AIEEE PAPER – 2010
Answers and Explanations

Code : C

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) $f(-1) \le \lim\limits_{x \to -1^+} f(x)$

$K + 2 \le 1$

$K \le -1$

$\boxed{K = -1}$

4. (4) Four numbers can selected in ${}^{20}C_4$ ways

Number of possible APs are = 57

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

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

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

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

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

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

$e^c = 1 \quad e^c = 2$

$\Rightarrow \quad c = 0$ or $c = \log_e 2$

statement-1 is true

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

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

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

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

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

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

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

$(1+x)^n = {}^nC_0 + {}^nC_1x + {}^nc_2x^2 \ldots {}^nC_nx^n \quad \ldots(i)$

Differentiating

$n(1+x)^{n-1} = {}^nC_1 + 2\,{}^nC_2x^2 \ldots n.{}^nC_nx^{n-1} \quad \ldots(ii)$

Put x = 1

$n.2^{n-1} = {}^nC_1 + 2\,{}^nC_2 + 3\,{}^nC_3 \ldots n\,{}^nC_n$

put n = 10 ${}^{10}C_1 + 2.{}^{10}C_2 \ldots 10.{}^{10}C_{10} = 10.2^9$

$S_2 = 10.2^9$ statement 2 is wrong from equation (ii)

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

Multiply by x

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

Differentiating

$n(1+x)^{n-1} + n(n-1)x(1+x)^{n-2}$

$= {}^nC_1 + 2^2\,{}^nC_2x + 3^2\,{}^nC_3x^2 \ldots n^2\,{}^nC_nx^{n-1}$

Put x = 1

${}^nC_1 + 2^2\,{}^nC_2 + 3^2\,{}^nC_3 \ldots n^2\,{}^nC_n$

$= n.2^{n-1} + n(n-1)2^{n-2}$

Put n = 10

$1^2\,{}^{10}C_1 + 2^2\,{}^{10}C_2 + \ldots 10^2\,{}^{10}C_{10} = 10.2^9 + 90.2^8$

$= 10.2^9 + 45.2^9 = 55.2^9$

$S_3 = 55.2^9$

Statement-1 is true.

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

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

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

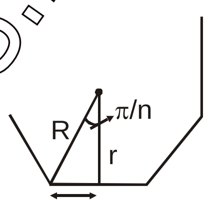
$\cos^2\gamma = \frac{1}{4} \Rightarrow \cos\gamma = \pm\frac{1}{2}$ but r is a centre

$\therefore\ \cos\gamma > 0$

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

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

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

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

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

$\Rightarrow$ 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 × 150 = 1500
remaining notes = 3000 a_{11} = 148 c.d. = –2,
remaining time = t

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

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

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

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

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

t = 21

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)

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

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

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

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

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

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

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

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

= e

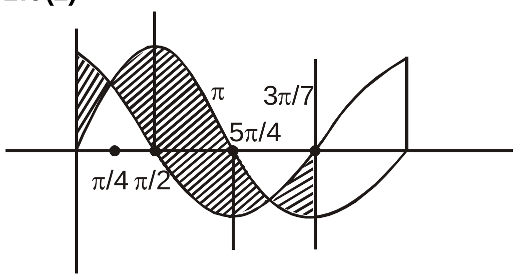
= | $\sec^2 x$|

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

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

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

17. (2)



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

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

$$+\int_{\pi}^{5\pi/4}(\sin x-\cos x)dx+\int_{5\pi/4}^{3\pi/2}(\cos x-\tan x)dx$$

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

$$=4\sqrt{2}-2$$

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) $g(x)\left(f\left(2f(x)+2\right)\right)^2$

$g'(x)=4f\left(2.f(x)+2\right).f'(x)f'(2f(x)+2)$

put x = 0

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

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

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

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

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

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

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

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

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

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

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

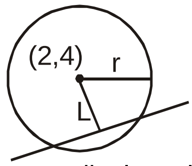
$\bar{x}_2=4\quad \sigma_2^2=5$

$$\sigma^2=\frac{1}{n_1+n_2}\left[n_1\sigma_1^2+n_2\sigma_2^2+\frac{n_1n_2}{n_1+n_2}\left(\bar{x}_1-\bar{x}_2\right)^2\right]$$

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

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) $\vec{a}.\vec{c} = 0$

$\Rightarrow \lambda + 2\mu = 1$ ...(i)

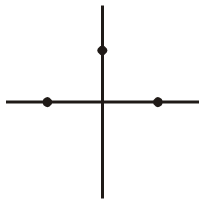
$\vec{b}.\vec{c} = 0$

$\Rightarrow 4\lambda + 2\mu = -8$ ...(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

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

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

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

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

$\oint \vec{E}.\vec{dA} = \frac{q_{enc}}{\epsilon_0}$

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

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

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

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

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

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

For cylindrical beam

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

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

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) $S = t^3 + 5$

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

$V = 3t^2 + 0$

at t = 2 sec V = 12 m/sec

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

$a_T = 6t$

at t = 2 sec a_T = 12 m/sec^2

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

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

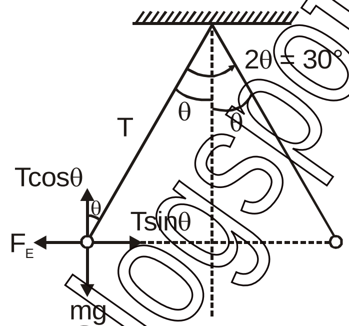
$\Rightarrow$ Total acceleration $a_{total} = \sqrt{(12)^2 + (72)^2}$

= 14 m/sec^2

40. (1) When charged sphere are in air

$F_E = T\sin\theta$

$mg = T\cos\theta$



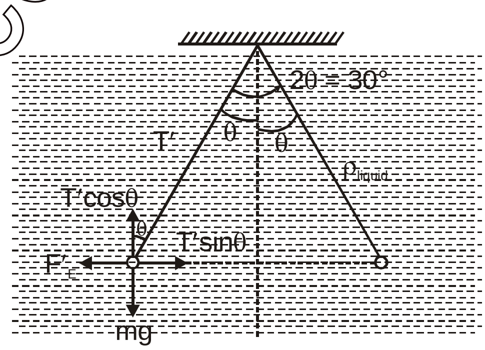
$\Rightarrow F_E = mg\tan\theta$ ...(1)

when in liquid,

$T'\sin\theta = F_E'$

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

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



$\Rightarrow F_E' = (mg - F_B)\tan\theta$ ...(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

$$R_{eff} = R_0 + R_0\alpha_1 t + R_0\alpha_2 t + R_0$$
$$= 2R_0 + R_0(\alpha_1 + \alpha_2)t$$

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

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

In parallel combination,

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

45. (4) ${}_Z X^A \rightarrow {}_{Z-8}Y^{A-12} + 3\,{}_2He^4 + 2\,{}_1e^0$

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

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

$= A - Z - 4$

Number of protons in Y = Z – 8

46. (3) 4KW = 4000 J/s

Number of photons/sec = 10^{20}

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

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

= 4.96 × 10^{-9}

= 49.6 Å (X-rays)

47. (4) Impulse = change in momentum

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

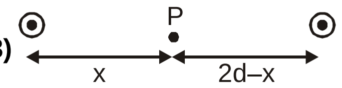
$$vv_i = \frac{\Delta x}{\Delta t} = -1$$

$\therefore$ Impulse = 0.4 (–1 –1) = – 0.8 Ns

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

$X = \overline{\bar{A}.\bar{B}} = A + B$ (OR gate)

49. (3)

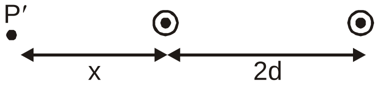


$$B_P = \frac{\mu_0 i}{2\pi}\left(\frac{1}{x} - \frac{1}{2d - x}\right)$$

At x = d, $B_P = 0$

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

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



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

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

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

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

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

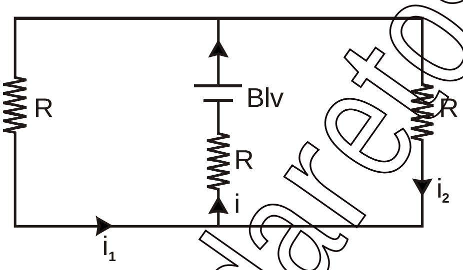
$$q = \frac{q_0}{4} = q_0 e^{-t/\tau}$$

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

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

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

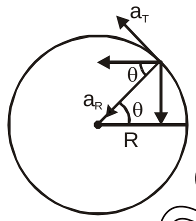
51. (4)



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

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

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



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

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

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

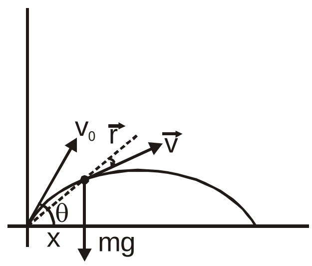
$a_{rel} = 0$

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

$$= mgx$$

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

$$\vec{\tau} = \frac{d\vec{l}}{dt}$$



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

$$|\bar{l}| = m\left(\vec{r} \times \vec{v}\right)$$

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

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

$T = \mu v^2$

from the equation of the wave

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

$v = \dfrac{\lambda}{T} = \dfrac{0.5}{0.04} = 12.5\,m/s$

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

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

for adiabatic expansion $T_1V_1^{r-1} = T_2V_2^{r-1}$

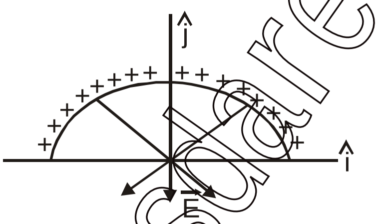
r for diatomic gas $= \dfrac{7}{5}$

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

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

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

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



Here $\phi = \pi$

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

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

58. (3)

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

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

$V_y = Kx = \dfrac{dy}{dt}$

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

$y\,dy = x\,dx$

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

$y^2 = x^2 + c$

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

At $t \to \infty$, $i = \dfrac{V}{R_1 || R_2} = \dfrac{V(R_1 + R_2)}{R_1R_2}$

PART C – CHEMISTRY

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

Only Cl^- outside the coordinate sphere is precipitated in AgCl.
The Moles of $CoCl_3.6NH_3 = 0.01$
Therefore three mole obtained from each mole of $CoCl_3.6NH_3$.

62.(4) $3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$; $\Delta H_r = -2 \times 46$

$\Delta H_r = [3\Delta H_{H_2} + \Delta H_{N_2}] - [2\Delta H_{NH_3}]$

$-92 = 3 \times 436 + 712 - 2\Delta H_{NH_3}$

$\Delta H_{NH_3} = 1056$ kJ/mol

N — H bond dissociation energy

$= \dfrac{1056}{3} = 352$ 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) $\Delta T_f = K_f \times m = 1.86 \times 0.01 = 0.0186$ K

$Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$; i = 3

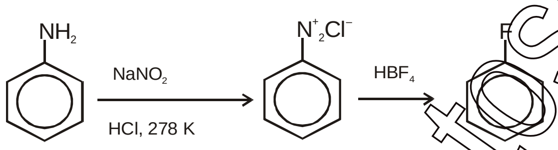
$\Delta T_f' = 3 \times 0.0186 = 0.0558$ K

65.(4) 2-methylpropan-2-ol react fastest with conc. HCl & $ZnCl_2$ because it is 3^0 alcohol and order of reactivity of alcohols towards this reaction is $3^0 > 2^0 > 1^0$ alcohols

66.(2) $H_2O(l) \rightleftharpoons H_2O(g)$
PV = nRT

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

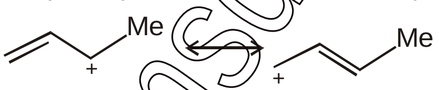
67.(1)



Benzene diazonium Chloride

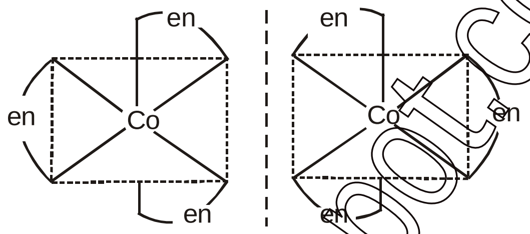
Fluorobenzene

68.(3) For SN1, 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) $p_s = P_A^o x_A + P_B^o x_B$

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

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

$p_s = 72.0$ 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 $RCOO^- < H_2N^- < HC \equiv C^- < R^-$

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 Machanism A: Rate $= [Cl_2][H_2S]$;

because $Cl_2 + H_2S \rightarrow H^+ + Cl^- + Cl^+ + HS^-$ is slow.

For Mechanism B: Rate $= kk_{eq} \dfrac{[Cl_2][H_2S]}{[H^+]}$

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_3CHO 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_3 = 2.0 – 1.5 = 0.5 mmol = moles of N
Therefore, weight of N in organic compound = 0.5x14 = 7 mg

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

80.(4)

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

$\Rightarrow I.E._{Li^{2+}} = 4.41 \times 10^{-17}$ J/atom
Therefore, energy of first stationary state = -4.41×10^{-17} 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) $K_{sp}(AgBr) = [Ag^+][Br^-]$

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

83.(2) more is $\frac{\text{Proton}}{\text{Electron}}$ value smaller is the size

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

84. (1) $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$

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

$$K_1 = \frac{\left[H^+\right]\left[HCO_3^-\right]}{\left[H_2CO_3\right]}$$

$4.2 \times 10^{-7} \times 0.034 = \left[H^+\right]\left[HCO_3^-\right]$

because $K_2 \lll K_1$

so $\left[H^+\right] \simeq \left[HCO_3^-\right]$

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

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

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

$pOH = 4; pH = 10$

86.(4)

87.(3) 2^o carbocation formed in the reaction rearranges into 2^o benzyl carbocation which is more stable than 3^o 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 $E^o_{M^{2+}/M}$ is Mn > Cr > Fe > Co.

90.(3) Proton doners are acids, so, $H_2SO_4^-$ act as acid in (ii)