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2082-9-12 Hints & Solution

Section – I

1.(a)	2.(b)	3.(c)	4.(d)	5.(d)	6.(d)
7.(a)	8.(a)	9.(b)	10.(b)	11.(d)	12.(a)

13.(a) Given equation is
$x^2 + (k + 2)x + 2k = 0$
For equal roots, $(k + 2)^2 - 4.1.2k = 0$
or, $k^2 + 4k + 4 - 8k = 0$
or, $k^2 - 4k + 4 = 0$
or, $(k - 2)^2 = 0$
i.e. $k = 2$

14.(b) $t_n = 2n - 1,\ \Sigma t_n = (2n - 1) = n^2$

15.(d) $A^2 - A + I = 0$
$I = A - A^2$
$A^{-1} = A^{-1}A - A^{-1}AA = I - A$

16.(c) $A \cap B = C \Rightarrow C \subseteq A$
$B \cap C = A \Rightarrow A \subseteq C$
So, $A = C$

17.(d) $\vec{i}.(\vec{j} \times \vec{k}) + \vec{j}.(\vec{k} \times \vec{i}) + \vec{k}.(\vec{i} \times \vec{j})$
$= \vec{i}.\vec{i} + \vec{j}.\vec{j} + \vec{k}.\vec{k}$
$= 1 + 1 + 1 = 3$

18.(c) Product of slopes $= -\dfrac{1}{-\sqrt{3}} \times -\dfrac{\sqrt{3}}{1} = -1$
$\therefore$ Angle between the lines = 90°

19.(d) Line $y = mx + c$ touches the circle $x^2 + y^2 = a^2$ if
$a = \pm\dfrac{m0 - 0 + c}{\sqrt{m^2 + (-1)^2}}$ i.e. $c = \pm a\sqrt{1 + m^2}$

20.(b) By definition, eccentricity of circle = 0

21.(a) Eq^n of plane cutting equal intercepts is $x + y + z = a$
But it passes through (2, 3, 4) So a = 9

22.(d) $\tan^{-1}\tan\dfrac{2\pi}{3} = \tan^{-1}(-\sqrt{3}) = -\dfrac{\pi}{3}$

23.(c) A complex number $r(\cos\theta + i\sin\theta)$ is purely imaginary if $\cos\theta = 0$ i.e. $\theta = \dfrac{\pi}{2}$

24.(c) Since $0 \le b_{xy} \times b_{yz} \le 1$
So range is [0, 1]

25.(c) $P(F \text{ or } S) = P(F) + P(S) - P(F \cap S) = \dfrac{2}{7} + \dfrac{2}{7} - \dfrac{1}{7} = \dfrac{3}{7}$

26.(d) By definition logarithm is defined for positive values only so the region is $-1 < x \le 1$

27.(a) $\lim\limits_{x \to 0^+}\dfrac{|x|}{x} = \lim\limits_{x \to 0^+}\dfrac{x}{x} = 1$

28.(d) $\log_{\sqrt{x}} x = 2\log_e x = 2$ and its derivative is 0

29.(c) Put $y = x + \log_e \sec x$ i.e. $dy = (1 + \tan x)\,dx$
So $\displaystyle\int\frac{(1 + \tan x)}{x + \log_e \sec x}dx = \log_e(x + \log_e \sec x) + c$

30.(b) For given sum, product is maximum when the numbers are equal. So x = y = 5.
xy = 5 × 5 = 25

31.(a)

32.(c) Required area $= \displaystyle\int_1^4 y\,dx = \int_1^4 \sqrt{x}\,dx$
$= \left.\dfrac{x^{3/2}}{3/2}\right]_1^4$
$= \dfrac{2}{3}[4^{3/2} - 1^{3/2}]$
$= \dfrac{2}{3}.7 = \dfrac{14}{3}$ sq. units

33.(c) $R = \sqrt{A^2 + 2AB\cos\theta + B^2}$
or, $A^2 + B^2 = A^2 + 2AB\cos\theta + B^2$
or, $\cos\theta = 0 = \cos 90°$
or, $\theta = 90° = \dfrac{\pi}{2}$

34.(d) KE = workdone against frinction
or, $\dfrac{1}{2}mv^2 = f_f \times S$
or, $\dfrac{1}{2}mv^2 = \mu mgS$
or, $S = \dfrac{v^2}{2\mu g}$

35.(d) $2T\cos\theta = \rho ghr$
or, $h_1r_1 = h_2r_2$
or, $h_1\sqrt{\dfrac{A_1}{\pi}} = h_2\sqrt{\dfrac{A_2}{\pi}}$
or, $4 \times \sqrt{A} = h_2\sqrt{\dfrac{A}{4}}$
or, $h_2 = 8$ cm

36.(a) $I_0 = I_1 + I_2 + 2\sqrt{I_1I_2}\cos\phi$
$= I + 4I + 2\sqrt{I \times 4I} \times \cos 90°$
$= 5I$

37.(b)

38.(a) $du = nC_vdT = n\dfrac{R}{\gamma - 1}(75 - 25)$
$= \dfrac{2 \times 50 \times R}{\gamma - 1}$
$= \dfrac{100R}{\gamma - 1}$

39.(b) $\sigma_1 = \sigma_2$
or, $\dfrac{Q_1}{4\pi r_1^2} = \dfrac{Q_2}{4\pi r_2^2}$
or, $\dfrac{Q_1}{4\pi\varepsilon_0 r_1 r_1} = \dfrac{Q_2}{4\pi\varepsilon_0 r_2 r_2}$
or, $\dfrac{V_1}{r_1} = \dfrac{V_2}{r_2}$
or, $\dfrac{V_1}{V_2} = \dfrac{r_1}{r_2}$

40.(b) $\dfrac{R'}{R} = \left(\dfrac{1 + \dfrac{l}{10}}{l}\right)^2 = (1.1)^2 = 1.21$
$\therefore$ $R' = 1.21 \times 10 = 12.1\ \Omega$

41.(d) $E = \dfrac{1}{2}mv^2$
$v = \sqrt{\dfrac{2E}{m}} = \sqrt{\dfrac{2 \times 2 \times 1.6 \times 10^{-13}}{1.67 \times 10^{-27}}}$
$= 1.96 \times 10^7$ m/s
$\therefore$ $F = Bev = 2.5 \times 1.6 \times 10 \times 1.96 \times 10^7$
$= 7.8 \times 10^{-12}$ N

42.(b) $\dfrac{H_1}{H_2} = \dfrac{\dfrac{V^2}{R_1}}{\dfrac{V^2}{R_2}} = \dfrac{R_2}{R_1}$

43.(b) $i = 2r$
$\mu = \dfrac{\sin i}{\sin r} = \dfrac{\sin 2r}{\sin r} = \dfrac{2\sin r\cos r}{\sin r}$
or, $\cos r = \dfrac{\mu}{2}$

or, $r = \cos^{-1}\left(\frac{\mu}{2}\right)$

$\therefore$ $i = 2r = 2\cos^{-1}\left(\frac{\mu}{2}\right)$

44.(b) $C = \sin^{-1}\left(\frac{3}{5}\right)$

or, $\frac{3}{5} = \sin C$

or, $\mu = \frac{1}{\sin C} = \frac{5}{3}$

$\therefore$ $\tan i_p = \mu$

or, $i_p = \tan^{-1}\left(\frac{5}{3}\right)$

45.(d)

46.(b) $\alpha = 0.9$

$\therefore$ $\beta = \frac{\alpha}{1-\alpha} = \frac{\alpha}{1-0.9} = 9$

$\beta = \frac{\Delta I_c}{\Delta I_b}$ or, $\Delta I_c = 9 \times 2 = 18\ \mu A$

47.(a) Let x be the required weight
0.05 = x/500 x 1000/(174)
= x ≈ 4.355 gm

48.(d) Since, H_2O_2 and H_2O are two compounds of 2 elements

49.(b) N/No = $(1/2)^2 = (\frac{1}{2})^{32/T_{1/2}}$
= $T_{1/2}$ = 32/2 = 16 minutes

50.(c) N_3H is hydrazoic acid that removes H^+ to give conjugate base N_3^-

51.(a) Heliox, a mixture of helium and oxygen used for the treatment of asthma patient due to its density three times less than that of air.

52.(b)

53.(d) In N_2O_5, oxygen atom is bonded to two N- atoms.

54.(a) ZnO is Chinese white

55.(d)

56.(b) Phorone is obtained by condensation polymerization of three molecules of acetone in presence of HCl (g).
PAN is polyacrylonitrile which is obtained by addition polymerization of acrylonitrile (vinyl cyanide)
Mesitylene is obtained by addition polymerization of propyne and condensation polymerization of acetone in presence of conc. H_2SO_4.

57.(b) Inductive effect : due to permanent displacement of σ – electrons
Electromeic effect : complete transfer of electrons of multiple bond to one of the bonded atoms (usually more electronegative)

58.(b)

59.(d) Cl^- is stronger leaving group than others.

60.(c) $CH_2Cl - C(CH_3)_2 - CH_3$

Section – II

61.(c) y is undefined when
x = 0
$\frac{x}{|x|} = \pm 1$
So Range = {–, 1}

62.(b) We have $(1 + x)^n = C_0 + C_1x + C_2x^2 + ... + C_nx^n$
On differentiation, $n(1 + x)^{n-1} = C_1 + 2C_2x + ... + nC_nx^{n-1}$
Putting x = 1, $n2^{n-1} = C_1 + 2C_2 + ... + nC_n$

63.(c)

64.(c) $(1 + \omega)(1 + \omega^2)(1 + \omega^4)(1 + \omega^8)$
$= (1 + \omega)(1 + \omega^2)(1 + \omega^3.\omega)(1 + (\omega^3)^2.\omega^2)$
$= (1 + \omega)(1 + \omega^2)(1 + \omega)(1 + \omega^2)$
$= (1 + \omega)^2(1 + \omega^2)^2$
$= (-\omega^2)^2(-\omega)^2$ $(\because 1 + \omega + \omega^2 = 0)$
$= \omega^4.\omega^2 = (\omega^3)^2 = 1$

65.(c) $|\vec{a}| = |\vec{b}| = |\vec{c}| = 1$, $\vec{a}.\vec{b} = \vec{b}.\vec{c} = \vec{c}.\vec{a} = 0$
Now $|\vec{a} + \vec{b} + \vec{c}|$
$= \sqrt{(\vec{a} + \vec{b} + \vec{c})^2}$
$= \sqrt{a^2 + b^2 + c^2 + 2(\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a})}$
$= \sqrt{1 + 1 + 1 + 0}$
$= \sqrt{3}$

66.(b) Eq^n: $ax^2 + 2hxy + by^2 = 0$ ...(i)
Let y = mx be one of the lines represented by (i) which bisects the angle between the coordinate axes.
Then m = ± 1.
So putting (i) $ax^2 + 2hx.(\pm x) + b(\pm x)^2 = 0$
$a \pm 2h + b = 0$
or, $a + b = \pm 2h$
$\therefore$ $(a + b)^2 = 4h^2$

67.(a) Centre (h, k) = (1, –3)
$r = \sqrt{(-2-1)^2 + (1+3)^2} = 5$
Equation of circle is
$(x - h)^2 + (y - k)^2 = r^2$
$\therefore$ $(x - 1)^2 + (y + 3)^2 = 25$

68.(c)

69.(c) Given, $\frac{2b^2}{a} = 3$

or, $b^2 = \frac{3a}{2}$

And $e = \sqrt{1 - \frac{b^2}{a^2}}$

or, $\frac{1}{\sqrt{2}} = \sqrt{1 - \frac{3a}{2a^2}}$

or, $\frac{1}{2} = 1 - \frac{3}{2a}$

$\therefore$ a = 3

$b^2 = 3.\frac{3}{2} = \frac{9}{2}$

The equation of ellipse is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

or, $\frac{x^2}{9} + \frac{y^2}{\frac{9}{2}} = 1$

$\therefore$ $x^2 + 2y^2 = 9$

70.(c) At yz-plane x = 0
Let ratio be k : 1
Then $x = \frac{kx_2 + x_1}{k + 1}$

or, $0 = \frac{k(-1) + 4}{k + 1}$

or, $k - 4 = 0$

$k = 4$

$\therefore$ Ratio = 4 : 1

Shortcut: By yz – plane ratio

$= \frac{-x_1}{x_2} = \frac{-4}{-1} = 4:1$

71.(b) We have C = 45°, So A + B = 135°

Then $\cot(A + B) = \cot 135°$

or, $\frac{\cot A.\cot B - 1}{\cot B + \cot A} = -1$

or, $\cot A \cot B - 1 = -\cot A - \cot B$

or, $\cot A \cot B - 1 + \cot A + \cot B = 0$

i.e. $\cot A \cot B + \cot A + \cot B = 1$

So $(1 + \cot A)(1 + \cot B) = 1 + \cot A + \cot B + \cot A \cot B = 1 + 1 = 2$

72.(b) $f(x) = x^3 + \alpha x^2 + \beta x + 1$

So $f'(x) = 3x^2 + 2\alpha x + \beta$

Now $f'(0) = 0 \Rightarrow 3.0 + 2.\alpha.0 + \beta = 0 \Rightarrow \beta = 0$

$f'(1) = 0 \Rightarrow 3.1^2 + 2.\alpha.1 = 0 \Rightarrow \alpha = -\frac{3}{2}$

73.(a) $y = \sec^{-1}\frac{\sqrt{x} + 1}{\sqrt{x} - 1} + \sin^{-1}\frac{\sqrt{x} - 1}{\sqrt{x} + 1}$

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

So $\frac{dy}{dx} = 0$

74.(c) Given $\int_a^b x^3 dx = 0$

$\left.\frac{x^4}{4}\right]_a^b = 0 \Rightarrow b^4 - a^4 = 0$

$\Rightarrow b^4 = a^4$

$\Rightarrow b = \pm a$

and $\int_a^b x^2 dx = \frac{2}{3}$

or, $\left.\frac{x^3}{3}\right]_a^b = \frac{2}{3}$

or, $\frac{b^3 - a^3}{3} = \frac{2}{3}$

or, $b^3 - a^3 = 2$ ...(ii)

When b = a, $b^3 - b^3 = 2 \Rightarrow 0 = 2$ (not possible)

So, $b = -a$, $-a^3 - a^3 = 2 \Rightarrow a^3 = -1$

$\Rightarrow a = -1$

and $b = 1$

75.(d) Solving y = x with $y = x^2$, we get

x = 0, 1

Also the curves are symmetrical about y-axis

So, required area

$= 2\int_0^1 (x - x^2)\, dx$

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

$= 2\left(\frac{1}{2} - \frac{1}{3}\right)$

$= 2 \times \frac{1}{6} = \frac{1}{3}$ sq. units

76.(c) $h_3 = u - \frac{a}{2}(2 \times 3 - 1)$

$= 10 - \frac{2}{2}(6 - 1)$

= 5 m

77.(c) Workdone (W) = change in PE of hanging part

$= \left(\frac{m}{l} \times x\right) g \times \frac{x}{2}$ (x = length of hanging part)

$= \frac{4}{2} \times 0.6 \times 10 \times \frac{0.6}{2}$

= 3.6 J

78.(b) $PA = 2\pi r.T$

or, $\rho gh \times \pi r^2 = 2\pi rT$

or, $r = \frac{2T}{\rho gh}$

$\therefore$ $d = 2r = \frac{4T}{\rho gh} = \frac{4 \times 0.07}{10^3 \times 10 \times 0.4}$

$= 7 \times 10^{-5}$ m

= 0.07 mm

79.(d) For 1st

$n_1 = \frac{1}{2l}\sqrt{\frac{T}{\pi(2r)^2\rho}} = \frac{1}{4lr}\sqrt{\frac{T}{\pi\rho}}$

2nd $n_2 = \frac{1}{2 \times 2l}\sqrt{\frac{T}{\pi r^2\rho}} = \frac{1}{4lr}\sqrt{\frac{T}{\pi\rho}}$

$\therefore$ $n_1 : n_2 = 1:1$

80.(b) Heat lost by block = Heat gained by ice

or, $2 \times S \times 500 = mL_f$

or, $m = \frac{2 \times 400 \times 500}{80 \times 4200} = 1.2$ kg

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

$\eta_1 = \left(1 - \frac{T_2}{T_1}\right) \times 100\%$

$\frac{40}{100} = \left(1 - \frac{300}{T_1}\right)$

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

or, $T_1 = 500K$

2nd case

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

or, $\frac{60}{100} = 1 - \frac{300}{T_1}$

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

or, $T_1' = 750$ K

$\Delta T = T_1' - T_1 = 750 - 500$

= 250 K

82.(a) Given,

$F_1 = 9$ N, $F_2 = ?$

$r_1 = d$, $r_2 = 3d$

$\because$ $F \propto \frac{1}{r^2}$

$\therefore$ $\frac{F_2}{F_1} = \left(\frac{r_1}{r_2}\right)^2$

or, $F_2 = \left(\frac{d}{3d}\right)^2 \times F_1$

$F_2 = \frac{1}{9} \times 9$ N

$\therefore$ $F_2 = 1$ N

83.(b) Across AC

$R' = \frac{18 \times 6}{18 + 6}$

$= \frac{18 \times 6}{244} = 4.5\ \Omega$

$R_T = R' + r = (4.5 + 1.5) = 6\Omega$

$I = \frac{E}{R_T} = \frac{18}{6} = 3A$

Now $I' \times 18 = (3 - I') \times 6$

or, $3I' = 3 - I'$

or, $I' = \frac{3}{4} = 0.75A$

84.(c) KE of electron = 10 eV

$\therefore \frac{1}{2} mv^2 = 10 \times 1.6 \times 10^{-19}$

$V = 1.875 \times 10^6$ m/sec

and $\frac{mV^2}{r} = eVB$

$r = \frac{mV}{eB} = 11 \times 10^{-2}$ m = 11 cm

85.(a) $u + v = x$

$v = x - u$

And $m = \frac{v}{u}$

or, $v = mu$

So $mu = x - u$

or, $u = \frac{x}{m + 1}$

& $v = x - \frac{x}{m + 1} = \frac{(m + 1)\,x - x}{m + 1}$

$= \frac{mx + x - x}{m + 1} = \frac{mx}{m + 1}$

$\therefore f = \frac{uv}{u + v} = \frac{\left(\frac{x}{m+1}\right)\left(\frac{mx}{m+1}\right)}{\frac{x}{m+1} + \frac{mx}{m+1}}$

$= \frac{\frac{mx^2}{(m+1)^2}}{\frac{(m+1)x}{(m+1)}}$

$= \frac{mx^2}{(m+1)^2 \times x}$

$= \frac{mx}{(m+1)^2}$

86.(c) $\frac{x}{f} = \frac{\lambda}{d}$

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

$\therefore 2x = \frac{2f\lambda}{d} = \frac{2 \times 0.5 \times 6000 \times 10^{-10}}{0.2 \times 10^{-3}}$

$= 3 \times 10^{-3}$ m

$= 3$ mm

87.(b) $\phi = 1.24$ eV

$KE = \frac{hc}{\lambda} - \phi$

$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{4.36 \times 10^{-7}} - 1.24 \times 1.6 \times 10^{-19}$

$= 2.57 \times 10^{-19}$ J

$\therefore KE = eV_s$

or, $V_s = \frac{KE}{e} = \frac{2.57 \times 10^{-19}}{1.6 \times 10^{-19}} = 1.6$ V

88.(a) **For S_1**

$A_1 = -\lambda 2N_0$

$5 \times 10^{-6} = \frac{0.693}{T_{1/2}} 2N_0$ ...(i)

For S_2

$A_2 = -\lambda\ N_0$

or, $10 \times 10^{-6} = -\frac{0.693}{T_{1/2}} \times N_0$ ...(ii)

Dividing (i) by (ii)

$\frac{5 \times 10^{-6}}{10 \times 10^{-6}} = \frac{2}{T_{1/2}} \times T_{1/2}'$

or, $\frac{T_{1/2}}{T_{1/2}} = 20 : 5$

89.(d)

90.(b) O.N. of S in SO_3^{2-} = +4

O.N of S in $S_2O_6^{2-}$ = +5

O.N of S in $S_2O_4^{2-}$ = +3

91.(c) In $CaCl_2$, $[Cl^-]$= 2 × 0.04 = 0.08 mol/L

$[Cl^-]$ from AgCl is very low so it is neglected

$K_{sp} = [Ag^+]\,[Cl^-]$

$4 \times 10^{-10} = [Ag^+] \times 0.08$

$\therefore [Ag+] = 4 \times 10^{-10}/0.08 = 5 \times 10^{-9}$M

92.(b) Relative atomic mass $= \frac{5 \times 54 + 90 \times 56 + 5 \times 57}{100}$

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

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

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

94.(b) In $[Ni(CN)_4]^{2-}$, Ni has +2 oxidation number. CO and CN- are strong ligands that result inward pairing of electrons and hence $[Ni(CN)_4]^{2-}$ has dsp^2 hybridization.

95.(d) Secondary prefixes are arranged in alphabetical order

96.(c) 4-primary amines, 3-secondary amines and 1-tertiary amine (draw structures or use NS trick)

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

…The End…