Section - I

1. (b) For given velocity range will be maximum if $\sin 2\theta$ is maximum. i.e. 1. So $145 - \theta$ is least.

2. (d) $I = \frac{1}{4} mR^2$

or, $mR^2 = 4I$

Moment of inertia about tangent parallel to diameter is

$I^1 = I_{CM} + mR^2 = \frac{1}{4} mR^2 + mR^2 = \frac{5}{4} mR^2$

$= 5I$

3. (a) $\frac{\rho g h}{2} \times 2\pi r h = \lambda r^2 \times \rho g h$

or, $h = r$

4. (b) Boiling point decreases if pressure of atmosphere above water decreases.

5. (a) In adiabatic process $dQ = 0$ so $d\omega = du$, in compression $d\omega$ is negative so du is positive so temperature rises.

6. (c) $\frac{I_{max}}{I_{min}} = \left(\frac{a_1 + a_2}{a_1 - a_2}\right)^2 = \left(\frac{5+3}{5-3}\right)^2 = 16:1$

7. (c) 2^{nd} overtone = 3^{rd} harmonics

= 3 lopes

No. of antinodes = No of loops = 3

No. of nodes = No of antinodes + 1 = 4

8. (a) Force on each is $F = \frac{KQ_1Q_2}{r^2}$ remain same.

9. (c) Total electric flux $= \frac{Q}{\varepsilon_0}$

There are 6 sides in cube so flux through each face is flux through face $= \frac{Q}{6\varepsilon_0}$

10. (b) $I = \frac{E}{R + \frac{r}{2}} = \frac{2E}{R + 2r}$

or, $\frac{1}{3 + \frac{r}{2}} = \frac{2}{3 + 2r}$

or, $3 + 2r = 6 + r$

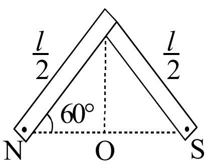
or, $r = 3\Omega$

11. (a) $\frac{P'}{P} = \left(\frac{V'}{V}\right)^2 = \left(\frac{160}{200}\right)^2$

or, $P' = 32\omega$

12. (b) $M = m \times l$

or, $m = \frac{M}{l}$



New magnetic moment (M') = m × NS

$= m \times 20N$

$= \frac{M}{l} \times 2 \times \frac{l}{2} \cos 60$

$= \frac{M}{2}$

13. (a) $\frac{E'}{E} = \left(\frac{r}{r'}\right)^2 = \left(\frac{40}{50}\right)^2 = 0.64$

% decrease $= \left(1 - \frac{E'}{E}\right) \times 100\%$

$= (1 - 0.64) \times 100\% = 36\%$

14. (b) $\mu = \frac{\sin i}{\sin r}$

for minimum deviation $r = \frac{4}{2}$ so $\sin I = \sqrt{2} \times \sin\frac{60}{2} = \frac{1}{\sqrt{2}} = \sin 45°$

$\therefore$ $i = 45°$

15. (d) When a particle disintegrate then momentum of each fragment will be equal & opposite so $\lambda = \frac{h}{p}$ remain same.

16. (a) $\frac{r_{Al}}{r_{Te}} = \left(\frac{A_{al}}{A_{Te}}\right)^{\frac{1}{3}} = \left(\frac{27}{125}\right)^{\frac{1}{3}} = \frac{3}{5}$

17. (c) Voltage gain $(A_v) = \frac{V_{out}}{V_{in}} = \frac{I_cR_{out}}{I_bR_{in}} = \beta \times \frac{5000}{500}$

$= 60 \times 10$

$= 600$

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) $\Delta n = 1 - 4 = -3$

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

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

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

27.(b)

28.(c)

29.(a) Total no. of elements = 5.

No. of subsets having not more than 3 elements

$= c(5, 3) + c(5, 2) + c(5, 1) + c(5, 0)$

$= 10 + 10 + 5 + 1 = 16$

30.(d) $2\tan^2 x = \sec^2 x$

i.e. $2\tan^2 x = 1 + \tan^2 x$

i.e. $\tan^2 x = 1$

i.e. $\tan^2 x = \tan^2\frac{\pi}{4}$

$\therefore\ x\pi \pm \frac{\pi}{4}$

31.(d) We have $\frac{a}{\sin A} = \frac{b}{\sin B}$

i.e. $\frac{3}{\frac{3}{4}} = \frac{4}{\sin B}$

i.e. $\sin B = 1$

$\therefore\ B = 90°$

32.(c) $\vec{a} = \lambda\hat{a}$ i.e. $|\vec{a}| = \lambda|\hat{a}|$

i.e. $\lambda = |\vec{a}|$

33.(b) $1 - \log_e 2 + \frac{(\log_e 2)^2}{2} - \frac{(\log_e 2)^3}{3!} + \ldots = e^{-\log_e 2}$

$= e^{\log_e \frac{1}{2}} = \frac{1}{2}$

34.(d) Sum of roots = 0

i.e. $-\frac{\lambda - 5}{\lambda - 2} = 0$

i.e. $\lambda = 5$

35.(b) We have $|A.\ \mathrm{Adj}\ A| = |A|\ |I| = 8.1 = 8$

36.(b) Here $D = \begin{vmatrix} 1 & 3 \\ 4 & -1 \end{vmatrix} = -1 - 12 = -13 \neq 0$

So it has unique solution.

37.(c) The required line is $5(x - 2) - 3(y - 3) = 0$

i.e. $5x - 3y - 19 = 0$

38.(d) y-coordinates of centroid = 0

i.e. $\frac{a + b - 3}{3} = 0$

i.e. $a + b = 3$

39.(b) By definition 'b'

40.(a) Here $a^2 = 25$, $b^2 = 9$, $e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{9}{25}}$

$= \sqrt{\frac{16}{25}} = \frac{4}{5}$

41.(d) Here $16x^2 - 9y^2 = 144$

i.e. $\frac{x^2}{9} - \frac{y^2}{16} = 1$

So $|PS_1 - PS_2| = 2.3 = 6$

42.(d) By definition, option 'd' is correct.

43.(b) $\lim_{x \to 0} \frac{\sin ax - \sin bx}{x} = \lim_{x \to 0} \left[\frac{\sin ax}{ax}\,.\,a - \frac{\sin bx}{bx}\,.\,b\right]$

$= 1.a - 1.b = a - b$

44.(d) $\lim_{x \to 0} f(x) = f(0)$

i.e. $\cos 0 + 1 = K$ $\qquad$ i.e. $K = 2$

45.(a) $e^{3\log_e x} = x^3$ and its derivative is $3x^2$

46.(c) $f'(x) = 2x - 4$

So, $f'(x) > 0$

i.e. $2x - 4 > 0$

i.e. $x > 2$

47.(b) Put $1 + e^x = y$

i.e. $dy = e^x dx$

Then $\int \frac{e^x dx}{1 + e^x} = \int \frac{dy}{dx} = \ln y + c = \ln(1 + e^x) + c$

48.(b) Req. area $= \int_1^2 dx = \int_1^2 x^3 dx = \left[\frac{x^4}{4}\right]_1^2 = \frac{16}{4} - \frac{1}{4}$

$= \frac{15}{4}$ sq. units

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

Section - II

61.(b) $a_t = 2m/s^2$

$a_c = \frac{v^2}{r} = \frac{30^2}{500} = \frac{9}{5} = 1.8\ m/s^2$

$\therefore\ a = \sqrt{a_c^{\,2} + a_t^{\,2}} = \sqrt{1.8^2 + 2^2}$

62.(c) $2t_s = t_r$

or, $2\sqrt{\frac{2l}{g\sin\theta}} = \sqrt{\frac{2l}{g\sin\theta - \mu g\cos\theta}}$

or, $\frac{4}{\sin\theta} = \frac{1}{\sin\theta - \mu\cos\theta}$

or, $4\sin\theta - 4\mu\cos\theta = \sin\theta$

or, $4\mu\cos\theta = 3\sin\theta$

or, $\mu = \frac{3}{4}\tan\theta = 0.75$

63.(a) Change in wt = change in upthrust

or, $200 = (l^2 \times 2) \times 1$

or, $l = 10$ cm

64.(c) Gain in time in day $= \frac{1}{2} \propto 4\theta \times 1$ day

or, $\alpha = \frac{8.6 \times 2}{10 \times 86400} = 2 \times 10^{-5}/°C$

65.(c) $Q = \frac{kAd\theta}{2l} \times t_1 = \frac{k2Ad\theta}{l} \times t_2$

or, $\frac{t_1}{2} = 2t_2$ or, $t_2 = \frac{12}{4} = 35$

66.(b) $\rho_m = \frac{4V\rho_H + V\rho_0}{4V + V} = \frac{4\rho_H + \rho_0}{5}$

$\therefore \frac{v_m}{v_H} = \sqrt{\frac{\rho_H}{\rho_m}} = \sqrt{\frac{\rho_H}{4\rho_H}} = \frac{1}{2}$

$\therefore v_m = \frac{1224}{2} = 612$ m/s

67.(a) $V = \frac{Q}{4\pi\varepsilon_0 R} - \frac{Q}{4\pi\varepsilon_0 3R} = \frac{Q}{4\pi\varepsilon_0 R}\left(1 - \frac{1}{3}\right)$

$\therefore \frac{Q}{4\pi\varepsilon_0 R} = \frac{3}{2}V$

Again, $E = \frac{Q}{4\pi\varepsilon_0 (3R)^2} = \frac{Q}{4\pi\varepsilon_0 R} \times \frac{1}{9R}$

$= \frac{3V}{2} \times \frac{1}{9R}$

$= \frac{V}{6R}$

68.(a) Resistance in GHF is open so

$R_{eq} = \frac{4 \times 2}{4 + 2} + 2 = \frac{4}{3} + 2 = \frac{10}{3}\,\Omega$

$I = \frac{E}{R_{eq}} = \frac{10}{\frac{10}{3}} = 3A$

Here current 1A flows along BGD & 2A along AD so voltage across capacitor = Pd across GP $= V_{GD} + V_{DF} = 1 \times 2 + 3 \times 2 = 8V$

69.(c) $B = \frac{\mu.I}{2R} = \frac{\mu_0 f}{2R}$

or, $6.28 = \frac{4\pi \times 10^{-7} \times 2 \times 10 \times 6.25 \times 10^{12}}{2R}$

or, $R = \frac{4\pi \times 10^{-7} \times 2 \times 10^{-6} \times 6.25 \times 10^{12}}{2 \times 6.28}$

$= 1.25$ m

70.(b) $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$

$= \frac{10}{\sqrt{10^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}} = \frac{10}{10\sqrt{2}} = \frac{1}{\sqrt{2}}$

$= \tan 45°$

$\phi = 45° = \frac{\pi}{4}$

71.(b) $I = I' + 2\sqrt{I'I'}\cos\phi + I'$

if path difference is λ then phase difference is 2π so $I = 4I' \Rightarrow I' = \frac{I}{4}$

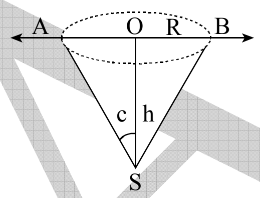
If path difference is $\frac{\lambda}{4}$ then phase difference (ϕ')

$= \frac{2\pi}{\lambda}\frac{\lambda}{4} = \frac{\pi}{2}$

$I_R = I' + 2\sqrt{I'I'}\cos\phi' + I'$

$= 2I' = 2 \times \frac{I}{4} = \frac{I}{2}$

72.(a)



$\tan c = \frac{R}{h}$

or, $R = h\frac{\sin c}{\cos c}$

$= h\frac{\sin c}{\sqrt{1 - \sin^2 c}}$

$= h\frac{\sin c}{\sqrt{1 - \sin^2 c}}$

$= h \times \frac{1}{\mu}\frac{1}{\sqrt{1 - \frac{1}{\mu^2}}} = \frac{h}{\sqrt{\mu^2 - 1}}$

$= \frac{4}{\sqrt{\left(\frac{5}{\sqrt{3}}\right)^2 - 1}} = 4 \times \frac{3}{4}$

$= 3m$

73.(c) **1st case**

$\frac{hc}{\lambda} = \phi + 3ev_0$ …. (i)

2nd case

$\frac{hc}{2\lambda} = \phi + ev_0$ ….. (ii)

From (i) & (ii)

$\frac{1}{2}(\phi + 3ev_0) = \phi + ev_0$

or, $\phi + 3ev_0 = 2\phi - 2ev_0$

or, $\phi = ev_0$ …. (iii)

From equation (i)

$\frac{hc}{\lambda} = \phi + 3\phi$

or, $4\phi = \frac{hc}{\lambda}$

or, $4\frac{hc}{\lambda_0} = \frac{hc}{\lambda}$

or, $\lambda = 4\lambda$

74.(d) $\frac{N_A}{N_B} = \frac{1}{e}$

or, $\frac{N_0 e^{-10\lambda t}}{N_0 e^{-\lambda t}} = \frac{1}{e}$

or, $\frac{1}{e^{9\lambda t}} = \frac{1}{e}$

or, $\left(\frac{1}{e}\right)^{9\lambda t} = \frac{1}{e}$

or, $9\lambda t = 1$

or, $t = \frac{1}{9\lambda}$

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)

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

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) $f(x) = \frac{\cos^2x + \sin^4x}{\sin^2x + \cos^4x} = \frac{\cos^2x + \sin^2x\,(1-\cos^2x)}{\sin^2x + \cos^2x(1-\sin^2x)}$

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

$= \frac{1 - \sin^2x\,\cos^2x}{1 - \sin^2x\,\cos x} = 1$

83.(c) Here $\alpha + \beta = \frac{5}{6}$, $\alpha\beta = \frac{1}{6}$

So $\tan^{-1}\alpha + \tan^{-1}\beta = \tan^{-1}\frac{\alpha+\beta}{1-\alpha\beta} = \tan^{-1}\frac{\frac{5}{6}}{1-\frac{5}{6}}$

$= \tan^{-1} 1 = \frac{\pi}{4}$

84.(a) Projection of $\vec{b}$ on $\vec{a} = \frac{\vec{a}.\vec{b}}{|\vec{a}|} = \frac{2.5 + 1.-3 + 2.1}{\sqrt{2^2+1^2+2^2}}$

$= \frac{10-3+2}{\sqrt{9}} = \frac{9}{3} = 3$

85.(a) No. of arrangements of CALCUTTA $= \frac{8!}{2!\,2!\,2!}$
$= 5040$

No. of arrangements of AMERICA $= \frac{7!}{2!} = 2520$

So ratio of arrangements = 5040 : 2520 = 2:1

86.(c) We have, $(1 + x)^n = c_0 + c_1x + c_2x^2 + c_3x^3 + ... + c_nx^n$
Putting x = 2, we get $(1 + 2)^n = c_0 + 2.c_1 + 2^2.c_2 + 2^3.c_3 + ... + 2^nc_n$
i.e. $c_0 + 2c_1 + 2^2.c_2 + 2^3.c_3 + ... + 2^n.c_n = 3^n$

87.(d) $\frac{1}{3.7} + \frac{1}{7.11} + \frac{1}{11.15} + ...$

$= \frac{1}{4}\left[\left(\frac{1}{3}-\frac{1}{7}\right) + \left(\frac{1}{7}-\frac{1}{11}\right) + \left(\frac{1}{11}-\frac{1}{15}\right) + ...\right]$

$= \frac{1}{4}\cdot\frac{1}{3} = \frac{1}{12}$

88.(b) Given $\left(\frac{1+i}{1-i}\right)^m = 1$

i.e. $\left(\frac{1+i}{1-i} \times \frac{1+i}{1+i}\right)^m = 1$

i.e. $\left(\frac{1+2i-1}{1+1}\right)^m = 1$

i.e. $i^m = 1 \Rightarrow m = 4$

89.(b) The condition for one slope equals n times the other is
$4nh^2 = ab(1 + n)^2$
Put x = 5, $4.5.h^2 = ab.(1 + 5)^2$
i.e. $20h^2 = 36$ ab
i.e. $5h^2 = 9ab$

90.(a) Here vertex = (a, 0)
i.e. h = a, K = 0
Focus = (a', 0) (b + α, K) = (a', 0)
i.e. α = a' – a
So the equation of parabola is
$(y - K)^2 = 4\alpha(x - h)$
i.e. $y^2 = 4(a' - a)\,(x - a)$

91.(b) The equation of plane passing through the intersection of two planes is

$2x + 3y + 10z - 8 + \lambda (2x - 3y + 7z - 2) = 0$

which is perpendicular to $3x - 2y + 4z = 5$, so $(2 + 2\lambda).3 + (3 - 3\lambda).-2 + (10 + 7\lambda).4 = 0$

i.e. $6 + 6\lambda - 6 + 6\lambda + 40 + 28\lambda = 0$

i.e. $\lambda = -1$

So the required equation is $2x + 3y + 10z - 8 - 2x + 3y - 7z + 2 = 0$

i.e. $6y + 3z - 6 = 0$

i.e. $2x + z = 2$

92.(b) For continuity, $\lim_{x \to 0} \frac{1 - \cos x}{x^2} = K$

i.e. $\lim_{x \to 0} \frac{\sin x}{2x} = K \Rightarrow K = \frac{1}{2}$

93.(d) Here, $y = x^{x^x}$ i.e. $y = x^y$

$\ln y = y \ln x$ i.e. $\ln y - y\ln x = 0$

$\therefore \frac{dy}{dx} = -\frac{-\frac{y}{x}}{\frac{1}{y} - \ln x} = \frac{y^2}{x(1 - y\ln x)}$

$= \frac{y^2}{x(1 - \ln y)}$

94.(d) Here, $a = 4$, $b = 9$, $f(x) = \sqrt{x}$, $f'(x) = \frac{1}{2\sqrt{x}}$

So, $f(b) - f(a) = (b - a) f'(c) \Rightarrow 3 - 2 = (9 - 4)\frac{1}{2}$

$\sqrt{c} \Rightarrow \sqrt{c} = 2.5 \ \therefore c = 6.25$

95.(c) Here $I = \int \frac{x^5\,dx}{\sqrt{1 + x^3}} = \int \frac{x^3.x^2\,dx}{\sqrt{1 + x^3}}$

Put $y = 14x^3$

$\therefore \frac{du}{3} = x^2dx$

Then $I = \int \frac{(y - 1)\frac{du}{3}}{\sqrt{y}} = \frac{1}{3}\int \left[\sqrt{y} - \frac{1}{\sqrt{y}}\right] dy$

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

$= \frac{2}{9}(1 + x^3)^{3/2} - \frac{2}{3}(1 + x^3)^{1/2} + c$

96.(a) Given curve is $y = a\sqrt{x} + bx$.

It passes through the point (1, 2), so $a + b = 2$ ... (i)

Clearly the curve passes through origin. Also, area between the curve, line $x = 4$ and x-axis = 8 sq. units.

So $\int_0^4 (a\sqrt{x} + bx)\,dx = 8$

$\therefore \left.\frac{2}{3}ax^{3/2} + \frac{b}{2}x^2\right]_0^4 = 8$

$\frac{2}{3}a.8 + \frac{b}{2}.16 = 8$

i.e. $2a + 3b = 3$ .... (ii)

Solving (i) and (ii) we get $a = 3$, $b = -1$

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

...The End...