Section – I

1.(c) $\sqrt{x} = t + 1$

or, $x = t^2 + 2t + 1$

or, $v = \frac{dx}{dt} = 2t + 2$

i.e. Increases with time.

2.(c) $\frac{w}{4} \times \left(\frac{L}{2} + x\right) = w \times x$

or, $\frac{L}{8} + \frac{x}{4} = x$

or, $\frac{L}{8} = \frac{3x}{4}$

or, $x = \frac{L}{6}$

Distance $= \frac{L}{2} + \frac{L}{6} = \frac{42}{6} = \frac{2L}{3}$

3.(a) $B = \frac{P}{-\frac{\Delta V}{V}}$ for rigid body $\frac{\Delta V}{V} = 0$

So, $B = \infty$

4.(a) $\Delta V = V_0\gamma\Delta\theta$ = constant

5.(a) $dQ = du + dw$

For adiabatic process $6Q = 0$ so $du = -dw$

6.(a) KE = PE

or, $\frac{1}{2} m\omega^2 (r^2 - y^2) = \frac{1}{2} m\omega^2 y^2$

or, $2y^2 = r^2$

or, $y = \frac{r}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$ cm

7.(b) $E = \frac{Q}{4\pi\varepsilon_0 r^2}$

$E' = \frac{Q}{4\pi\varepsilon_0 (2r)^2} = \frac{E}{4}$

8.(c) $\frac{R'}{R} = \left(\frac{2l}{l}\right)^2 = 4$

$R' = 4R$

$\therefore \quad \Delta R = R' - R = 4R - R = 3R$

9.(b) Diamagnetic material are repelled.

10.(a) At LCR resonance R = Z

11.(b) Focal length of mirror is independent of medium.

12.(b) $\beta = \frac{D\lambda}{d}$

β increases if d decreases.

13.(a) $I \propto \frac{1}{r^2}$ so if distance is made half then intensity become fourfold so photoelectric current become 4 times.

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

or, $40\, I_b = 8.2 - I_b$

or, $I_b = \frac{8.2}{41} = 0.2$ mA

15.(b) At STP, one mole of any gas occupies 22.4 L. Use this molar volume to calculate the number of moles from the given volume.

16.(c) Remember flame test colors for halogen compounds. Chlorine compounds give green, bromine compounds give orange-red, and iodine compounds give violet color.

17.(b) $AlCl_3$ is a salt of weak base ($Al(OH)_3$) and strong acid (HCl). Such salts undergo hydrolysis and Al^{3+} acts as a Lewis acid.

18.(b) Lattice energy is proportional to the product of charges and inversely proportional to the distance between ions. Consider both charge and size factors.

19.(d) This octahedral complex can have different spatial arrangements of ligands, and the chiral center can lead to non-superimposable mirror images.

20.(b) Look for a molecule with perfectly symmetrical geometry where all polar bonds cancel each other out completely.

21.(b) Write the electronic configurations for each ion and count unpaired electrons. Fe^{2+} is d^6, Fe^{3+} is d^5, Ni^{2+} is d^8, Cu^{2+} is d^9.

22.(d) Ionization energy generally increases across a period, but noble gases have completely filled shells making them exceptionally stable.

23.(d) Lanthanoid contraction causes 4d and 5d transition elements to have similar sizes and properties, especially affecting pairs in the same group.

24.(c) The block is determined by the subshell that receives the last electron. Look at which subshell is being filled last.

25.(b) Lewis bases are electron pair donors. Consider the availability of lone pairs and the tendency to donate them. Electronegativity and size affect basicity.

26.(c) Determine the change in oxidation state of Mn from MnO_4^- to MnO_2, then calculate the electrons involved. One faraday = one mole of electrons.

27.(c) With copper electrodes in $CuSO_4$ solution, the copper anode itself participates in the reaction rather than water or sulfate ions.

28.(b) Alkynes have electron-rich triple bonds that readily attract electron-deficient species, leading to a specific type of reaction mechanism.

29.(d)

30.(a) $Z = (3 - 2i)^2 = 9 - 12i + 4i^2 = 5 - 12i$

$\bar{Z} = 5 + 12i$

31.(d) $\alpha + \beta = -\frac{b}{a}, \alpha\beta = \frac{b}{a}$

$$\sqrt{\frac{\alpha}{\beta}} + \sqrt{\frac{\beta}{\alpha}} = \frac{\alpha + \beta}{\sqrt{\alpha\beta}} = \frac{-\frac{b}{a}}{\sqrt{\frac{b}{a}}} = -\sqrt{\frac{b}{a}}$$

32.(b) $\Delta = \begin{vmatrix} 1 & 2\omega \\ \omega & \omega^2 \end{vmatrix} = \omega^2 - 2\omega^2 = -\omega^2$

$\Delta^2 = (-\omega^2)^2 = \omega^4 = \omega^3.\omega = 1.\omega = \omega$

33.(c) $\sum_{n=3}^{\infty} \frac{1}{(n-1)!} = \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + ...$

$= e - 2$

34.(b) $\cos^{-1}x = \frac{\pi}{2} - \cos^{-1}y$

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

or, $\sin^{-1}\sqrt{1 - x^2} = \sin^{-1}y$

or, $\sqrt{1-x^2} = y$
Squaring, $x^2 + y^2 = 1$

35.(b) $\frac{\cos C + \cos A}{c + a} + \frac{\cos B}{b}$

$= \frac{b\cos C + b\cos A + c\cos B + a\cos B}{b(c + a)} = \frac{a + c}{b(a + c)}$

(Using projection laws)

$= \frac{1}{b}$

36.(a) $\overrightarrow{AB} = (3 - 2, -1 + 1, 2 - 5) = (1, 0, -3)$

$\overrightarrow{CD} = (1 - 3, 2 - 2, 1 + 5) = (-2, 0, 6)$

$= -2(1, 0, -3)$

$= -2\overrightarrow{AB}$

$\therefore \overrightarrow{AB} = -\frac{1}{2}\overrightarrow{CD}$

$\therefore k = -\frac{1}{2}$

37.(d)

38.(b) P(A or B) = P(A) + P(B) – P(A).P(B)

$= \frac{1}{4} + \frac{2}{3} - \frac{1}{4} \times \frac{2}{3} = \frac{3}{4}$

39.(c) The point C divides AB externally in the ratio 2:1.

Coordinates of C $= \left(\frac{2.2 - 1.(-3)}{2 - 1}, \frac{2.1 - 1.4}{2 - 1}\right)$

$= (7, -2)$

40.(a) a = 4, h = h, b = –7

$m_1 + m_2 = -\frac{2h}{b} = \frac{-2h}{-7} = \frac{2h}{7}$

$m_1m_2 = \frac{a}{b} = \frac{4}{-7}$

By given, $\frac{2h}{7} = \frac{4}{-7} \Rightarrow h = -2$

41.(a)

42.(c) We have, $l^2 + m^2 + n^2 = 1$

or, $k^2 + 4k^2 + 9k^2 = 1$

or, $14k^2 = 1$

$\therefore k = \frac{1}{\sqrt{14}}$

43.(c) $\lim_{x \to \frac{\pi}{2}} (\pi - 2x)\tan x$

$= \lim_{x \to \frac{\pi}{2}} \frac{\pi - 2x}{\cot x}$

$= \lim_{x \to \frac{\pi}{2}} \frac{-2}{-\text{cosec}^2 x} = \frac{2}{\text{cosec}^2\frac{\pi}{2}} = 2$

44.(b) LHL $= \lim_{x \to 0^-} f(x) = \lim_{x \to 0^-} \frac{x - (-x)}{2} = 0$

RHL $= \lim_{x \to 0^+} f(x) = \lim_{x \to 0^+} \frac{x - x}{2} = 0$

f(0) = 2

$\therefore$ LHL = RHL $\neq$ f(0)

So, f(x) is discontinuous at x = 0.

45.(d) $y = e^{x^2}$

$\frac{dy}{dx} = \frac{d}{dx}(e^{x^2}) = \frac{d(e^{x^2})}{d(x^2)} \cdot \frac{d(x^2)}{dx}$

$= e^{x^2} . 2x = 2xe^{x^2}$

46.(d) Average velocity $= \frac{\Delta s}{\Delta t} = \frac{s(3) - s(2)}{3 - 2}$

$= \frac{19 - 11}{1} = 8$ m/s

47.(a) $\int \cos\frac{x}{2}\,dx = \frac{\sin\frac{x}{2}}{\frac{1}{2}} + c = 2\sin\frac{x}{2} + c$

48.(c) Area $= \int_0^\pi y\,dx = \int_0^\pi \sin x\,dx = [-\cos x]_0^\pi$

$= (-\cos\pi) - (-\cos 0)$

$= 1 - (-1) = 1 + 1 = 2$

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

Section – II

61.(c) $\Delta h = h_1 - h_2$

$= \frac{1}{2}g\,3^2 - \frac{1}{2}g\,2^2$

$= \frac{1}{2}g\,(9 - 4) = 25$ m

62.(a) Horizontal $S_1 = ut = 1.5 \times 4 = 6$m

Vertical $a = \frac{F}{m} = \frac{5}{5} = 1 m/s^2$

$S_2 = \frac{1}{2}at^2 = \frac{1}{2} \times 1 \times 4^2 = 8$m

$S = \sqrt{S_1^2 + S_2^2} = \sqrt{6^2 + 8^2} = 10$m

63.(a) $E = 4\pi r^2T\,(n^{1/3} - 1)$

$= 4\pi(2 \times 10^{-3})^2 \times 0.465\,(8^{1/3} - 1)$

$= 23.3 \times 10^{-6}$ J = 23.3 μJ

64.(a) $T_2V_2^{\gamma-1} = T_1V_1^{\gamma-1}$

or, $T_2 = 300\left(\frac{V}{\frac{8V}{27}}\right)^{5/3-1}$

$= 300\left(\frac{27}{8}\right)^{2/3}$

$= 300 \times \frac{9}{4}$

= 675 K

$\Delta T = T_2 - T_1 = 675 - 300 = 375$K

= 375°C

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

$\eta_1 = \left(1 - \frac{T_2}{T_1}\right) \times 100\%$

or, $\frac{40}{100} = 1 - \frac{300}{T_1}$

or, $\frac{300}{T_1} = 1 - \frac{2}{5} = \frac{3}{5}$

or, $T_1 = 500$ K

2nd case $\eta_2 = 40\% + 50\%$ of 40%
$= 60\%$

$$\eta_2 = \left(1 - \frac{T_2}{T_1}\right) \times 100\%$$

or, $\frac{60}{100} = 1 - \frac{300}{T_1}$

or, $\frac{300}{T_1'} = 759$ K

$\therefore$ $\Delta T = T_1' = T_1 = 750$ K

66.(b) $\frac{\rho_0}{\rho_H} = 16$

$\rho_0 = 16\rho_H$

$$\rho_{mix} = \frac{V\rho_0 + V\rho_H}{2V} = 16\rho_H + \rho_H = \frac{17}{2}\rho_H$$

$$\frac{v_{mix}}{v_H} = \sqrt{\frac{\rho_H}{\rho_{mix}}} = \sqrt{\frac{\rho_H}{\frac{17}{2}\rho_H}} = \sqrt{\frac{2}{17}}$$

67.(c) $$\frac{E}{Vol} = \frac{\frac{1}{2}CV^2}{Vol} = \frac{1}{2}\frac{\varepsilon_r\varepsilon_0 AV^2}{d\ Ad}$$

$$= \frac{1}{2}\varepsilon_r\varepsilon_0\left(\frac{V}{d}\right)^2$$

$= 1.38$ J/m^3

68.(c) Along ABC, $R_1 = \frac{2 \times 6}{2 + 6} + 1.5 = 3\Omega$

$R_{eq} = \frac{3}{2}\Omega$

$\therefore$ $I = \frac{6}{R_{eq}} = \frac{6}{3} \times 2 = 4A$

69.(b) $I_0 = \frac{V}{R} = \frac{2}{2} = 1A$

Now, $I = I_0 (1 - e^{-Rt/L})$

or, $\frac{I_0}{2} = I_0 (1 - e^{-Rt/L})$

or, $e^{-Rt/L} = \frac{1}{2}$

or, $\frac{1}{e^{Rt/L}} = \frac{1}{2}$

or, $e^{Rt/L} = 2$

or, $\frac{Rt}{L} = ln2$

or, $t = \frac{ln2 \times 300 \times 10^{-3}}{2} = 0.1$ sec

70.(d) **First case**

$4 = \frac{f}{4 - f}$

or, $4u - 4f = f$

or, $u = \frac{5f}{4}$

2nd case

$3 = \frac{f}{4 + 3 - f}$

or, $3u + 9 - 3f = f$

or, $\frac{3 \times 5f}{4} + 9 = 4f$

or, $9 = 4f - \frac{15f}{4} = \frac{f}{4}$

$\therefore$ $f = 36$ cm

71.(d) $$\frac{\beta}{2} = \frac{D\lambda}{2d} = \frac{1 \times 550 \times 10^{-9}}{2 \times 1.1 \times 10^{-3}} = 2.5 \times 10^{-4}$$

$= 0.25$ mm

72.(b) $Rhc = 13.6$ eV

$$E = E_\infty - E_2 = 0 + \frac{13.6 \times 3^2}{2^2} = 30.6 \text{ eV}$$

73.(d) $$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

or, $\frac{12.5}{25} = \left(\frac{1}{2}\right)^{\frac{10}{T_{1/2}}}$

or, $T_{1/2} = 10$ sec

Again, $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $\frac{6.25}{100} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $t = 4T_{1/2} = 4 \times 10 = 40$ sec

74.(b) Count π bonds carefully: C_2H_2 has a triple bond (2π), C_6H_6 has 3 delocalized π bonds, CO_2 has two double bonds (2π), N_2 has a triple bond (2π).

75.(b) Chromium is an exception to the normal filling order. Half-filled and fully-filled subshells provide extra stability, causing an electron to move from 4s to 3d.

76.(d) Analyze the oxidation states of sulfur in H_2S (-2), SO_2 (+4), and S (0). Both H_2S and SO_2 are converted to the same product with different oxidation state.

77.(c) Look for a species that can both donate a proton (act as acid) and accept a proton (act as base). Consider what happens when it gains or loses H^+.

78.(a) Bond length is inversely related to bond order. Higher bond order means shorter bond length due to stronger attraction between atoms.

79.(b) The reaction shows a compound breaking down into simpler substances, and heat is absorbed (indicated by -heat). This tells you both the type of reaction and energy change.

80.(c) Dehydration of alcohols involves carbocation formation. The stability of carbocations follows a specific order: 3° > 2° > 1°.

81.(a) Count carefully: 6 C-H bonds, 6 C-C bonds (σ bonds), and 3 delocalized π bonds in the benzene ring. Each bond type contributes differently.

82.(b) To define f(x), $9 - x^2 > 0 \Rightarrow -3 < x < 3$ .... (i)

and $-1 \le x - 3 \le 1 \Rightarrow 2 \le x \le 4$ ... (ii)

From (i) and (ii), $2 \le x < 3$ i.e. [2, 3]

Domain = [2, 3]

83.(c) $$\frac{1}{3 \times 7} + \frac{1}{7 \times 11} + \frac{1}{11 \times 15} + \ldots$$

$$= \frac{1}{4}\left(\frac{4}{3 \times 7} + \frac{4}{7 \times 11} + \frac{4}{11 \times 15} + \ldots\right)$$

$= \frac{1}{4}\left(\frac{1}{3} - \frac{1}{7} + \frac{1}{7} - \frac{1}{11} + \frac{1}{11} - \frac{1}{15} + ...\right) = \frac{1}{12}$

84.(d) Required no. of ways $= {}^4C_1 + {}^4C_2 + {}^4C_3 + {}^4C_4$
$= 15$

85.(b) $\left(1 + \frac{1}{1}\right)^n = 64 \Rightarrow 2^n = 2^6$

$\Rightarrow n = 6$

General term $(t_{r+1}) = {}^nC_r\, x^{n-r}\left(\frac{1}{x}\right)^r$

$= {}^6C_r\, x^{6-2r}$

For the term independent of x,

$6 - 2r = 0 \quad \Rightarrow r - 3$

$\therefore \quad t_{3+1} = {}^6C_3 = 20$

86.(c) tanx + secx = 2cosx

$\Rightarrow$ $(\sin x + 1) = 2\cos^2 x$

$\Rightarrow$ $(\sin x + 1) = 2(1 - \sin x)(1 + \sin x)$

$\Rightarrow$ $(1 + \sin x)[2(1 - \sin x) - 1] = 0$

$\Rightarrow$ $2(1 - \sin x) - 1 = 0$

[$\because$ sinx $\neq -1$ othermise cosx = 0 and tanx, secx will be undefined]

$\Rightarrow \quad \sin x = \frac{1}{2} \quad \Rightarrow x = \frac{\pi}{6}, \frac{5\pi}{6}$ in $(0, 2\pi)$

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

Also, $\vec{a} + \vec{b} + \vec{c} = 0$

$\Rightarrow \quad \vec{b} + \vec{c} = -\vec{a}$

Squaring, $b^2 + 2\vec{b}.\vec{c} + c^2 = a^2$

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

or, $\cos\theta = -\frac{1}{2} = \cos\frac{2\pi}{3}$

$\therefore \quad \theta = \frac{2\pi}{3}$

88.(a) Variance = $(S.D)^2$

$= \frac{1}{n}\Sigma x^2 - \frac{\Sigma x}{n}$

$= \frac{n(n+1)(2n+1)}{6n} - \left(\frac{n(n+1)}{2n}\right)^2 = \frac{n^2 - 1}{12}$

89.(d) Length of latus rectum =
2(length of the perpendicular from (3, 3) on the line $3x - 4y - 2 = 0$)

$= 2\left|\frac{9 - 12 - 2}{\sqrt{9 + 16}}\right| = 2$

90.(d) The eq^n of plane through the point (2, –3, 1) is $a(x - 2) + b(y + 3) + c(z - 1) = 0$ ... (i)

D.r's of the line joining the points (3, 4, –1) and (2, –1, 5) are

$3 - 2, 4 + 1, -1 - 5$ i.e. 1, 5, –6

Required eq^n of plane is

$1(x - 2) + 5(y + 3) - 6(z - 1) = 0$

$\therefore \quad x + 5y - 6z + 19 = 0$

91.(c) Centre = (2, 4), Radius $= \sqrt{4 + 16 + 5} = 5$

Length of perpendicular from centre < radius

$\Rightarrow \quad \frac{|6 - 16 - m|}{\sqrt{3^2 + (-4)^2}} < 5$

$\Rightarrow \quad |10 + m| < 25$

$\Rightarrow \quad -25 < m + 10 < 25$

$\Rightarrow \quad -35 < m < 15$

92.(c) Let t be the radian measure of the angle whose degree measure is θ°.

So, $t = \frac{\pi\theta}{180}$ and $\theta° = \frac{180t}{\pi}$

When $\theta° \to 0, t \to 0$

Now, $\lim_{\theta° \to 0} \frac{\sin\theta°}{\theta°} = \lim_{t \to 0} \frac{\sin t}{\frac{180t}{\pi}}$

$= \frac{\pi}{180}\lim_{t \to 0}\frac{\sin t}{t} = \frac{\pi}{180}$

93.(a) $y = x^2 + \frac{1}{y}$

$\Rightarrow \quad y^2 = x^2 y + 1$

Diff. both sides w.r. to x

$2y\frac{dy}{dx} = x^2\frac{dy}{dx} + y.2x$

$\Rightarrow \quad \frac{dy}{dx} = \frac{2xy}{2y - x^2}$

94.(b) Let $f(x) = \left(\frac{1}{x}\right)^x = x^{-x} = e^{-x\,l\text{n}x}$

$f'(x) = e^{-x\,l\text{n}x}(-1 - l\text{n}x)$

For max. or min. values, $f'(x) = 0$

$\Rightarrow \quad x = \frac{1}{e}$

$f''(x) = e^{-x\,l\text{n}x}\left(-\frac{1}{x}\right) + (-1 - l\text{n}x)e^{-x\,l\text{n}x}$

$\therefore \quad f''\left(\frac{1}{e}\right) = -e.e^{1/e} < 0$ (max. value)

Max. value $= e^{1/e}$

95.(a) $I = \int_0^8 |x - 5|\,dx = \int_0^5 -(x - 5)\,dx + \int_5^8 (x - 5)dx$
$= 17$

96.(b) $\frac{dy}{dx} = 2\cos x - y\cot x$

$\Rightarrow \quad \frac{dy}{dx} + y\cot x = 2\cos x$

I.F. $= e^{\int \cot x dx} = \sin x$

Thus, $y.\sin x = \int 2\cos x.\sin x + c$

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

When $x = \frac{\pi}{2}$, $y = 2 \Rightarrow c = 1$

Thus, y = sinx + cosecx

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

...Best of Luck...