FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2025
PART TEST – II
PAPER –2
TEST DATE: 08-12-2024

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. B

Sol. At resonance, $R = \frac{V_0}{i_0} = \frac{200}{5} = 40\,\Omega$

Now $X_L = 40\Omega$ and $X_C = 80\,\Omega$

$\Rightarrow z = \sqrt{(40)^2 + (40-80)^2} = 40\sqrt{2}\,\Omega$

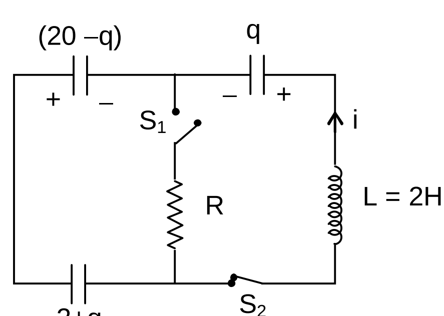
$i_0 = \frac{200}{40\sqrt{2}} = \left(\frac{5}{\sqrt{2}}\right)A$

$\therefore$ circuit is capacitive so current will lead voltage by $\tan^{-1}\left|\frac{X_L - X_C}{R}\right| = \tan^{-1}\left(\frac{\pi}{4}\right)$

$\Rightarrow i = \left(\frac{5}{\sqrt{2}}A\right)\sin\left(50t + \frac{7\pi}{12}\right)$

2. D

Sol. Let charge on C_2 is q when current in circuit is maximum.



$\frac{20-q}{6} - \frac{2+q}{2} - \frac{q}{2} = 0$

20 – q – 6 – 3q – 3q = 0

7q = 14

q = 2 μC

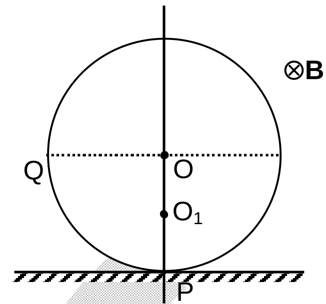
Using conservation of energy

$$\frac{(20\times10^{-6})^2}{2\times6\times10^{-6}} + \frac{(2\times10^{-6})^2}{2\times2\times10^{-6}} = \frac{(18\times10^{-6})^2}{2\times6\times10^{-6}} + \frac{(4\times10^{-6})^2}{2\times2\times10^{-6}} + \frac{(2\times10^{-6})^2}{2\times2\times10^{-6}} + \frac{1}{2}\times2i_0^2$$

$\Rightarrow \quad i_0 = \sqrt{\frac{7}{3}}$ mA

3. A

Sol. Instantaneous centre of rotation is O_1



and $OO_1 = \frac{R}{2}$

$$O_1Q = \sqrt{R^2 + \left(\frac{R}{2}\right)^2} = \frac{R\sqrt{5}}{2}$$

$$V_Q - V_{O_1} = \frac{1}{2} \times B \times \frac{2v_0}{R}\left(\frac{5R^2}{4}\right)$$

$$V_P - V_{O_1} = \frac{1}{2} \times B \times \frac{2v_0}{R}\left(\frac{R^2}{4}\right)$$

$$V_Q - V_P = \frac{1}{2} \times B \times \frac{2v_0}{R} R^2 = Bv_0R$$

$\Rightarrow 1 \times 1 \times 1 = 1$ volt

Hence, (a + b) = 1 + 1 = 2

4. B

Sol. $$C = C_V + \frac{R}{1-k}$$

$$= \frac{3}{2}R + \frac{R}{1-\frac{3}{2}} = \frac{3}{2}R - 2R = -\frac{R}{2}$$

$$Q = nC\Delta T = 2 \times \left(-\frac{R}{2}\right) \times 20 = -20R$$

Hence 20R heat will be released by the gas.

5. A, B, D

Sol. Torque of couple is same about any point

All points on the rod are accelerating except the centre of mass of the system (C).

$$\Rightarrow \alpha = \frac{\tau_C}{I_C}$$

$\because \quad \tau_C = I_C\alpha$

$$qE\ell \sin\theta = -I_C\alpha \Rightarrow \alpha = \frac{-qE\ell}{I_C}\theta \text{ (for small } \theta)$$

$$\Rightarrow T = 2\pi\sqrt{\frac{I_C}{qE\ell}}$$

6. B, C

Sol. **Case I:**

B and ω are oppositely directed then magnetic force on electrons will be directed radially outward and there fore electric field will be directed radially outwards also.

$(eE - evB) = mr\omega^2$

or $eE - er\omega B = mr\omega^2$

$$\Rightarrow E = \left(\frac{mr\omega^2 + e\omega Br}{e}\right) = \left(\frac{m\omega^2 + e\omega B}{e}\right)r$$

$\because \quad E \propto r$

Volume charge density should be uniform

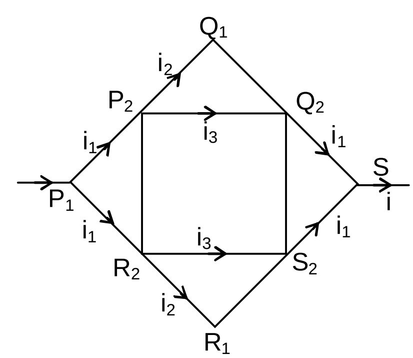
Case II:
B and ω are directed in same direction, magnetic force on electrons will be in radially inwards.
For $\omega = \frac{eB}{m}$, charge density is zero
For $\omega < \frac{eB}{m}$, charge density is negative
For $\omega > \frac{eB}{m}$, charge density is positive

7. C, D
Sol. $\vec{B} \cdot \overrightarrow{d\ell} = \frac{\mu_0 i}{2\pi}\Delta\theta$, where $\Delta\theta$ is angle subtended at wire by ends of path

SECTION – B

8. 17
Sol. Let Q is total change on sphere without cavity
$Q = \frac{4}{3}\pi R^3\rho$ …(i)
Potential at C_1 (after cavity is made)
$V_{C_1} = \frac{3kQ}{2R} - \frac{kQ/8}{R/2}$
$= \frac{3kQ}{2R} - \frac{kQ}{4R} = \frac{5kQ}{4R}$
Work done in putting charge q at C_1
$W = q\left[V_{C_1} - 0\right] = \frac{5kQq}{4R}$
$\frac{5}{4}\left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{\frac{4}{3}\pi R^3\rho q}{R}\right) = \frac{5}{12}\frac{(R^2\rho q)}{\varepsilon_0}$
$\Rightarrow$ (a + b) = 5 + 12 = 17

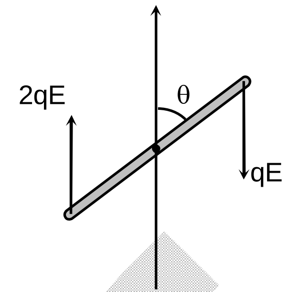
9. 0
Sol. Junction at points Q_1 and R_1 can be removed due to input-output symmetry
$\Rightarrow V_{Q_1} = V_{R_1}$



10. 20
Sol. Let mass of ice = m
$\Rightarrow$ mass of water = (100 − m)
$\Rightarrow m \times 80 + 150 \times 1 \times 30 = 10 \times 540 + 10 \times 1 \times 70$
80m + 4500 = 5400 + 700
80m = 1600
m = 20 gm

11. 3

Sol. When rod makes angle θ with E, torque acting on it about the centre of mass is



$$\tau = 2qE\frac{L}{2}\sin\theta + qE\cdot\left(\frac{L}{2}\sin\theta\right)$$

$$I\omega\frac{d\omega}{d\theta} = \frac{3}{2}qEL\sin\theta$$

$$\frac{mL^2}{2}\int_0^{\omega}\omega d\omega = \frac{3qEL}{2}\int_{\pi/3}^{\theta}(\sin\theta)d\theta$$

$$\Rightarrow \frac{mL^2}{2}\left(\frac{\omega^2}{2}\right) = \frac{3qEL}{2}\left(\frac{1}{2}-\cos\theta\right)$$

$$\omega^2 = \frac{6qE}{mL}\left(\frac{1}{2}-\cos\theta\right)$$

$$\Rightarrow \omega_{max} = \sqrt{\frac{9qE}{mL}} = 3\sqrt{\frac{qE}{mL}} = 3\text{ rad/s}$$

12. 2

Sol. Particle will come out of field in time $\left(\frac{\pi m}{qB}\right)$

Acceleration along y-axis $a_y = \frac{-qE}{m}$

Velocity along y-axis when it comes out

$$v_y = 4 - \frac{qE}{m}\times\frac{\pi m}{qB} = 4 - \frac{\pi E}{B} = -4 \text{ m/s}$$

$$\Rightarrow \vec{v} = -2\hat{i} - 4\hat{j} \text{ or } v = 2\sqrt{5}\text{ m/s}$$

13. 2

Sol. Current in each part of ring will be same

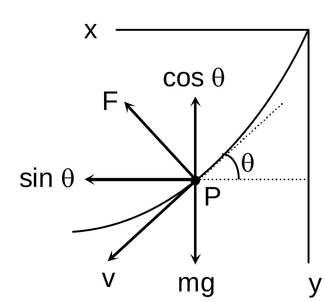
$$\Rightarrow \sigma_1 E_1 = \sigma_2 E_2$$

$$\Rightarrow \frac{E_2}{E_1} = \frac{\sigma_1}{\sigma_2} = 2$$

SECTION – C

14. 20.00

Sol. At point P



Let speed of particle is v

$\Rightarrow$ magnetic force, F = qvB

$$m\cdot a_y = mg - F\cos\theta \quad \text{...(i)}$$

$$m\cdot a_x = F\sin\theta \quad \text{...(ii)}$$

From (ii) $m\frac{dv_x}{dt} = qvB\sin\theta$

$= qB(v\sin\theta) = qBv_y$

or $m\frac{dv_x}{dt} = qB\cdot\frac{dy}{dt}$

$\Rightarrow m\int_0^{v_x} dv_x = qB\int_0^{y} dy$

$mv_x = qB \cdot y$

At lowest point $mv_x = qBh$ …(iii)

Also, $v_x = \sqrt{2gh}$ …(iv)

Equating (iii) and (iv)

$\frac{qBh}{m} = \sqrt{2gh}$

$\frac{q^2B^2h^2}{m^2} = 2gh$

$h = \frac{2m^2g}{q^2B^2} = \frac{2\times(10^{-4})^2\times10}{(100\times10^{-6})^2\times(1)^2} = 20 \text{ m}$

Magnetic force does no work

15. 14.14

Sol. Speed of ball at vertical displacement 10 m is

$v = \sqrt{2g\times10} = \sqrt{2\times10\times10} = 10\sqrt{2}$ m/s

16. 127.00

Sol. $\frac{V^2}{R_0} = \sigma 2\pi R^2T^4 - \sigma 2\pi R^2 T_0^4$ (R_0 = resistance of the resistor)

$5.6\times10^{-8}\times2\pi\times\frac{1}{5.6\pi}\times(300)^4 + \frac{(5\sqrt{70})^2}{5} = 5.6\times10^{-8}\times2\pi\times\frac{1}{5.6\pi}T^4$

$512 = 2\times10^{-8}T^4$

$T^4 = 256\times10^8$

$\Rightarrow$ T = 400 K= 127°C

17. 146.60

Sol. At steady state

$\Rightarrow \frac{KA(\Delta T)}{L} = 350$

$\Delta T = \frac{350L}{KA} = \frac{350L}{K\pi R^2}$

$= \frac{350\times1}{100\pi\left(\frac{1}{5.6\pi}\right)} = \frac{350\times5.6}{100} = 19.60$ °C

Temperature of the liquid is = 127 + 19.60 = 146.60°C

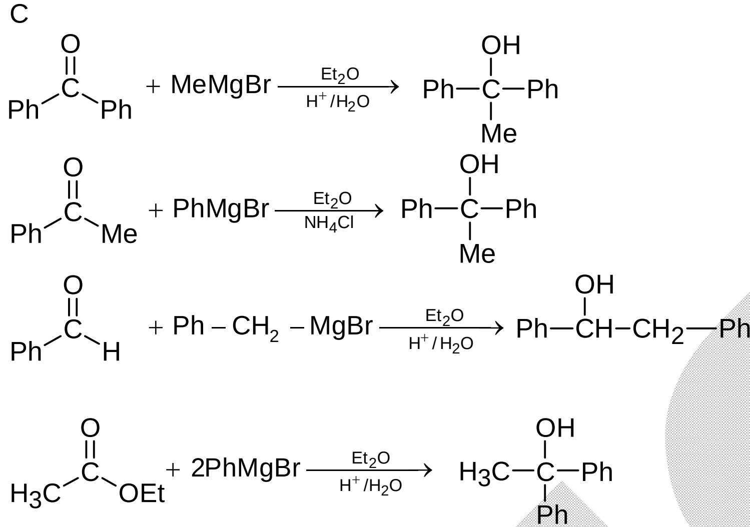
Chemistry

PART – II

SECTION – A

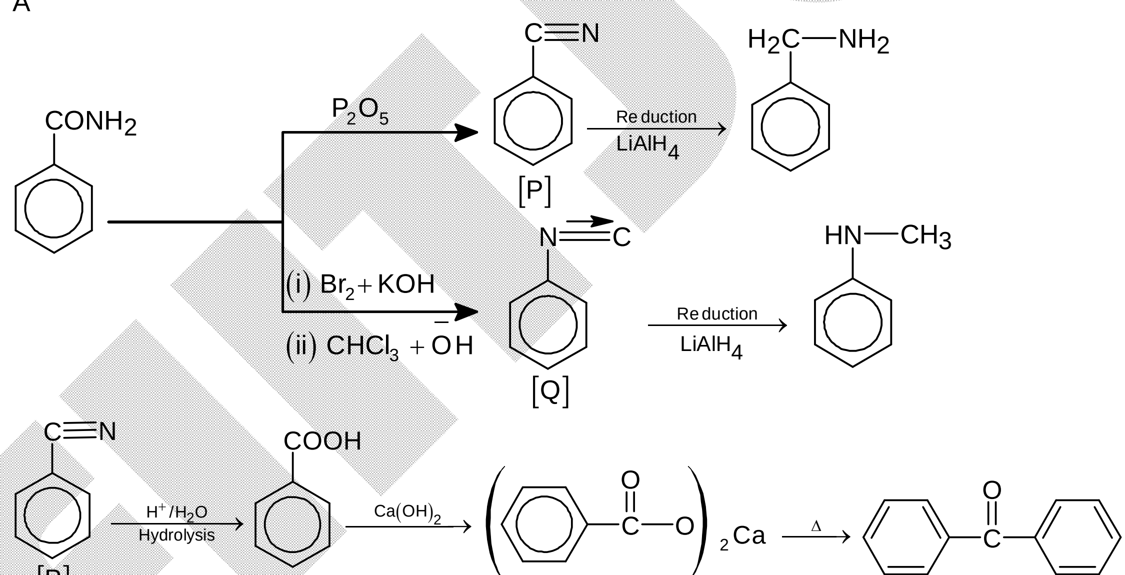
18. C

Sol.

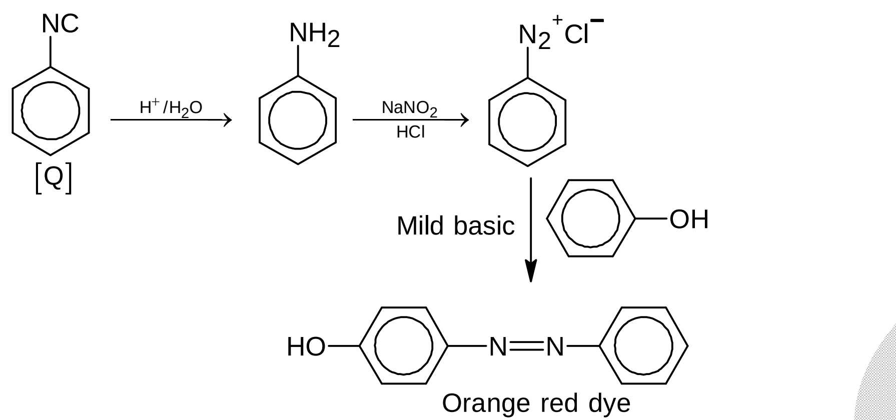


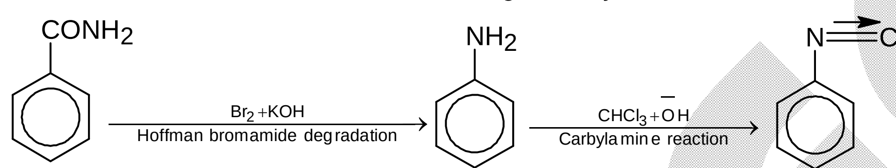
19. A

Sol.



Benzophenone

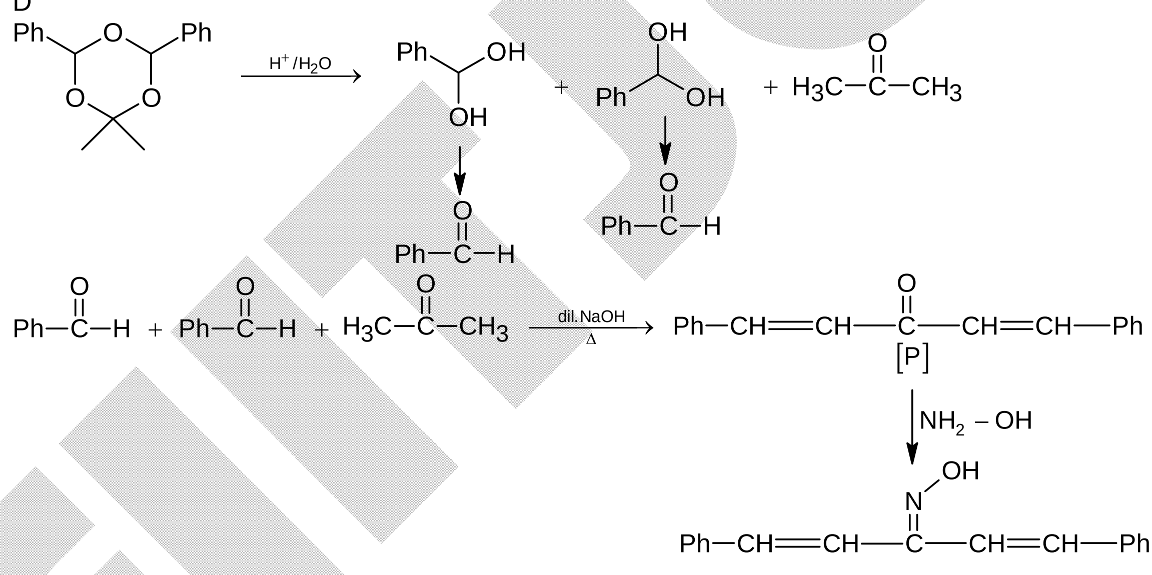




$CHCl_3 + \bar{O}H \longrightarrow :CCl_2$ (dichlorocarbene)

20. D

Sol.



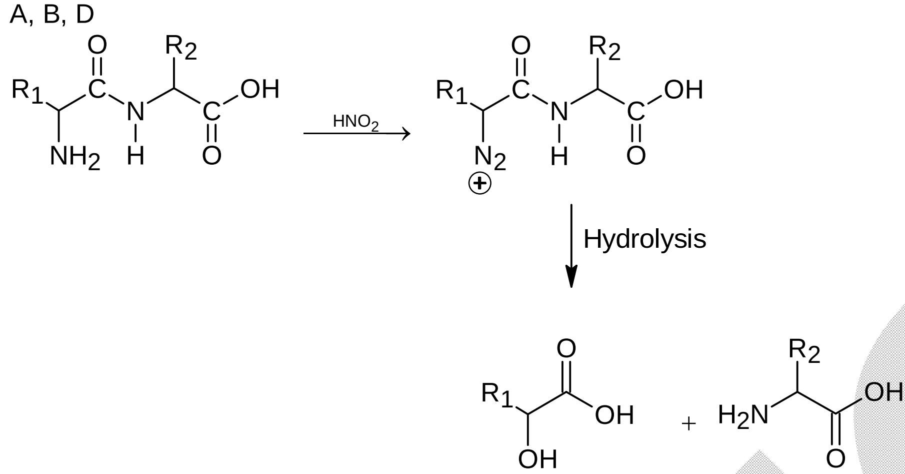
(Number of stereoisomers = 4)

21. B

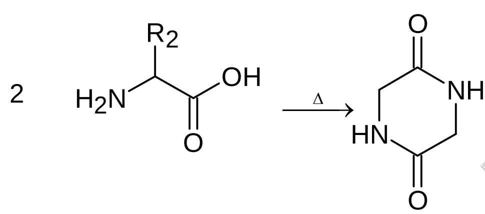
Sol. x is formed via S_Ni and y is formed via S_N2.

22. A, B, D

Sol.



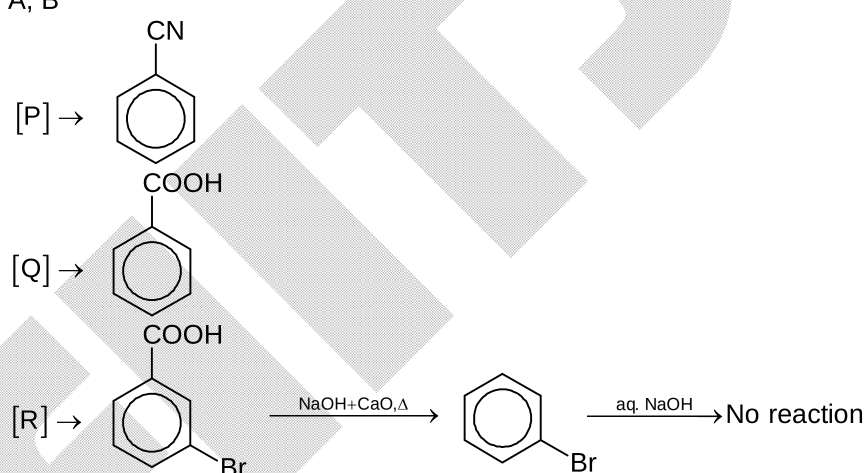
Lactic acid ($R_1 = CH_3$) [y]



2,5-diketopiperazine(R_2 = H)

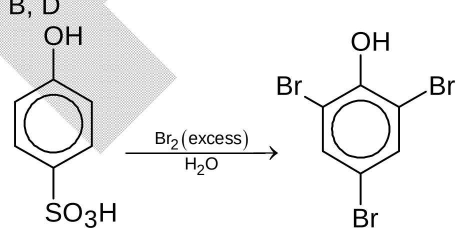
23. A, B

Sol.

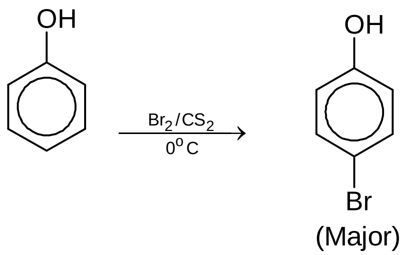


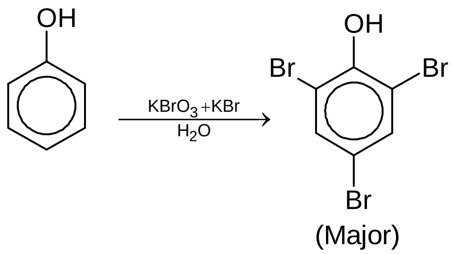
24. B, D

Sol.

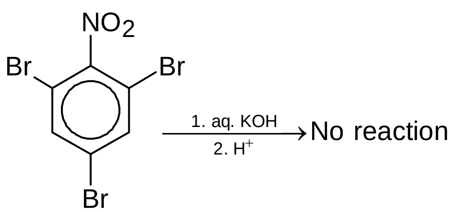


(Major)





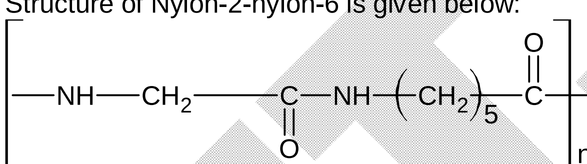
$\left(KBrO_3 + KBr + H_2O \longrightarrow Br_2\right)$



SECTION – B

25. 4

Sol. Structure of Nylon-2-nylon-6 is given below:



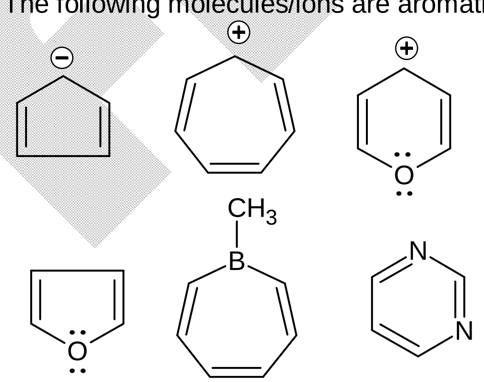
26. 10

Sol. $6HCHO + 4NH_3 \longrightarrow \underset{\text{Urotropine}}{(CH_2)_6 N_4} + 6H_2O$

Number of carbon atom = x = 6
Number of nitrogen atom = y = 4

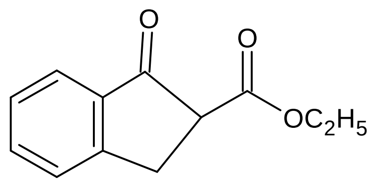
27. 6

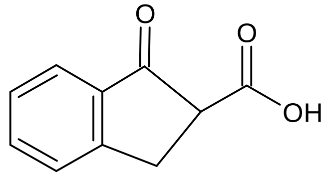
Sol. The following molecules/ions are aromatic



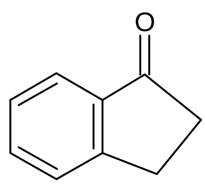
28. 4

Sol.

A = 

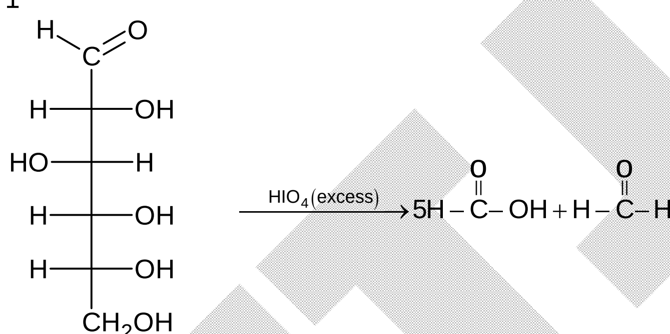
B = 

β – keto acid

C = 

29. 1

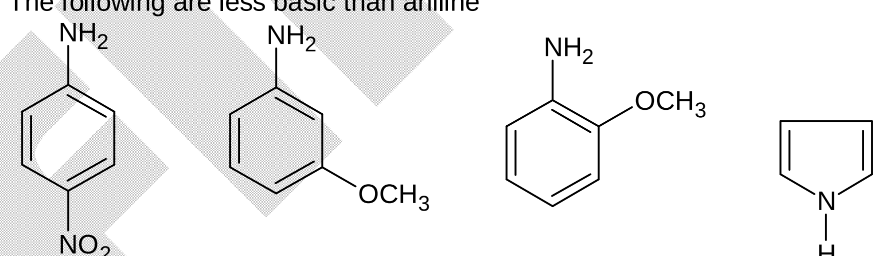
Sol.



D – Glucose

30. 4

Sol. The following are less basic than aniline



SECTION – C

31. 52.00

32. 26.40

Sol. 0.2 mole of PhCHO gives 0.2 mole of Ph – CH = CHCHO (B)

$\therefore W_{PhCHCHCHO} = 132 \times 0.2 = 26.40$ gm

$$PhCHO \xrightarrow[CH_3COONa]{(CH_3CO)_2O} \underset{(A)}{PhCH=CHCOOH} \xrightarrow[\text{(ii) Rosenmund reduction}]{\text{(i) } PCl_5} \underset{(B)}{PhCH=CH-CHO}$$

$$\underset{(A)}{PhCH=CHCOOH} \xrightarrow{NaOH / CaO,\ \Delta} \underset{(C)}{PhCH=CH_2}$$

33. 8.40

Sol. Meq. of residual $H_2SO_4 = \left(20 \times \frac{1}{20}\right) \times \frac{150}{50} = 3$

Meq.of H_2SO_4 taken $= 60 \times 0.1 = 6$

$\therefore$ Meq. of H_2SO_4 consumed $=$ Meq. of $NH_3 = 6 - 3 = 3$

Percentage of nitrogen $= \frac{1.4 \times 3}{0.5} \times 100 = 8.40$

34. 1.68
(Range 1.65 – 1.70)

Sol. Moles of $N_2 = \frac{1}{2}$ moles of $NH_3 = \frac{3}{1000} \times \frac{1}{2}$

$= 1.5 \times 10^{-3}$

$\therefore$ vol of N_2 at STP $= 22.4 \times 1.5 \times 10^{-3} = 0.0336$ lit.

$\therefore 0.0336 \times 50 = 1.68$

Mathematics

PART – III

SECTION – A

35. A

Sol. $\cos(\theta - \phi) = \sin\beta \sin\gamma$

$\Rightarrow \dfrac{\sin\beta \cdot \sin\gamma}{\sin^2\alpha} + \sin\theta \cdot \sin\phi = \sin\beta \cdot \sin\gamma$

$\Rightarrow \sin\theta \cdot \sin\phi = \sin\beta \cdot \sin\gamma\left(\dfrac{\sin^2\alpha - 1}{\sin^2\alpha}\right)$

Squaring both side

$\sin^2\alpha - \sin^2\beta - \sin^2\gamma = \sin^2\alpha \cdot \sin^2\beta \cdot \sin^2\gamma - 2\sin^2\beta \cdot \sin^2\gamma$

$\Rightarrow \text{cosec}^2\beta \cdot \text{cosec}^2\gamma - \text{cosec}^2\alpha \cdot \text{cosec}^2\gamma - \text{cosec}^2\alpha \cdot \text{cosec}^2\beta = 1 - 2\,\text{cosec}^2\alpha$

$\Rightarrow (1 + \cot^2\beta)(1 + \cot^2\gamma) = 1 - 2(1 + \cot^2\alpha)$

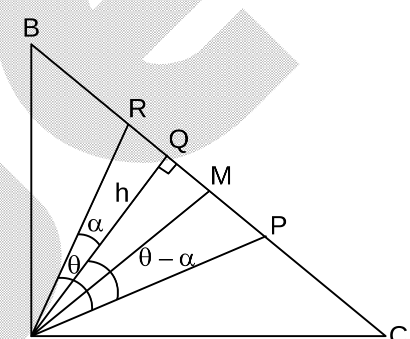
$\Rightarrow \tan^2\alpha - \tan^2\beta - \tan^2\gamma = 0$

36. D

Sol. $MQ = \sqrt{\dfrac{a^2}{4} - h^2}$; $PM = MR = \dfrac{a}{2(2m-1)}$

$\tan\theta = \tan(\alpha + (\theta - \alpha)) = \dfrac{\tan\alpha + \tan(\theta - \alpha)}{1 - \tan\alpha \cdot \tan(\theta - \alpha)}$

$\tan\theta = \dfrac{(2m-1)h}{am(m-1)}$



37. B

Sol. Let $A = \left(ct_1, \dfrac{c}{t_1}\right), B = \left(ct_2, \dfrac{c}{t_2}\right)$

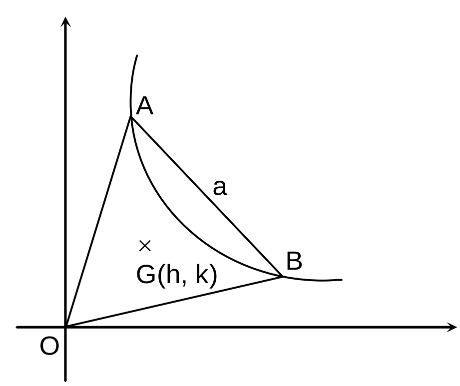
$\Rightarrow a^2 = c^2(t_1 - t_2)^2 + c^2\left(\dfrac{1}{t_1} - \dfrac{1}{t_2}\right)^2$

$= c^2(t_1 - t_2)^2\left(1 + \dfrac{1}{t_1^2 \times t_2^2}\right)$ ..... (1)

Where $3h = c(t_1 + t_2)$ and $3k = c\left(\dfrac{t_1 + t_2}{t_1 t_2}\right)$

$\Rightarrow \dfrac{h}{k} = t_1 t_2$ putting in equation (1)

$hk \cdot a^2 = (ahk - 4c^2)(h^2 + k^2) \Rightarrow (x^2 + y^2)(9xy - 4c^2) = a^2xy$



38. A

Sol. $\alpha = \sqrt{1 - \dfrac{3b^2 - 2a^2}{4b^2 - 3a^2}} \Rightarrow \left(\dfrac{b^2 - a^2}{4b^2 - 3a^2}\right) = \alpha^2$ and $\dfrac{3b^2 - 2a^2}{4b^2 - 3a^2} = (1 - \alpha^2)$

$f(\alpha) = \sqrt{1 - \dfrac{b^2}{3b^2 - a^2}} = \sqrt{\dfrac{2(b^2 - a^2)}{3b^2 - 2a^2}} = \left(\dfrac{\sqrt{2}\,\alpha}{\sqrt{1 - \alpha^2}}\right)$

39. A, C, D

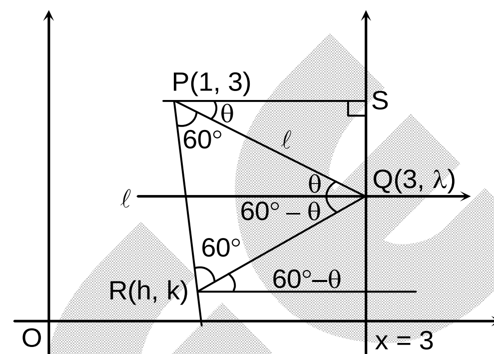
Sol. $(x-3)^2 + 5 + \sin^2 y = \frac{5}{\sqrt{2}}\left(\sin\frac{\pi x}{12} + \cos\frac{\pi x}{12}\right) = 5\left(\sin\left(\frac{\pi x}{12} + \frac{\pi}{4}\right)\right)$

L.H.S. ≥ 5, R.H.S. ≤ 5

$\Rightarrow x = 3$ and $y = n\pi,\ n \in I$

40. B, C

Sol. Inclination of PR $\Rightarrow \left(\frac{2\pi}{3} - \theta\right)$



$\Rightarrow h - 1 = \ell\cos\left(\frac{2\pi}{3} \pm \theta\right)$

and $k - 3 = \ell\sin\left(\frac{2\pi}{3} \pm \theta\right)$

In ΔPQS; $\cos\theta = \frac{2}{\ell} \Rightarrow \ell = 2\sec\theta$

$h - 1 = 2\sec\theta\left(-\frac{1}{2}\cos\theta \pm \frac{\sqrt{3}}{2}\cdot\sin\theta\right)$

$h = 1 + (-1) \pm \frac{\sqrt{3}\sin\theta}{\cos\theta} \Rightarrow \tan\theta = \pm\frac{h}{\sqrt{3}}$

$k = 3 + 2\sec\theta\left(\frac{\sqrt{3}}{2}\cdot\cos\theta \pm \frac{1}{2}\sin\theta\right) = 3 + \sqrt{3} \pm \tan\theta$

$\Rightarrow k = 3 + \sqrt{3} \pm \frac{h}{\sqrt{3}} \Rightarrow \sqrt{3}k = 3(\sqrt{3} + 1) \pm h$

41. B, D

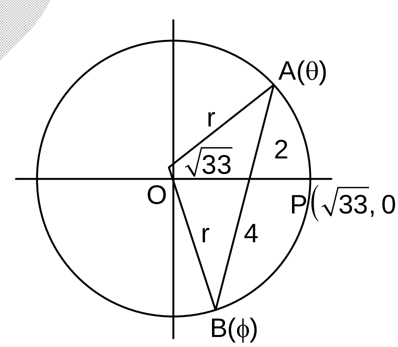
Sol. $r(4\cos\theta + \cos\phi) = 5\sqrt{33}$

$R(4\sin\theta + \sin\phi) = 0$

$\Rightarrow r^2(17 + 4\cos(\theta - \phi)) = 825$

Also, $\cos(\theta - \phi) = \frac{2r^2 - 100}{2r^2}$

$\Rightarrow r = 7,\ \cos(\theta - \phi) < 0$



SECTION – B

42. 6

Sol. $t® = (\sin^r\theta + \cos^r\theta)(\sin^2\theta + \cos^2\theta)$

$= \sin^{r+2}\theta + \cos^r\theta\cdot\sin^2\theta + \sin^r\theta\cdot\cos^2\theta + \cos^{r+2}\theta$

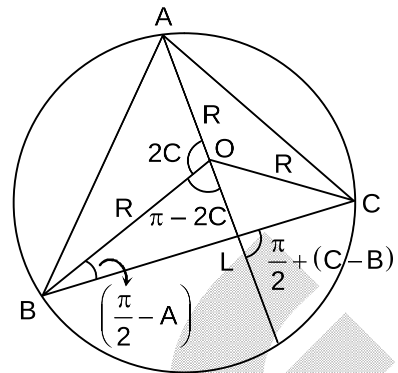
$= t(r) - t(r+2) = \left(\frac{1}{4}\cdot\sin^2(2\theta)\right) = t(r-2)$

$\Rightarrow \left|\frac{t(25) - t(23)}{t(21)}\right| = \left|-\frac{1}{4}\sin^2(2\theta)\right| \leq \frac{1}{4}$

$\Rightarrow 24\left|\frac{t(25) - t(23)}{t(21)}\right| \leq 6$

43. 2

Sol. In ΔOBL



$$\frac{R}{\sin\left(\frac{\pi}{2}+(C-B)\right)}=\frac{OL}{\sin\left(\frac{\pi}{2}-A\right)}$$

$$\Rightarrow OL=\frac{R\cdot\cos A}{\cos(C-B)}$$

$$\Rightarrow AL=R+\frac{R\cos A}{\cos(C-B)}=\frac{2R\cdot\sin B\cdot\sin C}{\cos(C-B)}$$

$$\Rightarrow \frac{R}{AL}=\left(\frac{\sin 2B+\sin 2C}{4\sin A\cdot\sin B\cdot\sin C}\right)$$

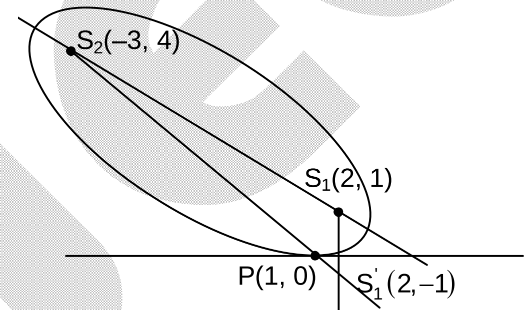
$$\Rightarrow R\left(\frac{1}{AL}+\frac{1}{BM}+\frac{1}{CN}\right)=\frac{2(\sin 2A+\sin 2B+\sin 2C)}{4\sin A\cdot\sin B\cdot\sin C}=2$$

44. 1

Sol. $S_1^{'}=(2,-1)$

Equation of $S_2S_1^{'}: y+1=-(x-2)$

$\Rightarrow \alpha = 1$



45. 3

Sol. $e=\sqrt{\frac{3}{2}} \Rightarrow \left(\frac{\alpha}{\beta}\right)^2=\frac{2}{\left(\frac{3}{2}-1\right)\left(1-\frac{2}{3}\right)}=12$

$\Rightarrow \left|\frac{\alpha}{\beta}\right|=2\sqrt{3}$

46. 8

Sol. Given $xy = c^2$, $x^2 + y^2 = c^2$

$\Rightarrow$ Distance of tangent at A trace origin

$d=\frac{c}{5^{\frac{1}{4}}} \Rightarrow$ distance between tangents

$\frac{2c}{5^{\frac{1}{4}}}=\frac{c}{a} \Rightarrow a=\frac{5^{\frac{1}{4}}}{2}$

47. 5

Sol. Tangent at R(θ) : $\left(\frac{\sec\theta}{a}\right)x-\left(\frac{\tan\theta}{b}\right)y-1=0$

Passes through (0, –b) $\Rightarrow \theta=\frac{\pi}{4}$

$\Rightarrow$ Equation of normal at R is $\sqrt{2}b(y-b)+a(x-\sqrt{2}a)=0$

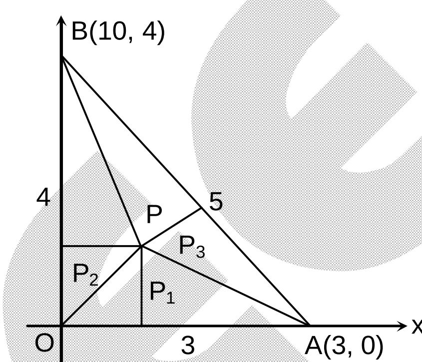
Passes through $(2\sqrt{2}a, 0) \Rightarrow a^2 = b^2 \Rightarrow e = \sqrt{2}$

SECTION – C

48. 9.40

49. 3.20

Sol. (Q. 48.-49.)



$\Delta(ABC) = \Delta(OPA) + \Delta(OPB) + \Delta(PAB)$

$6 = \frac{1}{2}(3P_1 + 4P_2 + 5P_3)$

$\Rightarrow 3P_1 + 4P_2 + 5P_3 = 12$

$\Rightarrow \frac{P_1}{4} + \frac{P_2}{3} + \frac{5P_3}{12} = 1$

$\alpha = 4, \beta = 3, \gamma = \frac{12}{5} \Rightarrow \alpha + \beta + \gamma = 9.4$

$\frac{3P_1 + 4P_2 + 5P_3}{3} \geq (60 \cdot P_1P_2P_3)^{\frac{1}{3}}$

$\Rightarrow 60 \cdot P_1P_2P_3 \leq 4^3 \Rightarrow 3P_1P_2P_3 \leq \frac{4\times16}{20} = \frac{16}{5}$

50. 0.75

51. 10.50

Sol. (Q. 50.-51.)

Equation of director circle of curve C_2 is

$x^2 + y^2 = 16$

Point A, B are (4, 0) and (0, 4)

Hence, maximum area = $2(\sqrt{13}+4)$