

**AIEEE PAPER – 2010**  
**Answers and Explanations**

Code :



1	1	16	2	31	4	46	3	61	3	76	4
2	2	17	2	32	4	47	4	62	4	77	1
3	1	18	1	33	4	48	3	63	1	78	1
4	4	19	3	34	2	49	3	64	4	79	1
5	4	20	1	35	4	50	1	65	4	80	4
6	2	21	1	36	3	51	4	66	2	81	2
7	2	22	2	37	2	52	1	67	1	82	4
8	4	23	3	38	2	53	1	68	3	83	2
9	4	24	3	39	2	54	1	69	4	84	1
10	4	25	3	40	1	55	2	70	1	85	4
11	3	26	4	41	2	56	4	71	3	86	4
12	4	27	2	42	1	57	1	72	4	87	3
13	3	28	3	43	2	58	3	73	1	88	3
14	3	29	4	44	3	59	2	74	4	89	3
15	1	30	1	45	4	60	4	75	2	90	3

**PART A – MATHEMATICS**

1. (1) The lines are  $4x - y = 20$  and  $4x - y = -3$

The distance between lines is  $\frac{23}{\sqrt{17}}$

2. (2)

3. (1)  $f(-1) \leq \lim_{x \rightarrow -1^+} f(x)$

$$K + 2 \leq 1$$

$$K \leq -1$$

$$\boxed{K = -1}$$

4. (4) Four numbers can be selected in  ${}^{20}C_4$  ways  
Number of possible APs are = 57

$$\text{Then probability is } = \frac{57}{{}^{20}C_4} = \frac{1}{85}$$

then statement-1 is true, statement-2 is false

5. (4)  $A^2 = I$   
 $A = A^{-1}$

6. (2)  $f(x) = \frac{1}{e^x + 2e^{-x}} = \frac{e^x}{e^{2x} + 2}$

$$\text{for } f(c) = \frac{1}{3}$$

$$\frac{e^c}{e^{2c} + 2} = \frac{1}{3}$$

$$3e^c = e^{2c} + 2$$

$$e^{2c} - 3e^c + 2 = 0$$

$$(e^c - 1)(e^c - 2) = 0$$

$$e^c = 1 \text{ or } e^c = 2$$

$$\Rightarrow c = 0 \text{ or } c = \log_e 2$$

statement-1 is true

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

$$\therefore e^x + e^{-x} \geq 2 \left[ T + \frac{1}{T} \geq 2 \text{ for } T > 0 \right]$$

$$e^x + e^{-x} + e^{-x} > 2$$

$$\therefore \frac{1}{e^x + 2e^{-x}} < \frac{1}{2}$$

7. (2) The mid point of (3, 1, 6) and (1, 3, 4) is (2, 2, 5) and it will lie on the plane  $x - y + z = 0$

$$\therefore 2 - 2 + 5 = 0$$

8. (4)  $S_3 = 1^2 \cdot {}^{10}C_1 + 2^2 \cdot {}^{10}C_2 + \dots + 10^2 \cdot {}^{10}C_{10}$

$$(1+x)^n = {}^nC_0 + {}^nC_1x + {}^nC_2x^2 + \dots + {}^nC_nx^n \dots (i)$$

Differentiating

$$n(1+x)^{n-1} = nC_1 + 2nC_2x + \dots + nC_nx^{n-1} \dots (ii)$$

Put  $x = 1$

$$n \cdot 2^{n-1} = nC_1 + 2nC_2 + 3nC_3 + \dots + nC_n$$

$$\text{put } n = 10 \quad {}^{10}C_1 + 2 \cdot {}^{10}C_2 + \dots + 10 \cdot {}^{10}C_{10} = 10 \cdot 2^9$$

$S_2 = 10 \cdot 2^9$  statement 2 is wrong from equation (ii)

$$n(1+x)^{n-1} = nC_1 + 2nC_2x + 3nC_3x^2 + \dots + nC_nx^{n-1}$$

Multiply by  $x$

$$nx(1+x)^{n-1} = nC_1x + 2nC_2x^2 + 3nC_3x^3 + \dots + nC_nx^n$$

Differentiating

$$\begin{aligned} n(1+x)^{n-1} + n(n-1)x(1+x)^{n-2} \\ = nC_1 + 2^2nC_2x + 3^2nC_3x^2 + \dots + n^2nC_nx^{n-1} \end{aligned}$$

Put  $x = 1$

$$\begin{aligned} nC_1 + 2^2nC_2 + 3^2nC_3 + \dots + n^2nC_n \\ = n \cdot 2^{n-1} + n(n-1)2^{n-2} \end{aligned}$$

Put  $n = 10$

$$\begin{aligned} 1^2 \cdot {}^{10}C_1 + 2^2 \cdot {}^{10}C_2 + \dots + 10^2 \cdot {}^{10}C_{10} = 10 \cdot 2^9 + 90 \cdot 2^8 \\ = 10 \cdot 2^9 + 45 \cdot 2^9 = 55 \cdot 2^9 \end{aligned}$$

$$S_3 = 55 \cdot 2^9$$

Statement-1 is true.

9. (4)  $\alpha = 45^\circ, \beta = 120^\circ, r = ?$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

$$\frac{1}{2} + \frac{1}{4} + \cos^2 \gamma = 1$$

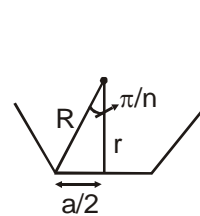
$$\cos^2 \gamma = \frac{1}{4} \Rightarrow \cos \gamma = \pm \frac{1}{2} \text{ but } r \text{ is a centre}$$

$$\therefore \cos \gamma > 0$$

$$\cos \gamma = \frac{1}{2} \Rightarrow \gamma = 60^\circ$$

10. (4) Let side of polygon be a

$$\cos \frac{\pi}{n} = \frac{r}{R}$$



$$(1) \frac{r}{R} = \cos \frac{\pi}{6} = \cos \frac{\pi}{n} \therefore n = 6$$

$$(2) \frac{r}{R} = \cos \frac{\pi}{3} = \cos \frac{\pi}{n} \therefore n = 3$$

$$(3) \frac{r}{R} = \cos \frac{\pi}{4} = \cos \frac{\pi}{n} \therefore n = 4$$

$$(4) \frac{r}{R} = \cos \frac{\pi}{n} = \frac{2}{3} \text{ } n \text{ is not an integer}$$

11. (3)  $\cos(\alpha + \beta) = \frac{4}{5} \quad \sin(\alpha - \beta) = \frac{5}{13}$

$$\therefore \tan(\alpha + \beta) = \frac{3}{4} \therefore \tan(\alpha - \beta) = \frac{5}{12}$$

$$\tan 2\alpha = \tan(\alpha + \beta + \alpha - \beta)$$

$$= \frac{\tan(\alpha + \beta) + \tan(\alpha - \beta)}{1 - \tan(\alpha + \beta)\tan(\alpha - \beta)}$$

$$= \frac{\frac{3}{4} + \frac{5}{12}}{1 - \frac{3}{4} \times \frac{5}{12}} = \frac{36 + 20}{48 - 15}$$

$$\tan 2\alpha = \frac{56}{33}$$

12. (4)

13. (3)  $P'(x) = P'(1-x)$   $P(0) = 1$   
 $P(1) = 41$

$$\Rightarrow \int_0^1 P'(x) dx = \int_0^1 P'(1-x) dx$$

$$\Rightarrow P(x) + P(1-x) = C$$

$$P(x) + P(1-x) = 42$$

$$\Rightarrow P(x)$$

$$\int_0^1 P(x) dx = -\int_1^0 P(1-x) dx$$

$$= \int_0^1 P(1-x) dx$$

$$2 \int_0^1 P(x) dx = \int_0^1 42 dx$$

$$2 \int_0^1 P(x) dx = 42$$

$$\Rightarrow \int_0^1 P(x) dx = 21$$

14. (3) First 10 min notes counted  $10 \times 150 = 1500$   
 remaining notes = 3000  $a_{11} = 148$  c.d. = -2,  
 remaining time = t

$$\Rightarrow 3000 = \frac{t}{2} [2 \times 149 + (t-1)(-2)]$$

$$6000 = t \times 296 - 2t^2 + 2t$$

$$2t^2 + 298 + 6000 = 0$$

$$t^2 - 149t + 3000 = 0$$

$$t^2 - 125t - 21t + 3000 = 0$$

$$t = 21$$

$$\text{total time} = 10 + 24 = 34$$

15. (1) as  $f(x)$  is positive  $f(x) > 0$

and increasing fraction  $f'(x) > 0$

$$f(x) < f(2x) < f(3x)$$

$$\Rightarrow 1 < \frac{f(2x)}{f(x)} < \frac{f(3x)}{f(x)}$$

$$\Rightarrow \lim_{x \rightarrow \infty} \frac{f(2x)}{f(x)} = 1$$

16. (2)  $\cos x \frac{dy}{dx} = y \sin x - y^2$

$$\frac{dy}{dx} - y \tan x = -\sec x y^2$$

$$-\frac{1}{y^2} \frac{dy}{dx} + \left(\frac{1}{y}\right) \tan x = \sec x$$

$$\frac{1}{y} = t$$

$$\frac{dt}{dx} + \tan x \cdot t = \sec x$$

$$\text{IF} = e^{\int \tan x dx} = \log_e |\sec x|$$

$$= e$$

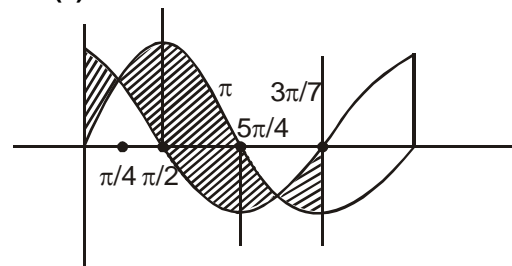
$$= |\sec^2 x|$$

$$\frac{d}{dx}(t \sec x) = \sec^2 x$$

$$t \sec x = \int \sec^2 x dx = \tan x + k$$

$$\sec x = y(\tan x + k)$$

17. (2)



$$\Delta = \int_0^{\pi/4} (\cos x - \sin x) dx + \int_{\pi/4}^{\pi/2} (\sin x - \cos x) dx$$

$$+ \int_{\pi/2}^{\pi} \sin x dx + \int_{\pi/2}^{\pi} (-\cos x) dx$$

$$\begin{aligned}
 & + \int_{\pi}^{5\pi/4} (\sin x - \cos x) dx + \int_{5\pi/4}^{3\pi/2} (\cos x - \tan x) dx \\
 & = (\sqrt{2} - 1) + (\sqrt{2} - 1) + (1) + (1) + (\sqrt{2} - 1) + (\sqrt{2} - 1) \\
 & = 4\sqrt{2} - 2
 \end{aligned}$$

18. (1)  $y = x + \frac{4}{x^2}$

as target is parallel to x-axis  $\Rightarrow y' = 0$

$$y' = 1 - \frac{8}{x^3} \Rightarrow x = 2, y = 3$$

Hence  $y = 3$

19. (3)  $g(x) = (f(2f(x) + 2))^2$

$$g'(x) = 4f(2f(x) + 2) \cdot f'(x) \cdot f'(2f(x) + 2)$$

put  $x = 0$

$$g'(0) = 4f'(0) \cdot f'(-2 + 2) \cdot f(0)$$

$$= f(f'(0))^2 (-1) = -4$$

20. (1)  ${}^3C_2 \times {}^9C_2 = 108$

21. (1)

$$\Delta = \begin{vmatrix} 1 & 2 & 1 \\ 2 & 3 & 1 \\ 3 & 5 & 2 \end{vmatrix} = 1(6 - 5) - 2(4 - 3) + 1(10 - 9)$$

$$\Delta_1 = \begin{vmatrix} 3 & 2 & 1 \\ 3 & 3 & 1 \\ 1 & 5 & 2 \end{vmatrix} = 3(6 - 5) - 2(3 - 1) + 1(15 - 3)$$

$$= 3 - 4 + 12 \neq 0$$

$$\Delta_2 = \begin{vmatrix} 1 & 3 & 1 \\ 2 & 3 & 1 \\ 3 & 1 & 2 \end{vmatrix} = 1(6 - 1) - 3(4 - 3) + 1(2 - 9)$$

$$= 5 - 3 - 7 \neq 0$$

22. (2)  $(\bar{a} \times \bar{b}) + \bar{c} = 0$

$$\bar{a} \times (\bar{a} \times \bar{b}) + \bar{a} \times \bar{c} = 0$$

$$(a \cdot b)\bar{a} - (a \cdot a)\bar{b} + \bar{a} \times \bar{c} = 0$$

$$(\bar{a} \times \bar{c}) = -2\hat{i} - \hat{j} - \hat{k}$$

$$3(\hat{j} - \hat{k}) - (1+1)\bar{b} + (-2\hat{i} - \hat{j} - \hat{k}) = 0$$

$$2\bar{b} = -2\hat{i} - \hat{j} - \hat{k} + 3\hat{i} - 3\hat{k}$$

$$= -2\hat{i} + 2\hat{j} - 4\hat{k}$$

$$\bar{b} = -\hat{i} + \hat{j} - 2\hat{k}$$

23. (3)  $x_1 = x_2 = 5 \quad \bar{x}_1 = 2 \quad \sigma_1^2 = 4$

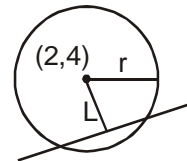
$$\bar{x}_2 = 4 \quad \sigma_2^2 = 5$$

$$\sigma^2 = \frac{1}{n_1 + n_2} \left[ n_1 \sigma_1^2 + n_2 \sigma_2^2 + \frac{n_1 n_2}{n_1 + n_2} (\bar{x}_1 - \bar{x}_2)^2 \right]$$

$$\sigma^2 = \frac{11}{2}$$

24. (3)  $x^2 + y^2 - 4x - 8y - 5 = 0$

$$r = \sqrt{4 + 16 + 5} = 5$$



length of perpendicular to line  $-3x + 4y + m = 0$

$$L = \left| \frac{-6 + 16 + m}{5} \right|$$

$$L < r$$

$$\left| \frac{m + 10}{5} \right| < 5$$

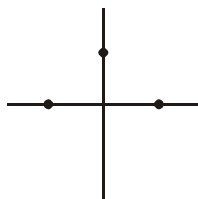
$m$  lies between  $(-35, 15)$

25. (3)  $\frac{{}^3C_1 \times {}^4C_1 \times {}^2C_1}{{}^9C_3} = \frac{2}{7}$

26. (4) Locus of point P is directrix  
 $x = -1$

27. (2)  $\vec{a} \cdot \vec{c} = 0$   
 $\Rightarrow \lambda + 2\mu = 1 \quad \dots(i)$   
 $\vec{b} \cdot \vec{c} = 0$   
 $\Rightarrow 4\lambda + 2\mu = -8 \quad \dots(ii)$   
 solving (i) and (ii)  
 $\lambda = -3$  and  $\mu = 2$

28. (3)



$|z - 1| = |z + 1| = |z - i|$   
 origin is location of z

29. (4)  $\alpha = -\omega$  and  $\beta = -\omega^2$   
 $(-\omega)^{2009} + (-\omega^2)^{2009}$   
 $-\omega - \omega^2 = 1$

30. (1)

## PART B – PHYSICS

31. (4) Since  $S > S_{oil}$  thus ball can't be in equilibrium in oil and  $S_{water} > S_{oil}$ , so water has to be below oil.

32. (4) By mass-energy relation.  
 Let speed of daughter nuclei be V

$$\Delta mc^2 = 2 \cdot \frac{1}{2} M V^2$$

$$\Rightarrow V^2 = \frac{2\Delta m C^2}{M}$$

$$V = C \sqrt{\frac{2\Delta m}{M}}$$

33. (4)

34. (2) When capacitance is taken out, then

$$\tan 30^\circ = \frac{X_L}{R} \Rightarrow X_L = \frac{200}{\sqrt{3}} \Omega$$

When inductance is taken out, then

$$\tan 30^\circ = \frac{X_C}{R} \Rightarrow X_C = \frac{200}{\sqrt{3}} \Omega$$

While all three are present,

$$\phi = 0 \{X_L = X_C\}$$

thus power dissipated  $P = E_{rms} i_{rms} \cos 0^\circ$

$$= \frac{220 \times 220}{\sqrt{(200)^2 + 0}} = \frac{220 \times 220}{200} = 242W$$

35. (4)  $\rho(r) = \rho_0 \left[ \frac{5}{4} - \frac{r}{R} \right]$

By Gauss Law

$$\int \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$$

$$\Rightarrow E \cdot 4\pi r^2 = \frac{\int_0^r \rho(r) 4\pi r^2 dr}{\epsilon_0}$$

$$= \frac{\int_0^r \rho_0 \left[ \frac{5}{4} - \frac{r}{R} \right] 4\pi r^2 dr}{\epsilon_0}$$

$$E \cdot 4\pi r^2 = \frac{\rho_0 4\pi \left[ \int_0^r \frac{5}{4} r^2 dr - \frac{1}{R} \int_0^r r^3 dr \right]}{\epsilon_0}$$

$$E \cdot r^2 = \frac{\rho_0}{\epsilon_0} \left[ \frac{5}{4} \frac{r^3}{3} - \frac{1}{R} \frac{r^4}{4} \right]$$

$$E \cdot r^2 = \frac{\rho_0}{4\epsilon_0} \left[ \frac{5}{3} r - \frac{r^2}{R} \right] \Rightarrow E = \frac{\rho_0 r}{4\epsilon_0} \left[ \frac{5}{4} - \frac{r}{R} \right]$$

36. (3) Since  $\mu(l) = \mu_0 + \mu_2(l)$  and  $l \propto \frac{1}{r}$ .

For cylindrical beam

$$\Rightarrow \frac{C}{V_{\text{medium}}} = \mu_0 + \mu_2(l)$$

$$\Rightarrow V_{\text{medium}} = \frac{C}{\mu_0 + \mu_2(l)} \Rightarrow V_{\text{medium}} \propto \frac{1}{(l)}$$

thus speed will be minimum at axis as intensity is maximum.

37. (2)

38. (2) Wavefront is perpendicular to direction of propagation of light.

39. (2)  $S = t^3 + 5$

$$\Rightarrow \text{tangential speed } V = \frac{ds}{dt}$$

$$V = 3t^2 + 0$$

$$\text{at } t = 2 \text{ sec } \quad V = 12 \text{ m/sec}$$

$$\text{Tangential acceleration } a_T = \frac{dv}{dt}$$

$$a_T = 6t$$

$$\text{at } t = 2 \text{ sec } a_T = 12 \text{ m/sec}^2$$

$$\text{centripetal acceleration } a_R = \frac{V^2}{R}$$

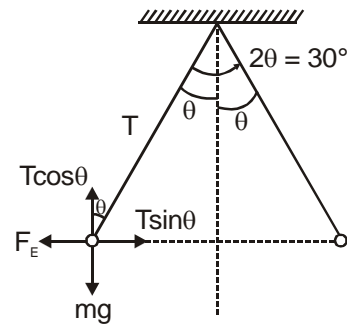
$$a_R = \frac{(12)^2}{20} = \frac{144}{20} = 7.2 \text{ m/sec}^2$$

$$\Rightarrow \text{Total acceleration } a_{\text{total}} = \sqrt{(12)^2 + (7.2)^2} \\ = 14 \text{ m/sec}^2$$

40. (1) When charged sphere are in air

$$F_E = T \sin \theta$$

$$mg = T \cos \theta$$



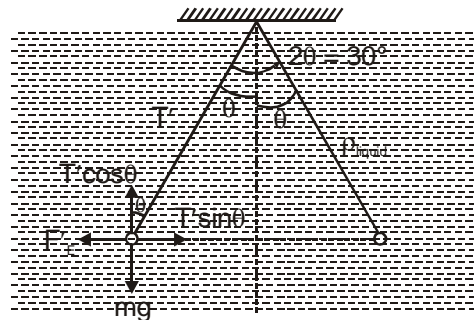
$$\Rightarrow F_E = mg \tan \theta \quad \dots(1)$$

when in liquid,

$$T' \sin \theta = F'_E$$

$$\Rightarrow T' \cos \theta + F_B = mg$$

$$T' \cos \theta = mg - F_B$$



$$\Rightarrow F'_E = (mg - F_B) \tan \theta \quad \dots(2)$$

By (1) and (2)

$$\Rightarrow \frac{F_E}{F'_E} = \frac{mg}{mg - F_B} \Rightarrow K = \frac{1}{1 - \frac{F_B}{mg}} = \frac{1}{1 - \frac{1}{R.D}}$$

$$K = \frac{1}{1 - \frac{1}{(1.6/0.8)}} = 2$$

41. (2) In series combination

$$R_{\text{eff}} = R_0 + R_0\alpha_1 t + R_0\alpha_2 t + R_0$$

$$= 2R_0 + R_0(\alpha_1 + \alpha_2)t$$

$$R_{\text{eff}} = 2R_0 \left[ 1 + \left( \frac{\alpha_1 + \alpha_2}{2} \right) t \right]$$

$$\Rightarrow \boxed{\alpha_{\text{eff}} = \frac{\alpha_1 + \alpha_2}{2}}$$

In parallel combination,

$$\frac{1}{R_{\text{eff}}} = \frac{1}{R_0(1 + \alpha_1 t)} + \frac{1}{R_0(1 + \alpha_2 t)}$$

$$\frac{1}{R_{\text{eff}}} = \frac{1}{R_0} [(1 - \alpha_1 t) + (1 - \alpha_2 t)]$$

$$R_{\text{eff}} = \frac{R_0}{[2 - (\alpha_1 + \alpha_2)t]}$$

$$R_{\text{eff}} = \frac{R_0}{2} \left[ 1 - \left( \frac{\alpha_1 + \alpha_2}{2} \right) t \right]^{-1}$$

$$= \frac{R_0}{2} \left[ 1 + \frac{(\alpha_1 + \alpha_2)t}{2} \right]$$

$$\alpha_{\text{eff}} = \frac{\alpha_1 + \alpha_2}{2}$$

42. (1)  $U(x) = \frac{a}{X^{12}} - \frac{b}{X^6}$

At equilibrium position,  $F_{\text{net}} = 0$

$$\Rightarrow \frac{dU(x)}{dx} = 0$$

$$\Rightarrow \frac{-12a}{X^{13}} + \frac{6b}{X^7} = 0$$

$$\Rightarrow X = 0 \text{ and } X = \left( \frac{2a}{b} \right)^{1/6}$$

$$\text{thus } D = \left[ \frac{a}{\left[ \left( \frac{2a}{b} \right)^{1/6} \right]^{12}} - \frac{b}{\left[ \left( \frac{2a}{b} \right)^{1/6} \right]^6} \right]$$

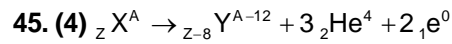
$$= - \left[ \frac{a \cdot b^2}{4a^2} - \frac{b^2}{2a} \right] = - \left[ -\frac{b^2}{4a} \right] = \frac{b^2}{4a}$$

43. (2)  $h\nu = h\nu_0 + eV_0$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + eV_0$$

as  $\lambda \downarrow, V_0 \uparrow, K_{\text{max}} \uparrow$

44. (3) In a perfectly inelastic collision, the losses are maximum.



Number of neutrons in Y is  $A' - Z'$

$$= (A - 12) - (Z - 8)$$

$$= A - Z - 4$$

Number of protons in Y =  $Z - 8$

46. (3)  $4\text{KW} = 4000 \text{ J/s}$

Number of photons/sec =  $10^{20}$

$$\therefore \text{energy/photon} = \frac{4000}{10^{20}} = 4 \times 10^{-17} \text{ J} = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = \frac{6.625 \times 10^{-34} \times 3 \times 10^8}{4 \times 10^{-17}}$$

$$= 4.96 \times 10^{-9}$$

$$= 49.6 \text{ \AA (X-rays)}$$

47. (4) Impulse = change in momentum

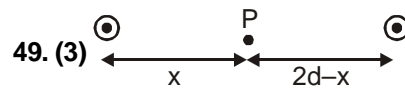
$$= m(\vec{v}_f - \vec{v}_i)$$

$$mv_i = \frac{\Delta x}{\Delta t} = -1$$

$$\therefore \text{Impulse} = 0.4(-1 - 1) = -0.8 \text{ Ns}$$

48. (3)  $\overline{A \cdot B} = \overline{A} + \overline{B}$  (De Morgan's theorem)

$$X = \overline{\overline{A \cdot B}} = A + B \text{ (OR gate)}$$

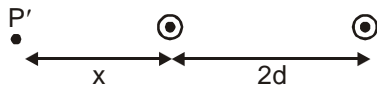


$$B_P = \frac{\mu_0 i}{2\pi} \left( \frac{1}{x} - \frac{1}{2d-x} \right)$$

At  $x = d$ ,  $B_P = 0$

At  $x \rightarrow 0, x \rightarrow 2d, B \rightarrow \infty$

Also as we cross the mid point, direction of  $B_P$  changes.



50. (1)  $q = q_0 e^{-t/\tau}$

$$U = \frac{1}{2} \frac{q^2}{C} = U_0 e^{-2t/\tau}$$

$$U = \frac{U_0}{2} = e^{-2t_1/\tau}$$

$$2 = e^{2t_1/\tau}$$

$$t_1 = \frac{\tau}{2} \ln 2$$

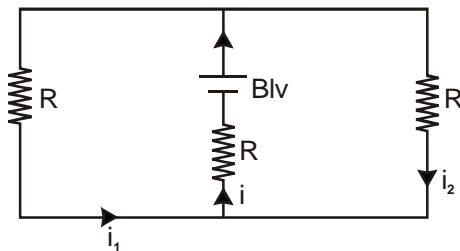
$$q = \frac{q_0}{4} = q_0 e^{-t/\tau}$$

$$4 = e^{+t_2/\tau}$$

$$t_2 = \tau \ln 4 = 2\tau \ln 2$$

$$\frac{t_1}{t_2} = \frac{1}{4}$$

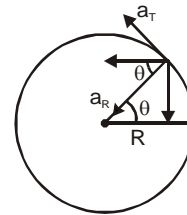
51. (4)



$$i = \frac{Blv}{R + R/2} = \frac{2Blv}{3}$$

$$i_1 + i_2 = \frac{i}{2} = \frac{Blv}{3}$$

52. (1) In a uniform circular motion  $a_T = 0$



$$a_R = \frac{v^2}{R}$$

$$\vec{a} = \frac{v^2}{R} \cos\theta (-\hat{i}) + \frac{v^2}{R} \sin\theta (-\hat{j})$$

53. (1)  $a_y = g$  for both the cases

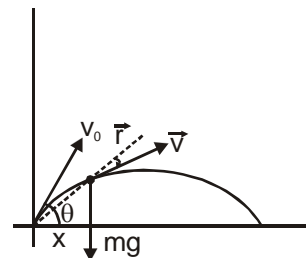
$$a_{rel} = 0$$

54. (1) Gravitational torque =  $F(\perp \text{ dist.})$

$$= mgx$$

$$= mg(v_0 \cos\theta) \tau$$

$$\bar{\tau} = \frac{dI}{dt}$$



$$|\bar{I}| |\bar{I}| = \int |\bar{I}| dt = mgv_0 \cos\theta \frac{t^2}{2}$$

$$|\bar{I}| = m(\vec{r} \times \vec{v})$$

$$= mgv_0 \cos\theta \frac{t^2}{2} (-\hat{k})$$

$$55. (2) v = \sqrt{\frac{T}{\mu}}$$

$$T = \mu v^2$$

from the equation of the wave

$$y = a \sin 2\pi \left( \frac{t}{T} - \frac{x}{\lambda} \right)$$

$$v = \frac{\lambda}{T} = \frac{0.5}{0.04} = 12.5 \text{ m/s}$$

$$T = 12.5 \times 12.5 \times 0.04 = 6.25$$

$$56. (4) \eta = 1 - \frac{T_2}{T_1}$$

for adiabatic expansion  $T_1 V_1^{r-1} = T_2 V_2^{r-1}$

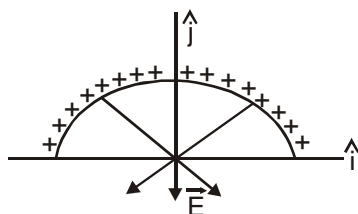
r for diatomic gas =  $\frac{7}{5}$

$$\frac{T_2}{T_1} = \left( \frac{V_1}{V_2} \right)^{r-1} = \left( \frac{1}{32} \right)^{2/5} = \frac{1}{4}$$

$$\eta = \frac{3}{4} = 0.75$$

57. (1) E due to an arc at the centre O is given by

$$\frac{Kq \sin \frac{\phi}{2}}{r^2 \phi/2}$$



Here  $\phi = \pi$

$$E = \frac{1}{4\pi \epsilon_0} \frac{q \sin \pi/2}{r^2 \pi/2}$$

$$= \frac{q}{2\pi^2 \epsilon_0 r^2}$$

58. (3)

$$59. (2) \vec{v} = Ky\hat{i} + kx\hat{j}$$

$$v_x = Ky = \frac{dx}{dt}$$

$$v_y = Kx = \frac{dy}{dt}$$

$$\frac{dy}{dx} = \frac{x}{y}$$

$$y dy = x dx$$

$$\int y dy = \int x dx + c$$

$$y^2 = x^2 + c$$

$$60. (4) \text{ At } t = 0, i = \frac{V}{R_2}$$

$$\text{ At } t \rightarrow \infty, i = \frac{V}{R_1 || R_2} = \frac{V(R_1 + R_2)}{R_1 R_2}$$

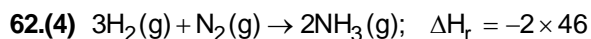
## PART C – CHEMISTRY

$$61. (3) \text{ Moles of AgCl} = \frac{4.78}{143.5} = 0.033 \text{ mol}$$

Only  $\text{Cl}^-$  outside the coordinate sphere is precipitated in AgCl.

The Moles of  $\text{CoCl}_3 \cdot 6\text{NH}_3 = 0.01$

Therefore three mole obtained from each mole of  $\text{CoCl}_3 \cdot 6\text{NH}_3$ .



$$\Delta H_r = [3\Delta H_{\text{H}_2} + \Delta H_{\text{N}_2}] - [2\Delta H_{\text{NH}_3}]$$

$$-92 = 3 \times 436 + 712 - 2\Delta H_{\text{NH}_3}$$

$$\Delta H_{\text{NH}_3} = 1056 \text{ kJ/mol}$$

N — H bond dissociation energy

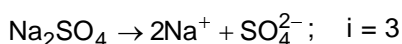
$$= \frac{1056}{3} = 352 \text{ kJ/mol}$$

63.(1)  $t_{1/2} \propto a$

$$\frac{t_{1/2}}{t'_{1/2}} = \frac{a}{a'}$$

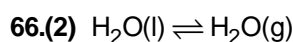
$$\frac{1}{t_{1/2}} = \frac{2}{0.5} \Rightarrow t'_{1/2} = 0.25 \text{ hr}$$

64.(4)  $\Delta T_f = K_f \times m = 1.86 \times 0.01 = 0.0186 \text{ K}$



$$\Delta T_f' = 3 \times 0.0186 = 0.0558 \text{ K}$$

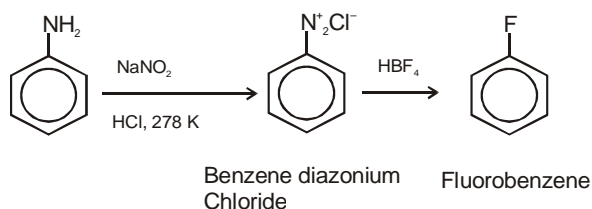
65.(4) 2-methylpropan-2-ol react fastest with conc. HCl & ZnCl<sub>2</sub> because it is 3<sup>o</sup> alcohol and order of reactivity of alcohols towards this reaction is 3<sup>o</sup> > 2<sup>o</sup> > 1<sup>o</sup> alcohols



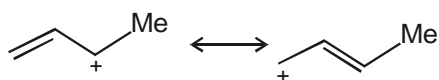
$$PV = nRT$$

$$n = \frac{3170 \times 10^{-3}}{8.314 \times 300} = 1.27 \times 10^{-3}$$

67.(1)

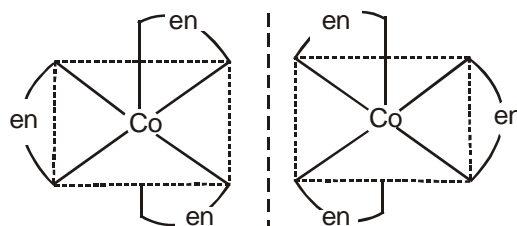


68.(3) For S<sub>N</sub>1, carbocation is formed, carbocation formed from B is stabilised by resonance, A is primary halide and C is secondary halide.



Therefore order is B > C > A.

69.(4)



70.(1)  $\Delta G = -nFE$

$$E = \frac{3}{2} \times \frac{966 \times 10^3}{6 \times 96500} = 2.5 \text{ V}$$

71.(3)  $p_s = P_A^0 x_A + P_B^0 x_B$

$$n_{\text{Hep}} = \frac{25}{100} = 0.25; \quad n_{\text{Oct}} = \frac{35}{144} = 0.24$$

$$x_{\text{Hep}} = \frac{0.25}{0.49} = 0.51; \quad x_{\text{Oct}} = \frac{0.24}{0.49} = 0.49$$

$$p_s = 72.0 \text{ Pa}$$

72.(4)  $\sqrt{2}a = 2r^+ + 2r^-$

$$r^- = \frac{\sqrt{2} \times 508}{2} - 110 = 398 \text{ pm}$$

73.(1) The correct order of basicity is  $\text{RCOO}^- < \text{H}_2\text{N}^- < \text{HC} \equiv \text{C}^- < \text{R}^-$

74.(4)  $\Delta G = \Delta H - T\Delta S = 0$

$\Delta G = 0$  for equilibrium and

$\Delta G = -ve$  for spontaneity

$$\Delta H - T\Delta S < 0 \Rightarrow T > \frac{\Delta H}{\Delta S} \Rightarrow T > T_e$$

75.(2) For Mechanism A: Rate =  $[\text{Cl}_2][\text{H}_2\text{S}]$ ;

because  $\text{Cl}_2 + \text{H}_2\text{S} \rightarrow \text{H}^+ + \text{Cl}^- + \text{Cl}^+ + \text{HS}^-$  is slow.

$$\text{For Mechanism B: Rate} = k k_{\text{eq}} \frac{[\text{Cl}_2][\text{H}_2\text{S}]}{[\text{H}^+]}$$

**76.(4)** Packing fraction of BCC = 68%, so, free space is 32%.

Packing fraction of CCP = 74%, so free space is = 26%.

**77.(1)** 3-methyl-1-pentene has one asymmetric carbon.

**78.(1)** Only CH<sub>3</sub>CHO has molecular weight equal to 44 u.

Its two moles can be obtained from ozonolysis of 2-butene only.

**79.(1)** The acid neutralised by NH<sub>3</sub> = 2.0 – 1.5 = 0.5 mmol = moles of N

Therefore, weight of N in organic compound = 0.5 × 14 = 7 mg

$$\text{Percentage of N} = \frac{7}{29.5} \times 100 = 23.7\%$$

**80.(4)**

$$\frac{I.E._{\text{He}^+}}{I.E._{\text{Li}^{2+}}} = \frac{(Z_{\text{He}^+})^2}{(Z_{\text{Li}^{2+}})^2} = \frac{4}{9}$$

$$\Rightarrow I.E._{\text{Li}^{2+}} = 4.41 \times 10^{-17} \text{ J/atom}$$

Therefore, energy of first stationary state =

$$-4.41 \times 10^{-17} \text{ J/atom}$$

81.(2)

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 6.023 \times 10^{23}}{242 \times 10^3}$$

$$= 0.4947 \times 10^{-6} \text{ m} = 494.7 \text{ nm}$$

**82.(4)**  $K_{sp}(\text{AgBr}) = [\text{Ag}^+][\text{Br}^-]$

$$[\text{Br}^-] = \frac{5 \times 10^{-13}}{0.05} = 10^{-11}$$

**83.(2)** more is  $\frac{\text{Proton}}{\text{Electron}}$

value smaller is the size

$$\text{O}^{2-} > \text{F}^- > \text{Na}^+ > \text{Mg}^{2+} > \text{Al}^{3+}$$

**84. (1)**  $\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$

$$K_1 = 4.2 \times 10^{-7}$$

$$K_1 = \frac{[\text{H}^+][\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]}$$

$$4.2 \times 10^{-7} \times 0.034 = [\text{H}^+][\text{HCO}_3^-]$$

because  $K_2 \ll K_1$

$$\text{so } [\text{H}^+] \approx [\text{HCO}_3^-]$$

**85.(4)**  $\text{Mg}(\text{OH})_2(\text{s}) \rightleftharpoons \text{Mg}^{2+}(\text{aq}) + 2\text{HO}^-(\text{aq})$

To start precipitation,  $K_{sp} = [\text{Mg}^{2+}][\text{HO}^-]^2$

$$1 \times 10^{-11} = 0.001[\text{HO}^-]^2 \Rightarrow [\text{HO}^-] = 10^{-4}$$

$$\text{pOH} = 4; \text{pH} = 10$$

**86.(4)**

**87.(3)** 2° carbocation formed in the reaction rearranges into 2° benzyl carbocation which is more stable than 3° carbocation. trans product is major product because it is more stable than cis isomer.

**88.(3)** Only carbonates don't give biuret test.

**89.(3)** Correct order of  $E_{M^{2+}/M}^0$  is Mn > Cr > Fe > Co.

**90.(3)** Proton donors are acids, so, H<sub>2</sub>SO<sub>4</sub><sup>-</sup> act as acid in (ii)