MOTION IIT-JEE
(Where Faith Counts the Success)

TARGET IIT-JEE
HINT & SOLUTIONS

ANSWER KEY WITH SOLUTION

PAPER-II CLASS XII & XIII (DATE 22-11-09)

MATHEMATICS

1. D **2.** B **3.** A **4.** B **5.** A,C **6.** B,C **7.** A,B
8. A,D **9.** A, B, C
10. **$A \to R$; $B \to P$; $C \to S$; $D \to Q$**
11. **(A) $\to$ (P,T) ; (B) $\to$ (R) ; (C) $\to$ (Q) ; (D) $\to$ (Q)**
12. $\frac{1}{\sqrt{2}}+\frac{i}{\sqrt{2}}$ **13.** $\left(\frac{2k}{3},0\right)$. **14.** $z=\frac{-z_2z_3}{z_1}$ **15.** 94 **16.** 20
17. 364 **18.** 7 **19.** $\theta \in \left[\frac{\pi}{2},\frac{3\pi}{2}\right]$

PHYSICS

20. C **21.** C **22.** D **23.** D **24.** A,B,D **25.** **A,B,C** **26.** **C**
27. **C,D** **28.** **A,D**
29. **$A \to R$; $B \to P,S$; $C \to R$; $D \to P, S$**
30. **$A \to Q$; $B \to R$, ; $C \to P$; $D \to$ S**
31. 21 μT **32.** $T=2\pi\sqrt{\frac{3M}{2(4K+\pi i B)}}$ **33.** $\frac{1}{\sqrt{5}}$ **34** $x \in [0.5, 0.9]$ **35.** $\frac{R[2-\pi]}{2[3\pi+2]}$
36. $\frac{1}{16\pi^2\varepsilon_0}\frac{q^2}{T}$ **37.** $20\pi \cos \pi t$ cm/s **38.** 14.3 s, 0.45 m/s^2

CHEMISTRY

39. B **40.** D **41.** A **42.** A **43.** A,C,D **44.** C,D **45.** A,C
46. A,B **47.** A,C
48. **A – P,R,S ; B – Q; C – Q; D – P,R**
49. **A – P,S,T ; B – R,Q; C – P,S; D – P,S**
50. 560 J **51.** 7 : 4 **52.** 3300 mg **53.** 1144 **54.** 10^{64} **55.** 6667 Rs **56.** 7
57. 180

1. **D**

$$\sum_{r=1}^{n}\left(\sum_{r_1=0}^{r-1} {}^nC_r.{}^rC_{r_1}.2^{r_1}\right)=\sum_{r=1}^{n} {}^nC_r\left(\sum_{r_1=0}^{r-1} {}^rC_{r_1}2^{r_1}\right)$$

$$= \sum_{r=1}^{n} {}^nC_r((1+2)^r - 2^r)$$

$$= \sum_{r=1}^{n} {}^nC_r3^r - \sum_{r=1}^{n} {}^nC_r2^r = (4^n-1)-(3^n-1) = 4^n - 3^n$$

2. **B**

Let γ be a real root of $x^2 + \alpha x + \beta = 0$

$\gamma^2 + \alpha\gamma + \beta = 0$ ...(1)

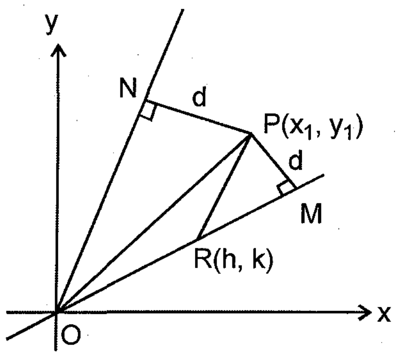
taking conjugate $\gamma^2 + \bar{\alpha}\gamma + \bar{\beta} = 0$ ...(2)

($\bar{\gamma} = \gamma$, since γ is real)

$$\frac{\gamma^2}{\alpha\bar{\beta}-\bar{\alpha}\beta} = \frac{\gamma}{\beta-\bar{\beta}} = \frac{1}{\bar{\alpha}-\alpha}$$

$$\Rightarrow \left(\frac{\beta-\bar{\beta}}{\bar{\alpha}-\alpha}\right)^2 = \frac{\alpha\bar{\beta}-\bar{\alpha}\beta}{\bar{\alpha}-\alpha} \Rightarrow (\beta-\bar{\beta})^2 = (\bar{\alpha}-\alpha)(\alpha\bar{\beta}-\bar{\alpha}\beta)$$

3. **A**



Let R (h, k) be any point on OM

$$\text{Area of } \Delta \text{ OPR} = \frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ h & k & 1 \\ 0 & 0 & 1 \end{vmatrix} = \frac{1}{2}|(kx_1 - hy_1)|$$

also area of Δ OPR $= \dfrac{\sqrt{h^2+k^2}.d}{2}$

$$\therefore \quad \frac{1}{2}|(kx_1 - hy_1)| = \frac{\sqrt{h^2+k^2}.d}{2}$$

locus of (h, k) is

$(xy_1 - yx_1)^2 = d^2(x^2 + y^2)$ **Ans.**

4. **B**

We known in ΔABC

$\cos A + \cos B + \cos C \le \dfrac{3}{2}$

$\Rightarrow \cos^2\dfrac{A}{2} + \cos^2\dfrac{B}{2} + \cos^2\dfrac{C}{2} \le \dfrac{9}{4}$

and $x^2 + \dfrac{1}{x^2} \ge 2 \Rightarrow y_{max} = \dfrac{9}{8}$

5. **A,C**

$f(x) = \dfrac{2-x}{\pi}\cos \pi(x+3) + \dfrac{1}{\pi^2}\sin \pi(x+3)$

$f'(x) = -\dfrac{1}{\pi}\cos\pi(x+3) - (2-x)\sin\pi(x+3)$

$+ \dfrac{1}{\pi}\cos\pi(x+3)$

$= (x-2)\sin\pi(x+3) = 0$

$x = 2, 1, 3.$

$f''(x) = \sin\pi(x+3) + \pi(x-2)\cos\pi(x+3)$

$f''(1) = -\pi < 0, f''(2) = 0$

$f''(3) = \pi > 0$

$\therefore$ x = 1 is a maximum and x = 3 is a minimum

x = 2 is a point of inflexion.

6. **B,C**

$\because$ g(x) is increasing & f(x) is decreasing.

$\Rightarrow g(x+1) > g(x-1)$ & $f(x+1) < f(x-1)$

$\Rightarrow f(g(x+1)) < f(g(x-1))$ & $g(f(x+1)) < g(f(x-1))$

7. **A,B**

$$I_n = \int_0^1 \frac{dx}{(1+x^2)^n} = \int_0^1 (1+x^2)^{-n}dx$$

$$= \left.\frac{x}{(1+x^2)^n}\right|_0^1 - \int_0^1 (-n)(1+x^2)^{-n-1}.2x.xdx$$

$$= \frac{1}{2^n} + 2n\int_0^1 \frac{x^2}{(1+x^2)^{n+1}} = \frac{1}{2^n} + 2n\int_0^1 \frac{1+x^2-1}{(1+x^2)^{n+1}}dx$$

$$= \frac{1}{2^n} + 2nI_n - 2nI_{n+1}$$

$$\therefore \quad 2n\,I_{n+1} = 2^{-n} + (2n-1)I_n$$

$$\therefore \quad 2I_2 = \frac{1}{2} + I_1 = \frac{1}{2} + \tan^{-1}x|_0^1$$

$$I_2 = \frac{1}{4} + \frac{\pi}{8}$$

8. **A,D**

All AAAAA BBB D EEF can be arranged in

$$\frac{12!}{5!\,3!\,2!}$$

Between the gaps C can be arranged in $^{13}C_3$ ways

Total ways = $^{13}C_3 \times \frac{12!}{5! \times 3! \times 2!}$

Number of ways = without considering separation of C - in which all C's are together – in which exactly two C's are together

$$= \frac{15!}{5!\,(3!)^2\,2!} - \frac{13!}{5!\,3!\,2!} - \frac{12!}{5!\,3!}\ {}^{13}C_2$$

9. **A, B, C**

(A) $P(E_1) = 1 - P(R\,R\,R)$ R

$$= 1 - \left[\frac{1}{3}\cdot\frac{2}{4}\cdot\frac{3}{5}\right] = 0.9$$ Bag

(B) $P(E_2) = 3\,P(B\,R\,R) = 3.\ \frac{2}{3}\cdot\frac{1}{4}\cdot\frac{2}{5} = 0.2$ B B

(C) $P(E_3) = P(R\,R\,R / R\,R\,R \cup B\,B\,B) = \frac{P(RRR)}{P(RRR)+P(BBB)}$

but $P(B\,B\,B) = \frac{2}{3}\cdot\frac{3}{4}\cdot\frac{4}{5} = \frac{8}{20} \Rightarrow P(E_3) = \frac{0.1}{0.1+0.4} = 0.2$

(D) $P(E_4) = 1 - P(B\,B\,B) = 1 - \frac{2}{5} = 0.6$

10. **A → R; B → P; C → S; D → Q**

(A) A wins the first set at 6 – 0 if he wins all the six games in a row

$$\begin{cases} I & II & III & IV & V & VI \\ 2/3 & 1/3 & 2/3 & 1/3 & 2/3 & 1/3 \end{cases}$$

The probability of A winning his first service game = $\frac{2}{3}$

The probability of B losing his first service game

$= \frac{1}{3}$ and so on

$\therefore$ the required probability = $\frac{2}{3}\times\frac{1}{3}\times\frac{2}{3}\times\frac{1}{3}\times\frac{2}{3}\times\frac{1}{3} = \frac{2^3}{3^6}$

(B) A is to win the first set at 6 – 1

They play 7 games and A has to won the 7th and B has to won 1 game (either his service game or the opponents service game)

A's service game :	1	3	5	7
B's service game :	2	4	6	

Probability of A winning corresponds to either A winning all his service games and two of B's service game or A losing one of his service games (except the 7th) and also all B's service games.

The required probability :

$$= \left(\frac{2}{3}\right)^4 \times {}^3C_1 \times \left(\frac{2}{3}\right) \times \left(\frac{1}{3}\right)^2 + {}^3C_1 \times \left(\frac{1}{3}\right) \times \left(\frac{2}{3}\right)^3 \times \left(\frac{1}{3}\right)^3$$

$$= \frac{1}{3^6}(32+8) = \frac{40}{3^6}$$

(C) B wins the first at 6 – 1 if B wins the 7th game and 5 other games. This is possible if either B wins all his service games and three of A's service games (including the last) or if B wins 2 of his service games and all four of A's service games.

The required probability is

$$\left(\frac{2}{3}\right)^3 \times {}^3C_2 \left(\frac{1}{3}\right)^3 \times \frac{2}{3} + {}^3C_2 \left(\frac{2}{3}\right)^2 \left(\frac{1}{3}\right) \times \left(\frac{1}{3}\right)^4 = \frac{20}{3^6}$$

(D) Now they play 8 games

1	3	5	7
2	4	6	8

Case I B wins 2 of his service games out of the first three and A wins all his service games.

$$p = \left(\frac{2}{3}\right)^4 \ {}^3C_2 \times \left(\frac{2}{3}\right)^2 \times \frac{1}{3} \times \frac{1}{3} = \frac{2^6}{3^7} = \frac{64}{3^7}$$

Case II A wins 3 service games and two out II, IV, VI games and also the VIII

$$p = {}^4C_3 \left(\frac{2}{3}\right)^3 \left(\frac{1}{3}\right) \times {}^3C_2 \times \left(\frac{1}{3}\right)^2 \times \left(\frac{2}{3}\right) \times \frac{1}{3} = \frac{64}{3^7}$$

Case III A wins 2 service games and also all of B's service games

$$p = {}^4C_2 \left(\frac{2}{3}\right)^2 \times \left(\frac{1}{3}\right)^2 \times \left(\frac{1}{3}\right)^4 = \frac{24}{3^8} = \frac{8}{3^7}$$

Hence the required probability

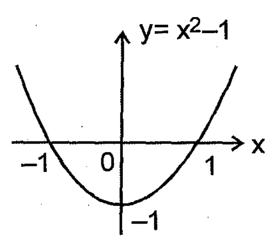
$$= \frac{64}{3^7} + \frac{64}{3^7} + \frac{8}{3^7} = \frac{136}{3^7}$$

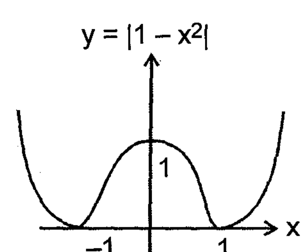
11. **(A) → (P,T) ; (B) → (R) ; (C) → (Q) ; (D) → (Q)**

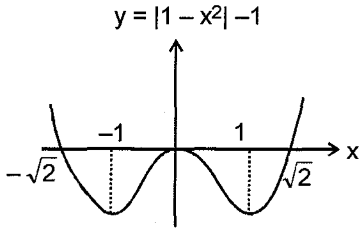
(A) Since $f(x) = \sin^{-1}x + \tan^{-1}x + \cot^{-1}x = \sin^{-1}x + \frac{\pi}{2}$

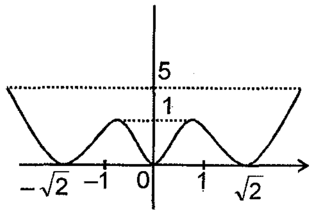
$\therefore$ f(x) is differentiable in (–1, 1)

(B)



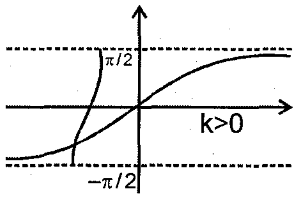


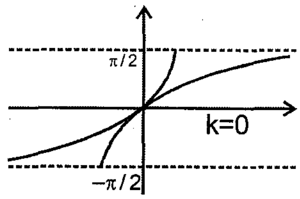


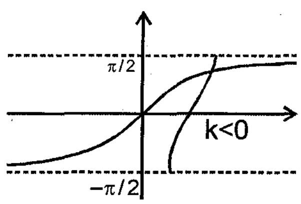


only two solution

(C)







One solution in each case.

(D) $y = |(x-1)^3| + |(x-2)^5| + |x-3|$ is non differentiable at $x = 3$ only

12.

$$z_1, z_2 \ldots\ldots z_k = \cos\left(\pi\sum_{n=1}^{k}\frac{1}{n(n+1)(n+2)}\right) + i\sin\left(\pi\sum_{n=1}^{k}\frac{1}{n(n+1)(n+2)}\right)$$

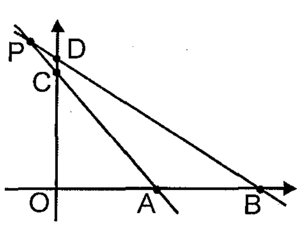
$$\because \frac{1}{n(n+1)(n+2)} = \frac{1}{2}\left[\frac{1}{n(n+1)} - \frac{1}{(n+1)(n+2)}\right]$$

$$= \cos\left(\frac{\pi}{2}\sum_{n=1}^{k}\left(\frac{1}{n(n+1)} - \frac{1}{(n+1)(n+2)}\right)\right) + i\sin\left(\frac{\pi}{2}\sum_{n=1}^{k}\left(\frac{1}{n(n+1)} - \frac{1}{(n+1)(n+2)}\right)\right)$$

$$= \cos\frac{\pi}{2}\left(\frac{1}{2} - \frac{1}{(k+1)(k+2)}\right) + i\sin\frac{\pi}{2}\left(\frac{1}{2} - \frac{1}{(k+1)(k+2)}\right)$$

$$\therefore \lim_{k\to\infty} z_1 z_2 \ldots\ldots z_k = \cos\frac{\pi}{4} + i\sin\frac{\pi}{4} = \frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}$$

13.



Let A(k,0), B(2k, 0), C(0, c) and D(0, d)

Equation of AC, $\frac{x}{k} + \frac{y}{c} = 1$

Equation of BD, $\frac{x}{2k} + \frac{y}{d} = 1$

Then equation of line OP is $\frac{x}{2k} + y\left(\frac{1}{c} - \frac{1}{d}\right) = 0$

AD and OP intersect at Q, then equation of CQ is

$$\frac{x}{2k} + y\left(\frac{1}{c} - \frac{1}{d}\right) + \lambda\left(\frac{x}{k} + \frac{y}{d} - 1\right) = 0$$

(line passes through point of intersection of OP and AD)

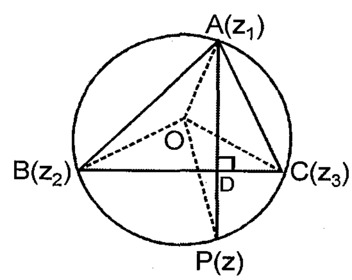
It also passes through C(0, c).

So $\left(1 - \frac{c}{d}\right) + \lambda\left(\frac{c}{d} - 1\right) = 0 \Rightarrow \lambda = 1$

Then we get equation of CQ as $\frac{3x}{2k} + \frac{y}{c} = 1$

it always passes through the point $\left(\frac{2k}{3}, 0\right)$.

14.



Let AD be the altitude which meets the circum-circle at point 'P'
Let O (origin) is circumcentre
OA = OP $\Rightarrow |z_1|^2 = |z|^2$

$$\Rightarrow z_1\bar{z}_1 = z\bar{z} \Rightarrow \frac{\bar{z}_1}{\bar{z}} = \frac{z}{z_1}$$

Similarly, $\frac{\bar{z}_2}{\bar{z}} = \frac{z}{z_2}, \frac{\bar{z}_3}{\bar{z}} = \frac{z}{z_3}$

Since AP ⊥ BC, $\arg\left(\frac{z_1 - z}{z_3 - z_2}\right) = \frac{\pi}{2}$ i.e. $\frac{z_1 - z}{z_3 - z_2}$ is purely imaginary

$$\frac{z_1 - z}{z_3 - z_2} + \frac{\bar{z}_1 - \bar{z}}{\bar{z}_3 - \bar{z}_2} = 0, \Rightarrow \frac{z_1 - z}{z_3 - z_2} + \frac{\frac{\bar{z}_1}{\bar{z}} - 1}{\frac{\bar{z}_3}{\bar{z}} - \frac{\bar{z}_2}{\bar{z}}} = 0,$$

$$\Rightarrow \frac{z_1 - z}{z_3 - z_2} + \frac{\frac{z}{z_1} - 1}{\frac{z}{z_3} - \frac{z}{z_2}} = 0$$

$$\Rightarrow \frac{z_1 - z}{z_3 - z_2} + \frac{(z - z_1)z_2z_3}{zz_1(z_2 - z_3)} = 0,$$

$$\Rightarrow \frac{z_1 - z}{z_3 - z_2}\left(1 + \frac{z_2z_3}{zz_1}\right) = 0, \Rightarrow 1 + \frac{z_2z_3}{zz_1} = 0, \Rightarrow z = \frac{-z_2z_3}{z_1}$$

15.

A	B	C	D	R
+	change	leave	change	+
+	leave	leave	leave	+
+	change	change	leave	+
+	leave	change	change	+

Required probability $= \frac{1}{3}\times\frac{2}{3}\times\frac{2}{3}\times\frac{1}{3}\times 3 + \frac{1}{3}\times\frac{1}{3}\times\frac{1}{3}\times\frac{1}{3} = \frac{13}{81}$

$\Rightarrow \quad 13 + 81 = 94$ **Ans.**

16. $g(x) = x^2 + x^2\int_{-1}^{1} tg(t)dt + x^3\int_{-1}^{1} g(t)dt$

by

$g(x) = x^2(1 + A) + Bx^3$

where $A = \int_{-1}^{1} tg(t)dt,\ B = \int_{-1}^{1} g(t)dt$

$A = \int_{-1}^{1} t[(1+A)t^2 + Bt^3]dt = \frac{2B}{5}$

Similarly $B = \int_{-1}^{1}[(1+A)t^2 + Bt^3]dt$

$\Rightarrow B = (A + 1)\ \frac{2}{3} \Rightarrow 3B = 2\left(1 + \frac{2B}{5}\right)$

$\Rightarrow A = \frac{4}{11}, B = \frac{10}{11} \Rightarrow g(x) = \frac{15}{11}x^2 + \frac{10}{11}x^3$

$\therefore \int_{-1}^{1}[g(x) + g(-x)]dx = \int_{-1}^{1}\left(\frac{15}{11}x^2 + \frac{10}{11}x^3 + \frac{15}{11}x^2 - \frac{10}{11}x^3\right)dx$

$\Rightarrow \int_{-1}^{1}[g(x) + g(-x)]dx = \frac{30}{11}\int_{-1}^{1}x^2dx = \frac{20}{11}$

$\Rightarrow 11\int_{-1}^{1}[g(x) + g(-x)]dx = 20$

17. **364**

$\because H = 4$

$\Rightarrow 2A + G^2 = 27$

$\Rightarrow 2A + AH = 27\ (\because G^2 = AH)$

$\Rightarrow \quad 6A = 27$

$\Rightarrow A = \frac{9}{2}$ and $G^2 = \frac{9}{2} \times 4 = 18$

$\therefore$ a,b are the roots of $x^2 - 9x + 18 = 0$

$\therefore$ a = 6, b = 3 or a = 3, b = 6

$\therefore \alpha = a + b = 9,\ \beta = |a - b| = 3$

and $1 + \left(\frac{\alpha}{\beta}\right) + \left(\frac{\alpha}{\beta}\right)^2 + \left(\frac{\alpha}{\beta}\right)^3 + \left(\frac{\alpha}{\beta}\right)^4 + \left(\frac{\alpha}{\beta}\right)^5$

$= 1 + 3 + 3^2 + 3^3 + 3^4 + 3^5 = 364$ **Ans.**

18. $[\tan x]^2 + \tan x - a = 0$

$\because [\tan x]^2$ and a are integral in nature $\Rightarrow$ tanx is integer.

$\Rightarrow$ equation reduces to $\tan^2x + \tan x - a = 0$

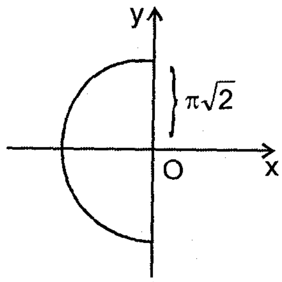
$\Rightarrow \tan x(\tan x + 1) = a$

$\therefore$ a is product of consecutive integer

Here a = 12, 20, 30, 42, 56, 72, 90

$\Rightarrow$ a has 7 values.

19.



Centre $\left(-\sqrt{g}, -f\right)$

given radius $= \pi\sqrt{2} \Rightarrow g + f^2 = 2\pi^2$

Now, replace $-\sqrt{g} \rightarrow x\ (x < 0)$

$-f \rightarrow y$

Locus $x^2 + y^2 = 2\pi^2$; $x < 0$

$\Rightarrow \theta \in \left[\frac{\pi}{2}, \frac{3\pi}{2}\right]$ (Only in 2nd and 3rd quadrant)

20. C

There is a need of potential difference for current to flow.

21. C

22. D

$(m_1 - 1)\theta - (\mu_2 - 1)\theta = \alpha$

$\Rightarrow \mu_1 - \mu_2 = \alpha/\theta$

23. D

24. A,B,D

$R = 10\,\Omega, X_L = 8\,\Omega, X_C = 3\,\Omega, X = 5\,\Omega$

$$Z = \sqrt{(5)^2 + (10)^2} = 5\sqrt{5}\,\Omega$$

$$P.F = \cos\phi = \frac{R}{Z} = \frac{2}{\sqrt{5}}$$

$$P_{av} = \frac{(v_{rms})^2}{Z}\cos\phi = \frac{100\times100}{5\sqrt{5}}\times\frac{10}{5\sqrt{5}} = 800\text{ W}$$

25. A,B,C

$$a_n = \frac{v^2}{R} = \omega^2 R$$

26. C

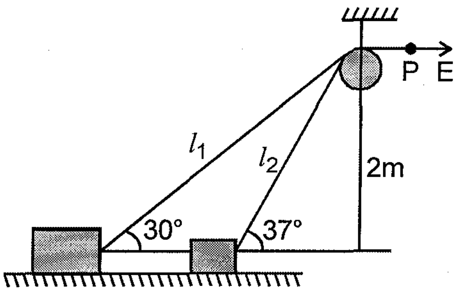
Centre of Mass is affected only by external forces.

27. B,C,D

28. A,D

$$l_1 = \frac{2}{\sin 30^\circ} = 4\text{m},\quad l_2 = \frac{2}{\sin 37^\circ} = \frac{10}{3}\text{m}$$

Displacement. of point P : $l_1 - l_2 = 4 - \frac{10}{3} = \frac{2}{3}$m



Work done, $W = F(l_1 - l_2) = 50 \times \frac{2}{3} = \frac{100}{3}$J

$$W = \frac{1}{2}m(v^2 - u^2),\ u = 0$$

$$\Rightarrow \frac{100}{3} = \frac{1}{2}10v^2 \Rightarrow v^2 = \frac{20}{3}$$

$$\Rightarrow v = \sqrt{\frac{20}{3}}\text{m/s}$$

Initial acceleration = $\frac{F\cos 30^\circ}{m}$

Final acceleration = $\frac{F\cos 37^\circ}{m}$

Ratio = $\frac{\cos 30^\circ}{\cos 37^\circ} = \frac{\sqrt{3}\times5}{2\times4} = \frac{5\sqrt{3}}{8}$

29. $A \to R$; $B \to P,S$; $C \to R$; $D \to P, S$

30. $A \to Q$; $B \to R$, ; $C \to P$; $D \to S$

31. 21 μT

According to Biot-Savart law,

$$B = \frac{\mu_0}{4\pi}\frac{qv\sin\theta}{r^2}$$

$$B = \frac{10^{-7}\times0.2\times4\times10^3\times3}{109\times\sqrt{109}} = 21\mu T$$

32. If ring is displaced by an angle θ along x direction then

torque due to magnetic field is $\tau_1 = \mu \times B$

$= iAB\sin\theta = \pi R^2 iB\sin\theta$

And torque due to spring force is τ_2

$= K(2R\sin\theta) \times 2R\cos\theta$

Both torque have the same sense so net torque is

$$\tau = \tau_1 + \tau_2 = \pi R^2 iB\sin\theta + 4KR^2\cos\theta\sin\theta$$

For θ to be small $\sin\theta = \theta$ and $\cos\theta = 1$

So $\tau = -(\pi R^2 iB + 4KR^2)\theta$ or $\frac{3MR^2}{2}\alpha$

$= -(\pi R^2 IB + 4KR^2)\theta$ or $\alpha = -\frac{2(\pi iB + 4K)}{3M}\theta$

Here $\alpha \propto -\theta$ so it is SHM, hence time period is

$$T = 2\pi\sqrt{\frac{3M}{2(4K + \pi iB)}}$$

33. Here $Z = x + yj + \omega Lj = x + j(y + \omega L)$

for power factor to be one $y + \omega L = 0 \Rightarrow y = -10$

$I = \frac{V_0}{x}$, $x = \frac{V_0}{I} = \frac{25}{5} = 5$, Impedance of box = 5 – 10 j,

$$\cos\varphi = \frac{5}{\sqrt{5^2 + 10^2}} = \frac{1}{\sqrt{5}}$$

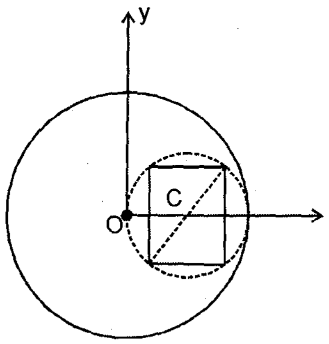
34. Let tension at A and B be T_1 and T_2 AP =x

Torque about A $20x + (60 \times 1.1) = 2T_2$

Torque about B $2T_1 = 20(2 - x) + (60 \times 0.9)$

$\therefore\ x \in [0.5,\ 0.9]$

35.



Side of square = $R\cos 45° = \frac{R}{\sqrt{2}}$

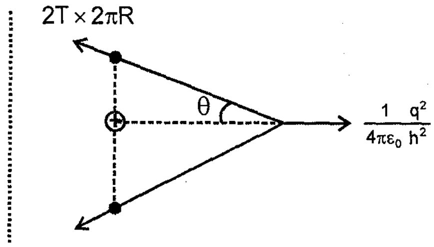
Area of square = $\frac{R^2}{2}$

$$X_{COM} = \frac{\pi R^2 \times \sigma \times 0 + \frac{\pi R^2}{4} \times (-\sigma) \times \frac{R}{2} + \frac{R^2}{2}\sigma.\frac{R}{2}}{\pi R^2 \sigma + \frac{\pi R^2}{4}(-\sigma) + \frac{R^2}{2}\sigma}$$

$$= \frac{R[2-\pi]}{2[3\pi+2]}$$

$\therefore$ The centre of mass of the system is at a distance of $\frac{R[2-\pi]}{2[3\pi+2]}$ from the centre O towards the plate as shown in the figure.

36.



$$2T \times 2\pi R\cos\theta = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{h^2} \Rightarrow h^3 = \frac{1}{16\pi^2\varepsilon_0}\frac{q^2}{T}$$

37. $20\pi\cos\pi t$ cm/s

38. **14.3 s, 0.45 m/s²**

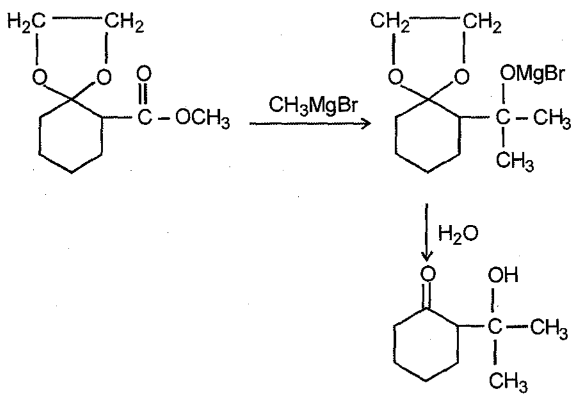
$1.5t + 0.7t = 2\pi R = 10\pi$

$$\therefore\quad t = \frac{10\pi}{2.2} = 14.3\text{s}$$

$$a = \frac{v_B^2}{R} = 0.45\text{m/s}^2$$

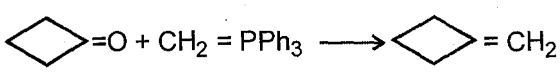
CHEMISTRY

39. **B**



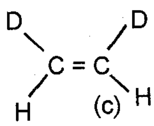
40. **D**

41. **A**



42. **A**

$DC \equiv CD \xrightarrow{B_2H_6} (DCH = CD)_3B \xrightarrow{E_tCOOH}$



$B \xrightarrow[OD^-]{D_2O_2} D_2CH - CD = O$

43. **A,C,D**

44. **C,D**

45. **A,C**

46. **A**

47. **A,C**

48. **A – P,R,S ; B – Q; C – Q; D – P,R**

49. **A – P,S,T ; B – R,Q; C – S; D – P,S**

50. **650 J**

51. Let the m.mole of $Fe_2(SO_4)_3$ and FeC_2O_4 are a and b m.mole respectively

m.e. of FeC_2O_4 = m.e. of $KMnO_4$

$b \times 3 = 40 \times \frac{1}{16}$ ...(1)

(only FeC_2O_4 can oxidise)

After reduction we will get 2a + b moles of Fe^{2+} ion which will oxidise by $KMnO_4$.

M.e. of Fe^{2+} = M.e. $KMnO_4$

$(2a + b) \times 1 = 60 \times \frac{1}{16}$ ...(ii)

a : b = 7 : 4 **Ans.** 7 : 4

52. Min OH^- for PPt of $A(OH)_2$

$[A^{+2}][OH^-]^2 = 2\times10^{-11}$

$[OH^-] = 2\times10^{-5}$

$BOH \rightleftharpoons B^+ + OH^-$

$K_b = [B^+]\ \frac{2\times10^{-5}}{0.05} \Rightarrow [B^+] = 0.05$

m.moles of B_2SO_4 = 0.025

wt = 0.025 × 132 = 3300 mg

53. $K_a = \frac{C\alpha^2}{1-\alpha} \Rightarrow \frac{1}{6} = \frac{\alpha^2}{1-\alpha}$

$\Rightarrow a = \frac{-1\pm\sqrt{(1)^2+4\times6\times1}}{12} = \frac{-1\pm\sqrt{1+24}}{12} = \frac{1}{3}$

$\therefore\ [IO_3^-] = 1\times\frac{1}{3} = \frac{1}{3}M$

$\therefore\ [Ag^+] = \frac{3\times10^{-8}}{\frac{1}{3}} = 9\times10^{-8}M$

Now $2Ag + Zn^{+2} \xrightarrow{2e^-} 2Ag^+ + Zn$

Gives $E = -1.56 + \frac{0.059}{2}\log\frac{1}{(9\times10^{-8})^2} = -1.144$

V = –1144 mV

Ans. 1144

54. $6CN^- + Co^{+2} \longrightarrow [Co(CN)_6]^{-4}$ $K_r = 10^{19}$

$6CN^- + Co^{+3} \longrightarrow [Co(CN)_6]^{-3}$ $K_f = x$

$[Co(CN)_6]^{-3} + e^- \longrightarrow [Co(CN)_6]^{-4}$

$E^o = -0.84$

$Co^{+3} + e^- \longrightarrow Co^{+2}$ $E^o = 1.82$

from (i) & (ii)

$[Co(CN)_6]^{-3} + Co^{+2} \longrightarrow [Co(CN)_6]^{4} + Co^{+3}$

$E^o = -1.82 - 0.84$

$K = \frac{10^{19}}{x}$

$-2.66 = E^o = \frac{0.059}{1}\log\frac{10^{19}}{x}$

$\Rightarrow x = 10^{64}$

55. Work = $6 \times 10^4 \times 10 \times 8000$

$= 48 \times 10^8$ J

Efficiency 30%

$48 \times 10^8 \times \frac{30}{100} = 144 \times 10^7$ J

Heat of comb. = 1440 kJ/mole

moles of octane = $\frac{1}{1440\times10^3}\times144\times10^7 = 10^3$ mole

wt of octane = $10^3 \times 114$ gm

$= 1.14 \times 10^5$ gm

volume of fuel = $\frac{1.14\times10^5}{d} = \frac{1.14\times10^5}{0.57}$

$= 2 \times 10^5$ ml $= 2 \times 10^2$ lit

Fuel cost = 200 × 3 = 600 Rs

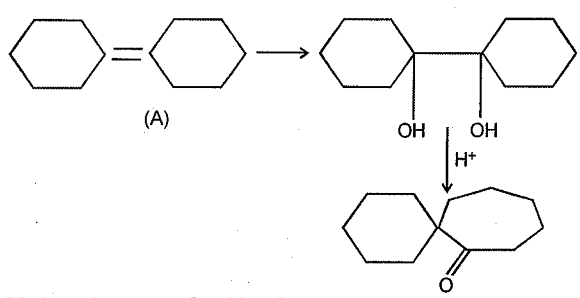
56. $Cr^{+3}(3d^3) \Rightarrow$ 3 Unpaired e^-

$Ni^{+2}(3d^8) \Rightarrow$ 2 unpaired e^-

$Cu^{+2}(3d^9) \Rightarrow$ 1 unpaired e^-

Total unpaired e^- = 3 + 2 + 1 + 1 = 7

57.



Molecular wt = $C_{12}H_{20}O$

144 + 20 + 16 = **180**