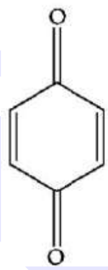
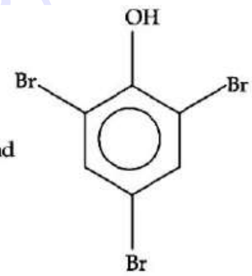
(D) 

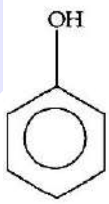
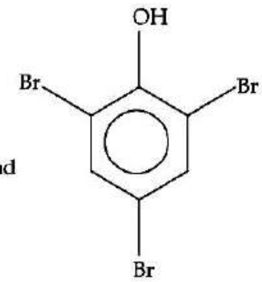
15. Identify the major product A and B for the below given reaction sequence.



(A)  and 

(B)  and 

(C)  and 

(D)  and 

16. Identify the correct statement for the below given transformation.

$$CH_3-CH_2-CH_2-\underset{\oplus N(CH_3)_3}{\underset{|}{CH}}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa} \underset{(Major)}{A} + \underset{(Minor)}{B}$$

(A) A - $CH_3CH_2CH = CH–CH_3$,
B – $CH_3CH_2CH_2CH = CH_2$,
Saytzeff products

(B) A - $CH_3CH_2CH = CH–CH_3$,
B – $CH_3CH_2CH_2CH = CH_2$,
Hafmann products

(C) A - $CH_3CH_2CH_2CH = CH_2$,
B – $CH_3CH_2CH = CHCH_3$,
Hofmann products

(D) A - $CH_3CH_2CH_2CH = CH_2$,
B – $CH_3CH_2CH = CHCH_3$,
Saytzeff products

17. Terylene polymer is obtained by condensation of :

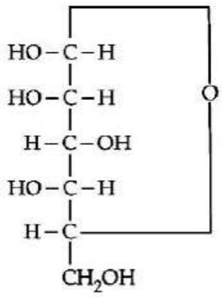
(A) Ethane-1, 2-diol and Benzene-1, 3 dicarboxylic acid

(B) Propane-1, 2-diol and Benzene-1, 4 dicarboxylic acid

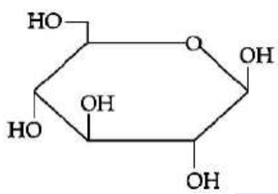
(C) Ethane-1, 2-diol and Benzene-1, 4 dicarboxylic acid

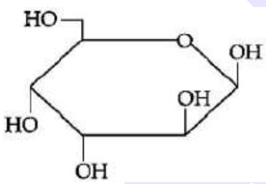
(D) Ethane-1, 2-diol and Benzene-1, 2 dicarboxylic acid

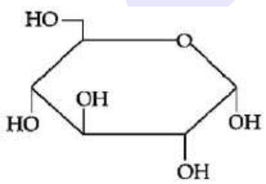
18. For the below given cyclic hemiacetal (X), the correct pyranose structure is :

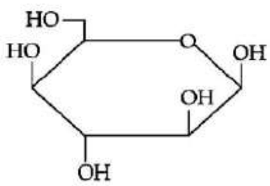


(X)

(A) 

(B) 

(C) 

(D) 

19. Statements about Enzyme Inhibitor Drugs are given below :

(A) There are Competitive and Non-competitive inhibitor drugs.

(B) These can bind at the active sites and allosteric sites.

(C) Competitive Drugs are allosteric site blocking drugs.

(D) Non-competitive Drugs are active site blocking drugs.

Choose the correct answer from the options given below :

(A) (A), (D) only

(B) (A), (C) only

(C) (A), (B) only

(D) (A), (B), (C) only

20. For kinetic study of the reaction of iodide ion with H_2O_2 at room temperature :

(A) Always use freshly prepared starch solution.

(B) Always keep the concentration of sodium thiosulphate solution less than that of KI solution.

(C) Record the time immediately after the appearance of blue colour.

(D) Record the time immediately before the appearance of blue colour.

(E) Always keep the concentration of sodium thiosulphate solution more than that of KI solution.

Choose the correct answer from the options given below :

(A) (A), (B), (C) only

(B) (A), (D), (E) only

(C) (D), (E) only

(D) (A), (B), (E) only

SECTION-B

1. In the given reaction,

$$X + Y + 3Z \rightleftarrows XYZ_3$$

if one mole of each of X and Y with 0.05 mol of Z gives compound XYZ_3. (Given : Atomic masses of X, Y and Z are 10, 20 and 30 amu, respectively). The yield of XYZ_3 is __________ g. (Nearest integer)

2. An element M crystallises in a body centred cubic unit cell with a cell edge of 300 pm. The density of the element is 6.0 g cm^{-3}. The number of atoms present in 180 g of the element is ______ $\times 10^{23}$. (Nearest integer)

3. The number of paramagnetic species among the following is ___________.

B_2, Li_2, C_2, C_2^-, O_2^{2-}, O_2^+ and He_2^+

4. 150 g of acetic acid was contaminated with 10.2 g ascorbic acid ($C_6H_8O_6$) to lower down its freezing point by $(x \times 10^{-1})$°C. The value of x is ________.

(Nearest integer) [Given K_f = 3.9 K kg mol^{-1}; Molar mass of ascorbic acid = 176 g mol^{-1}]

5. K_a for butyric acid (C_3H_7COOH) is 2×10^{-5}. The pH of 0.2 M solution of butyric acid is ___ $\times 10^{-1}$. (Nearest integer)

[Given log 2 = 0.30]

6. For the given first order reaction

$A \rightarrow B$

the half life of the reaction is 0.3010 min. The ratio of the initial concentration of reactant to the concentration of reactant at time 2.0 min will be equal to ___________. (Nearest integer)

7. The number of interhalogens from the following having square pyramidal structure is :

ClF_3, IF_7, BrF_5, BrF_3, I_2Cl_6, IF_5, ClF, ClF_5

8. The disproportionation of MnO_4^{2-} in acidic medium resulted in the formation of two manganese compounds A and B. If the oxidation state of Mn in B is smaller than that of A, then the spin-only magnetic moment (μ) value of B in BM is ___________.

(Nearest integer)

9. Total number of relatively more stable isomer(s) possible for octahedral complex $[Cu(en)_2(SCN)_2]$ will be ___________.

10. On complete combustion of 0.492 g of an organic compound containing C, H and O, 0.7938 g of CO_2 and 0.4428 g of H_2O was produced. The % composition of oxygen in the compound is _____.

MATHEMATICS

SECTION-A

1. Let the solution curve of the differential equation $xdy = \left(\sqrt{x^2+y^2}+y\right)dx,\ x > 0,$ intersect the line $x = 1$ at $y = 0$ and the line $x = 2$ at $y = \alpha$. Then the value of α is :

(A) $\frac{1}{2}$ (B) $\frac{3}{2}$ (C) $-\frac{3}{2}$ (D) $\frac{5}{2}$

2. Considering only the principal values of the inverse trigonometric functions, the domain of the function $f(x) = \cos^{-1}\left(\frac{x^2-4x+2}{x^2+3}\right)$ is :

(A) $\left(-\infty, \frac{1}{4}\right]$ (B) $\left[-\frac{1}{4}, \infty\right)$

(C) $\left(-\frac{1}{3}, \infty\right)$ (D) $\left(-\infty, \frac{1}{3}\right]$

3. Let the vectors $\vec{a} = (1+t)\hat{i} + (1-t)\hat{j} + \hat{k}$, $\vec{b} = (1-t)\hat{i} + (1+t)\hat{j} + 2\hat{k}$ and $\vec{c} = t\hat{i} - t\hat{j} + \hat{k}$, $t \in R$ be such that for $\alpha, \beta, \gamma \in R$, $\alpha\vec{a} + \beta\vec{b} + \gamma\vec{c} = \vec{0} \Rightarrow \alpha = \beta = \gamma = 0$. Then, the set of all values of t is :

(A) a non-empty finite set

(B) equal to N

(C) equal to $R - \{0\}$

(D) equal to R

4. Considering the principal values of the inverse trigonometric functions, the sum of all the solutions of the equation $\cos^{-1}(x) - 2\sin^{-1}(x) = \cos^{-1}(2x)$ is equal to :

(A) 0 (B) 1

(C) $\frac{1}{2}$ (D) $-\frac{1}{2}$

5. Let the operations $*, \odot \in \{\wedge, \vee\}$. If $(p * q) \odot (p \odot \sim q)$ is a tautology, then the ordered pair $(*, \odot)$ is :

(A) $(\vee, \wedge)$ (B) $(\vee, \vee)$

(C) $(\wedge, \wedge)$ (D) $(\wedge, \vee)$

6. Let a vector $\vec{a}$ has a magnitude 9. Let a vector $\vec{b}$ be such that for every $(x,y)\in R\times R-\{(0,0)\}$, the vector $(x\vec{a}+y\vec{b})$ is perpendicular to the vector $(6y\vec{a}-18x\vec{b})$. Then the value of $|\vec{a}\times\vec{b}|$ is equal to:

(A) $9\sqrt{3}$ (B) $27\sqrt{3}$ (C) 9 (D) 81

7. For $t\in(0, 2\pi)$, if ABC is an equilateral triangle with vertices A(sint, –cost), B(cost, sint) and C(a, b) such that its orthocentre lies on a circle with centre $\left(1, \frac{1}{3}\right)$, then $(a^2 - b^2)$ is equal to :

(A) $\frac{8}{3}$ (B) 8

(C) $\frac{77}{9}$ (D) $\frac{80}{9}$

8. For $\alpha\in N$, consider a relation R on N given by $R=\{(x,y): 3x+\alpha y \text{ is a multiple of } 7\}$. The relation R is an equivalence relation if and only if :

(A) $\alpha = 14$

(B) α is a multiple of 4

(C) 4 is the remainder when α is divided by 10

(D) 4 is the remainder when α is divided by 7

9. Out of 60% female and 40% male candidates appearing in an exam, 60% candidates qualify it. The number of females qualifying the exam is twice the number of males qualifying it. A candidate is randomly chosen from the qualified candidates. The probability, that the chosen candidate is a female, is :

(A) $\frac{3}{4}$ (B) $\frac{11}{16}$

(C) $\frac{23}{32}$ (D) $\frac{13}{16}$

10. If $y = y(x),\ x\in\left(0, \frac{\pi}{2}\right)$ be the solution curve of the differential equation

$$\left(\sin^2 2x\right)\frac{dy}{dx}+\left(8\sin^2 2x+2\sin 4x\right)y$$
$$= 2e^{-4x}\left(2\sin 2x+\cos 2x\right),\ \text{with } y\left(\frac{\pi}{4}\right)=e^{-\pi},$$

then $y\left(\frac{\pi}{6}\right)$ is equal to :

(A) $\frac{2}{\sqrt{3}}e^{-2\pi/3}$ (B) $\frac{2}{\sqrt{3}}e^{2\pi/3}$

(C) $\frac{1}{\sqrt{3}}e^{-2\pi/3}$ (D) $\frac{1}{\sqrt{3}}e^{2\pi/3}$

11. If the tangents drawn at the points P and Q on the parabola $y^2 = 2x - 3$ intersect at the point R(0, 1), then the orthocentre of the triangle PQR is :

(A) (0, 1) (B) (2, –1)

(C) (6, 3) (D) (2, 1)

12. Let C be the centre of the circle $x^2 + y^2 - x + 2y = \frac{11}{4}$ and P be a point on the circle. A line passes through the point C, makes an angle of $\frac{\pi}{4}$ with the line CP and intersects the circle at the points Q and R. Then the area of the triangle PQR (in unit^2) is :

(A) 2 (B) $2\sqrt{2}$

(C) $8\sin\left(\frac{\pi}{8}\right)$ (D) $8\cos\left(\frac{\pi}{8}\right)$

13. The remainder when $7^{2022} + 3^{2022}$ is divided by 5 is:

(A) 0 (B) 2 (C) 3 (D) 4

14. Let the matrix $A=\begin{bmatrix}0&1&0\\0&0&1\\1&0&0\end{bmatrix}$ and the matrix $B_0 = A^{49}+2A^{98}$. If $B_n = Adj(B_{n-1})$ for all $n\geq 1$, then $\det(B_4)$ is equal to :

(A) 3^{28} (B) 3^{30} (C) 3^{32} (D) 3^{36}

15. Let $S_1 = \left\{z_1 \in C : |z_1 - 3| = \frac{1}{2}\right\}$ and $S_2 = \{z_2 \in C : |z_2 - |z_2 + 1|| = |z_2 + |z_2 - 1||\}$. Then, for $z_1 \in S_1$ and $z_2 \in S_2$, the least value of $|z_2 - z_1|$ is :

(A) 0 (B) $\frac{1}{2}$ (C) $\frac{3}{2}$ (D) $\frac{5}{2}$

16. The foot of the perpendicular from a point on the circle $x^2 + y^2 = 1$, $z = 0$ to the plane $2x + 3y + z = 6$ lies on which one of the following curves ?

(A) $(6x + 5y - 12)^2 + 4(3x + 7y - 8)^2 = 1$, $z = 6 - 2x - 3y$

(B) $(5x + 6y - 12)^2 + 4(3x + 5y - 9)^2 = 1$, $z = 6 - 2x - 3y$

(C) $(6x + 5y - 14)^2 + 9(3x + 5y - 7)^2 = 1$, $z = 6 - 2x - 3y$

(D) $(5x + 6y - 14)^2 + 9(3x + 7y - 8)^2 = 1$, $z = 6 - 2x - 3y$

17. If the minimum value of $f(x) = \frac{5x^2}{2} + \frac{\alpha}{x^5}, x > 0$, is 14, then the value of α is equal to :

(A) 32 (B) 64

(C) 128 (D) 256

18. Let α, β and γ be three positive real numbers. Let $f(x) = \alpha x^5 + \beta x^3 + \gamma x, x \in R$ and $g : R \to R$ be such that $g(f(x)) = x$ for all $x \in R$. If $a_1, a_2, a_3, \ldots, a_n$ be in arithmetic progression with mean zero, then the value of $f\left(g\left(\frac{1}{n}\sum_{i=1}^{n} f(a_i)\right)\right)$ is equal to :

(A) 0 (B) 3

(C) 9 (D) 27

19. Consider the sequence $a_1, a_2, a_3, \ldots\ldots$ such that $a_1 = 1, a_2 = 2$ and $a_{n+2} = \frac{2}{a_{n+1}} + a_n$ for $n = 1, 2, 3, \ldots$. If

$$\left(\frac{a_1 + \frac{1}{a_2}}{a_3}\right) \cdot \left(\frac{a_2 + \frac{1}{a_3}}{a_4}\right) \cdot \left(\frac{a_3 + \frac{1}{a_4}}{a_5}\right) \cdots\cdots \left(\frac{a_{30} + \frac{1}{a_{31}}}{a_{32}}\right) = 2^{\alpha}\left({}^{61}C_{31}\right),$$

then α is equal to :

(A) –30 (B) –31

(C) –60 (D) –61

20. The minimum value of the twice differentiable function $f(x) = \int_0^x e^{x-t} f'(t)\,dt - (x^2 - x + 1)e^x$, $x \in R$, is :

(A) $-\frac{2}{\sqrt{e}}$ (B) $-2\sqrt{e}$

(C) $-\sqrt{e}$ (D) $\frac{2}{\sqrt{e}}$

SECTION-B

1. Let S be the set of all passwords which are six to eight characters long, where each character is either an alphabet from {A, B, C, D, E} or a number from {1, 2, 3, 4, 5} with the repetition of characters allowed. If the number of passwords in S whose at least one character is a number from {1, 2, 3, 4, 5} is $\alpha \times 5^6$, then α is equal to _____.

2. Let P(–2, –1, 1) and $Q\left(\frac{56}{17}, \frac{43}{17}, \frac{111}{17}\right)$ be the vertices of the rhombus PRQS. If the direction ratios of the diagonal RS are $\alpha, -1, \beta$, where both α and β are integers of minimum absolute values, then $\alpha^2 + \beta^2$ is equal to _________.

3. Let $f : [0, 1] \to R$ be a twice differentiable function in (0, 1) such that f(0) = 3 and f(1) = 5. If the line y = 2x + 3 intersects the graph of f at only two distinct points in (0, 1), then the least number of points $x \in (0, 1)$, at which $f''(x) = 0$, is ______.

4. If $\int_0^{\sqrt{3}} \frac{15x^3}{\sqrt{1 + x^2 + \sqrt{(1 + x^2)^3}}}dx = \alpha\sqrt{2} + \beta\sqrt{3}$, where α, β are integers, then $\alpha + \beta$ is equal to

5. Let $A = \begin{bmatrix} 1 & -1 \\ 2 & \alpha \end{bmatrix}$ and $B = \begin{bmatrix} \beta & 1 \\ 1 & 0 \end{bmatrix}$, $\alpha, \beta \in R$. Let α_1 be the value of α which satisfies $(A + B)^2 = A^2 + \begin{bmatrix} 2 & 2 \\ 2 & 2 \end{bmatrix}$ and α_2 be the value of α which satisfies $(A + B)^2 = B^2$. Then $|\alpha_1 - \alpha_2|$ is equal to _______.

6. For $p, q \in R$, consider the real valued function $f(x) = (x-p)^2 - q, x \in R$ and $q > 0$. Let a_1, a_2, a_3 and a_4 be in an arithmetic progression with mean p and positive common difference. If $|f(a_i)| = 500$ for all i = 1, 2, 3, 4, then the absolute difference between the roots of f(x) = 0 is

7. For the hyperbola H : $x^2 - y^2 = 1$ and the ellipse $E : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b > 0$, let the

(1) eccentricity of E be reciprocal of the eccentricity of H, and

(2) the line $y = \sqrt{\frac{5}{2}}x + K$ be a common tangent of E and H.

Then $4(a^2 + b^2)$ is equal to _______.

8. Let x_1, x_2, x_3, ….., x_{20} be in geometric progression with x_1 = 3 and the common ration $\frac{1}{2}$. A new data is constructed replacing each x_i by $(x_i - i)^2$. If $\overline{x}$ is the mean of new data, then the greatest integer less than or equal to $\overline{x}$ is _________.

9. $\lim_{x \to 0} \left(\frac{(x+2\cos x)^3 + 2(x+2\cos x)^2 + 3\sin(x+2\cos x)}{(x+2)^3 + 2(x+2)^2 + 3\sin(x+2)} \right)^{\frac{100}{x}}$ is equal to ___________.

10. The sum of all real values of x for which $\frac{3x^2 - 9x + 17}{x^2 + 3x + 10} = \frac{5x^2 - 7x + 19}{3x^2 + 5x + 12}$ is equal to ___.

SET # 08

PHYSICS

SECTION-A

1. Consider the efficiency of Carnot's engine is given by $\eta = \frac{\alpha\beta}{\sin\theta}\log_e\frac{\beta x}{kT}$, where α and β are constants. If T is temperature, k is Boltzman constant, θ is angular displacement and x has the dimensions of length. Then, choose the **incorrect** option.

(A) Dimensions of β is same as that of force.

(B) Dimensions of α^{-1} x is same as that of energy.

(C) Dimensions of $\eta^{-1}\sin\theta$ is same as that of $\alpha\beta$

(D) Dimensions of α is same as that of β

2. At time t = 0 a particle starts travelling from a height $7\hat{z}$ cm in a plane keeping z coordinate constant. At any instant of time it's position along the $\hat{x}$ and $\hat{y}$ directions are defined as 3t and $5t^3$ respectively. At t = 1s acceleration of the particle will be

(A) $-30\hat{y}$ (B) $30\hat{y}$

(C) $3\hat{x}+15\hat{y}$ (D) $3\hat{x}+15\hat{y}+7\hat{z}$

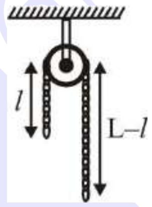
3. A pressure-pump has a horizontal tube of cross-sectional area 10 cm^2 for the outflow of water at a speed of 20 m/s. The force exerted on the vertical wall just in front of the tube which stops water horizontally flowing out of the tube, is:

[given : density of water = 1000 kg/m^3]

(A) 300 N (B) 500 N

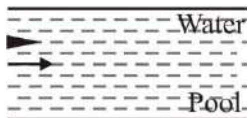
(C) 250 N (D) 400 N

4. A uniform metal chain of mass m and length 'L' passes over a massless and frictionless pulley. It is released from rest with a part of its length 'l' is hanging on one side and rest of its length 'L – l' is hanging on the other side of the pulley. At a certain point of time, when $l = \frac{L}{x}$, the acceleration of the chain is $\frac{g}{2}$. The value of x is ....



(A) 6 (B) 2 (C) 1.5 (D) 4

5. A bullet of mass 200 g having initial kinetic energy 90 J is shot inside a long swimming pool as shown in the figure. If it's kinetic energy reduces to 40 J within 1s, the minimum length of the pool, the bullet has a to travel so that it completely comes to rest is



(A) 45 m (B) 90 m

(C) 125 m (D) 25 m

6. Assume there are two identical simple pendulum Clocks-1 is placed on the earth and Clock-2 is placed on a space station located at a height h above the earth surface. Clock-1 and Clock-2 operate at time periods 4s and 6s respectively. Then the value of h is –

(consider radius of earth R_E = 6400 km and g on earth 10 m/s^2)

(A) 1200 km

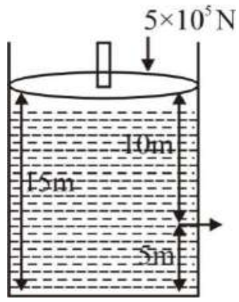
(B) 1600 km

(C) 3200 km

(D) 4800 km

7. Consider a cylindrical tank of radius 1m is filled with water. The top surface of water is at 15 m from the bottom of the cylinder. There is a hole on the wall of cylinder at a height of 5m from the bottom. A force of 5×10^5 N is applied an the top surface of water using a piston. The speed of efflux from the hole will be :

(given atmospheric pressure $P_A = 1.01 \times 10^5$ Pa, density of water $\rho_w = 1000$ kg/m^3 and gravitational acceleration g = 10 m/s^2)



(A) 11.6 m/s (B) 10.8 m/s

(C) 17.8 m/s (D) 14.4 m/s

8. A vessel contains 14 g of nitrogen gas at a temperature of 27°C. The amount of heat to be transferred to the gap to double the r.m.s. speed of its molecules will be :

(Take R = 8.32 J mol^{-1}k^{-1})

(A) 2229 J (B) 5616 J

(C) 9360 J (D) 13,104 J

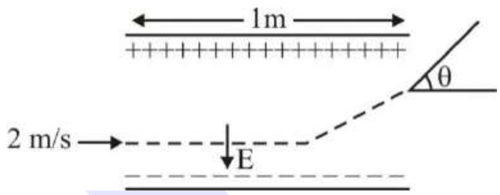
9. A slab of dielectric constant K has the same cross-sectional area as the plates of a parallel plate capacitor and thickness $\frac{3}{4}d$, where d is the separation of the plates. The capacitance of the capacitor when the slab is inserted between the plates will be :

(Given C_o = capacitance of capacitor with air as medium between plates.)

(A) $\frac{4KC_0}{3+K}$ (B) $\frac{3KC_0}{3+K}$

(C) $\frac{3+K}{4KC_0}$ (D) $\frac{K}{4+K}$

10. A uniform electric field E = (8m/e) V/m is created between two parallel plates of length 1m as shown in figure, (where m = mass of electron and e = charge of electron). An electron enters the field symmetrically between the plates with a speed of 2m/s. The angle of the deviation (θ) of the path of the electron as it comes out of the field will be ……….



(A) $\tan^{-1}(4)$ (B) $\tan^{-1}(2)$

(C) $\tan^{-1}\left(\frac{1}{3}\right)$ (D) $\tan^{-1}(3)$

11. Given below are two statements :

Statement I : A uniform wire of resistance 80Ω is cut into four equal parts. These parts are now connected in parallel. The equivalent resistance of the combination will be 5 Ω.

Statement II : Two resistance 2R and 3R are connected in parallel in a electric circuit. The value of thermal energy developed in 3R and 2R will be in the ratio 3 : 2.

In the light of the above statements, choose the most appropriate answer from the options given below

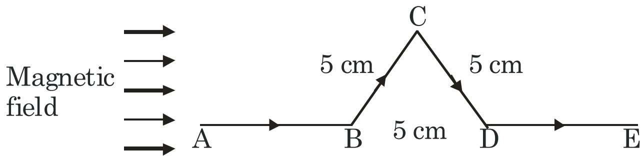
(A) Both statement I and statement II are correct

(B) Both statement I and statement II are incorrect

(C) Statement I is correct but statement II is incorrect

(D) Statement I is incorrect but statement II is correct.

12. A triangular shaped wire carrying 10A current is placed in a uniform magnetic field of 0.5T, as shown in figure. The magnetic force on segment CD is
(Given BC = CD = BD = 5 cm).



(A) 0.126 N (B) 0.312 N
(C) 0.216 N (D) 0.245 N

13. The magnetic field at the center of current carrying circular loop is B_1. The magnetic field at a distance of $\sqrt{3}$ times radius of the given circular loop from the center on its axis is B_2. The value of B_1/B_2 will be

(A) 9 : 4 (B) $12:\sqrt{5}$
(C) 8 : 1 (D) $5:\sqrt{3}$

14. A transformer operating at primary voltage 8 kV and secondary voltage 160 V serves a load of 80 kW. Assuming the transformer to be ideal with purely resistive load and working on unity power factor, the loads in the primary and secondary circuit would be
(A) 800 Ω and 1.06 Ω
(B) 10 Ω and 500 Ω
(C) 800 Ω and 0.32 Ω
(D) 1.06 Ω and 500 Ω

15. Sun light falls normally on a surface of area 36 cm^2 and exerts an average force of 7.2×10^{-9} N within a time period of 20 minutes. Considering a case of complete absorption, the energy flux of incident light is
(A) 25.92×10^2 W/cm^2
(B) 8.64×10^{-6} W/cm^2
(C) 6.0 W/cm^2
(D) 0.06 W/cm^2

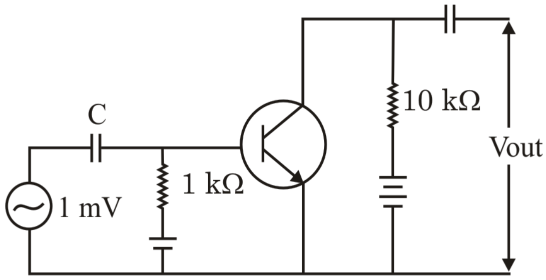
16. The power of a lens (biconvex) is 1.25 m^{-1} in particular medium. Refractive index of the lens is 1.5 and radii of curvature are 20 cm and 40 cm respectively. The refractive index of surrounding medium :

(A) 1.0 (B) $\frac{9}{7}$
(C) $\frac{3}{2}$ (D) $\frac{4}{3}$

17. Two streams of photons, possessing energies to five and ten times the work function of metal are incident on the metal surface successively. The ratio of the maximum velocities of the photoelectron emitted, in the two cases respectively, will be
(A) 1 : 2 (B) 1 : 3
(C) 2 : 3 (D) 3 : 2

18. A radioactive sample decays $\frac{7}{4}$ times its original quantity in 15 minutes. The half-life of the sample is
(A) 5 min (B) 7.5 min
(C) 15 min (D) 30 min

19. An n.p.n transistor with current gain β = 100 in common emitter configuration is shown in figure. The output voltage of the amplifier will be



(A) 0.1 V (B) 1.0 V
(C) 10 V (D) 100 V

20. A FM Broad cast transmitter, using modulating signal of frequency 20 kHz has a deviation ratio of 10. The Bandwidth required for transmission is :
(A) 220 kHz
(B) 180 kHz
(C) 360 kHz
(D) 440 kHz

SECTION-B

1. A ball is thrown vertically upwards with a velocity of 19.6 ms^{-1} from the top of a tower. The ball strikes the ground after 6 s. The height from the ground up to which the ball can rise will be $\left(\frac{k}{5}\right)$m. The value of k is …..
(use $g = 9.8\ m/s^2$)

2. The distance of centre of mass from end A of a one dimensional rod (AB) having mass density $\rho = \rho_0\left(1 - \frac{x^2}{L^2}\right)$ kg/m and length L (in meter) is $\frac{3L}{\alpha}$m. The value of α is ………. (where x is the distance form end A)

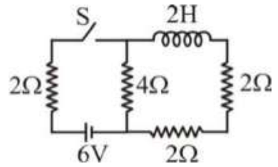
3. A string of area of cross-section 4 mm^2 and length 0.5 is connected with a rigid body of mass 2 kg. The body is rotated in a vertical circular path of radius 0.5 m. The body acquires a speed of 5 m/s at the bottom of the circular path. Strain produced in the string when the body is at the bottom of the circle is …… × 10^{-5}. (Use Young's modulus $10^{11}\ N/m^2$ and $g = 10\ m/s^2$)

4. At a certain temperature, the degrees of freedom per molecule for gas is 8. The gas performs 150 J of work when it expands under constant pressure. The amount of heat absorbed by the gas will be …….. J.

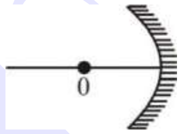
5. The potential energy of a particle of mass 4 kg in motion along the x-axis is given by U = 4(1 – cos 4x) J. The time period of the particle for small oscillation $(\sin\theta \simeq \theta)$ is $\left(\frac{\pi}{K}\right)$s. The value of K is ……..

6. An electrical bulb rated 220 V, 100 W, is connected in series with another bulb rated 220 V, 60 W. If the voltage across combination is 220 V, the power consumed by the 100 W bulb will be about ………. W.

7. For the given circuit the current through battery of 6 V just after closing the switch 'S' will be ………. A.



8. An object 'o' is placed at a distance of 100 cm in front of a concave mirror of radius of curvature 200 cm as shown in the figure. The object starts moving towards the mirror at a speed 2 cm/s. The position of the image from the mirror after 10s will be at ……. cm.



9. In an experiment with a convex lens. The plot of the image distance (v') against the object distance (μ') measured from the focus gives a curve v' μ' = 225. If all the distances are measured in cm. The magnitude of the focal length of the lens is ……….. cm.

10. In an experiment to find acceleration due to gravity (g) using simple pendulum, time period of 0.5 s is measured from time of 100 oscillation with a watch of 1s resolution. If measured value of length is 10 cm known to 1mm accuracy. The accuracy in the determination of g is found to be x %. The value of x is

CHEMISTRY

SECTION-A

1. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A : Zero orbital overlap is an out of phase overlap.

Reason : It results due to different orientation/ direction of approach of orbitals.

In the light of the above statements. Choose the ***correct*** answer from the options given below

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is NOT the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

2. The correct decreasing order for metallic character is
(A) Na > Mg > Be > Si > P
(B) P > Si > Be > Mg > Na
(C) Si > P > Be > Na > Mg
(D) Be > Na > Mg > Si > P

3. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : The reduction of a metal oxide is easier if the metal formed is in liquid state than solid state.

Reason R : The value of $\Delta G^{\ominus}$ becomes more on negative side as entropy is higher in liquid state than solid state.

In the light of the above statements. Choose the most appropriate answer from the options given below

(A) Both A and R are correct and R is the correct explanation of A
(B) Both A and R are correct but R is NOT the correct explanation of A
(C) A is correct but R is not correct
(D) A is not correct but R is correct

4. The products obtained during treatment of hard water using Clark's method are:
(A) $CaCO_3$ and $MgCO_3$
(B) $Ca(OH)_2$ and $Mg(OH)_2$
(C) $CaCO_3$ and $Mg(OH)_2$
(D) $Ca(OH)_2$ and $MgCO_3$

5. **Statement I:** An alloy of lithium and magnesium is used to make aircraft plates.

Statement II : The magnesium ions are important for cell-membrane integrity.

In the light the above statements, choose the *correct* answer from the options given below

(A) Both Statement I and Statement II are true
(B) Both Statement I and Statement II are false
(C) Statement I is true but Statement II is false
(D) Statement I is false but Statement II is true

6. White phosphorus reacts with thionyl chloride to give
(A) PCl_5, SO_2 and S_2Cl_2
(B) PCl_3. SO_2 and S_2Cl_2
(C) PCl_3, SO_2 and Cl_2
(D) PCl_5, SO_2 and Cl_2

7. Concentrated HNO_3 reacts with Iodine to give
(A) HI, NO_2 and H_2O
(B) HIO_2, N_2O and H_2O
(C) HIO_3, NO_2 and H_2O
(D) HIO_4, N_2O and H_2O

8. Which of the following pair is not isoelectronic species?
(At. no. Sm, 62; Er, 68: Yb, 70: Lu, 71; Eu, 63: Tb, 65; Tm, 69)
(A) Sm^{2+} and Er^{3+} (B) Yb^{2+} and Lu^{3+}
(C) Eu^{2+} and Tb^{4+} (D) Tb^{2+} and Tm^{4+}

9. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : Permanganate titrations are not performed in presence of hydrochloric acid.

Reason R : Chlorine is formed as a consequence of oxidation of hydrochloric acid.

In the light of the above statements, choose the ***correct*** answer from the options given below

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is NOT the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

10. Match **List I** with **List II**

	List I (Complex)		**List II (Hybridization)**
A	$Ni(CO)_4$	I	sp^3
B	$[Ni(CN)_4]^{2-}$	II	sp^3d^2
C	$[Co(CN)_6]^{3-}$	III	d^2sp^3
D	$[CoF_6]^{3-}$	IV	dsp^2

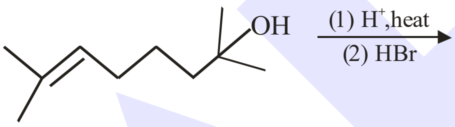
Choose the correct answer from the options given below:

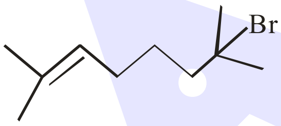
(A) A-IV, B-I, C-III, D-II
(B) A-I. B-IV, C-III, D-II
(C) A-I. B-IV, C-II, D-III
(D) A-IV, B-I, C-II. D-III

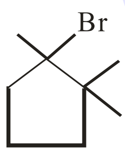
11. Dinitrogen and dioxygen. the main constituents of air do not react with each other in atmosphere to form oxides of nitrogen because

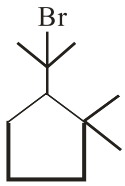
(A) N_2 is unreactive in the condition of atmosphere.
(B) Oxides of nitrogen are unstable.
(C) Reaction between them can occur in the presence of a catalyst.
(D) The reaction is endothermic and require very high temperature.

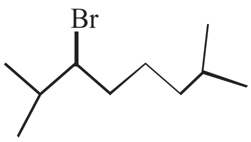
12. The major product in the given reaction is



(A) 

(B) 

(C) 

(D) 

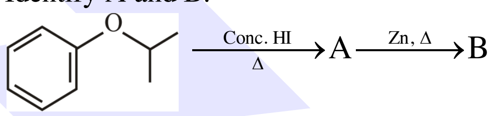
13. Arrange the following in increasing order of reactivity towards nitration

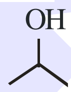
A. p-xylene
B. bromobenzene
C. mesitylene
D, nitrobenzene
E. benzene

Choose the correct answer from the options given below

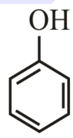
(A) C < D < E < A < B
(B) D < B < E < A < C
(C) D < C < E < A < B
(D) C < D < E < B < A

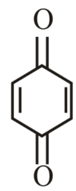
14. Compound I is heated with Conc. HI to give a hydroxy compound A which is further heated with Zn dust to give compound B. Identify A and B.

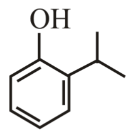


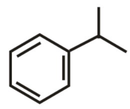
(A) A = 

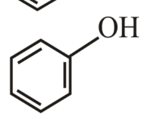
, B = 

(B) A = 

, B = 

(C) A = 

, B = 

(D) A = 

, B = 

15. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**

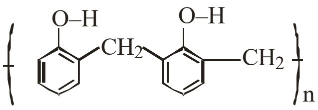
Assertion A : Aniline on nitration yields ortho, meta & para nitro derivatives of aniline.

Reason R : Nitrating mixture is a strong acidic mixture.

In the light of the above statements, choose the ***correct*** answer from the options given below.

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is NOT the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

16. Match **List I** with **List II**

List I (Polymer)	List II (Nature)
A. $\left[CH_2-\underset{Cl}{C}=CH-CH_2\right]_n$	I. Thermosetting polymer
B. $\left[\overset{H}{N}-(CH_2)_6-\overset{H}{N}-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}\right]_n$	II. Fibers
C. $\left[CH_2-\overset{Cl}{CH}\right]_n$	III. Elastomer
D. 	IV. Thermoplastic polymer

Choose the correct answer from the options given below:

(A) A-II, B-III, C-IV, D-I

(B) A-III, B-II, C-IV, D-I

(C) A-III, B-I, C-IV, D-II

(D) A-I. B-III, C-IV, D-II

17. Two statements in respect of drug-enzyme interaction are given below

Statement I : Action of an enzyme can be blocked only when an inhibitor blocks the active site of the enzyme.

Statement II : An inhibitor can form a strong covalent bond with the enzyme.

In the light of the above statements. Choose the ***correct*** answer from the options given below

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

18. Given below are two statements: One is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A : Thin layer chromatography is an adsorption chromatography.

Reason : A thin layer of silica gel is spread over a glass plate of suitable size in thin layer chromatography which acts as an adsorbent.

In the light of the above statements, choose the ***correct*** answer from the options given below

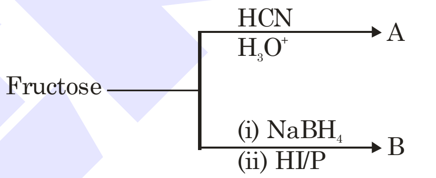
(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true but R is NOT the correct explanation of A

(C) A is true but R is false

(D) A is false but R is true

19. The formulas of A and B for the following reaction sequence are

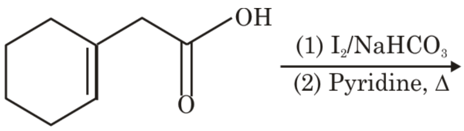


(A) A = $C_7H_{14}O_8$, B = C_6H_{14}

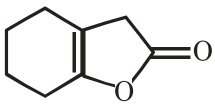
(B) A = $C_7H_{13}O_7$, B = $C_7H_{14}O$

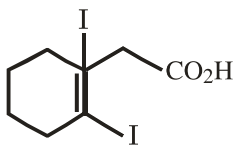
(C) A = $C_7H_{12}O_8$, B = C_6H_{14}

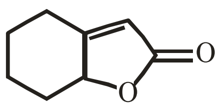
(D) A = $C_7H_{14}O_8$, B = $C_6H_{14}O_6$

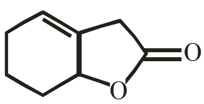
20. 

Find out the major product for the above reaction.

(A) 

(B) 

(C) 

(D) 

SECTION-B

1. 2L of 0.2 M H_2SO_4 is reacted with 2L of 0.1 M NaOH solution, the molarity of the resulting product Na_2SO_4 in the solution is _____ millimolar. (Nearest integer).

2. Metal M crystallizes into a FCC lattice with the edge length of 4.0×10^{-8} cm. The atomic mass of the metal is ______ g/mol. (Nearest integer).

(Use : $N_A = 6.02\times10^{23}$ mol^{-1}, density of metal, M = 9.03 g cm^{-3})

3. If the wavelength for an electron emitted from H-atom is 3.3×10^{-10}m, then energy absorbed by the electron in its ground state compared to minimum energy required for its escape from the atom, is _____ times. (Nearest integer).

[Given : h = 6.626×10^{-34} Js,

Mass of electron = 9.1×10^{-31}]

4. A gaseous mixture of two substances A and B, under a total pressure of 0.8 atm is in equilibrium with an ideal liquid solution. The mole fraction of substance A is 0.5 in the vapour phase and 0.2 in the liquid phase. The vapour pressure of pure liquid A is _______ atm. (Nearest integer)

5. At 600K, 2 mol of NO are mixed with 1 mol of O_2.

$$2NO_{(g)} + O_2(g) \rightleftharpoons 2NO_2(g)$$

The reaction occurring as above comes to equilibrium under a total pressure of 1 atom. Analysis of the system shows that 0.6 mol of oxygen are present at equilibrium. The equilibrium constant for the reaction is _______. (Nearest integer).

6. A sample of 0.125 g of an organic compound when analysed by Duma's method yields 22.78 mL of nitrogen gas collected over KOH solution at 280K and 759 mm Hg. The percentage of nitrogen in the given organic compound is ____. (Nearest integer).

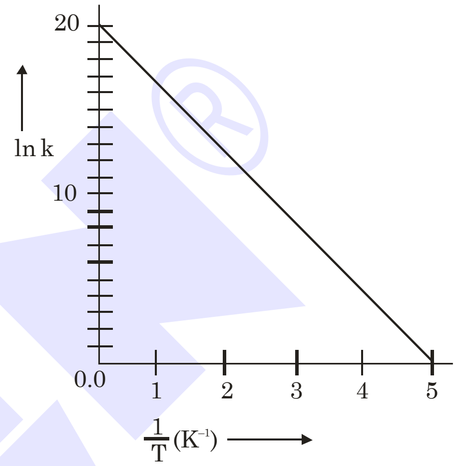
(a) The vapour pressure of water at 280 K is 14.2 mm Hg

(b) R = 0.082 L atm K^{-1} mol^{-1}

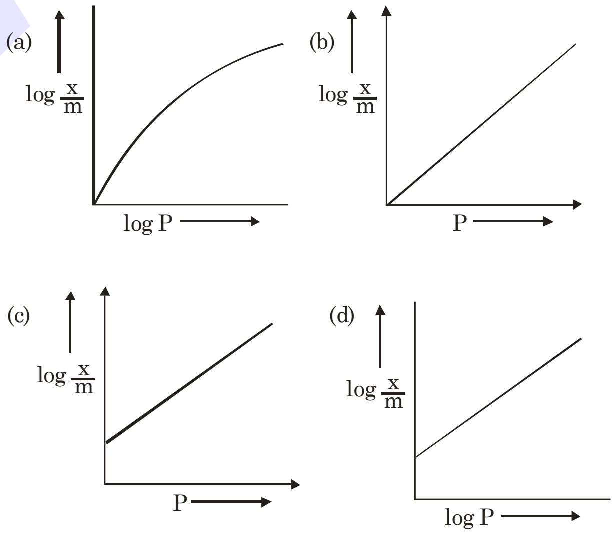
7. On reaction with stronger oxidizing agent like KIO_4, hydrogen peroxide oxidizes with the evolution of O_2. The oxidation number of I in KIO_4 changes to ______.

8. For a reaction, given below is the graph of $\ln k$ vs $\frac{1}{T}$. The activation energy for the reaction is equal to ________ cal mol^{-1}. (Nearest integer).

(Given : R = 2 cal K^{-1} mol^{-1})



9. Among the following the number of curves not in accordance with Freundlich adsorption isotherm is ______.



10. Among the following the number of state variable is ______.

Internal energy (U)

Volume (V)

Heat (q)

Enthalpy (H)

MATHEMATICS

SECTION-A

1. Let

$$S=\left\{x\in[-6,3]-\{-2,2\}:\frac{|x+3|-1}{|x|-2}\geq 0\right\}$$

and $T=\{x\in Z: x^2-7|x|+9\leq 0\}$. Then the number of elements in $S\cap T$ is

(A) 7 (B) 5

(C) 4 (D) 3

2. Let α, β be the roots of the equation $x^2-\sqrt{2}x+\sqrt{6}=0$ and $\frac{1}{\alpha^2}+1, \frac{1}{\beta^2}+1$ be the roots of the equation $x^2 + ax + b = 0$. Then the roots of the equation $x^2 - (a + b - 2) x + (a + b + 2) = 0$ are :

(A) non-real complex numbers

(B) real and both negative

(C) real and both positive

(D) real and exactly one of them is positive

3. Let A and B be any two 3×3 symmetric and skew symmetric matrices respectively. Then which of the following is **NOT** true?

(A) $A^4 - B^4$ is a symmetric matrix

(B) $AB - BA$ is a symmetric matrix

(C) $B^5 - A^5$ is a skew-symmetric matrix

(D) $AB + BA$ is a skew-symmetric matrix

4. Let $f(x) = ax^2 + bx + c$ be such that $f(1) = 3$, $f(-2) = \lambda$ and $f(3) = 4$. If $f(0) + f(1) + f(-2) + f(3) = 14$, then λ is equal to

(A) -4 (B) $\frac{13}{2}$

(C) $\frac{23}{2}$ (D) 4

5. The function $f : R \to R$ defined by

$$f(x)=\lim_{n\to\infty}\frac{\cos(2\pi x)-x^{2n}\sin(x-1)}{1+x^{2n+1}-x^{2n}}$$ is

continuous for all x in

(A) $R - \{-1\}$ (B) $R - \{-1, 1\}$

(C) $R - \{1\}$ (D) $R - \{0\}$

6. The function $f(x)=xe^{x(1-x)}, x\in R$, is

(A) increasing in $\left(-\frac{1}{2},1\right)$

(B) decreasing in $\left(\frac{1}{2},2\right)$

(C) increasing in $\left(-1,-\frac{1}{2}\right)$

(D) decreasing in $\left(-\frac{1}{2},\frac{1}{2}\right)$

7. The sum of the absolute maximum and absolute minimum values of the function $f(x) = \tan^{-1}(\sin x - \cos x)$ in the interval $[0, \pi]$ is

(A) 0 (B) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)-\frac{\pi}{4}$

(C) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)-\frac{\pi}{4}$ (D) $\frac{-\pi}{12}$

8. Let $x(t)=2\sqrt{2}\cos t\sqrt{\sin 2t}$ and $y(t)=2\sqrt{2}\sin t\sqrt{\sin 2t}$, $t\in\left(0,\frac{\pi}{2}\right)$. Then

$$\frac{1+\left(\frac{dy}{dx}\right)^2}{\frac{d^2y}{dx^2}}$$ at $t=\frac{\pi}{4}$ is equal to

(A) $\frac{-2\sqrt{2}}{3}$ (B) $\frac{2}{3}$

(C) $\frac{1}{3}$ (D) $\frac{-2}{3}$

9. Let $I_n(x)=\int_0^x\frac{1}{(t^2+5)^n}dt$, n = 1, 2, 3, ….

Then

(A) $50I_6-9I_5=xI_5'$

(B) $50I_6-11I_5=xI_5'$

(C) $50I_6-9I_5=I_5'$

(D) $50I_6-11I_5=I_5'$

10. The area enclosed by the curves $y = \log_e(x + e^2)$, $x = \log_e\left(\frac{2}{y}\right)$ and $x = \log_e 2$, above the line $y = 1$ is

(A) $2+e-\log_e 2$ (B) $1+e-\log_e 2$

(C) $e-\log_e 2$ (D) $1+\log_e 2$

11. Let $y = y(x)$ be the solution curve of the differential equation

$$\frac{dy}{dx}+\frac{1}{x^2-1}y=\left(\frac{x-1}{x+1}\right)^{\frac{1}{2}}, \quad x>1 \text{ passing}$$

through the point $\left(2,\sqrt{\frac{1}{3}}\right)$. Then $\sqrt{7}y(8)$ is equal to

(A) $11+6\log_e 3$ (B) 19

(C) $12-2\log_e 3$ (D) $19-6\log_e 3$

12. The differential equation of the family of circles passing through the points (0, 2) and (0, – 2) is

(A) $2xy\frac{dy}{dx}+\left(x^2-y^2+4\right)=0$

(B) $2xy\frac{dy}{dx}+\left(x^2+y^2-4\right)=0$

(C) $2xy\frac{dy}{dx}+\left(y^2-x^2+4\right)=0$

(D) $2xy\frac{dy}{dx}-\left(x^2-y^2+4\right)=0$

13. Let the tangents at two points A and B on the circle $x^2 + y^2 - 4x + 3 = 0$ meet at origin O (0, 0). Then the area of the triangle of OAB is

(A) $\frac{3\sqrt{3}}{2}$ (B) $\frac{3\sqrt{3}}{4}$

(C) $\frac{3}{2\sqrt{3}}$ (D) $\frac{3}{4\sqrt{3}}$

14. Let the hyperbola $H : \frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ pass through the point $\left(2\sqrt{2},-2\sqrt{2}\right)$. A parabola is drawn whose focus is same as the focus of H with positive abscissa and the directrix of the parabola passes through the other focus of H. If the length of the latus rectum of the parabola is e times the length of the latus rectum of H, where e is the eccentricity of H, then which of the following points lies on the parabola?

(A) $\left(2\sqrt{3},3\sqrt{2}\right)$ (B) $\left(3\sqrt{3},-6\sqrt{2}\right)$

(C) $\left(\sqrt{3},-\sqrt{6}\right)$ (D) $\left(3\sqrt{6},6\sqrt{2}\right)$

15. Let the lines $\frac{x-1}{\lambda}=\frac{y-2}{1}=\frac{z-3}{2}$ and $\frac{x+26}{-2}=\frac{y+18}{3}=\frac{z+28}{\lambda}$ be coplanar and P be the plane containing these two lines. Then which of the following points does **NOT** lies on P?

(A) (0, – 2, –2) (B) (– 5, 0, –1)

(C) (3, –1, 0) (D) (0, 4, 5)

16. A plane P is parallel to two lines whose direction ratios are –2, 1, –3, and –1, 2, –2 and it contains the point (2, 2, –2). Let P intersect the co-ordinate axes at the points A, B, C making the intercepts α, β, γ. If V is the volume of the tetrahedron OABC, where O is the origin and $p = \alpha + \beta + \gamma$, then the ordered pair (V, p) is equal to

(A) (48, –13) (B) (24, –13)

(C) (48, 11) (D) (24, –5)

17. Let S be the set of all $a \in R$ for which the angle between the vectors $\vec{u} = a\left(\log_e b\right)\hat{i}-6\hat{j}+3\hat{k}$ and $\vec{v} = \left(\log_e b\right)\hat{i}+2\hat{j}+2a\left(\log_e b\right)\hat{k}, (b>1)$ is acute. Then S is equal to

(A) $\left(-\infty,-\frac{4}{3}\right)$ (B) Φ

(C) $\left(-\frac{4}{3},0\right)$ (D) $\left(\frac{12}{7},\infty\right)$

18. A horizontal park is in the shape of a triangle OAB with AB = 16. A vertical lamp post OP is erected at the point O such that $\angle PAO = \angle PBO = 15°$ and $\angle PCO = 45°$, where C is the midpoint of AB. Then $(OP)^2$ is equal to

(A) $\frac{32}{\sqrt{3}}(\sqrt{3}-1)$ (B) $\frac{32}{\sqrt{3}}(2-\sqrt{3})$

(C) $\frac{16}{\sqrt{3}}(\sqrt{3}-1)$ (D) $\frac{16}{\sqrt{3}}(2-\sqrt{3})$

19. Let A and B be two events such that $P(B|A)=\frac{2}{5}$, $P(A|B)=\frac{1}{7}$ and $P(A\cap B)=\frac{1}{9}$. Consider

$(S1)\ P(A'\cup B)=\frac{5}{6}$,

$(S2)\ P(A'\cap B')=\frac{1}{18}$. Then

(A) Both (S1) and (S2) are true
(B) Both (S1) and (S2) are false
(C) Only (S1) is true
(D) Only (S2) is true

20. Let
p : Ramesh listens to music.
q : Ramesh is out of his village
r : It is Sunday
s : It is Saturday
Then the statement "Ramesh listens to music only if he is in his village and it is Sunday or Saturday" can be expressed as

(A) $((\sim q)\wedge(r\vee s))\Rightarrow p$

(B) $(q\wedge(r\vee s))\Rightarrow p$

(C) $p\Rightarrow(q\wedge(r\vee s))$

(D) $p\Rightarrow((\sim q)\wedge(r\vee s))$

SECTION-B

1. Let the coefficients of the middle terms in the expansion of $\left(\frac{1}{\sqrt{6}}+\beta x\right)^4$, $(1-3\beta x)^2$ and $\left(1-\frac{\beta}{2}x\right)^6$, $\beta>0$, respectively form the first three terms of an A.P. If d is the common difference of this A.P., then $50-\frac{2d}{\beta^2}$ is equal to _____

2. A class contains b boys and g girls. If the number of ways of selecting 3 boys and 2 girls from the class is 168, then b + 3 g is equal to

3. Let the tangents at the points P and Q on the ellipse $\frac{x^2}{2}+\frac{y^2}{4}=1$ meet at the point $R(\sqrt{2},2\sqrt{2}-2)$. If S is the focus of the ellipse on its negative major axis, then $SP^2 + SQ^2$ is equal to

4. If $1+(2+{}^{49}C_1+{}^{49}C_2+\ldots..+{}^{49}C_{49})$ $({}^{50}C_2+{}^{50}C_4+\ldots..+{}^{50}C_{50})$ is equal to $2^n.m$, where m is odd, then n + m is equal to _____

5. Two tangent lines l_1 and l_2 are drawn from the point (2, 0) to the parabola $2y^2 = -x$. If the lines l_1 and l_2 are also tangent to the circle $(x-5)^2 + y^2 = r$, then 17r is equal to

6. If

$$\frac{6}{3^{12}}+\frac{10}{3^{11}}+\frac{20}{3^{10}}+\frac{40}{3^9}+\ldots..+\frac{10240}{3}=2^n\cdot m,$$

where m is odd, then m.n is equal to _____

7. Let $S=\left[-\pi,\frac{\pi}{2}\right)-\left\{-\frac{\pi}{2},-\frac{\pi}{4},-\frac{3\pi}{4},\frac{\pi}{4}\right\}$.

Then the number of elements in the set

$$A=\left\{\theta\in S:\tan\theta\left(1+\sqrt{5}\tan(2\theta)\right)=\sqrt{5}-\tan(2\theta)\right\}$$

is _____

8. Let z = a + ib, b ≠ 0 be complex numbers satisfying $z^2=\bar{z}\cdot 2^{1-|z|}$. Then the least value of $n \in N$, such that $z^n = (z+1)^n$, is equal to _____

9. A bag contains 4 white and 6 black balls. Three balls are drawn at random from the bag. Let X be the number of white balls, among the drawn balls. If σ^2 is the variance of X, then $100\,\sigma^2$ is equal to

10. The value of the integral $\int_0^{\pi/2} 60\frac{\sin(6x)}{\sin x}dx$ is equal to

SET # 09

PHYSICS
SECTION-A

1. Given below are two statements : One is labelled as Assertion (A) and other is labelled as Reason (R).

Assertion (A) : Time period of oscillation of a liquid drop depends on surface tension (S), if density of the liquid is p and radius of the drop is r, then $T = k\sqrt{\dfrac{pr^3}{s^{3/2}}}$ is dimensionally correct, where K is dimensionless.

Reason (R) : Using dimensional analysis we get R.H.S. having different dimension than that of time period.

In the light of above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A)
(C) (A) is true but (R) is false
(D) (A) is false but (R) is true

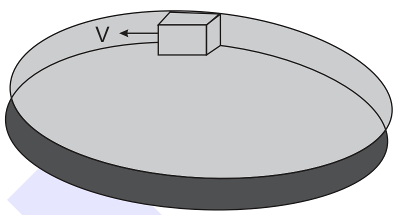
2. A ball is thrown up vertically with a certain velocity so that, it reaches a maximum height h. Find the ratio of the times in which it is at height $\frac{h}{3}$ while going up and coming down respectively.

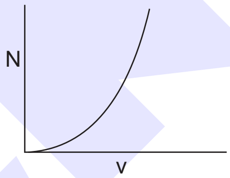
(A) $\dfrac{\sqrt{2}-1}{\sqrt{2}+1}$ (B) $\dfrac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$
(C) $\dfrac{\sqrt{3}-1}{\sqrt{3}+1}$ (D) $\dfrac{1}{3}$

3. If $t=\sqrt{x}+4$, then $\left(\dfrac{dx}{dt}\right)_{t=4}$ is:

(A) 4 (B) Zero
(C) 8 (D) 16

4. A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (v) ?



(A)


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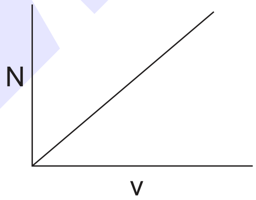

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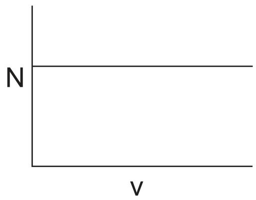
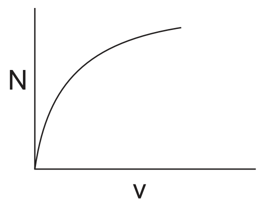


(D)


5. A ball is projected with kinetic energy E, at an angle of 60^0 to the horizontal. The kinetic energy of this ball at the highest point of its flight will become :

(A) Zero (B) $\dfrac{E}{2}$
(C) $\dfrac{E}{4}$ (D) E

6. Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i}+2\hat{j}+\hat{k}$ and $-3\hat{i}-2\hat{j}+\hat{k}$ respectively. The magnitude of position vector of centre of mass of this system will be similar to the magnitude of vector :

(A) $\hat{i}-2\hat{j}+\hat{k}$ (B) $-3\hat{i}-2\hat{j}+\hat{k}$

(C) $-2\hat{i}+2\hat{k}$ (D) $-2\hat{i}-\hat{j}+2\hat{k}$

7. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as
Reason (R).

Assertion (A) : Clothes containing oil or grease stains cannot be cleaned by water wash.

Reason (R) : Because the angle of contact between the oil/ grease and water is obtuse.

In the light of the above statements, choose the correct answer from the option given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is true but (R) is true

8. If the length of a wire is made double and radius is halved of its respective values. Then, the Young's modules of the material of the wire will :

(A) Remains same

(B) Become 8 times its initial value

(C) Become $\frac{1}{4}^{th}$ of its initial value

(D) Become 4 times its initial value

9. The time period of oscillation of a simple pendulum of length L suspended from the roof of a vehicle, which moves without friction down an inclined plane of inclination α, is given by :

(A) $2\pi\sqrt{L/(g\cos\alpha)}$

(B) $2\pi\sqrt{L/(g\sin\alpha)}$

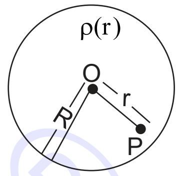
(C) $2\pi\sqrt{L/g}$

(D) $2\pi\sqrt{L/(g\tan\alpha)}$

10. A spherically symmetric charge distribution is considered with charge density varying as

$$\rho(r)=\begin{cases}\rho_0\left(\frac{3}{4}-\frac{r}{R}\right) & \text{for } r\le R\\ \text{Zero} & \text{for } r>R\end{cases}$$

Where, r(r < R) is the distance from the centre O (as shown in figure). The electric field at point P will be :



(A) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{3}{4}-\frac{r}{R}\right)$ (B) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{3}{4}-\frac{r}{R}\right)$

(C) $\frac{\rho_0 r}{4\varepsilon_0}\left(1-\frac{r}{R}\right)$ (D) $\frac{\rho_0 r}{5\varepsilon_0}\left(1-\frac{r}{R}\right)$

11. Given below are two statements.

Statement I : Electric potential is constant within and at the surface of each conductor.

Statement II : Electric field just outside a charged conductor is perpendicular to the surface of the conductor at every point.

In the light of the above statements, choose the most appropriate answer from the options give below.

(A) Both statement I and statement II are correct

(B) Both statement I and statement II are incorrect

(C) Statement I is correct but statement II is incorrect

(D) Statement I is incorrect but and statement II is correct

12. Two metallic wires of identical dimensions are connected is series. If σ_1 and σ_2 are the conductivities of the these wires respectively, the effective conductivity of the combination is :

(A) $\frac{\sigma_1\sigma_2}{\sigma_1+\sigma_2}$ (B) $\frac{2\sigma_1\sigma_2}{\sigma_1+\sigma_2}$

(C) $\frac{\sigma_1+\sigma_2}{2\sigma_1\sigma_2}$ (D) $\frac{\sigma_1+\sigma_2}{\sigma_1\sigma_2}$

13. An alternating emf E = 440 sin 100πt is applied to a circuit containing an inductance of $\frac{\sqrt{2}}{\pi}$ H. If an a.c. ammeter is connected in the circuit, its reading will be :

(A) 4.4 A (B) 1.55 A

(C) 2.2 A (D) 3.11 A

14. A coil of inductance 1 H and resistance 100 Ω is connected to a battery of 6 V. Determine approximately :

(a) The time elapsed before the current acquires half of its steady – state value

(b) The energy stored in the magnetic field associated with the coil at an instant 15 ms after the circuit is switched on.

(Given In2 = 0.693, $e^{-3/2} = 0.25$)

(A) t = 10 ms; U = 2 mJ

(B) t = 10 ms; U = 1 mJ

(C) t = 7 ms; U = 1 mJ

(D) t = 7 ms; U = 2 mJ

15. Match List – I with List – II

List – I	List – II
(a) UV rays	(i) Diagnostic tool in medicine
(b) X-rays	(ii) Water purification
(c) Microwave	(iii) Communication, Radar
(d) Infrared wave	(iv) Improving visibility in foggy days

Choose the correct answer from the options given below :

(A) (a)–(iii), (b)-(ii), (c)-(i), (d)-(iv)

(B) (a)–(ii), (b)-(i), (c)-(iii), (d)-(iv)

(C) (a)–(ii), (b)-(iv), (c)-(iii), (d)-(i)

(D) (a)–(iii), (b)-(i), (c)-(ii), (d)-(iv)

16. The kinetic energy of emitted electron is E when the light incident on the metal has wavelength λ. To double the kinetic energy, the incident light must have wavelength :

(A) $\frac{hc}{E\lambda - hc}$ (B) $\frac{hc\lambda}{E\lambda + hc}$

(C) $\frac{h\lambda}{E\lambda + hc}$ (D) $\frac{hc\lambda}{E\lambda - hc}$

17. Find the ratio of energies of photons produced due to transition of an election of hydrogen atom from its(i) second permitted energy level to the first level, and (ii) the highest permitted energy level to the first permitted level.

(A) 3 : 4 (B) 4 : 3

(C) 1 : 4 (D) 4 : 1

18. Find the modulation index of an AM wave having 8 V variation where maximum amplitude of the AM wave is 9 V.

(A) 0.8 (B) 0.5

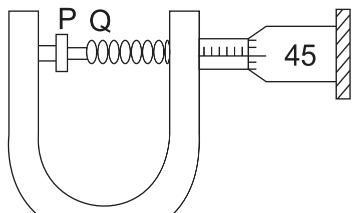
(C) 0.2 (D) 0.1

19. A travelling microscope has 20 divisions per cm on the main scale while its Vernier scale has total 50 divisions and 25 Vernier scale divisions are equal to 24 main scale divisions, what is the least count of the travelling microscope ?

(A) 0.001 cm (B) 0.002 mm

(C) 0.002 cm (D) 0.005 cm

20. In an experiment to find out the diameter of wire using screw gauge, the following observation were noted :



(a) Screw moves 0.5 mm on main scale in one complete rotation

(b) Total divisions on circular scale = 50

(c) Main scale reading is 2.5 mm

(d) 45^{th} division of circular scale is in the pitch line

(e) Instrument has 0.03 mm negative error

Then the diameter of wire is :

(A) 2.92 mm (B) 2.54 mm

(C) 2.98 mm (D) 3.45 mm

SECTION-B

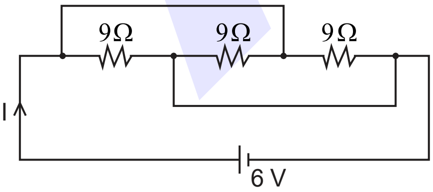
1. An object is projected in the air with initial velocity u at an angle θ. The projectile motion is such that the horizontal range R, is maximum. Another object is projected in the air with a horizontal range half of the range of first object. The initial velocity remains same in both the case. The value of the angle of projection, at which the second object is projected, will be _______degree.

2. If the acceleration due to gravity experienced by a point mass at a height h above the surface of earth is same as that of the acceleration due to gravity at a depth αh ($h << R_e$) from the earth surface. The value of α will be _________.
(use $R_e = 6400$ km)

3. The pressure P_1 and density d_1 of diatomic gas $\left(\gamma = \frac{7}{5}\right)$ changes suddenly to $P_2 (> P_1)$ and d_2 respectively during an adiabatic process. The temperature of the gas increases and becomes _________ times of its initial temperature.
(given $\frac{d_2}{d_1} = 32$)

4. One mole of a monoatomic gas is mixed with three moles of a diatomic gas. The molecular specific heat of mixture at constant volume is $\frac{\alpha^2}{4}R$ J/mol K; then the value of α will be _______. (Assume that the given diatomic gas has no vibrational mode.)

5. The current I flowing through the given circuit will be __________ A.



6. A closely wounded circular coil of radius 5 cm produces a magnetic field of 37.68×10^{-4} T at its center. The current through the coil is _________ A.
[Given, number of turns in the coil is 100 and $\pi = 3.14$]

7. Two light beams of intensities 4I and 9I interfere on a screen. The phase difference between these beams on the screen at point A is zero and at point B is π. The difference of resultant intensities, at the point A and B, will be _________ I.

8. A wire of length 314 cm carrying current of 14 A is bent to form a circle. The magnetic moment of the coil is _______ A-m^2. [Given $\pi = 3.14$]

9. The X-Y plane be taken as the boundary between two transparent media M_1 and M_2. M_1 in $Z \geq 0$ has a refractive index of $\sqrt{2}$ and M_2 with $Z < 0$ has a refractive index of $\sqrt{3}$. A ray of light travelling in M_1 along the direction given by the vector $\vec{A} = 4\sqrt{3}\hat{i} - 3\sqrt{3}\hat{j} - 5\hat{k}$, is incident on the plane of separation. The value of difference between the angle of incident in M_1 and the angle of refraction in M_2 will be ____________ degree.

10. If the potential barrier across a p-n junction is 0.6 V. Then the electric field intensity, in the depletion region having the width of 6×10^{-6}m, will be _________ $\times 10^5$ N/C.

CHEMISTRY
SECTION-A

1. Which of the following pair of molecules contain odd electron molecule and an expanded octet molecule?
(A) BCl_3 and SF_6
(B) NO and H_2SO_4
(C) SF_6 and H_2SO_4
(D) BCl_3 and NO

2. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
20 g   5 g
Consider the above reaction, the limiting reagent of the reaction and number of moles of NH_3 formed respectively are:
(A) H_2, 1.42 moles
(B) H_2, 0.71 moles
(C) N_2, 1.42 moles
(D) N_2, 0.71 moles

3. 100 mL of 5% (w/v) solution of NaCl in water was prepared in 250 mL beaker. Albumin from the egg was poured into NaCl solution and stirred well. This resulted in a/an :

(A) Lyophilic sol (B) Lyophobic sol
(C) Emulsion (D) Precipitate

4. The first ionization enthalpy of Na, Mg and Si, respectively, are: 496, 737 and 786 kJ mo1^{-1}. The first ionization enthalpy (kJ mol^{-1}) of Al is:

(A) 487 (B) 768
(C) 577 (D) 856

5. In metallurgy the term "gangue" is used for:

(A) Contamination of undesired earthy materials.
(B) Contamination of metals, other than desired metal
(C) Minerals which are naturally occuring in pure form
(D) Magnetic impurities in an ore.

6. The reaction of zinc with excess of aqueous alkali, evolves hydrogen gas and gives :

(A) $Zn(OH)_2$ (B) ZnO
(C) $[Zn(OH)_4]^{2-}$ (D) $[ZnO_2]^{2-}$

7. Lithium nitrate and sodium nitrate, when heated separately, respectively, give :

(A) $LiNO_2$ and $NaNO_2$
(B) Li_2O and Na_2O
(C) Li_2O and $NaNO_2$
(D) $LiNO_2$ and Na_2O

8. Number of lone pairs of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6, respectively, are :

(A) 0, 1, 2 and 2
(B) 2, 1, 2 and 0
(C) 1, 2, 2 and 0
(D) 2, 1, 2 and 0

9. In following pairs, the one in which both transition metal ions are colourless is :

(A) Sc^{3+}, Zn^{2+}
(B) Ti^{4+}, Cu^{2+}
(C) V^{2+}, Ti^{3+}
(D) Zn^{2+}, Mn^{2+}

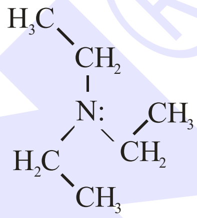
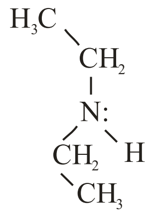
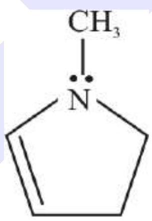
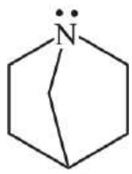
10. In neutral or faintly alkaline medium, $KMnO_4$ being a powerful oxidant can oxidize, thiosulphate almost quantitatively, to sulphate. In this reaction overall change in oxidation state of manganese will be :

(A) 5 (B) 1 (C) 0 (D) 3

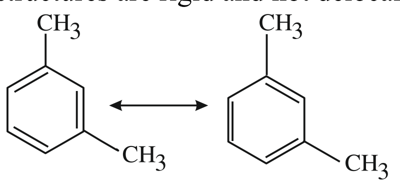
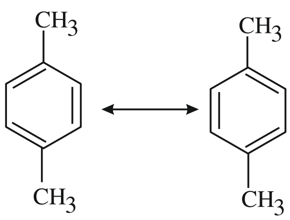
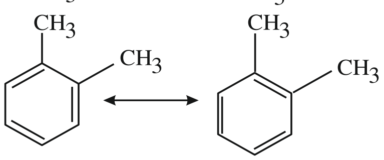
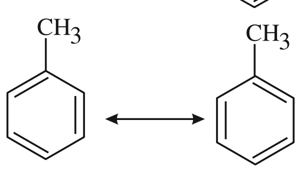
11. Which among the following pairs has only herbicides ?

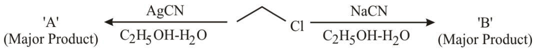
(A) Aldrin and Dieldrin
(B) Sodium chlorate and Aldrin
(C) Sodium arsinate and Dieldrin
(D) Sodium chlorate and sodium arsinite.

12. Which among the following is the strongest Bronsted base ?

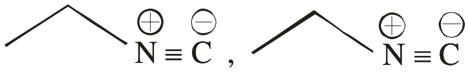
(A) 
(B) 
(C) 
(D) 

13. Which among the following pairs of the structures will give different products on ozonolysis? (Consider the double bonds in the structures are rigid and not delocalized.)

(A) 
(B) 
(C) 
(D) 

14. 

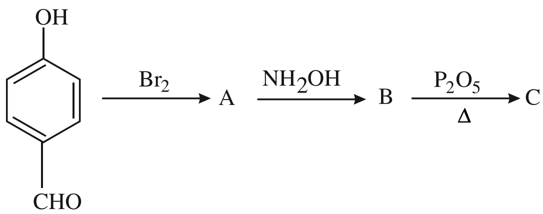
Considering the above reactions, the compound 'A' and compound 'B' respectively are :

(A) 

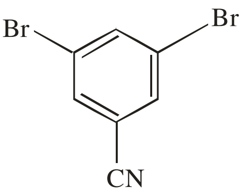
(B) 

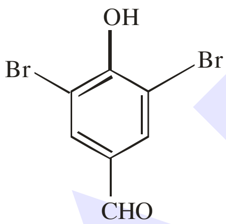
(C) 

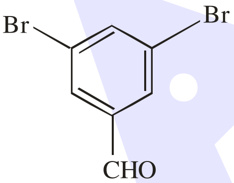
(D) 

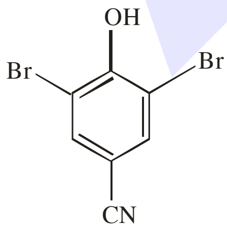
15. 

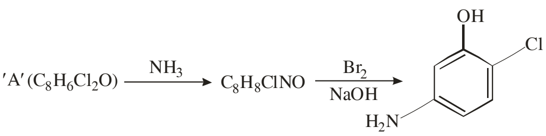
Consider the above reaction sequence, the Product 'C' is :

(A) 

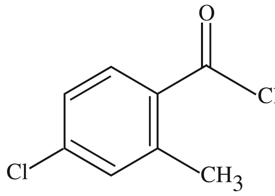
(B) 

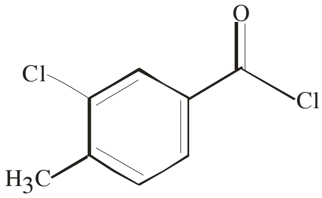
(C) 

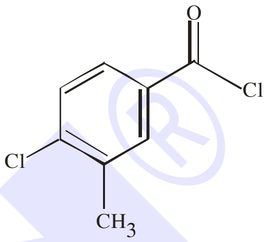
(D) 

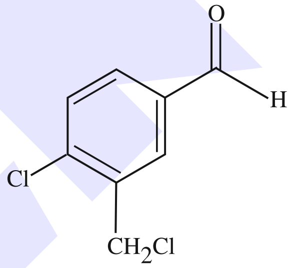
16. 

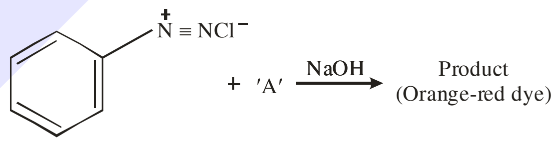
Consider the above reaction, the compound 'A' is :

(A) 

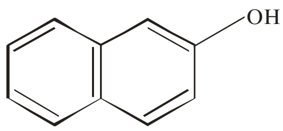
(B) 

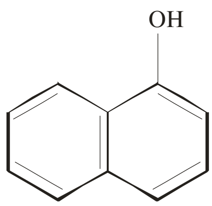
(C) 

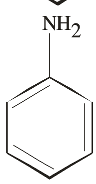
(D) 

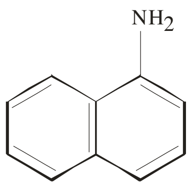
17. 

Which among the following represent reagent 'A'?

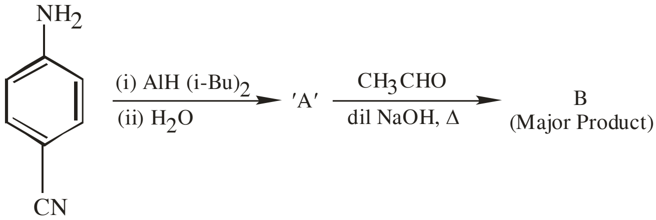
(A) 

(B) 

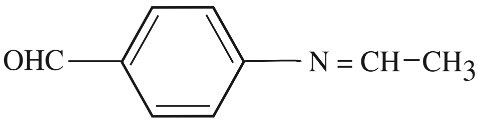
(C) 

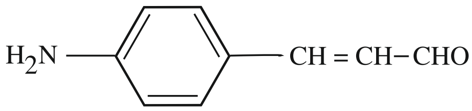
(D) 

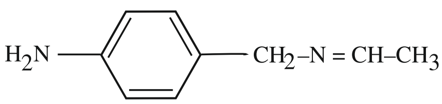
18. Consider the following reaction sequence :

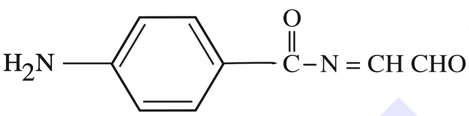


The product 'B' is :

(A) 

(B) 

(C) 

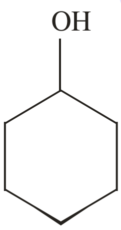
(D) 

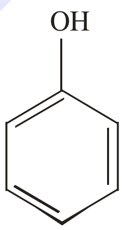
19. Which of the following compounds is an example of hypnotic drug ?

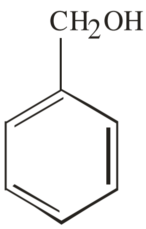
(A) Seldane (B) Amytal

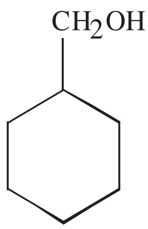
(C) Aspartame (D) Prontosil

20. A compound 'X' is acidic and it is soluble in NaOH solution, but insoluble in $NaHCO_3$ solution. Compound 'X' also gives violet colour with neutral $FeCl_3$ solution. The compound 'X' is :

(A) 

(B) 

(C) 

(D) 

SECTION-B

1. Resistance of a conductivity cell (cell constant 129 m^{-1}) filled with 74.5 ppm solution of KCl is 100 Ω (labelled as solution 1). When the same cell is filled with KCl solution of 149 ppm, the resistance is 50 Ω (labelled as solution 2). The ratio of molar conductivity of solution 1 and solution 2 is i.e. $\frac{\wedge_1}{\wedge_2} = x \times 10^{-3}$. The value of x is _____.

(Nearest integer)

Given, molar mass of KCl is 74.5 g mol^{-1}

2. Ionic radii of cation A^+ and anion B^- are 102 and 181 pm respectively. These ions are allowed to crystallize into an ionic solid. This crystal has cubic close packing for B^-. A^+ is present in all octahedral voids. The edge length of the unit cell of the crystal AB is _____ pm. (Nearest Integer)

3. The minimum uncertainty in the speed of an electron in an one dimensional region of length $2a_0$

(Where a_0 = Bohr radius 52.9 pm) is _____km s^{-1}.

(Given : Mass of electron = 9.1×10^{-31} kg, Planck's constant h = 6.63×10^{-34} Js)

4. When 600 mL of 0.2 M HNO_3 is mixed with 400 mL of 0.1M NaOH solution in a flask, the rise in temperature of the flask is _______ $\times 10^{-2}$ ^{0}C.

(Enthalpy of neutralisation = 57 kJ mol^{-1} and Specific heat of water = 4.2 JK^{-1} g^{-1})

(Neglect heat capacity of flask)

5. If O_2 gas is bubbled through water at 303 K, the number of millimoles of O_2 gas that dissolve in 1 litre of water is_______. (Nearest Integer)

(Given : Henry's Law constant for O_2 at 303 K is 46.82 k bar and partial pressure of O_2 = 0.920 bar)

(Assume solubility of O_2 in water is too small, nearly negligible)

6. If the solubility product of PbS is 8×10^{-28}, then the solubility of PbS in pure water at 298 K is $x \times 10^{-16}$ mol L^{-1}. The value of x is ________. (Nearest Integer)

[Given $\sqrt{2} = 1.41$]

7. The reaction between X and Y is first order with respect to X and zero order with respect to Y.

Experiment	$\frac{[X]}{mol\,L^{-1}}$	$\frac{[Y]}{mol\,L^{-1}}$	$\frac{\text{Initial rate}}{mol\,L^{-1}\,min^{-1}}$
I.	0.1	0.1	2×10^{-3}
II.	L	0.2	4×10^{-3}
III.	0.4	0.4	$M\times10^{-3}$
IV.	0.1	0.2	2×10^{-3}

Examine the data of table and calculate ratio of numerical values of M and L. (Nearest Inetger)

8. In a linear tetrapeptide (Constituted with different amino acids), (number of amino acids) - (number of peptide bonds) is______.

9. In bromination of Propyne, with Bromine 1, 1, 2, 2-tetrabromopropane is obtained in 27% yield. The amount of 1, 1, 2, 2 tetrabromopropane obtained from 1 g of Bromine in this reaction is ______ $\times 10^{-1}$ g. (Nearest integer)

(Molar Mass : Bromine = 80 g/mol)

10. $[Fe(CN)_6]^{3-}$ should be an inner orbital complex. Ignoring the pairing energy, the value of crystal field stabilization energy for this complex is (–) _________ Δ_o. (Nearest integer)

MATHEMATICS

SECTION-A

1. Let R be a relation from the set {1, 2, 3………,60} to itself such that

R = {(a, b) : b = pq, where p, q ≥ 3 are prime numbers}. Then, the number of elements in R is :

(A) 600 (B) 660

(C) 540 (D) 720

2. If z = 2 + 3i, then $z^5 + (\bar{z})^5$ is equal to :

(A) 244 (B) 224

(C) 245 (D) 265

3. Let A and B be two 3 × 3 non-zero real matrices such that AB is a zero matrix. Then

(A) The system of linear equations AX = 0 has a unique solution

(B) The system of linear equations AX = 0 has infinitely many solutions

(C) B is an invertible matrix

(D) adj (A) is an invertible matrix

4. If $\frac{1}{(20-a)(40-a)} + \frac{1}{(40-a)(60-a)} + \ldots\ldots + \frac{1}{(180-a)(200-a)} = \frac{1}{256}$, then the maximum value of a is :

(A) 198 (B) 202

(C) 212 (D) 218

5. If $\lim\limits_{x\to0} \frac{\alpha e^x + \beta e^{-x} + \gamma \sin x}{x \sin^2 x} = \frac{2}{3}$,

where α, β,γ ∈ R, then which of the following is NOT correct ?

(A) $\alpha^2 + \beta^2 + \gamma^2 = 6$

(B) $\alpha\beta + \beta\gamma + \gamma\alpha + 1 = 0$

(C) $\alpha\beta^2 + \beta\gamma^2 + \gamma\alpha^2 + 3 = 0$

(D) $\alpha^2 - \beta^2 + \gamma^2 = 4$

6. The integral $\int_0^{\frac{\pi}{2}} \frac{1}{3+2\sin x+\cos x}dx$ is equal to:

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}(2) - \frac{\pi}{4}$

(C) $\frac{1}{2}\tan^{-1}(2) - \frac{\pi}{8}$ (D) $\frac{1}{2}$

7. Let the solution curve y = y (x) of the differential equation $(1 + e^{2x})\left(\frac{dy}{dx} + y\right) = 1$ pass through the point $\left(0, \frac{\pi}{2}\right)$. Then, $\lim\limits_{x\to\infty} e^x y(x)$ is equal to :

(A) $\frac{\pi}{4}$ (B) $\frac{3\pi}{4}$

(C) $\frac{\pi}{2}$ (D) $\frac{3\pi}{2}$

8. Let a line L pass through the point of intersection of the lines $bx + 10y - 8 = 0$ and $2x - 3y = 0$, $b \in R - \left\{\frac{4}{3}\right\}$. If the line L also passes through the point (1, 1) and touches the circle $17(x^2 + y^2) = 16$, then the eccentricity of the ellipse $\frac{x^2}{5} + \frac{y^2}{b^2} = 1$ is :

(A) $\frac{2}{\sqrt{5}}$ (B) $\sqrt{\frac{3}{5}}$

(C) $\frac{1}{\sqrt{5}}$ (D) $\sqrt{\frac{2}{5}}$

9. If the foot of the perpendicular from the point A(– 1, 4, 3) on the plane P : $2x + my + nz = 4$, is $\left(-2, \frac{7}{2}, \frac{3}{2}\right)$, then the distance of the point A from the plane P, measured parallel to a line with direction ratios 3, – 1, – 4, is equal to :

(A) 1 (B) $\sqrt{26}$

(C) $2\sqrt{2}$ (D) $\sqrt{14}$

10. Let $\vec{a} = 3\hat{i} + \hat{j}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$. Let $\vec{c}$ be a vector satisfying $\vec{a} \times (\vec{b} \times \vec{c}) = \vec{b} + \lambda\vec{c}$. If $\vec{b}$ and $\vec{c}$ are non-parallel, then the value of λ is :

(A) – 5 (B) 5

(C) 1 (D) – 1

11. The angle of elevation of the top of a tower from a point A due north of it is α and from a point B at a distance of 9 units due west of A is $\cos^{-1}\left(\frac{3}{\sqrt{13}}\right)$. If the distance of the point B from the tower is 15 units, then $\cot\alpha$ is equal to :

(A) $\frac{6}{5}$ (B) $\frac{9}{5}$

(C) $\frac{4}{3}$ (D) $\frac{7}{3}$

12. The statement $(p \wedge q) \Rightarrow (p \wedge r)$ is equivalent to :

(A) $q \Rightarrow (p \wedge r)$ (B) $p \Rightarrow (p \wedge r)$

(C) $(p \wedge r) \Rightarrow (p \wedge q)$ (D) $(p \wedge q) \Rightarrow r$

13. Let the circumcentre of a triangle with vertices A(a, 3), B(b, 5) and C(a, b), $ab > 0$ be P(1, 1). If the line AP intersects the line BC at the point $Q(k_1, k_2)$, then $k_1 + k_2$ is equal to :

(A) 2 (B) $\frac{4}{7}$ (C) $\frac{2}{7}$ (D) 4

14. Let $\hat{a}$ and $\hat{b}$ be two unit vectors such that the angle between them is $\frac{\pi}{4}$. If θ is the angle between the vectors $(\hat{a} + \hat{b})$ and $(\hat{a} + 2\hat{b} + 2(\hat{a} \times \hat{b}))$, then the value of $164\cos^2\theta$ is equal to :

(A) $90 + 27\sqrt{2}$ (B) $45 + 18\sqrt{2}$

(C) $90 + 3\sqrt{2}$ (D) $54 + 90\sqrt{2}$

15. If $f(\alpha) = \int_1^{\alpha} \frac{\log_{10} t}{1+t} dt, \alpha > 0$, then $f(e^3) + f(e^{-3})$ is equal to :

(A) 9 (B) $\frac{9}{2}$

(C) $\frac{9}{\log_e(10)}$ (D) $\frac{9}{2\log_e(10)}$

16. The area of the region $\left\{(x, y) : |x - 1| \le y \le \sqrt{5 - x^2}\right\}$ is equal to :

(A) $\frac{5}{2}\sin^{-1}\left(\frac{3}{5}\right) - \frac{1}{2}$ (B) $\frac{5\pi}{4} - \frac{3}{2}$

(C) $\frac{3\pi}{4} + \frac{3}{2}$ (D) $\frac{5\pi}{4} - \frac{1}{2}$

17. Let the focal chord of the parabola P : $y^2 = 4x$ along the line L : $y = mx + c$, $m > 0$ meet the parabola at the points M and N. Let the line L be a tangent to the hyperbola H : $x^2 - y^2 = 4$. If O is the vertex of P and F is the focus of H on the positive x-axis, then the area of the quadrilateral OMFN is :

(A) $2\sqrt{6}$ (B) $2\sqrt{14}$

(C) $4\sqrt{6}$ (D) $4\sqrt{14}$

18. The number of points, where the function $f : \mathbf{R} \to \mathbf{R}$, $f(x) = |x-1| \cos |x-2| \sin |x-1| + (x-3)|x^2-5x+4|$, is **NOT** differentiable, is :

(A) 1 (B) 2 (C) 3 (D) 4

19. Let S = {1, 2, 3, …, 2022}. Then the probability, that a randomly chosen number n from the set S such that HCF (n, 2022) = 1, is :

(A) $\frac{128}{1011}$ (B) $\frac{166}{1011}$

(C) $\frac{127}{337}$ (D) $\frac{112}{337}$

20. Let $f(x) = 3^{(x^2-2)^3+4}$, $x \in \mathbf{R}$. Then which of the following statements are true ?

P : x = 0 is a point of local minima of f

Q : $x = \sqrt{2}$ is a point of inflection of f

R : f' is increasing for $x > \sqrt{2}$

(A) Only P and Q (B) Only P and R

(C) Only Q and R (D) All, P, Q and R

SECTION-B

1. Let $S = \{\theta \in (0, 2\pi) : 7\cos^2\theta - 3\sin^2\theta - 2\cos^2 2\theta = 2\}$. Then, the sum of roots of all the equations $x^2 - 2(\tan^2\theta + \cot^2\theta)x + 6\sin^2\theta = 0$ $\theta \in S$, is________.

2. Let the mean and the variance of 20 observations $x_1, x_2, \ldots x_{20}$ be 15 and 9, respectively. For $\alpha \in R$, if the mean of $(x_1+\alpha)^2, (x_2+\alpha)^2, \ldots, (x_{20}+\alpha)^2$ is 178, then the square of the maximum value of α is equal to ______.

3. Let a line with direction ratios a, –4a, –7 be perpendicular to the lines with direction ratios 3, –1, 2b and b, a, –2. If the point of intersection of the line $\frac{x+1}{a^2+b^2} = \frac{y-2}{a^2-b^2} = \frac{z}{1}$ and the plane $x - y + z = 0$ is (α, β, γ), then $\alpha + \beta + \gamma$ is equal to __________.

4. Let $a_1, a_2, a_3, \ldots$ be an A.P. If $\sum_{r=1}^{\infty} \frac{a_r}{2^r} = 4$, then $4a_2$ is equal to ________.

5. Let the ratio of the fifth term from the beginning to the fifth term from the end in the binomial expansion of $\left(\sqrt[4]{2} + \frac{1}{\sqrt[4]{3}}\right)^n$, in the increasing powers of $\frac{1}{\sqrt[4]{3}}$ be $\sqrt[4]{6}$: 1. If the sixth term from the beginning is $\frac{\alpha}{\sqrt[4]{3}}$, then α is equal to _______.

6. The number of matrices of order 3 × 3, whose entries are either 0 or 1 and the sum of all the entries is a prime number, is______.

7. Let p and p + 2 be prime numbers and let

$$\Delta = \begin{vmatrix} p! & (p+1)! & (p+2)! \\ (p+1)! & (p+2)! & (p+3)! \\ (p+2)! & (p+3)! & (p+4)! \end{vmatrix}$$

Then the sum of the maximum values of α and β, such that p^α and $(p+2)^\beta$ divide Δ, is _________.

8. If $\frac{1}{2\times3\times4} + \frac{1}{3\times4\times5} + \frac{1}{4\times5\times6} + \ldots + \frac{1}{100\times101\times102} = \frac{k}{101}$, then 34 k is equal to _____.

9. Let S = {4, 6, 9} and T = {9, 10, 11, …, 1000}. If $A = \{a_1 + a_2 + \ldots + a_k : k \in N, a_1, a_2, a_3, \ldots, a_k \in S\}$, then the sum of all the elements in the set T – A is equal to ______.

10. Let the mirror image of a circle $c_1 : x^2 + y^2 - 2x - 6y + \alpha = 0$ in line $y = x + 1$ be $c_2 : 5x^2 + 5y^2 + 10gx + 10fy + 38 = 0$. If r is the radius of circle c_2, then $\alpha + 6r^2$ is equal to ________

SET # 10

PHYSICS

SECTION-A

1. Two identical metallic spheres A and B when placed at certain distance in air repel each other with a force of F. Another identical uncharged sphere C is first placed in contact with A and then in contact with B and finally placed at midpoint between spheres A and B. The force experienced by sphere C will be :

(A) 3F/2 (B) 3F/4

(C) F (D) 2F

2. Match List I with List II.

List I		List II	
A.	Torque	I.	Nms^{-1}
B.	Stress	II.	$J\ kg^{-1}$
C.	Latent Heat	III.	Nm
D.	Power	IV.	Nm^{-2}

Choose the correct answer from the options given below:

(A) A-III, B-II, C-I, D-IV

(B) A-III, B-IV, C-II, D-I

(C) A-IV, B-I, C-III, D-II

(D) A-II, B-III, C-I, D-IV

3. Two identical thin metal plates has charge q_1 and q_2 respectively such that $q_1 > q_2$. The plates were brought close to each other to form a parallel plate capacitor of capacitance C. The potential difference between them is :

(A) $\frac{(q_1+q_2)}{C}$ (B) $\frac{(q_1-q_2)}{C}$

(C) $\frac{(q_1-q_2)}{2C}$ (D) $\frac{2(q_1-q_2)}{C}$

4. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: Alloys such as constantan and manganin are used in making standard resistance coils.

Reason R: Constantan and manganin have very small value of temperature coefficient of resistance.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

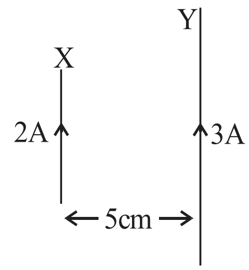
(D) A is false but R is true.

5. A 1 m long wire is broken into two unequal parts X and Y The X part of the wire is streched into another wire W. Length of W is twice the length of X and the resistance of W is twice that of Y. Find the ratio of length of X and Y.

(A) 1 : 4 (B) 1 : 2

(C) 4 :1 (D) 2 : 1

6. A wire X of length 50 cm carrying a current of 2 A is placed parallel to a long wire Y of length 5 m. The wire Y carries a current of 3 A. The distance between two wires is 5 cm and currents flow in the same direction. The force acting on the wire Y is :



(A) 1.2×10^{-5} N directed towards wire X.

(B) 1.2×10^{-4} N directed away from wire X.

(C) 1.2×10^{-4} N directed towards wire X.

(D) 2.4×10^{-5} N directed towards wire X.

7. A juggler throws balls vertically upwards with same initial velocity in air. When the first ball reaches its highest position, he throws the next ball. Assuming the juggler throws n balls per second, the maximum height the balls can reach is

(A) g/2n (B) g/n

(C) 2gn (D) $g/2n^2$

8. A circuit element X when connected to an a.c. supply of peak voltage 100 V gives a peak current of 5 A which is in phase with the voltage. A second element Y when connected to the same a.c. supply also gives the same value of peak current which lags behind the voltage by $\frac{\pi}{2}$. If X and Y are connected in series to the same supply, what will be the rms value of the current in ampere ?

(A) $\frac{10}{\sqrt{2}}$ (B) $\frac{5}{\sqrt{2}}$ (C) $5\sqrt{2}$ (D) $\frac{5}{2}$

9. An unpolarised light beam of intensity $2I_0$ is passed through a polaroid P and then through another polaroid Q which is oriented in such a way that its passing axis makes an angle of 30° relative to that of P. The intensity of the emergent light is

(A) $\frac{I_0}{4}$ (B) $\frac{I_0}{2}$ (C) $\frac{3I_0}{4}$ (D) $\frac{3I_0}{2}$

10. An α particle and a proton are accelerated from rest through the same potential difference. The ratio of linear momenta acquired by above two particals will be :

(A) $\sqrt{2}:1$ (B) $2\sqrt{2}:1$

(C) $4\sqrt{2}:1$ (D) 8 : 1

11. Read the following statements:

(A) Volume of the nucleus is directly proportional to the mass number.

(B) Volume of the nucleus is independent of mass number.

(C) Density of the nucleus is directly proportional to the mass number.

(D) Density of the nucleus is directly proportional to the cube root of the mass number.

(E) Density of the nucleus is independent of the mass number.

Choose the correct option from the following options.

(A) (A) and (D) only. (B) (A) and (E) only.

(C) (B) and (E) only. (D) (A) and (C) only

12. An object of mass 1 kg is taken to a height from the surface of earth which is equal to three times the radius of earth. The gain in potential energy of the object will be

[If, g=10ms^{-2} and radius of earth = 6400 km]

(A) 48 MJ (B) 24 MJ

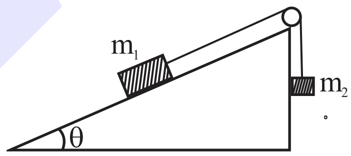
(C) 36 MJ (D) 12 MJ

13. A ball is released from a height h. If t_1 and t_2 be the time required to complete first half and second half of the distance respectively. Then, choose the correct relation between t_1 and t_2.

(A) $t_1 = (\sqrt{2})t_2$ (B) $t_1 = (\sqrt{2}-1)t_2$

(C) $t_2 = (\sqrt{2}+1)t_1$ (D) $t_2 = (\sqrt{2}-1)t_1$

14. Two bodies of masses m_1 = 5 kg and m_2 = 3 kg are connected by a light string going over a smooth light pulley on a smooth inclined plane as shown in the figure. The system is at rest. The force exerted by the inclined plane on the body of mass m_1 will be :[Take g = 10 ms^{-2}]



(A) 30 N (B) 40 N

(C) 50 N (D) 60 N

15. If momentum of a body is increased by 20%, then its kinetic energy increases by :

(A) 36% (B) 40%

(C) 44% (D) 48%

16. The torque of a force $5\hat{i}+3\hat{j}-7\hat{k}$ about the origin is τ. If the force acts on a particle whose position vector is $2\hat{i}+2\hat{j}+\hat{k}$, then the value of τ will be :

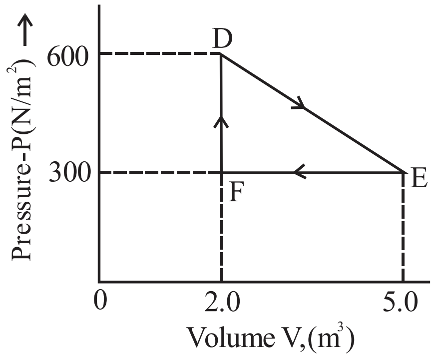
(A) $11\hat{i}+19\hat{j}-4\hat{k}$

(B) $-11\hat{i}+9\hat{j}-16\hat{k}$

(C) $-17\hat{i}+19\hat{j}-4\hat{k}$

(D) $17\hat{i}+9\hat{j}+16\hat{k}$

17. A thermodynamic system is taken from an original state D to an intermediate state E by the linear process shown in the figure. Its volume is then reduced to the original volume from E to F by an isobaric process. The total work done by the gas from D to E to F will be



(A) –450 J (B) 450 J

(C) 900 J (D) 1350 J

18. The vertical component of the earth's magnetic field is 6×10^{-5} T at any place where the angle of dip is 37°. The earth's resultant magnetic field at that place will be (Given tan 37° = $\frac{3}{4}$)

(A) 8×10^{-5} T (B) 6×10^{-5} T

(C) 5×10^{-4} T (D) 1×10^{-4} T

19. The root mean square speed of smoke particles of mass 5×10^{-17} kg in their Brownian motion in air at NTP is approximately.

[Given k = 1.38×10^{-23} JK^{-1}]

(A) 60 mm s^{-1} (B) 12 mm s^{-1}

(C) 15 mm s^{-1} (D) 36 mm s^{-1}

20. Light enters from air into a given medium at an angle of 45° with interface of the air-medium surface. After refraction, the light ray is deviated through an angle of 15° from its original direction. The refractive index of the medium is :

(A) 1.732 (B) 1.333

(C) 1.414 (D) 2.732

SECTION-B

1. A tube of length 50 cm is filled completely with an incompressible liquid of mass 250 g and closed at both ends. The tube is then rotated in horizontal plane about one of its ends with a uniform angular velocity $x\sqrt{F}$ rad s^{-1}. If F be the force exerted by the liquid at the other end then the value of x will be _______.

2. Nearly 10% of the power of a 110 W light bulb is converted to visible radiation. The change in average intensities of visible radiation, at a distance of 1 m from the bulb to a distance of 5 m is $a \times 10^{-2}$ W/m^2. The value of 'a' will be

3. A metal wire of length 0.5 m and cross-sectional area 10^{-4} m^2 has breaking stress 5×10^8 Nm^{-2}. A block of 10 kg is attached at one end of the string and is rotating in a horizontal circle. The maximum linear velocity of block will be____ ms^{-1}.

4. The velocity of a small ball of mass 0.3g and density 8g/cc when dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is 1.3 g/cc, then the value of viscous force acting on the ball will be x × 10^{-4} N, the value of x is____.

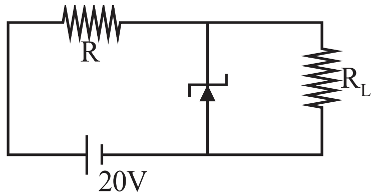
[use g = 10m/s^2]

5. A modulating signal 2sin(6.28×10^6)t is added to the carrier signal 4sin (12.56×10^9)t for amplitude modulation. The combined signal is passed through a non-linear square law device. The output is then passed through a band pass filter. The bandwidth of the output signal of band pass filter will be___MHz.

6. The speed of a transverse wave passing through a string of length 50 cm and mass 10 g is 60 ms^{-1}. The area of cross-section of the wire is 2.0 mm^2 and its Young's modulus is 1.2×10^{11} Nm^{-2}. The extension of the wire over its natural length due to its tension will be x × 10^{-5} m. The value of x is_______.

7. The metallic bob of simple pendulum has the relative density 5. The time period of this pendulum is 10 s. If the metallic bob is immersed in water, then the new time period becomes $5\sqrt{x}$ s. The value of x will be ________.

8. A 8 V Zener diode along with a series resistance R is connected across a 20 V supply (as shown in the figure). If the maximum Zener current is 25 mA, then the minimum value of R will be _____Ω.



9. Two radioactive materials A and B have decay constants 25λ and 16λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of B to that of A will be "e" after a time $\frac{1}{a\lambda}$. The value of a is_______.

10. A capacitor of capacitance 500 μF is charged completely using a dc supply of 100 V. It is now connected to an inductor of inductance 50 mH to form an LC circuit. The maximum current in LC circuit will be _______ A.

CHEMISTRY

SECTION-A

1. Consider the reaction

$4HNO_3(l) + 3KCl(s) \rightarrow Cl_2(g) + NOCl(g) + 2H_2O(g) + 3KNO_3(s)$

The amount of HNO_3 required to produce 110.0 g of KNO_3 is :

(Given : Atomic masses of H, O, N and K are 1, 16, 14 and 39, respectively.)

(A) 32.2 g (B) 69.4 g

(C) 91.5 g (D) 162.5 g

2. Given below are the quantum numbers for 4 electrons.

A. n = 3, l = 2, m_l = 1, m_s = +1/2

B. n = 4, l = 1, m_l = 0, m_s = +1/2

C. n = 4, l = 2, m_l = –2, m_s = –1/2

D. n = 3, l = 1, m_l = –1, m_s = +1/2

The correct order of increasing energy is :

(A) D < B < A < C (B) D < A < B < C

(C) B < D < A < C (D) B < D < C < A

3. $C(s) + O_2(g) \rightarrow CO_2(g) + 400$ kJ

$C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g) + 100$ kJ

When coal of purity 60% is allowed to burn in presence of insufficient oxygen, 60% of carbon is converted into 'CO' and the remaining is converted into 'CO_2'.

The heat generated when 0.6 kg of coal is burnt is ______.

(A) 1600 kJ (B) 3200 kJ

(C) 4400 kJ (D) 6600 kJ

4. 200 mL of 0.01 M HCl is mixed with 400 mL of 0.01M H_2SO_4. The pH of the mixture is ____.

(A) 1.14 (B) 1.78

(C) 2.34 (D) 3.02

5. Given below are the critical temperatures of some of the gases :

Gas	Critical temperature (K)
He	5.2
CH_4	190
CO_2	304.2
NH_3	405.5

The gas showing least adsorption on a definite amount of charcoal is :

(A) He (B) CH_4

(C) CO_2 (D) NH_3

6. In liquation process used for tin (Sn), the metal :

(A) is reacted with acid

(B) is dissolved in water

(C) is brought to molten form which is made to flow on a slope

(D) is fused with NaOH.

7. Given below are two statements.

Statement I : Stannane is an example of a molecular hydride.

Statement II : Stannane is a planar molecule.

In the light of the above statement, choose the most appropriate answer from the options given below :

(A) Both Statement I and Statement II are true.

(B) Both Statement I and Statement II are false.

(C) Statement I is true but Statement II is false.

(D) Statement I is false but Statement II is true.

8. Portland cement contains 'X' to enhance the setting time. What is 'X'?

(A) $CaSO_4.\frac{1}{2}H_2O$ (B) $CaSO_4.2H_2O$

(C) $CaSO_4$ (D) $CaCO_3$

9. When borax is heated with CoO on a platinum loop, blue coloured bead formed is largely due to :

(A) B_2O_3 (B) $Co(BO_2)_2$

(C) CoB_4O_7 (D) $Co[B_4O_5(OH)_4]$

10. Which of the following 3d-metal ion will give the lowest enthalpy of hydration ($\Delta_{hyd}H$) when dissolved in water ?

(A) Cr^{2+} (B) Mn^{2+}

(C) Fe^{2+} (D) Co^{2+}

11. Octahedral complexes of copper (II) undergo structural distortion (Jahn-Teller). Which one of the given copper (II) complexes will show the maximum structural distortion ?

(en–ethylenediamine; H_2N-CH_2-CH_2-NH_2)

(A) $[Cu(H_2O)_6]SO_4$

(B) $[Cu(en)(H_2O)_4]SO_4$

(C) cis-$[Cu(en)_2Cl_2]$

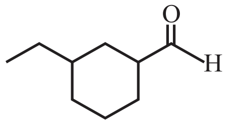
(D) trans-$[Cu(en)_2Cl_2]$

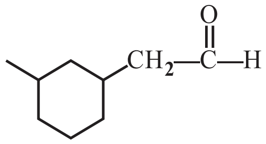
12. Dinitrogen is a robust compound, but reacts at high altitude to form oxides. The oxide of nitrogen that can damage plant leaves and retard photosynthesis is :

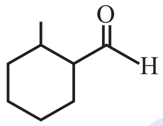
(A) NO (B) NO_3^-

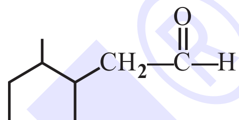
(C) NO_2 (D) NO_2^-

13. Correct structure of γ-methylcyclohexane carbaldehyde is :

(A) 

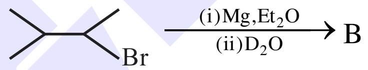
(B) 

(C) 

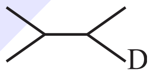
(D) 

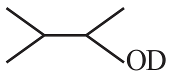
14. Compound 'A' undergoes following sequence of reactions to give compound 'B'. The correct structure and chirality of compound 'B' is:

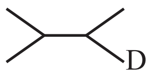
[where Et is $-C_2H_5$]



Compound 'A'

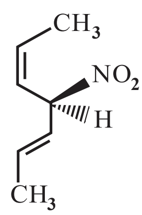
(A)  , Achiral

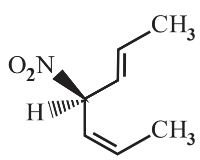
(B)  , Chiral

(C)  , Chiral

(D)  , Achiral

15. Given below are two statements.

Statement I : The compound  is optically active.

Statement II :  is mirror image of above compound A.

In the light of the above statement, choose the **most appropriate** answer from the options given below.

(A) Both Statement I and Statement II are correct

(B) Both Statement I and Statement II are incorrect.

(C) Statement I is correct but Statement II is incorrect.

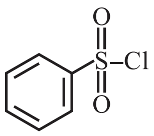
(D) Statement I is incorrect but Statement II is correct.

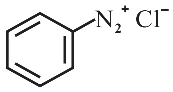
16. When enthanol is heated with conc. H_2SO_4, a gas is produced. The compound formed, when this gas is treated with cold dilute aqueous solution of Baeyer's reagent, is :

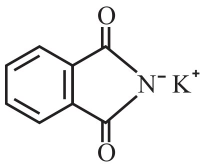
(A) Formaldehyde (B) Formic acid

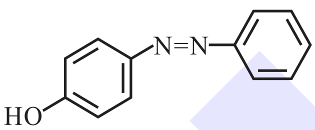
(C) Glycol (D) Ethanoic acid

17. The Hinsberg reagent is :

(A) 

(B) 

(C) 

(D) 

18. Which of the following is **NOT** a natural polymer?

(A) Protein (B) Starch

(C) Rubber (D) Rayon

19. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : Amylose is insoluble in water.

Reason R : Amylose is a long linear molecule with more than 200 glucose units.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both **A** and **R** are correct and **R** is the correct explanation of A.

(B) Both **A** and **R** are correct and **R** is NOT the correct explanation of A.

(C) **A** is correct but **R** is not correct.

(D) **A** is not correct but **R** is correct.

20. A compound 'X' is a weak acid and it exhibits colour change at pH close to the equivalence point during neutralization of NaOH with CH_3COOH. Compound 'X' exists in ionized form in basic medium. The compound 'X' is :

(A) methyl orange

(B) methyl red

(C) phenolphthalein

(D) erichrome Black T

SECTION-B

1. 'x' g of molecular oxygen (O_2) is mixed with 200 g of neon (Ne). The total pressure of the non-reactive mixture of O_2 and Ne in the cylinder is 25 bar. The partial pressure of Ne is 20 bar at the same temperature and volume. The value of 'x' is______.

[Given: Molar mass of O_2 = 32 g mol^{-1}.

Molar mass of Ne = 20 g mol^{-1}]

2. Consider, PF_5, BrF_5, PCl_3, SF_6, $[ICl_4]^-$, ClF_3 and IF_5.

Amongst the above molecule(s)/ion(s), the number of molecule(s)/ion(s) having sp^3d^2 hybridisation is_____.

3. 1.80 g of solute A was dissolved in 62.5 cm^3 of ethanol and freezing point of the solution was found to be 155.1 K. The molar mass of solute A is __g mol^{-1}.

[Given: Freezing point of ethanol is 156.0 K.

Density of ethanol is 0.80 g cm^{-3}.

Freezing point depression constant of ethanol is 2.00 K kg mol^{-1}]

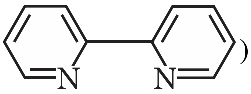
4. For a cell, Cu(s) $|Cu^{2+}(0.001M)|$ $|Ag^{+}(0.01M)|$ Ag(s) the cell potential is found to be 0.43 V at 298 K. The magnitude of standard electrode potential for Cu^{2+}/Cu is ___$\times 10^{-2}$ V.

$$\left[\text{Given}: E^{\ominus}_{Ag^+/Ag} = 0.80\text{V and } \frac{2.303RT}{F} = 0.06\text{V}\right]$$

5. Assuming 1μg of trace radioactive element X with a half life of 30 years is absorbed by a growing tree. The amount of X remaining in the tree after 100 years is____$\times 10^{-1}$μg.

[Given : ln 10 = 2.303; log2 = 0.30]

6. Sum of oxidation state (magnitude) and coordination number of cobalt in $Na[Co(bpy)Cl_4]$ is__.

(Given bpy = )

7. Consider the following sulphure based oxoacids.

H_2SO_3, H_2SO_4, $H_2S_2O_8$ and $H_2S_2O_7$.

Amongst these oxoacids, the number of those with peroxo(O-O) bond is_______.

8. A 1.84 mg sample of polyhydric alcoholic compound 'X' of molar mass 92.0 g/mol gave 1.344 mL of H_2 gas at STP. The number of alcoholic hydrogens present in compound 'X' is_____.

9. The number of stereoisomers formed in a reaction of (±) Ph(C=O) C(OH)(CN)Ph with HCN is______.

10. The number of chlorine atoms in bithionol is_____.

MATHEMATICS

SECTION-A

1. If $z \neq 0$ be a complex number such that $\left|z-\frac{1}{z}\right|=2$, then the maximum value of $|z|$ is:

(A) $\sqrt{2}$ (B) 1

(C) $\sqrt{2}-1$ (D) $\sqrt{2}+1$

2. Which of the following matrices can NOT be obtained from the matrix $\begin{bmatrix} -1 & 2 \\ 1 & -1 \end{bmatrix}$ by a single elementary row operation?

(A) $\begin{bmatrix} 0 & 1 \\ 1 & -1 \end{bmatrix}$ (B) $\begin{bmatrix} 1 & -1 \\ -1 & 2 \end{bmatrix}$

(C) $\begin{bmatrix} -1 & 2 \\ -2 & 7 \end{bmatrix}$ (D) $\begin{bmatrix} -1 & 2 \\ -1 & 3 \end{bmatrix}$

3. If the system of equations

$x + y + z = 6$

$2x + 5y + \alpha z = \beta$

$x + 2y + 3z = 14$

has infinitely many solutions, then $\alpha + \beta$ is equal to :

(A) 8 (B) 36

(C) 44 (D) 48

4. Let the function

$$f(x)=\begin{cases} \dfrac{\log_e(1+5x)-\log_e(1+\alpha x)}{x} & ;\text{if } x \neq 0 \\ 10 & ;\text{if } x = 0 \end{cases}$$

be continuous at x = 0. The α is equal to :

(A) 10 (B) –10

(C) 5 (D) –5

5. If [t] denotes the greatest integer $\leq t$, then the value of $\int_0^1 \left[2x-|3x^2-5x+2|+1\right]dx$ is:

(A) $\frac{\sqrt{37}+\sqrt{13}-4}{6}$ (B) $\frac{\sqrt{37}-\sqrt{13}-4}{6}$

(C) $\frac{-\sqrt{37}-\sqrt{13}+4}{6}$ (D) $\frac{-\sqrt{37}+\sqrt{13}+4}{6}$

6. Let $\{a_n\}_{n=0}^{\infty}$ be a sequence such that $a_0 = a_1 = 0$ and $a_{n+2} = 3a_{n+1} - 2a_n+1$, $\forall\ n \geq 0$.

Then $a_{25}\ a_{23} - 2\ a_{25}\ a_{22} - 2\ a_{23}\ a_{24} + 4\ a_{22}\ a_{24}$ is equal to:

(A) 483 (B) 528

(C) 575 (D) 624

7. $\sum_{r=1}^{20}(r^2+1)(r!)$ is equal to:

(A) 22! – 21! (B) 22! – 2 (21!)

(C) 21! – 2 (20!) (D) 21! – 20!

8. For $I(x)=\int\frac{\sec^2 x-2022}{\sin^{2022} x}dx$, if $I\left(\frac{\pi}{4}\right)=2^{1011}$, then

(A) $3^{1010} I\left(\frac{\pi}{3}\right)-I\left(\frac{\pi}{6}\right)=0$

(B) $3^{1010} I\left(\frac{\pi}{6}\right)-I\left(\frac{\pi}{3}\right)=0$

(C) $3^{1011} I\left(\frac{\pi}{3}\right)-I\left(\frac{\pi}{6}\right)=0$

(D) $3^{1011} I\left(\frac{\pi}{6}\right)-I\left(\frac{\pi}{3}\right)=0$

9. If the solution curve of the differential equation $\frac{dy}{dx}=\frac{x+y-2}{x-y}$ passes through the point (2,1) and (k + 1,2), k > 0, then

(A) $2\tan^{-1}\left(\frac{1}{k}\right)=\log_e\left(k^2+1\right)$

(B) $\tan^{-1}\left(\frac{1}{k}\right)=\log_e\left(k^2+1\right)$

(C) $2\tan^{-1}\left(\frac{1}{k+1}\right)=\log_e\left(k^2+2k+2\right)$

(D) $2\tan^{-1}\left(\frac{1}{k}\right)=\log_e\left(\frac{k^2+1}{k^2}\right)$

10. Let y = y (x) be the solution curve of the differential equation $\frac{dy}{dx}+\left(\frac{2x^2+11x+13}{x^3+6x^2+11x+6}\right)y=\frac{(x+3)}{x+1}$, x > –1, which passes through the point (0,1). Then y (1) is equal to:

(A) $\frac{1}{2}$ (B) $\frac{3}{2}$ (C) $\frac{5}{2}$ (D) $\frac{7}{2}$

11. Let m_1, m_2 be the slopes of two adjacent sides of a square of side a such that $a^2+11a+3\left(m_2^2+m_2^2\right)=220$. If one vertex of the square is (10(cosα – sinα), 10 (sinα + cosα)), where $\alpha\in\left(0,\frac{\pi}{2}\right)$ and the equation of one diagonal is (cosα – sinα) x + (sinα + cosα) y = 10, then 72 ($\sin^4\alpha + \cos^4\alpha$) + a^2 – 3a + 13 is equal to:

(A) 119 (B) 128

(C) 145 (D) 155

12. The number of elements in the set $S=\left\{x\in\mathbb{R}:2\cos\left(\frac{x^2+x}{6}\right)=4^x+4^{-x}\right\}$ is:

(A) 1 (B) 3

(C) 0 (D) infinite

13. Let A (α, –2), B (α, 6) and $C\left(\frac{\alpha}{4},-2\right)$ be vertices of a ΔABC. If $\left(5,\frac{\alpha}{4}\right)$ is the circumcentre of ΔABC, then which of the following is NOT correct about ΔABC:

(A) ares is 24 (B) perimeter is 25

(C) circumradius is 5 (D) inradius is 2

14. Let Q be the foot of perpendicular drawn from the point P (1, 2, 3) to the plane x + 2y + z = 14. If R is a point on the plane such that ∠PRQ = 60°, then the area of ΔPQR is equal to:

(A) $\frac{\sqrt{3}}{2}$ (B) $\sqrt{3}$

(C) $2\sqrt{3}$ (D) 3

15. If (2, 3, 9), (5, 2, 1), (1, λ, 8) and (λ, 2, 3) are coplanar, then the product of all possible values of λ is:

(A) $\frac{21}{2}$ (B) $\frac{59}{8}$

(C) $\frac{57}{8}$ (D) $\frac{95}{8}$

16. Bag I contains 3 red, 4 black and 3 white balls and Bag II contains 2 red, 5 black and 2 white balls. One ball is transferred from Bag I to Bag II and then a ball is draw from Bag II. The ball so drawn is found to be black in colour. Then the probability, that the transferred ball is red, is:

(A) $\frac{4}{9}$ (B) $\frac{5}{18}$ (C) $\frac{1}{6}$ (D) $\frac{3}{10}$

17. Let S = {z = x + iy : |z – 1 + i| ≥ | z |, |z| < 2, |z + i| = |z –1|}. Then the set of all values of x, for which w = 2x + iy ∈ S for some y ∈ $\mathbb{R}$, is

(A) $\left(-\sqrt{2},\frac{1}{2\sqrt{2}}\right]$ (B) $\left(-\frac{1}{\sqrt{2}},\frac{1}{4}\right]$

(C) $\left(-\sqrt{2},\frac{1}{2}\right]$ (D) $\left(-\frac{1}{\sqrt{2}},\frac{1}{2\sqrt{2}}\right]$

18. Let $\vec{a}, \vec{b}, \vec{c}$ be three coplanar concurrent vectors such that angles between any two of them is same. If the product of their magnitudes is 14 and
$(\vec{a}\times\vec{b}).(\vec{b}\times\vec{c})+(\vec{b}\times\vec{c}).(\vec{c}\times\vec{a})+(\vec{c}\times\vec{a}).(\vec{a}\times\vec{b})=168$
then $|\vec{a}|+|\vec{b}|+|\vec{c}|$ is equal to :
(A) 10 (B) 14
(C) 16 (D) 18

19. The domain of the function
$f(x)=\sin^{-1}\left(\dfrac{x^2-3x+2}{x^2+2x+7}\right)$ is :
(A) $[1, \infty)$ (B) $(-1, 2]$
(C) $[-1, \infty)$ (D) $(-\infty, 2]$

20. The statement $(p\Rightarrow q)\vee(p\Rightarrow r)$ is NOT equivalent to:
(A) $(p\wedge(\sim r))\Rightarrow q$
(B) $(\sim q)\Rightarrow((\sim r)\vee p)$
(C) $p\Rightarrow(q\vee r)$
(D) $(p\wedge(\sim q))\Rightarrow r$

SECTION-B

1. The sum and product of the mean and variance of a binomial distribution are 82.5 and 1350 respectively. They the number of trials in the binomial distribution is:

2. Let α, β $(\alpha > \beta)$ be the roots of the quadratic equation $x^2 - x - 4 = 0$. If $P_n = \alpha^n - \beta^n$, $n \in \mathbb{N}$, then $\dfrac{P_{15}P_{16}-P_{14}P_{16}-P_{15}^2+P_{14}P_{15}}{P_{13}P_{14}}$ is equal to _____.

3. Let $x=\begin{bmatrix}1\\1\\1\end{bmatrix}$ and $A=\begin{bmatrix}-1&2&3\\0&1&6\\0&0&-1\end{bmatrix}$. For $k \in \mathbb{N}$, if $X' A^k X = 33$, then k is equal to:

4. The number of natural numbers lying between 1012 and 23421 that can be formed using the digits 2, 3, 4, 5, 6 (repetition of digits is not allowed) and divisible by 55 is____,

5. If $\sum_{k=1}^{10} K^2\left(10_{C_K}\right)^2 = 22000L$, then L is equal to ____.

6. If [t] denotes the greatest integer ≤ t, then number of points, at which the function
$f(x) = 4|2x + 3| + 9\left[x+\dfrac{1}{2}\right] - 12[x + 20]$ is not differentiable in the open interval (–20, 20), is____.

7. If the tangent to the curve $y = x^3 - x^2 + x$ at the point (a , b) is also tangent to the curve $y = 5x^2 + 2x - 25$ at the point (2, –1), then $|2a + 9b|$ is equal to _____.

8. Let AB be a chord of length 12 of the circle $(x-2)^2 + (y+1)^2 = \dfrac{169}{4}$.
If tangents drawn to the circle at points A and B intersect at the point P, then five times the distance of point P from chord AB is equal to ____.

9. Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{a}+\vec{b}|^2=|\vec{a}|^2+2|\vec{b}|^2, \vec{a}.\vec{b}=3$ and $|\vec{a}\times\vec{b}|^2=75$.
Then $|\vec{a}|^2$ is equal to____.

10. Let
$S=\{(x,y)\in\mathbb{N}\times\mathbb{N}: 9(x-3)^2+16(y-4)^2\le 144\}$
and
$T=\{(x,y)\in\mathbb{R}\times\mathbb{R}: (x-7)^2+(y-4)^2\le 36\}$.
The $n(S\cap T)$ is equal to_____.

SET-01

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	A	B	B	D	B	B	A	A	A	B	C	C	B	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	C	A	B	A	3	3	5	60	20	45	4	4	3	150

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	C	C	C	D	D	A	A	B	B	C	D	B	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	A	B	C	2	104	22	NTA-4 Allen-2	1	0	5	56	0 OR 1	2

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	NTA-Drop Allen-Bonus	B	C	B	A	B	A	B	A	C	C	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	C	A	D	17	1492	6006	38	27560	3	5	2	10	NTA-3 Allen-Bonus

SET-02

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	A	B	A	A	D	B	A	B	C	D	D	B	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	D	D	B	100	2	90	5	18	25	60	6	10	250

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	B	D	A	NTA-B Allen-C	D	B	C	C	B	A	C	D	B	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	B	B	A	46	1655	4	2	2	3	4	33	2	8

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	B	D	B	A	C	B	B	D	B	A	D	D	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	A	D	B	D	107	25	24	15	3	8	5	25	170	130

SET-03

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	NTA-C Allen-A	B	C	B	B	C	B	B	B	A	A	B	B	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	C	C	B	5	5	2	200	60	20	44	10	5	9

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	D	A	A	B	B	C	A	C	D	B	C	C	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	D	A	C	24	2	1758	200	54	2	3	2	0	6

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	D	D	B	B	C	A	D	C	C	A	B	D	A	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	D	C	B	D	272	180	6993	3	23	24	6	3	45	153

SET-04

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	B	B	B	D	A	A	B	C	B	A	A	A	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	A	B	C	A	2	5	27	26	25	200	17	2	20	2

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	C	C	A	B	A	D	C	A	A	A	B	A or B	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	C	C	NTA-C Allen-D	8	4	57	1	4	2	5	12	3	1

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	D	A	C	NTA-Drop Allen-Bonus	C	D	D	B	B	B	A	C	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	D	B	A	D	112	2	30	166	3	238	125	3	53	50

SET-05

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	D	B	B	B	C	A	C	A	A	B	A	B	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	D	C	A	D	2400	412	2	3	136	1	16	48	18	1

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	A	C	B	D	A	C	D	D	B	C	B	NTA-A Allen-D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	A	C	A	C	24	2	4	2	3	0	NTA-1 Allen-3	1	42	30

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	D	A	D	A	B	B	C	C	A	D	NTA-Drop Allen-Bonus	B	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	D	C	D	C	12	2	12	1552	1	2	10620	5376	75	0

SET-06

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	D	A	C	C	B	D	A	B	B	B	A	B	C	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	D	B	A	2	40	4	12	10	240	3	2	120	2

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	A	B	C	B	A	B	D	A	A	C	B	A	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	A	C	D	D	1	25	35	NTA 3 Allen 3 or 6	165	4	4	6	2	530

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	NTA-Drop Allen-Bonus	B	B	D	A	D	B	C	D	A	C	B	NTA A or B Allen (A or B or Both
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	D	A	C	D	42	1440	24	120	5	16	385	12	20	NTA-Drop Allen-Bonus

SET-07

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	A	B	B	D	C	C	D	C	A	A	D	A	D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	A	D	C	B	A	5	15	630	250	780	6	340	11	24	3

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	A	C	C	C	C	B	A	C	A	D	C	B	C	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	C	D	C	A	2	22	4	15	27	100	3	4	3	46

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	A	B	B	B	D	NTA-A Allen-Bonus	A	B	B	C	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	C	A	C	A	7073	450	2	10	2	50	3	142	1	6

SET-08

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	D	D	A	C	C	C	A	B	C	C	C	C	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	NTA-B Allen-D	C	A	B	D	392	8	30	750	2	14	1	400	15	5

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	A	A	C	B	B	C	A or D	A	B	D	C	B	D	A
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	D	A	A	C	25	87	2	2	2	22	5	8	3	3

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	C	D	B	A	C	D	A	B	D	A	B	B	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	B	A	D	57	17	13	99	9	12	5	6	56	104

SET-09

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	B	A	C	A	A	A	A	C	A	B	C	C	B
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	A	A	C	C	15 or 75	2	4	3	2	3	24	11	15	1

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	C	A	C	A	NTA-D Allen-C or D	C	B	A	D	D	D	C	C	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	B	B	B	1000	NTA-512 Allen-566	548	54	1	282	40	1	3	2

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	B	C	C	B	B	B	B	A	A	D	B	A	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	D	B	B	D	D	16	4	10	16	84	282	4	286	11	12

SET-10

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	A	B	A	D	D	C	B	B	A	D	B	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	D	C	C	4	84	50	25	2	15	5	480	9	10

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	D	B	A	C	C	B	B	B	A	C	A	C	C
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	D	D	C	80	4	80	34	1	9	1	NTA-3 Allen-6	3	4

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	C	C	D	A	B	B	A	A	B	B	A	B	B	D
Q.No.	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	C	C	B	96	16	NTA-10 Allen-Drop or 10	6	221	79	195	72	14	27