Rankers Academy JEE

(1001CJA101021240024)

Test Pattern

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

CLASSROOM CONTACT PROGRAMME
(Academic Session : 2024 - 2025)

JEE (Main)
PART TEST
01-12-2024

JEE(Main + Advanced) : ENTHUSIAST COURSE (SCORE-I)

ANSWER KEY

PAPER-1 (OPTIONAL)

PART-1 : PHYSICS

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	C	B	A	A	A	A	A	A	D	C
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	C	D	C	A	A	A	C	D	A	B
SECTION-II	Q.	1	2	3	4	5					
	A.	3	7	2	21	7					

PART-2 : CHEMISTRY

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	C	B	B	D	C	A	A	B	D	B
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	C	C	A	C	D	A	C	C	D	C
SECTION-II	Q.	1	2	3	4	5					
	A.	80	4	7	6	60					

PART-3 : MATHEMATICS

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	D	B	A	C	B	A	B	B	A	B
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	C	C	A	C	A	A	B	B	C	B
SECTION-II	Q.	1	2	3	4	5					
	A.	5	2	3	5	1					

HINT – SHEET

PART-1 : PHYSICS

SECTION-I

1. **Ans (C)**

Radius of circular path described by a charged particle in a magnetic field is given by

$$r = \frac{\sqrt{2mK}}{qB};$$

Where K = Kinetic energy of electron

$$\Rightarrow K = \frac{q^2B^2r^2}{2m} = \left(\frac{e}{m}\right)\frac{eB^2r^2}{2}$$

$$= \frac{1}{2} \times 1.7 \times 10^{11} \times 1.6 \times 10^{-19} \times \left(\frac{1}{\sqrt{17}} \times 10^{-5}\right)^2 \times (1)^2$$

$$= 8 \times 10^{-20}\,J = 0.58V$$

By using $\Rightarrow W_0 = E - K_{max}$

$$= \left(\frac{12375}{2475}\right) eV \; - 0.5\,eV = 4.5\,eV$$

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2. Ans (B)

Given,

$m_y = 2m_x$

$\Rightarrow Z_y = 2Z_x$

$(\because \left(\frac{A}{Z}\right)_x = \left(\frac{A}{Z}\right)_y = 2 \Rightarrow n = p$ for both x and y)

Let $Z_x = Z$ and $Z_y = 2Z$

Energy of first line balmer $\longrightarrow \dfrac{13.6 \times Z^2 \times 5}{36}$

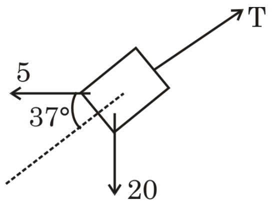
$\therefore \dfrac{13.6 \times 5}{36} \quad \dfrac{13.6 \times 5}{36} \times \left[(2Z)^2 - Z^2\right] = \dfrac{17}{3}$

$\Rightarrow Z = 1$

3. Ans (A)

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

5. Ans (A)



$T = 5 \cos 37° + 20 \cos 53° = 16$ N

$$Y = \frac{F/A}{\frac{\Delta L}{L}}$$

$$\Rightarrow \Delta L = \frac{FL}{YA} = 8 \times 10^{-5} \text{ m}$$

6. Ans (A)

$VT^{-2} =$ constant

$\Rightarrow PV^{\frac{1}{2}} =$ constant

$$Q = \frac{nR\Delta T}{\gamma - 1} + \frac{nR\Delta T}{1 - x}$$

$$= \frac{nR50}{\frac{7}{5} - 1} + \frac{nR50}{1 - \frac{1}{2}}$$

$= 225R$

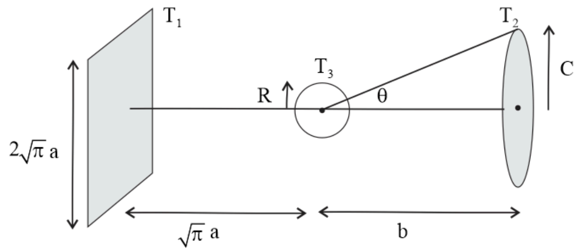
7. Ans (A)

Thermal resistance of rod A is $R_1 = \dfrac{3L}{4KA}$

similarly, $R_2 = \dfrac{2L}{3KA}$ and $R_3 = \dfrac{5L}{K_C A}$

If resistance of rod C is R_3 then $\dfrac{R_1 + R_2}{R_3} = \dfrac{2}{3}$

8. Ans (A)



$P_{total} = \sigma\,(4\pi R^2)T^4$

$P_{cross\text{-}section} = P_{square} + P_{circle}$

$= \dfrac{1}{6}\{\sigma(4\pi R^2)T^4\} + \dfrac{2\pi}{4\pi}(1 - \cos\theta)$

$\{\sigma(4\pi R^2)T^4\}$

$= \left(\dfrac{1}{6} + \dfrac{1}{10}\right)\{\sigma(4\pi R^2)T^4\}$

$\therefore \dfrac{P_{cross-section}}{P_{total}} = \dfrac{4}{15}$

9. Ans (D)

In process CA $PV^{-2} =$ constant

$\Rightarrow TV^{-3} =$ constant

$T_A = T_C \times \left(\dfrac{V_A}{V_C}\right)^3 = 2400K$

$W_{CA} = \dfrac{nR(T_A - T_C)}{1 - (-2)} = 700R$

In process AB (Isobaric),

$T_B = T_A \times \dfrac{V_B}{V_A} = 1200K$

$W_{AB} = nR(T_B - T_A) = -1200R$

$\Delta U_{BC} = nC_V(T_C - T_B) = -2250R$

$Q_{AB} = nC_P(T_B - T_A) = -4200R$

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11. **Ans (C)**

$$\frac{dN}{dt} = \alpha t^3 - \lambda N$$

At $t = t_1$, 'N' is minimum.

$$\Rightarrow N_{t_1} = \frac{\alpha t_1^{\,3}}{\lambda} = \frac{\alpha t_1^{\,3}}{3}$$

At $t = t_2$, $\frac{'dN'}{dt}$ is minimum,

$$\frac{d^2N}{dt^2} = 3\alpha t^2 - \lambda \frac{dN}{dt}$$

$$= 3\alpha t^2 - \lambda\,(\alpha t^3 - \lambda N) = 0$$

$$\Rightarrow \frac{\lambda \alpha t_2^{\,3} - 3\alpha t_2^{\,2}}{\lambda^2} = N_{t_2}$$

$$\Rightarrow \frac{3\alpha\left(t_2^{\,3} - t_2^{\,2}\right)}{9} = N_{t_2}$$

$$\therefore \frac{N_{t_1}}{N_{t_2}} = \frac{t_1^{\,3}}{t_2^{\,3} - t_2^{\,3}}$$

12. **Ans (D)**

Inelastic collision

$$Q = \frac{1}{2}\frac{M}{2} \times V^{\,2} = \frac{KE}{2}$$

$KE_{max} = 2Q_{max} = 2 \times 13.6 = 27.2$ eV.

13. **Ans (C)**

K.E. $= 2E_0 - E_0 = E_0$ (for $0 \le x \le 1$)

$$\Rightarrow \lambda_1 = \frac{h}{\sqrt{2mE_0}}$$

K.E. $= 2E_0$ (for $x > 1$)

$$\Rightarrow \lambda_2 = \frac{h}{\sqrt{4mE_0}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{2}$$

14. **Ans (A)**

Given, $\frac{\lambda_1}{\lambda_2} = 5 \qquad \frac{M_1}{M_2} = \frac{1}{3}$

$$\therefore \frac{P_1}{P_2} = \frac{\lambda_2}{\lambda_1} = \frac{1}{5} \Rightarrow P_2 = 5P_1$$

Also, $P_1^{\,2} + P_2^{\,2} + 2P_1P_2\cos 53^o = P^2$

$$\Rightarrow 26P_1^{\,2} + 10P_1^{\,2} = \left(\frac{3}{5}\right) = P^{\,2}$$

$$\Rightarrow 32P_1^{\,2} + P^2 \Rightarrow P_1 = \frac{P}{\sqrt{32}}$$

$$\therefore P_2 = \frac{5P}{\sqrt{32}}$$

$$\frac{K_f}{K_i} = \frac{\frac{P_1^2}{2M_1} + \frac{P_2^2}{2M_2}}{\frac{P^{\,2}}{2M}}.$$

$$= \frac{\frac{\left(\frac{P^{\,2}}{32}\right)}{2x\left(\frac{M}{4}\right)} + \frac{\left(\frac{25P^{\,2}}{32}\right)}{2\times\left(\frac{3M}{4}\right)}}{\left(\frac{P^{\,2}}{2M}\right)}$$

$$= 4\left[\frac{1}{32} + \frac{25}{3\,(32)}\right] = \frac{7}{6}$$

$$\therefore \frac{\Delta K}{K} = \frac{K_f}{K_i} - 1 = \frac{1}{6}$$

15. **Ans (A)**

Based on theory

16. **Ans (A)**

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow \frac{1}{\lambda} = R\left[\frac{1}{9} - \frac{1}{25}\right]$$

$$\Rightarrow \lambda = \frac{225}{16R}$$

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17. Ans (C)

'D_1' and 'D_4' in forward bias,

'D_2' and 'D_3' in reverse bias,

$V - 10i - 0.7 - 10(i - 0.5) - 0.7 = 0$

$\Rightarrow i = \dfrac{V + 3.6}{20}$

For zener diode,

Given $P = 1W$, $V_Z = 2V$

$\Rightarrow R_Z = \dfrac{V_Z 2}{P} = 4\Omega$, $i_Z = 0.5A$

$\therefore$ Voltage across "10Ω",

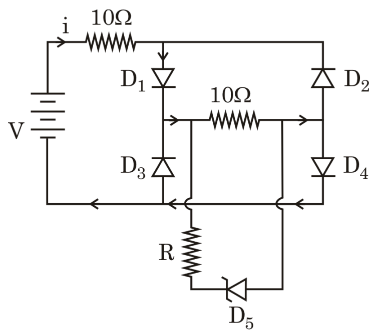
$V_1 = i\left[\dfrac{10(R+4)}{(R+14)}\right]$

$V_1 = i = \left(\dfrac{V+3.6}{20}\right)\left[\dfrac{10(R+4)}{(R+14)}\right]$

$= \left(\dfrac{V+3.6}{2}\right)\left[\dfrac{(R+4)}{(R+14)}\right]$

As, $V_{max} = 17.4$ V

$\Rightarrow V_{1max} = \dfrac{21}{2}\left(\dfrac{R+4}{R+14}\right)$



For safe operation,

$R = \dfrac{V_{1\,max} - V_Z}{i_Z}$

$$R = \frac{\left[\frac{21}{2}\left(\frac{R+4}{R+14}\right)\right] - 2}{0.5}$$

$\Rightarrow R^2 - 3R - 28 = 0$

$\Rightarrow R = 7\Omega.$

18. Ans (D)

$y = \overline{\left(\overline{AB}\right)\cdot\left(\overline{CD}\right)} = \overline{(\bar{A}+\bar{B})\cdot(\bar{C}+\bar{D})}$

$= \overline{(\bar{A}+\bar{B})} + \overline{(\bar{C}+\bar{D})} = AB + CD$

20. Ans (B)

$\dfrac{dN_x}{dt} = -(2\lambda)N_X \Rightarrow N_X = N_O e^{-2\lambda t}$

$\dfrac{dN_Y}{dt} = +3(2\lambda)N_X - \lambda N_Y$

"N_Y" is max at $t = \dfrac{\ell n 10}{\lambda}$

$\Rightarrow O = 6\lambda N_X - \lambda N_{Ymax}$

$\Rightarrow N_{Ymax} = 6N_X$

$\Rightarrow N_{Ymax} = 6Me^{-2\lambda}\left(\dfrac{\ell n10}{\lambda}\right)$

$\Rightarrow N_{Ymax} = \dfrac{6M}{100} = 0.06M$

PART-1 : PHYSICS

SECTION-II

1. Ans (3)

$\phi = 6 - 2 = 4eV$

$KE_{max} = 2 \times 6 - 4 = 8eV$ at emitter

At collection

$KE = 8 - 5 = 3eV$

3. Ans (2)

$V = A\ell$

$\dfrac{d\forall}{V} = \dfrac{dA}{A} + \dfrac{d\ell}{\ell}$

$0 = -2\mu\varepsilon + \varepsilon.$

$\Rightarrow \mu = \dfrac{1}{2}$

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4. Ans (21)

$f = f_0 \dfrac{z^2}{n^3} \Rightarrow \dfrac{z^2}{n^3} = 4$ .... (1)

$E = E_0 \dfrac{z^2}{n^2} \Rightarrow \dfrac{z^2}{n^2} = 16$ .... (2)

(1) and (2) $\Rightarrow$ n = 4 and z = 16

Now, $L = mvr = \dfrac{nh}{2\pi}$

$\Rightarrow \quad \tau = \dfrac{\Delta L}{\Delta t} = \dfrac{\Delta n}{\Delta t}\dfrac{h}{2\pi}$

$= \dfrac{3}{(15 \times 10^{-9})} \times \dfrac{(2.1 \times 10^{-34})}{2}$

$= 2.1 \times 10^{-26}$ N–m

5. Ans (7)

Max KE converted $= \dfrac{1}{2}\dfrac{4}{5} m_x V^2$

$= \dfrac{4}{5} \times 2.5 = 2\,\text{MeV}$

$BE_y = \dfrac{8A + 5 - 2}{A + 1} = 7$ MeV

PART-2 : CHEMISTRY

SECTION-I

1. Ans (C)

Slope of OA $= \dfrac{2}{\frac{1}{5.6}} = 11.2$

Slope of OB $= \dfrac{4}{\frac{1}{2.8}} = 11.2$

If slope of OA is equal to slope of OB than AB is isothermal reversible process.

$w = -nRT \ln \dfrac{v_2}{v_1}$

$= -PV \ln \dfrac{v_2}{v_1}$

$= -2 \times 5.6 \ln \dfrac{\cancel{2.8}}{\cancel{5.6}\ 2}$

= 7.84 ltr-atm

= 784 Joule

2. Ans (B)

$\Delta H = nC_P\Delta T$

C_P is highest for XeF_4.

(Non-linear polyatomic gas)

3. Ans (B)

$\Delta H^0_{Reaction} = (3 \times 380) - 3(150 + 250)$

$= 1140 - 1200$

$= -60$ KJ/mol

Resonance energy $= \Delta H^0_{f(exp)} - \Delta H^0_{f(theo)}$

$-120 = \Delta H^0_{f(exp)} - (-60)$

$\Delta H^0_{f(exp)} = -180$ KJ/mol

5. Ans (C)

$\Delta_f H^o = 0$ for elements in their reference elemental states and for $H^+(aq)$.

6. Ans (A)

$q = n\Delta H_{fusion}$

$= \dfrac{10^3}{18} \times 9$

$= 500$ KJ

7. Ans (A)

$$\begin{tikzcd} I_2(s) \arrow[rr, "\Delta H_{Atom}"] \arrow[d, dash, "\Delta H_{Sub.}"'] & & 2I(g) \\ {} \arrow[r] & I_2(g) \arrow[r, dash, "\Delta H_{Dis.}"] & {} \arrow[u] \end{tikzcd}$$

$\Delta H_{Atom} > \Delta H_{Diss.}$

$\Rightarrow \dfrac{a}{b} < 1$

8. Ans (B)

NCERT

9. Ans (D)

At equilibrium $\Delta G = 0$, $\Delta°G \neq 0$

All the process which are spontaneous has $\Delta G < 0$ and non-spontaneous has $\Delta G > 0$.

10. Ans (B)

$KK^*, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2, \pi^* 2p_y^0 = \pi^* 2p_x^0$

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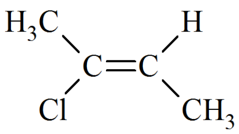
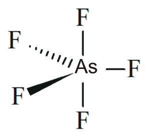
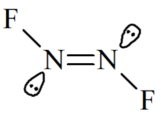
11. Ans (C)



$(\mu_{net} \neq 0)$





XeO_4 (Tetrahedral)

12. Ans (C)

$(\Delta S)_{syst}$ for reversible adiabatic process is zero.

as $q_{rev} = 0$

$\Delta s = \frac{q_{rev}}{T} = 0$

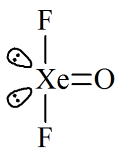
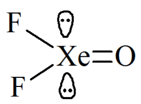
13. Ans (A)

$XeOF_2$

Hybridisation sp^3d

3-bond pair + 1 lone pair

Two possible structures :

(T-shape) (Trigonal planar)

14. Ans (C)

σ - molecular orbitals are symmetric whereas π-molecular orbitals are unsymmetric about the inter-nuclear axis.

15. Ans (D)

$Q_{syst} = q$ then $Q_{surr} = -q$

$(\Delta G)_{syst} < 0$ for all process occurring spontaneously.

16. Ans (A)

$HA + NaOH \longrightarrow NaA + H_2O$

$\Delta H = -13.7 + 6.7$

$= -7$ Kcal

Energy release = 7 Kcal

17. Ans (C)

Basicity of acid is number of replaceable H^+ ions.

18. Ans (C)

Factual

19. Ans (D)

SO_2 is sp^2 hybridised.

NH_3 and H_2O are sp^3 hybridised.

H_2S do not hybridise.

PART-2 : CHEMISTRY

SECTION-II

1. Ans (80)

$\Delta H_{vap} = \Delta H_{sub} - \Delta H_{fus}$

$= 38 - 6$

$= 32$ kJ/mole

$\Delta H_{vap} - T_b \Delta S_{vap} = \Delta G_{vap} = 0$

$\therefore \Delta S_{vap} = \frac{\Delta S_{vap}}{T_b}$

$= \frac{8\,\cancel{32} \times 10\,\cancel{00}}{\cancel{4}\,\cancel{00}}$

$= 80\ JK^{-1}\ mol^{-1}$

2. Ans (4)

Ans (4) : (1), (2), (3), (5) are correct.

3. Ans (7)

$PV^m =$ constant

$C_m = C_V - \frac{R}{m-1}$

Given $PV^{\frac{1}{2}} = K$

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

$C_m = \frac{3}{2}R - \frac{R}{\left(\frac{1}{2} - 1\right)}$

$C_m = \frac{3}{2}R + 2R$

$C_m = \frac{7}{2}R$

$C_m = \frac{7}{\cancel{2}} \times \cancel{2}$ cal $mol^{-1}\ K^{-1}$

$C_m = 7$ cal

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4. **Ans (6)**

$XeF_3^+, SF_3^+, CF_3^+, I_3^-$

2 1 0 3

5. **Ans (60)**

Resonance energy = $(E)R_{S_1} - (E)RH$

$= -240 - (-300)$

$= 60$

PART-3 : MATHEMATICS

SECTION-I

1. **Ans (D)**

$$f(x) = A_0 + \sum_{k=1}^{20} A_k x^k = \sum_{k=0}^{20} A_k x^k$$

$$\because \sum_{r=0}^{6} f(\alpha^r x) = f(x) + f(\alpha x) + f(\alpha^2 x) + f(\alpha^3 x)$$

$$+ f(\alpha^4 x) + f(\alpha^5 x) + f(\alpha^6 x)$$

$$= \sum_{k=0}^{20}\left(A_k x^k + A_k(\alpha x)^k + A_k(\alpha^2 x)^k + \ldots + A_k(\alpha^6 x)^k\right)$$

$$= \sum_{k=0}^{20}\left\{A_k x^k(1 + \alpha^k + (\alpha^2)^k + (\alpha^3)^k + \ldots + (\alpha^6)^k)\right\}$$

$$= A_0 x^0 (7) + A_7 x^7 (7) + A_{14} x^{14} (7) = 7$$

$$[A_0 + A_7 x^7 + A_{14} x^{14}]$$

$$\Rightarrow n = 7$$

2. **Ans (B)**

$$f(r) = \begin{bmatrix} 4r+1 & 4r^2+r^3 & 3r^3+r^5+r^4 \\ 3r+2 & 4r^2+r^3 & 2r^3+r^5+2r^4 \\ 4r+7 & 10r^2+r^3 & 3r^3+r^5+7r^4 \end{bmatrix}$$

$$|f(r)| = r^2 \cdot r^3 \begin{vmatrix} 4r+1 & 4+r & 3+r^2+r \\ 3r+2 & 4+r & 2+r^2+2r \\ 4r+7 & 10+r & 3+r^2+7r \end{vmatrix};$$

$R_2 \longrightarrow R_2 - R, \ \& \ R_3 \longrightarrow R_3 - R_1$

$$|f(r)| = r^5 \begin{vmatrix} 4r+1 & 4+r & 3+r^2+r \\ -r+1 & 0 & -1+0+r \\ 6 & 6 & 0+0+6r \end{vmatrix}$$

$$|f(r)| = 0$$

3. **Ans (A)**

$\cos\theta_1 + \cos\theta_2 + \cos\theta_3 = 0 = \sin\theta_1 + \sin\theta_2 + \sin\theta_3$

centroid and circum centre are origin.

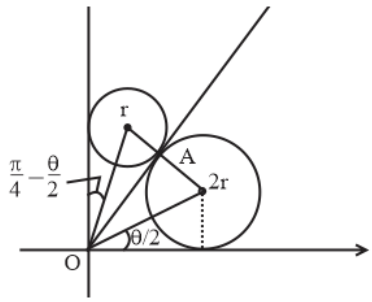
ΔABC is equilateral. ortho centre is.

Also origin.

4. **Ans (C)**

$$OA = r\cot\left(\frac{\pi}{4} - \frac{\theta}{2}\right) = 2r\cot\frac{\theta}{2}$$

Let, $\tan\frac{\theta}{2} = t$



$$\Rightarrow \frac{1+t}{1-t} = \frac{2}{t}$$

$$\Rightarrow t = \frac{-3 \pm \sqrt{17}}{2}$$

$$\therefore \tan\frac{\theta}{2} = \frac{\sqrt{17}-3}{2}$$

$$\Rightarrow a + b + c = 17 + 3 + 2 = 22$$

5. **Ans (B)**

$|2a - 1| = 3[a] + 2\{a\} = [a] + 2a$

case(i) If $a \geqslant \frac{1}{2}$

$2a - 1 = [a] + 2a$

$[a] = -1$

$a \in [-1, 0)$ Which is not possible

case(ii) If $a < \frac{1}{2}$

$-2a + 1 = [a] + 2a$

$4a - 1 = -[a]$

Case-1 : $0 \leq a < \frac{1}{2}$

$4a = 1$

$a = \frac{1}{4}$

No further solution possible.

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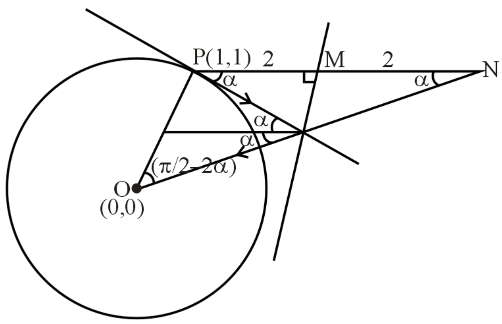
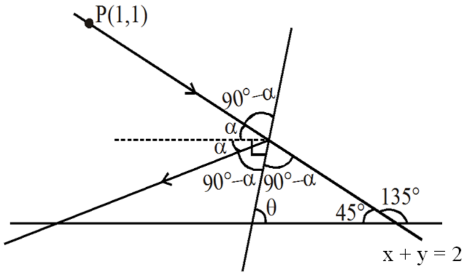
6. Ans (A)





$$\frac{\sin\alpha}{\sqrt{2}} = \frac{\cos(2\alpha)}{4}$$

$$\theta = 180° - (90° - \alpha + 45°)$$

$$2\sqrt{2}\sin\alpha = 1 - 2\sin^2\alpha$$

$$\Rightarrow \theta = 45° + \alpha$$

$$2\sin^2\alpha + 2\sqrt{2}\sin\alpha - 1 = 0$$

$$\sin\alpha = \frac{-2\sqrt{2} \pm \sqrt{8+8}}{4} = \frac{-2\sqrt{2}+4}{4} = -\frac{1}{\sqrt{2}} + 1$$

$$\sin\alpha = \left(\frac{-1+\sqrt{2}}{\sqrt{2}}\right)$$

7. Ans (B)

Shaded area is the region traced by P,

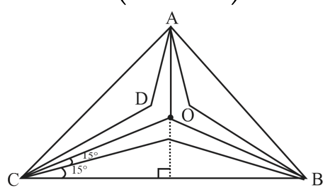
its area =

$\Delta ABC - 3\Delta ADC$

$$= \frac{\sqrt{3}}{4}a^2 - 3\left(\frac{a}{2} \times \frac{a}{2}\tan 15^0\right)$$

$$= \frac{\sqrt{3}}{4}a^2 - \frac{3}{4}a^2\tan 15^0$$

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



8. Ans (B)

$C_3 \longrightarrow C_3 + C_2 - C_1$

Expand along C_3

$$f(n) = \frac{1}{(n+1)(n+2)^2} - \frac{1}{(n+2)(n+3)^2},$$

$$\text{So } \sum_{n=1}^{\infty} f(n) = \left(\frac{1}{2.3^2} - \frac{1}{3.4^2}\right) + \left(\frac{1}{3.4^2} - \frac{1}{4.5^2}\right)$$

$$+\ldots\ldots+\left(\frac{1}{(n+1)(n+2)^2} - \frac{1}{(n+2)(n+3)^2}\right)$$

$$\text{So, for } n = 7 \sum_{n=1}^{7} f(n) = \frac{49}{900}$$

$$\text{For } n \longrightarrow \infty \sum f(n) = \frac{1}{18}$$

9. Ans (A)

(A) $\log_2 \frac{4}{5} . \log_2 20 + (\log_2 5)^2$

$= (2 - \log_2 5)(2 + \log_2 5) + (\log_2 5)^2$

$= 4 - (\log_2 5)^2 + (\log_2 5)^2 = 4$

(B) $\log_6 \dfrac{2^{x+3}}{3^x - 2} = x$

$\Rightarrow 8.2^x = 6^x . (3^x - 2)$

$\Rightarrow 8 = (3^x)^2 - 2.3^x$

$\Rightarrow (3^x - 4)(3^x + 2) = 0$

$\Rightarrow 3^x = 4 \Rightarrow x = \log_3 4 = a$

$\Rightarrow 9^{\log_3 4} = 16$

(C) $\log_6^3 4 + 6\log_6 4.\log_6 9 + \log_6^3 9$

$= (\log_6 4 + \log_6 9)^3 = 2^3 = 8$

(D) $(2a+1)^2 + (3b-1)^2 + (c-2)^2 = 0$

$\Rightarrow a = -\frac{1}{2}, b = \frac{1}{3}, c = 2$

$\Rightarrow 4a + 3b + c = -2 + 1 + 2 = 1$

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10. Ans (B)

$z^3 + (-\alpha z_1)^3 + ((\alpha-1)z_2)^3 = 3z(-\alpha z_1)((\alpha-1)z_2)$

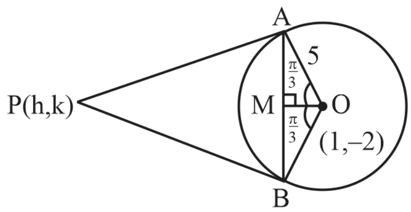
$\Rightarrow z - \alpha z_1 + (\alpha - 1)z_2 = 0$

$z = \dfrac{\alpha z_1 + (1-\alpha)z_2}{\alpha + (1-\alpha)}$

z lies on line joining z_1 and z_2.

$|z|_{min} =$ perpendicular distance of origin from line joining z_1 and z_2.

11. Ans (C)



eq. of circle $x^2 + y^2 - 2x + 4y - 20 = 0$

eq. of chord of central form point P(h,k) to the circle is.

$T = 0$

$\Rightarrow hx + ky - (h + x) + 2(k + y) - 20 = 0$

$\Rightarrow (h-1)x + (k+2)y - h + 2k - 20 = 0$

In ΔOAM,

$\cos\dfrac{\pi}{3} = \dfrac{OM}{OA}$

$\Rightarrow OM = \dfrac{5}{2}$

$\Rightarrow \dfrac{|(h-1) - 2(k+2) - h + 2k - 20|}{\sqrt{(h-1)^2 + (k+2)^2}} = \dfrac{5}{2}$

$\Rightarrow (h-1)^2 + (k+2)^2 = 100$

$\Rightarrow$ Locus is $(x-1)^2 + (y+2)^2 = 100$

Radius = 10

12. Ans (C)

Here $ABA^T = AB^TA^T = I$

So $C = A(ABA^T)^{25}(AB^TA^T)^{10}A^T = AA^T$

$= \begin{bmatrix} 1 & -2 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ -2 & 1 \end{bmatrix} = \begin{bmatrix} 5 & -2 \\ -2 & 1 \end{bmatrix}$

$\Rightarrow$ Trace of matrix C = 6

13. Ans (A)

$\log_2 a \,.\, \log_2 2a - \log_2 2a$

$= \log_2 c.\ \log_2 8c + \log_2 8c$

$\Rightarrow (\log_2 a - 1)\log_2 2a = \log_2 8c\ .\ (\log_2 c + 1)$

$\Rightarrow (\log_2 a - 1)(\log_2 a + 1) = (\log_2 c + 3)(\log_2 c + 1)$

$\Rightarrow \log_2{}^2 a - 1 = \log_2{}^2 c + 4\log_2 c + 3$

$\Rightarrow (\log_2 a)^2 = (\log_2 c + 2)^2$

$\log_2 a = \log_2 c + 2 \Rightarrow \dfrac{a}{c} = 4$

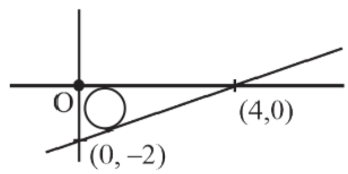
or $\log_2 a = -2 - \log_2 c$

$\Rightarrow \log_2 ac = -2 \Rightarrow ac = \dfrac{1}{4}$

$\Rightarrow a, \dfrac{1}{2}, c$ are in GP.

14. Ans (C)

$xy(x - 2y - 4) = 0$



$r = \dfrac{\Delta}{s} = \dfrac{4}{3+\sqrt{5}}$

$r_1 = \dfrac{\Delta}{s-a} = \dfrac{4}{1+\sqrt{5}}$

$r_2 = \dfrac{4}{\sqrt{5}-1}$

$r_3 = \dfrac{4}{3-\sqrt{5}}$

$\text{Sum} = \dfrac{1}{r} + \dfrac{1}{r_1} + \dfrac{1}{r_2} + \dfrac{1}{r_3} = \dfrac{3+\sqrt{5}}{2}$

so, a = 3 & b = 2

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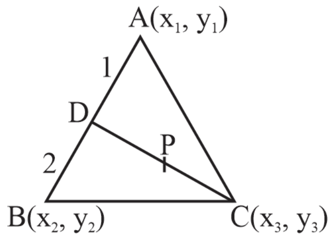
15. **Ans (A)**

$$\left(\frac{2x_1+x_2}{3} \cdot \frac{2y_1+y_2}{3}\right)$$



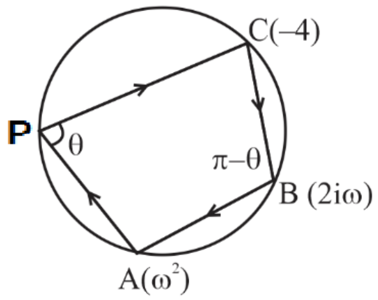
$$P = \left(\frac{\frac{2x_1+x_2}{3}+x_3}{2}, \frac{\frac{2y_1+y_2}{3}+y_3}{2}\right)$$

$$= \left(\frac{2x_1+x_2+3x_3}{6}, \frac{2y_1+y_2+3y_3}{6}\right)$$

$\therefore$ P lies in side the ΔABC

$\Rightarrow$ Area of $\Delta PBC <$ area of ΔABC

16. **Ans (A)**



Rotate $\overrightarrow{PA}$ to get $\overrightarrow{PC}$ and rotate $\overrightarrow{BC}$ to get $\overrightarrow{BA}$

Applying rotation formula at P and B we get

$$\frac{p+4}{p-\omega^2} \times \frac{2i\omega-\omega^2}{2i\omega+4} = -1$$

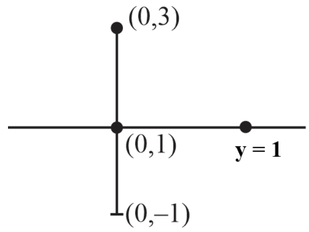
$\Rightarrow$p

$$= \frac{2i-8i\omega+8\omega^2}{4i\omega-\omega^2+4} = \frac{2(i-4i\omega+4\omega^2)}{(-4\omega^2-1+4i\omega)} \times i\omega = -2i\omega$$

$$\text{So, } z = \frac{p+2i\omega}{2} = 0 \Rightarrow |z|^2 = 0$$

17. **Ans (B)**

$|z+1| = |z-3i|$



$z = \alpha + i$

$w = z\bar{z} - 2z + 2$

$w = \alpha^2 + 1 - 2(\alpha + i) + 2$

$w = \alpha^2 - 2\alpha + 3 - 2i$

$\text{Re}(w) = \alpha^2 - 2\alpha + 3$

$= (\alpha - 1)^2 + 2$

at $\alpha = 1$

Re(w) min = 2, so that

$w = 2 - 2i$

$w = 2(1 - i)$

$w^n = 2^n (1 - i)^n$

so the minimum value of n is

$n = 4$

18. **Ans (B)**

$\Delta_1 = 3abc - a^3 - b^3 - c^3$

Δ_2 is formed by cofactors of elements of Δ_1

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19. **Ans (C)**

Equation of tangent at (6, −8) to the circle

$x^2 + y^2 = 100$ is :

T = 0

$\Rightarrow 6x - 8y = 100$ .... (1)

equation of normal at (6, −8) is

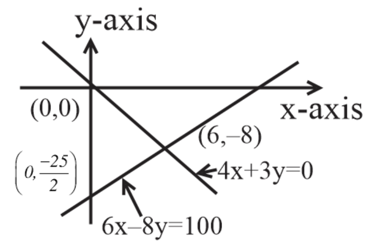
$(y+8) = -\frac{4}{3}(x-6)$

$\Rightarrow 4x + 3y = 0$ ...... (2)

Area of triangle

$= \frac{1}{2} \times \frac{25}{2} \times 6$

$= \frac{75}{2}$ sq units



20. **Ans (B)**

$$A = \frac{1967 + 1686i\sin\theta}{7 - 3i\cos\theta}$$

$$= \frac{281(7 + 6i\sin\theta)}{7 - 3i\cos\theta} \times \frac{7 + 3i\cos\theta}{7 + 3i\cos\theta}$$

$$= \frac{281(49 - 18\sin\theta\cos\theta + i(21\cos\theta + 42\sin\theta))}{49 + 9\cos^2\theta}$$

for positive integer

Im(A) = 0

$21\cos\theta + 42\sin\theta = 0$

$\tan\theta = \frac{-1}{2}$, $\sin 2\theta = \frac{-4}{5}$; $\cos^2\theta = \frac{4}{5}$

$$\text{Re}(A) = \frac{281(49 - 9\sin 2\theta)}{49 + 9\cos^2\theta}$$

$$= \frac{281\left(49 - 9 \times \frac{-4}{5}\right)}{49 + 9 \times \frac{4}{5}} = 281 \text{ (+ve integer)}$$

PART-3 : MATHEMATICS

SECTION-II

1. **Ans (5)**

$z = x + iy, \bar{z} = x - iy, (2\,iy)^2 = 12(x^2 + y^2) - 4$

$\Rightarrow 12x^2 + 16y^2 = 4 \Rightarrow 3x^2 + 4y^2 = 1$

$\Rightarrow \frac{x^2}{\frac{1}{3}} + \frac{y^2}{\frac{1}{4}} = 1$

$x = \sqrt{\frac{1}{3}}\cos\theta, \; y = \sqrt{\frac{1}{4}}\sin\theta$

$3\sqrt{3}\,\text{Re}(z) + 8\,\text{Im}(z) = 3\cos\theta + 4\sin\theta$

max = 5

2. **Ans (2)**

Point may lie on the same side of the line or

atleast one on the line so

$4[a^2 + 2b(a + b + c) + 4] \geq 0$

$a^2 + (2b)a + 2b(b + c) + 4 \geq 0$

$D \leq 0$

$4b^2 - 4[2b^2 + 2bc + 4] \leq 0$

$-b^2 - 2bc - 4 \leq 0$

$b^2 + 2bc + 4 \geq 0$

$D \leq 0$; $4c^2 - 16 \leq 0$

$c^2 - 4 \leq 0$

$-2 \leq c \leq 2$

Max value of c = 2

3. **Ans (3)**

Hint : $XX^T = I$

Now, $PQ = AXB\;\;BX^TA$

$= 3A^2$

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4. Ans (5)

Let $f(x) = x^4 + x^3 + ax^2 + bx + c$

& $x^2 + x + 1 = (x + \omega)(x + \omega^2)$

$\because$ f(x) is divisible by $x^2 + x + 1$

$f(\omega) = 0 \Rightarrow \omega + 1 + a\omega^2 + b\omega + c = 0$ .....(1)

$f(\omega^2) = 0 \Rightarrow \omega^2 + 1 + a\omega + b\omega^2 + c = 0$ ....(2)

eq. (1) – eq. (2)

$\Rightarrow \omega - \omega^2 - a(\omega - \omega^2) + b(\omega - \omega^2) = 0$

$\Rightarrow 1 - a + b = 0 \Rightarrow a - b = 1$ .....(3)

& eq. (1) + eq. (2)

$\Rightarrow (\omega + \omega^2) + 2 + a(\omega + \omega^2) + b(\omega + \omega^2) + 2c = 0$

$\Rightarrow -a - b + 2c + 1 = 0$

$\Rightarrow 2c = a + b - 1$ .....(4)

Now, $5a - b - 4c = 5a - b - 2a - 2b + 2$

$= 3(a - b) + 2 = 3 + 2 = 5$

5. Ans (1)

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

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

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

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

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

$= (1 - x)^2((x + 1)^2 + x^2) \le 0.$

Equality occurs if and only if $x = 1$.

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