Section - I

1. (b) $\rho = \frac{m}{V}$

or, $\frac{\Delta\rho}{\rho} = \pm\left(\frac{\Delta m}{m} + \frac{\Delta V}{V}\right) \times 100\%$

$= \pm\left(\frac{0.01}{20} + \frac{0.1}{5}\right) \times 100\% = \pm 2\%$

2.(b) When angle between $\vec{a}$ & instantaneous velocity is not same so angle between $\vec{a}$ and $\vec{v} \neq 0°$ due to which path is parabola.

3.(c) $W - F_f = ma$

or, $F_f = W - \frac{mg}{4} = W - \frac{W}{4} = \frac{3W}{4}$

4.(d)

5.(b) For 1st $PV = NKT$

or, $N_1 = \frac{PV}{KT}$

For 2nd $P'V' = N_2KT_2$

or, $N_2 = \frac{2P}{K \times 2T}\frac{V}{4} = \frac{PV}{4KT}$

Now $\frac{N_1}{N_2} = \frac{\frac{PV}{KT}}{\frac{PV}{4KT}} = 4:1$

6.(c) If temp. of surrounding is more than temp. of body then rate of energy absorbed is more than rate of energy radiated.

7.(a) Frequency remain same while moving from one medium to another medium.

8.(d) First overtone is 2nd harmonic

So, $\lambda = l$

9.(d) When $+3\mu c$ is added on $+3\mu c$ and $-3\mu c$ then net charge on 2nd ball will be zero due to which force become zero.

10.(d) $C = \frac{\varepsilon_r\varepsilon_0 A}{d}$, capacity depends on area, nature of matter in between plates, distance between plates.

11.(c) Current through bulb 1 & 4 is equal so the brightness of them will be equal.

12.(a) In series

$P_{eq} = \frac{P}{n} = \frac{40}{2} = 20$ W

13.(c) $V = IR$

$I = \frac{V}{R} = \frac{200}{50} = 4A$

$E = \frac{1}{2}LI^2 = \frac{1}{2} \times 5 \times 10^{-3} \times 4^2 = 0.04$ J = 40 mJ

14.(b) $4 = f + x$, $v = f + y$

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

or, $\frac{1}{f} = \frac{1}{f+x} + \frac{1}{f+y}$

or, $\frac{1}{f} = \frac{f+y+f+x}{(f+x)(f+y)}$

or, $f^2 + fx + fy + xy = 2f^2 + fx + fy$

or, $f^2 = xy$

15.(b) $\mu = \frac{\sin\frac{A+\delta_{min}}{2}}{\sin\frac{A}{2}} = \frac{\sin\left(\frac{60+30}{2}\right)}{\sin\frac{60}{2}}$

$= \frac{1}{\sqrt{2}} \times \frac{2}{1} = \sqrt{2}$

16.(d) $\lambda = \frac{h}{p} = \frac{h}{nh} \times \frac{1}{2\pi r}$

$= \frac{2\pi(0.53 \times 4) \times 10^{-10}}{2} = 6.6$ Å

17.(b) $\beta = \frac{\Delta I_c}{\Delta I_b} = \frac{\Delta I_c}{\Delta I_e - \Delta I_c}$

or, $100(\Delta I_e - 1) = 1$

or, $\Delta I_e = 1 + \frac{1}{100} = 1.01$ mA

18.(d) Atomic number of Na is 11 so Na^+ contains 10 electrons, 11 protons and 12 neutrons.

19.(b) Zn, Cd and Hg have completely filled d-orbitals so they do not show transition behavior as well as variable valencies.

20.(d) S^{2-} divalent

$\therefore$ Valency of metal = 3

Hence, formula of metal chloride = MCl_3

21.(b) Since, I^- donate electron pair to I_2

22.(d) Pauli's exclusion principle = in a given atom no. two atoms can have the same value of all the quantum numbers.

Hund's rule → When orbitals of same energy are available the electrons tend to occupy separate orbitals with same spin rather than getting paired and pairing occurs only with opposite spin.

Aufbau principle states that orbitals having low energy being filled first.

Uncertainty principle: It is impossible to measure both position and momentum of electron simultaneously with absolute precision $\Delta x \times \Delta p \geq h/4\pi$

23.(d) Due to the presence of dissolved hardness-producing salts, the boiling point of water is elevated. Elevation in boiling point is one of the most important colligative property. All the other options are correct.

24. (d) N_2O is used in surgery. It is also known as laughing gas.

25.(b) Bronsted -lowry concept.

According to this concept, acid is proton donor and base is proton acceptor.

In given equation HCl donates proton and H_2O accepts proton, so H_2O is base and HCl is acid.

26.(b)

27.(c) It contains > CHOH group

28.(b) These are keto and enol form of esters so known as tautomers.

29.(c) Total no. of elements = 5, no. of subsets having 3 elements = c(5, 3) = 10

30.(a) $\sec^2\theta = \frac{4}{3}$ i.e. $\cos^2\theta = \frac{3}{4}$ i.e. $\cos^2\theta = \left(\frac{\sqrt{2}}{2}\right)^2$

i.e. $\cos^2\theta = \cos^2\frac{\pi}{6}$ $\therefore$ $\theta = n\pi \pm \frac{\pi}{6}$

31.(b) asinA = bsinB

i.e. $a.\frac{a}{2R} = b.\frac{b}{2R}$

i.e. $a^2 = b^2$

i.e. a = b

∴ Δ is isosceles

32.(b) $\frac{|\vec{a} \times \vec{b}|}{\vec{a}.\vec{b}} = \frac{3}{\sqrt{3}}$

$\frac{ab\sin\theta}{ab\cos\theta} = \sqrt{3}\ \tan\theta = \sqrt{3}$

i.e. θ = 60°

33.(b) Logarithm is defined for positive values only so option 'b'

34.(c) Product of roots = 1

i.e. $\frac{-5}{K-2} = 1$

i.e. K – 2 = –5

i.e. K = –3

35.(a) By definition the determinant of a matrix and its transpose are equal, so 'a'

36.(b) For no solution, D = 0

∴ $\begin{vmatrix} \lambda & 3 \\ 1 & 2 \end{vmatrix} = 0$

i.e. 2λ – 3 = 0

i.e. $\lambda = \frac{3}{2}$

37. (d) The required line is 3(x – 1) + 5(y – 2) = 0

i.e. 3x + 5y – 13 = 0

38. (c) Given equations are 5x + 12y + 8 = 0, 10x + 24y – 3 = 0

i.e. 10x + 24y + 16 = 0, 10x + 24y – 3 = 0

∴ Distance = $\pm\frac{16-(-3)}{\sqrt{10^2+24^2}} = \frac{19}{26}$ units

39. (b) Radius = $\sqrt{g^2+f^2-c} = \sqrt{\sin^2\theta + \cos^2\theta + 8}$

$= \sqrt{9} = 3$

40. (d) Here, $\left(\frac{x}{a}\right)^2 + \left(\frac{y}{b}\right)^2 = \cos^2\theta + \sin^2\theta$, $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, which is an ellipse

41. (b) Given $x^2 - 4y^2 = 1$

i.e. $\frac{x^2}{1} - \frac{y^2}{\frac{1}{4}} = 1$

So, $e = \sqrt{1+\frac{1}{4}} = \sqrt{\frac{5}{4}} = \frac{\sqrt{5}}{2}$

42. (c) The equation is true only for x = 0, y = 0

So it represents z-axis

43. (a) $\lim_{x\to 0}\frac{e^{\sin x}-1}{x} = \lim_{x\to 0}\frac{e^{\sin x}-1}{\sin x}.\frac{\sin x}{x} = 1.1 = 1$

44. (c) For point of discontinuity, x – 3 = 0

i.e. x = 3

45. (b) By formula, option 'b' is correct.

46. (c) $2\frac{dy}{dx} = 0 - 2x$

i.e. $\frac{dy}{dx} = -1$

i.e. tanθ = –1 θ = 135°

47. (b) Put $t = \sqrt{x}$

i.e. $dt = \frac{1}{2}\sqrt{x}\ dx.$

So, $\frac{1}{2}\int \sec^2 t\ dt = \tan t + c = \tan\sqrt{x} + c$

48. (b) Rea. area $\int_0^\pi \sin x\ dx = \int_0^\pi \sin x\ dx$

$= [-\cos x]_0^\pi$

= (1 + 1) = 2 sq units

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

Section - II

61. (d) $h = \frac{1}{2}gT^2$ $T = \sqrt{\frac{2h}{g}}$

After $\frac{T}{2}$, $h_1 = \frac{1}{2}g\left(\frac{T}{2}\right)^2 = \frac{h}{4}$

Height from ground

$h' = h - \frac{h}{4} = \frac{3h}{4}$

62.(c) KE of ball = work done against upthrust

or, $\frac{1}{2}mv^2 = mah'$

or, $\frac{1}{2} \times 2gh = g\left(\frac{\sigma}{\rho} - 1\right)h'$

or, $h' = \frac{20}{\left(\frac{2\rho}{\rho} - 1\right)} = 20$ m

63.(b) $a = \frac{F}{m} = \frac{10}{20} = 0.5\ m/s^2$

v = u + at = 0 + 0.5 × 1 = 0.5 m/s

$W = KE = \frac{1}{2} \times 20(0.5)^2 = 2.5$ J

64.(c) $\frac{W'}{W} = \frac{mg'}{mg} = \frac{g\frac{R^2}{(R+h)}}{g}$

or, $\frac{W'}{W} = \frac{R^2}{\left(R+\frac{R}{2}\right)^2} = \frac{4}{9}$ ∴ $W' = \frac{4W}{9}$

65.(c) At bottom, $P_1 = P_a + P_w$

$V_1 = \frac{4\pi}{3}r^3$

At surface $P_2 = P_a$, $V_2 = \frac{4\pi}{3}(2r)^3 = 8V_1$

$P_1V_1 = P_2V_2$

or, $(P_a + P_w)\ V_1 = P_a \times 8V_1$

or, $P_w = 7P_a$

or, $\rho_w g h_w = 7 \times \rho_m g h_m$

or, $h_w = \frac{7 \times 13600 \times 0.76}{1000} = 72$ m

66.(b) $Q = \frac{KA\ d\theta}{2l} \times t_1 = \frac{K2Ad\theta}{l} \times t_2$

or, $\frac{t_1}{2} = 2t_2$ or, $t_2 = \frac{12}{4} = 3s$

67.(b) $f = nf_0 = 420$ … (1)
$f' = (n + 1) f_0 = 490$ …. (2)
Diving (2) by (1)
$\frac{n+1}{n} = \frac{490}{420} = \frac{7}{6}$
or, $6n + 6 = 7n$
or, $n = 6$
Now $f = 6 \times \frac{1}{2l}\sqrt{\frac{T}{m}}$
or, $l = \left(3\sqrt{\frac{360}{0.004}}\right) \times \frac{1}{420} = 2.14$ m

68.(c) $\frac{V}{v} = (n)^{2/3}$
or, $\frac{40}{10} = (n)^{2/3}$ or, $n = (4)^{3/2} = 8$

69.(a) **For A:** $P_1 \times t = msd\theta$
or, $P_1 = \frac{msd\theta}{t}$ … (1)
For B: $P_2 \times 2t = msd\theta$
or, $P_2 = \frac{msd\theta}{2t}$ …. (2)
When both are used $(P_1 + P_2)\, t' = msd\theta$
or, $t' = \frac{msd\theta}{\left(\frac{msd\theta}{t} + \frac{msd\theta}{2t}\right)} = \frac{2t.t}{3t} = \frac{2t}{3}$

70.(b) $E = -\frac{d\phi}{dt} = -(16t - 4)$
$= -(16 \times 0.1 - 4)$
$= 2.4$ V
$I = \frac{E}{R} = \frac{2.4}{10} = 0.24$ A

71.(b) Distance $= 2.5\,\beta = 2.5\,\frac{D\lambda}{d}$
$= \frac{2.5 \times 1 \times 6 \times 10^{-7}}{10^{-3}}$
$= 1.5 \times 10^{-3}$ m = 1.5 mm

72.(c) **For objective**
$u_0 = 200$ cm $f_0 = 50$ cm
$v_0 = \frac{f_0 u_0}{u_0 - f_0} = \frac{50 \times 200}{150} = \frac{200}{3}$ cm
For eye lens
$v_e = 25$ cm, $f_e = 5$ cm
$u_e = \frac{f_e . v_e}{v_e + f_e} = \frac{5 \times 25}{25 + 5}$
$= \frac{125}{30} = 4.16$ cm
Length $= v_0 + v_e = 66.6 + 4.16 = 70.8$ cm

73.(d) For Lyman series
$\frac{1}{\lambda_L} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$
or, $\lambda_L = \frac{4}{3R}$ …. (1)
And $\frac{1}{\lambda_s} = R\left[\frac{1}{1}\right]$
or, $\lambda_s = \frac{1}{R}$ …. (2)
$\therefore \frac{\lambda_L}{\lambda_s} = \frac{4}{3R} \times \frac{R}{1} = \frac{4}{3}$

74.(d) $\frac{N_A}{N_B} = \left(\frac{1}{e}\right)^2$
or, $\frac{N_0\, e^{-5\lambda t}}{N_0\, e^{-\lambda t}} = \left(\frac{1}{e}\right)^2$
or, $\left(\frac{1}{e}\right)^{4\lambda t} = \left(\frac{1}{e}\right)^2$
or, $4\lambda t = 2$ or, $t = \frac{1}{2\lambda}$

75.(b) Decarboxylation of salicylic acid gives benzene. During acylation of benzene, n-propyl carbocation (1°) electrophile rearranges to isopropyl carbocation (2°) so, isopropyl benzene i.e. cumene is formed.

76.(b) Alkylidene and alkylene compounds are always positional isomers. The no. of carboxylic acid (fatty acid) in C_4H_9-COOH are four.

77.(a) 2 moles of Na_2SO_3 are chemically equivalent to 1 mole of I_2 (two equivalents).
$\therefore$ Eq. wt. of $Na_2S_2O_3$
$= \frac{2 \times \text{mol.mass}}{2} = \text{mol.mass}$

78.(a) Charge passed = I×t = 1×965 = 965C
As 2F or 2×96500 = 1mole
Hence, 96500 c will deposit
= (1× 965)/(2×96500) = 1/200 = 0.005 moles

79.(b) Eqv. Wt. of $KMnO_4$ = mol.wt/ΔO.N.
= mol. wt/5
N_{KMnO4} = 5x molarity
or, N_{KMnO4} = 5x0.1 = 0.5
Eqv. Wt of $C_2O_4^{2-}$ = mol. wt/ ΔO.N. of 2 C atoms
= mol.wt/ 2 [4-3] = mol wt./2
$\therefore$ $NC_2O_4^{2-}$ = 2x molarity
Meq. of $KMnO_4 = 0.5 \times 20 = 10$
Meq of 50 ml of 0.1M $H_2C_2O_4 = 0.1 \times 2 \times 50 = 10$

80.(c) Minimum mol. wt. $= \frac{32 \times 100}{4}$. At least one S atom must be present.

81. (c) We can use PV = nRT for getting n and then number of molecules $= n \times 6.023 \times 10^{23}$.

82.(d) We have $e^x = y + \sqrt{1 + y^2}$
i.e. $e^x - y = \sqrt{1 + x^2}$
i.e. $(e^x - y)^2 = 1 + y^2$
i.e. $e^{ex} - 2e^x y + y^2 = 1 + y^2$
i.e. $e^{2x} - 1 = 2e^x y$
i.e. $y = \frac{e^x - e^{-x}}{2}$

83.(c) $\tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{yz}{xr} + \tan^{-1}\frac{zx}{yr}$
$= \tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{\frac{yz}{xr} + \frac{zx}{yr}}{1 - \frac{yz}{xr}\cdot\frac{zx}{yr}}$

$$= \tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{\frac{x}{xyr}(y^2+x^2)}{\frac{r^2-z^2}{r^2xy}}$$

$$= \tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{zr}{xy}\cdot\frac{y^2+x^2}{y^2+x^2}$$

$$= \tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{zr}{xy} = \tan^{-1}\frac{xy}{zr} + \cot^{-1}\frac{xy}{zr} = \frac{\pi}{2}$$

84.(c) $|\vec{x}| = |\vec{y}| = |\vec{z}| = 1$ and $\vec{x} + \vec{y} + \vec{z} = \vec{0}$

So, $\vec{y} + \vec{z} = -\vec{x}$

i.e. $y^2 + 2\vec{y}.\vec{z} + z^2 = x^2$

i.e. $1 + 2.11\cos\theta + 1 = 1$

i.e. $\cos\theta = -\frac{1}{2}$ $\quad\therefore\ \theta = \frac{2\pi}{3}$

85.(b) Total no. of distribution of prizes = $4^3 = 64$ & no of ways of getting all the prizes to one = 4

$\therefore$ Total no. of ways of distribution = 64 – 4 = 60

86.(d) We have, $(1+x)^n = c_0 + c_1x + c_2x^2 + c_3x^3 + \ldots + c_nx^n$

Integrating, $\frac{(1+x)^{n+1}}{n+1} = c_0x + \frac{c_1}{2}x^2 + \frac{c_2}{3}x^3 + \frac{c_3}{4}x^4 + \ldots + c_n\frac{x^{n+1}}{n+1} + K$

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

Then $\frac{(1+x)^{n+1}}{n+1}$

$$= c_0x + \frac{x^2}{2}c_1 + \frac{x^3}{3}c_2 + \frac{x^4}{4}c_3 + \ldots + \frac{x^{n+1}}{n+1}c_n + \frac{1}{n+1}$$

Putting x = 2, $\frac{3^{n+1}}{n+1} - \frac{1}{n+1} = 2c_0 + \frac{2^2}{2}c_1 + \frac{2^3}{3}c_2 + \frac{2^4}{4}c_3 + \ldots + \frac{2^{n+1}}{n+1}c_n$

87.(b) Put a = K, b = K + d, c = K + 2d

Also (b – a), (–b), a are in G.P.

So, d, d, a are in GP

i.e. $d^2 = ad \Rightarrow a = d$

So, a : b : c = K : 2K : 3K

= 1 : 2 : 3

88.(d) $(1+\omega^2)^m = (1+\omega^4)^m$

or, $(1+\omega^2)^m = (1+\omega)^m$

i.e. $(-\omega)^m = (-\omega^2)^m \Rightarrow \left(\frac{\omega^2}{\omega}\right)^m = 1$

i.e. $\omega^m = 1 = \omega^3 \Rightarrow m = 3$

89.(c) Pair of lines: xy – x – y + 1 = 0

i.e. x(y – 1) = 0

i.e. (x – 1) (y – 1) = 0

i.e. x – 1 = 0, y – 1 = 0

As the lines are concurrent, so put x = 1, y = 1 in ax + 2y – 3 = 0, we get a.1 + 2.1 – 3 = 0

i.e. a = 1

90.(d) Here m = tan45° = 1, $a' = \frac{a}{4}$

So point of contact

$$= \left(\frac{a'}{m^2}, \frac{2a'}{m}\right) = \left(\frac{a}{4.1^2}, 2.\frac{a}{4.1}\right) = \left(\frac{a}{4}, \frac{a}{2}\right)$$

91.(b) Equation of plane is $lx + my + nz = 1$

Which meets the coordinate axes at $\left(\frac{1}{l}, 0, 0\right)$, $\left(0, \frac{1}{m}, 0\right)$ and $\left(0, 0, \frac{1}{n}\right)$. Then the centroid of the triangle formed is $\left(\frac{1}{3l}, \frac{1}{3m}, \frac{1}{3n}\right)$. Thus $(31)^2 + (3m)^2 + (3n)^2 = K$

i.e. $K = 9(l^2 + m^2 + n^2) = 9$

92.(c) For continuity, $\lim_{x \to 0} f(x) = f(0)$

i.e. 0 = K

93.(c) Here $x = \sin^{-1}(3t - 4t^3) = 3\sin^{-1}t$,

$y = \cos^{-1}\sqrt{1-t^2} = \sin^{-1}t$

So, x = 3y i.e. $y = \frac{1}{3}x$

$\therefore\ \frac{dy}{dx} = \frac{1}{3}$ and $\frac{d^2y}{dx^2} = 0$

94.(b) Here $f(x) = x^3 + \lambda x^2 + \mu x + 1$

So, $f'(x) = 3x^2 + 2\lambda x + \mu$

Then $f'(0) = 0 \Rightarrow 3.0 + 2.\lambda.0 + \mu = 0 \Rightarrow \mu = 0$

and $f'(1) = 0 \Rightarrow 3.1 + 2\lambda.1 + 0 = 0 \Rightarrow \lambda = -\frac{3}{2}$

95.(c) $I = \int e^{\sqrt{x}}\,dx$ put $y = \sqrt{x}$

i.e. $dy = \frac{1}{2\sqrt{x}}dx$

i.e. dx = 2y dy

Then $I = 2\int ye^y dy$

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

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

96.(c) Here $\frac{dy}{dx} = 2x + 1$

So, $y = x^2 + x + K$

It passes through the point (1, 2).

So, 2 = 1 + 1 + K $\Rightarrow$ K = 0

The curve is $y = x^2 + x$

So it crosses x-axis a points 0 and –1

$\therefore$ Required area $= \int_{-1}^{0} y\,dx = \int_{-1}^{0}(x^2 + x)\,dx$

$$= 0 - \left[-\frac{1}{3} + \frac{1}{2}\right] = -\frac{1}{6} = \frac{1}{6} \text{ sq. units}$$

97.d 98.c 99.a 100.c

…Best of Luck…