FIITJEE

ALL INDIA TEST SERIES

JEE (Advanced)-2025

CONCEPT RECAPITULATION TEST – IV

PAPER –2

TEST DATE: 24-04-2025

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. C

Sol. On the horizontal, the path difference is decreasing so at the maximum distance from P where minima occurs, path difference is $\frac{\lambda}{2}$.

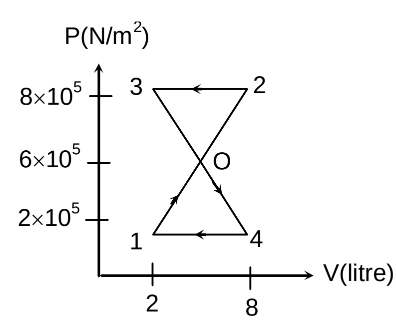
Hence $\sqrt{9\lambda^2 + x^2} - x = \frac{\lambda}{2} \Rightarrow x = 8.75\,\lambda$

2. C

Sol. $V_4 - V_1 = 6\text{litre}$

From geometry $V_2 - V_3 = 3\text{litre}$

$$W_{104} = \frac{1}{2} \times 4 \times 10^5 \times 6 \times 10^{-3}$$
$$= 1200\text{J}$$
$$W_{230} = -\frac{1}{2} \times 2 \times 10^5 \times 3 \times 10^{-3}$$
$$= -300\text{J}$$
$$W = 900\text{ J}$$



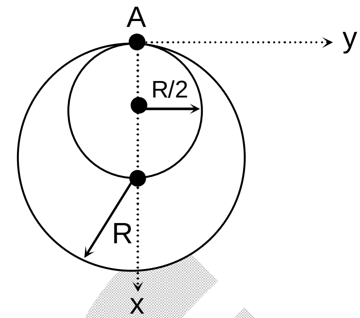
3. A

Sol. $y_1 = a\cos\omega_1 t$ and $y_2 = a\cos(\pi + \omega_2 t)$

For same phase $\omega_1 t = \pi + \omega_2 t$

$$t = \frac{\pi}{\omega_1 - \omega_2} = \frac{\pi}{\frac{2\pi}{3} - \frac{2\pi}{7}} = \frac{21}{8}\text{s}$$

4. C



Sol. $x_{cm} = \dfrac{m\left(\dfrac{R}{2}\right) + 2mR}{m + 2m} = \dfrac{5}{6}R$

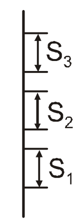
$I_A = I_1 + I_2$, $I_1 = m\left(\dfrac{R}{2}\right)^2 + m\left(\dfrac{R}{2}\right)^2 = \dfrac{mR^2}{2}$

$I_2 = 2mR^2 + 2mR^2 = 4mR^2 \Rightarrow I_A = \dfrac{9}{2}mR^2$

for compound pendulum $T = 2\pi\sqrt{\dfrac{I}{Mgd}}$

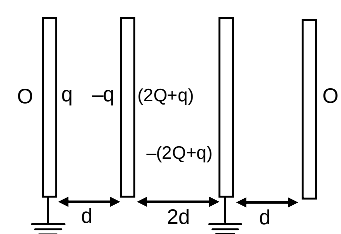
$\Rightarrow$ here M = 3m, $d = \dfrac{5}{6}R \Rightarrow T = 2\pi\sqrt{\dfrac{9R}{5g}}$

5. CD



Sol. As going up, speed of the particle is decreasing and hence time taken in crossing the windows
(if $S_1 = S_2 = S_3$) will be $t_1 < t_2 < t_3$.
Since, $\vec{u} = \vec{u} + \vec{a}\,t$
$\Delta u \propto t$ (as acceleration is same)
So, $\Delta u_1 < \Delta u_2 < \Delta u_3$
(as for equal windows $t_1 < t_2 < t_3$)
For unequal windows,
$t_1 = t_2 = t_3$ if $S_3 < S_2 < S_1$.

6. ACD



Sol. $\because$ Plate '1' and plate '3' is earthed hence the charge on left surface of plate '1' and right surface of plate '4' are zero.

$\because$ $V_1 - V_3 = 0$

$\Rightarrow \dfrac{q}{A\,t_o}d + \dfrac{2Q+q}{A\,t_o} = d = 0$

$\therefore$ $q = \dfrac{-4Q}{3}$ $\therefore$ $2Q + q = 2Q - \dfrac{4Q}{3} = \dfrac{2Q}{3}$

7. ABD

Sol. Since only 6 different wavelength are excited, therefore highest excited stat is n = 4.
Two wavelengths are shorter than λ_0, initially atoms were in excited state n = 2.
Corresponding transitions are $4 \to 3$, $4 \to 2$, $4 \to 1$, $3 \to 2$, $3 \to 1$, $2 \to 1$.

SECTION – B

8. 5

Sol. As stable equilibrium, U is minimum. Thus $\dfrac{d^2U}{dx^2} > 0$.

And $\dfrac{dv}{dx} = 0$.

$$= \frac{1}{dx}\left(\frac{x^3}{3} - \frac{ax^2}{2} + 20x\right) = 0.$$

$\Rightarrow \quad x^2 - 9x + 20 = 0. \quad \Rightarrow \quad (x-5)(x-4) = 0.$

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\frac{d^2U}{dx^2} > 0$. i.e. at x = 5.

9. 5

Sol. Draw FBD of rod and apply condition of equilibrium.

10. 7

Sol. Linear impulse of friction = F(dt)

$= \mu N(dt)$

= 80 N sec

Horizontal velocity of cart just after impact = $\frac{2}{5}$ m/s

Horizontal velocity of ball just after impact = 1 m/s

So, $x = 2\left[1 + \frac{2}{5}\right]$

11. 4

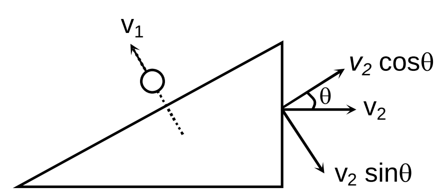
Sol. Since rate of heat flow remains same in both the cases, so

$$\int_R^{2R} \frac{dx}{k2\pi x l} = \int_{\frac{R}{4}}^{R} \frac{dx}{nk(2\pi x)\frac{l}{2}} \quad \Rightarrow \quad nk = 4k$$

$\Rightarrow$ n = 4.

12. 2

Sol. Equation of Newtons collision law



After collision

$$\frac{v_1 + v_2\sin\theta}{v_0}, \quad e = \frac{v_1 + \frac{v_2}{2}}{v_0}$$

$2v_1 + v_2 = 7$ … (i)

From momentum conservation

$mv\sin 30 = -mv_1\sin 30 + mv_2$

$5 = -\frac{v_1}{2} + 2v_2$ … (ii)

Solving v_1 = 2 m/s.

13. 5

Sol. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, $u = -60$ $f = -30$,

$\frac{1}{-60} + \frac{1}{v} = -\frac{1}{30}$, $\frac{1}{v} = -\frac{1}{30} + \frac{1}{60} = -\frac{1}{60}$

v = –60 cm and $\frac{1}{v^2}\frac{dv}{dt} + \frac{1}{u^2}\frac{du}{dt} = 0$, $\frac{du}{dt} = -\frac{v^2}{u^2}\left(\frac{du}{dt}\right)$

$\frac{dv}{dt} = -5 m/s$

$\therefore$ Speed = 5 m/s

SECTION – C

14. 0.33

Sol. For just slipping f = $\mu_3 N$

$\Rightarrow$ F cos θ = $\mu_s$mg – F sin θ)

$\Rightarrow \mu_s = \frac{F\cos\theta}{mg - F\sin\theta} = \frac{1}{3}$

15. 112.00

Sol. Just after t = 4 sec.

$a = \frac{F\cos\theta - \mu_k(mg - F\sin\theta)}{m}$

$a = \frac{2}{3} \Rightarrow \mu_k = \frac{1}{4}$

After t = 4 sec.

$a = \frac{F\cos\theta - \mu_k(mg - F\sin\theta)}{m}$

$\Rightarrow a = \frac{F(\cos\theta - \mu_k\sin\theta)}{m} - \mu_k g$

$\therefore v = \frac{19}{48}(t^2 - 16) - \frac{5}{2}(t - 4)$

At t = 20 sec, v = 112 m/s

16. 9.00

Sol. Work function of the metal (ϕ) = $\frac{hc}{\lambda_{green}} = \frac{12408}{4963} = 2.5$ eV

No. of photon emitted from the power source per unit time = $\frac{40}{2.5 \times 1.6 \times 10^{-19}} = 10^{20}$ photons

No. of photons incident on the metallic surface per unit time =

$\frac{10^{20} \times \pi \times (1 \times 10^{-2})^2}{4\pi(1)^2} = 2.5 \times 10^{15}$ photons

No. of photoelectrons coming out from the metal surface per unit time

$= \frac{2.5 \times 10^{15}}{10^6} = 2.5 \times 10^9$ photoelectrons

17. 0.50

Sol. The emission of photoelectron will stop when $\frac{hc}{\lambda_{violet}} = \varphi + eV$, where V is the potential of sphere.

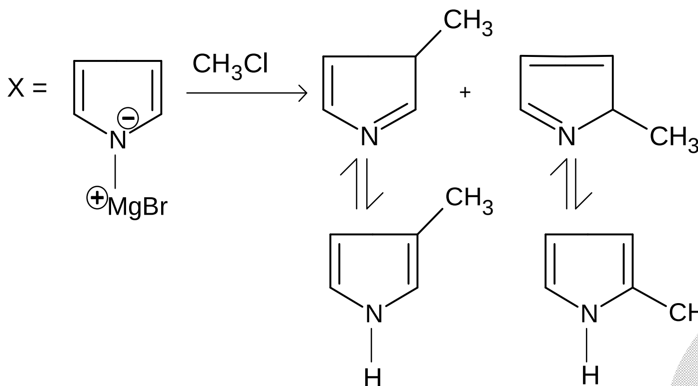
$\frac{12408}{4136} = 2.5 + eV$

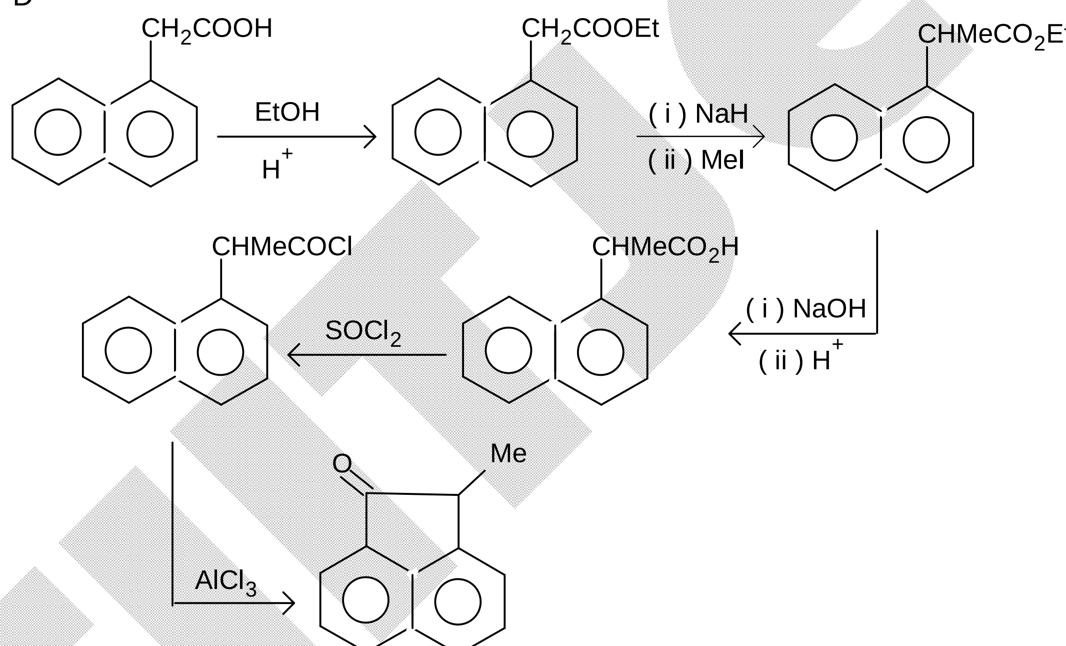
$V = 0.5\,V$.

Chemistry

PART – II

SECTION – A

18. D
Sol.


19. D
Sol.


20. C
Sol. $\dfrac{r_{final}}{r_{initial}} = \dfrac{(p'_X)^1 \times (p'_Y)^2}{(p_X)^1 \times (p_Y)^2} = \dfrac{0.1 \times (0.4)^2}{0.4 \times (1^2)} = \dfrac{1}{25}$.

21. A
Sol. In the undistorted unit cell, $X^+ = 4$ ions
$Y^- = 4$ ions
Ions present on the horizontal plane
4-face centre = $2Y^-$
4-edge centre = $1X^+$
1-body centre = $1X^+$
$\therefore$ Ions left in the distorted unit cell is:

$X^+ = 4 – 2 = 2$
$Y^- = 4 – 2 = 2$
$\therefore$ The required formula of the solid is X_2Y_2 or XY.

22. BD

Sol. $Mg(NO_3)_2 + NaCl \longrightarrow Mg^{2+} + NO_3^- + Na^+ + Cl^-$ (no reaction)

$BeSO_4 + BaS \longrightarrow BeS + BaSO_4 \downarrow$

$BaSO_4 + HCl \longrightarrow BaSO_4 \downarrow + H^+ + Cl^-$ (no reaction)

$BaCO_3 + CH_3COOH \longrightarrow Ba^{2+} + CH_3COO^- + CO_2 \uparrow + H_2O$

23. ACD

Sol. P is PhCH = N – OH(syn)

Q is HCONHPh, R is $Ph\overset{+}{N}H_3$

24. AB

Sol. The d-orbital configuration is $t_{2g}^6 e_g^4$

$\therefore$ CFSE = 0

SECTION – B

25. 6

Sol. $2PCl_2F_3 \longrightarrow [PCl_4]^+[PF_6]^-$

26. 4

Sol. A is $PbCl_2$, B is $PbCrO_4$, x = 2, y = 6

27. 6

Sol. $E_{Cell} = E^o_{Cell} - \frac{0.06}{n}\log\frac{[Zn^{2+}]}{[H^+]^2}$

or, $0.46 = [0 – (-0.76)] - \frac{0.06}{2}\log\frac{10^{-2}}{[H^+]^2}$

or, $0.46 = (0.76) - \frac{0.06}{2}\log\frac{10^{-2}}{[H^+]^2}$

or, $-0.3 = -0.03[\log 10^{-2} – \log[H^+]^2]$

or, $\frac{-0.3}{-0.03} = [-2 - \log[H^+]^2]$

or, $10 = -2 – \log[H^+]^2$

or, $\log 10^{12} = - \log[H^+]^2$

or, $-[H^+]^2 = 10^{12}$ or $[H^+]^2 = 10^{-12}$

or, $[H^+] = 10^{-6}$ or pH = 6

28. 408

Sol. $\Delta E = E_2 - E_1 = \left[\frac{-z^2}{n_2^2}(13.6)\right] - \left[\frac{-z^2}{n_1^2}\times 13.6\right]$

$= \left[-\frac{4}{4}(13.6) + \frac{4}{1} \times 13.6\right]$

= -13.6 + 54.4 = 40.8 eV

$\therefore$ 10x = 10 $\times$ 40. 8 = 408

29. 800

Sol. $\frac{-\Delta H^o}{2.303RT} = \frac{-100}{2.303T}$

$\therefore -\Delta H^o = \frac{-100}{2.303T} \times 2.303RT = -100R = -800$

$\therefore$ ΔH^o = 800 J

30. 2

Sol. W = -PΔV = -P($V_2 - V_1$)

$= -P\left(\frac{nRT_2}{P} - \frac{nRT_1}{P}\right)$

= -nR($T_2 - T_1$)

= -1 $\times$ 8(400 - 150)

= -2000 J = -2 KJ mol^{-1}

= -x $\therefore$ x = 2

SECTION – C

31. 14.80

Sol. P is $CH_3CH(Cl)COOH$, Q is $CH_3CH(CN)COOH$, R is $CH_3CH(COOH)COOH$, S is CH_3CH_2COOH, T is C_2H_6

$x = 74, \frac{x}{5} = 14.8$

32. 1.60

Sol. T is C_2H_6,

$\therefore$ x : y = 1 : 3

x + y = 4, $\frac{x+y}{2.5}$ = 1.6

33. 3.40

Sol. $MCl_3(s) \rightleftharpoons M^{3+}(aq) + 3Cl^-(aq)$

t = 0	1	0	0
t = t	1 - α	α	3α

$\therefore i = \frac{1-\alpha+\alpha+3\alpha}{1}$ = 1 + 3α = 1 + 3 $\times$ 0.8 = 3.4

34. 6.80

Sol. $\Delta T_f = K_f im$ = 1.86 $\times$ 3.4 $\times$ 1 $\times \frac{1000}{(1000-70)} = 6.8$

$\therefore$6.8 = T_f^o - T_f

or, 6.8 = 0 - T_f

or, T_f = - 6.8^{o}C = -x^{o}C

$\therefore$ x = 6.8

Mathematics PART – III

SECTION – A

35. A

Sol. $\frac{f(x)}{1+x^2} = 1 + \int_0^x \frac{f^2(t)}{1+t^2}dt \quad (f(0)=1)$ Differentiate

$\Rightarrow \frac{(1+x^2)f'(x) - 2xf(x)}{(1+x^2)^2} = \frac{f^2(x)}{1+x^2}$

$\Rightarrow \frac{dy}{dx} - \frac{2x}{1-x^2}.y = y^2$ L.D.E

$\Rightarrow \frac{1}{y^2}\frac{dy}{dx} - \frac{2x}{(1-x^2)}\frac{1}{y} = 1$

Put $\frac{-1}{y} = T$

$\Rightarrow f(x) = \frac{-3(1+x^2)}{x^3+3x-3}$

Answer is $\frac{15}{17}$

36. A

Sol. Equation of AD is

$y - 2at_1 = -\frac{t_2+t_3}{2}(x - at_1^2)$

It passes though the focus.

$\therefore\ t_1^3 - S_1t_1^2 - 5t_1 + S_1 = 0,$ where

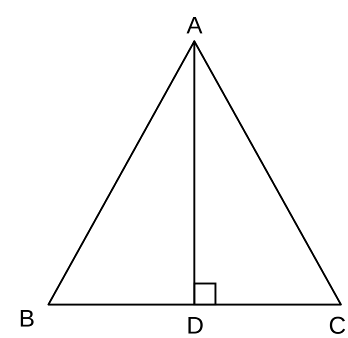
$S_1 = t_1 + t_2 + t_3$

Hence, the roots of $t^3 - S_1t^2 - 5t + S_1 = 0$

are t_1, t_2, t_3.

$\therefore\ t^3 - S_1t^2 - 5t + S_1 = (t-t_1)(t-t_2)(t-t_3)$

Put t = 1.



37. B

Sol. $3\tan 3x = \frac{3(3\tan x - \tan^3 x)}{1 - 3\tan^2 x} = \frac{3\tan^3 x - 9\tan x}{3\tan^2 x - 1}$

$= \frac{8\tan x}{3\tan^2 x - 1}$.

Hence

$\frac{1}{\cot x - 3\tan x} = \frac{\tan x}{1-3\tan^2 x} = \frac{1}{8}(3\tan 3x - \tan x)$ for all $x \neq k\frac{\pi}{2}, k \in \mathbb{Z}$.

It follows that the left – hand side telescopes as

$$\frac{1}{8}\left(3\tan 27^o - \tan 9^o + 9\tan 81^o - 3\tan 27^o + 27\tan 243^o - 9\tan 81^o + 81\tan 729^o - 27\tan 243^o\right)$$

$$= \frac{1}{8}\left(81\tan 9^o - \tan 9^o\right) = 10\tan 9^o.$$

38. C

Sol. From $AM \geq GM$

$$\sqrt{2}a^3 + \frac{3}{(a-b)b} \geq \sqrt{2}a^3 + \frac{3}{\left(\frac{a-b+b}{2}\right)^2}$$

$$= 2.\left(\frac{\sqrt{2}a^3}{2}\right) + 3\left(\frac{4}{a^2}\right) \geq 5\left(\left(\frac{\sqrt{2}}{2}a^3\right)^2 . \left(\frac{4}{a^2}\right)^3\right)^{\frac{1}{5}}$$

$= 5.\sqrt[5]{32} = 10,$ equality hold's when $a = 2b = \sqrt{2}$

39. BD

Sol. As y = 7x – 11 intersects the hyperbola at only one point

$\Rightarrow$ It is parallel to one of the asymptotes

$\Rightarrow$ Equation of one asymptote can be taken as 7x – y + k = 0 clearly mirror image of (2, 0) about transverse axis x – 3y + 2 = 0 lies on other asymptote

$\Rightarrow \left(\frac{6}{5}, \frac{12}{5}\right)$ lies on 7x – y + k = 0

$\Rightarrow$ k = –6

$\Rightarrow$ other asymptote is 7x – y – 6 = 0

$\Rightarrow$ centre is (1, 1)

$\Rightarrow$ Asymptote through (2, 0) is x + y = 2

$\therefore$ Equation of hyperbola is (7x – y – 6)(x + y – 2) – (7 × 2 – 3 – 6)(2 + 3 – 2) = 0

$\Rightarrow 7x^2 + 6xy - y^2 - 20x - 4y - 3 = 0$

40. ACD

Sol. $g'(0) = \lim\limits_{h \to \infty} \frac{g(0+h) - g(0)}{h} = 0$

$\Rightarrow g(x)$ is differentiable $\forall x \in R$

$$g'(x) = \begin{cases} 2x\sin\left(\frac{\pi}{x}\right) - \pi\sin\left(\frac{\pi}{x}\right) + 2(x-1)\sin\left(\frac{\pi}{x-1}\right) - \pi\sin\left(\frac{\pi}{x-1}\right); & x \neq 1 \\ 0\ ; & x = 0,1 \end{cases}$$

But $\lim\limits_{x\to 0} g'(x) =$ does not exist $\neq g'(0) \Rightarrow g'(x)$ is discontinuous at x = 0

Similarly $\lim\limits_{x\to 1} g'(x) =$ does not exist.

41. BC

Sol. We supposed to find m and n such that $\lim_{x\to\infty} 3\sqrt[3]{8x^3+mx^2}-nx=1$ or

$\lim_{x\to-\infty} \sqrt[3]{8x^3+mx}-nx=1$.

We compute

$$\sqrt[3]{8x^3+mx^2}-nx=\frac{\left(8-n^3\right)x^3+mx^2}{\sqrt[3]{\left(8x^3+mx^2\right)^2}+nx\sqrt[3]{8x^3+mx^2}+n^2x^2}.$$

$8-n^3$ must be equal to 0

$n=2$

Now $f(x)=\dfrac{m}{\sqrt[3]{\left(8+\dfrac{m}{x}\right)^2}+2\sqrt[3]{8+\dfrac{m}{x}}+4}$.

We see that $\lim_{x\to\infty} f(x)=\dfrac{m}{12}$. For this to be equal to 1, m must be equal to 12. Hence the answer to the problem is (m, n) = (12, 2).

SECTION – B

42. 3

Sol. If $\alpha_1,\alpha_2.........\alpha_n$ are roots

then

$$\sum_{i=1}^{n}\alpha_i^2=a_1^2-2a_2=1-2a_2$$

Also $\dfrac{\sum\alpha_i^2}{n}\ge\left(\alpha_i^2\right)^{1/n}=\left(a_n^2\right)=1$

$1-2a_2\ge n$

43. 28

Sol. If a_1 is mapped to 2, we have ${}^7C_5$ ways of mapping rest of the elements.
If a_1 is mapped to 3, we have ${}^6C_5$ ways of mapping rest of the elements.
If a_1 is mapped to 4, we have ${}^5C_5$ ways of mapping rest of the elements.
Hence total number of increasing functions = ${}^7C_5$ + ${}^6C_5$ + ${}^5C_5$ = 28.

44. 5

Sol. Let $\vec{d}.\vec{a}=\cos y\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]=-\vec{d}.\left(\vec{b}+\vec{c}\right)$ [as $\vec{d}.\left(\vec{a}+\vec{b}+\vec{c}\right)=0$]

$$\Rightarrow \quad \cos y=-\frac{\vec{d}.\left(\vec{b}+\vec{c}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]} \quad ....(1)$$

similarly $\sin x=-\dfrac{\vec{d}.\left(\vec{b}+\vec{a}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]}$ ....(2)

$$\Rightarrow 2 = -\frac{\vec{d}.\left(\vec{a}+\vec{c}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]} \qquad \text{..........(3)}$$

Adding these we get $\sin x + \cos y + 2 = 0$

$\Rightarrow \sin x + \cos y = -2$

$\Rightarrow \sin x = -1, \cos y = -1$

$$\Rightarrow x = (4n-1)\frac{\pi}{2},\ y = (2n+1)\pi$$

Since we want minimum value of $x^2 + y^2$, so $x = -\frac{\pi}{2}$, $y = \pi$

$$\Rightarrow x^2 + y^2 = \frac{5\pi^2}{4} \Rightarrow \lambda = 5$$

45. 16

Sol. $y = \frac{3x^2 + mx + n}{x^2 + 1}$

$\Rightarrow x^2(y-3) - mx + y - n = 0$

As $x \in R$,

$D \ge 0$

$\Rightarrow m^2 - 4(y-3)(y-n) \ge 0$

$\Rightarrow m^2 - 4\left(y^2 - ny - 3y + 3x\right) \ge 0$ ....(1)

Also given $(y+4)(y-3) \le 0$

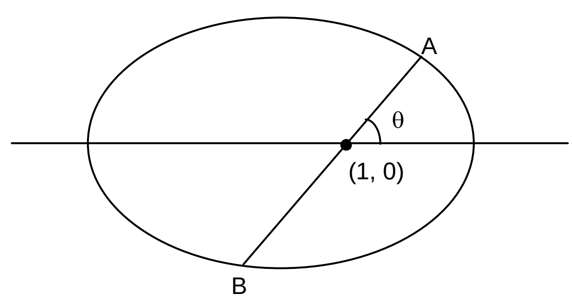
$\Rightarrow y^2 + y - 12 \le 0$ ......(2)

$\therefore$ compare (1) and (2) we get $\frac{4}{1} = \frac{4(n+3)}{1} = \frac{12n - m^2}{-12}$

$\Rightarrow m = 0$ and $n = -4$

46. 7

Sol. Let $AB = l_1$



Equation of $AB = \frac{x-1}{\cos\theta} = \frac{y-0}{\sin\theta} = r$

$$\Rightarrow \frac{(1+r\cos\theta)^2}{4} + \frac{(r\sin\theta)^2}{3} = 1$$

$$\Rightarrow r^2\left(3+\sin^2\theta\right) + 6r\cos\theta - 9 = 0$$

$$\Rightarrow r_1 - r_2 = -\frac{6\cos\theta}{3+\sin^2\theta}, r_1 r_2 = \frac{9}{3+\sin^2\theta}$$

$$l_1 = |r_1| + |r_2| = \sqrt{(r_1 - r_2)^2 + 4r_1 r_2} = \frac{12}{3+\sin^2\theta}$$

$$I_2 = \frac{12}{3+\sin^2\left(\frac{\pi}{2}+\theta\right)} = \frac{12}{3+\cos^2\theta}$$

$$\Rightarrow \frac{1}{I_1}+\frac{1}{I_2}=\frac{7}{12}$$

47. 2

Sol. $\log x + \log y \ge \log\left(x^2+y\right)$

$$\Rightarrow y \ge \frac{x^2}{x-1}$$

then $x+y \ge x+\frac{x^2}{x-1} = x+\frac{\left(x^2-1\right)+1}{x-1}$

$$= x+\left(x+1\right)+\frac{1}{x-1} = 2x+1+\frac{1}{x-1}$$

$$= 2\left(x-1\right)+\frac{1}{x-1}+3 \ge 2\sqrt{2}+3, \text{ (when } x=1+\frac{1}{\sqrt{2}}\text{)}$$

SECTION – C

48. 2.00

49. 2.00

Sol. (for Q. 48 to 49)

Case I

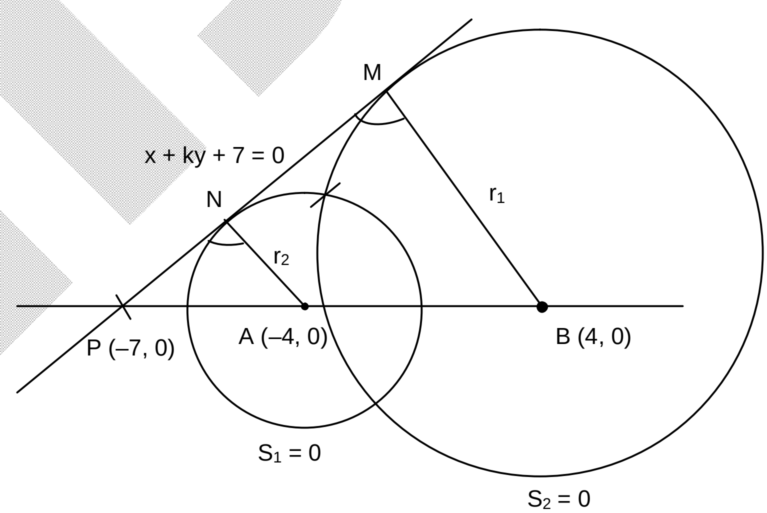
For exactly one parabola

$c_1c_2 = r_1 + r_2$

Case II

For exactly two parabolas

$\left|r_1 - r_2\right| < c_1c_2 < r_1 + r_2$



50. 1.00

51. 2025.00

Sol. **(for Q. 50 to 51)**

Rearrange the definitions we have $\frac{a_n}{a_{n-1}} = \frac{a_{n-1}}{a_{n-2}} + 1, \frac{b_n}{b_{n-1}} = \frac{b_{n-1}}{b_{n-2}} + 1$ from that

$\frac{a_n}{a_{n-1}} = 1 + \frac{a_{n-1}}{a_{n-2}} = ... = n - 1 + \frac{a_1}{a_0} = (n+2)$ and $\frac{b_n}{b_{n-1}} = 1 + \frac{b_{n-1}}{b_{n-2}} = ... = n - 1 + \frac{b_1}{b_0} = n$ these recursions $a_n = (n+2)a_{n-1}$ and $b_n = nb_{n-1}$

$$\frac{a_n}{b_n} = \frac{(n+1)(n+2)}{2}$$

$\Rightarrow a_n = \frac{\underline{|n+2}}{2}, b_n = \underline{|n}$ then

$$\sum_{n=1}^{\infty} \frac{b_n}{a_n} =$$