

94. The slope of the tangent to the curve $x = 3t^2 + 1$, $y = t^3 - 1$ at $x = 1$ is:
 (a) $\frac{1}{2}$ (b) 0 (c) -2 (d) ∞
95. General solution of $\tan 5\theta = \cot 2\theta$ is
 (a) $\theta = \frac{n\pi}{7} + \frac{\pi}{14}$ (b) $\theta = \frac{n\pi}{7} + \frac{\pi}{5}$
 (c) $\theta = \frac{n\pi}{7} + \frac{\pi}{2}$ (d) $\theta = \frac{n\pi}{7} + \frac{\pi}{3}$
96. How many different nine digit numbers can be formed from the number 2233558888 by rearranging its digits so that the odd digits occupy even positions?
 (a) 16 (b) 36 (c) 60 (d) 180
97. If the co-ordinates of the point in which the line joining the points (3, 5, -7) and (-2, 1, 8) is intersected by the plane yz is $\left[a, \frac{13}{b}, c \right]$, then $(a + b - c) =$
 (a) 2 (b) 3 (c) 4 (d) 5
98. If the straight lines $\frac{x-1}{k} = \frac{y-2}{2} = \frac{z-3}{3}$ and $\frac{x-2}{3} = \frac{y-3}{k} = \frac{z-1}{2}$ intersect at a point, then the integer k is equal to
 (a) -5 (b) 5
 (c) 2 (d) -2
99. If $f(x) = \begin{cases} x^2 - 1, & 0 < x < 2 \\ 2x + 3, & 2 \leq x < 3 \end{cases}$, then the quadratic equation whose roots are $\lim_{x \rightarrow 2^-} f(x)$ and $\lim_{x \rightarrow 2^+} f(x)$ is
 (a) $x^2 - 6x + 9 = 0$
 (b) $x^2 - 7x + 8 = 0$
 (c) $x^2 - 14x + 49 = 0$
 (d) $x^2 - 10x + 21 = 0$
100. The area of the region $R = \{(x, y) : 5x^2 \leq y \leq 2x^2 + 9\}$ is :
 (a) $11\sqrt{3}$ square units
 (b) $12\sqrt{3}$ square units
 (c) $9\sqrt{3}$ square units
 (d) $6\sqrt{3}$ square units
101. If $n(A) = 1000$, $n(B) = 500$ and if $n(A \cap B) \geq 1$ and $n(A \cup B) = p$, then
 (a) $500 \leq p \leq 1000$
 (b) $1001 \leq p \leq 1498$
 (c) $1000 \leq p \leq 1498$
 (d) $1000 \leq p \leq 1499$
102. If n is a positive integer, then $2 \cdot 4^{2n+1} + 3^{3n+1}$ is divisible by :
 (a) 2 (b) 7 (c) 11 (d) 27
103. The roots of the given equation $(p - q)x^2 + (q - r)x + (r - p) = 0$ are :
 (a) $\frac{p-q}{r-p}, 1$ (b) $\frac{q-r}{p-q}, 1$
 (c) $\frac{r-p}{p-q}, 1$ (d) None of these
104. $\int \tan^{-1} \sqrt{x} \, dx$ is equal to
 (a) $(x+1)\tan^{-1} \sqrt{x} - \sqrt{x} + C$
 (b) $x \tan^{-1} \sqrt{x} - \sqrt{x} + C$
 (c) $\sqrt{x} - x \tan^{-1} \sqrt{x} + C$
 (d) $\sqrt{x} - (x+1)\tan^{-1} \sqrt{x} + C$
105. If $(-4, 5)$ is one vertex and $7x - y + 8 = 0$ is one diagonal of a square, then the equation of second diagonal is
 (a) $x + 3y = 21$ (b) $2x - 3y = 7$
 (c) $x + 7y = 31$ (d) $2x + 3y = 21$
106. The function $f(x) = \log(1+x) - \frac{2x}{2+x}$ is increasing on
 (a) $(0, \infty)$ (b) $(-\infty, 0)$
 (c) $(-\infty, \infty)$ (d) None of these
107. The domain of the function $f(x) = \sqrt{x - \sqrt{1 - x^2}}$ is
 (a) $\left[-1, -\frac{1}{\sqrt{2}}\right] \cup \left[\frac{1}{\sqrt{2}}, 1\right]$
 (b) $[-1, 1]$
 (c) $\left(-\infty, -\frac{1}{2}\right] \cup \left[\frac{1}{\sqrt{2}}, +\infty\right)$
 (d) $\left[\frac{1}{\sqrt{2}}, 1\right]$

108. The sum to infinite term of the series

$$1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \dots \text{ is}$$

- (a) 3 (b) 4 (c) 6 (d) 2

109. Consider the function f in $A = \mathbb{R} - \left\{ \frac{2}{3} \right\}$ defined

as $f(x) = \frac{4x+3}{6x-4}$, then f^{-1} is equal to

- (a) $\frac{3+4x}{6x-4}$ (b) $\frac{6x-4}{3+4x}$
 (c) $\frac{3-4x}{6x-4}$ (d) $\frac{9+2x}{6x-4}$

110. The vertices of the hyperbola

$$9x^2 - 16y^2 - 36x + 96y - 252 = 0 \text{ are}$$

- (a) (6, 3), (-2, 3) (b) (6, 3), (-6, 3)
 (c) (-6, 3), (-6, -3) (d) (2, 3), (-2, 3)

111. If $y^x = e^{y-x}$, then $\frac{dy}{dx}$ is equal to

- (a) $\frac{1+\log y}{y \log y}$ (b) $\frac{(1+\log y)^2}{y \log y}$
 (c) $\frac{1+\log y}{(\log y)^2}$ (d) $\frac{(1+\log y)^2}{\log y}$

112. If $A = \begin{bmatrix} 0 & c & -b \\ -c & 0 & a \\ b & -a & 0 \end{bmatrix}$ and $B = \begin{bmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{bmatrix}$,

then AB is equal to

- (a) B (b) A (c) O (d) I

113. The coordinates of the foot of the perpendicular from the point (2, 3) on the line $x + y - 11 = 0$ are

- (a) (-6, 5) (b) (5, 6)
 (c) (-5, 6) (d) (6, 5)

114. If A and B are mutually exclusive events and if

$$P(B) = \frac{1}{3}, P(A \cup B) = \frac{13}{21}, \text{ then } P(A) \text{ is equal}$$

- to
 (a) 1/7 (b) 4/7 (c) 2/7 (d) 5/7

115. A coin is tossed twice. Then, the probability that atleast one tail occurs is

- (a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) $\frac{1}{3}$ (d) $\frac{3}{4}$

116. The solution set of $(x-2)^{x^3-6x+8} > 1$ is

- (a) (2, ∞)
 (b) (2, 3) \cup (4, ∞)
 (c) (4, 5) \cup (5, ∞)
 (d) (2, 3) \cup (4, 5)

117. If $f(x) = \sqrt{1 + \cos^2(x^2)}$, then the value of

$$f' \left(\frac{\sqrt{\pi}}{2} \right) \text{ is}$$

- (a) $\frac{\sqrt{\pi}}{6}$ (b) $-\sqrt{\frac{\pi}{6}}$ (c) $\frac{1}{\sqrt{6}}$ (d) $\frac{\pi}{\sqrt{6}}$

118. The integrating factor of $\frac{xdy}{dx} - y = x^4 - 3x$ is

- (a) x (b) log x (c) $\frac{1}{x}$ (d) -x

119. If E and F are events such that $0 < P(F) < 1$, then

- (a) $P(E|F) + P(\bar{E}|F) = 1$
 (b) $P(E|F) + P(E|\bar{F}) = 1$
 (c) $P(\bar{E}|F) + P(E|\bar{F}) = 1$
 (d) $P(E|\bar{F}) + P(\bar{E}|\bar{F}) = 0$

120. The shortest distance between the lines $x = y + 2 = 6z - 6$ and $x + 1 = 2y = -12z$ is

- (a) $\frac{1}{2}$ (b) 2 (c) 1 (d) $\frac{3}{2}$

121. The value of $\cos(2 \cos^{-1} x + \sin^{-1} x)$ at $x = \frac{1}{5}$ is

- (a) $-\frac{2\sqrt{6}}{5}$ (b) $-2\sqrt{6}$
 (c) $-\frac{\sqrt{6}}{5}$ (d) None of these

122. $\int_0^{\pi/4} \cos x e^{\sin x} dx$ is equal to

- (a) e + 1 (b) e - 1
 (c) e (d) -e

2023-12

BITSAT Year-Wise Solved Papers

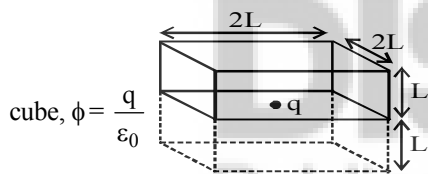
123. If x^{18} occurs in the r th term in the expansion of $\left(x^4 + \frac{1}{x^3}\right)^{15}$, then what is the value of r ?
(a) 3 (b) 5 (c) 7 (d) 9
124. Solve $\sqrt{5}x^2 + x + \sqrt{5} = 0$.
(a) $\pm \frac{\sqrt{19}}{5}i$ (b) $\pm \frac{\sqrt{19}i}{2}$
(c) $\frac{-1 \pm \sqrt{19}i}{2\sqrt{5}}$ (d) $\frac{-1 \pm \sqrt{19}i}{\sqrt{5}}$
125. If vertex of a parabola is $(2, -1)$ and the equation of its directrix is $4x - 3y = 21$, then the length of its latus rectum is
(a) 2 (b) 8
(c) 12 (d) 16
126. The modulus of $\frac{(1 + i\sqrt{3})(2 + 2i)}{(\sqrt{3} - i)}$ is
(a) 2 (b) 4
(c) $3\sqrt{2}$ (d) $2\sqrt{2}$
127. The equation of the circle with centre $(0, 2)$ and radius 2 is $x^2 + y^2 - my = 0$. The value of m is
(a) 1 (b) 2 (c) 4 (d) 3
128. If $f(x) = \cos x$, $g(x) = \cos 2x$, $h(x) = \cos 3x$ and $I(x) = \tan x$, then which of the following option is correct?
(a) $f(x)$ and $g(x)$ are strictly decreasing in $(0, \pi/2)$
(b) $h(x)$ is neither increasing nor decreasing in $(0, \pi/2)$
(c) $I(x)$ is strictly increasing in $(0, \pi/2)$
(d) All are correct
129. Value of $\int \frac{dx}{\sqrt{x(a-x)}}$ is
(a) $2 \sin^{-1} \sqrt{\frac{x}{a}} + c$
(b) $-2 \sin^{-1} \sqrt{\frac{x}{a}} + c$
(c) $2 \sin^{-1} \frac{\sqrt{x}}{a} + c$
(d) None of these
130. The standard deviation of 5 scores 1, 2, 3, 4, 5 is \sqrt{a} . The value of 'a' is
(a) 2 (b) 3 (c) 5 (d) 1

SOLUTIONS

PART - I : PHYSICS

1. (d) Given,
 Boiling point of water, = UFP 65°
 Freezing point of water, = LFP - 15°
- $$\frac{X - \text{LFP}}{\text{UFP} - \text{LFP}} = \frac{T_F - 32}{212 - 32}$$
- $$\Rightarrow \frac{-95 - (-15)}{65 - (-15)} = \frac{T_F - 32}{180}$$
- $$\Rightarrow \frac{-80}{80} = \frac{T_F - 32}{180} \Rightarrow T_F = -180 + 32$$
- $$\Rightarrow T_F = -148^\circ \text{F}$$
2. (d) After placing similar cubic at the bottom, we get cube of side 2L having charge q at its centre.

From the Gauss's law electric flux through whole



Flux passing through shaded face

$$\phi = \frac{q/\epsilon_0}{6} = \frac{q}{6\epsilon_0}$$

3. (a) Thermal energy is given by

$$H = P \times t = \frac{V^2}{R} \times t$$

Here, voltage V is same.

$$\therefore \frac{H_1}{H_2} = \frac{\frac{V^2 t}{3R}}{\frac{V^2 t}{R}} = 3:1$$

4. (a) $v = r^a \rho^b s^c \Rightarrow [v] = [r]^a [\rho]^b [s]^c$
- $$\Rightarrow [T^{-1}] = [L]^a [M^1 L^{-3}]^b \left[\frac{MLT^{-2}}{L} \right]^c$$
- $$\Rightarrow T^{-1} = M^{b+c} \cdot L^{a-3b} \cdot T^{-2c}$$
- $$\Rightarrow b + c = 0, a - 3b = 0, -2c = -1$$
- $$\Rightarrow c = \frac{1}{2}, b = -\frac{1}{2}, a - 3b = 0;$$

$$a + \frac{3}{2} = 0 \Rightarrow a = -\frac{3}{2}$$

5. (d) Velocity of train B w.r.t. train A = $\vec{V}_B - \vec{V}_A$
- $$= 54 - (-90) = 144 \text{ km/h}$$
- $$= \frac{144 \times 5}{18} = 40 \text{ m/s}$$

$$\text{Time of crossing} = \frac{\text{length of train}}{\text{relative velocity}} \Rightarrow (8) = \frac{\ell}{40}$$

$$\therefore \ell = 8 \times 40 = 320 \text{ m}$$

6. (a) Given,
 Initial velocity of projectile, $u = 40 \text{ m/s}$
 Angle, $\theta = 30^\circ$
 Time of flight

$$T = \frac{2u \sin \theta}{g} = \frac{2 \times 40 \times 1}{10 \times 2} = 4 \text{ s} \quad (\because g = 10 \text{ m/s}^2)$$

It means projectile is at maximum height at $t = 2 \text{ s}$. At maximum height vertical component of velocity is zero.

$$\text{Velocity at } t = 2 \text{ s} = V_x = u \cos \theta = 40 \cos 30^\circ$$

$$= 20\sqrt{3} \text{ ms}^{-1}$$

7. (c) The magnetic moment associated with circular coil,
 $M = NIA$
 $M_A = M_B$
 $\therefore N_A I_A A_A = N_B I_B A_B$
 $\therefore N_A I_A \pi(0.1)^2 = N_B I_B \pi(0.2)^2 \quad (\because A = \pi r^2)$
 $\therefore N_A I_A = 4N_B I_B$

8. (d) Induced emf, $\varepsilon = -L \frac{dI}{dt} \Rightarrow 20 = -L \frac{(0-2)}{10^{-3}}$

Hence, inductance of the coil.
 $L = 10 \text{ mH}$

9. (d) $\text{K.E.} = \frac{p^2}{2m}$

$$\therefore \frac{K_1}{K_2} = \frac{p_1^2}{2m_1} \times \frac{2m_2}{p_2^2} = \frac{m_2}{m_1} = \frac{16}{9}$$

$$\therefore \frac{m_1}{m_2} = \frac{9}{16}$$

10. (d) $\text{T.E} = \text{K.E} + \text{P.E}$

$$\Rightarrow \text{K.E} = \text{T.E} - \text{K.E}$$

$$= \frac{1}{2} kA^2 - \frac{1}{2} kx^2$$

$$\Rightarrow \text{K.E} = \frac{1}{2} m\omega^2 (A^2 - x^2) \quad [\because k = m\omega^2]$$

K.E is maximum at $x = 0$ & K.E is zero when $x = A$

\therefore K.E vs x graph is parabola.

11. (c) Radius of circle, $r = a$

Centrifugal force, $F = m\omega^2 r$

$$\Rightarrow \frac{Gmm}{(2a)^2} = m\omega^2 a$$

$$\left(\because F = \frac{G M_1 M_2}{d} \right)$$

Here $M_1 = m$; $M_2 = m$ and $d = 2a$

$$\Rightarrow \text{angular speed, } \omega = \sqrt{\frac{Gm}{4a^3}}$$

12. (c) Equivalent resistance in parallel combination is given by

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow R_{\text{eq}} = \frac{R_1 R_2}{R_1 + R_2} = \frac{10 \times 15}{10 + 15} = 6$$

Differentiating both sides, we get

$$\frac{\Delta R_{\text{eq}}}{R_{\text{eq}}^2} = \frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}$$

$$\Rightarrow \frac{\Delta R_{\text{eq}}}{R_{\text{eq}}} = \left(\frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} \right) R_{\text{eq}}$$

$$= \left(\frac{0.5}{100} + \frac{0.5}{225} \right) 6 = \left(\frac{6 \times 0.5}{25} \right) \left(\frac{1}{4} + \frac{1}{9} \right) = \frac{13}{300}$$

$$\frac{\Delta R_{\text{eq}}}{R_{\text{eq}}} \times 100 = \frac{13}{3} = 4.33\%$$

13. (a) Given,

Capacitive reactance, $X_C = 100 \Omega$

Inductive reactance, $X_L = 200 \Omega$

Resistance, $R = 100 \Omega$

$$\text{Impedance, } Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{100^2 + (200 - 100)^2} = 100\sqrt{2} \Omega$$

RMS value of current,

$$i_{\text{rms}} = \frac{V_{\text{rms}}}{Z} = \frac{200\sqrt{2}}{100\sqrt{2}} = 2 \text{ A}$$

14. (a) For an EM wave

$$\vec{B} = \frac{1}{\omega} (\vec{k} \times \vec{E})$$

15. (d) Angle of deviation for first prism

$$\delta_1 = A_1 (\mu_1 - 1) = 6(1.54 - 1)$$

Angle of deviation for second prism

$$\delta_2 = A_2 (\mu_2 - 1)$$

$$= A_2 (1.72 - 1)$$

For dispersion without deviation

$$\delta_1 = \delta_2$$

$$\Rightarrow 6^\circ (1.54 - 1) = A_2 (1.72 - 1)$$

$$\Rightarrow A_2 = \frac{6^\circ \times 0.54}{0.72} = \frac{18^\circ}{4} = 4.5^\circ$$

16. (c) Given that torque, $\vec{\tau} = 5\hat{i} + 3\hat{j} - 7\hat{k}$

Position vector, $\vec{r} = 2\hat{i} + 2\hat{j} + \hat{k}$

$$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 2 & 1 \\ 5 & 3 & -7 \end{vmatrix}$$

$$= \hat{i}(-14-3) - \hat{j}(-14-5) + \hat{k}(6-10)$$

$$= -17\hat{i} + 19\hat{j} - 4\hat{k}$$

17. (a) Potential due to sphere

$$V = \frac{GM}{2R^3}(3R^2 - r^2)$$

$$\text{At surface } r = R \Rightarrow V = \left(\frac{GM}{R}\right)$$

At centre, $r = 0$

$$\therefore V_0 = \frac{3GM}{2R} = \left(\frac{3V}{2}\right)$$

18. (b) Elongation produced in the wire is given by

$$\Delta L = \frac{FL}{AY}$$

Here, L = length of wire

A = area of cross-section of wire

Y = Young's moduli of material of wire.

$\therefore F$ and L is same and

$$\frac{Y_A}{Y_B} = \frac{1}{4} \quad (\text{given})$$

$$\frac{A_A}{A_B} = \frac{1}{3} \quad (\text{given})$$

$$\therefore \frac{\Delta L_A}{\Delta L_B} = \frac{A_B Y_B}{A_A Y_A} = \frac{3}{1} \times \frac{4}{1} = 12$$

19. (a) De-Broglie wavelength,

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2mq\Delta V}}$$

$$\therefore \frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{2m_p V_p q_p}{2m_\alpha V_\alpha q_\alpha}}$$

$$\therefore V_p = 2V \text{ and } V_\alpha = 4V \text{ (given)}$$

$$m_\alpha = 4m_p \text{ and } q_\alpha = 2q_p$$

$$\therefore \frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{1 \times 2 \times 1}{4 \times 4 \times 2}} = \frac{1}{4} \Rightarrow \lambda_p : \lambda_\alpha = 4 : 1$$

20. (c) From the Bohr's quantization rule

$$\text{Angular momentum } L = \frac{nh}{2\pi}, L_1 = \frac{1h}{2\pi} = L$$

($n = 1$ for first orbit)

$$\text{in } (n = 2 \text{ for second orbit}) L_2 = \frac{2h}{2\pi} = 2L$$

Hence, change in angular momentum $L_2 - L_1 = 2L - L = L$

21. (a) In adiabatic process

$$PV^\gamma = \text{constant}$$

$$\Rightarrow P_1 V_1^\gamma = P_2 V_2^\gamma$$

$$\Rightarrow \frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^\gamma \Rightarrow \frac{81}{16} = \left(\frac{27}{8}\right)^\gamma$$

$$\Rightarrow \left(\frac{9}{4}\right)^2 = \left(\frac{9 \times 3}{4 \times 2}\right)^\gamma \Rightarrow \left(\frac{9}{4}\right)^{2-\gamma} = \left(\frac{3}{2}\right)^\gamma$$

$$\Rightarrow \left(\frac{9}{4}\right)^{2-\gamma} = \left(\frac{9}{4}\right)^{\gamma/2} \Rightarrow 2-\gamma = \frac{\gamma}{2}$$

$$\Rightarrow 2 = \frac{3}{2}\gamma \Rightarrow \gamma = \frac{4}{3}$$

22. (b) Average kinetic energy for diatomic gases

$$K_{av} = \frac{5}{2}kT$$

$$\therefore \frac{(K_{av})_H}{(K_{av})_O} = \frac{(27+273)}{(27+273)} = 1$$

23. (b) Given that number of turns, $n = 1200$

Current, $I = 2A$

Magnetic field at centre inside the solenoid is given by,

$$B = \mu_0 nI$$

So magnetic intensity at centre of the solenoid,

$$H = \frac{B}{\mu_0} = nI = \left(\frac{1200}{2}\right)(2) \quad (\because B = \mu_0 H)$$

$$H = 1.2 \times 10^3 \text{ Am}^{-1}$$

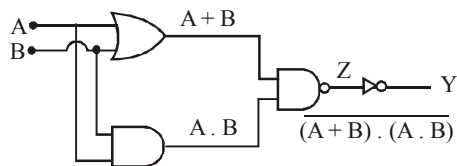
24. (c) It is given that

$$\left(\frac{T_1}{2}\right)_A = (T_{av})_B$$

$$\therefore T_{1/2} = \frac{\ell n 2}{\lambda} \text{ and } T_{av} = \frac{1}{\lambda}$$

$$\therefore \frac{\ell n 2}{\lambda_A} = \frac{1}{\lambda_B} \Rightarrow \lambda_A = \lambda_B \ell 2$$

25. (a)



$$Y = \bar{Z} = (A+B) \cdot (A.B) = A.A.B + AB.B$$

$$Y = AB + AB = A.B$$

\therefore It is an AND Gate.

26. (b) Let r be the radius of small drops of water.

R = radius of big drop formed
as volume remain same.

$$\therefore 8 \cdot \frac{4}{3} \pi r^3 - \frac{4}{3} \pi R^3 \Rightarrow R = 2r$$

Terminal velocity,

$$v_T = \frac{2}{9\eta} (\rho - \sigma) r^2 g$$

$$\therefore v_T \propto r^2$$

$$\therefore \frac{v_1}{v_2} = \left(\frac{r}{R}\right)^2$$

$$\Rightarrow \frac{10}{v_2} = \left(\frac{1}{2}\right)^2 \quad (\because v_1 = 10 \text{ cm/s given})$$

$$\Rightarrow v_2 = 40 \text{ cm/s}$$

27. (b) The rate of heat flow is given by

$$\frac{\Delta Q}{\Delta t} = -K(T - T_0) \Rightarrow \frac{\Delta Q}{\Delta t} = -K(T_{av} - T_0)$$

$$\text{Initially } T_{av} = \frac{T_1 + T_2}{2}$$

$$\text{Here, } T_1 = 98^\circ\text{C}$$

$$T_2 = 86^\circ\text{C}$$

$$(i) \quad \frac{ms \times 12}{2} = -K \left(\frac{98 + 86}{2} - 22 \right)$$

$$6 = -\frac{K}{ms} \left[\frac{98 + 86}{2} - 22 \right] \quad (\because \Delta Q = ms\Delta T)$$

$$6 = -\frac{K}{ms} [70] \quad \dots(i)$$

Now, cool from $T'_1 = 75^\circ\text{C}$

$$T'_2 = 69^\circ\text{C}$$

$$T_{avg} = \frac{T'_1 + T'_2}{2} = \frac{75 + 69}{2}$$

$$(ii) \quad \frac{ms \times 6}{\Delta t} = -K \left(\frac{75 + 69}{2} - 22 \right)$$

$$\frac{6}{\Delta t} = -\frac{K}{ms} (50) \quad \dots(ii)$$

Divide equation (ii) by (i), we have

$$\frac{6}{\Delta t (6)} = \frac{50}{70}$$

$$\Delta t = \frac{7}{5} = 1.4 \text{ min}$$

28. (c) From the Gauss's law

$$\phi = \frac{q_{in}}{\epsilon_0} = \frac{Q}{\epsilon_0} \quad \therefore Q = CV$$

$$\therefore \phi = \frac{CV}{\epsilon_0}$$

29. (b) Wavelength of monochromatic light,

$$\lambda = 600 \times 10^{-9} \text{ m}$$

As for first minima $a \sin \theta = \lambda$

$$\Rightarrow a \sin 30^\circ = 600 \times 10^{-9}$$

$$\Rightarrow a = 1200 \times 10^{-9} \text{ m} = 1.2 \mu\text{m}$$

30. (b) The relative velocity of a passenger with respect to source of sound (engine of train) is 0. So there will be no Doppler's effect. So frequency heard is 400 Hz.

PART - II : CHEMISTRY

31. (b) In boundary surface diagram (1) the four lobes lie between y and z -axis (d_{yz}) whereas, in boundary surface diagram (2) the four lobes lie on the x and y -axis ($d_{x^2-y^2}$).

32. (d) 6th period consists of 32 elements.

33. (b) $r = 0.529 \times \frac{n^2}{Z} \text{ \AA}$

$$r_3 = 0.529 \times \frac{3^2}{1} \Rightarrow r_4 = 0.529 \times \frac{4^2}{1}$$

$$\frac{r_4}{r_3} = \frac{4^2}{3^2} = \frac{16}{9} \Rightarrow r_4 = \frac{16r_3}{9}$$

34. (a) For first order reaction

$$k = \frac{1}{t} \ln \left(\frac{P_0}{P} \right) \Rightarrow \ln \left(\frac{P_0}{P} \right) = kt$$

$$\Rightarrow \ln \left(\frac{P}{P_0} \right) = -kt$$

On comparing with straight line equation $y = mx$
 $k = \text{slope} = 3.465 \times 10^4$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{3.465 \times 10^4} = 2 \times 10^{-5} \text{ s}$$

35. (c) Frenkel defect is due to dislocation of ion from its usual lattice site to interstitial position.

36. (d) Lattice enthalpy is required to completely separate one mole of a solid ionic compound into gaseous constituent ions.

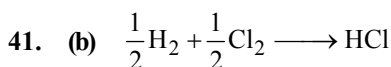
37. (a) The specific conductance increases with concentration. The number of ions per cm^3 increase with increase of concentration.

38. (c) $\left(P + \frac{a}{V^2} \right) (V - b) = RT$; Here $\left(P + \frac{a}{V^2} \right)$

represents the intermolecular forces.

39. (a) Photochemical smog $\Rightarrow \text{O}_3, \text{PAN}, \text{NO}_x$

40. (a) Colloid of liquid in liquid is called emulsion. Colloid of liquid in solid is gel.



$$\Delta H_{\text{HCl}} = \sum \text{B.E. of reactant} - \sum \text{B.E. of products}$$

$$-90 = \frac{1}{2} \times 430 + \frac{1}{2} \times 240 - \text{B.E. of HCl}$$

$$\therefore \text{B.E. of HCl} = 215 + 120 + 90 = 425 \text{ kJ mol}^{-1}$$

42. (a) Chromatography paper contains water trapped in it, which acts as the stationary phase.

43. (d) Vitamin B₁ - Thiamin
 Vitamin B₆ - Pyridoxine

44. (b) High density polythene is formed when addition polymerisation of ethene takes place in a hydrocarbon solvent in presence of catalyst such as Ziegler-Natta catalyst.

45. (a) Mg burns in CO₂ to give MgO and C.

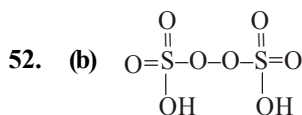
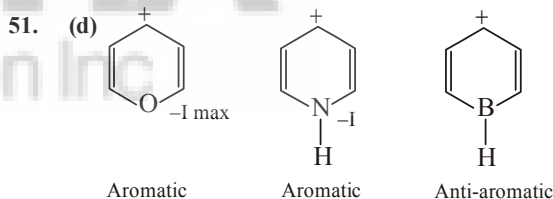
46. (d) Alkenes having double bonds with two different groups on each end of the double bond show geometrical isomerism. A₂b₂c₂, A₂b₂cd, A₂bcd₂.



48. (a) These drugs induce sleep and are habit forming common example of hypnotic drugs are luminal and saconal.

49. (a) 1° amines (aliphatic and aromatic) react with CHCl_3/KOH to yield isocyanide (foul smelling) This is known as carbylamine test which is not given by 2° and 3° amines.

50. (a) Urea acts as stabilising agent. It prevents the decomposition of H₂O₂.



Peroxodisulphuric acid
 (H₂S₂O₈)

53. (a) Pyrolusite (It is MnO₂)

54. (c) Reduction potential is maximum for S₂O₈²⁻, therefore, it is the strongest oxidising agent amongst the given species.

55. (d) In last case CH₄ is produced.

56. (c) [PtCl₂(NH₃)₄]Br₂ and [PtBr₂(NH₃)₄]Cl₂ are ionisation isomers.

57. (d) $(\text{CH}_3)_3\text{B}$ is an electron deficient, thus behave as a lewis acid.
58. (d) This reaction proceeds in the presence of anhydrous AlCl_3 or CuCl .
59. (b) $\Delta T_f = K_f \times m = 1.86 \times 0.5 = 0.93^\circ\text{C}$;
 $T_f = -0.93^\circ\text{C}$
60. (a) Gangue is the commercially worthless material which contaminates the ore.

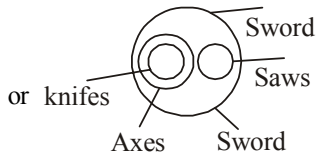
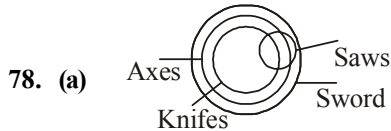
PART - III (A): ENGLISH PROFICIENCY

61. (a) 'Eloquent' means fluent or persuasive in speaking or writing.
62. (a) 'Nefarious' means morally bad in principles or practice.
63. (d) If a person is very fat, you euphemistically call him or her corpulent. Emaciated, on the other hand, means extremely thin or weak because of illness or lack of food.
64. (a) The sentence has a general tone which is in simple past tense with the usages of verb+s because the subject is singular.
65. (b) The mention of 'now we live in Delhi' suggests that they lived in London in the past. So for that we use 'used to'.
66. (a) A school of psychology argues that motorecycling – like gambling or skydiving – is one of the manifestations of impulse control disorder, a condition in which an individual cannot resist the impulse or temptation to perform an act harmful for oneself or others.
67. (d) With six of its neighbours ranking high on global roster of failed states there is a renewed warning for India to reassess its policy towards them and safeguard its own strategic interests.
68. (b) Murali was a vendor of sweets.
69. (a) Murali's main customers were children.
70. (d) At the stroke of nine in the morning, Murali would stand in front of the school with his tray of sweets.

PART - III (B) : LOGICAL REASONING

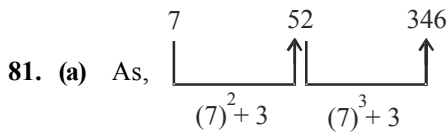
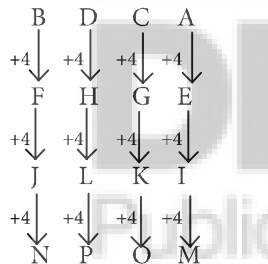
71. (a) $\text{XXIV} \times 2$
 $\Rightarrow 24 \times 2 = 48$
 Similarly,
 $\text{XIV} \times 2 = 14 \times 2 = 28$
72. (c) Answer figure (c) is the best fit to the question figure.
73. (d) $\text{do re me} \rightarrow \text{he is late}$
 $\text{fa me la} \rightarrow \text{she is early}$
 $\text{so ti do} \rightarrow \text{he leaves soon}$
 Hence $\text{re} \rightarrow \text{Late}$
74. (a) $\text{P}(+) \Leftrightarrow \text{S}(-)$
 $\begin{array}{l} | \quad \quad \quad | \\ \text{J} - \text{N}(+) \quad \quad \text{B}(+) - \text{C}(-) \end{array}$
 The gender of J is unknown, therefore J may be brother or sister of C.
75. (d) Given Series is:
 $22, 45, 91, 183, 367$
 $\xrightarrow{\times 2 + 1} \quad \xrightarrow{\times 2 + 1} \quad \xrightarrow{\times 2 + 1} \quad \xrightarrow{\times 2 + 1}$
76. (d) $\left(\frac{3}{2} - 1\right) = \frac{1}{2} \Rightarrow 1^{\text{st}} \text{ row}$
 $\left(\frac{8}{3} - 2\right) = \frac{2}{3} \Rightarrow 2^{\text{nd}} \text{ row}$
 $\left(\frac{19}{5} - 3\right) = \frac{4}{5} \Rightarrow 3^{\text{rd}} \text{ row}$
77. (c) Meaningful order of words:
 2. Vegetable
 \downarrow
 6. Cut
 \downarrow
 4. Prepare
 \downarrow
 3. Package

- ↓
5. Store
↓
1. Serve

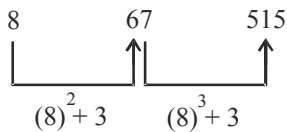


Hence, either 'some axes are saws' or 'no axes are saws'

79. (d) GREEN
80. (c)



Similarly,



82. (d) Lily, Daisy, Datura all have outer part white and inner part yellow.
Jasmine also has outer part white and inner part yellow.

83. (c) $142 : 15 \Rightarrow (1 \times 4 \times 2) + (1 + 4 + 2) = 15$
 $234 : ? \Rightarrow (2 \times 3 \times 4) + (2 + 3 + 4) = 33$

84. (a) $2678 \Rightarrow 2 \times 6 \times 7 \times 8 = 672$
 $4325 \Rightarrow 4 \times 3 \times 2 \times 5 = 120$
 $6931 \Rightarrow 6 \times 9 \times 3 \times 1 = 162$
 $2132 \Rightarrow 2 \times 1 \times 3 \times 1 = 161$

85. (a) As, $(4 + 6 + 9) \times 2 = 38$
 $(8 + 9 + 11) \times 2 = 56$

Similarly,

$(12 + 13 + 11) \times 2 = 72$

86. (a) From options

- (a) $37, 4 \rightarrow 37 \times 4 = 148$ {odd one}
(b) $24, 7 \rightarrow 24 \times 7 = 168$
(c) $42, 4 \rightarrow 42 \times 4 = 168$
(d) $14, 12 \rightarrow 14 \times 12 = 168$

87. (c)

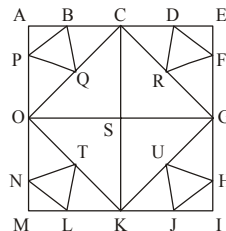
$\div \rightarrow >$	$\times \rightarrow +$
$+ \rightarrow \div$	$- \rightarrow =$
$> \rightarrow \times$	$= \rightarrow <$
$< \rightarrow -$	

$5 > 2 \times 1 - 3 > 4 < 1$

Using the proper notations in (c), we get the statement as:

$5 \times 2 + 1 = 3 \times 4 - 1$
 $10 + 1 = 12 - 1$
 $11 = 11$

88. (c)

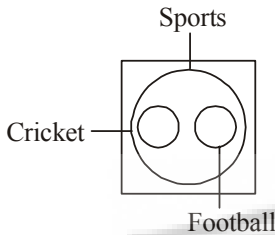


The triangles are:

$\Delta ABP; \Delta BQP; \Delta PQO; \Delta BCQ$

- $\Delta ACO; \Delta CSO; \Delta CDR; \Delta DRF;$
 $\Delta DEF; \Delta RFG; \Delta CSG; \Delta ECG;$
 $\Delta IJH; \Delta JUH; \Delta GHU; \Delta JKU$
 $\Delta GIH; \Delta SGK; \Delta ONT; \Delta NTL;$
 $\Delta NML; \Delta TLK; \Delta MOK; \Delta SOK;$
 $\Delta CGO; \Delta GKC; \Delta KGO; \Delta COK$

89. (d) The Venn diagrams best represent the relationship between - Sports, Cricket, Football figures are shown below.



Both Cricket and Football are comes under the category of sport but the cricket and football are different types of sports so they are separated here.

Hence, correct answer is option (d).

90. (b) It will appear line option (b), when unfolded

PART - IV : MATHEMATICS

91. (b) Z is 7 minimum at $(\frac{3}{2}, \frac{1}{2})$
92. (c) Given boolean expression are
 $\sim p \vee q \equiv p \rightarrow q$ and $\sim q \wedge p \equiv \sim(p \rightarrow q)$
 Negation of $\sim(p \rightarrow q) \rightarrow (p \rightarrow q)$
 is $\sim(p \rightarrow q) \wedge (\sim(p \rightarrow q))$ i.e., $\sim(p \rightarrow q)$
93. (a) A vector perpendicular to the plane is

$$(\hat{i} - 2\hat{j} - \hat{k}) \times (3\hat{i} - 2\hat{j} - \hat{k})$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & -1 \\ 3 & -2 & -1 \end{vmatrix} = -2\hat{j} + 4\hat{k}$$

$$\Rightarrow \text{unit vector } \hat{a} = \frac{-2\hat{j} + 4\hat{k}}{\sqrt{4+16}} = \frac{-2\hat{j} + 4\hat{k}}{2\sqrt{5}}$$

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Angle between the unit vector and $\vec{r} = \hat{i} + \hat{j} + \hat{k}$

$$= \cos^{-1} \frac{\vec{r} \cdot \hat{a}}{|\vec{r}| \cdot |\hat{a}|} = \cos^{-1} \frac{1}{\sqrt{15}} = \tan^{-1} \sqrt{14}$$

94. (b) Given curve is $x = 3t^2 + 1$... (i)

$$\therefore \frac{dx}{dt} = 6t$$

Second curve is $y = t^3 - 1$... (ii)

$$\therefore \frac{dy}{dt} = 3t^2$$

$$\therefore \frac{dy}{dx} = \frac{dy}{dt} \times \frac{dt}{dx} = 3t^2 \times \frac{1}{6t} = \frac{t}{2}$$

But from (i) when $x = 1$

$$\text{we have } 1 = 3t^2 + 1 \Rightarrow 3t^2 = 0 \Rightarrow t = 0$$

$$\therefore \text{When } x = 1 \text{ then } t = 0 \therefore \frac{dy}{dx} = 0$$

Hence, slope of the tangent to the curve = 0

95. (a) We have $\tan 5\theta = \cot 2\theta$
 $\Rightarrow \tan 5\theta = \tan\left(\frac{\pi}{2} - 2\theta\right) \dots$

$$\left[\because \tan\left(\frac{\pi}{2} - \theta\right) = \cot \theta \right]$$

$$\Rightarrow 5\theta = n\pi + \frac{\pi}{2} - 2\theta \Rightarrow 7\theta = n\pi + \frac{\pi}{2}$$

$$\Rightarrow \theta = \frac{n\pi}{7} + \frac{\pi}{14}$$

96. (c) X - X - X - X - X. The four digits 3, 3, 5, 5 can be arranged at (-) places in $\frac{4!}{2!2!} = 6$ ways. The five digits 2, 2, 8, 8, 8 can be arranged at (X) places in $\frac{5!}{2!3!}$ ways = 10 ways
 Total no. of arrangements = $6 \times 10 = 60$ ways

97. (b) Ratio = $-\left(\frac{3}{-2}\right) = \frac{3}{2}$

∴ Required co-ordinates of the points are

$$\left[\frac{6-6}{5}, \frac{10+3}{5}, \frac{-14+24}{5}\right] = \left(0, \frac{13}{5}, 2\right).$$

∴ a + b - c = 0 + 5 - 2 = 3

98. (a) When the two lines intersect then shortest distance between them is zero i.e.

$$\frac{(\vec{a}_2 - \vec{a}_1) \cdot \vec{b}_1 \times \vec{b}_2}{|\vec{b}_1 \times \vec{b}_2|} = 0$$

⇒ $(\vec{a}_2 - \vec{a}_1) \cdot \vec{b}_1 \times \vec{b}_2 = 0$

where $\vec{a}_1 = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b}_1 = k\hat{i} + 2\hat{j} + 3\hat{k}$

$\vec{a}_2 = 2\hat{i} + 3\hat{j} + \hat{k}$, $\vec{b}_2 = 3\hat{i} + k\hat{j} + 2\hat{k}$

⇒ $\begin{vmatrix} 1 & 1 & -2 \\ k & 2 & 3 \\ 3 & k & 2 \end{vmatrix} = 0$

⇒ $1(4 - 3k) - 1(2k - 9) - 2(k^2 - 6) = 0$

⇒ $-2k^2 - 5k + 25 = 0 \Rightarrow k = -5$ or $\frac{5}{2}$

99. (d) Since, $f(x) = \begin{cases} x^2 - 1, & 0 < x < 2 \\ 2x + 3, & 2 \leq x < 3 \end{cases}$

Now, $\lim_{x \rightarrow 2^-} f(x) = \lim_{x \rightarrow 2^-} (x^2 - 1)$

= $\lim_{h \rightarrow 0} [(2 - h)^2 - 1] = \lim_{h \rightarrow 0} [4 + h^2 - 4h - 1]$

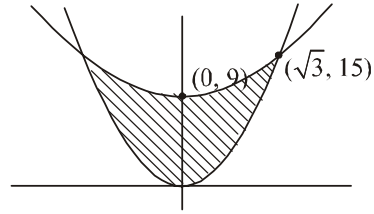
= $\lim_{h \rightarrow 0} [h^2 - 4h + 3] = 0 - 0 + 3 = 3$

and $\lim_{x \rightarrow 2^+} f(x) = \lim_{x \rightarrow 2^+} (2x + 3)$

= $\lim_{h \rightarrow 0} [2(2 + h) + 3] = \lim_{h \rightarrow 0} [4 + 2h + 3] = 7$

Hence the quadratic equation whose roots are 3 and 7 is given by $x^2 - (3 + 7)x + (3 + 7) = 0 \Rightarrow x^2 - 10x + 21 = 0$

100. (b)



Required area = $2 \int_0^{\sqrt{3}} (2x^2 + 9 - 5x^2) dx$

= $2 \left[9x - x^3 \right]_0^{\sqrt{3}} = 2[9\sqrt{3} - 3\sqrt{3}] = 12\sqrt{3}$.

101. (d) $n(A) = 1000$, $n(B) = 500$, $n(A \cap B) \geq 1$,
 $n(A \cup B) = p$; $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
 $p = 1000 + 500 - n(A \cap B) \Rightarrow 1 \leq n(A \cap B) \leq 500$
Hence $p \leq 1499$ and $p \geq 1000 \Rightarrow 1000 \leq p \leq 1499$

102. (c) Let $P(n) = 2 \cdot 4^{2n+1} + 3^{3n+1}$
Then $P(1) = 2 \cdot 4^3 + 3^4 = 209$, which is divisible by 11 but not divisible by 2, 7 or 27.
Further, let $P(k) = 2 \cdot 4^{2k+1} + 3^{3k+1}$ is divisible by 11, that is,

$2 \cdot 4^{2k+1} + 3^{3k+1} = 11q$ for some integer q. Now

$P(k+1) = 2 \cdot 4^{2k+3} + 3^{3k+4}$

= $2 \cdot 4^{2k+1} \cdot 4^2 + 3^{3k+1} \cdot 3^3$

= $16 \cdot 2 \cdot 4^{2k+1} + 27 \cdot 3^{3k+1}$

= $16 \cdot 2 \cdot 4^{2k+1} + (16+11) \cdot 3^{3k+1}$

= $16[2 \cdot 4^{2k+1} + 3^{3k+1}] + 11 \cdot 3^{3k+1}$

= $16 \cdot 11q + 11 \cdot 3^{3k+1}$

= $11(16q + 3^{3k+1}) = 11m$

where $m = 16q + 3^{3k+1}$ is another integer.

∴ $P(k+1)$ is divisible by 11.

103. (c) Given equation is

$(p - q)x^2 + (q - r)x + (r - p) = 0$

By using formula for finding the roots

viz: $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, we get

$$\frac{2}{3} S = 1 + \frac{1}{3} + \frac{4}{3^2} + \frac{4}{3^3} + \frac{4}{3^4} + \dots \infty$$

$$\Rightarrow \frac{2}{3} S = \frac{4}{3} + \frac{4}{3^2} + \frac{4}{3^3} + \frac{4}{3^4} + \dots \infty$$

$$\Rightarrow \frac{2}{3} S = \frac{\frac{4}{3}}{1 - \frac{1}{3}} = \frac{4}{3} \times \frac{3}{2} \Rightarrow S = 3$$

109. (a) Given $f(x) = \frac{4x+3}{6x-4}$

Let $y = \frac{4x+3}{6x-4}$,

$$\Rightarrow 6xy - 4y = 4x + 3 \Rightarrow x(6y - 4) = 3 + 4y$$

$$\Rightarrow x = \frac{3+4y}{6y-4}$$

$$f^{-1}(x) = \frac{3+4x}{6x-4}$$

110. (a) Given hyperbola is

$$9x^2 - 16y^2 - 36x + 96y - 252 = 0$$

$$\Rightarrow 9(x^2 - 4x) - 16(y^2 - 6y) = 252$$

$$\Rightarrow 9(x^2 - 4x + 4) - 16(y^2 - 6y + 9)$$

$$= 252 + 36 - 144$$

$$\Rightarrow 9(x-2)^2 - 16(y-3)^2 = 144$$

$$\Rightarrow \frac{(x-2)^2}{16} - \frac{(y-3)^2}{9} = 1 \quad \dots(i)$$

Put $x = X + 2$ and $y = Y + 3$

\therefore Equation (i) becomes $\frac{X^2}{16} - \frac{Y^2}{9} = 1$

Now, vertices are $X = \pm a$ where $a = 4$ and $Y = 0$

Hence, vertices are $(6, 3), (-2, 3)$.

111. (d) Here, $y^x = e^{y-x}$

Taking log on both sides, we get

$$\log y^x = \log e^{y-x}$$

$$\left(\because \log a^b = b \log a \text{ and } \log e = 1 \right)$$

$$\Rightarrow x \log y = (y-x) \log e \Rightarrow x \log y = y-x \quad \dots(i)$$

On differentiating w.r.t. x , we get

$$\frac{d}{dx}(x \log y) = \frac{d}{dx}(y-x)$$

(using product rule)

$$\Rightarrow x \left(\frac{1}{y} \right) \frac{dy}{dx} + \log y(1) = \frac{dy}{dx} - 1$$

$$\Rightarrow \frac{dy}{dx} \left(\frac{x}{y} - 1 \right) = -1 - \log y$$

$$\Rightarrow \frac{dy}{dx} \left[\frac{y}{(1+\log y)y} - 1 \right] = -(1+\log y)$$

$$\left[\because \text{from eq.(i), } x = \frac{y}{(1+\log y)} \right]$$

$$\Rightarrow \frac{dy}{dx} \left[\frac{1-1-\log y}{1+\log y} \right] = -(1+\log y)$$

$$\Rightarrow \frac{dy}{dx} = \frac{(1+\log y)^2}{-\log y}$$

$$\Rightarrow \frac{dy}{dx} = \frac{(1+\log y)^2}{\log y}$$

112. (c) $AB = \begin{bmatrix} 0 & c & -b \\ -c & 0 & a \\ b & -a & 0 \end{bmatrix} \begin{bmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{bmatrix}$

$$AB = \begin{bmatrix} abc - abc & b^2c - b^2c & bc^2 - bc^2 \\ -a^2c + a^2c & -abc + abc & -ac + ac \\ a^2b - a^2b & ab^2 - ab^2 & abc - abc \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = O$$

113. (b) Let (h, k) be the coordinates of the foot of the perpendicular from the point $(2, 3)$ on the line $x + y - 11 = 0$. Then, the slope of the perpendicular line is $\frac{k-3}{h-2}$. Again the slope of the given line $x + y - 11 = 0$ is -1 . Using the condition of perpendicularity of lines, we have

$$\left(\frac{k-3}{h-2}\right)(-1) = -1 \quad \text{or} \quad k-h=1 \quad \dots(i)$$

Since (h, k) lies on the given line, we have,
 $h+k-11=0$ or $h+k=11$ $\dots(ii)$
 Solving (i) and (ii), we get $h=5$ and $k=6$. Thus $(5, 6)$ are the required coordinates of the foot of the perpendicular.

114. (c) For mutually exclusive events

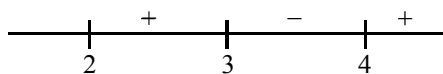
$$P(A \cup B) = P(A) + P(B) \Rightarrow P(A) = \frac{2}{7}$$

115. (d) The sample space is $S = \{HH, HT, TH, TT\}$
 Let E be the event of getting atleast one tail
 $\therefore E = \{HT, TH, TT\}$
 \therefore Required probability p

$$= \frac{\text{Number of favourable outcomes}}{\text{Total number of outcomes}} = \frac{n(E)}{n(S)} = \frac{3}{4}$$

116. (b) Clearly $x > 2$. Write the given inequality as
 $(x^2 - 6x + 8) \log(x-2) > 0 \Leftrightarrow (x-2)(x-4) \log(x-2) > 0$

$$\Leftrightarrow (x-4) \log(x-2) > 0 \quad [\because x > 2]$$



117. (b) We have, $f(x) = \sqrt{1 + \cos^2(x^2)}$ $\dots(i)$

On differentiating (i) w.r.t.x, we get

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

$$\Rightarrow f'(x) = \frac{-\sin 2x^2}{\sqrt{1 + \cos^2 x^2}}(x) \quad \dots(ii)$$

Put, $x = \frac{\sqrt{\pi}}{2}$ in (ii), we get

$$f'\left(\frac{\sqrt{\pi}}{2}\right) = -\frac{\sqrt{\pi}}{2} \cdot \frac{\sin 2\left(\frac{\pi}{4}\right)}{\sqrt{1 + \frac{1}{2}}}$$

$$= -\frac{\sqrt{\pi}}{2} \cdot \frac{\sin \frac{\pi}{2}}{\sqrt{\frac{3}{2}}} = -\sqrt{\frac{\pi}{6}}$$

118. (c) Since $x \frac{dy}{dx} - y = x^4 - 3x$

$$\therefore \frac{dy}{dx} - \frac{y}{x} = x^3 - 3$$

$$\text{Hence } IF = e^{\int P dx} = e^{-\int \frac{1}{x} dx} = e^{-\log x} = \frac{1}{x}$$

119. (a) $P(E|F) + P(\bar{E}|F)$

$$= \frac{P(E \cap F) + P(\bar{E} \cap F)}{P(F)} = \frac{P((E \cup \bar{E}) \cap F)}{P(F)} = \frac{P(F)}{P(F)} = 1$$

120. (b) The lines are $\frac{x}{6} = \frac{y+2}{6} = \frac{z-1}{1}$

$$\text{and } \frac{x+1}{12} = \frac{y}{6} = \frac{z}{-1}$$

Here,

$$\vec{a}_1 = -2\hat{j} + \hat{k}, \quad \vec{b}_1 + 6\hat{i} + 6\hat{j} + \hat{k}, \quad \vec{a}_2 = -\hat{i},$$

$$\vec{b}_2 = 12\hat{i} + 6\hat{j} - \hat{k}$$

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 6 & 6 & 1 \\ 12 & 6 & -1 \end{vmatrix} = -12\hat{i} + 18\hat{j} - 36\hat{k}$$

$$\text{Shortest distance} = \frac{|(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 - \vec{b}_2)|}{|\vec{b}_1 \times \vec{b}_2|}$$

$$= \frac{|(-\hat{i} + 2\hat{j} - \hat{k}) \cdot (-12\hat{i} + 18\hat{j} - 36\hat{k})|}{\sqrt{(-12)^2 + (18)^2 + (-36)^2}}$$

$$= \frac{|+12 + 36 + 36|}{\sqrt{1764}} = \frac{84}{42} = 2$$

121. (a) $\cos[2\cos^{-1}x + \sin^{-1}x]$

$$= \cos[\cos^{-1}x + \cos^{-1}x + \sin^{-1}x]$$

$$= \cos[\cos^{-1}x + \pi/2] = -\sin[\cos^{-1}x]$$

$$= -\sin[\sin^{-1}\sqrt{1-x^2}] = -\sqrt{1-x^2}$$

$$= -\sqrt{1 - \left(\frac{1}{5}\right)^2} = -\sqrt{\frac{24}{25}} = -\frac{2\sqrt{6}}{5}$$

122. (b) Suppose, $I = \int_0^{\pi/2} \cos x e^{\sin x} dx$

Let $\sin x = t \Rightarrow \cos x dx = dt$
 $x \rightarrow 0 \Rightarrow t \rightarrow 0$

and $x \rightarrow \frac{\pi}{2} \Rightarrow t \rightarrow 1$

So $I = \int_0^1 e^t dt = [e^t]_0^1 = e - 1$

123. (c) In the expansion of $\left(x^4 + \frac{1}{x^3}\right)^{15}$, let T_r is

the r^{th} term

$$T_r = {}^{15}C_{r-1} (x^4)^{15-r+1} \left(\frac{1}{x^3}\right)^{r-1}$$

$$= {}^{15}C_{r-1} x^{64-4r-3r+3} = {}^{15}C_{r-1} x^{67-7r}$$

x^{18} occurs in this term

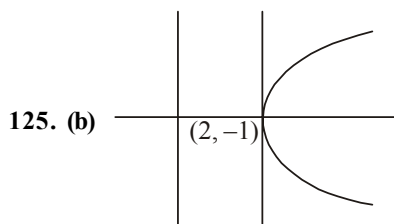
$$\Rightarrow 18 = 67 - 7r \Rightarrow 7r = 49 \Rightarrow r = 7.$$

124. (c) Here, $b^2 - 4ac = 1^2 - 4 \times \sqrt{5} \times \sqrt{5}$

$$= 1 - 20 = -19$$

Therefore, the solutions are

$$\frac{-1 \pm \sqrt{-19}}{2\sqrt{5}} = \frac{-1 \pm \sqrt{19}i}{2\sqrt{5}}$$



We are given that directrix of the parabola is $4x - 3y = 21$

and vertex of the parabola is $(2, -1)$

Now $a = \frac{|8 + 3 - 21|}{5} = \frac{10}{5} = 2$

\therefore latus rectum of the parabola $= 4a = 8$

126. (d) $\frac{(1 + i\sqrt{3})(2 + 2i)}{\sqrt{3} - i} = \frac{2 + 2\sqrt{3}i + 2i - 2\sqrt{3}}{\sqrt{3} - i}$

$$= \frac{(2 - 2\sqrt{3}) + (2\sqrt{3} + 2)i}{\sqrt{3} - i} \times \frac{\sqrt{3} + i}{\sqrt{3} + i}$$

$$= \frac{2\sqrt{3} - 6 + 2i - 2\sqrt{3}i + 6i + 2\sqrt{3}i - 2\sqrt{3} - 2}{3 + 1}$$

$$= \frac{8i - 8}{4} = -2 + 2i$$

\therefore Modulus $= \sqrt{(-2)^2 + (2)^2} = 2\sqrt{2}.$

127. (c) Here $h = 0, k = 2$ and $r = 2$. Therefore, the required equation of the circle is :

$$(x - 0)^2 + (y - 2)^2 = (2)^2$$

or $x^2 + y^2 - 4y + 4 = 4$ or $x^2 + y^2 - 4y = 0$

128. (d) (a) Let $f(x) = \cos x$, then $f'(x) = -\sin x$.

In interval $\left(0, \frac{\pi}{2}\right)$, $f'(x) < 0$

Therefore, $f(x)$ is strictly decreasing on $\left(0, \frac{\pi}{2}\right)$

(b) Let $f(x) = \cos 2x \Rightarrow f'(x) = -2 \sin 2x$

In interval $\left(0, \frac{\pi}{2}\right)$, $f'(x) < 0$

Because $\sin 2x$ will either lie in the first or second quadrant which will give a positive value.

Therefore, $f(x)$ is strictly decreasing on $\left(0, \frac{\pi}{2}\right)$

(c) Let $f'(x) = \cos 3x$

$\Rightarrow f'(x) = -3\sin 3x$. In Interval $\left(0, \frac{\pi}{3}\right)$, $f'(x) < 0$

Because $\sin 3x$ will either lie in the first or second quadrant which will give a positive value.

Therefore, $f(x)$ is strictly decreasing on $\left(0, \frac{\pi}{3}\right)$.

When $x \in \left(\frac{\pi}{3}, \frac{\pi}{2}\right)$, then $f'(x) > 0$

Because $\sin 3x$ will lie in the third quadrant.

Therefore, $f(x)$ is not strictly decreasing on

$\left(0, \frac{\pi}{2}\right)$

(d) Let $f(x) = \tan x \Rightarrow f'(x) = \sec^2 x$.

In Interval $x \in \left(0, \frac{\pi}{2}\right)$, $f'(x) > 0$

Therefore, $f(x)$ is not strictly decreasing on

$\left(0, \frac{\pi}{2}\right)$

129. (a) Let $x = a \sin^2 \theta$

then $dx = 2a \sin \theta \cos \theta d\theta$

$$\therefore I = \int \frac{2a \sin \theta \cos \theta}{\sqrt{a \sin^2 \theta} \cdot a \cos^2 \theta} d\theta$$

$$= 2 \int d\theta = 2\theta + c$$

$$= 2 \sin^{-1}(\sqrt{x/a}) + c$$

130. (a) Mean $(\bar{x}) = \frac{1+2+3+4+5}{5} = 3$

$$S.D = \sigma = \sqrt{\frac{1}{5}(1+4+9+16+25) - 9} = \sqrt{11-9}$$

$$= \sqrt{2}$$