Section – I

1.(a) $P = Fv$

or, $P = MLT^{-2}LT^{-1}$

or, $\frac{P}{M} = L^2T^{-3}$

or, $L^2 \propto T^3 \Rightarrow s^2 \propto t^3$

2.(d) $a = \frac{F}{m} = \frac{6}{1} = 6\ m/s^2$

Now, $v = 4 + at$

or, $30 = 0 + 6 \times t$

or, $t = 5$ sec.

3.(a) $\Delta T = \left(\frac{mv^2}{r} + mg\right) - \left(\frac{mv^2}{r} - mg\right)$

$= 2\ mg$

4.(c) $\Delta P = \frac{2T}{r} = \frac{2 \times 70 \times 10^{-3}}{10^{-3}} = 140\ N/m^2$

5.(a) $\Delta l = l \propto \Delta\theta$, in dependent of radius.

6.(b) $mgh = ms\Delta\theta$

or, $\Delta\theta = \frac{gh}{s} = \frac{10 \times 500}{4200} = 1.2°C$

7.(c) $x = 0.01 \sin(100\pi t + 5\pi)$

The equation is $x = a \sin(\omega t + \phi)$

Comparing, $\omega t = 100\ \pi t$

or, $\frac{2\pi}{T} = 100\pi$

or, $T = \frac{2\pi}{100\pi} = 0.02$ s

8.(c) $f = \frac{1}{2l}\sqrt{\frac{T}{\frac{\pi d^2}{4}\rho}}$

Again, $f' = \frac{1}{2l}\sqrt{\frac{2T}{\frac{\pi(2d)^2}{4} \times \frac{\rho}{2}}} = \frac{1}{2l}\sqrt{\frac{T}{\frac{\pi d^2}{4}\rho}} = f$

9.(d) $\frac{E_1}{E_2} = \frac{\sigma \times 4\pi r_1^2}{4\pi\varepsilon_0 r_1^2} \times \frac{4\pi\varepsilon_0 r_2^2}{\sigma 4\pi r_2^2} = 1:1$

10.(d) $W = Fs\cos\theta$

or, $4 = EQ \times s \cos 60°$

or, $E = \frac{4}{2 \times 0.2 \times \frac{1}{2}} = 20\ N/C$

11.(c) $R_1 = R_2$

or, $\frac{\rho l_1}{(5)^2} = \frac{\rho l_2}{\pi r^2}$

or, $r = \sqrt{\frac{25}{\pi}} = 2.8$ mm

12.(d) In series

$P_{eq} = \frac{P}{n}$

or, $P = 5 \times 5 = 25$ W

In parallel, $P_{eq} = nP = 5 \times 25$

$= 125$ W

13.(a) 1st case

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

2nd case

$F' = \frac{\mu_0\ 2I_1 \times 2I_2}{2\pi \times 3r} = \frac{4}{3}\left(\frac{\mu_0 I_1 I_2}{2\pi r}\right) = \frac{4}{3}F$

14.(a) When mirror move with v_m towards object then vel. of image relative to object is

$v' = 2\ v_m = 2 \times 5 = 10$ cm/s

15.(c) $\phi = 4\pi I = 4\pi$

16.(b) $\frac{\lambda_p}{\lambda_\alpha} = \frac{h}{P_p} \times \frac{P_\alpha}{h} = \frac{P_\alpha}{P_p}$

$= \sqrt{\frac{2m_\alpha q_\alpha V}{2m_p q_p V}}$

$= \sqrt{\frac{4m \times 2e}{me}} = 2\sqrt{2}:1$

17.(b) $\alpha = \frac{\Delta I_c}{\Delta I_e}$

or, $\Delta I_c = 0.99$ mA

$\therefore \Delta I_b = \Delta I_e - \Delta I_c = 1 - 0.99 = 0.01$ mA

18.(b) In Cr and Cu, 3d orbital gets electron from lower energy 4s orbital. Thus Cr, Cu, Mo, Ag and Au do not obey Aufbau principle.

19.(d) $K_4[Fe(CN)_6] \rightarrow 4K^+ + [Fe(CN)_6]^{4-}$ (Ionic bond)

$C \equiv N$ covalent bond and bond between Fe and CN is coordinate covalent bond.

20.(c) Atomic no. of Fe = 26

Electronic configuration = $1s^2 2s^2 2p^2 3s^2 3p^5 4s^2 3d^6$

For Fe^{+3} = 3e- are lost (2 from 4s and 1 from 3d) so Electronic configuration = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$ electron goes from outer most shell (4s) and one from penultimate shell (3d)

21.(d) $H_2O + CH_3COOH \rightarrow CH_3COO^- + H_3O^+$

For conjugate acid base pair

$K_a \times K_b = K_w$

$\therefore K_b = \frac{10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$

22.(a) $NH_3 + CuO \xrightarrow{\Delta} NO_2$

23.(c) Hardness of water is conventionally expressed in terms of equivalent amount of $CaCO_3$. The total water hardness is the sum of the molar concentrations of Ca^{2+} and Mg^{2+}, in mol/L or mmol/L units.

24.(a) It is known as potash alum and found under the name of 'Fitkiri'

25.(d) Generally, for a compound acidity ↑s as its central ion's oxidation state increases
Here, oxidation no of nitrogen increases as follows:
$NH_3 < N_2H_4 < N_2H_2 < N_3H$
So, property of compound vary from basic (NH_3) to acidic (N_3H)

26.(d) Dollucite is an ore of cesium (Cs)

27.(a) Benzene (12σ and 3π bonds), Toluene (15σ and 3π bonds), Xylene (18σ and 3π bonds), Mesitylene(21σ and 3π bonds)

28.(c) When ester group is directly bonded to cyclic ring, it is written as carboxylate.

29.(b) Empty set has no sub set other than it set of so, P (A) = {ϕ}

30.(d) The function does not one to one function, so inverse does not exit.

31.(a) $\lim_{n\to\infty} \frac{1}{x} \sin x = 0 \cdot$ (any value between -1 and 1)
= 0

32.(d) $f'(x) = \frac{-2}{(2x-1)^2}$ So $f'(0) = -2 < 0$

33.(d) $\int \frac{Sec\theta}{tan^2\theta} d\theta = \int cosec\theta \,. cot\theta d\theta = -\text{cosec}\theta + c$
$= \frac{-1}{\sin\theta} + c$

34.(a) If β is other root, then $\alpha\beta = 1$
So $\beta = \frac{1}{\alpha}$

35.(b) The sum of coefficients of odd powers of x = $2^{60-1} = 2^{59}$

36.(c) From the expansion of e^x

37.(d) $y = \frac{x}{1-(-x)}$ [$\because s_\infty = \frac{a}{1-r}$]
$= \frac{x}{1+x} \Rightarrow x = \frac{y}{1-y}$

38.(a) $\frac{1-i}{1+i} = \frac{(1-i)^2}{1-i^2} = \frac{1-2i-1}{2} = -i$
∴ The argument of –i is $-\frac{\pi}{2}$

39.(b) Matrix has 3 rows and 5 columns so each row contains 5 elements.

40.(d) $p(8, r) = 1680 = 8 \times 7 \times 6 \times 5$
$= 8_{p_4}$
r = 4

41.(d) No point in 2-dimensions satisfy the given relation so empty set.

42.(c) Make the coefficient of y^2 unity by dividing the equation of 3.
Then the coefficient of x is length of latus rectum so 2.

43.(d) The equation represents a plane parallel to z-axis. (z-absent)

44.(b) Value = $\log_{10}$ (tan 1° . tan 2° . tan 3° ...... tan 89°)
$\log_{10}[1.1 \ldots .1] = \log_{10} 1 = 0$

45.(b) $\cos^{-1} x = \frac{\pi}{2} - \sin^{-1} x = \frac{\pi}{2} - \frac{\pi}{5} = \frac{3\pi}{10}$

46.(b) $(s-b)(s-c) = x.\frac{(s-b)(s-c)}{bc} \Rightarrow x = bc$

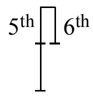
47.(c) θ lies in 2nd quadrant and $\sin\theta = \frac{1}{2}$
∴ $\theta = \frac{\pi}{6}$
So principal value = $\pi - \frac{\pi}{6} \Rightarrow \frac{5\pi}{6}$

48.(c) Vectors are parallel if $\frac{p}{5} = \frac{q}{1}$
or, p = 5q

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

Section – II

61.(c) Body comes to rest at the end of 5s
So 0 = u – gt
or, u = 10 × 5 = 50 m/s



62.(c) $\tan\theta = \frac{v^2}{rg} = \frac{(14\sqrt{3})^2}{20\sqrt{3} \times 10} = 1.697$
or, $\theta = \tan^{-1}(1.697) = 60°$

63.(a) $B = -\frac{PV}{\Delta V}$
or, $\Delta V = \frac{PV}{B} = \frac{(\rho_w g h_w \times 1)}{2.2 \times 10^9}$
$= \frac{10^3 \times 10 \times 200}{2.2 \times 10^9}$
$= 9.1 \times 10^{-4}\ m^3$

64.(d) dQ = 540 cal = 2268 J
$dW = PdV = 1.01 \times 10^5 (1671 - 1) \times 10^{-6}$
= 168.7 J
∴ du = dQ – dW = 2268 – 168.7
= 2100 J

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

or, $40\% + 50\% \text{ of } 40\% = \left(1 - \frac{300}{T_1'}\right) \times 100\%$

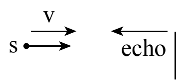
or, $\frac{-6d}{100} = 1 - \frac{300}{T_1'}$

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

or, $T_1' = \frac{1500}{2} = 750 \text{ K}$

$\therefore$ $\Delta T = T_1' - T_1 = 750 - 500 = 250 \text{ K}$

66.(c)



$v_s = v_0 = 30 \text{ m/s}$

$f' = \frac{v + v_0}{v - v_s} \times f$

$= \frac{330 + 30}{330 - 30} \times 600 = 720 \text{ Hz}$

67.(b) $Q_1 = C_1V_1 = 5 \times 10^{-6} \times 2000 = 10 \times 10^{-3}C$

$Q_2 = C_2V_2 = 10 \times 10^{-6} \times 5000 = 50 \times 10^{-3}C$

In series, $C_{eq} = \frac{C_1C_2}{C_1 + C_2} = \frac{5 \times 10}{5 + 10}$

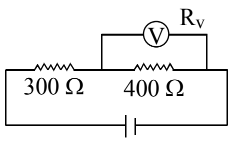
$= \frac{10}{3} \mu F$

Charge is equal to smaller charge

$Q_1 = C_{eq} V'$

or, $V' = \frac{10 \times 10^{-3}}{\frac{10}{3} \times 10^{-6}} = 3 \text{ KV}$

68.(a)



When, voltmeter read 30 V then equivalent resistance across voltmeter must be 300 Ω

So $300 = \frac{R_v \times 400}{R_v + 400}$

or, $3R_v + 1200 = 4R_v$

or, $R_v = 1200 \ \Omega$

69.(c) $B = \frac{\mu_0 I}{2r} = \frac{\mu_0 ef}{2r}$

$= \frac{4\pi \times 10^{-7} \times 1.6 \times 10^{-19} \times 6.6 \times 10^{15}}{2 \times 0.53 \times 10^{-10}}$

$= 12.5 \text{ T}$

70.(b) $E_2 = M \frac{dI_1}{dt}$

$= \left(\frac{\mu_0 N_1 N_2 A}{l}\right) \frac{dI_1}{dt}$

$= \frac{4\pi\times10^{-7}\times2000\times300\times1.2\times10^{-3}}{0.3} \times \frac{4}{0.25}$

$= 4.8 \times 10^{-2} \text{ V}$

71.(c) $\frac{\beta'}{\beta} = \frac{\lambda'}{\lambda} = \frac{6000}{5000}$

or, $\beta' = 1.2 \text{ mm}$

72.(c) When bird is observed from water then

${}_a\mu_w = \frac{\text{Observed height}}{\text{Actual height}}$

or, $\frac{4}{3} = \frac{h}{18}$

or, $h = 24 \text{ m}$

From swimmer

$h_T = 12 + 24 = 36 \text{ m}$

73.(b) Bev = Ee

or, $v = \frac{E}{B} = \frac{3.2 \times 10^5}{2 \times 10^{-3}} = 1.6 \times 10^8 \text{ m/s}$

Again $Bev = \frac{mv^2}{r}$

or, $r = \frac{mv}{Be}$

$= \frac{v}{\frac{e}{m} B} = \frac{1.6 \times 10^8}{1.8 \times 10^{11} \times 2 \times 10^{-3}} = 0.44 \text{ m}$

74.(b) 1st case

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t_1/T_{1/2}}$

$90\% = \left(\frac{1}{2}\right)^{t_1/T_{1/2}}$

or, $ln\ 0.9 = \frac{t_1}{T_{1/2}} ln\ 0.5$

or, $T_{1/2} = 1 \times \frac{ln\ 0.5}{ln\ 0.9} = 6.6 \text{ days}$

2nd case

$\frac{N'}{N_0} \times 100\% = \left(\frac{1}{2}\right)^{t_2/T_{1/2}} \times 100\%$

$= \left(\frac{1}{2}\right)^{2/6.6} \times 100\% = 81\%$

75.(b) $KOOC - CH_2 - CH_2 - COOK$ is potassium succinate which give ethene by Kolbe electrolysis and acetaldehyde on ozonolysis.

76.(b) Numbering of carbon atoms start from double bonded carbon and 3,4 addition gives conjugated system as: $CH_2 = CHCl - CH = CH_2$ (conjugated system and resonance stabilization)

77.(c) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O\ ] \times 2$

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-\ ] \times 5$

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

78.(c) W = (E × I × t)/96500
And masses of Zn and Cu deposited will be in ratio of their equivalent mass.

79.(b) By law of equivalence:
$\frac{\text{wt. of metallic oxide}}{\text{wt. of } O_2} = \frac{\text{eqv.wt of metallic oxide}}{\text{eqvt.wt. of } O_2}$

$\Rightarrow \frac{8}{1.6} = \frac{E+8}{8} \Rightarrow 64 = 1.6E + 12.8$

$\Rightarrow 1.6E = 51.2 \Rightarrow E = 32$

80.(c) Na_2SO_4 is salt of strong acid (i.e. H_2SO_4) & strong base (i.e. NaOH) when a neutral salt & a base is mixed to make a solution then solution become basic i.e. pH>7. The Na_2SO_4 has two +ve or two –ve charges so its equivalent weight = Molecular weight /2

81.(c) Since Basicity of H_2SO_4 is 2.
10 ml of 2 M H_2SO_4 = 10 ml of 4 N H_2SO_4
$V_1N_1 = V_2N_2$
When 10 ml of H_2O is added
$10 \times 4 = 20 \times N_2$
$\therefore N_2 = 2N$
$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
Again, when 10 ml of 2 N mixture taken
$V_1N_1 = V_2N_2$
$10 \times 2 = V_2 \times 2 \quad \therefore V_2 = 10$ ml

82.(b) Using L-Hospital's rule
$\lim_{x \to a} \frac{af^1(x) - f(a)}{1} = a f'(a) - f(a)$

83.(a) If m is slope of tangent to the curve, then $m = \frac{dy}{dx}$
$= -3x^2 + 6x + 9$
$\frac{dm}{dx} = -6x + 6, \frac{d^2m}{dx^2} = -6 < O$
Now, $\frac{dm}{dx} = 0 \Longrightarrow x = 1$
So at x = 1, the slope m will be maximum

84.(a) $\int \frac{e^x}{e^x+1} - \frac{1}{e^x+1} dx = \int \frac{e^x}{e^x+1} dx - \int \frac{-e^{-x}}{e^{-x}+1} dx$
$= \log(e^x+1) + \log(1+e^{-x}) + c$
$= \log(e^x+1) + \log \frac{e^x+1}{ex} + c$
$= 2\log(e^x+1) - \log e^x + c$
$= 2\log(e^x+1) - x + c$

85.(b) $A = \int_0^1 e^{-x} dx$
$= [-e^{-x}]_0^1$
$= -(e^{-1} - 1) = 1 - \frac{1}{e}$

86.(d) $\alpha + \beta = p, \ \alpha\beta = -p - q$
$\therefore (\alpha + 1)(\beta + 1) = \alpha\beta + \alpha + \beta + 1$
$= -p - q + p + 1 = 1 - q$

87.(c) $(3+3\omega+3\omega^2+2\omega)^2 + (3+3\omega+3\omega^2+2\omega^2)^2$
$= (2w)^2 + (2w^2)^2 = 4(w^2 + w) = -4$

88.(b) A (adj A) = $|A| = \begin{vmatrix} \cos x & \sin x \\ -\sin x & \cos x \end{vmatrix} = 1$

89.(d) First 5 boys should be seated keeping one seat vacant between any two this can be one in 5! Ways. Now there are 4 seats vacant between boys. And 2 end points seats 5 girls should be seated so that no two girls will to gather and It can sit.
Can be done in 6_{p_5} = 6! ways
$\therefore$ Required number = 5! 6!

90.(a) If $\vec{a} = x\vec{i} + y\vec{j} + 2\vec{k}$
Then $\vec{a}\ \vec{i} = x, \ \vec{a}.\vec{j} = y, \ \vec{a}.\vec{k} = z$
$\therefore x^2 + y^2 + z^2 = a^2$

91.(a) All planes are parallel to x-axis and only a satisfy the given points so a.

92.(a) $\tan\alpha + \tan\beta = -q, \ \tan\alpha - \tan\beta = -p$
$\therefore \tan(\alpha + \beta) = \frac{-q}{1+p}$

93.(a) $\frac{k}{\sqrt{9+4}} = 2r$ [∴ length of perpendicular from origin on line = radius]
or, $k^2 = 52r^2$

94.(a) $\frac{x^2}{2-k} + \frac{y^2}{5-k} = 1$
So, $2 - k > 0$ and $5 - k > 0$
$\therefore k < 2$

95.(b) Range of $|x - 2| > ,0$ for x∈R
Range = [0, ∞)

96.(a) $\frac{1}{r_1}, \frac{1}{r_2}, \frac{1}{r3}$ are in A.P.
$\Rightarrow \frac{s-a}{\Delta}, \frac{s-b}{\Delta}, \frac{s-c}{\Delta}$ are in A.P.
⇒ s-a, s-b, s-c are in A.P.
⇒ a,b,c are in A.P.

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

…Best of Luck…