Section - I

1. (a) If coin falls behind then train is accelerating.

2. (b) Vel. of projection $(\vec{v}_1) = u_x\hat{i} + u_y\hat{j}$

Vel. on hitting ground $(\vec{v}_2) = u_x\hat{i} - u_y\hat{j}$

$= 2\hat{i} - 3\hat{j}$

3. (b) Workdone (W) = change in energy

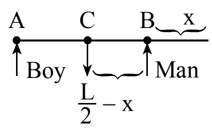
$= \frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2$

$= \frac{1}{2}k(x_2^2 - x_1^2)$

$= \frac{1}{2} \times 800\,(0.15^2 - .05^2)$

$= 8$ J

4. (a)



Taking moment of forces about B

$\frac{W}{4}(L - x) = W\left(\frac{L}{2} - x\right)$

or, $L - x = 2L - 4x$

or, $3x = L$

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

5. (b) $\Delta PE = ms\Delta\theta$

or, $\Delta\theta = \frac{mg(h_1 - h_2)}{ms}$

$\frac{10(20 - 0.2)}{0.09 \times 4200} = 0.5°C$

6. (a) In adiabatic dQ = 0 so

$0 = du + dw$

or, $dw = -du$

i.e. workdone is equal to change in internal energy.

7. (b) $v = \frac{dx}{dt} = 2 \times 10^{-2}\pi\,\sin\pi t$

Speed will be maximum if $\sin\pi t = 1$

or, $\sin\pi t = \sin 90°$

or, $\pi t = \frac{\pi}{2}$

or, $t = 0.5$s

8. (c) $v = v_p$

or, $f\lambda = AW$

or, $\lambda = \frac{A.2\pi f}{f} = 2\pi A$

9. (c) $F = \frac{Q^2}{4\pi\varepsilon_0 d^2}$

or, $Q^2 = 4\pi\varepsilon_0 d^2 F$

or, $n^2e^2 = 4\pi\varepsilon_0 d^2 F$

or, $n = \sqrt{\frac{4\pi\varepsilon_0 d^2 F}{e^2}}$

10. (d) When dielectric is introduced in between plates of capacitor then capacitance increases, charge increases keeping same Pd.

11. (a)

12. (b) Diamagnetic substance is magnetized in opposite direction of field so repel.

13. (d) $L = \frac{\mu_0 N^2 A}{l} = \mu_0\left(\frac{N}{l}\right)^2 Al = \mu_0 n^2 Al$

if n is doubled then

$L' = 4L$

14. (c) $\frac{1}{f} = ({}_m\mu_g - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$= \left(\frac{{}_a\mu_g}{{}_a\mu_m} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

if ${}_a\mu_g = {}_a\mu_m$ then

$f = \infty$

15. (c) At maxima

$I_{max} = 4I$

or, $I = \frac{I_{max}}{4}$

Again, $I_R = I + 2\sqrt{II}\cos\phi + I$

or, $\frac{I_{max}}{4} = 2I\,(1 + \cos\phi)$

or, $I = 2I\,(1 + \cos\phi)$

$\cos\phi = -\frac{1}{2} = \cos 120°$

$\therefore\ \phi = 120° = \frac{2\pi}{3}$

Here $\phi = \frac{2\pi x}{\lambda}$

or, $x = \frac{2\pi}{3} \times \frac{\lambda}{2\pi} = \frac{\lambda}{3}$

$d\sin\theta = \frac{\lambda}{3}$

or, $\theta = \sin^{-1}\left(\frac{\lambda}{3d}\right)$

16. (d) $\lambda = \frac{h}{\sqrt{2mKE}}$

$\therefore\ \frac{\lambda'}{\lambda} = \sqrt{\frac{KE}{KE'}} = \sqrt{\frac{KE}{2KE}}$

$\therefore\ \lambda' = \frac{\lambda}{\sqrt{2}}$

17. (d) $V_{in} = I_b R_{in}$

$I_b = \frac{0.01}{10^3} = 10^{-5} A$

Again $\beta = \frac{I_c}{I_b}$

or, $I_c = 50 \times 10^{-5}$

$= 500\ \mu A$

18. (a) Due to self linking property of carbon to result long chain, branched chain and cyclic chain.

19. (d) Carbone eg CH_2 (6 electrons)
Nitrene eg CH_3N (6 electrons)
Carbonium ion eg CH_3^+ (6 electrons)
Free radical eg CH_3 (7 electrons)

20. (a)

21. (c)

22. (b) $3Fe + conc^n\ 8HNO_3 \longrightarrow Fe_3O_4 + 4H_2O + 8NO_2$

23. (a) ZnO is amphoteric oxide but other are basic

24. (c) $2NaOH + Zn \longrightarrow Na_2ZnO_2 + H_2$

25. (b) Na is highly electropositive metal

26. (c) $\Delta n = 1 - 4 = -3$

$K_p = K_c (RT)^{\Delta n}$

$K_p = K_c (RT)^{-3}$

$K_p = \frac{K_c}{(RT)^3}$ $\therefore K_c > K_p$

27. (b)

28. (c)

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

${}^nC_1 + {}^nC_2 + {}^nC_3 + \ldots.. + {}^nC_n = 2^n - 1$

31. (d) We have:

${}^np_r = r!.{}^nc_r$

$720 = r!.120$

$r! = 6$

$r = 3$

32. (a) $x^{1/2 + 1/4 + 1/8 + \ldots\ldots \infty}$

$= x^{\frac{1/2}{1 - 1/2}} = x$

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

Section – II

61. (a) $h = v \times 12 + \frac{1}{2}g \times 12^2 = \frac{1}{2}g \times 18^2$

or, $12v = \frac{1}{2}g\,(18^2 - 12^2)$

or, $v = 5(18 + 12)\,(18 - 12)$

$= \frac{5 \times 30 \times 6}{12} = 75$ m/s

62. (b) $wt = mg = 0.1 \times 10 = 1N$
Limiting force of friction
$F_L = \mu F = 0.5 \times 5 = 2.5$ N
Here $F < F_L$ so frictional force is equal to applied force i.e. $F_f = 1N$

63. (d) $F = \mu mg = mr_1\omega_1^2 = mr_2\omega_2^2$

or, $r_1\omega_1^2 = r_2\omega_2^2$

or, $r_2 = r_1\left(\frac{\omega_1}{\omega_2}\right)^2 = r_1\left(\frac{f_1}{f_2}\right)^2$

$= 16\left(\frac{33}{66}\right)^2$

$= 4$ cm

64. (a) $(1000 - 160)t = msd\theta$

or, $t = \dfrac{2 \times 4200\ (77 - 27)}{840}$

$= 500s = 8$ min 20s

65. (a) $C_{rms} = \sqrt{\dfrac{3p}{\rho}}$

or, $P = \dfrac{C_{rms}{}^2 \times \rho}{3} = \dfrac{500^2 \times 6 \times 10^{-2}}{3}$

$= 5 \times 10^3\ N/m^2$

66. (a) $\dfrac{f'}{f} = \sqrt{\dfrac{T'}{R}} = \sqrt{\dfrac{v\rho g - \dfrac{v}{2}\sigma g}{v\rho g}}$

or, $f' = 300\sqrt{\dfrac{2\rho - 1}{2\rho}}$

67. (d) $Q_T = 4\pi R^2\sigma + 4\pi(2R)^2\sigma$

$= 5 \times 4\pi R^2\sigma$

When connected by wire charge will flow until they will have same potential so

$V = \dfrac{Q_T}{4\pi\varepsilon_0(R + 2R)} = \dfrac{20\pi R^2\sigma}{12\pi\varepsilon_0 R} = \dfrac{5R\sigma}{3\varepsilon_0}$

Charge density $(\sigma') = \dfrac{Q'}{A}$

$= \dfrac{C_2V}{4\pi(2R)^2}$

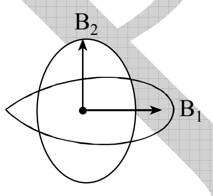
$= \dfrac{4\pi\varepsilon_0 \times 2R}{4\pi R^2 \times 4} \times \dfrac{5R\sigma}{3\varepsilon_0}$

$= \dfrac{5\sigma}{6}$

68. (d) $n = \dfrac{250}{25} = 10$

$R = (n - 1)\ G = (10 - 1)\ 100 = 900\ \Omega$

69. (a)



$B = \sqrt{B_1{}^2 + B_2{}^2}$

$= \sqrt{\left(\dfrac{\mu_0 I}{2R}\right) + \left(\dfrac{\mu_0 2I}{2R}\right)^2}$

$= \dfrac{\mu_0 I}{2R} \times \sqrt{5} = \sqrt{5}\ \dfrac{\mu_0 I}{2R}$

70. (b) $E = BAf$

$= B\pi l^2 \times \dfrac{2\pi f}{2\pi}$

$= \dfrac{B \times \pi l^2\omega}{2\pi}$

$= \dfrac{0.2 \times 10^{-4} \times 1^2 \times 5}{2}$

$= 5 \times 10^{-5}V = 50 \times 10^{-6}V = 50\ \mu V$

71. (b)

Object & image coincide so light incident normally at mirror meet at C so for mirror $r = 2f = 2 \times 18 = 36$ cm

for lens, $u = -(36 + 12) = -24$ cm

$v = x,\ f = 40$ cm

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

or, $\dfrac{1}{40} = -\dfrac{1}{24} + \dfrac{1}{x}$

or, $\dfrac{1}{x} = \dfrac{1}{40} + \dfrac{1}{24} = \dfrac{24 + 40}{40 \times 24}$

or, $x = \dfrac{40 \times 24}{64} = 15$ cm

72. (d) $d\sin\theta_1 = (2n + 1)\dfrac{\lambda}{2}$

or, $\lambda = \dfrac{2d\sin\theta_1}{3}$

$= \dfrac{2 \times 0.012 \times 10^{-3} \times \sin 5.2}{3}$

$= 7.250 \times 10^{-7}$ m $= 7250$ Å

73. (a) For 1st line of Balmer series

$\dfrac{1}{\lambda_B} = R\left[\dfrac{1}{2^2} - \dfrac{1}{3^2}\right] = \dfrac{5R}{36}$

or, $\lambda_B = \dfrac{36}{5R}$ …. (1)

For 1st line of Lyman series

$\dfrac{1}{\lambda_L} = R\left[\dfrac{1}{1^2} - \dfrac{1}{2^2}\right] = \dfrac{3R}{4}$

or, $\lambda_L = \dfrac{4}{3R}$ …. (2)

Dividing (2) by (1)

$\dfrac{\lambda_L}{\lambda_B} = \dfrac{4}{3R} \times \dfrac{5R}{36}$

$\therefore\ \lambda_L = \dfrac{5}{27} \times 6563 = 1215$ Å

74. (b) $\dfrac{A}{A_0} = \left(\dfrac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

or, $\left(\dfrac{1}{32}\right) = \left(\dfrac{1}{2}\right)^{\frac{7.5}{T_{1/2}}}$

or, $\left(\dfrac{1}{2}\right)^5 = \left(\dfrac{1}{2}\right)^{\frac{7.5}{T_{1/2}}}$

or, $5 = \dfrac{7.5}{T_{1/2}}$

or, $T_{1/2} = \dfrac{7.5}{5} = 1.5$ hrs

75. (c) $K_2Cr_2O_7 + 2KOH \longrightarrow 2K_2CrO_4 + H_2O$

red orange   lemon yellow

76. (d) $Cl_2 + H_2O \longrightarrow HCl + [O]$

Colour vegetable + [O] $\longrightarrow$ Colourless vegetable

77. (c)

$CH_3CH_2CH_2I \xrightarrow{\text{KOH (alc.)}} CH_3CH = CH_2 \xrightarrow{Br_2} CH_3 - CH - CH_2Br \xrightarrow{NaNH_2/NH_3} \underset{\text{Propyne}}{CH_3C \equiv CH}$

78. (b) $\frac{\text{Wt. of metal}}{\text{EW of metal}} = \frac{\text{Wt. of oxygen}}{\text{EW of oxygen}}$

$\frac{2}{x} = \frac{0.8}{8}$, $x = 20$

valency of metal = 2

At. wt. = EW × valency

= 20 × 2 = 40

79. (d) At. no. = 19 = 19e & 19P

No. of n = 39 – 19 = 20n

80. (a) 1L of $\frac{N}{2}$ HCl contains 18.25g of HCl

Remaining HCl = 18.25 – 16.425 = 1.825

$\frac{W}{E} = \frac{N \times V_m}{1000}$

$\frac{1.825}{36.5} = \frac{N \times 500}{1000}$, N = 0.1N HCl

$pH = -\log[H_3O^+]$

$= -\log[0.1]$

$= 1$

81. (a) $CaC_2O_4 \rightleftharpoons Ca^{++} + C_2O_4^{--}$

S S S

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

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

$\lambda = 1$

∴ 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. (b) $f'(x) = 4x^3 - 24x^2 + 36x$

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

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

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

…The End…