

HINTS & SOLUTIONS

PART-A MATHEMATICS

1. If $A = \sin^{-1} \dots$
Sol. (1)

$$\text{Let } \sin^{-1} \left(\sqrt{\frac{13}{17}} \right) = \theta \Rightarrow \sin \theta = \sqrt{\frac{13}{17}}$$

$$\Rightarrow \cot \theta = \frac{2}{\sqrt{13}} \Rightarrow A = \sin^{-1} \frac{2}{\sqrt{13}} = \tan^{-1} \frac{2}{3}$$

2. If $\lim_{h \rightarrow 0} \left[\frac{f(a+h)}{f(a)} \right] = c$ where.....

Sol. (1) Local minima $\Rightarrow f(a+h) > f(a)$

$$\Rightarrow \frac{f(a+h)}{f(a)} > 1 \Rightarrow \lim_{h \rightarrow 0} \left[\frac{f(a+h)}{f(a)} \right] = 1$$

$$\text{Local maxima} \Rightarrow \frac{f(a+h)}{f(a)} < 1 \Rightarrow \lim_{h \rightarrow 0} \left[\frac{f(a+h)}{f(a)} \right] = 0$$

3. If A and B be positive
Sol. (1)

$$\sin 2B = \frac{3}{2} \sin 2A \text{ and } 3 \sin^2 A = 1 - 2 \sin^2 B = \cos 2B$$

$$\text{so, } \tan 2B = \frac{(3/2) \cdot \sin 2A}{3 \sin^2 A} = \cot A$$

$$\text{or } \tan A \cdot \tan 2B = 1 \\ \Rightarrow A + 2B = \pi/2 \Rightarrow B = \pi/4 - A/2$$

4. If $\lim_{\theta \rightarrow 0} \left(\frac{1+a \cos \theta}{\theta^2} - \frac{b \sin \theta}{\theta^3} \right) \dots$

$$\text{Sol. (1)} \lim_{\theta \rightarrow 0} \left(\frac{1+a \cos \theta}{\theta^2} - \frac{b \sin \theta}{\theta^3} \right) = 1$$

$$\lim_{\theta \rightarrow 0} \left(\theta \left[1 + a \left(1 - \frac{\theta^2}{2} \right) \right] - b \left[\theta - \frac{\theta^3}{3!} \right] \right) = 1$$

$$\Rightarrow \lim_{\theta \rightarrow 0} \left(\frac{\theta(1+a-b) - \frac{a\theta^3}{2} + \frac{b\theta^3}{6}}{\theta^3} \right) = 1$$

$$\therefore 1 + a - b = 0$$

$$\text{and, } \frac{b}{6} - \frac{a}{2} = 1$$

$$\Rightarrow a = -5/2$$

$$b = -3/2$$

$$\Rightarrow b + a = -4$$

$$\therefore \lambda = 4$$

5. The maximum values
Sol. (4)

$$y = \frac{\log_e x}{x}$$

$$\frac{dy}{dx} = -\frac{1}{x^2} \log_e x + \frac{1}{x} \cdot \frac{1}{x} = \frac{1}{x^2} (1 - \log_e x) = 0$$

$$\log_e x = 1 \text{ or } x = e$$

$$x < e \Rightarrow \log_e x < 1$$

$$x > e \Rightarrow \log_e x > 1$$

at $x = e$, $\frac{dy}{dx}$ changes sign from positive to negative and hence if

$$\text{is more at } x = e \text{ and its value } \frac{\log_e e}{e} = e^{-1}.$$

6. If $f(x) = \frac{\sin(e^{x-2}-1)}{\ln(x-1)}$,

Sol. (3)

$$\lim_{x \rightarrow 2} \frac{\sin(e^{x-2}-1)}{(e^{x-2}-1)} \times \frac{(e^{x-2}-1)}{x-2} \times \frac{x-2}{\ln(1+x-2)} = 1$$

7. Let $f(x) = x^x$;

Sol. (2)

$$\text{we have } f(g(x)) = g(x)^{g(x)} = x$$

$$\text{also } g(f(x)) = x$$

$$\Rightarrow g'(f(x)) \cdot f'(x) = 1 \Rightarrow g'(f(x)) = \frac{1}{f'(x)}$$

$$\Rightarrow g'(f(x)) = \frac{1}{x^x \cdot (1 + \ln x)}$$

$$\Rightarrow g'(x) = \frac{1}{x(1 + \ln g(x))}$$

8. Rolle's Theorem holds

Sol. (2)

$$f(x) = x^3 + bx^2 + cx$$

$$f(1) = 1 + b + c$$

$$f(2) = 8 + 4b + 2c$$

By Rolle's Theorem

$$f(1) = f(2)$$

$$\Rightarrow 3b + c + 7 = 0 \quad \dots \dots \text{(i)}$$

$$f'(x) = 3x^2 + 2bx + c$$

$$f'\left(\frac{4}{3}\right) = 0$$

By Rolle's theorem

$$\Rightarrow 8b + 3c + 16 = 0 \quad \dots \dots \text{(ii)}$$

By (i) & (ii)

$$\frac{b}{-5} = \frac{c}{8} = \frac{1}{1}$$

$$b = -5$$

$$c = 8.$$

9. A curve passes through

Sol. (1) $y' = x^2 - 2x$

Thus, $y = \frac{x^3}{3} - x^2 + C$

as it passes through (2, 0)

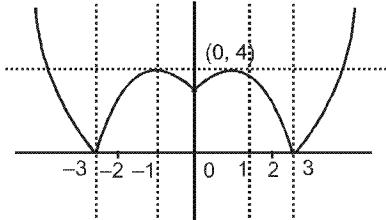
$$C = \frac{4}{3}$$

$$\therefore y = \frac{x^3}{3} - x^2 + \frac{4}{3}$$

$$y'(0^-) > 0, y'(0^+) < 0$$

\Rightarrow local maxima at $x = 0$

10. If $f(x) = ||x|^2 - 2|x| - 3|$
Sol. (4)



11. If in a $\triangle ABC$, $a\cos^2$
Sol. (4)

$$a\cos^2\left(\frac{C}{2}\right) + c\cos^2\left(\frac{A}{2}\right) = \frac{3b}{2}$$

$$a\left(\frac{s(s-c)}{ab}\right) + c\left(\frac{s(s-a)}{bc}\right) = \frac{3b}{2}$$

$$\text{L.H.S.} \Rightarrow s\left[\frac{s-c}{b} + \frac{s-a}{b}\right]$$

$$\Rightarrow \frac{s}{b}[a+b+c-a-c] \Rightarrow \frac{a+b+c}{2} = \frac{3b}{2}$$

$$\Rightarrow a+c = 2b$$

12. If $f(\theta) = (\sin \theta + \operatorname{cosec} \theta)^2$
Sol. (3)

$$f(\theta) = 1 + 4 + \operatorname{cosec}^2 \theta + \sec^2 \theta$$

$$\Rightarrow 5 + \frac{1}{\sin^2 \theta \cos^2 \theta} \Rightarrow 5 + \frac{4}{\sin^2 2\theta}$$

min. value $\Rightarrow 9$

13. The set $(A \cup B \cup C)$

- Sol. (1)

$$(A \cup B \cup C) \cap (A \cap B' \cap C')' \cap C'$$

$$= (A \cup B \cup C) \cap (A' \cup B \cup C) \cap C'$$

$$= [(A \cap A') \cup (B \cup C)] \cap C'$$

$$= (\emptyset \cup B \cup C) \cap C' = (B \cup C) \cap C'$$

$$= (B \cap C') \cup (C \cap C')$$

$$= (B \cap C') \cup \emptyset = B \cap C'$$

14. The value of \cos^{-1}

Sol. (44) $\because \sin^{-1}\left(\frac{\sqrt{2-\sqrt{3}}}{2}\right)$

$$= \tan^{-1}\left(\sqrt{\frac{2-\sqrt{3}}{2+\sqrt{3}}}\right) = \tan^{-1}(2 - \sqrt{3}) = \frac{\pi}{12}$$

$$\cos^{-1}\left(\frac{\sqrt{12}}{4}\right) = \cos^{-1}\left(\frac{\sqrt{3}}{2}\right) = \frac{\pi}{6} \Rightarrow \sec^{-1}(\sqrt{2}) = \frac{\pi}{4}$$

$$\Rightarrow \sin^{-1}\left(\frac{\sqrt{2-\sqrt{3}}}{2}\right) + \cos^{-1}\left(\frac{\sqrt{12}}{4}\right) + \sec^{-1}(\sqrt{2})$$

$$= \frac{\pi}{12} + \frac{\pi}{6} + \frac{\pi}{4} = \frac{\pi}{2}$$

$$\Rightarrow \cot \frac{\pi}{2} = 0 \text{ and } \cos^{-1}(0) = \frac{\pi}{2}$$

15. If $x^{3/4(\log_3 x)^2 + \log_3 x - 5/4} = \sqrt{3}$

- Sol. (4)

Taking logarithm,

$$\left\{ \frac{3}{4}(\log_3 x)^2 + \log_3 x - \frac{5}{4} \right\} \log_3 x = \log_3 \sqrt{3}$$

$$\text{or } \frac{3}{4}y^3 + y^2 - \frac{5}{4}y = \frac{1}{2}, \text{ (writing } y \text{ for } \log_3 x)$$

$$\text{or } 3y^3 + 4y^2 - 5y - 2 = 0 \text{ or } (y-1)(3y^2 + 7y + 2) = 0$$

$$\text{or } (y-1)(3y+1)(y+2) = 0$$

$$\therefore \log_3 x = 1, -\frac{1}{3}, -2 \Rightarrow x = 3, 3^{-1/3}, 3^{-2}.$$

16. $\lim_{x \rightarrow \infty} \frac{2.x^{1/2} + 3.x^{1/3} + 4.x^{1/4} + \dots + n.x^{1/n}}{(3x-4)^{1/2} + (3x-4)^{1/3} + \dots + (3x-4)^{1/n}}$

- Sol. (1) Divide N^r and D^r by $x^{1/2}$

$$\lim_{x \rightarrow \infty} \frac{2 + 3x^{\left(\frac{1}{3}-\frac{1}{2}\right)} + \dots + nx^{\left(\frac{1}{n}-\frac{1}{2}\right)}}{\left(3 - \frac{4}{x}\right)^{1/2} + x^{\frac{1}{3}-\frac{1}{2}}\left(3 - \frac{4}{x}\right)^{1/3} + \dots + x^{\frac{1}{n}-\frac{1}{2}}\left(3 - \frac{4}{x}\right)^{1/n}}$$

$$= \frac{2}{\sqrt{3}}$$

17. A solution (x, y) of

- Sol. (3)

$$\cos^2(\pi x) - \sin^2(\pi y) = 1/2$$

$$\Rightarrow \cos \pi(x+y) \cos \pi(x-y) = 1/2$$

$$\Rightarrow \cos \pi(x+y) \cos(\pi/3) = 1/2 \quad [\because x-y = 1/3]$$

$$\Rightarrow \cos \pi(x+y) = 1$$

$$\Rightarrow \pi(x+y) = 2n\pi \Rightarrow x+y = 2n$$

$$\text{Now } x+y = 2n \text{ and } x-y = 1/3$$

$$\Rightarrow x = n + 1/6, y = n - 1/6, (n \in I)$$

$$\therefore (x, y) = \left(n + \frac{1}{6}, n - \frac{1}{6}\right) \text{ which is satisfied by (3) for } n = 2.$$

18. Let $R = \{(3, 3), (6, 6), \dots\}$

- Sol. (1)

$$(3, 3), (6, 6), (9, 9), (12, 12) \rightarrow R$$

$$(3, 6) \text{ and } (6, 12) \in R \Rightarrow R$$

hence reflexive and transitive both

19. If $f(x)$ is a differentiable.....

- Sol. (1)

$$\frac{f(3) - f(1)}{3-1} = f'(c), \text{ for some } c \text{ such that } 1 < c < 3$$

$$f'(c) = \frac{f(3) - 2}{2} < 2$$

$$\therefore f(3) < 6$$

20. Let R be the relation

Sol. (1) 1R2 and 2R3 but 1R3 \Rightarrow not transitive

$$21. \text{ If } f(x) = \begin{cases} x^2 & , x < 2 \\ x^3 + 3x & , x > 2 \\ a & , x = 2 \end{cases} \dots$$

Sol. (2)

$$f(x)|_{x \rightarrow 2^-} \rightarrow 4$$

$$f(x)|_{x \rightarrow 2^+} \rightarrow 14$$

Thus for $f(x)$ to be strictly monotonically increasing $a \in [4, 14]$.

22. If the thrice repeated.....

Sol. (4)

As $x = 1$ is a repeated root

$$\therefore f(1) = 0 \Rightarrow a + b + c = 0$$

$$f'(1) = 0 \Rightarrow 2a + b + 4 = 0$$

$$f''(1) = 0 \Rightarrow 3a + b + 6 = 0$$

$$\therefore a = -2, b = 0, c = 2.$$

Alter :

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

by comparing coefficient

$$\therefore a = -2, b = 0, c = 2.$$

23. The curves $x^3 - 3xy^2 = a$

Sol. (3)

The two curves are

$$x^3 - 3xy^2 = a \dots \dots \dots (1)$$

$$\text{and } 3x^2y - y^3 = b \dots \dots \dots (2)$$

Differentiating (1) w.r.t. x we get

$$3x^2 - 3y^2 - 6xy \frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = \frac{x^2 - y^2}{2xy}$$

Differentiating (2) w.r.t. x we get

$$6xy + 3x^2 \frac{dy}{dx} - 3y^2 \frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = -\frac{2xy}{x^2 - y^2}$$

$$m_1 m_2 = \left(\frac{x^2 - y^2}{2xy} \right) \times \left(\frac{-2xy}{x^2 - y^2} \right) = -1$$

\therefore The curves cut each other orthogonally

24. If $\lim_{x \rightarrow 0} \frac{f(x)}{x^2} = 2$, then

Sol. (3)

$$\text{Since } \lim_{x \rightarrow 0} \frac{f(x)}{x^2} = 2$$

$$\therefore \lim_{x \rightarrow 0} f(x) = 0$$

Since the given limit is a positive quantity

$\therefore f(x)$ approaches 0 through positive values

$$\therefore \lim_{x \rightarrow 0} [f(x)] = 0$$

25. If $\sin A + \sin B = \sqrt{3} (\cos B - \cos A)$

Sol. (1)

$$\sin A + \sin B = \sqrt{3} (\cos B - \cos A)$$

$$\sin A + \sqrt{3} \cos A = \sqrt{3} \cos B - \sin B$$

$$\Rightarrow \frac{1}{2} (\sin A + \sqrt{3} \cos A) = \frac{1}{2} (\sqrt{3} \cos B - \sin B)$$

$$\sin(A + 60^\circ) = \sin(60^\circ - B)$$

$$A + 60^\circ = 2n\pi + 60^\circ - B \quad \text{or} \quad A + 60^\circ = (2n + 1)\pi - 60^\circ + B$$

$$\therefore \sin 3A + \sin 3B = 0$$

26. Let $f : R - \{1, 2, 3\} \rightarrow R$

Sol. (2)

we put $f(x) = 0$

$$\Rightarrow \frac{1}{x-1} + \frac{2}{x-2} + \frac{3}{x-3} = 0$$

$$\Rightarrow 6x^2 - 22x + 18 = 0 \Rightarrow 3x^2 - 11x + 9 = 0$$

$$\Rightarrow x = \frac{11 \pm \sqrt{13}}{6}$$

Here we get two different values of x for which $f(x) = 0$.
Therefore the function is many-one.

27. If $f(x) = 1 - x - x^3$

Sol. (1)

$$f(x) = 1 - x - x^3$$

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

$$f'(x) = -1 - 3x^2 \quad (\text{decreasing function})$$

$$\therefore f(x) < 1 - 5x$$

$$1 - x - x^3 < 1 - 5x$$

$$x^3 - 4x > 0$$

$$x(x^2 - 4) > 0$$

28. If $f(x) = \begin{cases} ax + b & , x \leq 2 \\ x^2 - 5x + 6 & , 2 < x < 3 \\ px^2 + qx + 1 & , x \geq 3 \end{cases}$

Sol. (4)

$$\lim_{x \rightarrow 2^-} f(x) = 2a + b$$

$$\lim_{x \rightarrow 2^+} f(x) = 0$$

$$\therefore 2a + b = 0 \dots \dots \dots (i)$$

$$\lim_{x \rightarrow 3^-} f(x) = 0, \lim_{x \rightarrow 3^+} f(x) = 9p + 3q + 1$$

$$\therefore 9p + 3q = -1 \dots \dots \dots (ii)$$

$$f'(x) = \begin{cases} a & , x < 2 \\ 2x - 5 & , 2 < x < 3 \\ 2px + q & , x \geq 3 \end{cases}$$

$$\therefore f'(2^-) = a = -1 = f'(2^+) \quad \text{i.e. } a = -1 \dots \dots \dots (iii)$$

$$f'(3^-) = 1 = 6p + q = f'(3^+) \quad \text{i.e. } 6p + q = 1 \dots \dots \dots (iv)$$

from (i) and (iii), we get

$$a = -1, b = 2$$

from (ii) and (iv), we get

$$p = \frac{4}{9}, q = -\frac{5}{3}$$

$$a = -1, b = 2$$

29. If $\alpha, \beta, \gamma \in \left(0, \frac{\pi}{2}\right)$

Sol. (1)

$$\sin(\alpha + \beta + \gamma) = \sin\alpha \cos\beta \cos\gamma + \sin\beta \cos\alpha \cos\gamma + \sin\gamma \cos\alpha$$

$$\cos\beta - \sin\alpha \sin\beta \sin\gamma$$

$$\Rightarrow \sin(\alpha + \beta + \gamma) - \sin\alpha - \sin\beta - \sin\gamma$$

$$= \sin\alpha (\cos\beta \cos\gamma - 1) + \sin\beta (\cos\alpha \cos\gamma - 1) + \sin\gamma$$

$$(\cos\alpha \cos\beta - 1) - \sin\alpha \sin\beta \sin\gamma$$

$$\Rightarrow \sin(\alpha + \beta + \gamma) - \sin\alpha - \sin\beta - \sin\gamma < 0$$

$$\Rightarrow \frac{\sin(\alpha + \beta + \gamma)}{\sin\alpha + \sin\beta + \sin\gamma} < 1$$

30. If $f(x)$ is continuous,

Sol. (3)

$$\text{Here } h(x) = \frac{1}{1-x}; x \neq 1$$

$$\Rightarrow h(h(x)) = \frac{x-1}{x}; x \neq 0, 1$$

$$\therefore h(h(h(x))) = x; x \neq 0, 1$$

Also $g(x) \geq 0 \quad \forall x \in R$

$$\Rightarrow f(x) \geq x \Rightarrow f(f(x)) \geq f(x) \geq x$$

$$\Rightarrow f(f(f(x))) \geq f(x) \geq x \Rightarrow f(f(f(x))) - x \geq 0$$

$\Rightarrow f(f(f(x))) - h(h(h(x))) \geq 0$ such that $x \neq 0, 1$

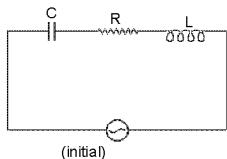
PART- B

PHYSICS

31. The r.m.s. value

Sol. (4)

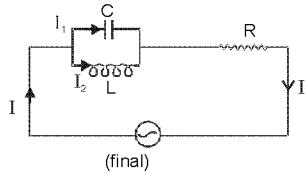
In figure $z = R$
 $X_L = X_C$



In figure

$$\text{If } I_1 = \frac{V_0}{X_C} \sin(\omega t + \pi/2)$$

$$\text{then } I_2 = \frac{V_0}{X_L} \sin(\omega t - \pi/2)$$



$$\text{and } I = I_1 + I_2 = 0$$

Ans. D

32. A conductor

Sol. (3)

$$B/Q = m\sqrt{2gh}$$

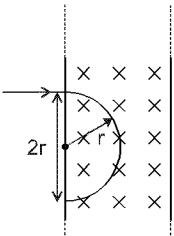
33. If a charged

Sol. (2)

Electromagnetic force will provide the necessary centripetal force.

$$\text{eqv} = \frac{mv^2}{r}$$

$$\Rightarrow r = \frac{mv}{qB} = \frac{v}{B\alpha} = \frac{(2\alpha d)(B)}{(B\alpha)} = 2d$$



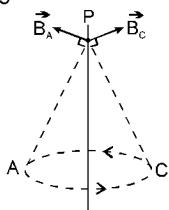
i.e. the electron will move out after travelling on a semicircular path of radius $r = 2d$.
Hence (2)

34. A point charge is

Sol. (1)

The point charge moves in circle as shown in figure. The magnetic field vectors at a point P on axis of circle are \vec{B}_A and

\vec{B}_C at the instants the point charge is at A and C respectively as shown in the figure.



Hence as the particles rotates in circle, only magnitude of magnetic field remains constant at the point on axis P but its direction changes.

Alternate solution

The magnetic field at point on the axis due to charged particle moving along a circular path is given by

$$\frac{\mu_0}{4\pi} \frac{q\vec{v} \times \vec{r}}{r^3}$$

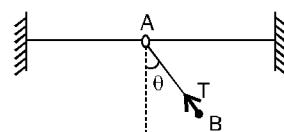
It can be seen that the magnitude of the magnetic field at an point on the axis remains constant. But the direction of the field keeps on changing.

35. A small ring

Sol. (2)

$$mgl \cos\theta = \frac{mv^2}{2}$$

$$T - mg \cos\theta = 2mg \cos\theta$$



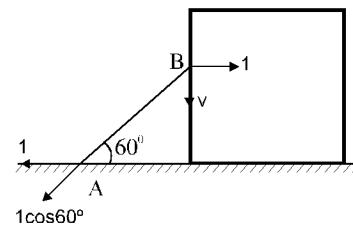
$$T = 3mg \cos\theta$$

$$3mg \cos\theta \sin\theta = \mu [mg + 3mg \cos^2\theta]$$

$$\theta = 45^\circ$$

36. Rod AB is placed

Sol. (4)



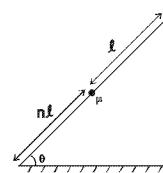
$$1 \cos 60^\circ = v \cos 30^\circ - 1 \cos 60^\circ$$

$$v = \frac{2}{\sqrt{3}}$$

$$v_{\text{net}} = \sqrt{\frac{7}{3}}$$

37. A particle starts

Sol. (3)



applying work-energy theorem from the top to bottom
 $(mg \sin\theta)\ell + (mg \sin\theta - \mu mg \cos\theta)n\ell = 0$

$$\sin\theta + n(\sin\theta - 3\sin\theta) = 0$$

$$\sin\theta = 2n \sin\theta \Rightarrow n = \frac{1}{2}$$

38. If particle move

Sol. (1)

$$\vec{r} = x\hat{i} + y\hat{j}$$

$$\vec{v} = v_x\hat{i} + v_y\hat{j}$$

$$\text{Distance} = |\vec{v}| \Delta t = 10 \times \pi \times t$$

$$= 10 \times \frac{22}{7} \times \frac{7}{22} = 10 \text{ m.}$$

39. A rocket is

Ans. (4)

40. Three particles

Sol. (2)

Velocity just after collision

$$V_0 = V_1 + V_2 \quad \dots(1)$$

$$\frac{1}{2} = \frac{-V_1 + V_2}{V_0}$$

$$-V_1 + V_2 = \frac{V_0}{2} \quad \dots(2)$$

from (1) & (2)

$$\Rightarrow V_1 = \frac{V_0}{4} \text{ & } V_2 = \frac{3V_0}{4}$$

When maximum extension occurs then angular speed with rest to centre for mass m_2 & m_3 are same. Using angular momentum conservation about centre of circle.

$$m \frac{3}{4} V_0 (2R) + 0 = mR^2\omega + m (2R)^2 \omega$$

$$\omega = \frac{3}{10} \frac{V_0}{R}$$

$$\text{So velocity of } m_2 = \frac{3}{5} V_0$$

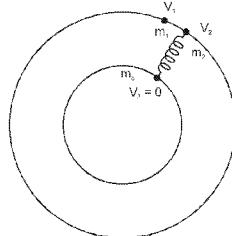
$$\text{& velocity of } m_3 = \frac{3}{10} V_0$$

When extension is maximum using energy conservation.

$$\frac{1}{2} m \left(\frac{3}{4} V_0 \right)^2 = \frac{1}{2} m \left(\frac{3}{5} V_0 \right)^2 + \frac{1}{2} m \left(\frac{3}{10} V_0 \right)^2$$

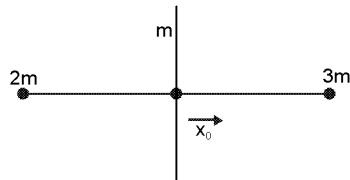
$$+ \frac{1}{2} kx_{\max}^2$$

$$\Rightarrow x_{\max} = \frac{3}{4} V_0 \sqrt{\frac{m}{5k}}$$



41. A frame made

Sol. (3)



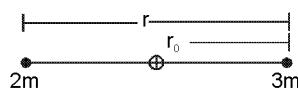
$$x_0 = \frac{2m\left(-\frac{l_0}{2}\right) + 3m\left(\frac{+l_0}{2}\right)}{6m} = \frac{-m l_0 + \frac{3}{2}m l_0}{6m} = \frac{+l_0}{12}$$

42. In a binary star

Sol. (3)

$$3m \left(\frac{2\pi}{T} \right)^2 (r_0) = \frac{G(2m)(3m)}{r^2}$$

$$\text{and } r_0 = \frac{2}{5}r$$



$$T = 5\pi r_0 \sqrt{\frac{r_0}{2Gm}}$$

43. At t = 0 spring

Sol. (4)

At t = 0 system is in equilibrium position and perform SHM with

$$\text{time period } T = 2\pi \sqrt{\frac{2m}{3k}}$$

$$\text{length of spring is minimum at } \frac{T}{4}, \frac{5T}{4} \dots$$

$$\text{length of spring is maximum at } \frac{3T}{4}, \frac{7T}{4} \dots$$

length of spring is natural length and its acceleration is zero at a

$$\text{time } t = 0, \frac{T}{2}, \frac{3T}{2} \dots$$

44. Initially A' and

Ans. (1)

45. An electromagnetic

Sol. (3)

$$\vec{B} = \frac{\vec{E}}{c} = \frac{1}{c} (\vec{E}_1 \hat{i} + \vec{E}_2 \hat{j}) \cos(kz - \omega t)$$

46. In the Fraunhofer

Sol. (3)

$$\frac{1 \times \lambda_1 D}{d} = \frac{3 \times \lambda_2 D}{d}$$

$$\lambda_1 = 3\lambda_2$$

47. A polaroid is

Sol. (2)

$$I = I_0 \cos^2 \theta = I_0 \cos^2 45^\circ = \frac{I_0}{2}$$

48. In the given

Sol. (3)

At the instant of same energy, energy of capacitor is half of

$$\text{maximum energy. So charge on capacitor is } \frac{q_{\max}}{\sqrt{2}}$$

So, time required for this process is

$$\frac{T}{8} = \frac{1}{8} \frac{2\pi}{\omega} = \frac{\pi}{4\sqrt{LC}}$$

49. A car of mass

Sol. (2)

$$P = F v$$

Engine power = 600 W = rate of increase in Potential energy + rate of increase in kinetic energy

$$= mgsin\theta v + m a v = 500 \times 10 \times \frac{1}{50} v + 500 \times 1 v$$

$$\therefore v = 1 \text{ m/s}$$

50. A small block

Sol. (3)

Apply Newton's laws on cart

$$10 = 2 a$$

51. A man carries

Sol. (4)

$$N = P + w$$

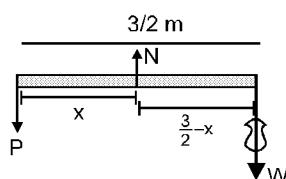
$$P = 2w$$

$$P_x = w \left(\frac{3}{2} - x \right)$$

$$2x = \frac{3}{2} - x$$

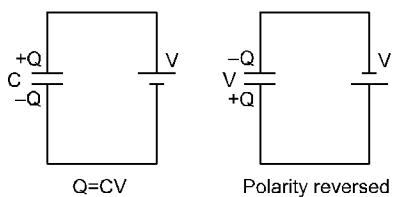
$$3x = \frac{3}{2}$$

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



52. A capacitor of

Sol. (3)



Total charge flown through battery after reversing polarity is $2CV$

Total energy given by battery + initial energy of capacitor

= final energy of capacitor + Heat

Heat = $2CV^2$.

53. An electric field

Sol. (2)

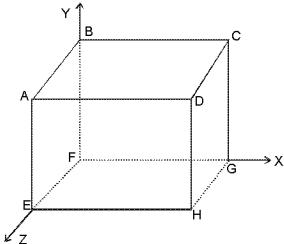
At face EFGH, $Y = 0$

$$\phi_{out} = 6 \text{ Nm}^2/\text{C}$$

At face ABCD, $Y = 1$

$$\phi_{in} = -9 \text{ Nm}^2/\text{C}$$

$$q_{en} = -3\epsilon_0$$



54. Two cells of

Sol. (4)

$$\epsilon_1 = 300 \alpha \quad \dots \text{(i)}$$

$$-\epsilon_2 + \epsilon_1 = 100 \alpha \quad \dots \text{(ii)}$$

where, α is the potential gradient

$$\therefore \frac{\epsilon_2}{\epsilon_1} = \frac{2}{3}.$$

55. Two inductor

Ans. (2)

56. A uniform current

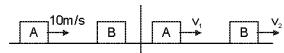
Sol. (2)

$$mgR = B_0 \pi R^2 i$$

$$i = \frac{mg}{\pi R B_0}.$$

57. In the figure

Sol. (3)



$$m \times 10 = mv_1 + mv_2$$

$$\Rightarrow 10 = v_1 + v_2 \quad \dots \text{(i)}$$

$$\text{and } \frac{1}{2} \times 10 = v_2 - v_1 \quad \dots \text{(ii)}$$

From I and II

$$v_1 = \frac{5}{2} \text{ m/s}; v_2 = \frac{15}{2} \text{ m/s}$$

Distance between the two blocks

$$S = (-v_1 + v_2) \cdot t$$

$$= \left(-\frac{5}{2} + \frac{15}{2} \right) \times 5 = 25 \text{ m}$$

58. A particle is

Sol. (4)

Change in momentum = Impulse

$$\Delta \vec{P} = J_x \hat{i} + J_y \hat{j} + J_z \hat{k}$$

$$= 30(0.1) \hat{i} + \frac{1}{2}(80)(0.1) \hat{j} + (-50) \times (0.1) \hat{k}$$

$$= 3\hat{i} + 4\hat{j} - 5\hat{k}$$

$$|\Delta \vec{P}| = 5\sqrt{2} \text{ kg sec.}$$

59. In the series

Sol. (1)

$$\text{Heat} = (i_{rms})^2 \cdot Rt$$

$$i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{25}{Z\sqrt{2}}$$

$$\text{where, } Z = \sqrt{R^2 + (x_L - x_C)^2}$$

$$= \sqrt{4^2 + (7 - 4)^2} = 5 \Omega$$

$$\Rightarrow \text{Heat} = \left(\frac{25}{5\sqrt{2}} \right)^2 \cdot 4.80 = 4000 \text{ J and Amplitude of wattless}$$

$$\text{current} = i_0 \sin \phi$$

$$\text{where; } \phi = \tan^{-1} \left(\frac{x_L - x_C}{R} \right) = \tan^{-1} \left(\frac{7 - 4}{4} \right) = 37^\circ$$

$$\Rightarrow \text{Amplitude} = i_0 \sin 37^\circ = \frac{25}{5} \cdot \frac{3}{5} = 3 \text{ Ampere}$$

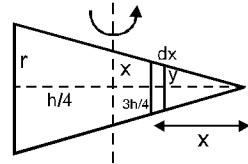
Hence (1)

60. Moment of inertia

Sol. (4)

$$I_c = \int_0^R \frac{1}{3} \pi R^2 \cdot R \left[\frac{x^2}{3} + x^2 \right]$$

$$= \frac{3M}{R^3} \int_0^R \left(\frac{x^4}{4} + x^4 \right) dx$$



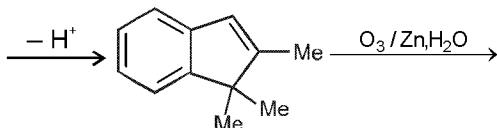
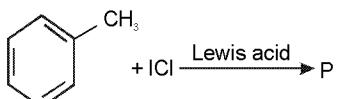
$$= \frac{3M}{R^3} \left(\frac{R^5}{20} + \frac{R^5}{5} \right) = \frac{3}{4} MR^2$$

Applying parallel axis theorem,

$$\Rightarrow I_c = I_{cm} + \left(\frac{3R}{4} \right)^2 = \frac{3}{4} MR^2$$

$$I_{cm} = \frac{3MR^2}{16} \quad \text{Ans.}$$

78. The product (P) of the following



Sol. (2)

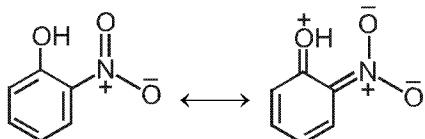
It is simple example of electrophilic aromatic substitution :

79. The correct order of dipole moment

Sol. (3)

I > II > III

High dipole moment of (I) is due to ionic structure of resonating form.



80. The order of acidities of the H-atoms.....

Sol. (1)

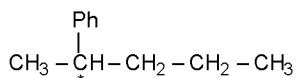
IV > II > I > III

Structure IV is most acidic as the conjugate base is aromatic.
IV > II > I > III

81. The compound that is chiral.....

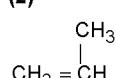
Sol. (3)

Only (3) has asymmetric carbon atom.



82. The monomer/s of the following polymer

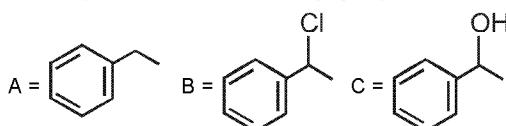
Sol. (2)



83. The product (3) of the following sequence

Sol. (4)

In our opinion there are no methyl group in above reaction



but official answer given A.

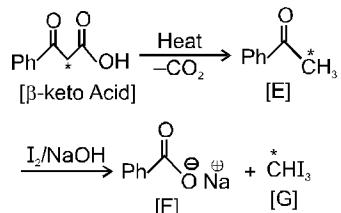
84. The order of reactivity of ammonia

Sol. (2)

Acid chloride is more electrophilic than alkyl halide, hence more reactive.

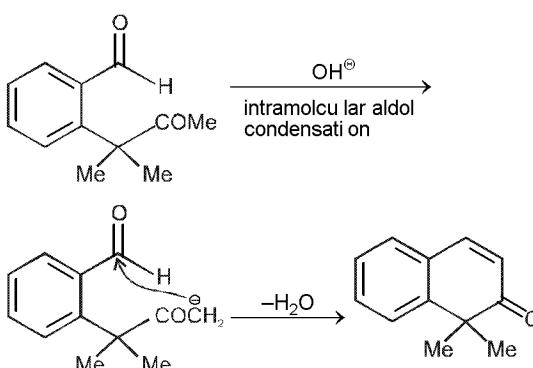
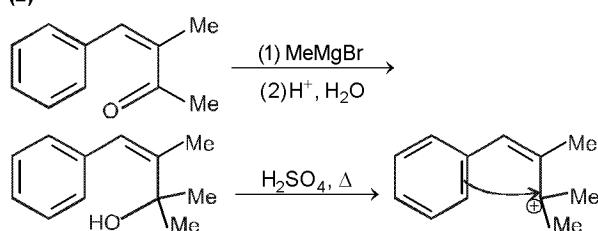
85. In the following reaction sequence, the correct

Sol. (3)



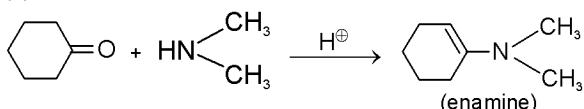
86. A carbonyl compound P, which.....

Sol. (2)

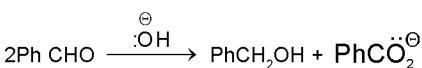


87. Reaction of cyclohexanone with dimethylamine

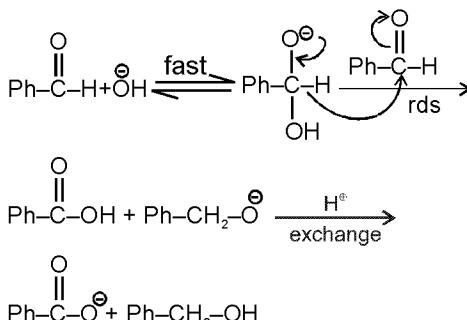
Sol. (3)



88. In Cannizzaro reaction given below

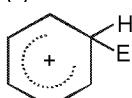


Sol. (1)



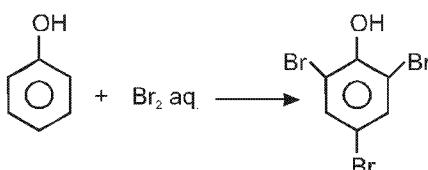
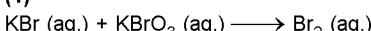
89. The electrophile, E+. attacks

Sol. (1)



90. Phenol is heated with a solution

Sol. (4)



2, 4, 6-tribromophenol