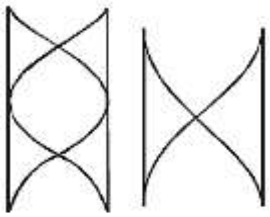
1. **(b)** Let the fundamental frequency of organ pipe be f
   Case I: $f = 200 \pm 5 = 205$ Hz or 195 Hz



Case II: frequency of 2 nd harmonic of organ pipe = 2f (as is clear from the second figure)

$2f = 420 \pm 10$ or $f = 210 \pm 5$ or $f = 205$ or 215

Hence fundamental frequency of organ pipe $= 205$ Hz

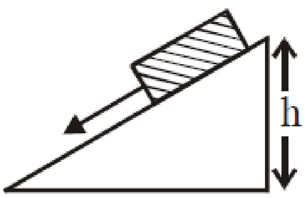
2. **(b)** Apparent depth $= d/\mu_1 + d/\mu_2$
3. **(d)** Acceleration of block while sliding down upper half $= g\sin\phi$; retardation of block while sliding down lower half $= -(g\sin\phi - \mu g\cos\phi)$
   For the block to come to rest at the bottom, acceleration in I half = retardation in II half.

$$g\sin\phi = -(g\sin\phi - \mu g\cos\phi)$$
$$\Rightarrow \mu = 2\tan\phi$$

Alternative method: According to work-energy theorem, $W = \Delta K = 0$
(Since initial and final speeds are zero)
$\therefore$ Work done by friction + Work done by gravity $= 0$
i.e., $-(\mu mg\cos\phi)\frac{\ell}{2} + mg\ell\sin\phi = 0$
or $\frac{\mu}{2}\cos\phi = \sin\phi$ or $\mu = 2\tan\phi$

4. **(c)** The effective acceleration of the body

$$g' = \left(1 - \frac{\rho}{\rho'}\right)g$$



Now, the depth to which the body sinks

$$h' = \left(\frac{u^2}{2g'}\right) = \frac{2gh}{2g'} = \frac{gh}{g'} = \frac{h \times \rho'}{\rho - \rho'}$$

5. **(c)** Forward resistance

$$= \frac{\Delta V}{\Delta I} = \frac{0.7 - 0.5}{1.0 \times 10^{-3}} = 200\Omega$$

6. **(d)**

$$\frac{\Delta Q}{Q}\times 100 = \frac{2\Delta I}{I}\times 100+\frac{\Delta R}{R}\times 100+\frac{\Delta t}{t}\times 100$$
$$= 2\times 2\% + 1\% + 1\% = 6\%$$

7. (c)

$$v_{oxg.} = \sqrt{\frac{3R\times 289}{32}}\left(v_{rms}=\sqrt{\frac{3RT}{M}}\right)$$

$$v_H = \sqrt{\frac{3R\times 400}{2}} \text{ so } v_H = 2230.59 \text{ m/sec}$$

8. (c) This happen when vertical velocity of both are same.

$$\therefore\ v_2 = v_1 \sin 30^\circ \text{ or } \frac{v_2}{v_1}=\frac{1}{2}$$

9. (b) $\mu mg = mv^2/r$ or $v=\sqrt{\mu gr}$

or $v=\sqrt{(0.25\times 9.8\times 20)} = 7\text{ m/s}$

10. (c) $W = Fs\cos\theta = 10\times 2\cos 60^\circ = 10$ J.

11. (d) $\frac{mv^2}{t}=\frac{ms^2}{t^3}$

since both P and m are constants

$$\therefore\ \frac{s^2}{t^3} = \text{ constant}$$

12. (b) $\frac{1}{2}mv_e^2 = \frac{GMm}{R}; v_e=\sqrt{\frac{GMm}{R}}=\sqrt{2gR}$

In tunnel body will perform SHM at centre

$$V_{max} = A\omega \text{ (see chapter on SHM)}$$
$$= \frac{R2\pi}{2\pi\sqrt{R/g}} = \sqrt{gR} = \frac{v_e}{\sqrt{2}}$$

13. (b)

14. (c) Volume of ball $=\frac{40}{0.8} = 50\text{ cm}^3$

Down thrust on water = 50 g.
Therefore reading is 650 g.

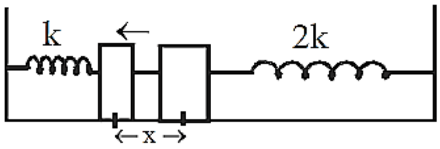
15. (a)

$$PV^{3/2} = K$$
$$\log P + \frac{3}{2}\log V = \log K$$
$$\frac{\Delta P}{P}+\frac{3}{2}\frac{\Delta V}{V} = 0$$
$$\frac{\Delta V}{V} = -\frac{2}{3}\frac{\Delta P}{P} \text{ or } \frac{\Delta V}{V} = \left(-\frac{2}{3}\right)\left(\frac{2}{3}\right) = -\frac{4}{9}$$

16. (b) Comparing the given equation with

$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$, we get $\tan\theta = \sqrt{3}$

17. (a)



Let mass is displaced towards left by x then force on mass $= -kx - 2kx = -3kx$
[negative sign is taken because force is opposite to the direction of motion]

$$\Rightarrow F = -3kx = -m\omega^2 x \Rightarrow \omega = \sqrt{\frac{3k}{m}}.$$

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{3k}{m}}.$$

Thus it is propotional to $\sqrt{3k/m}$

18. (a) Current flowing through the conductor, $I = n\,e\,vA$. Hence

$$\frac{4}{1} = \frac{nev_{d_1}\pi(1)^2}{nev_{d_2}\pi(2)^2} \text{ or } \frac{v_{d_1}}{v_{d_2}} = \frac{4\times 1}{1} = \frac{16}{1}.$$

19. (a) Velocity, $v = \frac{dx}{dt} = -A\omega\sin(\omega t + \pi/4)$

Velocity will be maximum, when $\omega t + \pi/4 = \pi/2$ or $\omega t = \pi/2 - \pi/4 = \pi/4$ or $t = \pi/4\omega$

20. (a) $\frac{1}{\lambda_{max}} = R\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right]$

$$\Rightarrow \lambda_{max} = \frac{4}{3R} \approx 1213\text{Å}$$

and

$$\frac{1}{\lambda_{min}} = R\left[\frac{1}{(1)^2} - \frac{1}{\infty}\right] \Rightarrow \lambda_{min} = \frac{1}{R} \approx 910\text{Å}.$$

21. (b) Potential difference across the branch de is 6 V. Net capacitance of de branch is 2.1μF

So, $q = CV$

$$\Rightarrow q = 2.1 \times 6\mu C \ \Rightarrow q = 12.6\mu C$$

Potential across 3μF capacitance is

$$V = \frac{12.6}{3} = 4.2 \text{ volt}$$

Potential across 2 and 5 combination in parallel is $6 - 4.2 = 1.8$ V
So, $q' = (1.8)(5) = 9\mu C$

$$\begin{aligned}\gamma &= \alpha_1+\alpha_2+\alpha_3\end{aligned}$$

22. (c) $= 13\times10^{-7}+231\times10^{-7}+231\times10^{-7}$

$= 475\times10^{-7}$

23. (a) Solid cylinder reaches the bottom first because for solid cylinder $\frac{K^2}{R^2}=\frac{1}{2}$ and for hollow cylinder, $\frac{K^2}{R^2}=1$.

Acceleration down the inclined plane $\propto \frac{1}{1+K^2/R^2}$. Solid cylinder has greater acceleration. It reaches the bottom first.

24. (a) By the concept of accoustic, the observer and source are moving towards each other, each with a velocity of $18\ \mathrm{m\,s^{-1}}$.

$$\therefore v' = \frac{330+18}{330-18}\times1000 \approx 1115\ \mathrm{Hz}$$

25. (a)

$$n\lambda = (\mu-1)t;$$
$$\therefore\ \lambda = \frac{(\mu-1)t}{n} = \frac{(1.5-1)\times6\times10^{-6}}{5} = 6000\text{Å}$$

26. (b) Use theorem of parallel axes.

27. (a)

28. (a)

29. (d) $Bqv = mv^2/r$ or $q/m = v/rB$.

30. (c) The ball thrown upward will lose velocity in 1s. It return back to thrown point in another 1 s with the same velocity as second. Thus the difference will be 2 s.

31. (a) Angular retardation,

$$\begin{aligned}\alpha &= \frac{\omega_2-\omega_1}{t} = \frac{2\pi(n_2-n_1)}{t}\\ &= \frac{2\pi(0-900/60)}{60} = \frac{\pi}{2}\mathrm{rad/s^2}.\end{aligned}$$

32. (a) The amplitude is a maximum displacement from the mean position.

33. (d) Since the magnetic field is uniform the flux f through the square loop at any time t is constant, because

$$f = B\times A = B\times L^2 = \text{ constant}$$
$$\therefore\ \varepsilon = -\frac{d\phi}{dt} = \text{ zero}$$

34. (d) Limiting friction

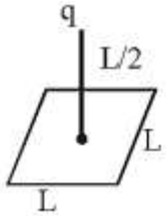
$= 0.5\times2\times10 = 10\ \mathrm{N}$

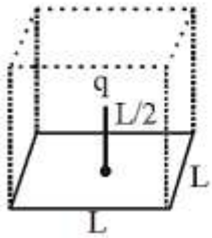
The applied force is less than force of friction, therefore the force of friction is equal to the applied force.

35. (b) As momentum is conserved, therefore

$$\frac{m_1}{m_2} = \frac{A_1}{A_2} = \frac{v_2}{v_1} = \frac{1}{2}$$
$$\therefore\ \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{1}{2}\right)^{1/3} = 1:2^{1/3}$$

36. (c)





The given square of side L may be considered as one of the faces of a cube with edge L. Then given charge q will be considered to be placed at the centre of the cube. Then according to Gauss's theorem, the magnitude of the electric flux through the faces (six) of the cube is given by

$$\phi = q/\varepsilon_0$$

Hence, electric flux through one face of the cube for the given square will be

$$\phi' = \frac{1}{6}\phi = \frac{q}{6\varepsilon_0}$$

37. **(c)** Incident momentum, $p = \frac{E}{c}$

For perfectly reflecting surface with normal incidence

$$\Delta p = 2p = \frac{2E}{c}$$
$$F = \frac{\Delta p}{\Delta t} = \frac{2E}{ct}$$
$$P = \frac{F}{A} = \frac{2E}{ctA}$$

38. **(d)** $\because$ Both wires are same materials so both will have same Young's modulus, and let it be Y.

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F}{A \cdot (\Delta L/L)}, F = \text{ applied force}$$

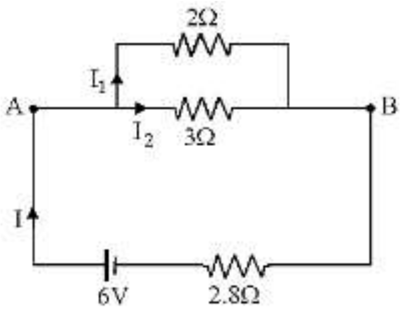
A = area of cross-section of wire
Now,

$$Y_1 = Y_2 \Rightarrow \frac{FL}{(A_1)(\Delta L_1)} = \frac{FL}{(A_2)(\Delta L_2)}$$

Since load and length are same for both

$$\Rightarrow r_1^2 \Delta L_1 = r_2^2 \Delta L_2, \left(\frac{\Delta L_1}{\Delta L_2}\right) = \left(\frac{r_2}{r_1}\right)^2 = 4$$
$$\Delta L_1 : \Delta L_2 = 4:1$$

39. **(c)** At steady state the capacitor will be fully charged and thus there will be no current in the 1Ω resistance. So the effective circuit becomes



Net current from the 6 V battery,

$$I = \frac{6}{\left(\frac{2\times 3}{2+3}\right)+\frac{2.8}{1}} = \frac{6}{1.2+2.8} = \frac{3}{2} = 1.5\ \text{A}$$

Between A and B, voltage is same in both resistances, $2I_1 = 3I_2$ where

$$I_1 + I_2 = I = 1.5$$
$$\Rightarrow\ 2I_1 = 3(1.5 - I_1) \Rightarrow I_1 = 0.9\ \text{A}$$

40. (b) At a height h above the surface of earth the gravitational potential energy of the particle of mass m is

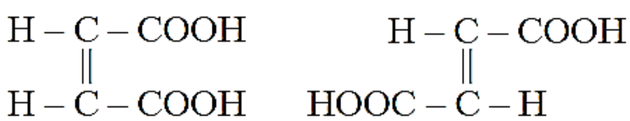
$$U_h = -\frac{GM_e m}{R_e + h}$$

Where M_e&R_e are the mass & radius of earth respectively.
In this question, since $h = R_e$
So $U_{h=R_e} = -\frac{GM_e m}{2R_e} = \frac{-mgR_e}{2}$

41. (a)

$$\%\ \text{of C} = \frac{12}{44}\times\frac{0.147}{0.2}\times 100 = 20.045\%$$
$$\%\ \text{of H} = \frac{2}{18}\times\frac{0.12}{0.2}\times 100 = 6.666\%$$
$$\%\ \text{of O} = 100 - (20.045 + 6.666) = 73.29\%$$

42. (b)
43. (c)
44. (d) Maleic acid and fumaric acids are geometrical isomers.



Maleic acid　　Fumaric acid

45. (a) Gaseous ions, when dissolved in water, get hydrated and heat is evolved (heat of hydration).
$Cl^-(g) + aq \rightarrow Cl^-(aq)$ is such reaction

46. (c) AB : Isobaric expansion
BC : Isothermal expansion
CD: Isochoric
DA: Isothermal compression

47. (c)
48. (b) Red P does not react with NaOH to give PH_3.

49. (b) $C_2H_6 + 3.5O_2 \longrightarrow 2CO_2 + 3H_2O$;

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

Let volume of ethane is x litre,

$$22.4 \times 4 = 3.5x + 3(28 - x)$$
$$\Rightarrow x = 11.2 \text{ litre}$$

at constant T and P, $V \propto n$;

$\Rightarrow$ Mole fraction of C_2H_6 in mixture $= \frac{11.2}{28} = 0.4$

50. (b)

$$\frac{1}{\lambda} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R \times 2^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$\Rightarrow 3R; \lambda = \frac{1}{3R}$

51. (a) Acidic character of oxide $\propto$ Non-metallic nature of element.
Non-metallic character increases along the period. Hence order of acidic character is

$Cl_2O_7 > SO_2 > P_4O_{10}$.

52. (a) $2PCl_5 \rightleftharpoons PCl_4^+ + PCl_6^-$
$\uparrow sp^3d \ \uparrow sp^3 \ \uparrow sp^3d^2$

53. (b) More will be the electronegativity of X, lesser will be the bond length of $X - O$ bond.

54. (a) Given conditions

$$V_1 = 16.4 \text{ L}, \ V_2 = 5 \text{ L}$$
$$P_1 = 1.5 \text{ atm}, P_2 = 4.1 \text{ atm}$$
$$T_1 = 273 + 27 = 300 \text{ K}$$
$$T_2 = 273 + 227 = 500 \text{ K}$$

Applying gas equation, $\frac{P_1 V_1}{P_2 V_2} = \frac{n_1 T_1}{n_2 T_2}$

$$\frac{n_1}{n_2} = \frac{P_1 V_1 T_1}{P_2 V_2 T_2}$$
$$\therefore \frac{1.5 \times 16.4 \times 500}{4.1 \times 5 \times 300} = \frac{2}{1}$$

55. (c) $\Delta H = \Delta U + \Delta nRT$
$\Delta n = n_P - n_R$
Now, $\Delta n = 2 - \frac{5}{2} = -\frac{1}{2}$
$\therefore \Delta H = \Delta U - \frac{1}{2}RT$
Thus, $\Delta U = \Delta H + \frac{1}{2}RT$
$\therefore \Delta U > \Delta H$

56. (a) $K_P = K_C(RT)^{\Delta n_g}$

For the reaction

$$CO(g)+\frac{1}{2}O_2(g) \leftrightharpoons CO_2(g)$$
$$\Delta n_g = 1-\left(1+\frac{1}{2}\right) = -\frac{1}{2}$$
$$\therefore\ K_P = \frac{K_C}{\sqrt{RT}};\ \frac{K_P}{K_C} = \frac{1}{\sqrt{RT}}$$

57. (c)

$$pH = 8, pOH = 6; [OH^-] = 10^{-6}M;$$
$$\text{Ionic product of } Fe(OH)_2 = 0.2\times(1\times10^{-6})^2$$
$$= 2\times10^{-13} > K_{sp}(= 8.1\times10^{-16})$$

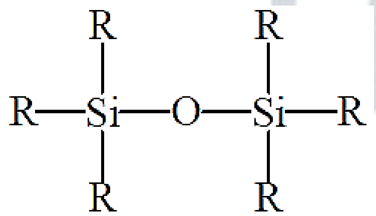
58. (d) Disproportionation involves simultaneous oxidation and reduction of the same atom in a molecule.

59. (a) Molecular weight of $H_2O_2 = 34$

Equivalent weight of $H_2O_2 = 17$
$\therefore$ 1 L of $1NH_2O_2$ has $= 17$ g of H_2O
$\therefore$ 1 L of $1.5NH_2O_2$ has $= 1.5\times17 = 25.5 g of H_2O_2$

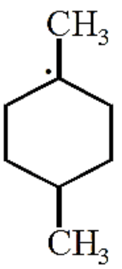
60. (c) Be^{2+} being small in size is heavily hydrated and heat of hydration exceeds the lattice energy. Hence BeF_2 is soluble in water.

61. (b) The hydrolysis of Trialkylchlorosilane R_3SiCl yields dimer:



62. (b) The resulting compound is $C_3H_7CH(OH)C_2H_5$ which is optically inactive and reaction leads the racemisation

63. (a) Bromine is more selective
$\therefore$ abstract that hydrogen which forms stable free- radical



(3° free-radical) is most stable.

64. (c)

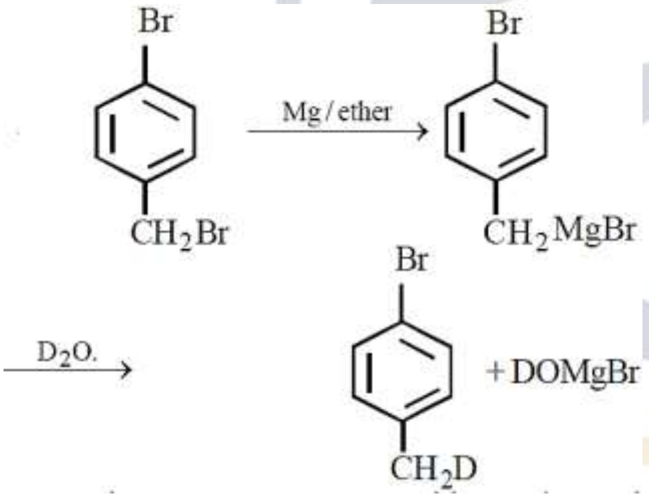
$\text{V. P. of solution at } t°C = 760 \text{ mm}$
$[\text{at b. p., V. P. of solution } = \text{ atompheric pressure }]$
$\text{Thus } = P_A^\circ \cdot x_A + P_B^\circ \cdot x_B$
$\text{or } P = P_A^\circ \cdot x_A + P_B^\circ \cdot (1 - x_A)[\because x_A + x_B = 1]$
$\text{or } 760 = 400X_A + 800(1 - X_A)\ [\because P = 760\text{mmofHg}]$
$\text{or } -800 + 760 = -400x_A$
$\text{or } -40 = -400x_A$
$\text{or } x_A = \frac{40}{400} = 0.1$

Thus, mole fraction in solution is 0.1

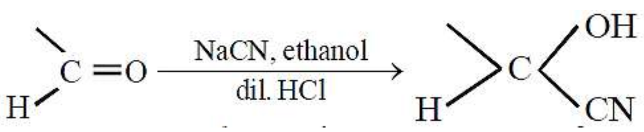
65. (d) Since 1 mole of compound X reacts with Na to evolve 1 mole of H_2 gas, therefore the compound should have 2 active hydrogen atoms per mole which is possible only in option d.

$CH_2OHCH_2CH_2CH_2OH + 2Na$
$\longrightarrow NaOCH_2CH_2CH_2CH_2ONa + 2H$

66. (b) $LiAlH_4$ will give the desired compound.
67. (a) Green- house gases such as CO_2, ozone, methane, the chlorofluorocarbon compounds and water vapour form a thick cover around the earth which prevents the IR rays emitted by the earth to escape. It gradually leads to increase in temperature of atmosphere.
68. (b) The adsorption of methylene blue on activated charcoal is an example of physiosorption which is exothermic, multilayer and does not have energy barrier.
69. (c)



70. (a) Only- CHO group reacts with CN^-ion and the reaction is



71. (a)
72. (a) Since the compound forms a yellow crystalline solid, i.e. osazone with phenylhydrazine, it may be an aldohexose or a ketohexose. Further, since on reduction, compound forms a mixture of sorbitol and mannitol, it must be a ketohexose, i.e. fructose. Recall that glucose on reduction gives only one alcohol glucitol (Sorbitol)
73. (d) When structures I and II are C-2 epimers, it implies that these are epimers and diastereomers too.
74. (a) Option (a) is incorrect as Yb^{3+} is colorless.
75. (b) (a) $C_6H_5COOC_2H_5 + (CH_3)_2NH \rightarrow C_6H_5CON(CH_3)_2 + C_2H_5OH$

(b) $C_6H_5CONH_2 + CH_3MgI \rightarrow C_6H_5CONHMgI + CH_4$

(c) $C_6H_5COCl + (CH_3)_2NH \rightarrow C_6H_5CON(CH_3)_2 + HCl$

(d) $C_6H_5\ CO.O.COC_6\ H_5 + (CH_3)_2NH \rightarrow C_6H_5CON(CH_3)_2 + C_6H_5COOH$

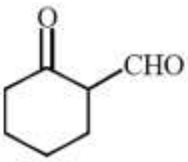
76. (d)

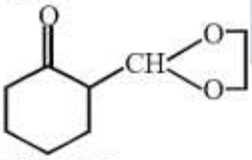
$$n\,(CF_2 = CF_2) \xrightarrow[(NH_4)_2S_2O_8]{\text{Benzoyl peroxide or}} \underset{\substack{\text{PTFE} \\ (X)}}{-\!\!(CF_2 - CF_2)\!\!-}$$

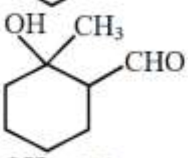
Here X is polytetrafluoroethylene. So, none of these i.e., option (d) is correct choice

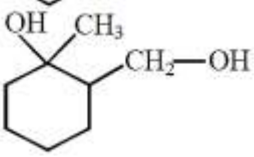
77. (d) Bacteriostatic drugs inhibit the growth of organisms while bactericidal drugs kill the microorganisms.

78. (b)

(A) 

(B) 

(C) 

(D) 

79. (c) $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$; ΔS increases. Hence, as the temperature increases, $T\Delta S$ increases and hence $\Delta G(\Delta H - T\Delta S)$ decreases. In other words, the slope of the curve for formation of CO decreases. However, for all other oxides, it increases.

80. (c)

Given $t_{1/2} = 3$

Total time $T = 12$

No. of half lives $(n) = \frac{12}{3} = 4$

$\left(\frac{1}{2}\right)^n = \frac{N}{N_0}$ $\therefore \left(\frac{1}{2}\right)^4 = \frac{3}{N}$

$\frac{3}{N} = \frac{1}{16}$

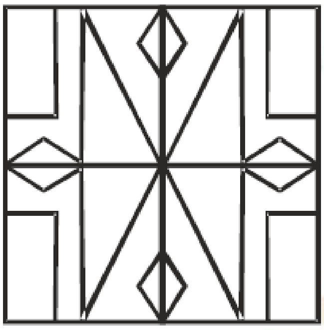
$N = 48g$

81. (b) Warn a person of possible danger or a potential problem.

Warn a person against a fault. Hence out of all four prepositions in options, 'of' is the correct choice.

82. **(b)** Attributes means regard something as being caused by.
83. **(a)** Write 'asked for'
84. **(c)** Write 'that in' after 'like'.
85. **(b)** Use preposition 'to' after 'succumbed'. Verb 'Succumb' is characterized by preposition 'to'. Moreover, 'Succumb to something' is an idiomatic expression which means to yield to something, especially a temptation, fatal disease, a human weakness, etc.
86. **(a)** Harold succeeded in overcoming the need for security.
87. **(c)** Slimy tentacles and slug-like animals
88. **(c)** In a different land
89. **(d)** In it he saw slimy creatures feeding on people's bodies
90. **(b)** Subched Lacking in vitality, intensity, or strength
91. **(b)** Fervent having or displaying a passionate intensity. Dispassionate not influenced by strong emotion, and so able to be rational and impartial.
92. **(a)** Scrupulous (of a person or process) diligent. thorough, and extremely attentive to details.
93. **(d)** Onslaught a fierce or destructive attack. Invasion an instance of invading a country or region with an armed force.
94. **(c)** Ignominy public shame or disgrace.
95. **(b)** Tryst An agreement (as between lovers) to meet
96. **(b)** Closest Resemblance is mirror image of question figure.
97. **(b)**

98. **(c)**



99. **(c)**

Front Face	–	'	$
Opposite Face	?	.	+

Only cube (4) can be formed.

100. **(b)** $(100 + 12) - (28 + 25) = 59$

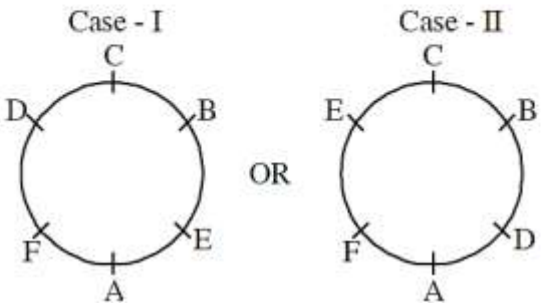
Similarly,

$(102 + 52) - (36 + 28) = 90$

101. **(c)** In this time 12: 30 we subtract that time from

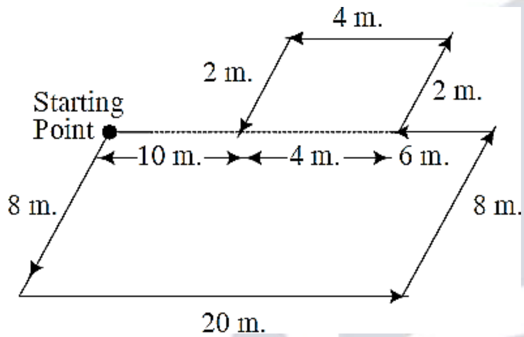
$17:90 - 12:30 = 5:60 = 6:00$

102. **(c)**



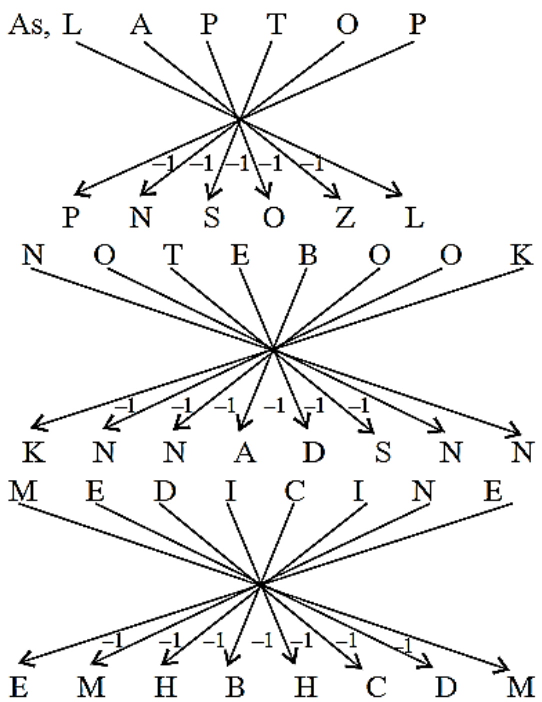
So, C is sitting third right to A

103. **(b)**



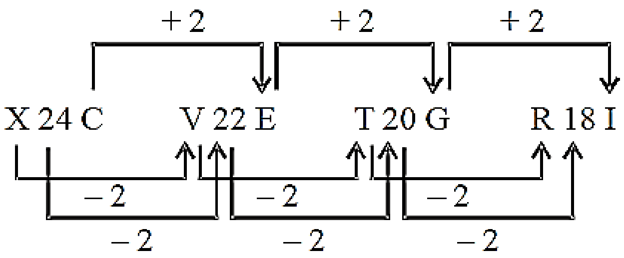
Ganesh is **10m**. far from the starting point

104. **(a)**



So, required answer = ED

105. **(c)**



106. **(d)** Given that, $f(x) = [x]$ and $g(x) = |x|$

Now, $f\left(g\left(\frac{8}{5}\right)\right) = g\left(\frac{8}{5}\right) = \left[\frac{8}{5}\right] = 1$

and $g\left(f\left(-\frac{8}{5}\right)\right) = g\left(\left[-\frac{8}{5}\right]\right) = g(-2) = |-2| = 2$

$\therefore f\left(g\left(\frac{8}{5}\right)\right) - g\left(f\left(-\frac{8}{5}\right)\right) = 1 - 2 = -1.$

107. **(c)** Since the chord makes equal intercepts of length a on the coordinate axes. So, its equation can be written as $x \pm y = \pm a$. This line meets the given circle at two distinct points. So, length of the perpendicular from the centre $(0,0)$ of the given circle must be less than the radius.

i.e. $\left|\pm\frac{a}{\sqrt{2}}\right| < \sqrt{8} \Rightarrow a^2 < 16 \Rightarrow |a| < 4$

108. **(a)** We have $x^2 + y^2 + 4y - 5 = 0$. Its centre is $C_1(0, -2)$,

$r_1 = \sqrt{4+5} = 3$. Let $C_2(h, k)$ be the centre of the smaller circle and its radius r_2. Then $C_1C_2 = 4$.

$\Rightarrow \sqrt{h^2 + (k+2)^2} = 3 + r_2 = 4$

$\Rightarrow r_2 = 1$

But $k = r_2 = 1$ [it touches x-axis]

$\therefore$ From eq (1), $4 = \sqrt{h^2 + (1+2)^2}$

$\Rightarrow 16 = h^2 + 9 \Rightarrow h^2 = 7 \Rightarrow h = \pm\sqrt{7}$

Since $h > 0 \ \therefore h = \sqrt{7}$

Hence, required circle is

$(x - \sqrt{7})^2 + (y - 1)^2 = 1$

109. **(c)** We have,

$$\sin^4 x - (k+2)\sin^2 x - (k+3) = 0$$

$$\Rightarrow \sin^2 x = \frac{(k+2) \pm \sqrt{(k+2)^2 + 4(k+3)}}{2}$$

$$= \frac{(k+2) \pm (k+4)}{2}$$

$$\Rightarrow \sin^2 x = k + 3 (\because \sin^2 x = -1 \text{ is not possible})$$

Since $0 \le \sin^2 x \le 1$,

$\therefore 0 \le k + 3 \le 1$ or $-3 \le k \le -2$

110. **(c)** Required number of ways

$=$ coeff. of x^{16} in $(x^3+x^4+x^5+x^6+x^7)^4$

111. **(c)**

$$\begin{aligned}&\mathrm{AM} \geq \mathrm{HM}\\ &\Rightarrow \frac{a+b+c}{3} \geq \frac{3}{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}}\\ &\Rightarrow (a+b+c)\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}\right) \geq 9\end{aligned}$$

112. **(c)**

$$\begin{aligned}&\int_0^{\infty} \frac{dx}{(x^2+a^2)(x^2+b^2)}=\frac{1}{b^2-a^2}\\ &\int_0^{\infty} \frac{(x^2+b^2)-(x^2+a^2)}{(x^2+a^2)(x^2+b^2)}\\ &=\frac{1}{b^2-a^2} \int_0^{\infty}\left[\frac{1}{x^2+a^2}-\frac{1}{x^2+b^2}\right] dx\\ &=\frac{1}{b^2-a^2}\left[\frac{1}{a} \tan^{-1} \frac{x}{a}-\frac{1}{b} \tan^{-1} \frac{x}{b}\right]_0^{\infty}\\ &=\frac{1}{b^2-a^2}\left[\frac{\pi}{2a}-\frac{\pi}{2\,b}\right]=\frac{\pi}{2ab(a+b)}\end{aligned}$$

113. **(d)** For minimum value $|\vec{r}+b\vec{s}|=0$.

Let $\vec{r}$ and $\vec{s}$ are anti-parallel so $b\vec{s}=-\vec{r}$

$\therefore |b\vec{s}|^2+|\vec{r}+b\vec{s}|^2=|\vec{r}|^2+|\vec{r}-\vec{r}|^2=|\vec{r}|^2$

114. **(d)** The equation represents a pair of lines if

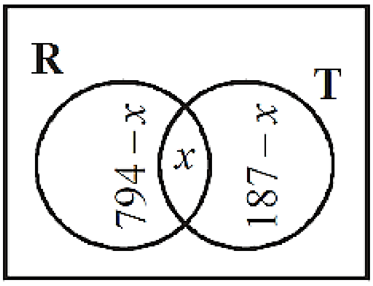
$$\begin{aligned}&1 \cdot 1 \cdot 4+2 \cdot f \cdot g \cdot 1-1 \cdot f^2-1 \cdot g^2-4 \cdot 1^2=0\\ &\Rightarrow (f-g)^2=0 \Rightarrow f=g\end{aligned}$$

The equation becomes $(x+y)^2+2g(x+y)+4=0$ Which represents pair of parallel lines, which are real provided $(2\,g)^2-4 \cdot 4 \cdot 1 \geq 0 \Rightarrow |g| \geq 2$.

115. **(a)**

$$\begin{aligned}&z_1\bar{z}_1=z_2\bar{z}_2=\cdots.=z_n\bar{z}_n=1\\ &\Rightarrow \bar{z}_1=\frac{1}{z_1}, \bar{z}_2=\frac{1}{z_2}, \bar{z}_3=\frac{1}{z_3}, \ldots \ldots, \bar{z}_n=\frac{1}{z_n}\\ &\therefore |z_1+z_2+\cdots.+z_n|-\left|\frac{1}{z_1}+\frac{1}{z_2}+\cdots.+\frac{1}{z_n}\right|\\ &=|z_1+z_2+\cdots+z_n|-|\bar{z}_1+\bar{z}_2+\cdots.+\bar{z}_n|=0\end{aligned}$$

116. **(b)**



Let R be the set of families having a radio and T the set families having a T.V.,
then $n(R \cup T)$ = The number of families having at least on of the radio and T.V. $= 1003 - 63 = 940$ $n(R) = 794$ and $n(T) = 187$

Let x families have both a radio and a T.V. Then number of families who have only radio $= 794 - x$

And the number of families who have only T.V. $= 187 - x$

From Venn diagram, $794 - x + x - 187 - x = 940 \Rightarrow\ 981 - x = 940$ or $x = 981 - 940 = 41$

Hence, the required number of families having both a radio and a T.V. $= 41$

117. **(d)** For $f(x)$ to be defined, we must have

$$x - \sqrt{1 - x^2} \geq 0 \text{ or } x \geq \sqrt{1 - x^2} > 0$$
$$\therefore\ x^2 \geq 1 - x^2 \text{ or } x^2 \geq \frac{1}{2}.$$

Also, $1 - x^2 \geq 0$ or $x^2 \leq 1$.

Now, $x^2 \geq \frac{1}{2} \Rightarrow \left(x - \frac{1}{\sqrt{2}}\right)\left(x + \frac{1}{\sqrt{2}}\right) \geq 0$

$\Rightarrow x \leq -\frac{1}{\sqrt{2}}$ or $x \geq \frac{1}{\sqrt{2}}$

Also, $x^2 \leq 1 \Rightarrow (x - 1)(x + 1) \leq 0$

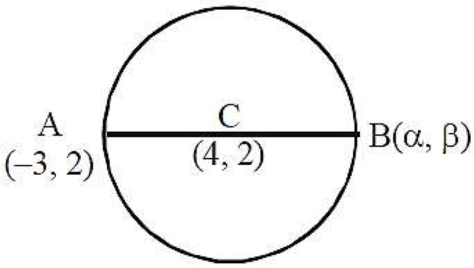
$\Rightarrow -1 \leq x \leq 1$

Thus, $x > 0, x^2 \geq \frac{1}{2}$ and $x^2 \leq 1$

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

118. **(d)** The centre of the given circle is $C \equiv (4,2)$

Let $A = (-3 \quad 2)$



If (α, β) are the coordinates of the other end of the diameter, then, as the middle ploint of the diameter is the centre,

$$\therefore\ \frac{\alpha - 3}{2} = 4 \text{ and } \frac{\beta + 2}{2} = 2 \Rightarrow \alpha = 11, \beta = 2$$

Thus, the coordinates of the other end of diameter are $(11,2)$

119. **(b)**

$$\sin\left[n\pi + (-1)^n \frac{\pi}{4}\right] = (-1)^n \sin\left[(-1)^n \frac{\pi}{4}\right]$$

$[\because \sin(n\pi + \theta) = (-1)^n \sin\theta]$

$= (-1)^n (-1)^n \sin\frac{\pi}{4}$

$\therefore \sin[(-1)^n \theta] = (-1)^n \sin\theta]$

$= (-1)^{2n} \sin\frac{\pi}{4} = \sin\frac{\pi}{4} = \frac{1}{\sqrt{2}}$

120. **(c)** Total number of ways $= 6 \times 6 \times \ldots$ to n times $= 6$.

Total number of ways to show only even number $= 3 \times 3 \times \ldots$. to n times $= 3^n$. $\therefore$ required number of ways $= 6^n - 3^n$.

121. **(c)** We know that

$$\frac{e^x + e^{-x}}{2} = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \frac{x^6}{6!} + \cdots$$

keeping $x = 2$, we get

$$\text{Expression} = \frac{1}{2}\left[\frac{e^2 + e^{-2}}{2}\right] - 1 = \frac{(e^2 - 1)^2}{2e^2}$$

122. **(c)** The given equation is

$$\frac{dy}{dx} - \frac{y}{x+1} = e^{3x}(x+1)$$

$$\text{I.F.} = e^{\int -\frac{1}{x+1}dx} = e^{-\log(x+1)} = \frac{1}{x+1}$$

The solution is

$$y\left(\frac{1}{x+1}\right) = \int e^{3x}(x+1)\cdot\frac{1}{x+1}dx + a$$

$$\Rightarrow \frac{y}{x+1} = \int e^{3x}dx + a = \frac{e^{3x}}{3} + a$$

$$\Rightarrow \frac{3y}{x+1} = e^{3x} + c, c = 3a$$

123. **(d)** $f(x) = \frac{|x-1|}{x^2} = \begin{cases} \frac{1-x}{x^2}, & x < 1, x \neq 0 \\ \frac{x-1}{x^2}, & x > 1 \end{cases}$

Clearly, $f(x)$ is continuous for all $x \in R$ except at $x = 0$.

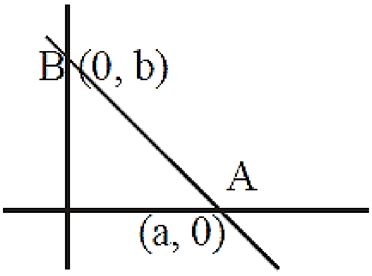
$$f'(x) = \begin{cases} \frac{x-2}{x^3}, & x < 1, x \pm 0 \\ & \frac{2-x}{x^3}, x > 1 \end{cases}$$

$f'(x) > 0 \Rightarrow x < 0$ or $1 < x < 2$
$f'(x) < 0 \Rightarrow 0 < x < 1$ or $x > 2$
Hence, $f(x)$ is increasing in $(-\infty, 0) \cup (1,2)$ and decreasing in $(0,1) \cup (2, \infty)$.

124. **(b)** Let end A is $(a, 0)$ and end B is $(0, b)$ then

$a^2 + b^2 = 81$

If centroid is (x, y) then



$x = \frac{a}{3}, y = \frac{b}{3}$, putting in (1) we get the locus as $x^2 + y^2 = 9$

125. **(b)** The given relation is $xy + y^2 = \tan x + y$. Differentiating both sides with respect to x, we get

$$\frac{d}{dx}(xy) + \frac{d}{dx}(y^2) = \frac{d}{dx}(\tan x) + \frac{dy}{dx}$$
$$\text{or } \left[y \cdot 1 + x \cdot \frac{dy}{dx}\right] + 2y\frac{dy}{dx} = \sec^2 x + \frac{dy}{dx}$$
$$\text{or } (x + 2y - 1)\frac{dy}{dx} = \sec^2 x - y$$
$$\therefore \frac{dy}{dx} = \frac{\sec^2 x - y}{(x + 2y - 1)}$$

126. **(c)** Probability that the electronic component fails when first used is $P(F) = 0.10$. Therefore, $P(F') = 1 - P(F) = 0.90$
Let E be the event that a new component will last for one year.
Then, $P(E) = P(F)P\left(\frac{E}{F}\right) + P(F')P\left(\frac{E}{F'}\right)$
[total probability theorem]

$= 0.10 \times 0 + 0.90 \times 0.99 = 0.891.$

127. **(b)**

$$x = \frac{3 - \cos 4\theta + 4\sin 2\theta}{2}$$
$$= \frac{3 - (1 - \sin^2 2\theta) + 4\sin 2\theta}{2} = (1 + \sin 2\theta)^2$$
$$y = \frac{3 - \cos 4\theta - 4\sin 2\theta}{2}$$
$$= \frac{3 - (1 - \sin^2 2\theta) + 4\sin 2\theta}{2} = (1 - \sin 2\theta)^2$$
$$\therefore xy = (1 - \sin^2 2\theta)^2 = \cos^4 2\theta \le 1$$

128. **(d)** 2 white squares can be selected in $^{32}C_2$ ways If they belong to some row or same column then $2(8.\ ^4C_2)$ ways.

129. **(d)** Length of latus rectum $= 2 \times$ distance of focus from directrix

$$= 2 \times \frac{|1-4+3-24|}{5} = 10$$

130. **(b)**

In the interval $\frac{\pi}{3}$ to $\frac{\pi}{2}$, $[x] = 1$

$\therefore I = \int_{\pi/3}^{\pi/2} x\sin(\pi - x)dx = \int_{\pi/3}^{\pi/2} x\sin x dx$

$= [-x\cos x + \sin x]_{\pi/3}^{\pi/2} = 1 - \frac{\sqrt{3}}{2} + \frac{\pi}{6}$

131. **(d)** $\frac{5}{2}\{2a + 4(-2)\} = -5 \Rightarrow 2a = 6$

$\therefore$ Actual sum $= \frac{5}{2}\{6 + 4(2)\} = 35$

132. **(c)** Equation holds if and only if $x - 1 = 0, x - 2 = 0$ and $x - 3 = 0$ simultanesouly, which is not possible.

133. **(a)** We have, $\sin\pi(x^2 + x) = \sin\pi x^2$

$\Rightarrow \pi(x^2 + x) = n\pi + (-1)^n\pi x^2$

$\therefore$ Either $x^2 + x = 2m + x^2 \Rightarrow x = 2m \in I$
or $x^2 + x = k - x^2$, where k is an odd integer

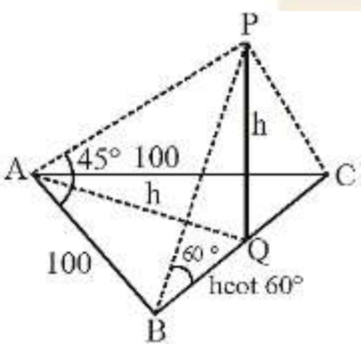
$\Rightarrow 2x^2 + x - k = 0 \Rightarrow x = \frac{-1 \pm \sqrt{1 + 8k}}{4}$

For least positive non-integral solution is $x = \frac{1}{2}$, when $k = 1$

134. **(b)** $\tan 45^\circ = \frac{PQ}{AQ} = \frac{h}{AQ} \Rightarrow h = AQ$

Where PQ is tower and ABC is the park, with Q being mid point of the side BC and $PQ = h$
Also, $AQ^2 + BQ^2 = 100^2$

$\Rightarrow h^2 + h^2\cot^2 60^\circ = 100^2$



$\Rightarrow h^2\left[1 + \frac{1}{3}\right] = 100^2$

$\Rightarrow h^2 = \frac{3 \times 100^2}{4} \Rightarrow h = 50\sqrt{3}$

135. **(d)**

$$x^2+4y^2+9z^2-6yz-3zx-2xy$$
$$=x^2+(2y)^2+(3z)^2-(2y)(3z)-(3z)(x)-$$
$$x(2y)\geq 0\forall x,y,z$$
$$[\because a^2+b^2+c^2-ab-bc-ca\geq 0]$$

136. **(b)** Selection of 6 guests $=10C6$

Permutation of 6 on round table $=5\,!$
Permutation of 4 on round table $=3\,!$

Then, total number of arrangements $=10\ C6.5!3!=\frac{(10)!}{6!\cdot 4!}\cdot 5!\cdot 3!=\frac{(10)!}{24}$.

137. **(d)** AM $>$ GM

$$\Rightarrow \frac{a+b}{2}>\sqrt{ab},\frac{b+c}{2}>\sqrt{bc},\frac{c+a}{2}>\sqrt{ca},$$

So, $(a+b)(b+c)(c+a)>8abc$

138. **(d)** $y=be^{-x/a}$ meets the y-axis at $(0,b)$. Again, $\frac{dy}{dx}=be^{-x/a}\left(-\frac{1}{a}\right)$

$$\text{At}(0,b),\frac{dy}{dx}=be^{0}\left(-\frac{1}{a}\right)=-\frac{b}{a}$$

Therefore, required tangent is $y-b=-\frac{b}{a}(x-0)$ or $\frac{x}{a}+\frac{y}{b}=1$

139. **(a)** Putting $x+y+1=u$, we have $du=dx+dy$ and the given equation reduces to $u(du-dx)=dx$

$$\Rightarrow \frac{udu}{u+1}=dx\ \Rightarrow u-\log(u+1)=x$$
$$\Rightarrow \log(x+y+2)=y+\text{ constant}$$
$$\Rightarrow x+y+2=Ce^{y}$$

140. **(a)**

We have $y=3x+6x^2+10x^3+\cdots..$

$$\Rightarrow 1+y=1+3x+6x^2+10x^3+\cdots..$$
$$\Rightarrow 1+y=(1-x)^{-3}\Rightarrow 1-x=(1+y)^{-1/3}$$
$$\Rightarrow x=1-(1+y)^{-1/3}$$
$$=\frac{1}{3}y-\frac{1\cdot 4}{3^2\cdot 2}y^2+\frac{1\cdot 4\cdot 7}{3^2\cdot 3}y^3-\cdots..$$

141. **(a)** Since the system is homogeneous and has a non-trivial solution

$$0=\begin{vmatrix} p+a & b & c\\ a & q+b & c\\ a & b & r+c\end{vmatrix}=\begin{vmatrix} p & -q & 0\\ 0 & q & -r\\ a & b & r+c\end{vmatrix}$$

using $R_1\to R_1-R_2$ and $R_2\to R_2-R_3$.
Expanding along C_1 we get

$$\Rightarrow p[q(r+c)+br]+aqr=0$$
$$\Rightarrow pqr+pqc+prb+qra=0$$
$$\Rightarrow \frac{a}{p}+\frac{b}{q}+\frac{c}{r}=-1$$

142. **(c)**

Area of the triangle

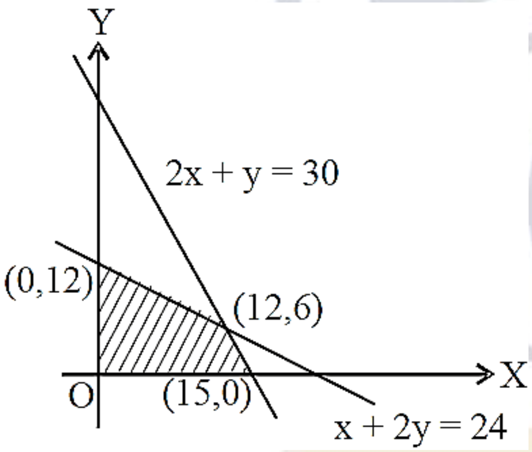
$$=\frac{1}{2}(\text{x intercept}) \times (\text{y intercept})$$
$$=\frac{1}{2}\left(-\frac{c}{a}\right)\left(-\frac{c}{b}\right)=\frac{1}{2}\frac{c^2}{ab}=\frac{1}{2}\text{ unit}$$
$[\because a, c, b$ are in G. P. $\Rightarrow c^2=ab]$

143. **(a)** Using LMVT in $[0,2]$

$$\frac{f(2)-f(0)}{2-0}=f'(c), \text{ where } c \in (0,2)$$
$$\frac{f(2)+3}{2} \leq 5 \Rightarrow f(2) \leq 7.$$

144. **(b)** Here, $2x+y \leq 30, x+2y \leq 24, x, y \geq 0$

The shaded region represents the feasible region, hence
$z=6x+8y$. Obviously, it is maximum at $(12,6)$.
Hence $z=12 \times 6+8 \times 6=120$



145. **(c)** Let $a=b-d$ and $c=b+d$, then $a+b+c=21$

$\Rightarrow b=7$

So, the equation is $a+c=14$
$\therefore$ No. of solution = coeff. of x^{14} in $(x+x^2+\cdots..)$

$={}^{13}C_{12}=13$

146. **(a)** The line is $y=-\frac{nb}{ma}x-nb$. It will touch the ellipse if

$(-nb)^2 = a^2\left(-\frac{nb}{ma}\right)^2 + b^2$

$[c^2 = a^2 m^2 + b^2]$

$\Rightarrow n^2 = \frac{n^2}{m^2} + 1$

$\Rightarrow m^2 = \frac{n^2}{n^2-1}$ or $n^2 = \frac{m^2}{m^2-1}$

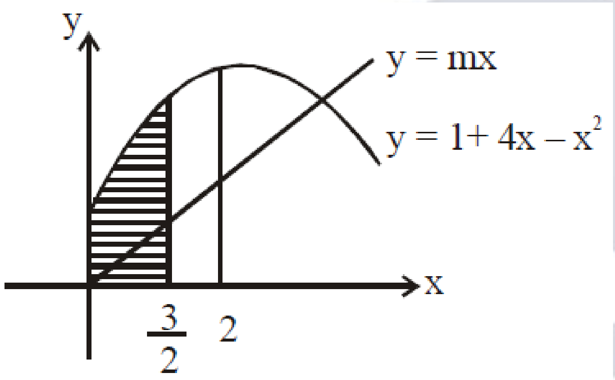
147. **(d)** For $x < 1, f(x) = \frac{x^2-1}{x^2+2x-3} = \frac{x+1}{x+3}$

$\therefore \lim_{x\to 1^-} f(x) = \frac{1}{2}$

For $x > 1, f(x) = \frac{x^2-1}{x^2-2x+1} = \frac{x+1}{x-1} \therefore \lim_{x\to 1^+} f(x) = \infty$

$\therefore$ The function is not continuous at $x = 1$.

148. **(a)** $y = 1 + 4x - x^2 = 5 - (x-2)^2$



We have $\int_0^{3/2}(1 + 4x - x^2)dx = 2\int_0^{3/2} mxdx$

$= \frac{3}{2} + 2\left(\frac{9}{4}\right) - \frac{1}{3}\left(\frac{27}{8}\right) = m \cdot \frac{9}{4}$

On solving we get $m = \frac{13}{6}$

149. **(b)** Let the last three numbers in A.P. be a, a +6 , $a + 12$, then the first term is also $a + 12$. But $a + 12, a, a + 6$ are in G.P.

$\therefore a^2 = (a + 12)(a + 6) \Rightarrow a^2 = a^2 + 18a + 72$

$\therefore a = -4$

$\therefore$ The numbers are $8, -4, 2, 8$.

150. **(c)** Anypoint on the line is $(r + 3, 2r + 4, 2r + 5)$.

It lies on the plane $x + y + z = 17$,

$\therefore (r + 3) + (2r + 4) + (2r + 5) = 17$ i.e $r = 1$

Thus the point of intersection of the plane and the line is $(4,6,7)$

Required distance = distance between $(3,4,5)$ and $(4,6,7)$

$= \sqrt{\{(4-3)^2 + (6-4)^2 + (7-5)^2\}} = 3$