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

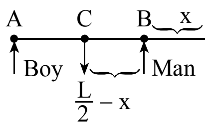
$= \frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2$

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

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

$= 8$ J

4\. (a)



Taking moment of forces about

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

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

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

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) $V_{in} = I_b R_{in}$

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

or, $I_c = 50 \times 10^{-5} = 500\ \mu A$

18. (c)

19. (a)

20. (a) In basic medium

$$2\overset{+7}{K}MnO_4 + 2KOH \longrightarrow 2\overset{+6}{K_2}MnO_4 + H_2O + [O]$$

Change in O.N. of Mn = +7 – (+6) = 1

$$\text{EW of } KMnO_4 = \frac{158}{1} = 158$$

$$\frac{W}{E} = \frac{N \times V_{ml}}{1000}$$

$$\frac{x}{158} = \frac{0.1 \times 100}{1000}$$

$$x = \frac{0.1 \times 100 \times 158}{1000} = 1.58$$

21. (b) 1.8L = 1.8 × 1000 = 1800 ml

Mass = V × D = 1800 × 1 = 1800g

18g water = 1 mole

$$1800\text{g water} = \frac{1}{18} \times 1800 = 100 \text{ moles}$$

22. (a)

23. (a)
(a) 24 mg
(b) 1 mole = 30g
0.9 moles = 30 × 0.9 = 27g
(c) 22.4L N_2 = 28g
(d) 6.023×10^{23} O_2 molecules = 32g

24. (a)

$$N_2H_4 \longrightarrow Y + 10e^-$$

$\longrightarrow$ (7 + 3) moles $\not\Rightarrow$ NH_3^-

$\longrightarrow$ (7 + 1) moles = $\overset{-1}{N}\overset{+1}{H}$

25. (b)

26. (d)

27. (c)

28. (b)

29. (b) $A \cap \bar{B} = \{x : x \in A \text{ and } x \notin B\}$
$= \{x : x \in A - B\} = A - B$

30. (c) $f(x - 1) = x + 2$
$= (x - 1) + 3$
$\therefore\ f(x)^2 = x^2 + 3$

31. (b) $\tan ax = \cot bx = \tan\left(\frac{\pi}{2} - bx\right)$

$\Rightarrow\ ax = \frac{\pi}{2} - bx$

$\Rightarrow\ x = \frac{2x + 1}{a + b} \cdot \frac{\pi}{2}$

32. (b) Let $\sin^{-1}x = \theta$

$\Rightarrow\ x = \sin\theta$

$\Rightarrow\ x = \cos\left(\frac{\pi}{2} - \theta\right)$

$\Rightarrow\ \cos^{-1}x = \frac{\pi}{2} - \theta$

$\Rightarrow\ \sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}$

33. (d) $\begin{vmatrix} 4 & 2 \\ k & 5 \end{vmatrix} = 0$

$\Rightarrow\ 20 - 2k = 0$

$\Rightarrow\ k = 10$

34. (b) $\alpha + \beta = k$, $\alpha\beta = 8$

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

or, $k^2 = 4 + 32$

$\Rightarrow\ k = \pm 6$

35. (c) $e^{2x+3} = e^3.e^{2x}$

$$= e^3\left(1 + \frac{2x}{1!} + \frac{(2x)^2}{2!} + \frac{(2x)^3}{3!} + \ldots\right)$$

$$\text{Coefficient of } x^3 = e^3.\frac{(2)^3}{3!} = \frac{8e^3}{3!}$$

36. (d) Obvious

37. (a) Formula

38. (c) L.H.L = R.H.L

3 × 2 – 4 = 2 × 2 + k

$\Rightarrow\ k = -2$

39. (d)
$$\frac{d(\sin x)}{d(\cos x)} = \frac{\frac{d}{dx}(\sin x)}{\frac{d}{dx}(\cos x)} = \frac{\cos x}{-\sin x} = -\cot x$$

40. (a) For increasing function, $f'(x) > 0$

$\Rightarrow\ 3x^2 + 6x + 3 > 0$

$\Rightarrow\ 3(x + 1)^2 > 0$ which is true for all $x \in \Re$

41. (c) We have, $\frac{d}{dx}(|x|) = \frac{|x|}{x}$

$d(|x|) = \frac{|x|}{x}\,dx$

$\Rightarrow\ \int \frac{|x|}{x}\,dx = |x| + c$

42. (d) Solving we get x = 0, 1

$$\text{Required area} = \int_0^1 (x - x^2)\,dx = \left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1 = \frac{1}{6}$$

43. (c)

44. (b) Formula

45. (c) $P = \left|\frac{-52}{\sqrt{3^2 + 4^2 + 12^2}}\right| = \left|\frac{52}{13}\right| = 4$

46. (a) Let r = length of line

Then, $lr = 2$, $mr = 3$, $nr = 6$

Now, $r^2(l^2 + m^2 + n^2) = 4 + 9 + 36$

$\Rightarrow\ r^2 = 49$

$\Rightarrow\ r = 7$

47. (a) Radius $= \frac{1}{2}$(distance between parallel tangents)

48. (b) Sum of focal distances = major axis
$= 2b$

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

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, $r_2 = r_1\left(\frac{w_1}{w_2}\right)^2 = r_1\left(\frac{f_1}{f_2}\right)^2$

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

$= 4$ cm

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

or, $t = \frac{2 \times 4200\,(77.27)}{840}$

$= 500s$
$= 8$ min $20s$

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

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

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

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

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

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

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

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

$= \frac{C_2V}{4\pi(RR)^2}$

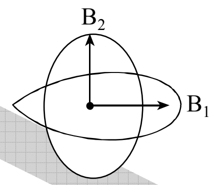
$= \frac{4\pi\varepsilon_0 \times 2R}{4\pi R^2 \times 4} \times \frac{5R\sigma}{3\varepsilon_0}$

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

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

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

69. (a)



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

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

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

70. (b) $E = BAf$

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

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

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

71. (b)

Object & image coincide so light incident normally at mirror meet at C so fro mirror $r = 2f$ $= 2 \times 18 = 36$ cm
for lens $u = -(36 + 12) = -24$ cm
$v = x$, $f = 40$ cm

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

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

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

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

72. (d) $d\sin\theta_1 = (an + 1)\,\frac{\lambda}{2}$

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

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

$= 7.250 \times 10^{-7}$ m $= 7250$ Å

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

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

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

For 1st line of Lyman series

$$\frac{1}{\lambda_2} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3R}{4}$$

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

Dividing (2) by (1)

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

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

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

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

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

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

75. (d)

$$HC \equiv CH \xrightarrow[\text{(ii) } H_2O/Zn]{\text{(i) } O_3} H - \underset{\underset{O}{\|}}{C} - \underset{\underset{O}{\|}}{C} - H$$

Glyoxal

76. (b) $NH_4Cl + KNO_2 \xrightarrow{\Delta} KCl + NH_4NO_2$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

77. (b)

78. (d) $\frac{W}{E} = \frac{N \times V_{ml}}{1000}, \frac{0.23}{E} = \frac{0.1 \times 30}{1000}$

$E = \frac{0.23 \times 1000}{0.1 \times 30} = \frac{230}{3} = 76.67$

MW = 2 × 76.67 = 153.3

Metal oxide = 153.3 M = 153. 3 – 16

M + 0 = 153.3 M = 137.3

79. (d) $Mg(OH)_2 \rightleftharpoons Mg^{++} + 2OH^-$

S S 2S

$K_{sp} = 4s^3$

$S = \sqrt[3]{\frac{1 \times 10^{-11}}{4}} = 1.358 \times 10^{-4}$ mol L^{-1}

$OH^- = 25 = 2 \times 1.358 \times 10^{-4} = 2.716 \times 10^{-4}$ mol/L^{-1}

pOH = log[2.716×10^{-4}] = 3.566

pH = 14 – pOH = 14 – 3.566 = 10.43

80. (c) Number of moles of O_2 used up = 25% = $\frac{25}{100}$

= 0.25 mole

$$\underset{'g'}{2SO_2} + \underset{'g'}{O_2} \rightleftharpoons \underset{'g'}{2SO_3}$$

Initial moles: 4 mol 4 mole

At equation (4–2 moles) (4–4 × 0.25 moles) 2 mole

Total no. of moles = 2 + 3 + 2 = 7 moles.

81. (a) 100g of $CaCO_3$ = 6.023×10^{23} no. of C-atoms

25g of $CaCO_3 = \frac{6.023 \times 10^{23}}{100} \times 25 = 1.5 \times 10^{23}$

82. (d) $f(x) = e^{\sqrt{5x - 3 - 2x^2}}$

$\Rightarrow \quad 5x - 3 - 2x^2 \geq 0$

$\Rightarrow \quad (x - 1)\left(x - \frac{3}{2}\right) \leq 0$

$\Rightarrow \quad x \in \left[1, \frac{3}{2}\right]$

Domain = $\left[1, \frac{3}{2}\right]$

83. (c) $4R \cos\frac{A}{2} \cos\frac{B}{2} \cos\frac{C}{2}$

$= 4R\sqrt{\frac{s(s-a)}{bc}}\sqrt{\frac{s(s-b)}{ca}}\sqrt{\frac{s(s-c)}{ab}}$

$= \frac{4R}{abc}\sqrt{s^2.s(s-a)(s-b)(s-c)} = \frac{1}{\Delta}.s.\Delta = s$

84. (a) Let $\vec{a} = x\vec{i} + y\vec{j} + z\vec{k}$

Then, $\vec{a}.\vec{i} = x$, $\vec{a}.\vec{j} = y$ & $\vec{a}.\vec{k} = z$

Now, $(\vec{a}.\vec{i})\vec{i} + (\vec{a}.\vec{j})\vec{j} + (\vec{a}.\vec{k})\vec{k}$

$= x\vec{i} + y\vec{j} + z\vec{k} = \vec{a}$

85. (b) $\begin{vmatrix} 1 + \frac{1}{a} & \frac{1}{a} & \frac{1}{a} \\ \frac{1}{b} & 1 + \frac{1}{b} & \frac{1}{b} \\ \frac{1}{c} & \frac{1}{c} & 1 + \frac{1}{c} \end{vmatrix}$

$= abc\left(1 + \frac{1}{a} + \frac{1}{b} + \frac{1}{c}\right) = abc\,(1 + 0) = abc$

86. (b) 6 couples can be arranged in 6! ways

In each couple, husband and wife can interchange their seats in 2! ways.

Total no. of ways = 6! × $(2!)^6$

87. (b) $(1 + 3x + 8x^2)^{10} = (1 + (3x + 8x^2))^{10}$

For the coefficient of x, the power of $(3x + 8x^2)$ must be 1 and this happens in 2nd term.

$t_2 = t_{1+1} = {}^{10}c_1\,(3x + 8x^2)$

Coefficient of x = 3 × ${}^{10}c_1$ = 3 × 10 = 30

88. (d) $(1+i)^4\left(1+\frac{1}{i}\right)^4$

$= (1+i)^4 (1-i)^4 \left[\because \frac{1}{i} = -i\right]$

$= 2^4$

$= 16$

89. (d) $\lim_{x\to\frac{\pi}{2}} \frac{\cos x}{\frac{\pi}{2}-x} \left[\frac{0}{0}\text{ form}\right]$

$= \lim_{x\to\frac{\pi}{2}} \frac{-\sin x}{-1} = \sin\frac{\pi}{2} = 1$

90. (c) At $x = \frac{2\pi}{3}$, $|\cos x| = -\cos x$, $|\sin x| = \sin x$

Then, $y = -\cos x + \sin x$

$\frac{dy}{dx} = \sin x + \cos x$

At $x = \frac{2\pi}{3}$, $\frac{dy}{dx} = \sin\frac{2\pi}{3} + \cos\frac{2\pi}{3} = \frac{\sqrt{3}}{2} - \frac{1}{2} = \frac{\sqrt{3}-1}{2}$

91. (b) Put $l\text{n}x = t$

$\Rightarrow \quad x = e^t$

$\Rightarrow \quad dx = e^t dt$

$I = \int\left(\frac{1}{t}-\frac{1}{t^2}\right) e^t dt = e^t.\frac{1}{t} + c = \frac{x}{l\text{n}x} + c$

92. (c) $f'(x) < 0$ for decreasing function

i.e. $\quad e^x(x-1)(x-2) < 0$

$\Rightarrow \quad (x-1)(x-2) < 0 \quad (\because e^x > 0)$

$\Rightarrow \quad 1 < x < 2$

93. (c) $y^2 = x$ and $y = |x|$

$\Rightarrow \quad x^2 = x$

$\Rightarrow \quad x = 0, 1$

Required area

$= \int_0^1 (\sqrt{x} - x)\, dx$

$= \left[\frac{2}{3}x^{3/2} - \frac{x^2}{2}\right]_0^1$

$= \frac{2}{3} - \frac{1}{2} = \frac{1}{6}$

94. (d) Given line is $\frac{x}{\frac{2k}{5}} + \frac{y}{\frac{2k}{6}} = 1$

Area of triangle $= \frac{1}{2}$ (x – intercept) (y-intercept)

or, $\quad 135 = \frac{1}{2}\cdot\frac{2k}{5}\cdot\frac{2k}{6}$

or, $\quad k^2 = 2025$

$\therefore \quad k = \pm 45$

95. (d) Here, $a = 2$, $t_1 = 1$

We have, $t_2 = -t_1 - \frac{2}{t_1}$

$\Rightarrow \quad t_2 = -3$

The other point $= (at_2^2, 2at_2) = (18, -12)$

96. (a) The conic is $\frac{x^2}{16} - \frac{y^2}{9} = 1$ (hyperbola)

$a^2 = 16$, $b^2 = 9$

Now, $e = \sqrt{1+\frac{b^2}{a^2}} = \sqrt{1+\frac{9}{16}} = \frac{5}{4}$

97.d 98.c 99.b 100.c

...The End...