Section – I

1.(d)

2.(b) $CH_3CH_2NH_4$ and $CH_3CO_2NH_4$ contain equal no. of NH_4^+ ion.

3.(d) After addition KCN it does not affect the K_{sp} of AgCN

4.(c) $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$
In this reaction Cu_2O acts as a reducing agent and Cu_2S acts as an oxidizing agent and this reaction is a self reduction reaction.

5.(b)

6.(d) According to Ostwald's dilution law the degree of dissociation of weak electrolyte is increased by the diluting $\alpha \propto \sqrt{V}$

7.(c) When the excited state the hydrogen atom in the sixth energy level and it return come back to ground state

$\left.\begin{array}{l} n_1 = 1, \text{ Pfund series} \\ n_1 = 2, \text{ Brackette series} \\ n_1 = 3, \text{ Paschen series} \end{array}\right\}$ IR-region

$n_1 = 4$, Balmer series — Visible region
$n_1 = 5$, Lyman series — UV region

8.(c) F, O and N are highly electronegative elements and extremely small in size so they do not easily hydrolyzed.

9.(d) Each benzene molecule ring contains three double covalent bond each double covalent bond contains two π electrons.

10.(a) $N_2 = 2 \times 7 = 14$
$NO^+ = 7 + 8 - 1 = 14$
$CN^- = 6 + 7 + 1 = 14$
Different species having same number of electrons is known isoelectronic species.

11.(b) In SO_4^{2-}, the oxidation state of S = +6
In $S_2O_3^{2-}$, the oxidation state of S = +2
In $S_2O_4^{2-}$, the oxidation state of S = +3
In $S_2O_6^{2-}$, the oxidation state of S = +5
Lower the oxidation state of central atom higher will be the reducing character.

12.(a) $f(x) = \sqrt{\tan x}$
$f(x + \pi) = \sqrt{\tan(\pi + x)} = \sqrt{\tan x} = f(x)$

13.(c) A = {2, 3, 5, 7}, n = 4
No. of non empty proper subsets
$= 2^n - 2 = 2^4 - 2 = 14$

14.(a) Given a, b, c are in G.P. So, $b^2 = ac$
$\log_e b^2 = \log_e ac \Rightarrow 2\log_e b = \log_e a + \log_e c$
$\therefore$ $\log_e a, \log_e b, \log_e c$ are in A.P.

15.(d) $\begin{vmatrix} 1/a & 1 & bc \\ 1/b & 1 & ca \\ 1/c & 1 & ab \end{vmatrix} = \dfrac{1}{abc}\begin{vmatrix} abc/a & 1 & bc \\ abc/b & 1 & ca \\ abc/c & 1 & ab \end{vmatrix}$

$= \dfrac{1}{abc}\begin{vmatrix} bc & 1 & bc \\ ca & 1 & ca \\ ab & 1 & ab \end{vmatrix} = 0 \ (\because C_1 = C_3)$

16.(c) $x^2 - y^2 = a^2(\text{sech}^2 t - \tanh^2 t) = a^2$ which is a rectangular hyperbola.

17.(c) $\dfrac{a + b\omega + c\omega^2}{a\omega + b\omega^2 + c} = \dfrac{a + b\omega + c\omega^2}{a\omega + b\omega^2 + c\omega^3}$
$= \dfrac{(a + b\omega + c\omega^2)}{\omega(a + b\omega + c\omega^2)} = \dfrac{1}{\omega} = \dfrac{\omega^3}{\omega} = \omega^2$

18.(c) As both roots are common, we have $1 = \dfrac{b}{d} = \dfrac{c}{e} \Rightarrow$ be = cd

19.(d) If l, m, n are dc's of a line then we have $l^2 + m^2 + n^2 = 1$

20.(c) Any line parallel to x-axis have slope 0.

21.(a) $(a, b) = \lambda(5, 1) \Rightarrow 5\lambda = a, \lambda = b \Rightarrow a = 5b$

22.(a) Here the function $\sin^7 x$ is odd so $\int_{-1}^{1} \sin^7 x \, dx = 0$

23.(c) $\lim\limits_{x \to 1} \dfrac{x + x^2 + x^3 + \ldots + x^n - n}{x - 1}$
$= \lim\limits_{x \to 1} \dfrac{1 + 2x + 3x^2 + \ldots + nx^{n-1}}{1}$
(Using L' Hospital rule)
$= 1 + 2 + 3 + \ldots + n = \dfrac{n(n + 1)}{2}$

24.(c) $2y = 2 - x^2$ on differentiating $2\dfrac{dy}{dx} = -2x$
i.e. $\dfrac{dy}{dx} = -x$
At $x = -1$, $\dfrac{dy}{dx} = 1$. So slope = 1

25.(d) $\log_{\sqrt{x}} x = \dfrac{1}{\log_x \sqrt{x}} = \dfrac{1}{\frac{1}{2}\log_x x} = 2$,
which is constant and so its derivative is 0.

26.(d) Eq^n of normal is $y - 0 = \dfrac{4 - 0}{3 - 0}(x - 0)$
i.e. $y = \dfrac{4}{3}x \Rightarrow 4x - 3y = 0$

27.(a) By definition, the eccentricity of the parabola is 0.

28.(d) Required area $= \int_0^{\pi/4} \sec^2 x \, dx = [\tan x]_0^{\pi/4} = \tan\dfrac{\pi}{4} - \tan 0 = 1$ sq. unit.

29.(d) Using sine law, $\dfrac{a}{\sin A} = \dfrac{b}{\sin B}$
$\Rightarrow \sin B = \dfrac{b}{a}\sin A = \dfrac{4}{3} \cdot \dfrac{3}{4} = 1$
$\Rightarrow B = 90°$

30.(b) $\sin x + \cos x = 2$, $\dfrac{1}{\sqrt{2}}\sin x + \dfrac{1}{\sqrt{2}}\cos x = \dfrac{2}{\sqrt{2}}$
$\Rightarrow \sin x \cos\dfrac{\pi}{4} + \cos \sin\dfrac{\pi}{4} = \sqrt{2}$
$\Rightarrow \sin\left(x + \dfrac{\pi}{4}\right) = \sqrt{2}$, impossible

31.(d) Here the lines are parallel and donot intersect and has no solution.

32.(b) $1 = \sqrt{1^2 + 2.1\cos\theta + 1^2}$

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

$\theta = 120°$

Difference (R) $= \sqrt{1^2 - 2.1^2\cos 120° + 1^2} = \sqrt{3}$

33.(c) $I \propto d^2$

$\frac{\Delta I}{I} = \frac{2\Delta d}{d} = 2\times 1\% = 2\%$

34.(a) Random motion of particle is called Brownian motion.

35.(b) Efficiency will be maximum if ratio of $\frac{T_2}{T_1}$ is least.

36.(d) On introducing conductor in between plates of capacitor capacitance increase.

37.(d) $F = \frac{\mu_0 I_1 I_2}{2\pi r}$

If current is doubled then

$F' = \frac{\mu_0 2I_1 \times 2I_2}{2\pi r} = 4F$

38.(a) $2d\sin\theta = \lambda$

For diffraction. $2d \le \lambda$

39.(b) $\alpha = \frac{I_c}{I_e} < I$

40.(c)

41.(d) $f_{max} = 20000$ Hz

$\lambda_{min} = \frac{v}{f_{max}} = \frac{330}{20000} = 0.0165$ m $= 16.5$ mm

42.(b) $\frac{T}{2} = 0.25$ s

or, $T = 0.5$ s $\quad \therefore \ f = \frac{1}{T} = \frac{1}{0.5} = 2$ Hz

43.(d) $\frac{w_m}{w_h} = \frac{T_h}{T_m}$; T_h = period of hour hand

T_m = period of minute hand

or, $\frac{w_m}{w_h} = \frac{12 \text{ hrs}}{60 \text{ min}} = \frac{12\times 60}{60} = 12:1$

44.(d) $\lambda_m = \frac{\lambda v}{\mu}$

$\therefore$ $\mu > 1$, so $\lambda_m < \lambda_w$, i.e. wavelength decrease but frequency is unchanged.

45.(a) $f = \frac{v}{4l}$ $\qquad$ i.e. $f \propto \frac{1}{l}$

As length of air column in vessel decrease, frequency increase.

46.(b) $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_2}$

$F_m = \frac{1}{4\pi\varepsilon_0 K}\frac{q_1 q_2}{r_2}$ or, $F_m = \frac{F}{K}$

47.(b) When a battery is connected in series another battery of higher emf with their negative terminal connected together, then battery is charged, so its emf will be less than its terminal p.d.

48.(a) $\frac{\left(\frac{q}{m}\right)_p}{\left(\frac{q}{m}\right)_a} = \frac{\frac{e}{m_p}}{\frac{2e}{4m_p}} = 2$

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

Section – II

61.(b) $Ni^{++} + S^{--} \xrightarrow[\text{medium}]{\text{alkaline}} NiS\downarrow$

62.(c)

63.(b)

64.(a) $Zn(NO_3)_2 \rightleftharpoons Zn^{++} + 2NO_3^-$

$H_2O \rightleftharpoons H^+ + OH^-$

Reaction at an anode: $40H^- \rightarrow 2H_2O + O_2 + 4e^-$

Reaction at cathode: $Zn^{++} + 2e^- \rightarrow Zn$

Zn and O_2 are products

65.(d) For 2nd I.P.

$Be^+ = 4 - 1 = 3 = 1s^2\,2s^1$

$C^+ = B - 1 = 5 = 1s^2\,2s^2\,2p^1$

$N^+ = 7 - 1 = 6 = 1s^2\,2s^2\,2p^2$

$O^+ = 8 - 1 = 7 = 1s^2\,2s^2\,2p^3$

So 2nd I.P. of Be < C < N < O

66.(b) $KBrO_3 \longrightarrow K^+ + BrO_3^-$

This compound contains either six +ve charge or six –ve charge.

Mol. wt. of $KBrO_3 = 167$, $E = \frac{167}{6} = 27.83$

$\frac{W}{E} = \frac{N \times V_{ml}}{1000}$

$\frac{0.1262}{27.83} = \frac{N\times 45}{1000}$

$N = \frac{126.2}{1252.5} = 0.1007$ N

67.(b) AgCl is AB type

$K_{sp} = 1.5 \times 10^{-10}$

$K_{sp} = s^2$

$s = \sqrt{1.5\times 10^{-10}} = 1.22\times 10^{-5}$

68.(d) $|\vec{a}\times\vec{b}| = 27 \Rightarrow |\vec{a}|\,|\vec{b}|\sin\theta = 27$

$\Rightarrow$ $9.5\sin\theta \Rightarrow 27 \Rightarrow \sin\theta = \frac{3}{5}$

So $\cos\theta = \frac{4}{5}$. Then $\vec{a}.\vec{b} = |\vec{a}|\,|\vec{b}|\cos\theta = 9.5.\frac{4}{5} = 36$

69.(c) $\cos^{-1}x + \cos^{-1}y = \frac{\pi}{2} \Rightarrow \cos^{-1}x = \frac{\pi}{2} - \cos^{-1}y$

$\Rightarrow$ $\cos^{-1}x = \sin^{-1}y$

$\Rightarrow$ $\cos^{-1}x = \cos^{-1}\sqrt{1-y^2}$

$\Rightarrow$ $x = \sqrt{1-y^2}$ $\qquad \Rightarrow$ $x^2 + y^2 = 1$

70.(b) One root = 3 + 4i, other root = 3 – 4i, sum = 6, product = 25

$\Rightarrow -\frac{p}{1} = 6, \frac{q}{1} = 25 \Rightarrow p = -6, q = 25$

71.(c) $\tan A = \frac{1-\cos B}{\sin B} = \frac{2\sin^2\frac{B}{2}}{2\sin\frac{B}{2}\cos\frac{B}{2}} = \tan\frac{B}{2}$

$\Rightarrow A = \frac{B}{2} \Rightarrow 2A = B$

So $\tan 2A = \tan B$

72.(a) As the pair of lines intersect on y-axis, so x = 0. Then $by^2 + 2fy + c = 0$. Also discriminant = 0

$(2f)^2 - 4.bc = 0 \quad \Rightarrow f^2 = bc$

73.(b) Intercept on y-axis $= 2\sqrt{f^2 - c} = 2\sqrt{(-3)^2 + 12}$

$= 2\sqrt{21}$ units

74.(d) $c = -\lambda, m = -2, a = -2$

So $c = -2am - am^3$ to be a normal

$-\lambda = -2.-2.-2 - (-2).(-2)^3$

$\Rightarrow -\lambda = -8 - 16 \quad \Rightarrow \lambda = 24$

75.(d) Eq^n is $9x^2 + 36y^2 = 324$

i.e. $\frac{x^2}{36} + \frac{y^2}{9} = 1$

So $a = 6, b = 3$

$\therefore |PS + PS'| = 2a = 2.6 = 12$

76.(a) Eq^n of plane cutting equal intercepts on the axes is $x + y + z = a$

As it passes through the point (2, 3, 4)

So, $2 + 3 + 4 = a$

i.e. $a = 9 \qquad \therefore$ Eq^n is $x + y + z = 9$

77.(d) Let $z = \sqrt{-1 - \sqrt{-1 - \sqrt{-1 \ldots \text{to } \infty}}}$

$\Rightarrow z = \sqrt{-1 - z} \Rightarrow z^2 + z + 1 = 0$

$\Rightarrow z = \frac{1 \pm \sqrt{1^2 - 4.1.1}}{2.1} = \frac{-1 \pm \sqrt{-3}}{2}$

$= \frac{-1 \pm \sqrt{3}i}{2} = \omega, \omega^2$

78.(c) No. of sides of polygon = n then no. of diagonals $= \frac{n(n-3)}{2}$

As per question, $n = \frac{n(n-3)}{2} \Rightarrow n - 3 = 2 \Rightarrow n = 5$

79.(b) Given $y = \sqrt{\tan x + \sqrt{\tan x + \sqrt{\tan x \ldots \text{to } \infty}}}$

$y = \sqrt{\tan x + y}$

or, $y^2 = y + \tan x$

On differentiation, $2y\frac{dy}{dx} = \frac{dy}{dx} + \sec^2 x$

$\Rightarrow (2y - 1)\frac{dy}{dx} = \sec^2 x$

80.(b) $\int \left\{\frac{1}{\log x} - \frac{1}{(\log x)^2}\right\} dx$

$= \int \frac{1}{\log x} dx - \int \frac{1}{(\log x)^2} dx$

$= (\log x)^{-1} \int dx - \int \left\{\frac{d(\log x)^{-1}}{d\log x} . \frac{d\log x}{dx} \int dx\right\} dx - \int \frac{1}{(\log x)^2} dx$

$= \frac{x}{\log x} - \int -\frac{1}{(\log x)^2}.\frac{1}{x} x dx - \int \frac{1}{(\log x)^2} dx$

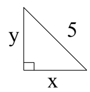
$= \frac{x}{\log x} + \int \frac{1}{(\log x)^2} dx - \int \frac{1}{(\log x)^2} dx = \frac{x}{\log x} + c$

81.(d) Here $x^2 + y^2 = 25$

So when x = 3m, then y = 4m, $\frac{dy}{dt} = -3$ m/s

On differentiation, $2x\frac{dx}{dt} + 2y\frac{dy}{dt} = 0$

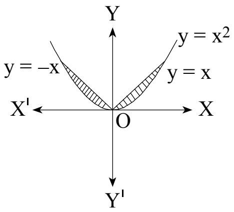
i.e. $\frac{dx}{dt} = -\frac{y}{x}\frac{dy}{dt} = \frac{3y}{x}$



When x = 3m, $\frac{dx}{dt} = 3.\frac{4}{3} = 4$ m/s

82.(b) Solving $y = x^2$ and $y = x$, we get x = 0, 1

With reference to figure, we have,



Required area $= 2\int_0^1 (y_1 - y_2)\, dx$

$= 2\int_0^1 (x^2 - x)\, dx = 2\left[\frac{x^3}{3} - \frac{x^2}{2}\right]_0^1$

$= 2\left[\frac{1}{3} - \frac{1}{2}\right] = 2.-\frac{1}{6} = -\frac{1}{3} = \frac{1}{3}$ sq. units.

83.(c) Let, u = velocity of projection

Time to reach greatest height (t) = 5 sec.

Then, $v = u - gt$

or, $0 = u - 10 \times t$

or, $u = 10 \times 5$

or, $u = 50$ m/s

84.(b) Work-done against friction = loss in kinetic energy

or, $F_f \times s = \frac{1}{2}mv^2$

or, $\mu mg \times s = \frac{1}{2}mv^2 = \frac{v^2}{2\mu g} = \frac{(10)^2}{2 \times 0.5 \times 10} = 10$m

85.(a) $\tau = I \times \alpha$

or, $F \times R = I$

or, $\alpha = \frac{F \times R}{I} = \frac{15 \times 10 \times 10^{-2}}{0.02} = 75$ rad/s^2

86.(c) $\frac{h_1}{\cos\theta_1} = \frac{h_2}{\cos\theta_2}$

$$\left(\begin{array}{l} hpg = \frac{2T}{r}\cos\theta \\ \text{or} \quad \frac{h}{\cos\theta} = \frac{2T}{rpg} = \text{cons tan t} \end{array}\right)$$

or, $\cos\theta_2 = \frac{h_2}{h_1}\cos\theta_1$

or, $\cos\theta_2 = \frac{1}{2}\cos 0°$

or, $\theta_2 = \cos^{-1}\left(\frac{1}{2}\right) = 60°$

87.(b) $PV = NKT$

or, $\frac{N}{V} = \frac{P}{KT}$

or, $\frac{N}{V} = \frac{1.01 \times 10^{-13}}{1.38\times10^{-23} \times 293}$

or, $\frac{N}{V} = 24.97 \times 10^6/ms^3 = 25 / cm^3$

88.(b) $PV = nRT$

$\therefore$ $PdV + VdP = nRdT$

$\because$ Pressure is constant, $dP = 0$

$\therefore$ $PdV = nRdT$

The, $dW = PdV = nRdT = 5 \times 8.31 \times 20 = 831$ J

89.(d) $\theta_{air} = \frac{\beta_a}{D}$ $\therefore$ $\theta_{water} = \frac{\beta_w}{D}$

or, $\frac{\theta_w}{\theta_a} = \frac{\beta_w}{\beta_a} = \frac{\lambda_w}{\lambda_a} = \frac{1}{\mu w}$ $[\because \mu_w = \lambda_a/\lambda_w]$

or, $\theta_w = \frac{\theta_a}{\mu_w} = \frac{0.25}{1.33} = 0.19°$

90.(a) $\nu_b = 0.02\ \nu_s$; ν_s = velocity of sound

ν_b = velocity of bat

Now for wave reflected from wall,

$f' = \frac{\nu_s + \nu_b}{\nu_s - \nu_b} \times f = \frac{\nu_s + 0.02\ \nu_s}{\nu_s - 0.02\ \nu_s} \times 39$

$= 40.59$ KHz

91.(c) $E = \frac{\sigma}{2\varepsilon_0}$

or, $\frac{V}{d} = \frac{\sigma}{2\varepsilon_0}$

or, $d = \frac{V \times 2\varepsilon_0}{\sigma} = \frac{50 \times 2 \times 8.854 \times 10^{-22}}{0.10 \times 10^{-6}}$

or, $d = 8.8 \times 10^{-3}$ m $= 8.8$ mm

92.(a) $P = I^2R$

or, $I = \sqrt{\frac{P}{R}} = \sqrt{\frac{10}{0.1}} = 10A$

or, $\frac{E}{R+r} = 10$

or, $\frac{1.5}{0.1+r} = 10$

or, $0.1 + r = \frac{1.5}{10}$

or, $r = 0.15 - 0.1 = 0.05\ \Omega$

93.(b) Loop current due to electron

$I = \frac{e}{T}$ T = period of motion

$= \frac{e}{\frac{2\pi r}{\nu}}$ $= \frac{e\nu}{2\pi r}$

Magnetic moment of current loop (μ) = IA

$\therefore$ $\tau_{max} = \mu B = IAB = \frac{e\nu}{2\pi r} \times \pi r^2 \times B$

$= \frac{e\nu r}{2} \times B$

$= \frac{1.6\times10^{-19} \times 4.2\times10^6 \times 5.29\times10^{-11}}{2} \times 7.10\times10^{-3}$

$= 1.23 \times 10^{-25}$ Nm

94.(c) Total energy (E_n) = –3.4 eV

$\therefore$ K. E. of electron in orbit (K.E) = $-E_n$

$= -(-3.4) = 3.4$ eV

$\therefore$ $\lambda = \frac{h}{\sqrt{2mK.E.}}$

$= \frac{6.62\times10^{-34}}{\sqrt{2\times9.1\times10^{-31} \times 3.4\times1.6\times10^{-19}}}$

$= 6.65 \times 10^{-10}$ m $= 6.65$Å

95.(c) Initial activity per 1g (A0) = 32 dis/min

Final activity per 1g (A) = $\frac{48}{6} = 8$ dis/min

$T_{1/2} = 5730$ yrs

t = ?

Now, $\frac{A}{A_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $\frac{8}{32} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

$\therefore$ $\frac{t}{T_{1/2}} = 2$

or, $t = 2 \times T_{1/2} = 2 \times 5730 = 11460$ years

96.(d) $E = -\frac{LdI}{dt}$

or, $2 = -L \times \frac{1}{10^{-3}}$

or, $L = 2$ mH

97.(b) 98.(b) 99.(a) 100.(c)

…Best of Luck…