

SOLUTIONS

1. The unit digit of 3^{27} is

- (a) 3 (b) 1 (c) 7 (d) 9

Ans. (c)

Sol. $N = 3^{27}$

$$N = 3^{4 \times 6 + 3} = 3^{4k+3}$$

$$\text{Unit digit of } 3^{4k+3} = \text{unit digit of } 3^3 = 7$$

$$\text{So unit digit of } 3^{27} = 7$$

So option (c) is correct.

2. The given function $f(x) = 2x^4 - 6x^3 + 3x^2 + 3x - 2$ is not divisible by $g(x)$, where the function $g(x)$ is

- (a) $g(x) = x^2 - 3x + 2$ (b) $g(x) = x - 2$
(c) $g(x) = x - 1$ (d) $g(x) = x^2 - 2x + 2$

Ans. (d)

Sol. $f(x) = 2x^4 - 6x^3 + 3x^2 + 3x - 2$

$$= 2x^4 - 2x^3 - 4x^3 + 3x^2 + 3x - 2$$

$$= 2x^4 - 2x^3 - 4x^3 + 4x^2 - x^2 + 3x - 2$$

$$= 2x^3(x-1) - 4x^2(x-1) - (x-1)(x-2)$$

$$= (x-1)(2x^3 - 4x^2 - x + 2)$$

$$= (x-1)[2x^2(x-2) - 1(x-2)]$$

$$= (x-1)(x-2)(2x^2-1)$$

$$f(x) = (x-1)(x-2)(2x^2-1)$$

$$f(x) \text{ is divisible by } (x-1), (x-2) \text{ and } (x-1)(x-2) = x^2 - 3x + 2$$

So option (d) is correct.

3. Mr. Venkat takes a trip from Chennai to Bengaluru and back. While going his speed is 40 km/hr half the way and 60 km/hr for the remaining half of the distance. When he returns he drives at 40 km/hr for half the time and at 60 km/hr for the remaining half of time of travel back. His average speed in the entire trip is

- (a) 48 km/hr (b) 48.98 km/hr (c) 49.12 km/hr (d) 50 km/hr

Ans. (b)

Sol. Let distance between Chennai to Bengaluru is x km.

Case 1 : Time taken by Venkat when he goes from Chennai to Bengaluru

$$t_1 = \frac{\frac{x}{2}}{40} + \frac{\frac{x}{2}}{60} = \frac{x}{80} + \frac{x}{120} = \frac{3x+2x}{240} = \frac{5x}{240} = \frac{x}{48} \text{ hrs.}$$

Case 2: Let time taken by Venkat when he return back is t_2 then

$$x = \frac{t_2}{2} \times 40 + \frac{t_2}{2} \times 60$$

$$x = 50 t_2$$

$$t_2 = \frac{x}{50} = \frac{x}{50} \text{ hr}$$

$$\begin{aligned}\text{Average speed of entire trip} &= \frac{\text{total distance}}{\text{total time}} = \frac{x+x}{\frac{x}{48} + \frac{x}{50}} = \frac{2 \times 48 \times 50}{48+50} \\ &= \frac{4800}{98} = \frac{2400}{49} \approx 48.98 \text{ km/hr}\end{aligned}$$

So option (b) is correct.

4. The factorization over Z of $(a+b+c)^3 - (a^3 + b^3 + c^3)$ is
- (a) $(a+b)(b+c)(c+a)$ (b) $(a+3b)(b+3c)(c+3a)$
(c) $3(a+b)(b+c)(c+a)$ (d) $2(a+b+c)(a^2+b^2+c^2)$

Ans. (c)

Sol. $(a+b+c)^3 - (a^3 + b^3 + c^3)$

$$\begin{aligned}\Rightarrow & [(a+b+c)^3 - a^3] - [b^3 + c^3] \\ & (a+b+c-a)\{(a+b+c)^2 + a^2 + a(a+b+c)\} - (b+c)(b^2+c^2-bc) \\ & (b+c)[3a^2+b^2+c^2+3ab+3ac+2bc] - (b+c)(b^2+c^2-bc) \\ & (b+c)[3a^2+3ab+3bc+3ac] \\ & (b+c)[3a(a+b)+3c(a+b)] \\ & (b+c)(a+b) \times 3(a+c) \\ & = 3(a+b)(b+c)(c+a)\end{aligned}$$

So option (c) is correct.

5. The area of the square having end points of one of its diagonals as $(1, 3)$ and $(5, 1)$ in appropriate units, is
- (a) 100 (b) 10 (c) 20 (d) 40

Ans. (b)

Sol. End point of diagonal of square are $(1, 3)$ and $(5, 1)$

length of diagonal $= \sqrt{2} \times \text{side} = \sqrt{(5-1)^2 + (1-3)^2}$ (by using distance formula)

$$\sqrt{2} \times \text{side} = \sqrt{16+4} = \sqrt{20} = 2\sqrt{5}$$

$$\text{Side} = \frac{2\sqrt{5}}{\sqrt{2}} = \sqrt{10}$$

$$\text{Area of square} = (\text{side})^2 = 10 \text{ unit}^2$$

So option (b) is correct.

6. How many total terms, 'the square terms' and 'the product terms' will the expansion of $(x_1 + x_2 + \dots + x_{20})^2$ contain?
- (a) 1.8×10^2 (b) $20 + 170$ (c) 200 (d) 210

Ans. (d)

Sol. We know that

$$(x_1 + x_2 + \dots + x_n)^2 = x_1^2 + x_2^2 + \dots + x_n^2 + 2\sum x_1 x_2$$

Square terms $= n$

Product terms $= {}^nC_2$

For $(x_1 + x_2 + \dots + x_{20})^2$ number of total terms $= 20 + {}^{20}C_2$

$$= 20 + \frac{20 \times 19}{2}$$

$$= 20 + 190 = 210$$

So option (d) is true.

7. Given that α and β are the roots of the quadratic equation $x^2 - 2bx + c = 0$.

The value of $\alpha^4\beta^4 + \alpha^4\beta^3 + \alpha^3\beta^4$ is equal to

- (a) $c^3(c + 2b)$ (b) $c^3(c - 2b)$ (c) $c^3(2c + b)$ (d) $c^3(2c - b)$

Ans. (a)

Sol. α, β are roots of equation $x^2 - 2bx + c = 0$

$$\alpha + \beta = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2} = \frac{2b}{1} = 2b$$

$$\alpha\beta = \frac{\text{Constant term}}{\text{Coefficient of } x^2} = c$$

$$\begin{aligned}\alpha^4\beta^4 + \alpha^4\beta^3 + \alpha^3\beta^4 &= \alpha^4\beta^4 + \alpha^3\beta^3(\alpha + \beta) \\ &= (\alpha\beta)^4 + (\alpha\beta)^3(\alpha + \beta) \\ &= c^4 + c^3(2b) \\ &= c^3(c + 2b)\end{aligned}$$

Option (a) is true.

8. The lengths of six non-collinear line-segments are 3, 4, 5, 6, 7 and 8 units. The maximum number of scalene triangles that can be formed by using these line segments is

- (a) 15 (b) 17 (c) 19 (d) 20

Ans. (b)

Sol. There are six different length of line segments so possible triangle made by these line segments

$$= {}^6C_3 = \frac{6 \times 5 \times 4}{3 \times 2 \times 1} = 20$$

But all triangle will not follow

triangular property : $(a + b > c \text{ or } a - b < c)$

Such triangles are:

(3, 4, 7), (3, 4, 8) and (3, 5, 8)

So maximum number of scalene triangles = $20 - 3 = 17$

So option (b) is true.

9. Given that P is a point on the circum-circle (on arc AC) of an equilateral triangle ABC other than its vertices such that $2PA = PC$, then PA : PB is

- (a) 1 : 3 (b) 1 : 2 (c) 3 : 5 (d) 2 : 3

Ans. (a)

Sol. In equilateral $\triangle ABC$:

Let $AB = BC = AC = a$ and $AP = x$ and $PC = 2x$

ABCP is a cyclic quadrilateral.

By using Ptolmy's theorem:

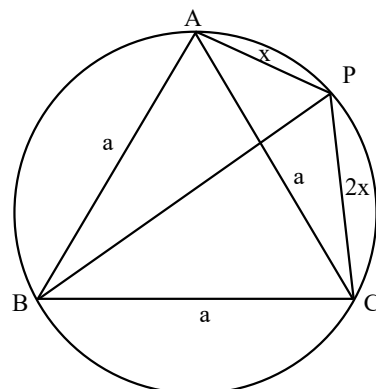
$$AC \times BP = AP \times BC + AB \times PC$$

$$a \times PB = a \times x + a \times 2x = 3ax$$

$$PB = 3x$$

$$PA : PB = x : 3x = 1 : 3$$

So option (a) is true.



10. There are 2025 cards numbered from 01 to 2025 (i.e. 1, 2, 3 2025). One card is drawn at random, then the probability that the number on the selected card leaves remainder of 25 when it divides 2025, is

- (a) $\frac{2}{405}$ (b) $\frac{11}{2025}$ (c) $\frac{4}{675}$ (d) $\frac{4}{405}$

Ans. (b)

Sol. Let selected number from $\{1, 2, \dots, 2025\}$ is x then

A.T.Q.

$$2025 = x \times k + 25 \quad (x > 25)$$

$$2020 = x \times k$$

x is factor of 2000.

$$\begin{aligned} \text{No. of factors of 2000} &= (4 + 1)(3 + 1)(2000 = 2^4 \times 5^3) \\ &= 5 \times 4 = 20 \end{aligned}$$

1, 2, 4, 5, 8, 10, 16, 20, 25 are values of x which are less than 25.

So probability that the selected card number leaves remainder 25 when it divides 2025 is

$$= \frac{20 - 9}{2025} = \frac{11}{2025}$$

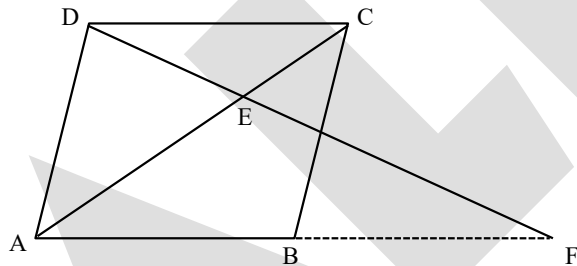
Option (b) is true.

11. ABCD is a parallelogram. The point E lies on diagonal AC such that EC is one-fifth of AE. Given that DE and AB meet at F, when produced further. The ratio CD : FB equals

- (a) 1 : 5 (b) 5 : 1 (c) 1 : 4 (d) 4 : 1

Ans. (c)

Sol.



A.T.Q.

$$EC = \frac{1}{5} \times AE$$

$$\text{Let } EC = x, AE = 5x$$

By AA similarity

$$\triangle AEF \sim \triangle CED$$

$$\frac{AF}{CD} = \frac{AE}{CE}$$

$$\frac{AF}{CD} = \frac{5x}{x} = 5$$

$$\frac{AB + BF}{CD} = 5$$

Put $AB = CD$ ($\because$ ABCD is a parallelogram)

$$\frac{CD + BF}{CD} = 5$$

$$4CD = BF$$

$$\frac{CD}{BF} = \frac{1}{4}$$

So option (c) is true.

12. If the two quadratic equation $ax^2 + 2bx + c = 0$ and $ax^2 + 8bx + 7c = 0$, have a common root, then a, b and c are in
- (a) Arithmetic Progression (b) Geometric Progression
(c) Harmonic Progression (d) None of the above

Ans. (b)

Sol. Let α is common root.

$$a\alpha^2 + 8b\alpha + 7c = 0 \quad \dots(1)$$

$$a\alpha^2 + 2b\alpha + c = 0 \quad \dots(2)$$

By subtracting equation (2) from equation (1)

$$6b\alpha + 6c = 0$$

$$\alpha = -\frac{c}{b}$$

$\alpha = -\frac{c}{b}$ is a common root.

Put $\alpha = -\frac{c}{b}$ in equation (2)

$$a \times \frac{c^2}{b^2} + 2b \left(-\frac{c}{b} \right) + c = 0$$

$$\frac{ac^2}{b^2} - c = 0 \quad b^2 = ac$$

So a, b, c are in geometric progression

So option (b) is true.

13. A point particle of mass m moving with velocity u in a straight line subjected to a constant acceleration at an instant $t = 0$. Sometime later, at time $t = n$, its velocity is found to be n time the initial velocity. The distance covered by the particle during the time interval $t = 0$ to $t = n$ is expressed as
- (a) $\frac{n(n+1)u}{2}$ (b) $\frac{(n-1)u}{2}$ (c) $\frac{1}{2}nu^2$ (d) $\frac{2u(n-1)}{n}$

Ans. (a)

Sol. $nu = u + an$

$$an = (n-1)u \quad \dots (1)$$

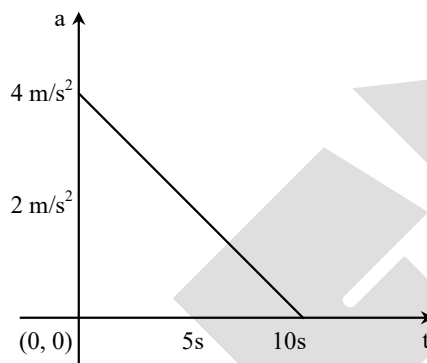
$$S = un + \frac{1}{2}an^2$$

$$S = un + \frac{1}{2}(n-1)u$$

$$S = \frac{un}{2} + \frac{n^2u}{2}$$

$$S = \frac{nu}{2}(1+n)$$

14. The following figure represents the acceleration versus time graph of a particle which starts its journey from the rest position at time $t = 0$. The velocity of the particle at $t = 5$ s is



(a) 80 m/s

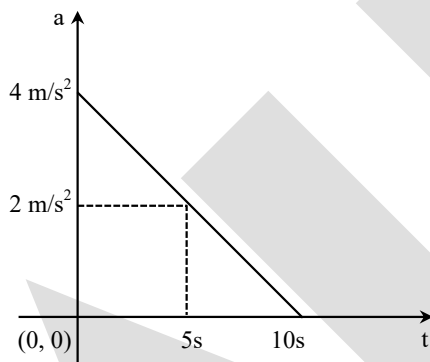
(b) 40 m/s

(c) 25 m/s

(d) 15 m/s

Ans. (d)

Sol.



$\Delta v = v - u = \text{area under the graph}$

$$v = \frac{1}{2}(2 + 4) \times 5$$

$$v = 15 \text{ m/s}$$

15. The heart of an animal pumps 40 cc of blood per second under the pressure 15000 N/m^2 . The power of the heart of the animal is

(a) 6 W

(b) 0.6 W

(c) $6 \times 10^5 \text{ W}$

(d) 0.06 W

Ans. (b)

Sol. Power = $\frac{dw}{dt} = P \frac{dV}{dt}$ [V = Volume, P = Pressure]

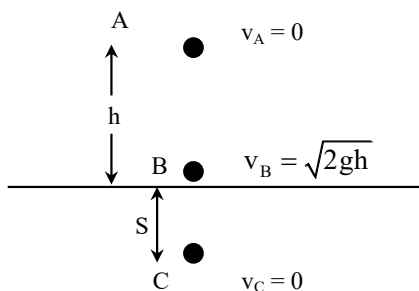
$$\begin{aligned} \text{Power} &= 15000 \times 40 \times 10^{-6} \\ &= 0.6 \text{ W} \end{aligned}$$

16. A small metallic spherical ball is dropped from height h on the wet clay on the Earth surface. It travels distance S inside the wet clay before it stops. The uniform resistive force offered by the clay to the ball, as it penetrates a vertical distance S through the clay, is (the size of the ball is ignored as compared to S)

- (a) $mg\left(1 + \frac{S}{h}\right)$ (b) mg (c) $mg\left(1 + \frac{h}{S}\right)$ (d) $mg\left(1 + \frac{h}{S}\right)^2$

Ans. (C)

Sol.



By Work energy theorem from $B \rightarrow C$

$$W_F + W_{mg} = \Delta E_K$$

$$-FS + mgS = 0 - mgh$$

$$FS = mg(S + h)$$

$$F = mg\left(1 + \frac{h}{S}\right)$$

17. A bullet of mass 10 g is moving with a speed u when it enters a bunch of a certain identical fixed wooden blocks kept in sequence in line. the velocity of the bullet drops to zero as it just leaves the third plank. How many such planks will the same bullet can penetrate when the initial speed of the bullet is doubled (assume all the planks to be fixed on the floor and the bullet travels horizontally)

- (a) 4 (b) 6 (c) 12 (d) 10

Ans. (c)

Sol. Stopping distance $S = \frac{u^2}{2a}$

if $u \rightarrow 2u$

$$S^1 = \frac{4u^2}{2a} = 4S$$

$$nd = 4(3d) \quad [d = \text{thickness of each block}]$$

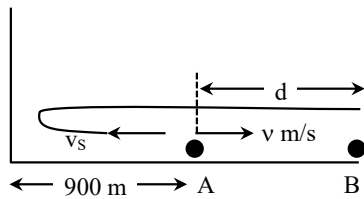
$$n = 12$$

18. An engine is going away from a hill with a constant speed. When it is at a distance of 900 m, it blows a whistle. The echo of the same is heard by the driver after 6 sec. If speed of sound in air is 330 m/s, the speed of engine is

- (a) 10 m/s (b) 20 m/s (c) 30 m/s (d) 40 m/s

Ans. (c)

Sol.



$$v_s = 330 \text{ m/s}$$

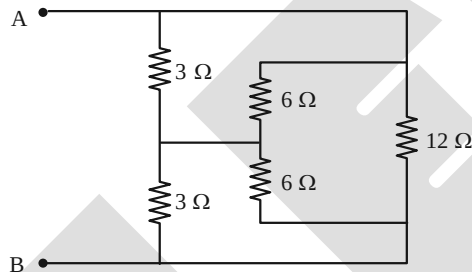
If echo is heard at B then the distance travelled by sound

$$= 330 \times 6 = 1800 + d$$

$$\Rightarrow d = 180 \text{ m}$$

$$v = \frac{d}{t} = \frac{180}{6} = 30 \text{ m/s}$$

19. In the given network of resistance, the equivalent resistance across terminals A and B is estimated to be



(a) 30 Ω

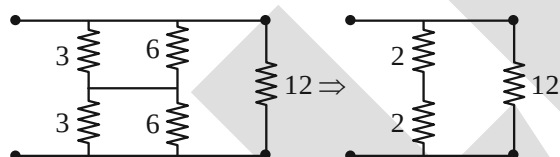
(b) 3 Ω

(c) 2 Ω

(d) 16 Ω

Ans. (b)

Sol.



$$R_{eq} = \frac{4 \times 12}{4 + 12} = 3 \Omega$$

20. The mass of the Moon is $\frac{1}{81}$ times the mass of Earth while the radius of the Moon is $\frac{1}{3.7}$ times the radius (R) of the Earth. At what height h above the surface of Earth, an object will have the same weight as it weighs on the surface of the Moon?

(a) $h = 21.9 R$

(b) $h = 3.68 R$

(c) $h = 2.43 R$

(d) $h = 1.43 R$

Ans. (d)

Sol. $W_{\text{moon}} = W_{\text{earth}}$

$$g_{\text{moon}} = g_{\text{earth}}$$

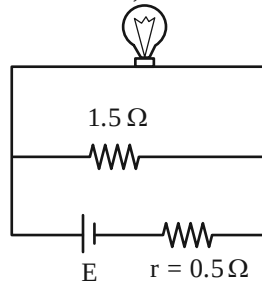
$$\frac{G \left(\frac{M}{81} \right)}{\left(\frac{R}{3.7} \right)^2} = \frac{GM}{(R+h)^2} \Rightarrow \frac{3.7}{9R} = \frac{1}{R+h}$$

$$\Rightarrow 3.7h = 9R - 3.7R$$

$$h = (1.43) R$$

21. A torch bulb rated as 6 W, 1.5 V is connected in a circuit as shown in the figure. The e.m.f of the cell needed to make the bulb glow normally is

6.0 W, 1.5 V



(a) 4.5 V

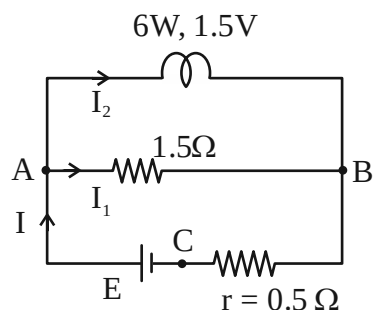
(b) 4.0 V

(c) 2.0 V

(d) 1.5 V

Ans. (b)

Sol.



For Bulb $\rightarrow P = VI_2$

$$I_2 = \frac{P}{V} = \frac{6}{1.5} = 4\text{ A}$$

$$V_{AB} = I_1 \times 1.5 = 1.5\text{ V}$$

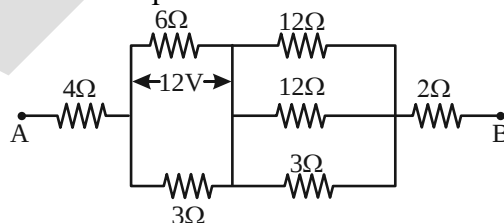
$$I_1 = 1\text{ A}$$

$$I = I_1 + I_2 = 5\text{ A}$$

$$\text{For cell } \rightarrow E = V_{AB} + Ir$$

$$= 1.5 + 5 \times \frac{1}{2} = 4\text{ V}$$

22. The given network of resistance is a part of an electric circuit containing the source of EMF providing current. The potential difference across 6 Ω resistance is measured to be 12 volt as shown in the figure. The value of the potential difference across terminals A and B.



(a) 120 volt

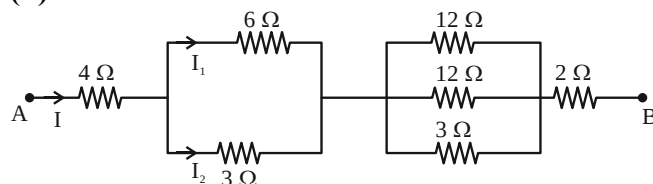
(b) 60 volt

(c) 48 volt

(d) 24 volt

Ans. (b)

Sol.



$$I_1 = \frac{12}{6} = 2A$$

$$I_2 = \frac{12}{3} = 4A$$

$$I = 4 + 2 = 6A$$

$$V_{AB} = IR_{eq} = 6 [4 + 2 + 2 + 2] = 60 \text{ volt}$$

23. A solid cylinder, made up of a material of resistivity ρ , has length l and radius $r\sqrt{3}$. Three coaxial cylinders A, B and C of equal length l have been cut from this thick cylinder. The cylinder A is a solid cylinder of radius r . B is a hollow cylinder with inner radius r and uniform wall thickness $(\sqrt{2}-1)r$ while the hollow cylinder C has inner radius $r\sqrt{2}$ and outer radius $r\sqrt{3}$. The relationship between their end-to-end resistance is

- (a) $R_A = R_B = R_C$ (b) $R_A > R_B > R_C$ (c) $R_A < R_B < R_C$ (d) $R_A = 2R_B = 3R_C$

Ans. (a)

Sol. $R_A = \frac{\rho l}{\pi r^2}$

$$R_B = \frac{\rho l}{\pi [(\sqrt{2}r)^2 - r^2]} = \frac{\rho l}{\pi r^2}$$

$$R_C = \frac{\rho l}{\pi [(\sqrt{3}r)^2 - (\sqrt{2}r)^2]} = \frac{\rho l}{\pi r^2}$$

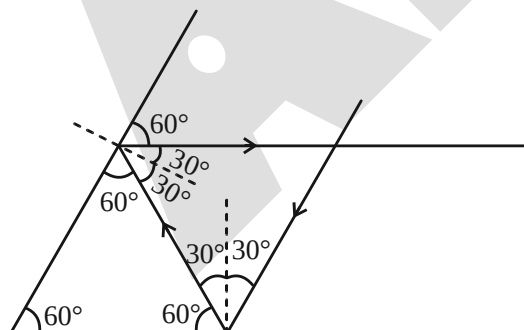
$$R_A = R_B = R_C$$

24. Two plane mirrors are inclined at an angle of 60° with each other. A ray of light is incident on one of the mirrors at an arbitrary angle of incidence $\angle i$. The ray is reflected from this mirror and falls on the second mirror where it further gets reflected parallel to the first mirror. The angle of incidence $\angle i$ is

- (a) 60° (b) 30° (c) 45° (d) 15°

Ans. (b)

Sol.



$$\angle i = 30$$

25. Which of the following forms 'Fried-egg' like structures during lab-culture?

- (a) Mycoplasma (b) Ricketts (c) Spirochaetes (d) Escherichia coli

Ans. (a)

Sol. Mycoplasma

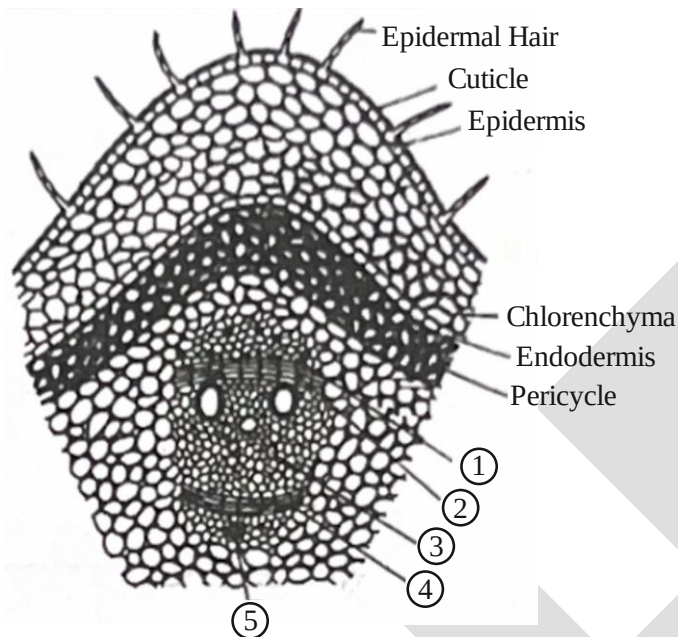
26. Which of the following is India's first cloned Gir cow, born on March 16, 2023 at the National Dairy Research Institute (NDRI) Karnal (Haryana)?

- (a) Karishma (b) Garima (c) Mahima (d) Ganga

Ans. (d)

Sol. Ganga

27. Study the following T.S. Cucurbita stem:



Choose the option showing the correct sequence of labeled part 1 to 5:

- (a) Hypodermis, Outer Cambium, Xylem, Inner Cambium & Inner Xylem
 (b) Outer phloem, Outer Cambium, Xylem, Inner Cambium & Inner Phloem
 (c) Inner Phloem, Inner Xylem, Cambium, Outer Xylem & Outer Phloem
 (d) Adaxial Phloem, Adaxial Cambium, Ground Tissue, Abaxial Cambium & Abaxial Phloem

Ans. (b)

Sol. Outer phloem, Outer Cambium, Xylem, Inner Cambium & Inner Phloem

28. Following is the list (COLUMN I) of characteristics related to some animals. Make the correct matches with the animals listed under (COLUMN II)

CHARACTERISTICS		ANIMALS	
(i)	Brow Spot	(a)	Viper
(ii)	Coprophagy	(b)	Man
(iii)	Ambulacra	(c)	Frog
(iv)	Viviparous	(d)	Rabbit
(v)	Coccyx	(e)	Ophioderma

Choose the correct option:

- (a) (i)-(b); (ii)-(e); (iii)-(c); (iv)-(a); (v)-(d) (b) (i)-(c); (ii)-(d); (iii)-(e); (iv)-(a); (v)-(b)
 (c) (i)-(d); (ii)-(c); (iii)-(b); (iv)-(a); (v)-(e) (d) (i)-(c); (ii)-(a); (iii)-(d); (iv)-(c); (v)-(b)

Ans. (b)

Sol. (i)-(c); (ii)-(d); (iii)-(e); (iv)-(a); (v)-(b)

29. Which of the following has the largest number of protected wetlands designated under the Ramsar Convention?

- (a) Mexico (b) India (c) UK (d) China

Ans. (c)

Sol. UK

30. Given below are two statements, one labelled as Assertion (A) and other labeled as Reason (R). Choose the correct option from the codes given below.

Assertion (A): Complex food molecules, like proteins, carbohydrates and fats are broken down into simpler substances (e.g., amino acids, glucose and fatty acids) through hydrolysis.

Reason (R): The process of breaking down a water molecule (H_2O) into its components, hydrogen (H_2) and oxygen (O_2), is known as electrolysis. Hydrolysis, on the other hand, occurs when water reacts with another compound and splits it apart —like in the digestion of food or the breakdown of ATP in cells.

- (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) R is true but A is false

Ans. (a)

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

31. Which of the following are known to possess two types of nuclei, Macro- and Micronuclei?

- (a) Sporozoans (b) Ciliates (c) Cnidarians (d) Cnidosporans

Ans. (b)

Sol. Ciliates

32. Cholesterol serves as the precursor for the synthesis of various steroid hormones. Which of the following is the source of C19 Steroidal Hormone Androsterone?

- (a) Corpus Luteum (b) Kidneys (c) Testes (d) Adrenal Medulla

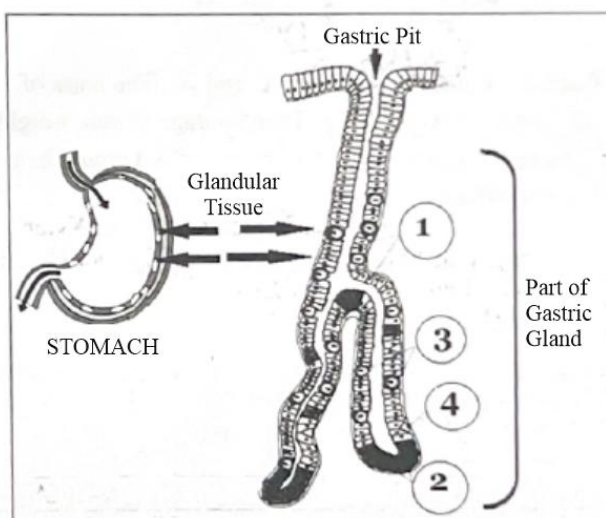
Ans. (c)

Sol. Testes

33. Given here is the histological diagram of the mammalian stomach. Its mucosal membrane is profusely folded and the pit-like distally form numerous simple or branched tubular gastric glands occurring in the fundus and corpus part. The principal type of cells found in each gland are labeled 1 – 4.

Choose the correct option representing Pepsinogen, Hydrochloric acid, Gastrin Hormone and Mucus-secreting cells, respectively (1 to 4):

- (a) 1, 2, 3 & 4 (b) 3, 2, 4 & 1 (c) 4, 2, 1 & 3 (d) 2, 3, 4 & 1



Ans. (d)

Sol. 2, 3, 4 & 1

34. Translation is an important stage in the central Dogma of Protein synthesis. Which of the following is involved in the activation of Amino Acids?

- (a) Amino Peptidyl Transferase (b) Aminoacyl methionyl synthetase
(c) Aminoacyl tRNA synthase (d) Petidyl Amino Transferase

Ans. (c)

Sol. Aminoacyl tRNA synthase

35. Some character of human beings follow a 'criss-cross' pattern of inheritance. Which of the following exemplifies this?

- (a) Sex-limited Inheritance (b) Sex-influenced Inheritance
(c) Sex-dominated Inheritance (d) Sex-linked Inheritance

Ans. (d)

Sol. Sex-linked Inheritance

36. The periplastidial and perimitochondrial spaces are :

- (a) 100-300Å and 40-70Å, respectively
(b) 400-450Å and 80-100Å, respectively
(c) 350-550Å and 10-20Å, respectively
(d) 50-100Å and 20-30Å, respectively

Ans. (a)

Sol. 100-300Å and 40-70Å, respectively

37. An alkane having 16 covalent bonds is the mth member of alkane homologous series. The ratio of carbon to hydrogen by weight in the mth member of alkyne homologous series is

- (a) 15 : 2 (b) 5 : 1 (c) 36 : 5 (d) 6 : 1

Ans. (a)

Sol. The general formula of Alkane is C_nH_{2n+2}

$$\begin{aligned} \rightarrow \text{Total covalent bond in an alkane} &= \text{C-C bond} + \text{C-H bond} \\ &= (n-1) + (2n+2) \\ &= 3n+1 \end{aligned}$$

$$\text{Given } 3n+1=16$$

$$n=5$$

So the alkane is the 5th member ($m=5$)

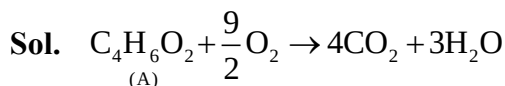
Alkyne series ($m=5$) : $C_nH_{2n-2} \rightarrow C_5H_8$

$$\text{Now weight ratio : } \frac{12 \times 5}{8 \times 1} ; 15 : 2$$

38. The IUPAC nomenclature of organic compound 'A' is But-2-enoic acid. The weight of carbon dioxide produced by complete combustion of 44 g of the organic compound 'A' would be

- (a) 44 g (b) 88 g
(c) greater than 88 g (d) greater than 44 g, but less than 88 g

Ans. (c)



By using stoichiometry

$$\frac{n_{\text{C}_4\text{H}_6\text{O}_2}}{1} = \frac{n_{\text{CO}_2}}{4}$$

$$\frac{44}{86} = \frac{x}{44 \times 4}$$

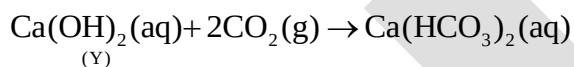
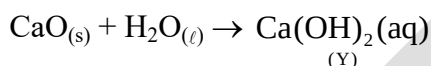
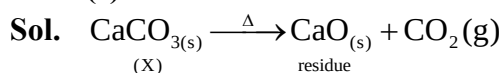
$$\Rightarrow x = \frac{44 \times 44 \times 4}{86}$$

$$x = 90.04 \text{ g CO}_2$$

- 39.** A solid compound 'X' on heating gives CO_2 gas and a residue. The residue when mixed with water forms compound 'Y'. On passing an excess of CO_2 through 'Y' in water, a clear solution of 'Z' is obtained. On boiling 'Z', the compound 'X' is reformed. The pH of aqueous solution of compound 'X' at 25°C is

- (a) 7 (b) less than 7 (c) more than 7 (d) cannot predict

Ans. (c)



The pH of aqueous solution of compound CaCO_3 (X) at 25°C is more than 7.

- 40.** In an organic compound of molar mass greater than 100 containing only C, H and N. the percentage of C is 6 times the percentage of H while the sum of the percentages of C and H is 1.5 times the percentage of N. Knowing that the percentage is taken by mass, the least value of the molar mass of the organic compound is

- (a) 105 (b) 140 (c) 175 (d) 210

Ans. (b)

Sol. Let % of mass of H = x

% of mass of C = 6x

$6x + x = 1.5 \times \%$ of N

$$\% \text{ of N} = \frac{7x}{1.5}$$

Element	%	Mole%	Simplest ratio
H	x	$\frac{x}{1} = x$	6
C	6x	$\frac{6x}{12} = \frac{x}{2}$	3
N	$\frac{7x}{1.5}$	$\frac{7x}{1.5+14} = \frac{x}{3}$	2

Simplest formula = $C_3H_6N_2$

Molecular weight = 70(not greater than 100)

The least value of the molar mass of the organic compound is $(70 \times 2) = 140$ (molar mass is greater than 100)

41. A hypothetical element 'Coronium' has two isotopes A_1 and A_2 . The mass of 3×10^{22} atoms of A_1 is 20 g while the mass of 1.5×10^{22} atoms of A_2 is 10.5 g. Then average atomic weight of element 'Coronium' in isotopic mixture (3×10^{22} atoms of A_1 and 1.5×10^{22} atoms of A_2) would be approximately
- (a) 418.30 (b) 408.23 (c) 406.67 (d) Data insufficient

Ans. (c)

Sol. Molar mass of $A_1 = \frac{20N_A}{3 \times 10^{22}} = 400 \text{ g/mole}$

($N_A = 6 \times 10^{23}$)

Molar mass of $A_2 = \frac{10.5N_A}{1.5 \times 10^{22}} = 420 \text{ g/mole}$

Abundance of $A_1 = \frac{3 \times 10^{22}}{4.5 \times 10^{22}} \times 100$

Abundance of $A_2 = 33.33\%$

Average atomic weight = $400 \times \frac{66.67}{100} + 420 \times \frac{33.33}{100} = 406.67$

42. For an experiment in the laboratory only two solutions are available ;
Solution A : 250 g of 40% (w/w) NaCl solution and
Solution B : 300 g of 60% (w/w) NaCl solution
The Maximum weight of a solution (having exactly 55% (w/w) NaCl concentration) that can be prepared by the mixing of Solution A and Solution B only can be
- (a) 500 g (b) 400 g (c) 450 g (d) 550 g

Ans. (b)

Sol. Mass of NaCl in solution A = $250 \times 0.40 = 100 \text{ g}$

Mass of NaCl in solution B = $300 \times 0.60 = 180 \text{ g}$

Let m_A and m_B mass of solution A and solution B used

$0.40 m_A + 0.60 m_B = 0.55 (m_A + m_B)$

$\frac{m_A}{m_B} = \frac{1}{3} \Rightarrow m_B = 3m_A$

$\Rightarrow m_A = \frac{300}{3} = 100 \text{ g of A}$

Maximum amount of solution is = $100 + 300 \text{ g} = 400 \text{ g}$

43. The nucleus of the element X with mass number 81 contains 31 % more neutrons as compared to protons. Then the relationship between the nuclei of element X with nuclei of element ^{79}As is that they are
- (a) Isotopes (b) Isotones (c) Isobars (d) Isoelectronic

Ans. (b)

Sol. $A = Z + N$

$$81 = Z + N$$

The problem states that X contain 31% more neutron as compared to proton.

$$N = Z + 0.31Z = 1.31Z$$

$$\therefore Z + 1.31Z = 81$$

$$Z = 35 (\text{Atomic number})$$

$$N(\text{neutron}) = 81 - 35 = 46$$

Element X is Bromine ($Z = 35$)

According to question ${}^{79}_{33}\text{As}$

$$N = (79 - 33) = 46$$

Both are isotones.

44. If the atomic weight of the most stable isotope of the element M is 40 times that of the lightest element then formula of the compound of its phosphate is

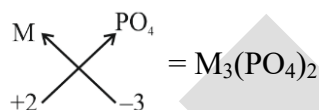
- (a) $\text{M}_3(\text{PO}_4)_2$ (b) $\text{M}_2(\text{PO}_4)_3$ (c) MPO_4 (d) M_3PO_4

Ans. (a)

Sol. The lightest element is H with atomic mass 1 amu. The atomic mass of M is 40 times that of the lightest element.

Atomic mass of M = 40 amu

Element M is calcium and valency of +2



45. An oxide of nitrogen has molecular weight 30. The total number of electrons. in a sample containing three molecules of the oxide would be (assuming that nitrogen and oxygen are present in are present in their most stable isotopic state)

- (a) 15 (b) 30 (c) 90 (d) 45

Ans. (d)

Sol. The only oxide with a molecular weight of 30 is NO (nitric oxide)

Total number of e^- in one molecule of NO = $7 + 8 = 15e^-$

Total number of e^- in three molecule = $3 \times 15 = 45$

46. Elements P, Q R and S belong to the same group in periodic table. The oxide of P is acidic, oxide of Q and R are amphoteric while the oxide of S is basic. The most electropositive element among them is

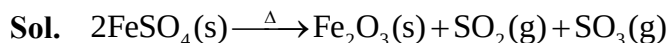
- (a) P (b) Q (c) R (d) S

Ans. (d)

Sol. Elements in the same group have increasing metallic character and electro positivity as on moves down the group. Therefore 'S' is the most metallic and electropositive element.

47. An element X, which is a yellow solid at room temperature, shows catenation and allotropy. The element X forms mainly two oxides which are also formed during the thermal decomposition of ferrous sulphate crystals and are the major air pollutants. Most likely the element X is
 (a) Carbon (b) Silicon (c) Nitrogen (d) Sulphur

Ans. (d)



Element X is sulphur

48. Ram treated a lustrous divalent element M with potassium hydroxide. He observed the formation of bubbles in the reaction mixture. He made the same observations when this element was treated with sulphuric acid. Then element M would be
 (a) Zinc (b) Calcium (c) Aluminum (d) Copper

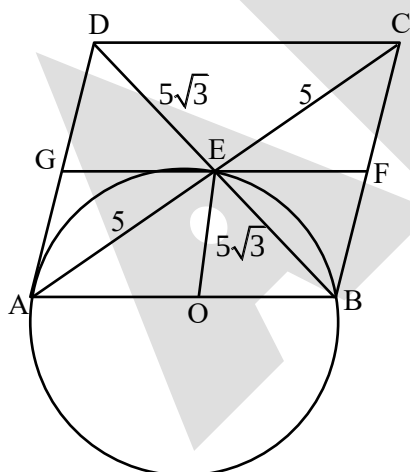
Ans. (a)

Sol. Element M(Zn) is a amphoteric metal.

49. ABCD is rhombus with diagonals $AC = 10$ cm and $BD = 10\sqrt{3}$ cm intersecting at point E. A circle is drawn passing through three points A, E and B with its center at O. Straight line EF is drawn parallel to AB such that the point F lies on the side BC. Also there lies a point P somewhere inside the rhombus then,
 (a) $OE : BC = 1 : 2$
 (b) $FB = 5.0$ cm
 (c) The probability that the point P lies inside the trapezium AEFB is 0.375
 (d) The probability that the point P lies inside the triangle EFC is $\frac{1}{8}$

Ans. (a,b,c,d)

Sol. $\because \triangle AEB$ is right triangle and O is mid point of Hypotenuse AB



$$BC = \sqrt{5^2 + (5\sqrt{3})^2} = 10$$

$\because \triangle AEB$ is right triangle and O is mid point of hypotenuse AB.

$$\therefore AO = OB = OE = 5$$

$$OE : BC = 5 : 10 = 1 : 2$$

$\therefore GF \parallel AB$ and $AG \parallel BF$

$\therefore ABFG$ is a parallelogram

$$\Rightarrow FG = 2EF = 10 \text{ cm}$$

$$EF = 5 \text{ cm}$$

$$\text{And } FE = FB = 5 \text{ cm}$$

$$\text{Height of trapezium ABFE} = \frac{5\sqrt{3}}{2} \quad \left\{ \frac{1}{2} \times AB \times h = \frac{1}{2} \times 5 \times 5\sqrt{3} \right\}$$

Probability that P lies inside trapezium AEFB

$$= \frac{\text{Area of trapezium AEFB}}{\text{Area of Rhombus ABCD}}$$

$$= \frac{\frac{1}{2} \times (10+5) \times \frac{5\sqrt{3}}{2}}{\frac{1}{2} \times 10\sqrt{3} \times 10}$$

$$= \frac{3}{8}$$

Probability that point P lies inside triangle EFC

$$= \frac{\text{Area of } \triangle EFC}{\text{Area of rhombus ABCD}}$$

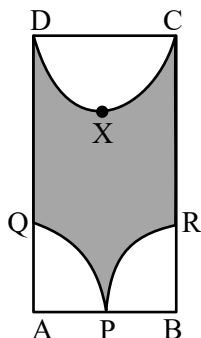
$$= \frac{\frac{1}{2} \times \text{Area of } \triangle EBC}{\text{Area of rhombus AEFB}}$$

$$= \frac{\frac{1}{2} \times \frac{1}{2} \times 5 \times 5\sqrt{3}}{\frac{1}{2} \times 10\sqrt{3} \times 10} = \frac{1}{8}$$

So, options (a),(b),(c),(d) are true.

50. ABCD is a rectangle length ℓ and breadth b . The breadth is two-seventh $\left(\frac{2}{7}\right)$ of its length ℓ , P is

the mid-point of side AB. As shown in the figure, APQ and BPR are the two quadrants while CXD is a semicircle with X-as the mid-point of the arc CXD, then



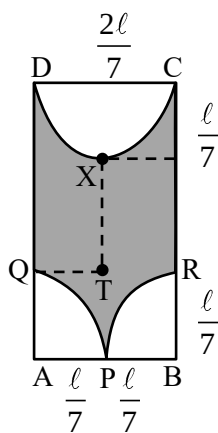
- (a) $CR : AB :: 3 : 1$
 (b) $XQ : AQ :: \sqrt{26} : 1$
 (c) ΔXQR is scalene triangle
 (d) The ratio of area of rectangle to the area of shaded region is $14 : (14 - \pi)$

Ans. (a,b,d)

Sol. Length of rectangle

$$AD = \ell$$

$$\text{Breadth } b = AB = \frac{2\ell}{7}$$



$$CR = \ell - \frac{\ell}{7} = \frac{6\ell}{7}$$

$$CR : AB = \frac{6\ell}{7} : \frac{2\ell}{7} = 3 : 1$$

$$XQ = \sqrt{XT^2 + TQ^2}$$

$$= \sqrt{\left(\frac{5\ell}{7}\right)^2 + \left(\frac{\ell}{7}\right)^2}$$

$$= \sqrt{\frac{26\ell^2}{49}}$$

$$XQ : AQ = \sqrt{\frac{26\ell^2}{49}} : \frac{\ell}{7} = \sqrt{26} : 1$$

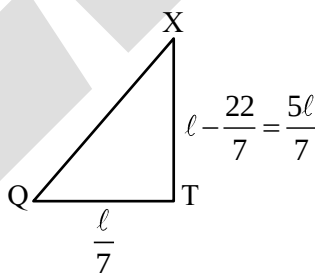
In ΔXQR :

$$XQ = XR$$

So, ΔXQR is not scalene triangle

Area of shaded region = total area of rectangle – unshaded region

$$= \ell \left(\frac{2\ell}{7} \right) - \pi \left(\frac{\ell}{7} \right)^2$$



$$\frac{\text{Area of rectangle}}{\text{Area of shaded Region}} = \frac{\ell \times \frac{2\ell}{7}}{\frac{2\ell^2}{7} - \frac{\pi\ell^2}{49}} = \frac{14}{14 - \pi}$$

So, option (a),(b) and (d) are true

51. Given that k is the number of distinct ordered pair (x, y) of real numbers satisfying equations $x + y = xy$ and

$x - y = 3xy$ then k is one of the roots of the quadratic equations(s)

(a) $x^2 - 3x + 2 = 0$ (b) $x^2 - 4x + 3 = 0$ (c) $x^2 - 6x + 8 = 0$ (d) $x^2 - 7x + 12 = 0$

Ans. (a,c)

Sol. $x + y = xy$ (1)

$x - y = 3xy$ (2)

By adding eq.(1) and (2)

$2x = 4xy$

$x = 0$ or $y = \frac{1}{2}$

When $x = 0$

from eq.(1)

$0 + y = 0$

$y = 0$

When $y = \frac{1}{2}$

From eq.(1)

$x + \frac{1}{2} = x \times \frac{1}{2}$

$\frac{x}{2} = \frac{-1}{2}$ $x = -1$

So, two different ordered pairs $(0, 0)$ and $\left(-1, \frac{1}{2}\right)$ are possible

Hence $k = 2$

Now check options

(a) $x^2 - 3x + 2 = (x - 1)(x - 2)$

(b) $x^2 - 4x + 3 = (x - 1)(x - 3)$

(c) $x^2 - 6x + 8 = (x - 2)(x - 4)$

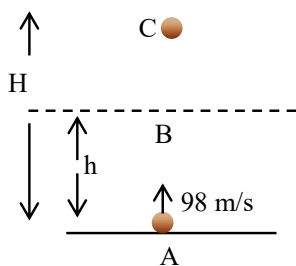
(d) $x^2 - 7x + 12 = (x - 3)(x - 4)$

2 is factor of equations which are in options (a) and (c)

So, options (a) and (c) are true.

52. A ball of mass $m = 100 \text{ g}$ is thrown vertically up with an initial velocity $u = 98 \text{ ms}^{-1}$. The ball goes up in the space and falls back to the ground. During its motion, the ball is observed to be at certain height h at time t_1 and at time t_2 . Also the speed of the ball is equal after time t_3 and t_4 from the start of its journey. With the given observation one can conclude that
- the algebraic sum $t_1 + t_2 = 20 \text{ s}$
 - the algebraic sum $t_3 + t_4 = 20 \text{ s}$
 - the ball can reach a maximum height of 980 m
 - if $t_1 t_2 = 50 \text{ s}^2$, the will rise to a height $h = 245 \text{ m}$ at time $t = t_1$.

Ans. (a,b,d)



Sol.

[H = maximum height]

$$t_{AB} = t_1$$

$$t_{ACB} = t_2$$

$$t_{BCB} = t_2 - t_1$$

$$t_{AC} = \frac{u}{g} = \frac{98}{9.8} = 10 \text{ sec}$$

$$t_{AC} = t_{AB} + t_{BC} = 10$$

$$\Rightarrow t_1 + \frac{t_2 - t_1}{2} = 10$$

$$t_2 + t_1 = 20 \quad \dots(1)$$

$$\text{Similarly, } t_3 + t_4 = 20 \quad \dots(2)$$

$$H = \frac{u^2}{2g} = \frac{(98)^2}{2 \times 9.8} = 490 \text{ m}$$

$$t_1 t_2 = 50 \quad \dots(3)$$

from equation (1) and (3)

$$t_1 = 2.92$$

$$t_2 = 17.08$$

$$h = 98t_1 - \frac{1}{2}gt_1^2$$

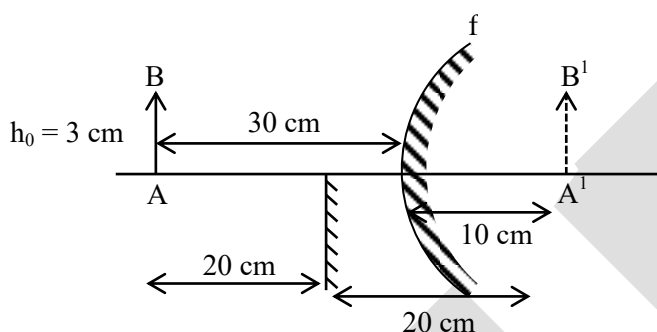
$$= 98 \times 2.92 - 4.9(2.92)^2$$

$$= 245 \text{ m}$$

53. A 3 cm long object pin is kept vertical on the horizontal principal axis of a convex mirror in front of it. The distance of the object pin (standing above the principal axis) is 30 cm from the pole of the convex mirror. A plane mirror facing the pin is placed perpendicular to the principal axis at a distance of 10 cm from and in front of the same convex mirror covering just the lower half of it. The images of the object pin, formed by the two mirrors, are found to coincide. Then
- the focal length of the convex mirror is $f = 15$ cm.
 - the linear magnification produced by convex mirror is $\frac{1}{3}$.
 - the image formed by the convex mirror is virtual and inverted.
 - the image formed by the plane mirror stands above the principal axis of the convex mirror.

Ans. (a,b,d)

Sol.



[A'B' = Image formed by plane mirror]

For convex mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

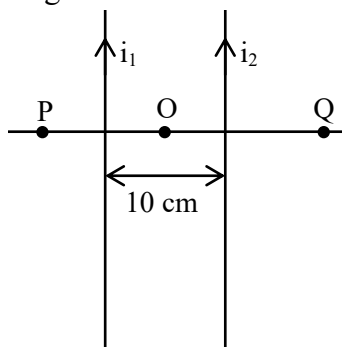
$$\frac{1}{10} - \frac{1}{30} = \frac{1}{f}$$

$$f = 15 \text{ cm}$$

$$m_T = -\frac{v}{u} = -\left(\frac{10}{-30}\right) = \frac{1}{3}$$

[Virtual and erect image]

54. Two long straight copper wires, carrying parallel currents of $i_1 = 2$ A and $i_2 = 5$ A respectively, lie 10 cm apart in the plane of paper as shown. Knowing that the steady current through a wire produces magnetic field, one can argue that

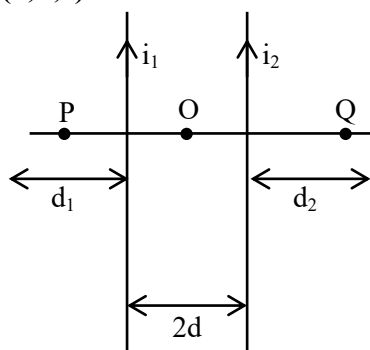


- because of the magnetic field produced by current i_1 , it attracts the wire carrying i_2 .

- (b) the resultant magnetic field produced by both the wires at the midpoint O is directed outward perpendicular to the plane of paper.
- (c) the resultant magnetic field produced by both the wires at point P on the left of the wire carrying current i_1 is directed outward perpendicular to the plane of paper.
- (d) the resultant magnetic field at point Q on the right of current i_2 is directed outward perpendicular to the plane of paper

Ans. (a,b,c)

Sol.



By right hand thumb rule

Net magnetic field at P will be outward perpendicular to the plane.

Similarly at Q net magnetic field will be into the plane of paper

$$\text{at 'O'} \rightarrow \vec{B}_0 = \frac{\mu_0 i_1}{2\pi d} \otimes + \frac{\mu_0 i_2}{2\pi d} \odot$$

$$i_2 > i_1$$

So, will be out of the plane.

By Fleming's left hand rule force between wires will be attractive

- 55.** In samara fruits, wings for dispersal are modified outgrowths of the pericarp. Which of the following wings fruits is/are not samara?
- (a) Shorea (Sal) (b) Fraxinus (Ash)
 (c) Dipterocarpus (New Guinea rosewood) (d) Holoptelea (Indian Elm)

Ans. (a,c)

Sol. Shorea (Sal), Dipterocarpus (New Guinea rosewood)

- 56.** Study the following statements and choose the correct option (s)

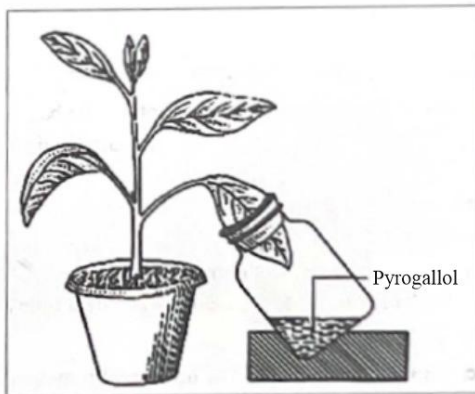
- (a) Kupffer cells are found in pancreas
 (b) Mast cells secrete a vasoconstrictor called Heparin
 (c) Plasma cells superficially resemble lymphocytes
 (d) Supporting framework of bone marrow is formed by reticular connective tissue.

Ans. (c,d)

Sol. Plasma cells superficially resemble lymphocytes,

Supporting framework of bone marrow is formed by reticular connective tissue.

57. In the following set-up the leaf was distracted by keeping it in dark overnight. The bottle contains a solution of Pyrogallol. After exposing the set-up to sun light for a few hours, the entire leaf was tested for the presence of starch by iodine test.



Choose the option(s) showing correct observations(s)

- (a) The leaf will not show any starch.
- (b) The part of leaf inside the bottle will show positive starch test.
- (c) The part of leaf outside the bottle will show positive starch test.
- (d) The part of leaf inside will show positive starch test while outer part will not show the presence of starch.

Ans. (b,c)

Sol. The part of leaf inside the bottle will show positive starch test.
The part of leaf outside the bottle will show positive starch test.

58. Which of the following statement(s) is/are correct regarding the different atom models?
- (a) Rutherford's atom model establishes that the α -particle is four times as heavy as a hydrogen atom.
 - (b) Thomson's atom model assumes that the mass of the atom is uniformly distributed over the entire atom.
 - (c) Bohr's atom model assumes that there are a large number of circular electron orbits around the nucleus.
 - (d) Rutherford's α -particle scattering experiment establishes that most of the space in the atom is empty.

Ans. (b,c,d)

Sol. Theoretical

59. What happens when an iron nail is dipped into a copper sulphate solution?

- (a) The solution turns plane green
- (b) The iron nail dissolves in the solution
- (c) Copper (Cu) is deposited on the iron nail
- (d) A redish-brown coating forms on the iron nail

Ans. (a,b,c,d)

Sol. $\text{Fe}_{(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{FeSO}_4(\text{aq}) + \text{Cu}_{(s)}$
 Blue Plane green

60. Two solutions are available as sample :
Section A : 2 L of 0.1 M H_2SO_4 solution, and
Section B : 1 L of 0.2 M NaOH solution
Then the correct statement(s) is/are
- (a) pH of solutions A increase and pH of Solution B decrease with increasing dilution.
 - (b) final pH of both solutions would be approximately 7 after infinite dilution at 25°C temperature.
 - (c) pH would be 7 after mixing of solution A and Solution B at 25°C temperature.
 - (d) pH of solution A increases and pH of solution B decrease with slight increase in temperature.

Ans. (a,b)

Sol. On dilution pH of acidic solution increase as well as pH of basic solution decrease.
Final pH of both solutions would be approximately 7 after infinite dilution at 25°C temperature.