Section – I

1.(d) When a particle move with uniform velocity then position of particle changes.

2.(c) Both wheel travel equal linear distance is same time so $v_f = v_r$

3.(b) $h = \dfrac{2T\cos\theta}{\rho gr}$, i.e. pressure

4.(d) $\dfrac{Q}{t} = \dfrac{KAd\theta}{dl}$

5.(a) For a diabetic process $\Delta Q = 0$

So $du + dw = 0$ or, $-dw = du$

6.(b) $PE = \dfrac{1}{4} E_T$

or, $\dfrac{1}{2} m\omega^2 y^2 = \dfrac{1}{4} \times \dfrac{1}{2} m\omega^2(A^2)$

or, $4y^2 = A^2$

or, $A = 2y$

or, $y = \dfrac{A}{2}$

7.(d) At Q, $E = \dfrac{2Q}{4\pi\varepsilon_0 r^2}$

At –2Q, $E' = \dfrac{Q}{4\pi\varepsilon_0 r^2} = \dfrac{E}{2}$

8.(d)

$R_{eq} = \dfrac{R_{ABC} \times R_{AC}}{R_{ABC} + R_{AC}} = \dfrac{8 \times 4}{8 + 4} = \dfrac{32}{3} = \dfrac{8}{3}\,\Omega$

9.(c) $M = \sqrt{M^2 + M^2 + 2M^2 \cos 60°}$

$= \sqrt{3}\, M$

10.(c) $P = I_{rms} V_{rms} \cos\phi$

$= \dfrac{I_0}{\sqrt{2}} \times \dfrac{V_0}{\sqrt{2}} \cos 60°$

$= \dfrac{100}{\sqrt{2}} \times 10^{-3} \times \dfrac{100}{\sqrt{2}} \times \dfrac{1}{2}$

$= 2.5$ W

11.(d) $\dfrac{1}{f} = (\mu - 1)\left(\dfrac{1}{R_1} + \dfrac{1}{R_2}\right)$

f will be maximum if μ is least

Where $\mu = A + \dfrac{B}{\lambda^2}$ i.e. $\lambda_r > \lambda_v$

So, $\mu_r < \mu_v$

12.(b) $\dfrac{\beta_r}{\beta_v} = \dfrac{\lambda_r}{\lambda_v} = \dfrac{8000 \times 10^{-10}}{4000 \times 10^{-10}} = 2:1$

13.(a) $mvr = \dfrac{nh}{2\pi}$

or, $mv = \dfrac{nh}{2\pi r}$

$\therefore \lambda = \dfrac{h}{mv} = \dfrac{h}{nh} \times 2\pi r = \dfrac{2\pi r}{n}$

14.(a) $\alpha = 0.98 = \dfrac{I_c}{I_e}$

$\beta = \dfrac{\alpha}{1 - \alpha} = \dfrac{0.98}{1 - 0.98} = 49$

15.(b) Last electron of Cl is 3P

$n = 3,\ l = 1,\ m = 0,\ s = -\dfrac{1}{2}$

16.(c)

	F	Na	Mg	Al
p	q	11	12	13
e	10	10	10	10

Most force of attraction between electron & Nucleus in case Al so smaller size for Al^{+++} than Mg^{++} than Na^+ than F^-.

17.(b) $\Delta n = 2 - 1 = 1$

$\therefore K_p = K_c (RT)$

or, $\dfrac{K_p}{K_c} = RT \qquad \therefore K_p > K_c$

18.(b) Since conc^n B is double rate 4 times thus order of B is 2nd so, A is 1st.

19.(b) Only Mg and Mn can displace hydrogen from dil. HNO_3.

20.(d)

21.(b) $NH_3 + CO_2 + H_2O \rightarrow NH_4HCO_3$

$NH_4HCO_3 + NaCl \rightarrow NaHCO_3\downarrow + NH_4Cl$

White crystal

22.(b) $Fe^{+++} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$ (most unpaired)

23.(d) $NaCNS + FeCl_3 \rightarrow Fe(CNS)_3 + NaCl$

blood red

24.(d) Priority of numbering goes to double bond.

25.(b)

26.(b) Reimer Tieman reaction)

27.(d)

28.(c)

29.(c) Given equations $x^2 + bx + c = 0$,

$x^2 + dx + e = 0$

If the both roots are common then

$\dfrac{1}{1} = \dfrac{b}{d} = \dfrac{c}{e} \Rightarrow be = cd$

30.(c) Given $1 + 2 + 3 + ... + n = \dfrac{1}{5}(1^2 + 2^2 + ... + n^2)$

or, $\dfrac{n(n+1)}{2} = \dfrac{1}{5}\dfrac{n(n+1)(2n+1)}{6}$

or, $2n + 1 = 15$

i.e. $n = 7$

31.(d) Using properties, $(AB)^T = B^TA^T$

32.(b) $A \cap B = \{3, 4\}$, $n(A \cap B) = 2$

So $n[(A \times B) \cap (B \times A)] = \{n(A \cap B)\}^2 = 2^2 = 4$

33.(a) By definition, projection of $\vec{b}$ on $\vec{a} = \dfrac{\vec{a}.\vec{b}}{|\vec{a}|}$

34.(a) $x^2 + y^2 = a^2\cos^2\theta + a^2\sin^2\theta = a^2$

35.(d) Circle is $x^2 + y^2 - 4x - 6y - 12 = 0$

Comparing with $x^2 + y^2 + 2gx + 2fy + c = 0$

$g = -2,\ f = -3,\ c = -12$

So, $r = \sqrt{g^2 + f^2 - c} = 5$

and circumference $= 2\pi r = 2\pi \times 5 = 10\pi$

36.(d) Eq^n is $y^2 = 4ax + 4a^2$

i.e. $(y - 0)^2 = 4a\{x - (-a)\}$

So the vertex is $(-a, 0)$

37.(b) $\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 1 - \cos^2\alpha + 1 - \cos^2\beta + 1 - \cos^2\gamma$

$= 3 - (\cos^2\alpha + \cos^2\beta + \cos^2\gamma) = 3 - 1 = 2$

38.(c) $\sin^{-1}x + \cos^{-1}x = \dfrac{\pi}{2}$

i.e. $\cos^{-1}x = \dfrac{\pi}{2} - \sin^{-1}x = \dfrac{\pi}{2} - \dfrac{\pi}{10} = \dfrac{5\pi - \pi}{10}$

$= \frac{4\pi}{10} = \frac{2\pi}{5}$

39.(b) $Z^2 = (1+i)^2 = 1 + 2i + i^2 = 1 + 2i - 1 = 2i$

So multiplicative inverse of

$$Z^2 = \frac{1}{2i} = \frac{i^2}{2i} = -\frac{i}{2}$$

40.(c) Fact

41.(b) $P(B) = 1 - P(\overline{B}) = 1 - \frac{5}{8} = \frac{3}{8}$

and $P(A/B) = \frac{P(A\cap B)}{P(B)} = \frac{\frac{1}{4}}{\frac{3}{8}} = \frac{1}{4} \times \frac{8}{3} = \frac{2}{3}$

42.(a) $\frac{2}{2!} + \frac{3}{3!} + \frac{4}{4!} + ...$

$= \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + ... = 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + ... - 1$

$= e - 1$

43.(c) $\lim\limits_{x\to 0^+} \frac{e^{\frac{1}{x}}}{e^{\frac{1}{x}} + 1} = \lim\limits_{x\to 0^+} \frac{1}{1 + e^{-1/x}} = \frac{1}{1+0} = 1$

44.(b) $y = \sin^{-1}(3x - 4x^3) = 3\sin^{-1}x$

So, $\frac{dy}{dx} = \frac{3}{\sqrt{1-x^2}}$

45.(d) $I = \int \frac{\sin^4 x}{\cos^6 x} dx = \int \frac{\sin^4 x}{\cos^4 x} \frac{1}{\cos^2 x} dx$

$= \int \tan^4 x \sec^2 x\, dx = \frac{\tan^5 x}{5} + c$

46.(b) For tangent parallel to x-axis, put x = 0,

$y^2 = 25$ i.e. $y = \pm 5$

47.(b) I.F. $= e^{\int P dx} = \sec x$

$\Rightarrow \int P dx = \log_e \sec x \Rightarrow P = \tan x$

48.(c) Required area $= \int_1^3 y dx = \int_1^3 \frac{1}{x} dx$

$= ln x \Big]_1^3 = ln 3 - ln 1$

$= ln 3$ sq. units

49.c	**50.d**	**51.a**	**52.a**	**53.c**	**54.a**
55.d	**56.b**	**57.c**	**58.a**	**59.a**	**60.c**

Section – II

61.(c) $v_1 = \sqrt{2gh_1} = \sqrt{2 \times 10 \times 5} = 10$ m/s

$v_2 = \sqrt{2gh_2} = \sqrt{2 \times 10 \times 1.8} = 6$ m/s

Fractional decrease in velocity $= \frac{\Delta v}{v}$

$= \frac{v_1 - v_2}{v_1} = 1 - \frac{6}{10}$

$= \frac{2}{5}$

62.(b) $I = I_{cm} + mh^2$

$= \frac{1}{2} mR^2 + mR^2$

$= \frac{3}{2} mR^2 = \frac{3}{2} \times 2 \times 0.1^2$

$= 0.03$ kgm^2

63.(c) **1st case**

$T_1 = \frac{YA(l_1 - l)}{l}$

or, $\frac{T_1 l}{l_1 - l} = YA$ .... (i)

2nd case

$T_2 = \frac{YA(l_2 - l)}{l}$

or, $\frac{T_2 l}{l_2 - l} = YA$ ... (2)

From (1) & (2)

$\frac{T_1 l}{l_1 - l} = \frac{T_2 l}{l_2 - l}$

or, $T_1 l_2 - T_1 l = T_2 l_1 - T_2 l$

or, $(T_1 - T_2) l = T_1 l_2 - T_2 l_1$

or, $l = \frac{T_1 l_2 - T_2 l_1}{T_1 - T_2}$

64.(a) m be mass of steam condensed

$m \times 540 + m(100 - 90) = 22 \times (90 - 20)$

or, $m = \frac{22 \times 70}{560} = 2.75$g

Water = 22 + 2.75 = 24.75g

65.(c) $\left(\frac{T_2}{T_1}\right)^{\gamma} = \left(\frac{P_2}{P_1}\right)^{\gamma - 1}$

or, $T_2 = 300\left(\frac{P}{8P}\right)^{\frac{5/3 - 1}{5/3}} = 300\left(\frac{1}{8}\right)^{\frac{2}{3} \times \frac{3}{5}}$

$= 130.5$ K

$= -142°$C

66.(b) $\frac{\Delta f}{f} = \frac{2v_s}{v}$

or, $2\% = \frac{2v_s}{v}$

or, $v_s = \frac{2}{100} \times \frac{300}{2} = 3$ m/s

67.(d) $E_1 = \frac{1}{2} CV_0^2 = \frac{1}{2} \frac{\varepsilon_0 A V_0^2}{d}$

$C' = \frac{\varepsilon_0 A}{3d}$ so

$E_2 = \frac{Q^2}{2C'} = \frac{\left(\frac{\varepsilon_0 A V_0}{d}\right)^2}{2 \times \frac{\varepsilon_0 A}{3d}}$

$= \frac{\varepsilon_0^2 A^2 V_0^2}{d^2} \times \frac{3d}{2\varepsilon_0 A}$

$= \frac{3}{2} \frac{\varepsilon_0 A V_0^2}{d}$

$W = E_2 - E_1 = \frac{3}{2} \frac{\varepsilon_0 A V_0^2}{d} - \frac{\varepsilon_0 A V_0^2}{2d}$

$= \frac{\varepsilon_0 A V_0^2}{d}$

68.(c) $Q = ms\Delta\theta = \frac{V^2}{R} t = \frac{(V/2)^2}{R} \times t'$

or, $t = \frac{t'}{4}$

or, $t' = 4t$

69.(a) $E = \left(\frac{-BAN - BAN}{t}\right) = \frac{2BAN}{t}$

$= \frac{2 \times 0.3 \times 70 \times 10^{-4} \times 200}{0.1} = 8.4$ V

70.(d) $u = mf$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

or, $-\frac{1}{f} = \frac{1}{mf} + \frac{1}{v}$

or, $\frac{1}{v} = -\frac{(m+1)}{mf} \Rightarrow v = -\frac{mf}{m+1}$

$\therefore$ Magnification $= \frac{v}{u} = \frac{mf}{(m+1) \times mf}$

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

71.(d) $\frac{x}{D} = \frac{\lambda}{d}$

$x = \frac{D\lambda}{d}$

$\therefore \quad 2x = \frac{2D\lambda}{d} = \frac{2 \times 2 \times 600 \times 10^{-9}}{10^{-3}}$

$= 2.4 \times 10^{-3}$ m

$= 2.4$ mm

72.(d) **1st case**

$\frac{hc}{\lambda} = \phi + \frac{1}{2}mv^2$

or, $v = \sqrt{\frac{2}{m}\left(\frac{hc}{\lambda} - \phi\right)}$

2nd case

$\frac{4hc}{3\lambda} = \phi + \frac{1}{2}mv'^2$

or, $v' = \sqrt{\frac{2}{3}\left(\frac{4hc}{3\lambda} - \phi\right)}$

$\therefore \frac{v'}{v} = \sqrt{\frac{\frac{4}{3}\frac{hc}{\lambda} - \phi}{\frac{hc}{\lambda} - \phi}}$

73.(a) $\frac{A}{A_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $A = A_0\left(\frac{1}{2}\right)^{\frac{30}{0.693} \times \frac{6.93}{60}}$

$= 128\left(\frac{1}{2}\right)^{\frac{6.93}{0.693 \times 2}}$

$= 4$ mci

74.(d) Given mole ratio (1:2:3) and mole ratio in the reaction (2:6:3)

Thus, H_2O is limiting reagent

$\therefore$ 6 mole H_2O gives 4 mole $Fe(OH)_3$

1 mole H_2O gives $\frac{4}{6}$ mole $Fe(OH)_3$ 2 mole H_2O gives $\frac{4}{6} \times 2$ mole $Fe(OH)_3$

$= 1.34$ mole $Fe(OH)_3$

75.(c) Since 3 mole of $Zn(NO_3)_2 \Rightarrow 6HNO_3$ as acid

2 mole NO is formed by reduction of HNO_3

2 mole HNO_3 act as oxidizing agent.

76.(a) $T = 273 \quad P_T = 1$ atm

$R = 0.0821$

$nH_2 = \frac{4}{2} = 2$ mole & $nN_2 = \frac{2.8}{28} = 0.1$

$V_T = \frac{n_TRT}{P_T} = \frac{2.1 \times 0.0821 \times 273}{1}$

$= 47.07$ litre

77.(c) VAgCl = 500 ml

NAgCl = 0.1

EAgCl = 143.8

WAgCl = ?

$W = \frac{EVN}{1000} = 7.17$ gm

78.(b)

79.(b)

80.(a) Both HCl & NaCl are strong electrolyte.

81.(c) $4KI + 2CuSO_4 \rightarrow Cu_2I_2\downarrow + 2K_2SO_4 + I_2$

82.(c) As $1 + x^2 \neq 0$ for real x.

So domain = R

$x^2 \geq 0$ so $1 + x^2 > x^2$

So, $\frac{x^2}{1+x^2} < 1$ i.e. $y < 1$

$\therefore$ Range = [0, 1)

83.(b) We have $(1 + x)^n = C_0 + C_1x + C_2x^2 + ... + C_nx^n$

Integrating, $\frac{(1+x)^{n+1}}{n+1} = C_0x + \frac{C_1}{2}x^2 + \frac{C_2}{3}x^3 + ... + \frac{C_n}{n+1}x^{n+1} + K$

Putting x = 0, $K = \frac{1}{n+1}$

Then $\frac{(1+x)^{n+1}}{n+1} = C_0x + \frac{C_1}{2}x^2 + \frac{C_2}{3}x^3 + ... + \frac{C_n}{n+1}x^{n+1} + \frac{1}{n+1}$

Putting x = 1, we get

$C_0 + \frac{C_1}{2} + \frac{C_2}{3} + ... + \frac{C_n}{n+1} = \frac{2^{n+1}}{n+1} - \frac{1}{n+1}$

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

84.(c) Given word is SOCIETY

There are 3 vowels and 4 consonants so there are 3 choices for vowels and 4 choices for consonants for the alternate arrangements so total no. of arrangements = P(3, 3) × P(4, 4)

= 3! × 4!

85.(b) $x + \frac{1}{x} = -1$ i.e. $x^2 + x + 1 = 0$

i.e. $x = \frac{-1 \pm \sqrt{1^2 - 4.1.1}}{2.1} = \frac{-1 \pm \sqrt{3}i}{2} = w, w^2$

So, $x^{2010} + \frac{1}{x^{2010}} = w^{2010} + \frac{1}{w^{2010}}$

$= (w^3)^{670} + \frac{1}{(w^3)\ 670} = 1 + \frac{1}{1} = 2$

86.(c) Given $|\vec{a}| = |\vec{b}| = |\vec{c}| = 1$

and $\vec{a} + \vec{b} + \vec{c} = \vec{0}$

So, $\vec{b} + \vec{c} = -\vec{a}$

$(\vec{b} + \vec{c})^2 = (-\vec{a})^2$

or, $b^2 + c^2 + 2|\vec{b}|\,|\vec{c}| \cos\theta = a^2$

or, $1 + 1 + 2\cos\theta = 1$

or, $2\cos\theta = -1$

or, $\cos\theta = -\frac{1}{2}$ i.e. $\theta = 120°$

87.(b) Given equations are

$ax^2 + 2hxy - ay^2 = 0$ ...(i)

$bx^2 + 2gxy - by^2 = 0$ ...(ii)

Eqn of bisector of angle between lines represented by (i) is

$h(x^2 - y^2) = (a + a)$ xy

i.e. $hx^2 - 2axy - hy^2 = 0$ ....(iii)

Since (ii) & (iii) are identical,

So, $\frac{b}{h} = \frac{2g}{-2a} = \frac{-b}{h}$

$\therefore \quad ab + gh = 0$

88.(c) Circle: $x^2 + y^2 = a^2$ Centre $(c_1) = (0, 0)$ radius $(r_1) = a$

Circle: $(x - c)^2 + y^2 = b^2$

Centre $(c_2) = (c, 0)$ radius $(r_2) = b$

Circles touches externally

So distance between centres = sum of radii

i.e. $c = a + b$

89.(c) Parabola: $y^2 = 4ax$

Line: $ty = x + at^2$ i.e. $y = \frac{1}{t}x + at$

Where $m = \frac{1}{t}$, $c = at$

$\therefore$ Point of contact $= \left(\frac{a}{m^2}, \frac{2a}{m}\right) = \left(\frac{a}{\frac{1}{t^2}}, \frac{2a}{\frac{1}{t}}\right)$

$= (at^2, 2at)$

90.(b) Given $2ae = 6$ i.e. $ae = 3$ i.e. $a^2e^2 = 9$

and $2b = 8$, $b = 4$ i.e. $b^2 = 16$

We have, $a^2 - a^2e^2 = b^2$ i.e. $a^2 = 25$ i.e. $a = 5$

So, $e = \frac{3}{5}$

91.(c) Equation of plane is $lx + my + nz = 3p$

So it meets the axes at points $\left(\frac{3p}{l}, 0, 0\right)$, $\left(0, \frac{3p}{m}, 0\right)$ and $\left(0, 0, \frac{3p}{n}\right)$ respectively. Let (α, β, γ) be the centroid of ΔABC. Then

$$\alpha = \frac{\frac{3p}{l} + 0 + 0}{3}, \beta = \frac{0 + \frac{3p}{m} + 0}{3}, \gamma = \frac{0 + 0 + \frac{3p}{n}}{3}$$

i.e. $\frac{1}{\alpha} = \frac{l}{p}, \frac{1}{\beta} = \frac{m}{p}, \frac{1}{\gamma} = \frac{n}{p}$

So $\frac{1}{\alpha^2} + \frac{1}{\beta^2} + \frac{1}{\gamma^2} = \frac{l^2}{p^2} + \frac{m^2}{p^2} + \frac{n^2}{p^2}$

$= \frac{l^2 + m^2 + n^2}{p^2} = \frac{1}{p^2}$

$\therefore$ Locus of (α, β, γ) is $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = \frac{1}{p^2}$

92.(d) Given a, b, c are in AP

So, $2b = a + c$

Now, $3 \tan\frac{A}{2} \tan\frac{C}{2}$

$= \sqrt{\frac{(s - b)(s - c)}{s(s - a)}} \sqrt{\frac{(s - a)(s - b)}{s(s - c)}}$

$= 3\frac{(s - b)}{s}$

$= 3\left(\frac{2s - 2b}{2s}\right)$

$= 3\left(\frac{a + b + c - 2b}{a + b + c}\right)$

$= 3\frac{2b + b - b}{2b + b}$

$= \frac{3b}{3b} = 1$

93.(a) Let x = distance of man from wall

y = length of shadow

From similar triangles

$\frac{AB}{CD} = \frac{BE}{DE}$

or, $\frac{5}{2} = \frac{x + y}{y}$

or, $5y = 2x + 2y$

or, $3y = 2x$

$y = \frac{2}{3}x$

$\frac{dx}{dt} = 3$ m/s

$\frac{dy}{dt} = ?$

$\therefore \frac{dy}{dt} = \frac{2}{3}\frac{dx}{dt} = \frac{2}{3}.3 = 2$ m/s

94.(d) Given $f(x) = ax + b$

Now $f(0) = 1 \Rightarrow a.0 + b = 1 \Rightarrow b = 1$

$f'(0) = 1 \Rightarrow a = 1$

So, $f(x) = x + 1$

Then $f(2) = 2 + 1 = 3$

95.(b) Put $y = \sqrt{x}$ $\therefore$ $dy = \frac{1}{2\sqrt{x}}dx$

i.e. $dx = 2ydy$

Then $\int e^{\sqrt{x}}dx = \int e^y 2ydy$

$= 2\int ye^y dy$

$= 2[y\int e^y dy - \int\left(\frac{dy}{dy}\int e^y dy\right)dy]$

$= 2[ye^y - e^y] + c$

$= 2(y - 1)e^y + c$

$= 2(\sqrt{x} - 1)e^{\sqrt{x}} + c$

96.(b) Solving $y = \sqrt{x}$ and $x = \sqrt{y}$

We have, $x^2 = \sqrt{x}$

or, $x^4 - x = 0$

or, $x(x^3 - 1) = 0$

$\therefore$ $x = 0, 1$

$\therefore$ Required area $= \int_0^1 (\sqrt{x} - x^2)dx$

$= \left[\frac{2}{3}x^{3/2} - \frac{x^3}{3}\right]_0^1$

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

$= \frac{1}{3}$ sq. units

97.c **98.a** **99.b** **100.b**

…The End…