Section – I

1.(c) It pass the vertical line test perfectly.

2.(b) $\tan^2\theta + \cot^2\theta = 2$
$\tan^4\theta - 2\tan^2\theta + 1 = 0$
$\tan^2\theta - 1 = 0$
$\tan^2\theta = \tan^2\frac{\pi}{4} \Rightarrow \theta = n\pi \pm \frac{\pi}{4}$

3.(d) $2x + 3y = 5$
$x + 7y = 8$
Let $A = \begin{bmatrix} 2 & 3 \\ 1 & 7 \end{bmatrix}$
$|A| = 2 \times 7 - 1 \times 3 = 11 \neq 0$
$A^{-1} = \frac{1}{|A|}$ Ad joint matrix of $A = \frac{1}{11}\begin{bmatrix} 7 & -3 \\ -1 & 2 \end{bmatrix}$

4.(c) At x-axis
$4x^3 - 68x^2 + 280x = 0$
$4x(x^2 - 17x + 70) = 0$
$4x = 0 \Rightarrow x = 0$
or, $x^2 - 7x + 70 = 0$
$x = 10, 7$
So, meets at three points

5.(a) Area $= \frac{1}{2}|a| \times |a|$ $[\because a = b]$
$2 \times 8 = a^2 \Rightarrow a = \pm 4$
Equation: $\frac{x}{a} + \frac{y}{a} = 1 \Rightarrow x + y = 4$

6.(c) The no. of lines determined by the given plane is three because a line in 3–D space is determined by intersection of two distinct planes.

7.(d) Because three vectors in the same plane (coplanar) are always linearly dependent.

8.(b) If $x - 3 = 0$
$x = 3$
Because $f(3) = \frac{0}{0}$; which is undefined, the function is discontinuous at $x = 3$.

9.(b) $\frac{d\{\cos^{-1}(\sin x)\}}{dx}$
$= -\frac{\cos x}{\sqrt{1-\sin^2 x}} = -1$ $\left[\because \frac{d[\cos^{-1}x]}{dx} = \frac{-1}{\sqrt{1-x^2}}\right]$

10.(a) $I = \int \frac{\sec^2\sqrt{x}}{\sqrt{x}}dx$
$= 2\int \frac{\sec^2\sqrt{x}}{2\sqrt{x}}dx$
$= 2\tan\sqrt{x} + c$
Other method
Put $\sqrt{x} = y$ proceed

11.(c) $f(x) = x^5 + \cos(x)$
$f(-x) = (-x)^5 + \cos(-x)$
$= -x^5 + \cos x$
Neither even nor odd function.

12.(a) $(x - 1)(x^2 + x + 1) = 0$
$x^3 - 1 = 0 \Rightarrow x^3 = 1$
$\therefore x^{3n} = (x^3)^n = (1)^3 = 1$

13.(d) Projection of $2\vec{i} + 3\vec{j} + 2\vec{k}$ on $\vec{i} + 2\vec{j} + 3\vec{k}$
$= \frac{2 \times 1 + 3 \times 2 + 2 \times 3}{\sqrt{1^2 + 2^2 + 3^2}}$
$= \frac{14}{\sqrt{14}} = \sqrt{14}$

14.(b) $ar^3 = 2$
Product $= a.ar.ar^2.ar^3.ar^4.ar^5.ar^6$
$= a^7.r^{21} = (ar^3)^7 = (2)^7 = 2^7$

15.(b) $\frac{\cos C + \cos A}{c + a} + \frac{\cos B}{b}$
$\frac{b\cos C + b\cos A + c\cos B + a\cos B}{b(c + a)}$
$\frac{b\cos C + c\cos B + b\cos A + a\cos B}{b(c + a)}$
$\frac{a + c}{b(c + a)} = \frac{1}{b}$

16.(a) [Note: $n(A \cup B) \leq n(U)$]
$\therefore n(A \cup B) = 125$

17.(c) Range of $\cos^{-1}x$ is $[0, \pi]$
So, $\cos^{-1}\left(-\frac{\sqrt{2}}{2}\right) = \cos^{-1}\left(-\frac{1}{\sqrt{2}}\right) = 135°$ or $\frac{3\pi}{4}$
$\therefore$ Principal value $= \frac{3\pi}{4}$

18.(a) $S = \frac{a}{1 - r}$ $\left[r = \frac{0.0045}{0.45} = 0.01\right]$
$= \frac{0.45}{1 - 0.01} = \frac{45}{99} = \frac{5}{11}$

19.(a) No. of choices for each seat together
$= 5 \times 4 \times 3$
$= 60$ ways.

20.(a) Substituting $x = K$ then
$6K^2 - K - 2 = 0$
$6K^2 - 4K + 3K - 2 = 0$
$2K(3K - 2) + 1(3K - 2) = 0$
$(3K - 2)(2K + 1) = 0$
$\therefore K = \frac{2}{3}, -\frac{1}{2}$

21.(a) $a^2 + b^2 > c^2 \rightarrow$ It is an acute angle triangle
$a^2 + b^2 = c^2 \rightarrow$ It is a right angled triangle
$a^2 + b^2 < c^2 \rightarrow$ It is an obtuse angle.
Since $3^2 + 5^2 < 7^2 \Rightarrow$ Obtuse angle triangle

22.(d) $R_3 \rightarrow R_3 + R_2$
$\begin{vmatrix} 1 & 1 & 1 \\ x & y & z \\ x+y+z & x+y+z & x+y+z \end{vmatrix}$
$\Rightarrow (x + y + z)\begin{vmatrix} 1 & 1 & 1 \\ x & y & z \\ 1 & 1 & 1 \end{vmatrix}$
$= (x + y + z) \times 0$ [as $R_1 = R_3$]
$= 0$

23.(b) $\sqrt{3 + 4i}$
$= \sqrt{4 + 4i + i^2}$
$= \sqrt{2^2 + 2.2.i + i^2}$
$= \pm(2 + i)$

24.(c) Check by using bisector formula
$h(x^2 - y^2) = (a - b)xy$
For all option; we get correct answer.

25.(d) Because, area of parallelogram = $|\vec{a} \times \vec{b}|$

26.(d) $\left(x^2 - \frac{1}{x^3}\right)^{25}$

$T_{r+1} = C(25, r)\,(x^2)^{25-r}.\left(-\frac{1}{x^3}\right)^r$

$= C(25, r)\, x^{50-5r}.(-1)^r$

Equating power of x

$50 - 5r = 10$

$\therefore\ r = 8$

$\therefore\ T_{r+1} = T_{8+1} = 9^{th}$ term

27.(b) Use the general equation of circle is

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

Point (0, 0)

$0 + 0 + 0 + 0 + c = 0 \Rightarrow c = 0$

Point (3, 0)

$9 + 0 + 6g + 0 + 0 = 0$

$6g = -9 \Rightarrow g = -\frac{3}{2}$

Point (0, 5)

$0 + 25 + 0 + 10f + 0 = 0 \Rightarrow f = -\frac{5}{2}$

$\therefore\ x^2 + y^2 - 2 \times \left(-\frac{3}{2}\right) x + 2 \times \left(-\frac{5}{2}\right) \times y + 0 = 0$

$\therefore\ x^2 + y^2 - 3x - 5y = 0$

28.(c) Because, A parabola is a curved shaped represented by a quadratic.

29.(d) Because directrix of $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is $x = \pm\frac{a}{e}$

30.(c) $x = e^t(\sin t + \cos t)$

$\frac{dx}{dt} = e^t(\cos t - \sin t) + (\sin t + \cos t)e^t = 2\cos t.e^t$

$y = e^t(\sin t - \cos t)$

$\frac{dy}{dt} = e^t(\cos t + \sin t) + (\sin t - \cos t)e^t = 2\sin t e^t$

$\therefore\ \frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{2\sin t.e^t}{2\cos t.e^t} = \tan t$

31.(a) $\frac{dr}{dt} = \frac{1}{4}$ cm/sec

$A = 4\pi r^2$

$\frac{dA}{dt} = 8\pi r\frac{dr}{dt}$

$= 8\pi \times 5 \times \frac{1}{4}$ cm²/sec

$= 10\,\pi$ cm²/sec

32.(b) $I = \int \frac{dx}{\sqrt{2ax - x^2}}$

$= \int \frac{dx}{\sqrt{a^2 - a^2 + 2ax - x^2}}$

$= \frac{dx}{\sqrt{a^2 - (x-a)^2}}$

$= \sin^{-1}\left(\frac{x-a}{a}\right) + c$

33.(c) $I = \int_0^{\pi/4} \frac{1}{1+\sin x} \times \frac{1-\sin x}{1-\sin x}\,dx$

$= \int_0^{\pi/4} \frac{1-\sin x}{\cos^2 x} = \int_0^{\pi/4} (\sec^2 x - \tan x.\sec x)dx$

$= |\tan x - \sec x|_0^{\pi/4}$

$= (1 - \sqrt{2}) - (0 - 1) = 2 - \sqrt{2}$

34.(a) $x^3 = x$

$x^3 - x = 0$

$x(x + 1)(x - 1) = 0$

$x = 0, 1, -1$

For first quadrant

$A = \int_0^1 (x - x^3)\,dx = \left|\frac{x^2}{2} - \frac{x^4}{4}\right|_0^1$

$= \frac{1}{4} = \frac{1}{4}$ sq. unit

35.(b) Applying distance formula

$d = \left|\frac{ax_1 + by_1 + cz_1 + d}{a^2 + b^2 + c^2}\right|$

$d = \left|\frac{3 \times 1 - 2 \times (-2) + 1 \times (3) - 5}{\sqrt{3^2 + (-2)^2 + 1^2}}\right|$

$d = \left|\frac{10 - 5}{\sqrt{14}}\right| = \frac{5}{\sqrt{14}}$ unit

36.(b) $t_n = \frac{n(n+1)}{n!} = \frac{n+1}{(n-1)!} = \frac{(n-1)+2}{(n-1)!}$

$= \frac{1}{(n-2)!} + \frac{2}{(n-1)!}$

$S_\infty = e + 2e = 3e$

37.(c) $\int e^{2y}\,dy = \int dx$

$\frac{e^{2y}}{2} = x + c$

At x = 5, y = 0

$\frac{1}{2} = 5 + c \Rightarrow c = -\frac{9}{2}$

Also, At y = 3

$\frac{e^6}{2} = \frac{x-9}{2} \Rightarrow x = \frac{e^6 + 9}{2}$

38.(c) $\int y\,dy$ where $y = f(x)$

$= \frac{y^2}{2} + c$

$= \frac{[f(x)]^2}{2} + c \Rightarrow I = \frac{[g(x)]^2}{2} + c$

39.(a) s.d. $= \sqrt{\frac{\Sigma d^2}{n} - \left(\frac{\Sigma d}{n}\right)^2}$

$= \sqrt{\frac{460}{7} - \left(-\frac{14}{7}\right)^2} = 7.85$

40.(a) $-1 \le \sin 4x \le 1$

$-1 + 3 \le \sin 4x + 3 \le 1 + 3$

$2 \le \sin 4x + 3 \le 4$

Max. value = 4

Min. value 2

41.(b) Acceleration obtained from (gradient) of velocity-time graph.

42.(c) $\Delta PE = -\frac{Gmm}{R+h} - \left(-\frac{GMm}{R}\right) = \frac{GMm}{R} - \frac{GMm}{2R}$

$$= \frac{GMm}{R}\left(1 - \frac{1}{2}\right)$$
$$= \frac{gR^2m}{2R} = \frac{mgR}{2}$$

43.(c) Brass has a larger coefficient of thermal expansion than steel so, cool the pin and heating the block.

44.(a) Yes, for an ideal gas internal energy only depends on temperature.

45.(d) $\sin C = \frac{1}{\mu}$, $\mu = A + \frac{B}{\lambda^2}$

$\lambda_v < \lambda_v$ so $\mu_v > \mu_r$ due to which $C_v < C_r$

46.(c) In case of organ pipe $v \propto \sqrt{T}$ so $f \propto \sqrt{T}$

i.e. frequency increases on increasing temperature.

47.(c) $L = \frac{\mu_0 N^2 A}{l}$ so $L \propto \frac{N^2}{l}$

$\therefore \quad \frac{L'}{L} = \frac{(2N)^2}{2l} \times \frac{l}{N^2} = 2$

$\therefore \quad L' = 2L$

48.(a) $F = qE = q.\frac{\sigma}{2\varepsilon_0} = q.\frac{q}{2\varepsilon_0 A}$

$$= \frac{(CV)^2}{2\varepsilon_0 A}$$
$$= \frac{\varepsilon_0 A}{d} . \frac{CV^2}{2\varepsilon_0 A}$$
$$= \frac{CV^2}{2d}$$

49.(c) $P = \frac{n}{t}\frac{hc}{\lambda}$

or, $\frac{n}{t} = \frac{P\lambda}{hc} = \frac{33 \times 6000 \times 10^{-10}}{6.62 \times 10^{-34} \times 3 \times 10^8} = 9.96 \times 10^{19}$

50.(a) As Pd of P–n junction is increased, this narrows the depletion region, allowing an increasing number of majority charge carrier, resulting rising forward current.

51.(b) $U = \frac{1}{2} F \times \Delta l = \frac{1}{2} \times 20 \times 3 \times 10^{-3} = 0.03J$

52.(d) $(a + b)\sin\theta = n\lambda$

For max. order $\sin\theta = 1$ so

$$n = \frac{a+b}{\lambda} = \frac{1}{N\lambda} = \frac{1}{500 \times 10^3 \times 600 \times 10^{-9}}$$
$$= 3.3 = 3$$

$\therefore \quad$ Total images $= 2n + 1 = 2 \times 3 + 1 = 7$

53.(b) $E = 20V$, $r = 0.3\Omega$ right side branch has resistors, 7Ω, 1Ω and 10Ω in series.

i.e. $7 + 1 + 10 = 18\Omega$

This 18Ω branch is in parallel with 6Ω resistor

$R_p = \frac{6 \times 18}{6 + 18} = 4.5\ \Omega$

Here circuit becomes $2 + 4.5 + 8\Omega = 14.5\Omega$

Including 'r' $R_{total} = 14.5 + 0.3 = 14.8\Omega$

i.e. $\quad I = \frac{E}{R_{total}} = \frac{20}{14.8} \approx 1.35A$

54.(b) $n = \frac{t}{T_{1/2}} = \frac{30}{10} = 3$ half-lives

Now, $N = N_0 \times \left(\frac{1}{2}\right)^n = 6 \times 10^{20} \times \frac{1}{8} = 7.5 \times 10^{19}$

55.(c) $mu = (M + m)v$

$v = \frac{0.1 \times 150}{2.9 + 0.1} = 5$ m/s

For bullet & block

$\Delta KE = \Delta PE$

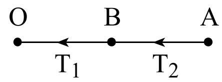
or, $\quad \frac{1}{2}(M + m)v^2 = (M + m)gh$

or, $\quad h = \frac{5^2}{2 \times 10} = 1.25$ m

$\cos\theta = \frac{l - h}{l} = \frac{2.5 - 1.25}{2.5} = \frac{1}{2} = \cos 60°$

$\theta = 60°$

56.(b)



For A

$T_2 = \frac{mv^2}{r} = \frac{0.5 \times 4^2}{0.8} = 10N$

For B

$V_B = (OB)\,\omega = OB\left(\frac{V_A}{OA}\right)$

$$= \frac{0.4 \times 4}{0.8} = 2m/s$$

$T_1 = \frac{mv^2}{r} = \frac{0.5 \times 2^2}{0.4} = 5N$

$\therefore \quad T = T_1 + T_2 = 5 + 10 = 15N$

57.(a) Buoyant force = weight of child

$\rho Vg = mg \Rightarrow V = \frac{mg}{\rho g} = \frac{40 \times 10}{1000 \times 10} = 0.04^3$ m

$V = \frac{4}{3}\pi r^3 \Rightarrow r = \sqrt[3]{\frac{3V}{4\pi}} = \sqrt[3]{\frac{3 \times 0.04}{4\pi}} = 0.212$ m

58.(d) $I = \frac{1}{2} mR^2 = 0.25$ kgm^2

$\tau = \vec{r} \times \vec{F} = I\alpha$

$\therefore \quad \alpha = \frac{0.1 \times 20}{0.25} = 8$ rad/s^2

59.(a) $Q = \frac{K_a A\,\Delta\theta}{l} \times t_a = \frac{K_c A \Delta\theta}{l} \times t_c$

or, $\quad K_a t_a = K_c t_c$

or, $\quad t_c = \frac{K_a t_a}{K_c} = \frac{240 \times 520}{390} = 320$ sec

60.(b) $T_2 V_2^{\gamma-1} = T_1 V_1^{\gamma-1}$

or, $\quad T_2 = 300\left(\frac{V}{\frac{V}{4}}\right)^{1.4-1}$

$$= 300(4)^{0.4}$$
$$= 522K$$

$\Delta T = T_2 - T_1 = 522 - 300$
$= 222K$

61.(a) $d = u + v$, $m = \frac{v}{u}$, $v = mu$

$u + mu = d \Rightarrow u = \frac{d}{1 + m}$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{m+1}{d} + \frac{m+1}{md} = \frac{(m+1)(m+1)}{md}$

$\frac{1}{f} = \frac{(1+m)^2}{md} \Rightarrow f = \frac{md}{(1+m)^2}$

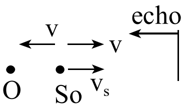
62.(a) $I = \frac{P}{4\pi r^2}, \frac{I_2}{I_1} = \left(\frac{P_2}{P_1}\right) \cdot \left(\frac{r_1}{r_2}\right)^2$

$I_1 = 1 w/m^2$, $P_2 = 2P_1$ (power is doubled)

$r_1 = 2m$, $r_2 = 4m$

$\frac{I_2}{1} = 2 \cdot \left(\frac{2}{4}\right)^2 \Rightarrow I_2 = 0.5\ W/m^2$

63.(a) Beats are noticed between direct sound from source & echo from wall for direct sound



For direct sound

$f' = \frac{v}{v + v_s} f = \frac{336}{336 + 1.5} \times 500 = 497.7\ Hz$

For echo

$f'' = \frac{v}{v - v_s} f = \frac{336}{336 - 1.5} \times 500 = 502.2\ Hz$

$\therefore \quad f_b = f'' - f' = 502.2 - 497.7$
$= 4.5$ beats/s

64.(a) $W = \frac{1}{2} mv^2$

$v = \sqrt{\frac{2Fd}{m}} = \sqrt{\frac{2Eed}{m}}$

$= \sqrt{\frac{2 \times 10^5 \times 1.6 \times 10^{-19} \times 12 \times 10^{-3}}{9.1 \times 10^{-31}}}$

$= 2.1 \times 10^7$ m/s

65.(d) $Q = C_1V_1 = 0.01 \times 10^{-6} \times 5000 = 50\ \mu C$

$C_{eq} = C_1 + C_2 = 0.01\ \mu F + 1\mu F = 1.01\ \mu F$

$V = \frac{Q}{C_{eq}} = \frac{50\ \mu C}{1.01\ \mu F} \approx 49.50V \approx 50V$

66.(b) $\tan\theta = \frac{EQ}{mg}$

$\tan 45° = \frac{EQ}{mg}$

or, $\quad Q = \frac{mg}{E} = \frac{mgd}{V} = \frac{5 \times 10^{-15} \times 10 \times 5 \times 10^{-3}}{500}$

$= 5 \times 10^{-19} C$

$= \frac{5 \times 10^{-19}}{1.6 \times 10^{-19}} e = 3e$

67.(a) $\lambda_{min} = 380\ nm = 380 \times 10^{-9}\ m$

$E_{max} = \frac{hc}{\lambda_{min}} = \frac{6.62 \times 10^{-3}4 \times 3 \times 10^8}{380 \times 10^{-9}} = 3.27\ eV$

$K.E_{max} = E_{max} - \phi = 3.27\ eV - 2.28\ eV$
$= 0.99\ eV = 1.58 \times 10^{-19}\ J$

68.(b) $W = \Delta KE$

or, $\quad (mg - F)h = \frac{1}{2} mv^2$

or, $\quad mg - F = \frac{1}{2} \times \frac{5 \times 10^2}{20}$

or, $\quad F = 5 \times 10 - 12.5 = 37.5\ N$

For air $W' = Fh\cos 180°$
$= 37.5 \times 20 \times (-1)$
$= -750\ J$

69.(c) For convex lens

$V = \frac{fu}{u - f} = \frac{20 \times 30}{30 - 20} = 60\ cm$

$\therefore \quad d = V - r = 60 - 20 = 40\ cm$

70.(a) $\frac{\rho}{\sigma} = \rho^2$, $\rho = \rho_0(1 + \alpha\Delta\theta)$

Increases on increasing temperature.

71.(b) **Hint:** First find the molar mass of $CaCO_3$, then multiply by the number of moles.

Solution: Molar mass of $CaCO_3 = 40 + 12 + (3 \times 16) = 100$ g/mol.

Mass = 0.5 × 100 = 50 g.

72.(c) **Hint:** The azimuthal quantum number l can only take values from 0 to (n − 1). Check each set against this rule.

Solution: For n = 2, l can only be 0 or 1 (since l ≤ n − 1). Therefore l = 2 with n = 2 is not permitted.

73.(b) **Hint:** Metallic character is linked to the ease of losing electrons. Consider how atomic size and ionization energy change down a group.

Solution: Down a group, atomic size increases and ionization energy decreases, so electrons are lost more easily and metallic character increases.

74.(c) **Hint:** A bidentate ligand donates two lone pairs and binds the metal at two points. Look for a ligand with two donor atoms.

Solution: Ethylenediamine ($H_2N - CH_2 - CH_2 - NH_2$) has two nitrogen donor atoms and binds the metal at two sites, so it is bidentate. (NH_3, Cl^-, H_2O are monodentate.)

75.(c) **Hint:** A transition element has a partially filled d-subshell in its atom or in one of its common ions. Check the d-configuration of each.

Solution: Zn has $[Ar]3d^{10}4s^2$ and Zn^{2+} is $3d^{10}$ (completely filled d). With no partially filled d in its atom or ion, Zn is not regarded as a true transition element.

76.(c) **Hint:** Assign oxidation numbers to nitrogen in each compound using H = +1 and O = −2.

Solution: In HNO_3: (+1) + x + 3(−2) = 0 ⟹ x = +5. (NH_3 = −3, NO = +2, N_2O = +1.) So HNO_3 has N in its highest oxidation state.

77.(b) **Hint:** A Lewis acid accepts a lone pair of electrons. Look for an electron-deficient species with an incomplete octet.

Solution: BF_3 has only 6 electrons around boron (an incomplete octet) and can accept a lone pair, so it acts as a Lewis acid. (NH_3, H_2O, OH^- are Lewis bases.)

78.(b) **Hint:** Apply Boyle's law (PV = constant at constant temperature). If pressure doubles, what happens to volume?

Solution: Boyle's law: $P_1V_1 = P_2V_2$ at constant T. If pressure is doubled, volume is halved.

79.(b) **Hint:** Look for a chlorinating reagent that replaces the −OH group with −Cl and gives gaseous by-products.

Solution: Thionyl chloride ($SOCl_2$) converts R−OH → R−Cl (with SO_2 and HCl escaping as gases), giving a pure alkyl chloride.

80.(c) **Hint:** Only acids strong enough to displace carbonic acid from bicarbonate will release CO_2. Compare the acidity of the options.

Solution: Carboxylic acids (e.g. acetic acid) react with $NaHCO_3$ to liberate CO_2. Phenol is too weak, and alcohols/aldehydes do not react. So acetic acid gives effervescence.

81.(b) **Hint:** Benzene is aromatic and tends to preserve its stable π-electron sextet. Consider which reaction keeps the ring intact.

Solution: To retain its aromatic stability, benzene undergoes electrophilic substitution (e.g. nitration, halogenation) rather than addition.

82.(b) **Hint:** Chlorophyll is a porphyrin complex of an alkaline earth metal ion. (Recall: haemoglobin contains Fe^{2+}.)

Solution: Chlorophyll contains Mg^{2+} at the centre of its porphyrin ring. (Haemoglobin, by contrast, contains Fe^{2+}.)

83.(b) **Hint:** Find moles of carbon, use the 1:1 mole ratio from the equation, then convert moles of CO_2 to mass.

Solution: Moles of C = 24/12 = 2 mol.

From $C + O_2 \rightarrow CO_2$, moles of CO_2 = 2 mol.

Mass of $CO_2 = 2 \times 44 = 88$ g.

84.(a) **Hint:** $Ca(OH)_2$ gives two OH^- ions per formula unit. Find $[OH^-]$, then pOH, then pH = 14 − pOH.

Solution: $Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$, so $[OH^-] = 2 \times 0.001 = 2 \times 10^{-3}$ M.

$pOH = -\log(2 \times 10^{-3}) = 3 - 0.30 = 2.70$.

$pH = 14 - 2.70 = 11.30$.

85.(b) **Hint:** Order with respect to a reactant is found from how the rate responds to its concentration. Add the orders for A and B.

Solution: Rate $\propto [A]^1$ (rate doubles when [A] doubles) and rate $\propto [B]^0$ (no effect).

Overall order = 1 + 0 = 1.

86.(b) **Hint:** Use $\Delta G = \Delta H - T\Delta S$, taking care to convert ΔS (in J) to kJ or ΔH to J so the units match.

Solution: $\Delta G = \Delta H - T\Delta S = 30000 - (300)(100) = 30000 - 30000 = 0$ J.

(The reaction is at equilibrium at this temperature.)

87.(b) **Hint:** Write the anode half-reaction for water and find how many faradays are needed to produce one mole of O_2.

Solution: Anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$, so 4 F produces 1 mole of O_2.

Volume at STP = 1 × 22.4 = 22.4 L.

88.(b) **Hint:** Balance the redox change: MnO_4^- gains 5 electrons, while each oxalate loses 2 electrons. Equate the total electrons exchanged.

Solution: n-factor of MnO_4^- = 5; n-factor of oxalic acid = 2.

Balanced: $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$.

So 5 mol oxalic acid need 2 mol $KMnO_4$ ⟹ 1 mol needs 2/5 = 0.4 mol $KMnO_4$.

89.(a) **Hint:** Apply the de Broglie relation $\lambda = h/(mv)$.

Solution: $\lambda = h/(mv) = (6.6 \times 10^{-34})/[(9.1 \times 10^{-31})(2.2 \times 10^6)]$

$= (6.6 \times 10^{-34})/(2.0 \times 10^{-24}) \approx 3.3 \times 10^{-10}$ m.

90.(d) **Hint:** Use the formula: degree of unsaturation = (2C + 2 + N − H − X)/2. Each ring or π bond counts as one.

Solution: Degree of unsaturation = (2×6 + 2 − 6)/2 = (12 + 2 − 6)/2 = 8/2 = 4.

(For benzene: 3 double bonds + 1 ring = 4.)

91.(d)	**92.(b)**	**93.(d)**	**94.(b)**	**95.(a)**
96.(a)	**97.(b)**	**98.(d)**	**99.(c)**	**100.(b)**

...Best of Luck...