FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2025
FULL TEST – IV
PAPER –1
TEST DATE: 18-02-2025

ANSWERS, HINTS & SOLUTIONS

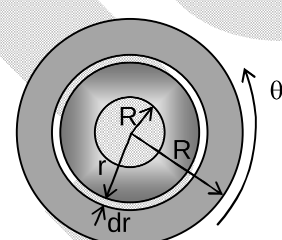
Physics

PART – I

SECTION – A

1. D

Sol. $\int d\tau = \int_R^{2R} \eta\left(\frac{r\theta}{\ell}\right) r 2\pi r dr$



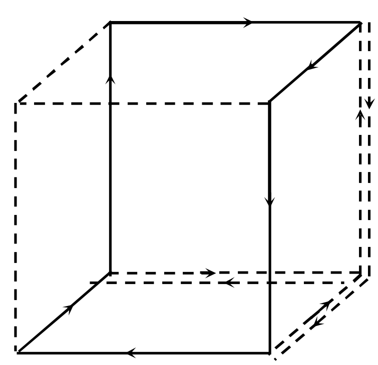
$\tau = \frac{2\pi\eta\theta}{\ell}\int_R^{2R} r^3 dr$

$\tau = \frac{2\pi\eta\theta}{\ell}\left[\frac{r^4}{4}\right]_R^{2R}$

$\tau = \frac{15\pi\eta R^4\theta}{2\ell}$

2. C

Sol. The current distribution is equivalent to three current carrying loops as shown in the figure.



3. A

Sol. $\tau_n = \frac{2v_n}{g}$, where $v_n = \alpha^n v_i$

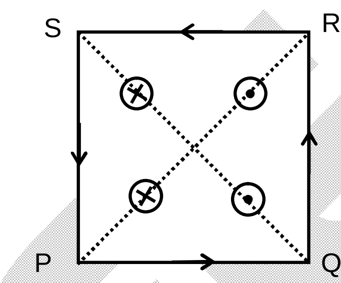
So, $\tau_n = \tau_0\alpha^n$, where $\tau_0 = \dfrac{2v_i}{g}$

$t_n = \tau_0\Sigma\alpha^n = \tau_0\dfrac{1-\alpha^n}{1-\alpha} = \dfrac{\tau_0-\tau_n}{1-\alpha}$

So, $\tau_n = \tau_0-(1-\alpha)t_n$

4. C

Sol. Let $\int_P^Q \vec{B}_A\cdot d\vec{\ell} = -9\mu_0 = x$



$\int_R^S \vec{B}_B\cdot d\vec{\ell} = 5\mu_0 = y$

Now, apply amperes low in loop PQRS

$2\left[\left(x-\dfrac{y}{2}\right)+(-2x+y)+(-8x+4y)+(4x-2y)\right] = \mu_0(5i_0)$

$i_0 = 23\,\text{amp}$

5. A, C, D

Sol. If $n_3 < n_1$, $\dfrac{n_3}{n_2} < \dfrac{n_1}{n_2} \Rightarrow \sin\theta'_C < \sin\theta_C \Rightarrow \theta'_C < \theta_C$

So, total internal reflection occurs at AB since $\theta > \theta_C$
If $n_3 > n_1$, the ray will refract at surface AB
If θ_1 is the angle of refraction for surface AB

$n_3\sin\theta_1 = n_2\sin\theta \Rightarrow \sin\theta_1 = \dfrac{n_2}{n_3}\sin\theta$

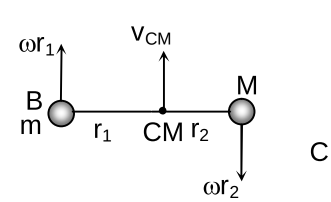
Since, $\sin\theta > \dfrac{n_1}{n_2}$, $\sin\theta_1 > \dfrac{n_2}{n_3}\dfrac{n_1}{n_2}$

$\Rightarrow \sin\theta_1 > \dfrac{n_1}{n_3} \Rightarrow \sin\theta_1 > \sin\theta''_C$

where θ''_C is the critical angle for interface CD So, the ray will undergo total internal reflection at interface CD and will return to medium of refractive index n_2 (according to optical reversibility of light)

6. A, D

Sol. The bead and the centre of the ring will move along the circular paths about their centre of mass with a constant angular velocity, $\omega = \dfrac{u}{R} = \dfrac{5}{0.5} = 10$ rad/s



N = $m\omega^2 r$ = 4 × 100 × 0.3 = 120 N
The velocity of their centre of mass

$v_{CM} = \dfrac{mu+0}{m+M} = \dfrac{4\times5}{10} = 2$ m/s

The speed of the bead relative to the centre of mass

$v_1 = \omega r_1 = 10\times0.3 = 3$ m/s

$K_{1(\min)} = \dfrac{1}{2}m(v_1-v_{cm})^2 = \dfrac{1}{2}\times4\times(3-2)^2 = 2\,J$

7. B, D

Sol. L.C. = $\frac{1}{20}\times 0.1 = 0.005$ cm

Let 1 V.S.D. = x

$\Rightarrow \frac{1}{20} = 1 - x \Rightarrow x = 0.95$ mm

$(n-4)\times 1 = n \times 0.95$

$\Rightarrow n = 80$

Length of pencil = $8.4 + 0.005\times\left(\frac{80}{5}\right) = 8.48$ cm

8. D

Sol. Use basic formulae for the given physical quantities to derive the dimensions.

9. B

Sol. (P) Loss in kinetic energy = gain in elastic potential energy

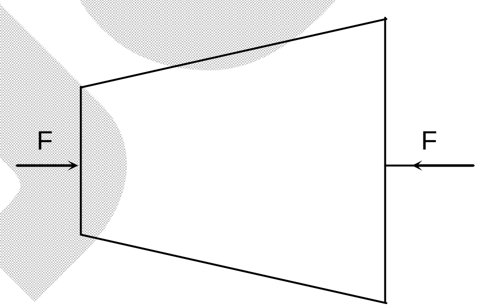
$$\Rightarrow \frac{1}{2}mv_0^2 = \frac{1}{2}\times \text{stress}\times\text{strain}\times\text{volume} = \frac{1}{2}\sigma_{max}\times\frac{\sigma_{max}}{E}\times A\ell$$

$$\Rightarrow \sigma_{max} = \sqrt{\frac{Emv_0^2}{A\ell}} = 2 \text{ unit}$$

(Q) $\frac{\alpha\ell\Delta T}{\ell} = \frac{4F}{\pi DdE}$

$$\Rightarrow F = \frac{\pi\alpha DdE\Delta T}{4}$$

$$\Rightarrow \sigma_{max} = \frac{4F}{\pi d^2} = \frac{DE\alpha\Delta T}{d} = 4 \text{ unit}$$



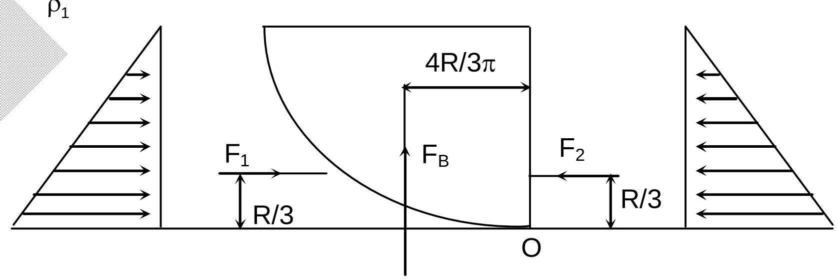
(R) $$30\times10^{-2}\,\frac{1}{-2}gt^2 = \frac{1}{2}g\left(\frac{40\times10^2}{\sqrt{2gh}}\right) = \frac{1}{2}\times g\times\frac{40\times10^{-2}\times40\times10^{-2}}{2\times g\times h}$$

$$h = \frac{40\times40}{4\times30}\times10^{-2}\text{m} = \frac{40}{3}\text{cm} \Rightarrow n = 1$$

(S) Taking torque about O $F_2\times\frac{R}{3} - F_1\times\frac{R}{3} - F_B\times\frac{4R}{3\pi} = 0$

$$\Rightarrow \rho_1 g\frac{R^2\ell}{2}\times\frac{1}{3} - \rho_2 gR^2\frac{\ell}{2}\times\frac{1}{3} - \frac{\pi R^2\ell}{4}\rho_1 g\times\frac{4}{3\pi} = 0$$

$$\Rightarrow \frac{\rho_2}{\rho_1} = 3$$



10. D

Sol. (P) Magnetic pressure exerted on the wall of the outer cylinder,

$$P_0 = \frac{3I}{4\pi a}\left(\frac{3\mu_0 I}{8\pi a} - \frac{\mu_0 I}{4\pi a}\right)$$

$$P_0 = \frac{3I}{4\pi a} \times \frac{\mu_0 I}{8\pi a} = \frac{3\mu_0 I^2}{32\pi^2 a^2}$$

(Q) Magnetic pressure exerted on the wall of the outer cylinder,

$$P_0 = \frac{2I}{4\pi a}\left(\frac{\mu_0 I}{4\pi a} + \frac{\mu_0 I}{4\pi a}\right)$$

$$P_0 = \frac{I}{2\pi a} \times \frac{\mu_0 I}{2\pi a} = \frac{\mu_0 I^2}{4\pi^2 a^2}$$

(R) Magnetic pressure exerted on the wall of the outer cylinder,

$$P_0 = \frac{I}{4\pi a}\left(\frac{\mu_0 I}{2\pi a} + \frac{\mu_0 I}{8\pi a}\right)$$

$$P_0 = \frac{5\mu_0 I^2}{32\pi^2 a^2}$$

(S) Magnetic pressure exerted on the wall of the outer cylinder,

$$P_0 = \frac{3I}{4\pi a}\left(\frac{3\mu_0 I}{8\pi a} - \frac{\mu_0 I}{8\pi a}\right)$$

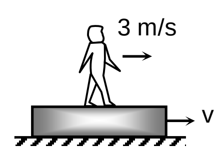
$$P_0 = \frac{3I}{4\pi a} \times \frac{\mu_0 I}{4\pi a} = \frac{3\mu_0 I^2}{16\pi^2 a^2}$$

11. A

Sol. (P) 0 = 100v + 50(v + 3) (COLM)

v = –1 m/s

So, work done by man = $\frac{1}{2}(100)(1)^2 + \frac{1}{2}(50)(2)^2 = 150$ J



(Q) $W_N + W_{mg} = \Delta$ K.E. (WET)

$$W_N - \frac{1}{2}(2)(10)^2 = \frac{1}{2}(2)\left[(5)^2 - (15)^2\right]$$

$W_N = -100$ J

(R) Unstable equilibrium points are x = 10 m, 30 m

Stable equilibrium point is x = 20 m

So, $U_i = 0$, and $U_f = -\frac{1}{100}(10)^4 = -100$ J

$W_{\text{conservative force}} = U_i - U_f = 100$ J

(S) $W_{ext} = U_f - U_i = mg\left(\frac{5R}{8} - \frac{3R}{8}\right) = \frac{mgR}{4} = 100$ J

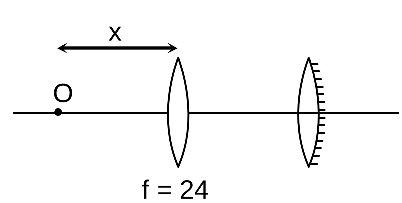
SECTION – B

12. 6

Sol. $\frac{1}{v} - \frac{1}{-x} = \frac{1}{24}$

$\Rightarrow \frac{1}{v} = \frac{1}{24} - \frac{1}{x}$

$$\frac{1}{v} = -\frac{1}{\left(\frac{24-x}{24x}\right)}$$



Object distance for silvered lens is $(14-x)+\frac{24x}{(24-x)}$ for image to be on object O, this distance must be equal to equivalent radius of mirror.
For (Reflecting lens is effectively mirror)

$$-\frac{2}{R_{eq}} = 2\left(\frac{3}{2}-1\right)\left(\frac{1}{32}-\frac{1}{-32}\right)-\frac{3}{-32}$$

$\Rightarrow R_{eq} = -16$ cm

$$\therefore\ 16 = (14-x)+\frac{24x}{(24-x)}$$

$\Rightarrow x = 6$ cm

13. 9

Sol. Given : y(0, t) = 8 sin 4t

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{10}{2}} = \sqrt{5}\text{ m/sec}$$

Wave equation : $y(x, t) = 8\sin 4\left(t-\frac{x}{v}\right)$

Average power transmitted due to the wave $\bar{P} = \frac{1}{2}\mu v\omega^2A^2$

Average rate of heat supplied to the bath = $\frac{1}{4}\mu v\omega^2A^2$

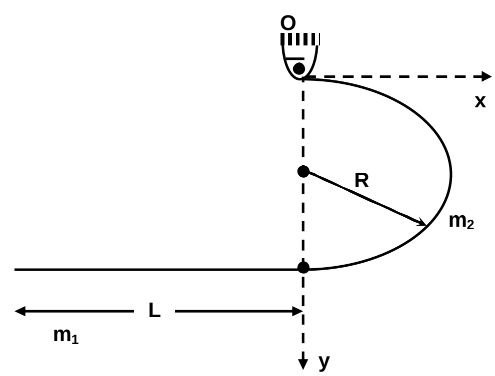
$\Rightarrow \frac{1}{4}\mu v\omega^2A^2t = ms\Delta t$

$\Rightarrow t = 9.17\times10^5$ sec

$\Rightarrow n = 9$

14. 8

Sol. In equilibrium, the centre of mass of the system must lies on the vertical line passing through hinge.



$\therefore\ X_{CM} = 0$

$$-m_1\frac{L}{2}+m_2\left(\frac{2R}{\pi}\right)=0$$

$$\frac{\lambda L^2}{2} = \lambda(\pi R)\frac{2R}{\pi}$$

$\therefore\ L = 2R$

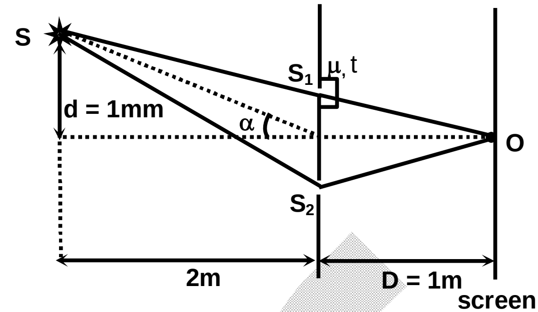
$$Y_{CM} = \frac{m_1(2R)+m_2R}{m_1+m_2}$$

$$= \frac{\lambda L^2+\lambda\pi R^2}{\lambda L+\lambda\pi R} = \left(\frac{\pi+4}{\pi+2}\right)\frac{L}{2} \Rightarrow \alpha = 4, \beta = 2$$

$\therefore\ \alpha\beta = 8.$

15. 1

Sol. $\tan\alpha = \frac{1\times10^{-3}}{2} = 5\times10^{-4}$



For the intensity at point 'O' to be maximum

$d \sin \alpha - (\mu - 1)t = \lambda$ (for $t = t_{min}$)

$1\times10^{-3}\times5\times10^{-4} - (1.5-1)t = 4\times10^{-7}$

$5\times10^{-7} - (1.5-1)t = 4\times10^{-7}$

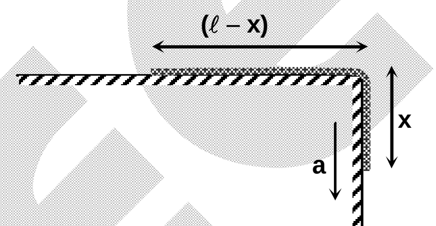
$(1.5 - 1)t = 1 \times 10^{-7}$

$0.5t = 1 \times 10^{-7}$

$t_{min} = 0.20\ \mu m$

16. 560

Sol. Let mass per unit length of the rope is λ



The breaking tension of the rope, $T_{max} = \lambda\ell_0 g$

The acceleration of the rope,

$$a = \frac{\lambda x g}{\lambda\ell}$$

$$a = \frac{gx}{\ell} \quad \ldots(i)$$

$T = \lambda(\ell - x)a$

$$T = \lambda(\ell - x)\frac{gx}{\ell}$$

$$T = \frac{\lambda g}{\ell}(\ell - x)x \quad \ldots(ii)$$

For T to be maximum, $\frac{dT}{dx} = 0$

$$\frac{\lambda g}{\ell}(\ell - 2x) = 0, \quad x = \frac{\ell}{2}$$

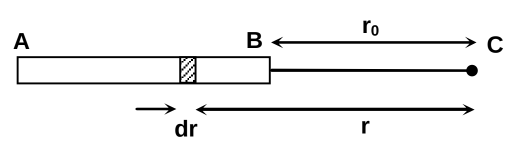
Hence, $T_{max} = \frac{\lambda g}{\ell}\left(\ell - \frac{\ell}{2}\right)\frac{\ell}{2}, \quad \lambda\ell_0 g = \frac{\lambda g \ell}{4}$

$\ell = 4\ell_0$

$\ell = 4 \times 1.40 = 5.60$ m

17. 5

Sol. Potential due to rod at C



$$V = -\frac{GM}{L}\int_{r_0}^{r_0+L}\frac{dx}{x}$$

$v = -\frac{GM}{L}\ell n\left(1 + \frac{L}{r_0}\right)$, where r_0 changes from L to $\frac{L}{2}$ then kinetic energy gained by m is

$$\frac{1}{2}mu^2 = \frac{mGM}{L}\ell n\left(\frac{3}{2}\right)$$

$$v = \sqrt{\frac{2GM}{L}\ell n\left(\frac{3}{2}\right)}$$

$\therefore$ x + y = 2 + 3 = 5

Chemistry PART – II

SECTION – A

18. C

19. A

Sol. The mass of 1 cc of $(C_2H_5)_4Pb$ is = 1 × 1.66 = 1.66g and this is the amount needed per litre.

No. of moles of $(C_2H_5)_4Pb$ needed = $\frac{1.66}{323}$ = 0.00514 ml

1 mole of $(C_2H_5)_4Pb$ requires 4 × (0.00514) = 0.0206 ml of C_2H_5Cl

∴ Mass of C_2H_5 Cl = 0.0206 × 64.5 = 1.33 g

20. A

Sol. Due to non availability of d-orbitals, boron is unable to expand its octet. Therefore it cannot extend its covalency more than 4.

21. C

Sol. It is called Zinc blend

22. A, B

Sol. Roult's law for ideal solutions can be represented in the above two given ways.

23. A, B

24. B, C, D

25. A

26. C

Sol. (P) $K_P > Q$ the reaction will proceed in forward direction spontaneously.

(Q) $\Delta G^o < RT\log_e Q$ then $\Delta G = +ve$ then non spontaneous.

(R) $K_P = Q \rightarrow$ equilibrium

(S) $\Delta G = \Delta H - T.\Delta S$

27. B

28. A

SECTION – B

29. 3

30. 6

Sol. Conductivity of Na_2SO_4 = 2.6×10^{-4}

$$\Lambda_m(Na_2SO_4) = \frac{1000 \times 2.6 \times 10^{-4}}{0.001} = 260 \text{ S cm}^2$$

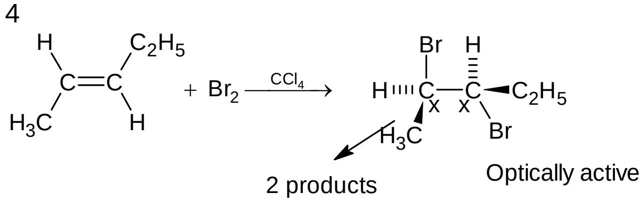
$$\Lambda_m(SO_4^{2-}) = \Lambda_m(Na_2SO_4) - 2\Lambda_m(Na^+)$$

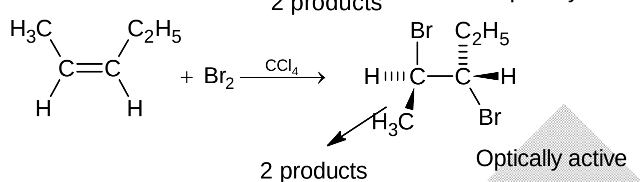
= 260 – 2 × 50 = 160 S cm^2 mol^{-1}

Coductivity of $CaSO_4$ solution

= $7 \times 10^{-4} - 2.6 \times 10^{-4} = 4.4 \times 10^{-4}$ S cm^{-1}

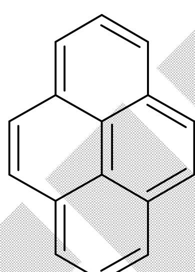
$\Lambda_m(CaSO_4) = \Lambda_m(Ca^{2+}) + \Lambda_m(SO_4^{2-})$
= 120 + 160 = 280 S cm^2 mol^{-1}
Solubility, S = $\dfrac{1000 \times K}{\Lambda_m} = \dfrac{1000 \times 4.4 \times 10^{-4}}{280}$
= 1.57 × 10^{-3} cm
$K_{sp} = [Ca^{2+}][SO_4^{2-}]_{total} = (0.00157)(0.00157 + 0.001)$
= 4 × 10^{-6} M^2
= y × 10^{-x} M^2

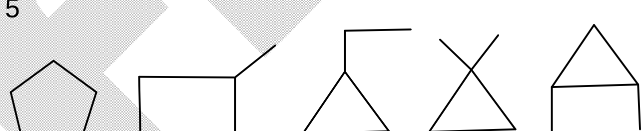
31. 4
Sol.




total = 2 + 2 = 4

32. 2
Sol. rate $\propto \dfrac{1}{[A]}$

33. 7
Sol.

The central pi-bond is not in conjugation.

34. 5
Sol.


Mathematics

PART – III

SECTION – A

35. C
Sol. $(9 - x_1) + (9 - x_2) + (9 - x_3) + (9 - x_4) + (9 - x_5) + (9 - x_6) = 49$
$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 = 5$
Number of solution is ${}^{5+6-1}C_{6-1} = {}^{10}C_5$

36. D
Sol. $A^3 = A^2 \cdot A = (2I - A)A = 2A - A^2 = 2A - (2I - A) = 3A - 2I$
$A^4 = A^3 \cdot A = (3A - 2I)A = 3A^2 - 2A = 3(2I - A) - 2A = 6I - 5A$
$A^5 = (6I - 5A)A = 6A - 5A^2 = 6A - 5(2I - A) = 11A - 10I$
$\Rightarrow P = 11$ and $K = -10$

37. D
Sol. $x(f(x))^2 - x^2 f(x) = \left(\sqrt{x} f(x)\right)^2 - 2 \cdot \sqrt{x} \times f(x) \cdot \frac{x^{3/2}}{2} + \frac{x^3}{4} - \frac{x^3}{4}$

$$\left(\sqrt{x}\, f(x) - \frac{x^{3/2}}{2}\right)^2 - \frac{x^3}{4}$$

$$\therefore B - A = \int_0^1 \left(\sqrt{x}\, f(x) - \frac{x^{3/2}}{2}\right)^2 dx - \int_0^1 \frac{x^3}{4} dx$$

$$\therefore A - B \le \frac{1}{16}$$

38. A
Sol. Say, $\lambda < 0$
$\omega = \sqrt{-\lambda}$
$\therefore |I + \lambda A^2| = |I - \omega^2 A^2| = |I - \omega A||I + \omega A|$
As, $A = -A'$
$I - \omega A = I + \omega A' = (I + \omega A)' \Rightarrow |I + \lambda A^2| = |I + \omega A||I + \omega A|' = |I + \omega A|^2 \ge 0$
Same, can be seen for $\lambda \ge 0$

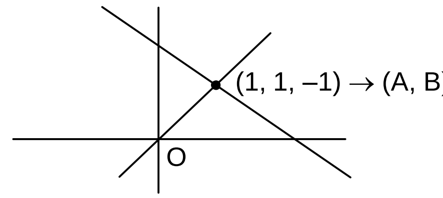
39. A, B
Sol. $x = 4k + 1$, $y = 2m$ ($k_1 m \in N$)
$y^x = (2m)^{4n+1}$ (it is divisible by 8)
$x^y = (4n + 1)^{2m}$ (it leave remainder 1)

40. A, C, D
Sol. As $f(x)f''(x) > 0 \ \forall x \in R$
For $y = f(x)f'(x)$; $y' = (f'(x))^2 + f(x)f''(x) > 0$
If $f(x)_0 < 0$ then $f''(x_0) < 0$

41. B, D
Sol. If it is parallelogram $z_1 + z_3 = z_2 + z_4 = 0$ (in some order)
$\Rightarrow$ If it is rhombus then area is $2|z_1||z_2|$ where $|z_1|^2|z_2|^2 = \left|\frac{d}{a}\right|$

42. B

Sol. (P) $d = 2\sqrt{3}$
(Q) These lines are skew and O lies on shortest distance
(R) Lines are parallel and O lies mid way between them
(S) Lines are coplanar and perpendicular

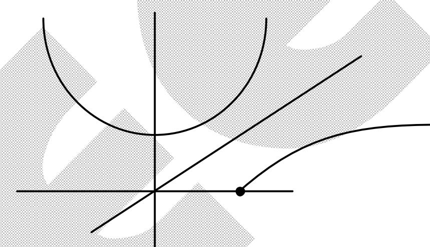


43. D

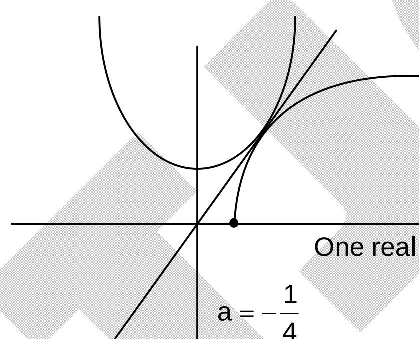
Sol. We can consider 9 cells as 9 different boxes and we have to fill these boxes by 3 identical balls (2 written on them), 4 identical balls (3 written on them) and 7 identical balls (5 written on them) as per given conditions

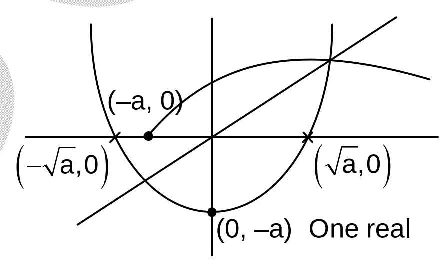
44. A

Sol. (P) $x^2 - a = x$
$x^2 - x - a = 0$
$D < 0$
$1 + 4a < 0$
$a < -\frac{1}{4}$



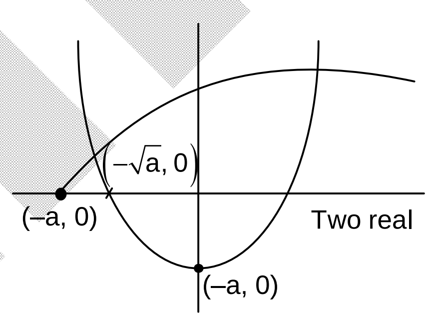
(Q) $-\sqrt{a} < -a$
$\sqrt{a} > a$
$a > a^2$
$a^2 - a < 0$
$a(a - 1) < 0$
$0 < a < 1$

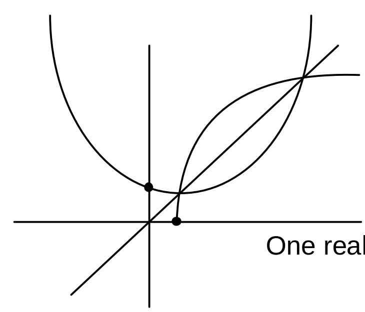




(R) $x^2 - x - a = 0$
$1 + 4a > 0, -a > 0$
$a > -\frac{1}{4}, a < 0$
$-\frac{1}{4} < a \le 0$

$-a < -\sqrt{a}$
$a > \sqrt{a}$, $a^2 > a$
$a(a - 1) > 0, a \ge 1$





45. A

Sol. For regular quadrilateral n must be multiple of 4. Perpendiculars dropped from a plane circumcentre to side is always collinear. For one of the side to be diameter $P(E) = \frac{{}^5C_1\,{}^8C_1}{{}^{10}C_3}$ and orthocentre is inside for acute angled triangle $P(E) = 1 - \frac{{}^9C_1\,{}^4C_2}{{}^9C_3} = \frac{5}{14}$

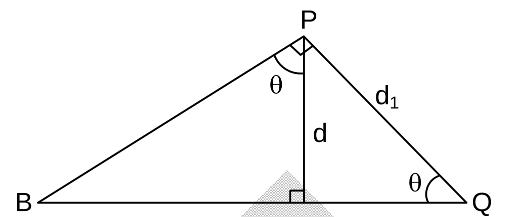
SECTION – B

46. 9

Sol. Let ABCD have coordinates
O, $\lambda(i + j)$, $\lambda(j + k)$, $\lambda(i + k)$ respectively

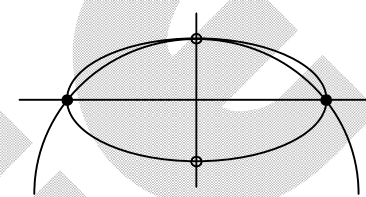
$\frac{d_1}{d} = \text{cosec}\,\theta = \sqrt{3}$

Where θ is angle between AB and normal of BCD



47. 2

Sol. The given equation reduces to $4f^2(x) + x^2 = 9$, an ellipse.
As in the figure it has two solutions

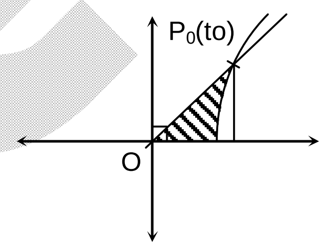


48. 480

Sol. $\frac{1}{2}\left(\frac{e^{to}+e^{-to}}{2}\right)\left(\frac{e^{to}-e^{-to}}{2}\right)-\int_0^{to} y\,dx$

$\frac{1}{8}\cdot e^{2to}-e^{-2to}-\int_0^{to}\frac{\left(e^{t}-e^{-t}\right)^2}{4}dt=\frac{to}{2}=240$

to = 480



49. 3

Sol. $I = \cos\alpha\cos\beta + \sin^2\alpha\sin\beta - \cos^2\gamma\sin\alpha \le \cos\alpha\cos\beta + \sin\alpha\sin\beta = \cos(\alpha - \beta)$

$\Rightarrow \alpha - \beta = 0$ & $\cos\gamma = 0$, $\sin\alpha = 1$

$\Rightarrow \alpha = \beta = \gamma = \frac{\pi}{2}$

50. 57060

Sol. For point of intersection we take say two points A and B, from each we can draw ${}^9C_2$ lines cut of which ${}^8C_2$ are parallel. So total number of intersection points are

${}^{10}C_2\left((36)^2 - 28\right) = 57060$

51. 21

Sol. $\begin{vmatrix} a & d & 1 \\ b & e & 1 \\ c & f & 1 \end{vmatrix} = -5 \quad \begin{vmatrix} a & d & 1 \\ b & e & 2 \\ c & f & 3 \end{vmatrix} = 3$

$2\begin{vmatrix} a & d & 1 \\ b & e & 2 \\ c & f & 3 \end{vmatrix} - 3\begin{vmatrix} a & d & 1 \\ b & e & 1 \\ c & f & 1 \end{vmatrix} = 21$

$\begin{vmatrix} a & d & -1 \\ b & e & 1 \\ c & f & 3 \end{vmatrix} = 21$