1. **(b)**
2. **(c)** Given that $x = At^2 - Bt^3$

$\therefore$ velocity $= \frac{dx}{dt} = 2At - 3Bt^2$

and acceleration $= \frac{d}{dt}\left(\frac{dx}{dt}\right) = 2A - 6Bt$

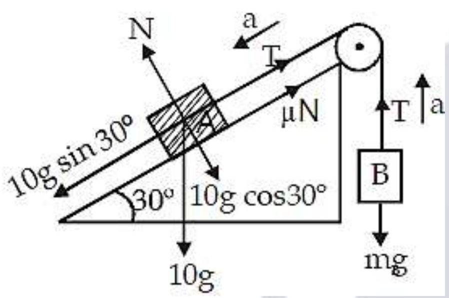
For acceleration to be zero $2A - 6Bt = 0$.

$\therefore \; t = \frac{2A}{6B} = \frac{A}{3B}$

3. **(a)** $T = \frac{2u\sin\theta}{g}$, lesser is the value of θ, lesser is $\sin\theta$ and hence lesser will be the time taken. Hence A will fall earlier.
4. **(c)** Body moves with constant speed it means that tangential acceleration $a_T = 0$ & only centripetal acceleration a_C exists whose direction is always towards the centre or inward (along the radius of the circle).
5. **(b)** Considering the equilibrium of A, we get

$10a = 10\,g\sin 30° - T - \mu N$

where $N = 10\,g\cos 30°$



$\therefore 10a = \frac{10}{2}\,g - T - \mu \times 10\,g\cos 30°$

but $a = 0$, $T = m_B\,g$

$0 = 5\,g - m_B\,g - \frac{0.2\sqrt{3}}{2} \times 10 \times g$

$\Rightarrow m_B = 3.268 \approx 3.3$ kg

6. **(c)** Applying law of conservation of linear momentum

$m_1v_1 + m_2v_2 = 0,$

$\frac{m_1}{m_2} = -\frac{v_2}{v_1}$ or $\frac{v_1}{v_2} = -\frac{m_2}{m_1}$

7. **(b)**

$$F_x = -\frac{\partial U}{\partial x} = \sin(x+y)$$

$$F_y = -\frac{\partial U}{\partial x} = \sin(x+y)$$

$$F_x = \sin(x+y)]_{(0,\pi/4)} = \frac{1}{\sqrt{2}},$$

$$F_y = \sin(x+y)\big]_{(0,\pi/4)} = \frac{1}{\sqrt{2}}$$

$$\therefore F = \frac{1}{\sqrt{2}}[\hat{\imath} + \hat{\jmath}]$$

8. (d)

$$V=\frac{1}{2}k(x)^2=\frac{1}{2}k(2)^2 \text{ or } k=\frac{2\,V}{4}=\frac{V}{2}$$
$$V'=\frac{1}{2}k(10)^2=\frac{1}{2}\times\left(\frac{V}{2}\right)(10)^2=25\,V$$

9. (a) For solid sphere rolling without slipping on inclined plane, acceleration

$$a_1=\frac{g\sin\theta}{1+\frac{K^2}{R^2}}$$

For solid sphere slipping on inclined plane without rolling, acceleration

$a_2=g\sin\theta$

Therefore required ratio $=\frac{a_1}{a_2}$

$$=\frac{1}{1+\frac{K^2}{R^2}}=\frac{1}{1+\frac{2}{5}}=\frac{5}{7}$$

10. (b) The coordinates of C.M of three particle are

$$x=\frac{m_1x_1+m_2x_2+m_3x_3}{m_1+m_2+m_3}\,\&y=\frac{m_1y_1+m_2y_2+m_3y_3}{m_1+m_2+m_3}$$
$$\text{here } m_1=m_2=m_3=m$$
$$\text{so } x=\frac{(x_1+x_2+x_3)m}{m+m+m}=2,$$
$$y=\frac{(y_1+y_2+y_3)m}{m+m+m}=2$$

so coordinates of C.M. of three particle are (2,2)

$V=300\text{ m/s}$

11. (c)

$$F=KR^{-n}=MR\omega^2\Rightarrow\omega^2=KR^{-(n+1)}$$
$$\text{or } \omega=K'R^{\frac{-(n+1)}{2}}$$
$$\left[\text{ where } K'=K^{1/2}, \text{a constant }\right]$$
$$\frac{2\pi}{T}\propto R^{\frac{-(n+1)}{2}}\quad\therefore T\propto R^{\frac{(n+1)}{2}}$$

12. (a)

$$v_e=\sqrt{2gR}=\sqrt{\frac{2GM}{R^2}R}=\sqrt{\frac{2Gd\frac{4}{3}\pi R^3}{R^2}R}$$
$$=R\sqrt{2Gd\frac{4}{3}\pi}$$

as $v_e \propto R$ for same density, $\frac{v_A}{v_B} = 2$

13. (b) $r\theta = \ell\phi \Rightarrow \phi = \frac{r\theta}{\ell} = \frac{6\text{ mm}\times 30^\circ}{1\text{ m}} = 0.18^\circ$

14. (b)

15. (d) $\frac{4}{3}\pi R^3 = 2\times\frac{4}{3}\pi r^3 \Rightarrow R = 2^{1/3}r$

Surface energy of bigger drop,

$$E = 4\pi R^2 T = 4\times 2^{2/3}\pi r^2 T = 2^{8/3}\pi r^2 T$$

16. (c) $F = \frac{2AT}{d} = \frac{2\times\pi\times(0.05)^2\times 73\times 10^{-3}}{0.01\times 10^{-3}}$

$= 36.5\pi \approx 115$ newton

17. (a)

18. (a) PV = constant represents isothermal process.

19. (b)

$$T_2 = 273 - 13 = 260,$$
$$K = \frac{T_2}{T_1 - T_2};\ 5 = \frac{260}{T_1 - 260}$$
$$\text{or } T_1 - 260 = 52;\ T_1 = 312\text{ K},$$
$$T_2 = 312 - 273 = 39^\circ\text{C}$$

20. (b) Energy possessed by the ideal gas at 27°C is

$$E_1 = 3\left(\frac{3}{2}R\times 300\right) = \frac{2700R}{2}$$

Energy possessed by the ideal gas at 227°C is

$$E_2 = 2\left(\frac{3R}{2}\times 500\right) = 1500R$$

If T be the equilibrium temperature, of the mixture, then its energy will be

$$E_m = 5\left(\frac{3RT}{2}\right)$$

Since, energy remains conserved,

$$E_m = E_1 + E_2$$
$$\text{or } 5\left(\frac{3RT}{2}\right) = \frac{2700R}{2} + 1500R$$
$$\text{or } T = 380\text{ K or } 107^\circ\text{C}$$

21. (a)

$$t \propto \frac{1}{\sqrt{9.8}}, t' \propto \frac{1}{\sqrt{12.8}}$$
$$(\because g' = 9.8 + 3 = 12.8)$$
$$\therefore \frac{t'}{t} = \sqrt{\frac{9.8}{12.8}} \Rightarrow t' = \sqrt{\frac{9.8}{12.8}}\,t$$

22. (b) Equation of a wave

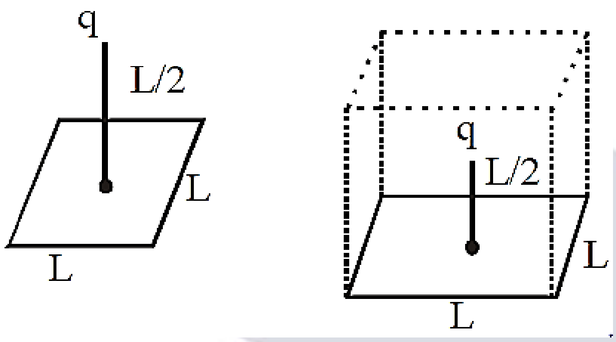
$y_1 = a\sin(\omega t - kx)$

Let equations of another wave may be,

$$y_2 = a\sin(\omega t + kx)$$
$$y_3 = -a\sin(\omega t + kx)$$

If Eq. (i) propagate with Eq. (ii), we get $y = 2a\cos kx\sin\omega t$
IfEq. (i), propagate with Eq. (iii), we get $y = -2a\sin kx\cos\omega t$
At $x = 0, y = 0$, wave produce node
So, Eq.(iii) is the equation of unknown wave

23. (a)
24. (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

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

25.(b)

$$\frac{kx}{1\text{ cm}} = \frac{k(Q-x)}{3\text{ cm}}$$
$$3x = Q - x \Rightarrow 4x = Q$$
$$x = \frac{Q}{4} = \frac{4\times10^{-2}}{4}C = 1\times10^{-2}$$
$$Q' = Q - x = 3\times10^{-2}\text{C}$$

26. (d)

$$\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$
$$= -[(6-8y)\hat{i} + (-8x - 8 + 6z)\hat{j} + (6y)\hat{k}]$$
$$\text{At}(1,1,1), \vec{E} = 2\hat{i} + 10\hat{j} - 6\hat{k}$$
$$\Rightarrow (\vec{E}) = \sqrt{2^2 + 10^2 + 6^2} = \sqrt{140} = 2\sqrt{35}$$
$$\therefore\ F = q\vec{E} = 2\times2\sqrt{35} = 4\sqrt{35}$$

27. (c) $P=\frac{V^2}{R_{\text{eq}}}$

$$\frac{1}{R_{\text{eq}}}=\frac{1}{R}+\frac{1}{5}=\frac{5+R}{5R}\ R_{\text{eq}}=\left(\frac{5R}{5+R}\right)\ P=30\text{ W}$$

Substituting the values in equation (i)

$$30=\frac{(10)^2}{\left(\frac{5R}{5+R}\right)}\Rightarrow R=10\Omega$$

28. (d) Only number of free electrons is constant, other factors are temperature dependent.

29. (c)

$$\begin{aligned}\mathrm{B_{OD}}&=0,\ \mathrm{B_{OB}}=0\\ \mathrm{B_{AB}}&=\frac{\mu_0\mathrm{I}}{4\pi\mathrm{a}\sqrt{2}}[\cos 45^\circ(-\hat{\imath})+\cos 45^\circ\hat{\mathrm{k}}]\\ &=\frac{\mu_0\mathrm{I}}{8\pi\mathrm{a}}(-\hat{\imath}+\hat{\mathrm{k}})\end{aligned}$$

30. (d)

$$\mathrm{e}=-\mathrm{L}\frac{\mathrm{di}}{\mathrm{dt}}$$

$$\text{But e}=4\text{ V and }\frac{\mathrm{di}}{\mathrm{dt}}=\frac{0-1}{10^{-3}}=-1/10^{-3}$$

$$\therefore\frac{-1}{10^{-3}}(-\mathrm{L})=4\Rightarrow\mathrm{L}=4\times10^{-3}\text{ henry}$$

31. (b) From $\mathrm{L}=\frac{\mu_0\,\mathrm{N}^2\,\mathrm{A}}{1}\alpha\frac{\mathrm{N}^2}{1}$

we get, $\frac{\mathrm{L}_1}{\mathrm{L}_2}=\frac{(1/2)^2}{1/2}=\frac{1}{2}$

32. (a) The phase angle between voltage V and current I is $\pi/2$.

33. (d) $$\begin{aligned}\mathrm{V_R}&=\mathrm{iR}=5\times16=80\text{ Volt}\\ \mathrm{V_L}&=\mathrm{i}\times(\omega\mathrm{L})=5\times24=120\text{ Volt}\\ \mathrm{V_C}&=\mathrm{i}\times(1/\omega\mathrm{C})=5\times12=60\text{ Volt}\end{aligned}$$

34. (d)

35. (a) $\mathrm{E_k}=\frac{\mathrm{hc}}{\mathrm{e}}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)=2.0\mathrm{eV}$

36. (b)

37. (c) Number of spectral lines $=\frac{\mathrm{n(n-1)}}{2}=6$

38. (b) Plutonium 239 is processed by breeder mechanism to be used as nuclear feul.

39. (c) $\mathrm{I_C}=\mathrm{I_E}-\mathrm{I_B}=90-1=89\text{ mA}$

40. (b) In forward biasing, the diode conducts. For ideal junction diode, the forward resistance is zero; therefore, entire applied voltage occurs across external resistance R i.e., there occurs no potential drop, so potential across R is V in forward biased.

41. (c) We know that,

Molecular weight of compound or molecules = 2 × V. D.

Vapour density (V. D.) of ozone molecules

$= \frac{\text{M. wt. of } O_3}{2} = \frac{48}{2} = 24.$

Hence, V. D. of O_3 is 24.

42. **(a)** In redox reaction,

g equivalent of reducing agent = g. equivalent of oxidising agent

Hence 1 g equ. of reducing agent = Pg equ. of oxidising agent.

43. **(b)**

44. **(b)** ${}_{11}Na \Rightarrow 2,8,1;\ {}_{17}Cl \Rightarrow 2,8,7$

These have same number of shells. Hence, they are the elements of the same period.

45. **(a)**

46. **(a)** All the three statements are correct.

47. **(b)**

48. **(a)**

$$q = \frac{c}{m}$$
$$\Rightarrow C_v = q \times m$$
$$= 0.075 \times 40$$
$$= 3.0\text{cal}$$
$$C_p - C_v = R$$
$$C_p = C_V + R$$
$$= 3 + 2 = 5$$
$$\frac{C_P}{C_V} = \frac{5}{3} = 1.66$$

Monoatomic gas.

49. **(b)** BF_3 is Lewis acid (e^-pair acceptor)

50. **(a)** For CuS, solubility = $(10^{-31})^{1/2}$;

For $Ag_2S = \left(\frac{K_{sp}}{4}\right)^{\frac{1}{3}} = \left(\frac{10^{-44}}{4}\right)^{\frac{1}{3}}$ and for $HgS = (10^{-54})^{\frac{1}{2}}$

51. **(d)** SO_2 changes to H_2SO_4 (O.N. changes from +4 to +6 oxidation)

$2KI \rightarrow I_2$ (O.S. changes from -1 to 0 oxidation)

$PbS \rightarrow PbSO_4$ (O.S. changes from -2 to +6 oxidation)

$Ag_2O \rightarrow 2Ag$ (O.S. changes from +1 to 0 reduction)

52. **(c)** $Na_2O_2 + H_2O \longrightarrow 2NaOH + \frac{1}{2}O_2$

53. **(b)** Graphite and boron nitride have similar structure.

54. **(d)** The given structure has three double bonds whose each carbon atom is differently substituted hence number of geometrical isomers will be $2^n = 2^{3'} = 8$, where n is the number of double bonds whose each carbon atom is differently substituted.

55. **(d)**

$$\underset{1}{H_2C} = \underset{2}{\overset{\overset{\displaystyle CH_3}{|}}{C}} - \underset{3}{CH_2} - \underset{4}{CH_2} - \underset{5}{CH_3}$$

2–Methylpent–1–ene

56. **(c)**

57. (d)

58. (b) The given reaction is Diel's Alder reaction.

59. (c)

$$CH_2 \vdots CH - C(CH_3) \vdots CH - CH_3$$
$$\xrightarrow[ZnO/H_2O]{O_3} HCHO + CH_3CHO + CH_3COCHO$$

60. (d) Minamata is caused by Hg poisoning.

61. (a) Phosphate pollution is caused by sewage and agricultural fertilizers.

62. (a) Eutrophication causes reduction in dissolved oxygen.

63. (a)

$$\Delta T_f = 0.3^\circ C$$
$$\Delta T_f = \frac{K_f \times W_B \times 1000}{M_B \times W_A}$$
$$0.3 = \frac{1.86 \times W_B \times 1000}{62 \times 5000}$$
$$\therefore W_B = 50 \text{ g}$$

The amount used should be more than 50 g.

64. (a) In electrolytic cell the cathode is of higher reduction potential.

65. (b) Since the nature of reaction (i.e. exothermic or endothermic) is not given, E_a for reverse reaction can be more or less.

66. (b) $NH_4NO_2 \longrightarrow N_2 + 2H_2O$

Volume of N_2 formed in successive five minutes are 2.75cc, 2.40cc and 2.25cc which is in decreasing order. So rate of reaction is dependent on concentration of NH_4NO_2. As decrease is not very fast so it will be first order reaction.

67. (d) All nitrides react with H_2O to give NH_3 and $CaCN_2$ also react with H_2O

$CaNCN + 3H_2O \longrightarrow CaCO_3 + NH_3$

68. (a) Reactivity follows the order $F > Cl > Br > I$

69. (a) Limestone ($CaCO_3$) is mixed with Fe_2O_3 and it acts as flux to form slag ($CaSiO_3$)

70. (a) $[PtCl_4]^{2-}$ has square planar geometry.

Pt : $5d^9 6s^1$

Pt^{2+} =	⇅	⇅	⇅	⇅					
			5d			6s		6p	

Two electrons are removed from $5d$ shell and $6s$ shell. So, hybridisation takes place is dsp^2 i.e. square planar geometry.

71. (b) When ethyl alcohol is treated with PCl_5, then ethyl chloride is formed.

$$CH_3CH_2-OH + PCl_5 \xrightarrow[\Delta]{} CH_3CH_2-Cl + HCl + POCl_3$$

72. (c)

73. (c) CH_3OH does not have $-CH(OH)CH_3$ group hence it will not form yellow precipitate with an alkaline solution of iodine (haloform reaction).

74. (c) Formic acid (HCOOH) has aldehydic group.

75. **(a)** When ethylamine is heated with sodium metal, then hydrogen gas is evolved.

$$2C_2H_5NH_2 + 2Na \longrightarrow$$
$$2C_2H_5\bar{N}HNa^+ + H_2 \uparrow$$

76. **(b)** The secondary structure of a protein refers to the shape in which a long peptide chain can exist. There are two different conformations of the peptide linkage present in protein are α-helix and β-conformation. The α-helix always has a right-handed arrangement.
In β-conformation all peptide chains are streched out to nearly maximum extension and then laid side by side held together by intermolecular hydrogen bonds. The structure resembles the pleated folds of drapery and therefore is known as β-pleated shelt.

77. **(d)** CoS is not precipitated in acidic medium.

78. **(a)** Ammonia can dissolve ppt. of AgCl only due to formation of complex as given below:

$$AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]Cl$$

79. **(b)**

$$Pb(NO_3)_2 + 2NH_4OH$$
$$\rightarrow Pb(OH)_2 \downarrow + 2NH_4NO_3 \text{ (white ppt)}$$
$$Pb(NO_3)_2 + 2HCl \rightarrow PbCl_2 \downarrow + 2HNO_3 \text{ (white ppt)}$$
$$Pb(NO_3)_2 + H_2S \rightarrow PbS \downarrow + 2HNO_3 \text{ (black)}$$

80. **(a)**

81. **(b)**

$$A = [x : x \in R, -1 < x < 1]$$
$$B = [x : x \in R : x - 1 \leq -1 \text{ or } x - 1 \geq 1]$$
$$= [x : x \in R : x \leq 0 \text{ or } x \geq 2]$$
$$\therefore A \cup B = R - D,$$

where $D = [x : x \in R, 1 \leq x < 2]$

82. **(c)**

$$12\cot^2\theta - 31\operatorname{cosec}\theta + 32 = 0$$
$$\Rightarrow 12(\operatorname{cosec}^2\theta - 1) - 31\operatorname{cosec}\theta + 32 = 0$$
$$\Rightarrow 12\operatorname{cosec}^2\theta - 31\operatorname{cosec}\theta + 20 = 0$$
$$\Rightarrow 12\operatorname{cosec}^2\theta - 16\operatorname{cosec}\theta - 15\operatorname{cosec}\theta + 20 = 0$$
$$\Rightarrow (4\operatorname{cosec}\theta - 5)(3\operatorname{cosec}\theta - 4) = 0$$
$$\Rightarrow \operatorname{cosec}\theta = \frac{5}{4}, \frac{4}{3}; \therefore \sin\theta = \frac{4}{5}, \frac{3}{4}$$

83. **(c)**

$$\sqrt{3} = \tan 60^\circ = \tan(40^\circ + 20^\circ)$$
$$= \frac{\tan 40^\circ + \tan 20^\circ}{1 - \tan 40^\circ \tan 20^\circ}$$
$$\therefore \sqrt{3} - \sqrt{3}\tan 40^\circ \tan 20^\circ$$
$$= \tan 40^\circ + \tan 20^\circ$$

Hence $\tan 40^\circ + \tan 20^\circ + \sqrt{3}\tan 40^\circ \tan 20^\circ$

$= \sqrt{3}$

84. (a) The discriminant of the equation $(-2\sqrt{2})^2 - 4(1)(1) = 8 - 4 = 4 > 0$ and a perfect square, so roots are real and different but we can't say that roots are rational because coefficients are not rational therefore.

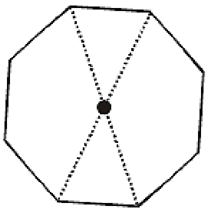
$$\sqrt{\frac{2\sqrt{2} \pm \sqrt{(2\sqrt{2})^2 - 4}}{2}} = \frac{2\sqrt{2} \pm 2}{2} = \sqrt{2} \pm 1$$

this is irrational ∴ the roots arereal and different.

85. (a)

$$\mathrm{A} + \mathrm{iB} = \frac{1 - \mathrm{i}\alpha}{1 + \mathrm{i}\alpha} \Rightarrow \mathrm{A} - \mathrm{iB} = \frac{1 + \mathrm{i}\alpha}{1 - \mathrm{i}\alpha}$$
$$\Rightarrow (A + iB)(A - iB) = \frac{(1 - i\alpha)(1 + i\alpha)}{(1 + i\alpha)(1 - i\alpha)} = 1$$
$$\Rightarrow A^2 + B^2 = 1$$

86. (a) A combination of four vertices is equivalent to one interior poin of intersection of diagonals.



∴ No. of interior points of intersection

$$= {}^{\mathrm{n}}\mathrm{C}_4 = 70$$
$$\Rightarrow \mathrm{n}(\mathrm{n} - 1)(\mathrm{n} - 2)(\mathrm{n} - 3) = 5.6.7.8$$
$$\therefore \mathrm{n} = 8$$

So, number of diagonals $= {}^{8}\mathrm{C}_2 - 8 = 20$

87. (a) The two letters, the first and the last of the four lettered word can be chosen in $(17)^2$ ways, as repetition is allowed for consonants. The two vowels in the middle are distinct so that the number of ways of filling up the two places is ${}^{5}\mathrm{P}_2 = 20$.

The no. of different words $= (17)^2 \cdot 20 = 5780$.

88. (b) We know by Binomial expansion, that $(x + a)^{\mathrm{n}}$

$$= {}^{n}C_0 x^n a^0 + {}^{n}C_1 x^{n-1} \cdot a + {}^{n}C_2 x^{n-2} a^2$$
$$+ {}^{n}C_3 x^{n-3} a^3 + {}^{n}C_4 x^{n-4} \cdot a^4 + \cdots .. + {}^{n}C_n x^0 a^n$$

Given expansion is $\left(x^4 - \frac{1}{x^3}\right)^{15}$

On comparing we get $n = 15, x = x^4,$

$a=\left(-\frac{1}{x^3}\right)$

$\therefore\left(x^4-\frac{1}{x^3}\right)^{15}={ }^{15}C_0\left(x^4\right)^{15}\left(-\frac{1}{x^3}\right)^0$

$+{ }^{15}C_1\left(x^4\right)^{14}\left(-\frac{1}{x^3}\right)+{ }^{15}C_2\left(x^4\right)^{13}\left(-\frac{1}{x^3}\right)^2$

$+{ }^{15}C_3\left(x^4\right)^{12}\left(-\frac{1}{x^3}\right)^3+{ }^{15}C_4\left(x^4\right)^{11}\left(-\frac{1}{x^3}\right)^4+\cdots$

$T_{r+1}={ }^{15}C_r\left(x^4\right)^{15-r}\cdot\left(-\frac{1}{x^3}\right)^r={ }^{15}C_r x^{60-7r}$

$\Rightarrow x^{60-7r}=x^{32}\Rightarrow 60-7r=32$

$\Rightarrow 7r=28\Rightarrow r=4$

So, 5 th term, contains x^{32}

$={ }^{15}C_4\left(x^4\right)^{11}\left(-\frac{1}{x^3}\right)^4={ }^{15}C_4 x^{44}x^{-12}$

$={ }^{15}C_4 x^{32}$

Thus, coefficient of $x^{32}={ }^{15}C_4$.

89. **(a)** Let the means be $x_1,x_2,\ldots\ldots x_m$ so that

$1,x_1,x_2,\ldots.x_m,31$ is an A.P. of $(m+2)$ terms.

Now, $31=T_{m+2}=a+(m+1)d=1+(m+1)d$

$\therefore d=\frac{30}{m+1}$ Given : $\frac{x_7}{x_{m-1}}=\frac{5}{9}$

$\therefore\frac{T_8}{T_m}=\frac{a+7d}{a+(m-1)d}=\frac{5}{9}$

$\Rightarrow 9a+63d=5a+(5m-5)d$

$\Rightarrow 4.1=(5m-68)\frac{30}{m+1}$

$\Rightarrow 2m+2=75m-1020\Rightarrow 73m=1022$

$\therefore m=\frac{1022}{73}=14$

90. **(a)** Let $Q(a,b)$ be the reflection of $P(4,-13)$ in the line $5x+y+6=0$

Then themid-point $R\left(\frac{a+4}{2},\frac{b-13}{2}\right)$ lies on

$5x+y+6=0$

$\therefore 5\left(\frac{a+4}{2}\right)+\frac{b-13}{2}+6=0$

$\Rightarrow 5a+b+19=0$

Also PQ is perpendicular to $5x+y+6=0$

Therefore $\frac{b+13}{a-4}\times\left(-\frac{5}{1}\right)=-1$

$\Rightarrow a-5b-69=0$

Solving (i) and (ii), we get $a=-1,b=-14$

91. (c) Equations of the sides of the parallelogram are

$$(x-3)(x-2)=0 \text{ and } (y-5)(y-1)=0$$
$$\text{i.e. } x=3, x=2; y=5, y=1$$

Hence its vertices are : A $(2,1); B(3,1);$

$C(3,5); D(2,5)$

Equation of the diagonal AC is

$$y-1=\frac{4}{1}(x-2) \Rightarrow y=4x-7$$

Equation of the diagonal BD is

$$y-1=\frac{4}{-1}(x-3) \Rightarrow 4x+y=13$$

92. (a) Given eq ^{n} of parabola is $y^2-kx+6=0$

$$\Rightarrow y^2=kx-6 \Rightarrow y^2=k\left(x-\frac{6}{k}\right)$$

Now, directrix, $x-\frac{6}{k}=-\frac{k}{4}$

$$\Rightarrow x=\frac{6}{k}-\frac{k}{4}$$

But directrix is given $\Rightarrow x=\frac{1}{2}$

$$\therefore \frac{6}{k}-\frac{k}{4}=\frac{1}{2} \Rightarrow 24-k^2=2k$$
$$\Rightarrow k^2+2k-24=0$$
$$\Rightarrow (k+6)(k-4)=0 \ \Rightarrow k=-6, k=4$$

93. (c) Clearly $ax+by=1$

i.e $y=-\frac{a}{b}x+\frac{1}{b}$ is tangent to

$$cx^2+dy^2=1 \Rightarrow \frac{x^2}{\frac{1}{c}}+\frac{y^2}{\frac{1}{d}}=1$$

$$\therefore \left(\frac{1}{b}\right)^2=\left(\frac{1}{c}\right)\left(-\frac{a}{b}\right)^2+\left(\frac{1}{d}\right)$$

$$\Rightarrow 1=\frac{a^2}{c}+\frac{b^2}{d}$$

94. (a)

$$T=S_1 \Rightarrow x(4)+y(3)-4(x+4)=16+9-32$$
$$\Rightarrow 3y-9=0 \Rightarrow y=3$$

95. (a)

$$\lim_{x\to 0}\frac{\sqrt{1+x^2}-\sqrt{1-x^2}}{x^2}\cdot\frac{\sqrt{1+x^2}+\sqrt{1-x^2}}{\sqrt{1+x^2}+\sqrt{1-x^2}}$$

$$\Rightarrow \lim_{x\to 0}\frac{1+x^2-1+x^2}{x^2\left(\sqrt{1+x^2}+\sqrt{1-x^2}\right)}$$

$$\Rightarrow \lim_{x\to 0}\frac{2x^2}{x^2\left(\sqrt{1+x^2}+\sqrt{1-x^2}\right)}=\frac{2}{\sqrt{1}+\sqrt{1}}=\frac{2}{2}=1$$

96. (b)

$$\text{Mean } \bar{x}=\frac{\Sigma x}{n} \text{ or } \Sigma x=n\bar{x}$$

$$\Sigma x=25\times 78.4=1960$$

But this $\sum x$ is incorrect as 96 was misread as 69.

$$\therefore \text{ correct } \sum x=1960+(96-69)=1987$$

$$\therefore \text{ correct mean }=\frac{1987}{25}=79.48$$

97. (b)

$$-\frac{1}{2}, \text{ We have } S_K=\frac{\text{Mean } - \text{ Mode}}{\text{S.D.}}$$

$$\frac{41-45}{8}=-\frac{1}{2}$$

98. (b) The number of favourable cases are shown below:

Number on white die	Number on black die
1	3
1	4
1	5
1	6
2	5
2	6

There are 6 favourable cases in which the number on black die is more than twice the number on the white die.
$\therefore$ m = 6
n = Total number of cases = 6 × 6
($\therefore$ with each die there are six possibilities)
$\therefore$ Probability $p=\frac{m}{n}=\frac{6}{6\times 6}=\frac{1}{6}$

99. (a) If set A has m elements and set B has n elements then number of onto functions from A to B is

$$\sum_{r=1}^{n} (-1)^{n-r}\, {}^nC_r r^m \text{ where } 1 \le n \le m$$

Here $E = \{1,2,3,4\}, F = \{1,2\}$

$m = 4, n = 2$

∴ No. of onto functions from E to F

$$= \sum_{r=1}^{2} (-1)^{2-r}\, {}^2C_r (r)^4$$
$$= (-1)^2 C_1 + {}^2C_2 (2)^4 = -2 + 16 = 14$$

100. **(b)** $f(x) = \frac{x}{\sqrt{1+x^2}}$

$$(f \circ f)(x) = \frac{\frac{x}{\sqrt{1+x^2}}}{\sqrt{1+\frac{x^2}{1+x^2}}} = \frac{x}{\sqrt{2x^2+1}}$$

$$(\text{fofof})(x) = \frac{\frac{x}{\sqrt{2x^2+1}}}{\sqrt{1+\frac{x^2}{2x^2+1}}} = \frac{x}{\sqrt{1+3x^2}}$$

101. **(b)** Let $\cos^{-1} x = y$

$\Rightarrow x = \cos y$, so that $\frac{1}{2} \le x \le 1$ or $0 \le y \le \frac{\pi}{3}$

and $\frac{x}{2} + \frac{1}{2}\sqrt{3-3x^2} = \frac{1}{2}\cos y + \frac{\sqrt{3}}{2}\sin y$

$= \cos\frac{\pi}{3}\cos y + \sin\frac{\pi}{3}\sin y = \cos\left(\frac{\pi}{3} - y\right)$

$\Rightarrow \cos^{-1}\left(\frac{x}{2} + \frac{1}{2}\sqrt{3-3x^2}\right) = \frac{\pi}{3} - y$

∴ the given expression is equal to

$y + \frac{\pi}{3} - y$, i.e., $\frac{\pi}{3}$

102. **(c)**

103. **(c)**

$$\begin{vmatrix} 1 & 2 & 3 \\ -4 & 3 & 6 \\ 2 & -7 & 9 \end{vmatrix} = 1\begin{vmatrix} 3 & 6 \\ -7 & 9 \end{vmatrix} - 2\begin{vmatrix} -4 & 6 \\ 2 & 9 \end{vmatrix} + 3$$
$$\begin{vmatrix} -4 & 3 \\ 2 & -7 \end{vmatrix}$$
$$= 1(3 \times 9 - 6(-7)) - 2(-4 \times 9 - 2 \times 6) + 3$$
$$((-4)(-7) - 3 \times 2)$$
$$= (27 + 42) - 2(-36 - 12) + 3(28 - 6) = 231$$

104. **(d)**

$$\mathrm{L}f'(1)=\lim_{h\to 0}\frac{f(1-h)-f(1)}{-h}$$
$$=\lim_{h\to 0}\frac{(1-h+a)-(1+a)}{-h}=\lim_{h\to 0}\frac{-h}{-h}=1$$
$$Rf'(1)=\lim_{h\to 0}\frac{f(1+h)-f(1)}{h}$$
$$=\lim_{h\to 0}\frac{[a(1+h)^2+1]-(1+a)}{h}$$
$$=\lim_{h\to 0}(ah+2a)=2a$$
Since $f'(1)$ exists, $\therefore \mathrm{L}f'(1)=\mathrm{R}f'(1)\Rightarrow a=1/2$

105. **(a)** Let A sq. units in the area measure when the radius is r units. their $\mathrm{A}=\pi \mathrm{r}^2$ Differentiate both side w.r.t ' t '

$$\frac{dA}{dt}=2\pi r\frac{dr}{dt}$$

We have, $\frac{dA}{dt}=3c\frac{dr}{dt}$
From eqn (i), we get
$$3c\cdot\frac{dr}{dt}=2\pi r\cdot\frac{dr}{dt}\Rightarrow 3c=2\pi r$$
Now, $c=\frac{2}{3}\pi(6)=4\pi$ when $r=6$

106. **(a)** $f(x)=\tan x-4x\Rightarrow f'(x)=\sec^2 x-4$
When $\frac{-\pi}{3}<x<\frac{\pi}{3}, 1<\sec x<2$
Therefore, $1<\sec^2 x<4$
$\Rightarrow -3<(\sec^2 x-4)<0$
Thus, for $\frac{-\pi}{3}<x<\frac{\pi}{3}, f'(x)<0$
Hence, f is strictly decreasing on $\left(\frac{-\pi}{3},\frac{\pi}{3}\right)$

107. **(b)** Differentiating the given equation of the curve

$$4x-6y\cdot(dy/dx)=0 \;\therefore dy/dx=2x/3y$$
$$\left(\frac{dy}{dx}\right)_{(3,2)}=\frac{2}{3}\cdot\frac{3}{2}=1$$

108. **(a)**

$$\int 4\cos\left(x+\frac{\pi}{6}\right)\cos 2x\cdot\cos\left(\frac{5\pi}{6}+x\right)dx$$
$$=2\int\left(\cos(2x+\pi)\cos\frac{2\pi}{3}\right)\cos 2x\,dx$$
$$=2\int\left(-\cos 2x-\frac{1}{2}\right)\cos 2x\,dx$$
$$=\int(-2\cos^2 2x-\cos 2x)dx$$
$$=-\int(1+\cos 4x+\cos 2x)dx$$
$$=-x-\frac{\sin 4x}{x}-\frac{\sin 2x}{2}+c$$

109. **(c)**

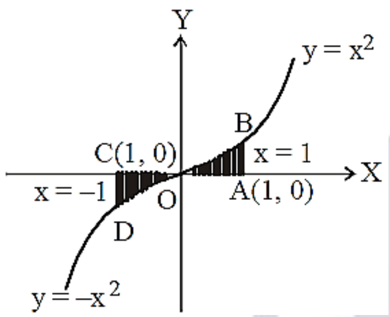
$$I_{10} = \int_1^e 1 \cdot (\ln x)^{10} dx = [(\ln x)^{10} x]_1^e$$
$$- \int_1^e 10(\ln x)^9 \cdot \frac{1}{x} \cdot x dx = e - 0 - 10 \int_1^e (\ln x)^9 dx$$
$$= e - 10I_9 + 10I_9 = e$$

110. **(c)** The area of the region bounded by the curve $y = f(x)$ and the ordinates $x = a, x = b$ is given by

$$\text{Area } = \left| \int_a^b y dx \right|$$

According to the question,

$$y = x|x| = \begin{cases} x^2, & x \geq 0 \\ -x^2, & x < 0 \end{cases}$$



Required area
= area of region OAB + area of region OCD
= 2 × Area of region OAB
$= 2\int_0^1 x^2 dx = \frac{2}{3}$ sq. units

111. **(a)**

$$\frac{dy}{dx} + 2y = 1 \Rightarrow \frac{dy}{dx} = 1 - 2y$$
$$\int \frac{dy}{1-2y} = \int dx - \frac{1}{2} \log|1 - 2y| = x + C$$
$$\text{at } x = 0, y = 0; -\frac{1}{2} \log 1 = 0 + C \Rightarrow C = 0$$
$$1 - 2y = e^{-2x} \Rightarrow y = \frac{1 - e^{-2x}}{2}$$

112. **(d)**

$$\text{We have, } 2x\frac{dy}{dx} = y + 3 \Rightarrow \frac{2}{y+3} dy = \frac{dx}{x}$$
$$\text{integrating, } 2\ln(y+3) = \ln x + \ln c = \ln cx$$
$$\Rightarrow \ln(y+3)^2 = \ln cx \Rightarrow (y+3)^2 = cx$$

which is a family of parabolas.

113. **(a)**

$(\vec{a}\times\vec{b})^2+(\vec{a}\cdot\vec{b})^2=676$

$(|\vec{a}|\cdot|\vec{b}|\sin\theta\hat{n})^2+(|\vec{a}|\cdot|\vec{b}|\cos\theta)^2=676$

$\Rightarrow a^2b^2\sin^2\theta+a^2b^2\cos^2\theta=676[(\hat{n})^2=1]$

$$a^2b^2(\sin^2\theta+\cos^2\theta)=676\Rightarrow a^2=\frac{676}{b^2}=\frac{676}{4}$$

$$|\vec{a}|=\sqrt{\frac{676}{4}}\Rightarrow|\vec{a}|=\frac{26}{2}\Rightarrow|\vec{a}|=13$$

114. **(a)** According to question $a=-\hat{\imath}+\hat{\jmath}+\hat{k}$ and $b=\hat{\imath}-\hat{\jmath}+\hat{k}$

Then, $\mathbf{a}\times\mathbf{b}=\begin{vmatrix}\hat{\imath}&\hat{\jmath}&\hat{k}\\-1&1&1\\1&-1&1\end{vmatrix}$

$=\hat{\imath}[1+1]-\hat{\jmath}[-1-1]+\hat{k}[1-1]=2(\hat{\imath}+\hat{\jmath})$

and $|a\times b|=\sqrt{4+4}=2\sqrt{2}$

$\therefore$ Required unit vector $=\pm\frac{2(\hat{\imath}+\hat{\jmath})}{2\sqrt{2}}=\pm\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}$

115. **(a)**

$\vec{r}=\vec{a}+\vec{b}+\vec{c}=4\hat{\imath}-\hat{\jmath}-3\hat{\imath}+2\hat{\jmath}-\hat{k}=\hat{\imath}+\hat{\jmath}-\hat{k}$

$\hat{r}=\frac{\vec{r}}{|r|}=\frac{\hat{\imath}+\hat{\jmath}-\hat{k}}{\sqrt{1^2+1^2+(-1)^2}}=\frac{\hat{\imath}+\hat{\jmath}-\hat{k}}{\sqrt{3}}$

116. **(d)** The position vector of points D, E, F are respectively

$$\frac{i+j}{2}+k,i+\frac{k+j}{2}\text{ and }\frac{i+k}{2}+j$$

So, position vector of centre of $\triangle$ DEF

$$=\frac{1}{3}\left[\frac{i+j}{2}+k+i\frac{k+j}{2}+\frac{i+k}{2}+j\right]=\frac{2}{3}[i+j+k]$$

117. **(a)** The point A(6,7,7) is on the line. Let the perpendicular from P meet the line in L. Then

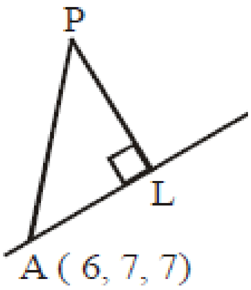
$AP^2=(6-1)^2+(7-2)^2+(7-3)^2=66$

Also AL = projection of AP on line

$$\left(\text{actual d.c.'s }\frac{3}{\sqrt{17}},\frac{2}{\sqrt{17}},\frac{-2}{\sqrt{17}}\right)\frac{A(6,7,7)}{L}$$

$$\Rightarrow(6-1)\cdot\frac{3}{\sqrt{17}}+(7-2)\cdot\frac{2}{\sqrt{17}}+(7-3)\frac{-2}{\sqrt{17}}$$

$=\sqrt{17}$



$\therefore\ \perp$ distance d of P from the line is given by

$d^2 = AP^2 - AL^2 = 66 - 17 = 49$ so that $d = 7$

118. **(b)** If the given plane contains the given line then the normal to the plane, must be perpendicular to the line and the condition for the same is $a\ell + bm + cn = 0$.

119. **(d)**

$$\text{Since, } P(X = r) = \frac{e^{-\lambda}\lambda^r}{r!} (\text{ where } \lambda = \text{ mean })$$
$$\therefore\ P(X = r > 1.5) = P(2) + P(3) + \cdots \infty$$
$$= 1 - P(X = r \leq 1) = 1 - P(0) - P(1)$$
$$= 1 - \left(e^{-2} + \frac{e^{-2} \times 2}{1!}\right) = 1 - \frac{3}{e^2}$$

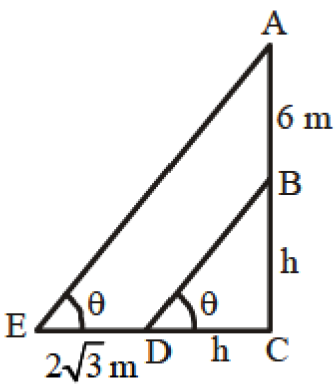
120. **(a)**

$$P(A \cup B) = P(A) + P(B) - P(AB)$$
$$\Rightarrow \frac{2}{3} = \frac{1}{3} + P(B) - \frac{1}{6} \Rightarrow P(B) = \frac{1}{2}$$

Now, $P(AB) = P(A)P(B)$, A and B are independent events.

121. **(a)** Accordingly,

$$\tan\theta = \frac{h}{x} = \frac{h+6}{x+2\sqrt{3}} = \frac{6}{2\sqrt{3}} \Rightarrow \theta = 60^\circ$$



[Since the triangles AEC and BDC are similar] $h\cot\alpha = (h - 100)\cot\beta$

$\therefore h = \dfrac{100\cot\beta}{\cot\beta - \cot\alpha}$

122. **(b)** For maximum profit, $z = 40x + 25y$.

123. **(b)**

By A. M. $\geq$ G. M.

$x^4 + y^4 \geq 2x^2y^2$ and $2x^2y^2 + z^2 \geq \sqrt{8}xyz$

$\Rightarrow \dfrac{x^4 + y^4 + z^2}{xyz} \geq \sqrt{8}$

124. **(d)**

$$\mathrm{Lt}_{x\to 0} \frac{(e^x - 1)^2}{\sin\left(\frac{x}{a}\right)\log\left(1 + \frac{x}{4}\right)}$$

$$= \mathrm{Lt}_{x\to 0} \frac{\frac{(e^x-1)^2}{x}\cdot x^2}{\frac{x}{a}\cdot\frac{\sin\left(\frac{x}{a}\right)}{\left(\frac{x}{a}\right)}\cdot\frac{\log\left(1+\frac{x}{4}\right)}{\frac{x}{4}}\cdot\frac{x}{4}} \Rightarrow 4a = 12$$

$\Rightarrow a = 3$

125. **(d)** $|x|$ is non-differentiable function at

$x = 0$ as L.H.D $= -1$ and R.H. D $= 1$

$\because |x| = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$

But $\cos|h|$ is differentiable

$\therefore$ Any combination of two such functions will be non-differentiable. Hence option (a) and (b) are ruled out.

Now, consider $\sin|x| + |x|$

$$L' = \lim_{h\to 0}\frac{\sin|-h| + |-h|}{-h} = \lim_{h\to 0}\frac{\sin h}{-h} - 1 = -1 - 1$$

$= -2$

$$R' = \lim_{h\to 0}\frac{\sin|h| + |h|}{h} = \lim_{h\to 0}\frac{\sin h}{h} + 1 = 1 + 1 = 2$$

Consider $\sin|x| - |x|$

$$L' = \lim_{h\to 0}\frac{\sin|-h| - |-h|}{-h} = \lim_{h\to 0}\frac{\sin h}{-h} + 1 = 0$$

$$R' = \lim_{h\to 0}\frac{\sin|h| - |h|}{h} = \lim_{h\to 0}\frac{\sin h}{h} - 1 = 0$$

Hence, $\sin|x| - |x|$ is diffble at $x = 0$.

126. **(d)**
127. **(c)**
128. **(a)**
129. **(a)**
130. **(a)**
131. **(c)**

132. **(c)**

133. **(d)**

134. **(a)**

135. **(d)**

136. **(c)**

137. **(a)**

138. **(b)**

139. **(b)** Ambition-a cherished desire Abstruse-hard to understand intricate complex

140. **(b)** Amalgamation-joining of two organization to form one large organization Regulated means controlled.

141. **(b)**

As, $\boxed{\text{EFJK}} \xrightarrow{+7} \boxed{\text{LMQR}}$

Similarly, $\boxed{\text{LMQR}} \xrightarrow{+7} \boxed{\text{STXY}}$

142. **(a)** As, the birth place of Mahatma Gandhi was Porbandar. Similarly, the birth place of Pt. Jawaharlal Nehru was Allahabad.

143. **(d)** The use of the words 'impoverished community' in the statement makes I implicit while the phrase 'college education should be restricted to a brilliant few' makes II implicit.

144. **(b)**

145. **(c)**

$2 \xrightarrow{2\times1+1} 3 \xrightarrow{2\times3+1} 7 \xrightarrow{3\times7+1} 22 \xrightarrow{7\times22+1} 155 \xrightarrow{22\times155+1} \boxed{3411}$

146. **(b)**

147. **(d)**

148. **(a)**

149. **(d)**

150. **(c)**