## PART-1 : PHYSICS

### SECTION-I : (Maximum Marks: 80)

This section contains **20 questions**. Each question has 4 options for correct answer. Multiple-Choice Questions (MCQs) **Only one option is correct**. For each question, marks will be awarded as follows:

*Full Marks* : +4 If correct answer is selected.

*Zero Marks* : 0 If none of the option is selected.

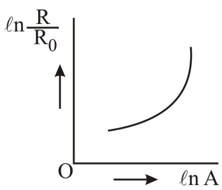
*Negative Marks* : –1 If wrong option is selected.

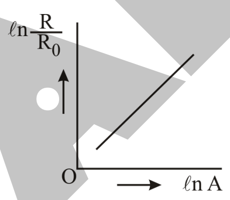
**1.** A proton, a neutron, an electron and an α-particle have same energy. If $\lambda_p$, $\lambda_n$, $\lambda_e$ and $\lambda_\alpha$ are the de Broglie's wavelengths of proton, neutron, electron and a particle respectively, then choose the correct relation from the following :

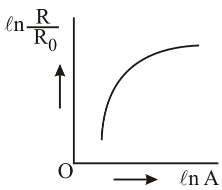
(A) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$ (B) $\lambda_\alpha < \lambda_n < \lambda_p < \lambda_e$

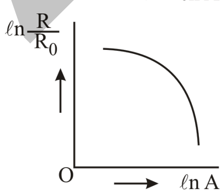
(C) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$ (D) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

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

(A) 


(B) 


(C) 


(D) 


**3.** 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:

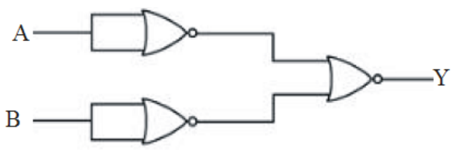
(A) Both statement I and statement II are true.

(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.

**4.** Identify the logic operation performed by the given circuit :

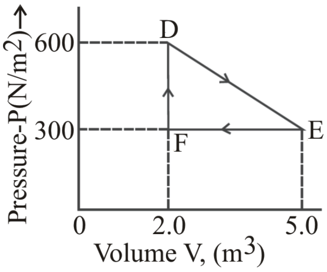



(A) AND gate (B) OR gate

(C) NOR gate (D) NAND gate

**SPACE FOR ROUGH WORK**

**5.** 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

**6.** 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 $\alpha^{-1}$ x is same as that of energy.

(C) Dimensions of $h^{-1}$ sinθ is same as that of αβ

(D) Dimensions of α is same as that of β

**7.** 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

**8.** 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) $3\hat{x}+15\hat{y}+7\hat{z}$

**9.** 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 =10$ms^{-2}$ and radius of earth = 6400 km]

(A) 48 MJ

(B) 24 MJ

(C) 36 MJ

(D) 12 MJ

SPACE FOR ROUGH WORK

**10.** The torque of a force $5\hat{i} + 3\hat{j} - 7\hat{k}$ about the origin is $\tau$. If the force acts on a particle whose position vector is $2\hat{i} + 2\hat{j} + \hat{k}$, then the value of $\tau$ will be :

(A) $11\hat{i} + 19\hat{j} - 4\hat{k}$ (B) $-11\hat{i} + 9\hat{j} - 16\hat{k}$

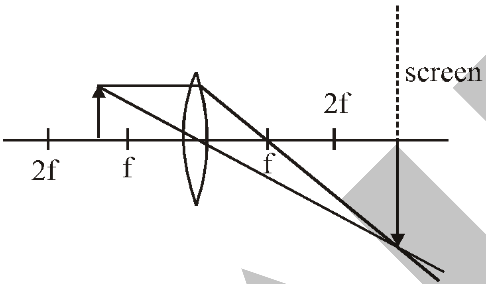
(C) $-17\hat{i} + 19\hat{j} - 4\hat{k}$ (D) $17\hat{i} + 9\hat{j} + 16\hat{k}$

**11.** 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

**12.** Formation of real image using a biconvex lens is shown below :




If the whole set up is immersed in water without disturbing the object and the screen position, what will one observe on the screen ?

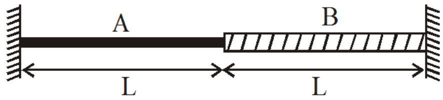
(A) Image disappears

(B) No change

(C) Erect real image

(D) Magnified image

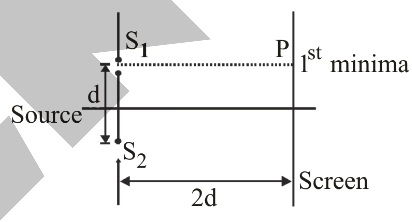
**13.** A wire of length 2L, is made by joining two wires A and B of same length but different radii r and 2r and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire A is p and that in B is q then the ratio p : q is :




(A) 4 : 9 (B) 3 : 5

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

**14.** Consider a Young's double slit experiment as shown in figure. What should be the slit separation d in terms of wavelength $\lambda$ such that the first minima occurs directly in front of the slit ($S_1$) ?




(A) $\dfrac{\lambda}{2\left(5-\sqrt{2}\right)}$ (B) $\dfrac{\lambda}{\left(5-\sqrt{2}\right)}$

(C) $\dfrac{\lambda}{\left(\sqrt{5}-2\right)}$ (D) $\dfrac{\lambda}{2\left(\sqrt{5}-2\right)}$

**15.** A tuning fork A of unknown frequency product 5 beats/s with a fork of known frequency 340 Hz. When fork A is filed, the beat frequency decreases to 2 beats/s. What is the frequency of fork A ?

(A) 342 Hz (B) 345 Hz

(C) 335 Hz (D) 338 Hz

**SPACE FOR ROUGH WORK**

**16.** Figure A and B shown two long straight wires of circular cross-section (a and b with a < b), carrying current I which is uniformly distributed across the cross-section. The magnitude of magnetic field B varies with radius r and can be represented as :

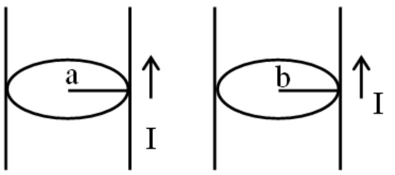
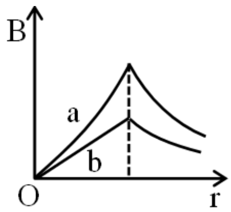
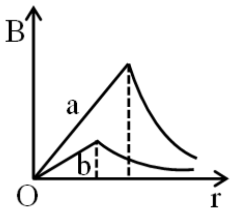
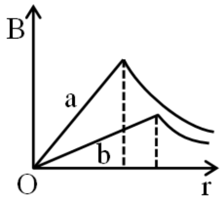
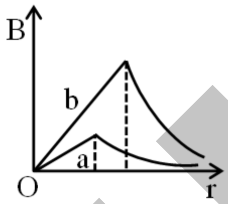



Fig. A Fig. B

(A)



(B)



(C)


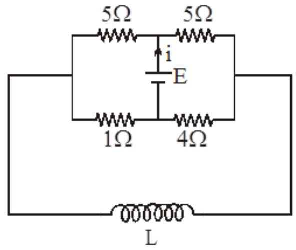

(D)



**17.** Electric field of plane electromagnetic wave propagating through a non–magnetic medium is given by $E = 20\cos(2 \times 10^{10} t - 200x)$ V/m. The dielectric constant of the medium is equal to : (Take $\mu_r = 1$)

(A) 9 (B) 2

(C) $\frac{1}{3}$ (D) 3

**18.** The current (i) at time t = 0 and t = ∞ respectively for the given circuit is:




(A) $\frac{18E}{55}, \frac{5E}{18}$ (B) $\frac{10E}{33}, \frac{5E}{18}$

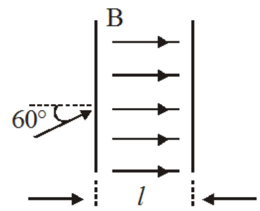
(C) $\frac{5E}{18}, \frac{18E}{55}$ (D) $\frac{5E}{18}, \frac{10E}{33}$

**19.** An inductance coil has a reactance of 100 Ω. When an AC signal of frequency 1000 Hz is applied to the coil, the applied voltage leads the current by 45°. The self-inductance of the coil is :

(A) $1.1 \times 10^{-2}$ H (B) $1.1 \times 10^{-1}$ H

(C) $5.5 \times 10^{-5}$ H (D) $6.7 \times 10^{-7}$ H

**20.** The figure shows a region of length '$\ell$' with a uniform magnetic field of 0.3 T in it and a proton entering the region with velocity $4 \times 10^5$ ms$^{-1}$ making an angle 60° with the field. If the proton completes 10 revolution by the time it cross the region shown, '$\ell$' is close to (mass of proton $= 1.67 \times 10^{-27}$ kg, charge of the proton $= 1.6 \times 10^{-19}$ C)




(A) 0.11 m (B) 0.22 m

(C) 0.44 m (D) 0.88 m

SPACE FOR ROUGH WORK

SECTION-II : (Maximum Marks: 20)

**This section contains 10 questions Candidates have to attempt any 5 questions out of 10. If more than 5 questions are attempted, then only first 5 attempted questions will be evaluated.**

The answer to each question is a **Numerical Value.**

For each question, enter the correct integer value (In case of non-integer value, the answer should be rounded off to the nearest Integer).

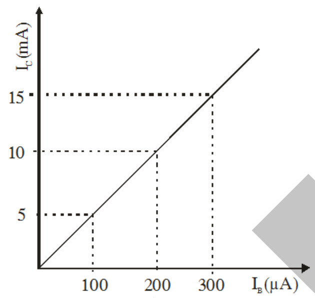
Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : +4 If correct answer is entered.

*Zero Marks* : 0 If the question is unanswered.

*Negative Marks* : –1 If wrong answer is entered.

**1.** 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 ______

**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 resistanceR = 100Ω. In the given circuit $R_L$ represents the variable load resistance. The ratio of maximum and minimum value of $R_L$ is ______

**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.** 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 $m/s^2$)

**5.** 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?

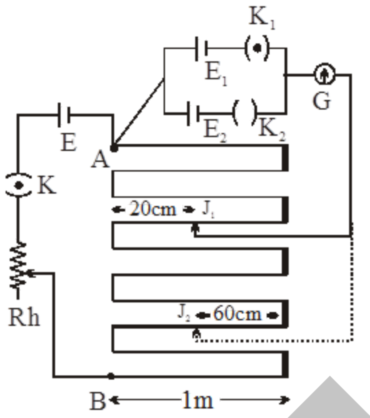
**6.** Two waves executing simple harmonic motion travelling in the same direction with same amplitude and frequency are superimposed. The resultant amplitude is equal to the $\sqrt{3}$ times of amplitude of individual motions. The phase difference between the two motions is _____ (degree)

**7.** 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.

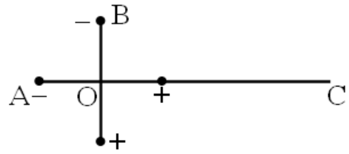
SPACE FOR ROUGH WORK

**8.** 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 = ___

**9.** In the given circuit of potentiometer, the potential difference E across AB (10m length) is larger than $E_1$ and $E_2$ as well. For key $K_1$ (closed), the jockey is adjusted to touch the wire at point $J_1$ so that there is no deflection in the galvanometer. Now the first battery ($E_1$) is replaced by second battery ($E_2$) for working by making $K_1$ open and $K_2$ closed. The galvanometer gives then null deflection at $J_2$. The value of $\frac{E_1}{E_2}$ is $\frac{a}{b}$, where a = ___.




**10.** Two ideal electric dipoles A and B, having their dipole moment $p_1$ and $p_2$ respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37° with the axis. The ratio of the dipole moment of A and B, $\frac{p_1}{p_2}$ is $\frac{x}{3}$, where x is : (take $\sin 37° = \frac{3}{5}$)




SPACE FOR ROUGH WORK

## PART-2 : CHEMISTRY

### SECTION-I : (Maximum Marks: 80)

This section contains **20 questions**. Each question has 4 options for correct answer. Multiple-Choice Questions (MCQs) **Only one option is correct**. For each question, marks will be awarded as follows:

*Full Marks* : +4 If correct answer is selected.
*Zero Marks* : 0 If none of the option is selected.
*Negative Marks* : –1 If wrong option is selected.

**1.** The exact volumes of 1 M NaOH solution required to neutralise 50 mL of 1 M $H_3PO_3$ solution and 100 mL of 2 M $H_3PO_2$ solution, respectively, are :

(A) 100 mL and 100 mL

(B) 100 mL and 50 mL

(C) 100 mL and 200 mL

(D) 50 mL and 50 mL

**2.** Match items of **List–I** with those of **List–II** :

| List–I (Property) | | List–II (Example) | |
|---|---|---|---|
| (a) | Diamagnetism | (i) | MnO |
| (b) | Ferrimagnetism | (ii) | $O_2$ |
| (c) | Paramagnetism | (iii) | NaCl |
| (d) | Antiferromagnetism | (iv) | $Fe_3O_4$ |

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

(A) (a)–(ii), (b)–(i), (c)–(iii), (d)–(iv)

(B) (a)–(i), (b)–(iii), (c)–(iv), (d)–(ii)

(C) (a)–(iii), (b)–(iv), (c)–(ii), (d)–(i)

(D) (a)–(iv), (b)–(ii), (c)–(i), (d)–(iii)

**3.** The solubility of AgCN in a buffer solution of pH = 3 is x. The value of x is:

[Assume : No cyano complex is formed ;

$K_{sp}(AgCN) = 2.2 \times 10^{-16}$ and

$K_a(HCN) = 6.2 \times 10^{-10}$]

(A) $0.625 \times 10^{-6}$

(B) $1.9 \times 10^{-5}$

(C) $2.2 \times 10^{-16}$

(D) $1.6 \times 10^{-6}$

SPACE FOR ROUGH WORK

**4.** During which of the following processes, does entropy decrease ?

(a) Freezing of water to ice at 0°C

(b) Freezing of water to ice at –10°C

(c) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

(d) Adsorption of CO(g) and lead surface

(e) Dissolution of NaCl in water

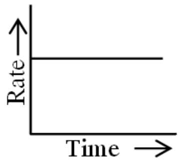
(A) (a), (b), (c) and (d) only

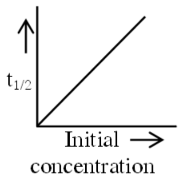
(B) (b) and (c) only

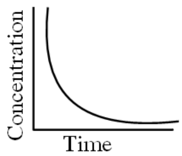
(C) (a) and (e) only

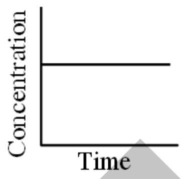
(D) (a), (c) and (d) only

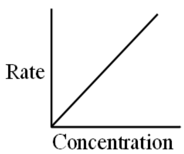
**5.** For the following graphs,

(a) 


(b) 


(c) 


(d) 


(e) 


Choose from the options given below, the **correct** one regarding order of reaction is :

(A) (b) zero order (c) and (e) First order

(B) (a) and (b) Zero order (e) First order

(C) (b) and (d) Zero order (e) First order

(D) (a) and (b) Zero order (c) and (e) First order

**6.** Match **List I** with **List II** :

| List-I Example of colloids | | List-II Classification | |
|---|---|---|---|
| (a) | Cheese | (i) | dispersion of liquid in liquid |
| (b) | Pumice stone | (ii) | dispersion of liquid in gas |
| (c) | Hair cream | (iii) | dispersion of gas in solid |
| (d) | Cloud | (iv) | dispersion of liquid in solid |

Choose the most appropriate answer from the options given below

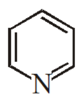
(A) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

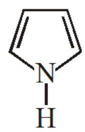
(B) (a)-(iv), (b)-(i), (c)-(iii), (d)-(ii)

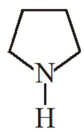
(C) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

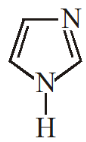
(D) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

**7.** The increasing order of basicity of the following compounds is :


(A)


(B)


(C)


(D)

(A) (A) < (B) < (C) < (D)

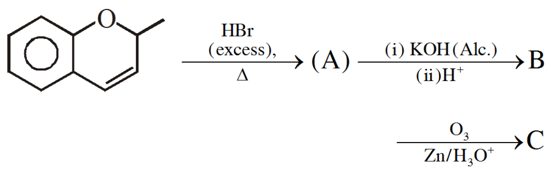
(B) (B) < (A) < (C) < (D)

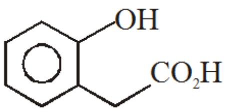
(C) (D) < (A) < (B) < (C)

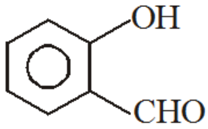
(D) (B) < (A) < (D) < (C)

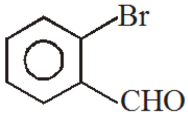
**SPACE FOR ROUGH WORK**

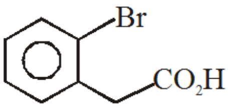
8. The major aromatic product C in the following reaction sequence will be :



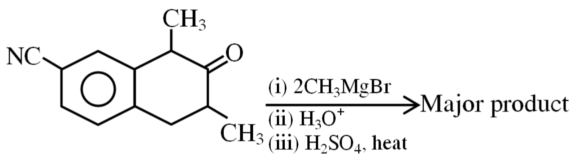

(A) 

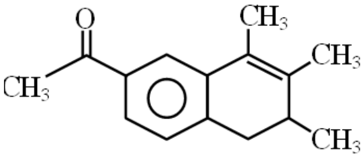

(B) 

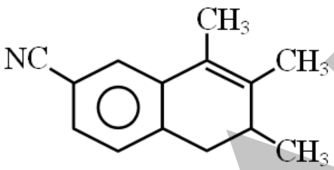

(C) 

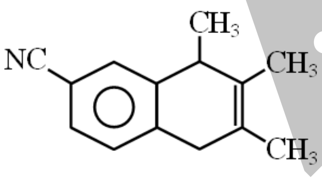

(D) 

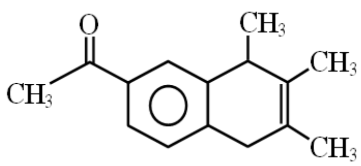

9. Which one of the following is the major product of the given reaction?

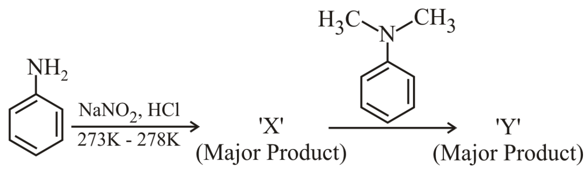



(A) 

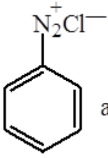
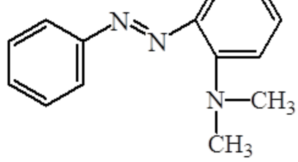
(B) 

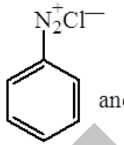
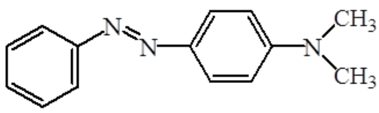
(C) 

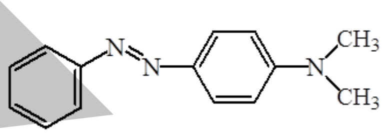
(D) 

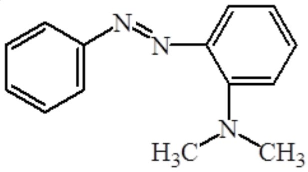
10. 

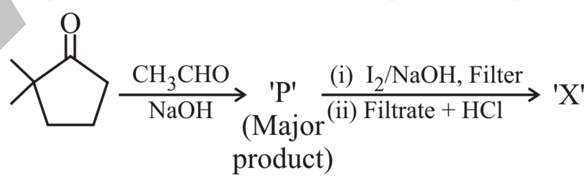

Considering the above reaction, X and Y respectively are :

(A)  and 

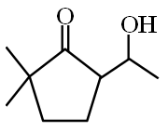
(B)  and 

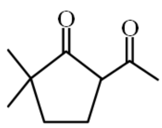
(C)  and 

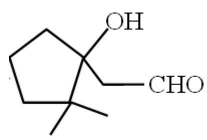
(D)  and 

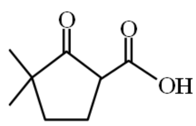
11. 


Consider the given reaction, the product 'X' is :

(A) 

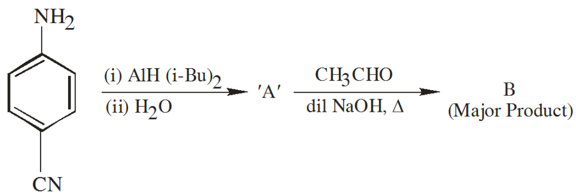
(B) 

(C) 

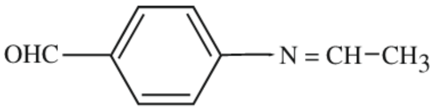
(D) 

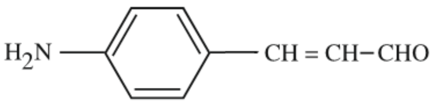
SPACE FOR ROUGH WORK

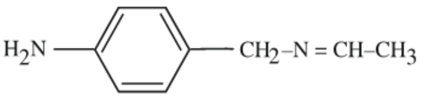
12. Consider the following reaction sequence :

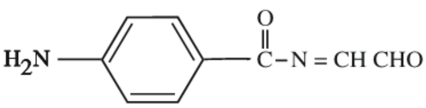


The product 'B' is :

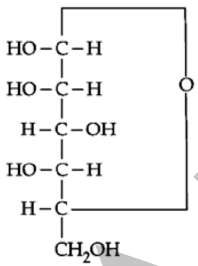
(A) 

(B) 

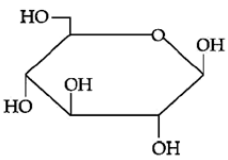
(C) 

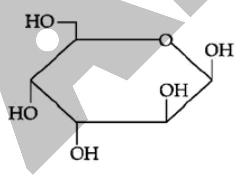
(D) 

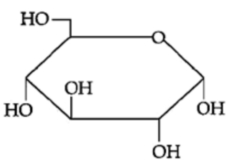
13. For the below given cyclic hemiacetal (X), the correct pyranose structure is :

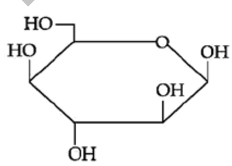


(X)

(A) 

(B) 

(C) 

(D) 

14. The correct order of the spin-only magnetic moment of metal ions in the following low spin complexes, $[V(CN)_6]^{4-}$, $[Fe(CN)_6]^{4-}$, $[Ru(NH_3)_6]^{3+}$, and $[Cr(NH_3)6]^{2+}$, is :

(A) $V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$

(B) $V^{2+} > Ru^{3+} > Cr^{2+} > Fe^{2+}$

(C) $Cr^{2+} > V^{2+} > Ru^{3+} > Fe^{2+}$

(D) $Cr^{2+} > Ru^{3+} > Fe^{2+} > V^{2+}$

15. Chlorine on reaction with hot and concentrated sodium hydroxide gives :

(A) $Cl^-$ and $ClO_2^-$

(B) $Cl^-$ and $ClO_3^-$

(C) $Cl^-$ and $ClO^-$

(D) $ClO_3^-$ and $ClO_2^-$

16. The reaction that does NOT define calcination is :-

(A) $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

(B) $Fe_2O_3 \cdot XH_2O \xrightarrow{\Delta} Fe_2O_3 + XH_2O$

(C) $CaCO_3 \cdot MgCO_3 \xrightarrow{\Delta} CaO + MgO + 2\ CO_2$

(D) $2\ Cu_2S + 3\ O_2 \xrightarrow{\Delta} 2\ Cu_2O + 2\ SO_2$

17. Which of the following compound CANNOT act as a Lewis base?

(A) $NF_3$

(B) $PCl_5$

(C) $SF_4$

(D) $ClF_3$



SPACE FOR ROUGH WORK

**18.** In the following the correct bond order sequence is:

(A) $O_2^{2-} > O_2^{+} > O_2^{-} > O_2$

(B) $O_2^{+} > O_2^{-} > O_2^{2-} > O_2$

(C) $O_2^{+} > O_2 > O_2^{-} > O_2^{2-}$

(D) $O_2 > O_2^{-} > O_2^{2-} > O_2^{+}$

**19.** 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) $Sr^{2+}$

**20.** 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) $[Ag(NH_3)Cl]Cl$



SPACE FOR ROUGH WORK

## SECTION-II : (Maximum Marks: 20)

**This section contains 10 questions Candidates have to attempt any 5 questions out of 10. If more than 5 questions are attempted, then only first 5 attempted questions will be evaluated.**

The answer to each question is a **Numerical Value.**

For each question, enter the correct integer value (In case of non-integer value, the answer should be rounded off to the nearest Integer).

Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : +4 If correct answer is entered.

*Zero Marks* : 0 If the question is unanswered.

*Negative Marks* : –1 If wrong answer is entered.

**1.** 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)

**2.** $PCl_5$ 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_____ $\times 10^{-3}$. (nearest integer)

(Given: R = 0.082 L atm $K^{-1}$ $mol^{-1}$ : Assume ideal gas behaviour)

**3.** 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]

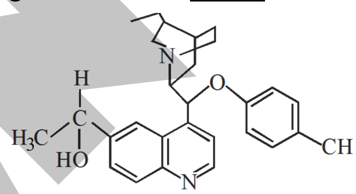
(Given: Molar mass of $N_2$ is 28 $mol^{-1}$. Molar volume of $N_2$ at STP : 22.4 L)

**4.** 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 $mol^{-1}$

**5.** The number of chiral carbons present in the molecule given below is _____ .




**6.** How many of the following drugs is/are example(s) of broad spectrum antibiotic ? Ofloxacin, Penicillin G, Terpineol, Salvarsan

**7.** The number of $sp^3$ hybridised carbons in an acyclic neutral compound with molecular formula $C_4H_5N$ is :

**8.** The hybridization of P exhibited in $PF_5$ is $sp^xd^y$. The value of y is __________.

**9.** 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

**10.** The difference between spin only magnetic moment values of $[Co(H_2O)_6]Cl_2$ and $[Cr(H_2O)_6]Cl_3$ is__________.

SPACE FOR ROUGH WORK

## PART-3 : MATHEMATICS

### SECTION-I : (Maximum Marks: 80)

This section contains **20 questions**. Each question has 4 options for correct answer. Multiple-Choice Questions (MCQs) **Only one option is correct**. For each question, marks will be awarded as follows:

*Full Marks* : +4 If correct answer is selected.

*Zero Marks* : 0 If none of the option is selected.

*Negative Marks* : –1 If wrong option is selected.

**1.** If $\int \frac{d\theta}{\cos^2\theta\,(\tan 2\theta + \sec 2\theta)}$

$= \lambda \tan\theta + 2\log_e|f(\theta)| + C$ where C is a constant of integration, then the ordered pair $(\lambda, f(\theta))$ is equal to :

(A) $(-1, 1 + \tan\theta)$

(B) $(-1, 1 - \tan\theta)$

(C) $(1, 1 - \tan\theta)$

(D) $(1, 1 + \tan\theta)$

**2.** The curve amongst the family of curves, represented by the differential equation, $(x^2 - y^2)dx + 2xy\,dy = 0$ which passes through (1,1) is :

(A) A circle with centre on the y-axis

(B) A circle with centre on the x-axis

(C) An ellipse with major axis along the y-axis

(D) A hyperbola with transverse axis along the x-axis

**3.** The value of $\int_0^{\pi} |\cos x|^3 dx$

(A) 2/3

(B) 0

(C) –4/3

(D) 4/3

**4.** A triangle ABC lying in the first quadrant has two vertices as A(1, 2) and B(3, 1).

If $\angle BAC = 90°$, and $ar(\Delta ABC) = 5\sqrt{5}$ sq. units, then the abscissa of the vertex C is :

(A) $2 + \sqrt{5}$

(B) $1 + \sqrt{5}$

(C) $1 + 2\sqrt{5}$

(D) $2\sqrt{5} - 1$

**5.** Let the volume of a parallelopiped whose coterminous edges are given by $\vec{u} = \hat{i} + \hat{j} + \lambda\hat{k}, \vec{v} = \hat{i} + \hat{j} + 3\hat{k}$ and $\vec{w} = 2\hat{i} + \hat{j} + \hat{k}$ be 1 cu. unit. If $\vec{u}$ be the angle between the edges and , then $\cos\theta$ can be

(A) $\frac{7}{6\sqrt{3}}$

(B) $\frac{5}{7}$

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

(D) $\frac{5}{3\sqrt{3}}$

**6.** Two tangents are drawn from the point P(–1, 1) to the circle $x^2 + y^2 - 2x - 6y + 6 = 0$. If these tangents touch the circle at points A and B, and if D is a point on the circle such that length of the segments AB and AD are equal, then the area of the triangle ABD is equal to

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

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

**7.** The locus of the midpoints of the chord of the circle, $x^2 + y^2 = 25$ which is tangent to the hyperbola, $\frac{x^2}{9} - \frac{y^2}{16} = 1$ is :

(A) $(x^2 + y^2)^2 - 16x^2 + 9y^2 = 0$

(B) $(x^2 + y^2)^2 - 9x^2 + 144y^2 = 0$

(C) $(x^2 + y^2)^2 - 9x^2 - 16y^2 = 0$

(D) $(x^2 + y^2)^2 - 9x^2 + 16y^2 = 0$

**8.** Let a parabola P be such that its vertex and focus lie on the positive x–axis at a distance 2 and 4 units from the origin, respectively. If tangents are drawn from O(0, 0) to the parabola P which meet P at S and R, then the area (in sq. units) of ΔSOR is equal to :

(A) $16\sqrt{2}$ (B) 16

(C) 32 (D) $8\sqrt{2}$

**9.** 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

**10.** The remainder when $(2021)^{2023}$ is divided by 7 is :

(A) 1 (B) 2

(C) 5 (D) 6

**11.** 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) $-\sqrt{2}$

**12.** The numbers of pairs (a, b) of real numbers, such that whenever α is a root of the equation $x^2 + ax + b = 0$ , $\alpha^2 - 2$ is also a root of this equation, is :

(A) 6 (B) 2

(C) 4 (D) 8

**13.** If $a_r = \cos\frac{2r\pi}{9} + i\sin\frac{2r\pi}{9}$ , r = 1, 2, 3,..., $i = \sqrt{-1}$ , then the determinant $\begin{vmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{vmatrix}$ is equal to :

(A) $a_2a_6 - a_4a_8$ (B) $a_9$

(C) $a_1a_9 - a_3a_7$ (D) $a_5$

SPACE FOR ROUGH WORK

**14.** Let S = {1, 2, 3, 4, 5, 6}. Then the probability that a randomly chosen onto function g from S to S satisfies g(3) = 2g(1) is :

(A) $\frac{1}{10}$ (B) $\frac{1}{15}$

(C) $\frac{1}{5}$ (D) $\frac{1}{30}$

**15.** 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

**16.** 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) $(p \wedge q) \wedge (\sim (p \wedge q))$

**17.** $\lim\limits_{x\to 0} \dfrac{x\left(e^{\left(\sqrt{1+x^2+x^4}-1\right)/x}-1\right)}{\sqrt{1+x^2+x^4}-1}$

(A) does not exist.

(B) is equal to $\sqrt{e}$.

(C) is equal to 0.

(D) is equal to 1.

**18.** Let f be a differentiable function such that $f(1) = 2$ and $f'(x) = f(x)$ for all $x \in R$.

If $h(x) = f(f(x))$, then $h'(1)$ is equal to :

(A) $4e$

(B) $4e^2$

(C) $2e$

(D) $2e^2$

**19.** Let $f(x) = \cos\left(2\tan^{-1}\sin\left(\cot^{-1}\sqrt{\frac{1-x}{x}}\right)\right)$ $0 < x < 1$. Then :

(A) $(1-x)^2 f'(x) - 2(f(x))^2 = 0$

(B) $(1+x)^2 f'(x) + 2(f(x))^2 = 0$

(C) $(1-x)^2 f'(x) + 2(f(x))^2 = 0$

(D) $(1+x)^2 f'(x) - 2(f(x))^2 = 0$

**20.** The minimum value of $f(X) = a^{a^x} + a^{1-a^x}$, where $a, x \in R$ and $a > 0$, is equal to :

(A) $2a$

(B) $2\sqrt{a}$

(C) $a+\frac{1}{a}$

(D) $a+1$

**SPACE FOR ROUGH WORK**

## SECTION-II : (Maximum Marks: 20)

**This section contains 10 questions Candidates have to attempt any 5 questions out of 10. If more than 5 questions are attempted, then only first 5 attempted questions will be evaluated.**

The answer to each question is a **Numerical Value.**

For each question, enter the correct integer value (In case of non-integer value, the answer should be rounded off to the nearest Integer).

Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : +4 If correct answer is entered.

*Zero Marks* : 0 If the question is unanswered.

*Negative Marks* : –1 If wrong answer is entered.

**1.** Let [t] denote the greatest integer less than or equal to t. Then the value of $\int_1^2 |2x - [3x]|dx$ is_______.

**2.** The area (in sq. units) of the region $\{(x, y) \in R^2 : x^2 \le y \le 3 - 2x\}$, is 3A, then A equal

**3.** 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(α, β, γ) be a point that divides internally the line segment PQ in the ratio 1 : 3. Then the value of 22(α + β + γ) is equal to

**4.** 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____.

**5.** 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 _____.

**6.** If for the complex numbers z satisfying $|z - 2 - 2i| \le 1$, the maximum value of $|3iz + 6|$ is attained at a + ib, then a + b is equal to ________.

**7.** If the angle of elevation of a cloud from a point P which is 25 m above a lake be 30º and the angle of depression of reflection of the cloud in the lake from P be 60º, then the height of the cloud (in meters) from the surface of the lake is :

**8.** If the sum of the deviations of 50 observations from 30 is 50, then the mean of these observation is :

**9.** If the value of

$$\lim_{x\to 0}\left(2-\cos x\sqrt{\cos 2x}\right)^{\left(\frac{x+2}{x^2}\right)}$$

is equal to $e^a$, then a is equal to _____.

**10.** The number of solutions of the equation $\sin^{-1}\left[x^2+\frac{1}{3}\right]+\cos^{-1}\left[x^2-\frac{2}{3}\right]=x^2$ for x ∈ [–1, 1], and [x] denotes the greatest integer less than or equal to ≤ x, is :

**SPACE FOR ROUGH WORK**