Section - I

1. (a) $h_1 = \frac{1}{2} g \times 5^2$ … (1)

$h_2 = \frac{1}{2} g(10^2 - 5^2) = \frac{1}{2} g \times 75$ …. (2)

$h_3 = \frac{1}{2} g(15^2 - 10_2) = \frac{1}{2} g \times 125$ …. (3)

$\therefore$ $h_1 : h_2 : h_3 = 25 : 75 : 125$

or, $h_1 : h_2 : h_3 = 1 : 3 : 5$

$\therefore$ $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

So $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

2. (c) $T_{max} = \frac{mv^2}{r} + mg = \frac{m \times 5gr}{r} + mg = 6\ mg$

$T_{min} = \frac{mv^2}{r} - mg = \frac{mgr}{r} - mg = 0$

$\therefore$ $\Delta T = T_{max} - T_{min} = 6\ mg$

3. (d) $mg - T = ma$

or, $T = mg - \frac{mg}{8} = \frac{7\ mg}{8}$

$W = T.h \cos 180° = -\frac{7mgd}{8}$

4. (b) $v_0 = \sqrt{2R}$

$KE = \frac{1}{2} mv_0^2 = \frac{mgR}{2} = E$

$v_e = \sqrt{2gR}$

$KE' = \frac{1}{2} = mv_0^2 = \frac{1}{2} m \times 2gR$

$= mgR = 2E$

5. (c) $\frac{E'}{E} = \frac{\sigma A'T'^4}{\sigma AT^4} = \frac{(2R^2)(2T)^4}{R^2T^4}$

$= 64:1$

6. (d) $C_{rms}{}^{H} = C_{rms}{}^{o}$

or, $\sqrt{\frac{3RT_H}{M_H}} = \sqrt{\frac{3RT_0}{M_0}}$

or, $\sqrt{\frac{T_H}{2}} = \sqrt{\frac{320}{32}}$

or, $T_H = 20K$

7. (d) $g' = \sqrt{g^2 + a^2}$

8. (c) $3f_0{}^0 = 5f_0{}^e$

or, $3 \times \frac{v}{2l_0} = 5 \times \frac{v}{4l_c}$

or, $\frac{l_0}{l_c} = \frac{3}{2} \times \frac{4}{5} = \frac{6}{5}$

9. (c) $\frac{1}{2} mv^2 = \frac{Qq}{4\pi\varepsilon r}$ …. (i)

Again $\frac{1}{2} m(2v)^2 = \frac{Q.q}{4\pi\varepsilon_0 r'}$

or, $4 \times \frac{Q.q}{4\pi\varepsilon_0 r} = \frac{Qq}{4\pi\varepsilon_0 r'}$

or, $r' = \frac{r}{4}$

10. (b) $\frac{E}{V} = \frac{\frac{1}{2} CV}{Ad} = \frac{1}{2} \frac{\varepsilon_0 A}{d.Ad} . V^2$

$= \frac{1}{2} \varepsilon_0 \frac{V^2}{d^2}$

11. (b) $\frac{E_1}{E_2} = \frac{\frac{V^2}{R} \times t}{\frac{V^2}{2R}.t} = 2:1$

12. (a) $M = 2\ ml$

If magnet is divided in 4 equal parts with length and breadth half then new length (l') = l

Pole strength (m')= $\frac{m}{2}$

Magnetic moment (M') = $\frac{m}{2} \times l$

$= \frac{M}{4}$

13. (c) $E = -\frac{d\phi}{dt}$

14. (b) $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

or, $0 = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

or, $\frac{d}{f_1 f_2} = \frac{f_1 + f_2}{f_1 f_2}$

or, $d = f_1 + f_2$

15. (d) $\frac{x}{D} = \frac{\lambda}{d}$

or, $x = \frac{D\lambda}{d}$

$x \propto \lambda$, when red light is replaced by blue, $\lambda_r > \lambda_b$ so $x_r > x_b$ i.e. become closer.

16. (c) $\lambda_p = \lambda_e$

or, $\frac{h}{\sqrt{2m_pE_p}} = \frac{h}{\sqrt{2m_eE_e}}$

or, $m_pE_p = m_eE_e$

or, $m_p > m_e$ so $E_p < E_e$

i.e. energy of proton is less than electron.

17. (b) $R = \frac{\Delta V}{\Delta I} = \frac{1}{0.5 \times 10^{-6}} = 2 \times 10^6\ \Omega$

18.(a)

19. (b)

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20. (b) $2H_2 + O_2 \longrightarrow 2H_2O$

2 moles 1 mole 2 moles

0.2 moles 0.1 mole 0.2 moles

21. (c)

22. (c)

23. (d)
24. (d)
25. (a) $O_3 \xrightarrow{UV} O_2 + [O]$
Nascent oxygen acts as an good oxidizing agent.
26. (d) Isoelectronic means same number of electrons
$C = 6e = N^+$
27. (c) $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
CaO acts as a basic flux
28. (d) Cation moves towards cathode and reduction reaction takes place.
29. (b) $\cos\left\{\sin^{-1}\left(\frac{1-\sqrt{x}}{1+\sqrt{x}}\right) + \cos^{-1}\left(\frac{1-\sqrt{x}}{1+\sqrt{x}}\right)\right\}$
$= \cos\frac{\pi}{2} = 0$
30. (b) Obvious
$^nC_1 + {}^nC_2 + {}^nC_3 + ... + {}^nC_n = 2^n - 1$
31. (d) We have:
$^np_r = r!.{}^nc_r$
$720 = r!.120$
$r! = 6$
$r = 3$
32. (a) $x^{\frac{1/2 + 1/4 + 1/8 + ... \infty}{}}$
$= x^{\frac{1/2}{1 - 1/2}} = x$
33. (b) Taking 4 common from R_2, we get
$= 4\begin{vmatrix} 4^2 & 4^3 & 4^4 \\ 4^2 & 4^3 & 4^4 \\ 4^4 & 4^5 & 4^6 \end{vmatrix} = 0$ [$\because R_2 = R_1$]
34. (c) $|\omega| + |\omega^2| = 1 + 1 = 2$
35. (a) Sum of the roots $(\alpha + (-\alpha) = 0$
$-\frac{b}{a} = 0$
$K - 7 = 0$
$K = 7$
36. (c) Putting x = 1, 2, 3, we get
$B = \{1, 2, 3\}$
i.e. $\boxed{A = B}$
37. (a) It is obvious
38. (b) Using L-Hospital's rule:
$= \lim_{x \to e} \frac{\frac{1}{x} - 0}{1 - 0} = \frac{1}{e}$
39. (c) $\frac{a}{\sqrt{a^2+b^2}}\sin x + \frac{b}{\sqrt{a^2+b^2}}\cos x = \frac{c}{\sqrt{a^2+b^2}} > 1$
$\sin(x + \alpha) > 1$ (No solution)
40. (b) $\frac{dy}{dx} = -\frac{1}{\sqrt{1-\sin^2 x}} . \cos x = -1$
41. (d) $I = \frac{1}{2}\int\frac{2x\,dx}{(x^2+5)} = \frac{1}{2}\log(x^2 + 5) + c$
42. (c) Obvious
43. (c) Obvious
44. (b) $\frac{a}{2R} + \frac{b}{2R} + \frac{c}{2R} = \frac{a+b+c}{2R} = \frac{2s}{2R} = \frac{s}{R}$
45. (b) $9r^2\cos^2\theta + 4r^2\sin^2\theta = 36$
$9x^2 + 4y^2 = 36$ (Ellipse)
46. (b) It is a pair of perpendicular planes.
47. (a) Obvious
48. (d) Obvious

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

Section – II

61. (b) $S_c - S_b = 96$
or, $20t - \frac{1}{2}at^2 = 96$
or, $t^2 - 20t + 96 = 0$
or, $t^2 - 8t - 12t + 96 = 0$
or, $t(t - 8) - 12(t - 8) = 0$
or, $t(t - 8)(t - 12) = 0$
Either t = 8s
or, 12s
$\therefore$ t = 8s
62. (c) $mg\sin\theta = F_f$
or, $m = \frac{10}{g\sin 30°} = 2$ kg
63. (a) Potential difference per^m (V) $= \frac{2}{20} = \frac{1}{10}$ J/kg
$W = m \times V \times h$
$= 5 \times \frac{1}{10} \times 4 = 2J$
64. (a) $Q = \frac{KAd\theta}{l} \times t = mL_f$
or, $K = \frac{4.8 \times 80 \times 4200 \times 0.1}{0.36 \times 100 \times 3600}$
$= 1.24\ Wm^{-1}K^{-1}$
65. (c) $\left(\frac{T_2}{T_1}\right)^{\gamma} = \left(\frac{P_2}{P_1}\right)^{\gamma-1}$
or, $\frac{T_2}{300} = \left(\frac{P}{8P}\right)^{\frac{\frac{5}{3}-1}{\frac{5}{3}}}$
or, $T_2 = \left(\frac{1}{8}\right)^{\frac{2}{3}\times\frac{3}{5}}$
$= 130.6K$
$= 142°C$
66. (a) $\sqrt{\frac{T'}{T}} = \frac{606}{600}$
or, $\frac{T'}{T} = 1.02$

Fractional increase $= \frac{T' - T}{T}$

$= \frac{T'}{T} = 1$

$= 1.02 - 1 = 0.02$

67. (d) $F_g = F_e$

or, $\frac{Gm^2}{r^2} = \frac{q^2}{4\pi\varepsilon_0 r^2}$

or, $\frac{q^2}{m^2} = 4\pi\varepsilon_0 G$

or, $\frac{q}{m} = \sqrt{4\pi\varepsilon_0 G}$

68. (b) **1st case**

$V_1 = E - \frac{E}{R + r}.r$

or, $V_1 = E\frac{R}{R + r}$

or, $5 = \frac{ER}{R + r}$ ..... (1)

2nd case

$V_2 = E - \frac{E}{6R + r}.r$

or, $10 = \frac{6RE}{6R + r}$ ..... (2)

Dividing (2) by (1)

$\frac{10}{5} = \frac{6ER}{6R + r} \times \frac{R + r}{ER}$

or, $12R + 2r = 6R + 6r$

or, $6R = 4r$

or, $r = 1.5R$

From (1)

$5 = \frac{E \times R}{R + 1.5R}$

or, $E = 5 \times 2.5 = 12.5V$

69. (b) $Bqv = \frac{mv}{r}$

or, $Bqr = mv = \sqrt{2mE}$

Now for proton

$Ber = \sqrt{2mE_p}$ .... (1)

For α particle

$B.2er = \sqrt{2 \times 4mE_\alpha}$ .... (2)

Dividing (2) by (1)

$2 = \sqrt{\frac{8E_\alpha}{2 \times 1}}$

or, $E_\alpha = 1$ MeV

70. (d) When capacitor is removed then current lag the voltage by 30° and when inductor is removed then voltage lag the current by 30°

$X_L = X_C$ so $Z = R$

$P = \frac{V_{rms}^2}{R}$

$= \frac{220^2}{200} = 242$ W

71. (b) $f = \frac{1}{p} = \frac{1}{4}$ m $= 25$ cm

For near object

$u = ?$ $v = -25$ cm $f = 25$ cm

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

or, $\frac{1}{u} = \frac{1}{25} + \frac{1}{25} = \frac{2}{25}$

or, $u = 12.5$ cm

For distant object

$u = ?$ $v = \infty$, $f = 25$ cm

or, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

or, $u = 25$ cm

$\therefore$ Range $= 12.5$ cm $+ 0.25$ cm

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

or, $\Delta\beta = \frac{\lambda.\Delta D}{d}$

or, $\lambda = \frac{\Delta\beta d}{\Delta D} = \frac{10^{-3} \times 0.03 \times 10^{-3}}{5 \times 10^{-2}}$

$= 6 \times 10^{-7}$ m $= 6000$Å

73. (c) $V_s = 1.36$ V

$E = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{5000 \times 10^{-10}} = 3.97 \times 10^{-19}$ J

$= 2.48$ eV

$\therefore$ $\phi = E - eV_s = 2.4 - 1.36$

$= 1.12$ eV

74. (c) No of atoms $(N_0) = \frac{6.023 \times 10^{23}}{226}$

$A = \lambda N_0 = \frac{0.693}{T_{1/2}} N_0$

$= \frac{0.693 \times 6.023 \times 10^{23}}{226 \times 1620 \times 365 \times 24 \times 3600}$

$= 3.6 \times 10^{10}$ dis/s

75. (a)

76. (d) ECE(Z) of Ag $= \frac{E}{F} = \frac{108}{96500} = 1.12 \times 10^{-3}$

77. (a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2$

78. (a)

79. (c) $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \rightarrow 2K_2SO_4 + FeSO_4 + 2(NH_4)_2SO_4 + 6CO$

80. (b) $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

$E_v = \frac{22400}{2} = 11200$

$\frac{W_v}{E_v} = \frac{N \times V_{ml}}{1000}$

$\frac{10}{11200} = \frac{N \times 25}{1000}$

$N = \frac{10 \times 1000}{11200 \times 25} = \frac{100}{2800} = 0.0357\ N$

81. (b) pH = 13

$H^+ = 10^{-13}$ M

No. of moles $= \frac{M \times V_{ml}}{1000} = \frac{10^{-13} \times 1}{1000} = 10^{-16}$

No. of $H^+ = 10^{-16} \times 6.02 \times 10^{23}$

$= 6.02 \times 10^7$

82. (a) Let $5^{5^{5^x}} = y$

$5^{5^{5^x}} . 5^{5^x} . 5^x (\log 5)^3\, dx = dy$

Now, $I = \int \frac{dy}{(\log 5)^3} = \frac{y}{(\log 5)^3} + c$

$= \frac{5^{5^{5^x}}}{(\log 5)^3} + c$

83. (c) $f'(x) = 2^x \log 2$

$f'(0) = \log 2$

$g'(0) = \log 3$

$f'(0)\, g'(0) = \log 2 . \log 3$

84. (d) $y = \frac{1}{f(x)} = \frac{x-1}{x}$

$f(y) = f\left(\frac{x-1}{x}\right) = \frac{\frac{x-1}{x}}{\left(\frac{x-1}{x}\right) - 1} = (1 - x)$

85. (c) $(\alpha + \beta)^2 = (\alpha - \beta)^2 + 4\alpha\beta$

$p^2 = 2^2 + 4.8$

$p = 6$

86. (a) $\log[(1 - 2x)(1 - 3x)]$

$= -\left[\frac{(2x)}{2} + \frac{(2x)^2}{2} + \frac{(2x)^3}{3} + ...\infty\right]$

$- \left[\frac{3x}{1} + \frac{(3x)^2}{2} + \frac{(3x)^3}{3} + ...\right]$

Coefficient of $x^3 = -\frac{8}{3} - \frac{27}{3} = -\frac{35}{3}$

87. (d) $\begin{vmatrix} a & a^2 & a^3 \\ b & b^2 & b^3 \\ c & c^2 & c^3 \end{vmatrix} + \begin{vmatrix} a & a^2 & -1 \\ b & b^2 & -1 \\ c & c^2 & -1 \end{vmatrix} = 0$

$abc \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} - \begin{vmatrix} a & a^2 & 1 \\ b & b^2 & 1 \\ c & c^2 & 1 \end{vmatrix} = 0$

$(abc - 1) \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = 0$

$\Rightarrow\ abc = 1$

88. (b) $(\vec{u} + \vec{v} + \vec{w}).(\vec{u} + \vec{v} + \vec{w}) = 0$

$|\vec{u}|^2 + |\vec{v}|^2 + |\vec{w}|^2 + 2(\vec{u}.\vec{v} + \vec{v}.\vec{w} + \vec{w}.\vec{u}) = 0$

$3^2 + 4^2 + 5^2 + 2(\vec{u}.\ \vec{v} + \vec{v}.\vec{w} + \vec{w}.\vec{u}) = 0$

$\vec{u}.\vec{v} + \vec{v}.\vec{w} + \vec{w}.\vec{u} = -25$

89. (d) $P_1 + \lambda P_2 = 0$

$(2x + z - 4) + \lambda\, (2y + z) = 0$

Passing through the point (2, 1, –1) is

$4 - 1 - 4 + \lambda(2 - 1) = 0$

$\lambda = 1$

$\therefore$ The required equation of the plane is

$x + y + z - 2 = 0$

90. (b) Option (b) passes through all the points.

91. (b) On solving: we get the points (0, 0) and (1, 1) length of the common chord

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

92. (d) $A = \int_1^3 y dx = \int_1^3 \frac{4}{x} dx = [4\log x]_1^3 = 4\log 3$

93. (d) $\tan\left(\frac{\pi}{2} - \sec^{-1}3\right) = \cot(\sec^{-1}3)$

Put $\sec^{-1}3 = \theta$

$\sec\theta = \frac{3}{1} = \frac{h}{b}$

$p = 2\sqrt{2}$

Now, $\cot\theta = \frac{b}{p} = \frac{1}{2\sqrt{2}}$

94. (c) $f'(x) = 4x^3 - 24x^2 + 36x$

$f''(x) = 12x^2 - 48x + 36$

$= 12(x - 1)(x - 3)$

For (1, 3), $f''(x) < 0$ (Concave downward)

95. (a) By tangent law:

$\tan\left(\frac{A-B}{2}\right) = \left(\frac{a-b}{a+b}\right) \cot\frac{C}{2}$

$\frac{\tan\left(\frac{A-B}{2}\right)}{\tan\left(\frac{A+B}{2}\right)} = \left(\frac{a-b}{a+b}\right)$

96. (d) Sum of the roots $(\alpha + \beta) = -a$

$6 = -a$

$a = -6$

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

...The End...