# BITSAT
## ENTRANCE EXAM
## SOLVED PAPER 2007



### Mathematics

**1.** The sum of 24 terms of the following series $\sqrt{2}+\sqrt{8}+\sqrt{18}+\sqrt{32}+\ldots$ is
(a) 300 (b) $200\sqrt{2}$
(c) $300\sqrt{2}$ (d) $250\sqrt{2}$

**2.** If $\sin A+\cos B=a$ and $\sin B+\cos A=b$, then $\sin(A+B)$ is equal to
(a) $\frac{a^2+b^2}{2}$ (b) $\frac{a^2-b^2+2}{2}$
(c) $\frac{a^2+b^2-2}{2}$ (d) none of these

**3.** The number of solution of the equation $1+\sin x\sin^2\frac{x}{2}=0$, in $[-\pi,\pi]$ is
(a) zero (b) one
(c) two (d) three

**4.** If $C=2\cos\theta$, then the value of the determinant $\Delta=\begin{vmatrix} C & 1 & 0 \\ 1 & C & 1 \\ 6 & 1 & C \end{vmatrix}$ is
(a) $\frac{2\sin^2 2\theta}{\sin\theta}$
(b) $8\cos^3\theta-4\cos\theta+6$
(c) $\frac{2\sin 2\theta}{\sin\theta}$
(d) $8\cos^3\theta+4\cos\theta+6$

**5.** If $A=\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$ and $I$ is the unit matrix of order 2, then $A^2$ equals
(a) $4A-3I$ (b) $3A-4I$
(c) $A-I$ (d) $A+I$

**6.** The horizontal distance between two towers is 60 m and the angle of depression of the top of the first tower as seen from the top of the second is 30°. If the height of the second tower be 150 m, then the height of the first tower is
(a) 90 m (b) $(150-60\sqrt{3})$ m
(c) $(150+20\sqrt{3})$ m (d) none of these

**7.** If a vertex of a triangle is (1, 1) and the mid points of two sides through the vertex are (−1, 2) and (3, 2), then the centroid of the triangle is
(a) $\left(1,\frac{7}{3}\right)$ (b) $\left(\frac{1}{3},\frac{7}{3}\right)$
(c) $\left(-\frac{1}{3},\frac{7}{3}\right)$ (d) $\left(-1,\frac{7}{3}\right)$

**8.** Let $R=\{(1,3),(4,2),(2,4),(2,3),(3,1)\}$ be a relation on the set $A=\{1,2,3,4\}$. The relation $R$ is
(a) a function (b) transitive
(c) not symmetric (d) reflexive

**9.** $(x-1)(x^2-5x+7)<(x-1)$, then $x$ belongs to
(a) $(1,2)\cup(3,\infty)$ (b) $(-\infty,1)\cup(2,3)$
(c) $(2,3)$ (d) none of these

**10.** Let $A$ be an orthogonal non-singular matrix of order $n$, then the determinant of matrix '$A-I_n$' ie, $|A-I_n|$ is equal to
(a) $|I_n-A|$ (b) $|A||I_n-A|$
(c) $|A|$ (d) $(-1)^n|A||I_n-A|$

**11.** If $(\cos\theta+i\sin\theta)(\cos 2\theta+i\sin 2\theta)\ldots(\cos n\theta+i\sin n\theta)=1$, then the value of $\theta$ is
(a) $\frac{2m\pi}{n(n+1)}$ (b) $4m\pi$
(c) $\frac{4m\pi}{n(n+1)}$ (d) $\frac{m\pi}{n(n+1)}$

**12.** If one root of the quadratic equation $ax^2+bx+c=0$ is equal to $n$th power of the other root, then the value of $(ac^n)^{\frac{1}{n+1}}+(a^nc)^{\frac{1}{n+1}}$ is equal to
(a) $b$ (b) $-b$
(c) $\frac{1}{b^{n+1}}$ (d) $-b^{\frac{1}{n+1}}$

**13.** In how many ways can 5 boys and 5 girls sit in a circle so that no two boys sit together ?
(a) $5! \times 5!$ (b) $4! \times 5!$
(c) $\frac{5! \times 5!}{2}$ (d) none of these

**14.** The probability that the same number appear on throwing three dice simultaneously, is
(a) 1/36 (b) 5/36
(c) 1/6 (d) 4/13

**15.** The length of the common chord of the ellipse $\frac{(x-1)^2}{9}+\frac{(y-2)^2}{4}=1$ and the circle $(x-1)^2+(y-2)^2=1$ is
(a) 0 (b) $\sqrt{3}$
(c) 4 (d) 5

**16.** For hyperbola $\frac{x^2}{\cos^2\alpha}-\frac{y^2}{\sin^2\alpha}=1$ which of the following remains constant with change in '$\alpha$'?
(a) Abscissae of vertices
(b) Abscissae of foci
(c) Eccentricity
(d) Directrix

**17.** Area of the region satisfying $x \le 2$, $y \le |x|$ and $x \ge 0$ is
(a) 4 sq unit (b) 1 sq unit
(c) 2 sq unit (d) none of these

**18.** The solution of the differential equation $\frac{dy}{dx}+\frac{2yx}{1+x^2}=\frac{1}{(1+x^2)^2}$ is
(a) $y(1+x^2)=c+\tan^{-1}x$
(b) $\frac{y}{1+x^2}=c+\tan^{-1}x$
(c) $y\log(1+x^2)=c+\tan^{-1}x$
(d) $y(1+x^2)=c+\sin^{-1}x$

**19.** Number of solutions of $y=e^x$ and $y=\sin x$ is
(a) 0 (b) 1
(c) 2 (d) infinite

**20.** If $f(x)=\begin{cases}\frac{1-\cos x}{x}, & x \ne 0\\ x, & x=0\end{cases}$ is continuous at $x=0$, then the value of $k$ is
(a) 0 (b) $\frac{1}{2}$
(c) $\frac{1}{4}$ (d) $-\frac{1}{2}$

**21.** In $\Delta ABC$, $(a-b)^2\cos^2\frac{C}{2}+(a+b)^2\sin^2\frac{C}{2}$ is equal to
(a) $a^2$ (b) $b^2$
(c) $c^2$ (d) none of these

**22.** $\int\frac{1+\tan^2 x}{1-\tan^2 x}dx$ is equal to
(a) $\log\left(\frac{1-\tan x}{1+\tan x}\right)+c$
(b) $\log\left(\frac{1+\tan x}{1-\tan x}\right)+c$
(c) $\frac{1}{2}\log\left(\frac{1-\tan x}{1+\tan x}\right)+c$
(d) $\frac{1}{2}\log\left(\frac{1+\tan x}{1-\tan x}\right)+c$

**23.** $\int_0^8|x-5|\,dx$ is equal to
(a) 17 (b) 9
(c) 12 (d) 18

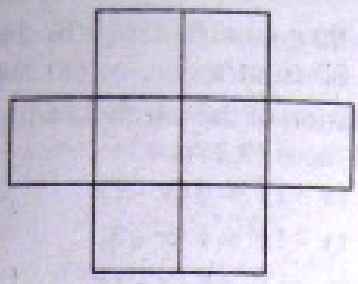
**24.** If $I_1=\int_0^1 2^{x^2}dx$, $I_2=\int_0^1 2^{x^3}dx$, $I_3=\int_1^2 2^{x^2}dx$ and $I_4=\int_1^2 2^{x^3}dx$, then
(a) $I_3>I_4$ (b) $I_3=I_4$
(c) $I_1>I_2$ (d) $I_2>I_1$

**25.** Distance between the pair of lines represented by the equation $x^2-6xy+9y^2+3x-9y-4=0$ is
(a) $\frac{15}{\sqrt{10}}$ (b) $\frac{1}{2}$
(c) $\sqrt{\frac{5}{2}}$ (d) $\frac{1}{\sqrt{10}}$

**26.** Centre of circle whose normals are $x^2-2xy-3x+6y=0$, is
(a) $\left(3,\frac{3}{2}\right)$ (b) $\left(3,-\frac{3}{2}\right)$
(c) $\left(\frac{3}{2},3\right)$ (d) none of these

**27.** A coin is tossed $n$ times. The probability of getting head at least once is greater than 0.8, then the least value of $n$ is
(a) 2 (b) 3
(c) 5 (d) 4

**28.** Six $X$'s have to be placed in the square of the figure such that each row contains at least one '$X$'. In how many different ways can this be done ?



(a) 27 (b) 28
(c) 26 (d) 35

**29.** For all complex numbers $z_1, z_2$ satisfying $|z_1| = 12$ and $|z_2 - 3 - 4i| = 5$, the minimum value of $|z_1 - z_2|$ is
(a) 4 (b) 3
(c) 1 (d) 2

**30.** If $a = \log_2 3$, $b = \log_2 5$, $c = \log_7 2$, then $\log_{140} 63$ in terms of $a, b, c$ is
(a) $\frac{2ac+1}{2c+abc+1}$ (b) $\frac{2ac+1}{2a+c+a}$
(c) $\frac{2ac+1}{2c+ab+a}$ (d) none of these

**31.** $49^n + 16n - 1$ is divisible by
(a) 3 (b) 29
(c) 19 (d) 64

**32.** The solution set of the equation $\sin^{-1} x = 2\tan^{-1} x$ is
(a) $\{1, 2\}$ (b) $\{-1, 2\}$
(c) $\{-1, 1, 0\}$ (d) $\left\{1, \frac{1}{2}, 0\right\}$

**33.** The sum to $n$ terms of the infinite series $1 \cdot 3^2 + 2 \cdot 5^2 + 3 \cdot 7^2 + \ldots \infty$ is
(a) $\frac{n}{6}(n+1)(6n^2+14n+7)$
(b) $\frac{n}{6}(n+1)(2n+1)(3n+1)$
(c) $4n^3 + 4n^2 + n$
(d) none of the above

**34.** The minimum value of $2x + 3y$, when $xy = 6$, is
(a) 9 (b) 12
(c) 8 (d) 6

**35.** The derivative of $\sin^{-1}\left(\frac{2x}{1+x^2}\right)$ with respect to $\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$ is
(a) $-1$ (b) 1
(c) 2 (d) 4

**36.** The equation of the sides of a triangle are $x - 3y = 0$, $4x + 3y = 5$ and $3x + y = 0$. The line $3x - 4y = 0$ passes through
(a) the incentre
(b) the centroid
(c) the orthocentre
(d) the circumcentre

**37.** The centres of a set of circles, each of radius 3, lie on the circle $x^2 + y^2 = 25$. The locus of any point in the set is
(a) $4 \le x^2 + y^2 \le 64$ (b) $x^2 + y^2 \le 25$
(c) $x^2 + y^2 \ge 25$ (d) $3 \le x^2 + y^2 \le 9$

**38.** If $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$, then $\frac{dy}{dx}$ is equal to
(a) $\frac{x}{y}$ (b) $-\frac{x}{y}$
(c) $\frac{y}{x}$ (d) $-\frac{y}{x}$

**39.** If $\lim_{x\to\infty}\left[\frac{x^3+1}{x^2+1} - (ax+b)\right] = 2$, then
(a) $a = 1$ and $b = 1$ (b) $a = 1$ and $b = -1$
(c) $a = 1$ and $b = -2$ (d) $a = 1$ and $b = 2$

**40.** The unit vector which is orthogonal to the vector $3\hat{i} + 2\hat{j} + 6\hat{k}$ and is coplanar with the vectors $2\hat{i} + \hat{j} + \hat{k}$ and $\hat{i} - \hat{j} + \hat{k}$ is
(a) $\frac{2\hat{i} - 6\hat{j} + \hat{k}}{\sqrt{41}}$ (b) $\frac{2\hat{i} - 3\hat{j}}{\sqrt{13}}$
(c) $\frac{3\hat{j} - \hat{k}}{\sqrt{10}}$ (d) $\frac{4\hat{i} + 3\hat{j} - 3\hat{k}}{\sqrt{34}}$

**41.** Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three non-coplanar vectors and let $\vec{p}$, $\vec{q}$ and $\vec{r}$ be vectors defined by the relations

$$\vec{p} = \frac{\vec{b}\times\vec{c}}{[\vec{a}\,\vec{b}\,\vec{c}]}, \quad \vec{q} = \frac{\vec{c}\times\vec{a}}{[\vec{a}\,\vec{b}\,\vec{c}]} \text{ and } \vec{r} = \frac{\vec{a}\times\vec{b}}{[\vec{a}\,\vec{b}\,\vec{c}]}.$$

Then the value of the expression
$(\vec{a}+\vec{b})\cdot\vec{p} + (\vec{b}+\vec{c})\cdot\vec{q} + (\vec{c}+\vec{a})\cdot\vec{r}$ is equal to
(a) 0 (b) 1
(c) 2 (d) 3

**42.** The points $(5, -4, 2)$, $(4, -3, 1)$, $(7, -6, 4)$ and $(8, -7, 5)$ are the vertices of
(a) a rectangle (b) a square
(c) a parallelogram (d) none of these

**43.** Let $A=[-1, 1]$ and $f: A \to A$ be difined as $f(x)=x|x|$ for all $x \in A$, then $f(x)$ is
(a) many-one into function
(b) one-one into function
(c) many-one onto function
(d) one-one onto function

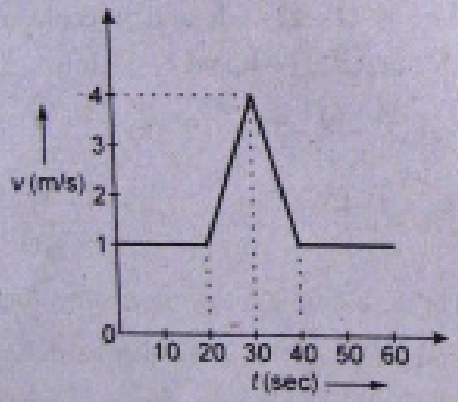
**44.** The radius of a cylinder is increasing at the rate of 3 m/s and its altitude is decreasing at the rate of 4 m/s. The rate of change of volume when radius is 4 m/s. The rate of change of volume when radius is 4m and altitude is 6m, is
(a) $80\pi$ cu m/s (b) $144\pi$ cu m/s
(c) 80 cu m/s (d) 64 cu m/s

**45.** Equation of the parabola with its vertex at (1, 1) and focus (3, 1) is
(a) $(x-1)^2=8(y-1)$
(b) $(y-1)^2=8(x-3)$
(c) $(y-1)^2=8(x-1)$
(d) $(x-3)^2=8(y-1)$

## Physics

**46.** In the relation $P=\frac{\alpha}{\beta}\epsilon^{-\frac{\alpha z}{k\theta}}$, $P$ is the pressure, $z$ the distance, $k$ is Boltzmann constant and $\theta$ is the temperature, the dimensional formula of $\beta$ will be
(a) $[M^0L^2T^0]$ (b) $[ML^2T]$
(c) $[ML^0T^{-1}]$ (d) $[ML^2T^{-1}]$

**47.** Velocity-time ($v$-$t$) graph for a moving object is shown in the figure. Total displacement of the object during the time interval when there is non-zero acceleration and retardation is




(a) 60 m (b) 50 m
(c) 30 m (d) 40 m

**48.** Three weights $w$, $2w$ and $3w$ are connected to identical spring suspended from a rigid horizontal rod. The assembly of the rod and the weights fall freely. The positions of the weight from the rod are such that
(a) $3w$ will be farthest
(b) $w$ will be farthest
(c) all will be at the same distance
(d) $2w$ will be farthest

**49.** At the top of the trajectory of a projectile, the direction of its velocity and acceleration are
(a) perpendicular to each other
(b) parallel to each other
(c) inclined to each other at an angle of 45°
(d) antiparallel to each other

**50.** Consider the following statement. When jumping from some height, you should bend your knees as you come to rest instead of keeping your legs stiff. Which of the following relations can be useful in explaining the statement?
(a) $\Delta\vec{p}_1=-\Delta\vec{p}_2$
(b) $\Delta E=-\Delta(PE+KE)=0$
(c) $\vec{F}\Delta t=m\Delta\vec{v}$
(d) $\Delta\vec{x}\propto\Delta\vec{F}$
where symbols have their usual meaning.

**51.** A ball is released from the top of a tower. The ratio of work done by force of gravity in first, second and third second of the motion of the ball is
(a) 1 : 2 : 3 (b) 1 : 4 : 9
(c) 1 : 3 : 5 (d) 1 : 5 : 3

**52.** Two rings of radius $R$ and $nR$ made up of same material have the ratio of moment of inertia about an axis passing through centre is 1 : 8. The value of $n$ is
(a) 2 (b) $2\sqrt{2}$
(c) 4 (d) $\frac{1}{2}$

**53.** There are two planets. The ratio of radius of the two planets is $K$ but ratio of acceleration due to gravity of both planets is $g$. What will be the ratio of their escape velocity?
(a) $(Kg)^{1/2}$ (b) $(Kg)^{-1/2}$
(c) $(Kg)^2$ (d) $(Kg)^{-2}$

**54.** The extension in a string obeying Hooke's law $v$ is $x$. The speed of sound in the stretched string is $v$. If the extension in the string is increased to 1.5 $x$, the speed of sound will be

(a) 1.22 $v$ (b) 0.61 $v$

(c) 1.50 $v$ (d) 0.75 $v$

**55.** A ball whose density is $0.4 \times 10^3 kg/m^3$ falls into water from a height of 9 cm. To what depth does the ball sink?

(a) 9 cm (b) 6 cm

(c) 4.5 cm (d) 2.25 cm

**56.** A thermodynamical system is changed from state $(P_1, V_1)$ to $(P_2, V_2)$ by two different processes, the quantity which will remain same will be

(a) $\Delta Q$ (b) $\Delta W$

(c) $\Delta Q + \Delta W$ (d) $\Delta Q - \Delta W$

**57.** The relative hunidity on a day when partial pressure of water vapour is $0.012 \times 10^5$ Pa at 12°C is (Take vapour pressure of water at this temperature as $0.016 \times 10^5$ Pa)

(a) 70% (b) 40%

(c) 75% (d) 25%

**58.** In the absence of intermolecular forces of attraction, the observed pressure $P$ will be

(a) $P$ (b) $< P$

(c) $> P$ (d) zero

**59.** In a second pendulum, mass of bob is 30 g. If it is replaced by 90 g mass, then its time period will be

(a) 1 s (b) 2 s

(c) 4 s (d) 3 s

**60.** A wave has velocity $v$ in medium $P$ and velocity $2v$ in medium $Q$. If the wave is incident in medium $P$ at an angle of 30°, then the angle of refraction will be

(a) 30° (b) 45°

(c) 60° (d) 90°

**61.** The equation of progressive wave is $y = 0.2 \sin 2\pi\left[\frac{t}{0.01} - \frac{x}{0.3}\right]$, where $x$ and $y$ are in metre and $t$ is in second. The velocity of propagation of the wave is

(a) 30 m/s (b) 40 m/s

(c) 300 m/s (d) 400 m/s

**62.** The displacement of a charge $Q$ in the electric field $\vec{E} = e_1\hat{i} + e_2\hat{j} + e_3\hat{k}$ is $\vec{r} = a\hat{i} + b\hat{j}$. The work done is

(a) $Q(ae_1 + be_2)$

(b) $Q\sqrt{(ae_1)^2 + (be_2)^2}$

(c) $Q(e_1 + e_2)\sqrt{a^2 + b^2}$

(d) $Q(\sqrt{e_1^2 + e_2^2})(a + b)$

**63.** An electric line of force in the $xy$ plane is given by equation $x^2 + y^2 = 1$. A particle with unit positive charge, initially at rest at the point $x = 1$, $y = 0$ in the $xy$ plane

(a) not move at all

(b) will move along straight line

(c) will move along the circular line of force

(d) information is insufficient to draw any conclusion

**64.** If a rod has resistance 4Ω and if rod is turned as half circle, then the resistance along diameter is

(a) 1.56 Ω (b) 2.44 Ω

(c) 4 Ω (d) 2Ω

**65.** The relation between voltage sensitivity ($\sigma_v$) and current sensitivity ($\sigma_i$) of a moving coil galvanometer is (resistance of galvanometer is $G$).

(a) $\frac{\sigma_i}{G} = \sigma_v$ (b) $\frac{\sigma_v}{G} = \sigma_i$

(c) $\frac{G}{\sigma_v} = \sigma_i$ (d) $\frac{G}{\sigma_i} = \sigma_v$

**66.** A current carrying small loop behaves like a small magnet. If $A$ be its area and $M$ its magnetic moment, the current in the loop will be

(a) $M/A$ (b) $A/M$

(c) $MA$ (d) $AM^2$

**67.** A magnet of magnetic moment 20 CGS units is freely suspended in a uniform magnetic field of intensity 0.3 CGS units. The amount of work done in deflecting it by an angle of 30° in CGS units is

(a) 6 (b) $3\sqrt{3}$

(c) $3(2 - \sqrt{3})$ (d) 3

**68.** An inductor of 2 H and a resistance of 10Ω are connected in series with a battery of 5 V. The initial rate of change of current is

(a) 0.5 A/s (b) 2.0 A/s

(c) 2.5 A/s (d) 0.25 A/s

**69.** When radiation is incident on a photoelectron emitter, the stopping potential is found to be 9V. If $e/m$ for the electron is $1.8 \times 10^{11}$ C $kg^{-1}$, the maximum velocity of the ejected electron is
(a) $6 \times 10^5$ $ms^{-1}$ (b) $8 \times 10^5$ $ms^{-1}$
(c) $1.8 \times 10^6$ $ms^{-1}$ (d) $1.8 \times 10^5$ $ms^{-1}$

**70.** $A$ and $B$ are two radioactive substances whose half-lives are 1 and 2 years respectively. Initially 10 g of $A$ and 1 g of $B$ is taken. The time (approximate) after which they will have same quantity remaining is
(a) 6.62 year (b) 5 year
(c) 3.2 year (d) 7 year

**71.** The optical path of a monochromatic light is same if it goes through 4.0 cm of glass of 4.5 cm of water. If the refractive index of glass is 1.53, the refractive index of the water is
(a) 1.30 (b) 1.36
(c) 1.42 (d) 1.46

**72.** The length, breadth and thickness of a block are given by $l = 12$ cm, $b = 6$ cm, and $t = 2.45$ cm. The volume of the block according to the idea of significant figure should be
(a) $1 \times 10^2 cm^3$ (b) $2 \times 10^2 cm^3$
(c) $1.763 \times 10^2 cm^3$ (d) None of these

**73.** 10000 small balls, each weighing 1g, strike one square centimetre of area per second with a velocity 100 m/s in a normal direction and rebound with the same velocity. The value of pressure on the surface will be
(a) $2 \times 10^3$ $N/m^2$ (b) $2 \times 10^5$ $N/m^2$
(c) $10^7$ $N/m^2$ (d) $2 \times 10^7$ $N/m^2$

**74.** Two springs have their force constant as $k_1$ and $k_2$ ($k_1 > k_2$). when they are stretched by the same force
(a) no work is done in case of both the springs
(b) equal work is done in case of both the springs
(c) more work is done in case of second spring
(d) more work is done in case of first spring

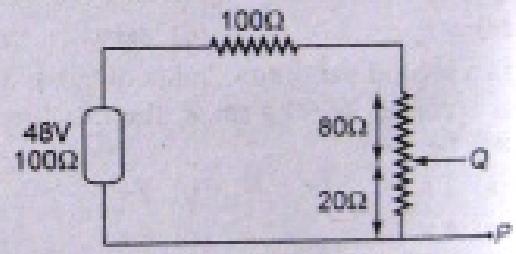
**75.** A mass $m$ is moving with a constant velocity along a line parallel to $x$-axis. Its angular momentum with respect to origin on $z$-axis is
(a) zero
(b) remains constant
(c) goes on increasing
(d) goes on decreasing

**76.** At a given place where acceleration due to gravity is 'g' $m/s^2$, a sphere of lead of density 'd' $kg/m^3$ is gently released in a column of liquid of density 'p' $kg/m^3$. If $d > \rho$, the sphere will
(a) fall vetically with an acceleration 'g' $m/s^2$
(b) fall vertically with no acceleration
(c) fall vertically with an acceleration $g\left(\frac{d-\rho}{d}\right)$
(d) fall vertically with an acceleration $g\left(\frac{\rho}{d}\right)$

**77.** Amplitude of a wave is represented by
$$A = \frac{c}{a+b-c}$$
Then resonance will occur when
(a) $b = -c/2$ (b) $b = 0$ and $a = c$
(c) $b = -a/2$ (d) None of these

**78.** Capacitance of a capacitor made by a thin metal foil is 2μF. If the foil is folded with paper of thickness 0.15 mm, dielectric constant of paper is 2.5 and width of paper is 400 mm, the length of foil will be
(a) 0.34 m (b) 1.33 m
(c) 13.4 m (d) 33.9 m

**79.** In the circuit, the potential difference across PQ will be nearest to




(a) 9.6 V (b) 6.6 V
(c) 4.8 V (d) 3.2 V

**80.** A rod of a certain metal is 1.0 m long and 0.6 cm in diameter. Its resistance is $3.0 \times 10^{-3}$ ohm. Another disc made of the same metal is 2.0 cm in diameter and 1.0 mm thick. What is the resistance between the round faces of the disc?
(a) $1.35 \times 10^{-8}$ Ω (b) $2.70 \times 10^{-7}$ Ω
(c) $4.05 \times 10^{-6}$ Ω (d) $8.10 \times 10^{-5}$ Ω

**81.** The cyclotron frequency of an electron gyrating in a magnetic field of 1 T is approximately
(a) 28 MHZ (b) 280 MHZ
(c) 2.8 GHZ (d) 28 GHZ

**82.** The transformation ratio in the step-up transformer is
(a) 1
(b) greater than one
(c) less than one
(d) the ratio greater or less than one depends on the other factors

**83.** Radiations of intensity 0.5 $W/m^2$ are striking a metal plate. The pressure on the plate is
(a) $0.166 \times 10^{-8}$ $N/m^2$
(b) $0.332 \times 10^{-8}$ $N/m^2$
(c) $0.111 \times 10^{-8}$ $N/m^2$
(d) $0.083 \times 10^{-8}$ $N/m^2$

**84.** If $n$ represents the order of a half period zone the area of this zone is approximately proportional to $n^m$ where $m$ is equal to
(a) zero (b) half
(c) one (d) two

**85.** Monochromatic light of wavelength 3000 Å is incident on a surface area 4 $cm^2$. If intensity of light is 150 $mW/m^2$, then rate at which photones strike the target is
(a) $3 \times 10^{10}$/sec (b) $9 \times 10^{13}$/sec
(c) $7 \times 10^{15}$/sec (d) $6 \times 10^{19}$/sec

## Chemistry

**86.** The ratio of $Fe_2O_3$ and Al, in thermite is
(a) 1 : 3 (b) 1 : 2
(c) 3 : 1 (d) none of these

**87.** A solid has a structural in which 'W' atom are located at the corners of a cubic latice 'O' atom at the centre of edge and Na atoms at the centre of cube. The formula for the compound is
(a) $Na_2WO_3$ (b) $Na_2WO_2$
(c) $NaWO_2$ (d) $NaWO_3$

**88.** Which one of the following substances is used in the laboratory for a fast drying of neutral gases?
(a) Phosphorous pentoxide
(b) Active charcol
(c) Anhydrous calcium chloride
(d) $Na_3PO_4$

**89.** $H_2O_2$ used in rocket has the concentration
(a) 50% (b) 70%
(c) 30% (d) 90%

**90.** The IUPAC name of the compound,

$$CH_2(OH)-CH(NH_2)-COOH$$

(a) 2-Amino-3-hydroxy propanoic acid
(b) 1-Hydroxy-2-amino propan-3-oic acid
(c) 1-Amino-2-hydroxypropanoic acid
(d) 3-Hydroxy-2-amino propanoic acid

**91.** The compound which gives the most stable carbonium ion on dehydration is
(a) $CH_3CH(CH_3)CH_2OH$
(b) $(CH_3)_3COH$
(c) $CH_2{=}CHCH_2CH_2OH$
(d) $CH_3CHOHCH_2{-}CH_3$

**92.** The ionic conductance is least for
(a) $Cs^+$ (b) $Rb^+$
(c) $K^+$ (d) $Na^+$

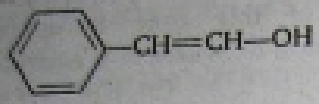
**93.** Setting of plaster of Peris involves
(a) Oxidation with atmospheric oxygen
(b) Combination with atmospheric $CO_2$
(c) Dehydration
(d) hydration to yield another hydrate

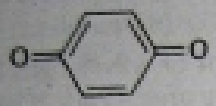
**94.** A solution of sucrose (Molar mass = 342g/mol) is prepared by dissolving 68.4 g of it per litre of solution, what is its osmotic pressure ($R$ = 0.082 L atom $K^{-1}$ $mol^{-1}$) at 273 K?
(a) 3.92 atm (b) 4.48 atm
(c) 5.92 atm (d) 29.4 atm

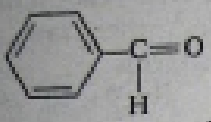
**95.** A 27°C one mole of an ideal gas is compressed isothermally and reversible from a pressure of 2 atm to 10 atm. The value of $\Delta E$ and $q$ are ($R$ = 2 cal)
(a) 0, – 965.84 cal
(b) – 965.84 cal, – 865.58 cal
(c) + 865.58 cal, – 865.58 cal
(d) + 965.84 cal, + 865.58 cal

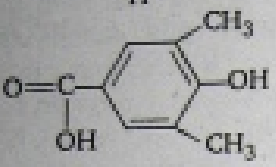
**96.** For a reaction equilibrium, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, the concentrations of $N_2O_4$ and $NO_2$ at equilbrium are $4.8 \times 10^{-2}$ and $1.2 \times 10^{-2}$ mol/L respectively. The value of $k_c$ for the reaction is :
(a) $3 \times 10^{-3}$ mol/L (b) $3.3 \times 10^{-3}$ mol/L
(c) $3 \times 10^{-1}$ mol/L (d) $3.3 \times 10^{-1}$ mol/L

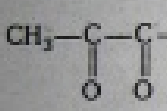
**97.** Tautomerism is exhibited by

(a) 

(b) 

(c) 

(d) 

**98.** $CH_3—C\equiv C—CH_3 \xrightarrow[(ii)\ Zn/H_2O]{(i)\ x}$  In the above reaction $x$ is.

(a) $HNO_3$ (b) $O_2$
(c) $O_3$ (d) $KMnO_4$

**99.** $C_7H_8 \xrightarrow{3Cl_2,\ Heat} A \xrightarrow{Fe\ /\ Br_2} B \xrightarrow{Zn/HCl} C$

Here, the compound $C$ is
(a) 3-Bromo 2,4, = 6-trichlorotoluene
(b) O - bromo toluene
(c) P - bromo toluene
(d) m - bromo toluene

**100.** Alizarin belongs to the class of
(a) Vat dyes (b) Mordant dyes
(c) Basic dyes (d) Reactive dyes

**101.** 2,4-Dichlorophenoxyacetic acid is used as
(a) Fungicide (b) Insecticide
(c) Herbicide (d) Moth repellant

**102.** Which glass has the highest percentage of lead?
(a) Soda glass (b) Flint glass
(c) Jena glass (d) Pyrex glass

**103.** Which one of the following pentafluorides cannot be formed?
(a) $PF_5$ (b) $AsF_5$
(c) $SbF_5$ (d) $BiF_5$

**104.** Which out of the following compounds is called photogropher's fixer?
(a) $Na_2SO_3$ (b) $Na_2S_2O_3 \cdot 5H_2O$
(c) $Na_2SO_4$ (d) $Na_2S$

**105.** The isoelectronic pair is
(a) $Cl_2O$, $ICl_2^-$ (b) $Cl_2^-$, $ClO_2$
(c) $IF_2^+$, $I_3^-$ (d) $ClO_2^-$, $ClF_2^+$

**106.** When radioactive minerals like cleveite, monozite and pitchblende are heated to 1270 K in vacuo the noble gas obtained is
(a) Rn (b) Kr
(c) He (d) Ne

**107.** Conjugate base of $H_2PO_4^-$ is
(a) $H_3PO_4$ (b) $P_2O_5$
(c) $PO_4^{3-}$ (d) $HPO_4^{2-}$

**108.** Given standard electrode potentials

$Fe^{2+} + 2e^- \longrightarrow Fe \quad E^\circ = -0.440$ V

$Fe^{3+} + 3e^- \longrightarrow Fe \quad E^\circ = -0.036$ V

The standard electrode potential ($E^\circ$) for $Fe^{3+} + e^- \longrightarrow Fe^{2+}$ is :
(a) + 0.772 V (b) − 0.772 V
(c) + 0.417 V (d) − 0.414 V

**109.** For the reaction

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The rate of change of concentration in hydrogen is $0.3 \times 10^{-4}$ $MS^{-1}$

The rate of change of concentration of ammonia is :
(a) $-0.2 \times 10^{-4}$ (b) $0.2 \times 10^{-4}$
(c) $0.1 \times 10^{-4}$ (d) $0.3 \times 10^{-4}$

**110.** The root mean square velocity of a gas is doubled when temperature is
(a) increased four times
(b) increased two times
(c) reduced to half
(d) reduced to one-fourth

**111.** The specific conductivity of 0.1 N KCl solution is 0.0129 $ohm^{-1}cm^{-1}$. The resistance of the solution in the cell is 100 Ω. The cell constant of the cell will be
(a) 1.10 (b) 1.29
(c) 0.56 (d) 2.80

**112.** Which of the most volatile compounds?
(a) HI (b) HCl
(c) HBr (d) HF

**113.** Which of the following transition metal ion will have definite value of magnetic moment?
(a) $Sc^{3+}$ (b) $Ti^{3+}$
(c) $Cu^+$ (d) $Zn^{2+}$

**114.** Cr has electronic configuration as
(a) $3s^2 3p^6 3d^4 4s^1$ (b) $3s^2 3p^6 3d^5 4s^1$
(c) $3s^2 3p^6 3d^6$ (d) none of these

**115.** Which of the following compound is expected to be coloured?

(a) $Ag_2SO_4$ (b) $CuF_2$

(c) $MgF_2$ (d) CuCl

**116.** The effective atomic number of Cr (at no = 24) in $[Cr(NH_3)_6]Cl_3$ is

(a) 35 (b) 27

(c) 33 (d) 36

**117.** In Nessler's reagent for the detection of ammonia the active species is

(a) $Hg_2Cl_2$ (b) $Mg^{2+}$

(c) $Hg_2I_2$ (d) $HgI_4^{2-}$

**118.** Which of the following ketones will not respond to iodoform test?

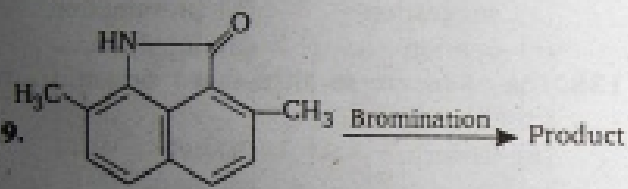
(a) Methyl isopropyl ketone

(b) Ethyl isopropyl ketone

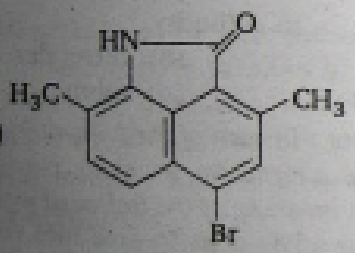
(c) Dimethyl ketone

(d) 2-hexanone

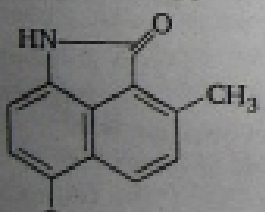
**119.**



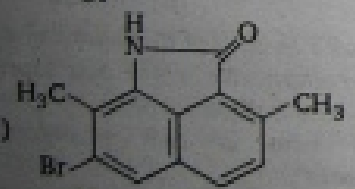

(a)



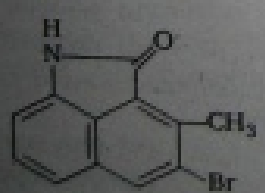

(b)




(c)

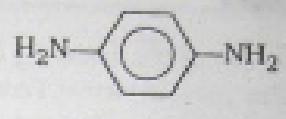



(d)

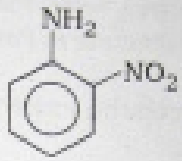



**120.** Aniline reacts with conc $HNO_3$ to give

(a)

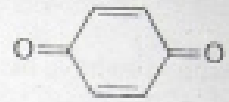



(b)

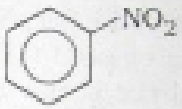



and


(c)




(d)




**121.** Bakelite is a product of the reaction between

(a) formaldehyde and NaOH

(b) aniline and Urea

(c) phenol and Methanal

(d) phenol and Chloroform

**122.** Cellulose is a polymer of

(a) glucose (b) fructose

(c) ribose (d) sucrose

**123.** Iodine value related to

(a) fats and oils (b) alcohols

(c) Esters (d) hydrocarbon

**124.** In aqueous solution, amino acids mostly exit as

(a) $NH_2—CHR—COOH$

(b) $NH_2—CHR—COO^-$

(c) $\overset{+}{N}H_3—CHR—COOH$

(d) $H_3\overset{+}{N}CHR—COO^-$

**125.** Gibb's free energy G, enthalpy H and entropy S are interrelated as in

(a) $G = H + TS$ (b) $G = H - TS$

(c) $G - TS = H$ (d) $G = S = H$

## English

***Directions :*** *In each of the following questions, a sentence has been given in Active/Passive voice. Out of the four alternatives, select the one which best expresses the same sentence in Passive/Active voice.*

**126.** People claim to have seen the suspect in several cities
(a) The suspect is being seen in several cities
(b) The suspect has been the people in several cities
(c) The suspect is claimed to have been seen in several cities
(d) The suspect was seen by people in several cities

**127.** The teacher punished the boys who had not done their homework.
(a) The boys who had not done their homework had been punished by their teacher
(b) The boys were punished by their teacher who had not done their homework
(c) The boys who had not done their homework were punished by the teacher
(d) The boys who had not done their homework were being punished by the teacher

***Directions :*** *In each of the following questions, choose the alternative which best expresses the meaning of the idiom/phrase given in italics in the sentence.*

**128.** The prices are going up *by leaps and bounds.*
(a) systematically (b) irregularly
(c) gradually (d) rapidly

**129.** He *bids fair* to be an excellent cricketer.
(a) seems likely (b) is ambitious
(c) is confident (d) is unlikely

**130.** To find real happiness in the world is *a wild goose chase.*
(a) ideal seeking (b) hunting
(c) futile search (d) real aim

***Directions :*** *In each of the following questions, choose the alternative which can best improve the given sentence by substituting the italicised portion. If the sentence is correct as it is, your answer is (d).*

**131.** The monograph which was published 3 years ago, would suggest that by 2001 there will be 73 million TV sets in India.
(a) has been suggesting
(b) had suggested
(c) would have suggested
(d) no improvement

**132.** Vishal, who *studies* medicine at present, hope to go abroad after graduation.
(a) has been studying (b) is studying
(c) will study (d) no improvement

**133.** The greatest thing in style is to have a use metaphor.
(a) command (b) knowledge
(c) need (d) no improvement

***Directions :*** *In each of the following question choose the best alternative to fill in the blank.*

**134.** Mr. Shyam Lal has gone to his native villag with the ..... of starting an adult school.
(a) suggestion (b) presumption
(c) opinion (d) intention

**135.** The twins are so alike that I cannot..... on from the other.
(a) discern (b) tell
(c) say (d) notice

**136.** We must .....to authority.
(a) bend (b) surrender
(c) subdue (d) submit

***Directions :*** *In each of the following question choose the alternative which is closest to th opposite in meaning of the italicised word.*

**137.** The doctor advised us to give him *wholesom* nutrition.
(a) sickly (b) stupendous
(c) depressing (d) fragmentary

**138.** He is good fellow; but what I dislike is h *reckless* handling of things.
(a) intelligent (b) cautious
(c) soft (d) brilliant

***Directions :*** *In each of the following question choose the alternative which best expresses th meaning of the italicised word.*

**139.** The one who is rich possesses many ***superfluous*** things.
(a) needless (b) superior
(c) essential (d) expensive

**140.** Many of his acquaintances avoid him becaus he is so *garrulous.*
(a) proud (b) unreasonable
(c) talkative (d) quarrelsome

## Reasoning

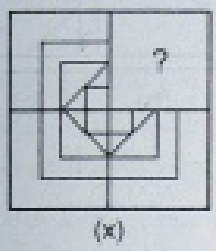
**141.** 'Cell' is related to 'Tissue' in the same way as 'Tissue' is related to :

(a) object (b) organ
(c) limb (d) none of these

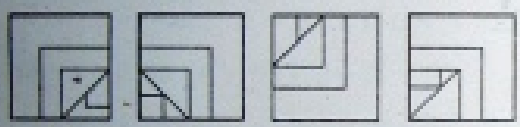
**142.** In the following question, which pair of numbers is different from the other three.

(a) 488 (b) 929
(c) 776 (d) 667

**143.** Identify the missing part of the figure and select it from the given alternatives.




(x)



(a) (b) (c) (d)

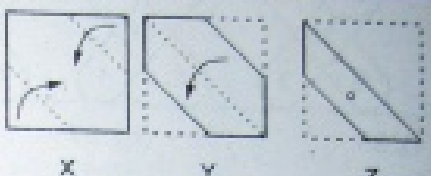
***Direction :*** *In the following question, a statement is given followed by some conclusions. Choose the conclusion which logically follows from the given statement.*

**144. Statement :** Soldiers serve their country.

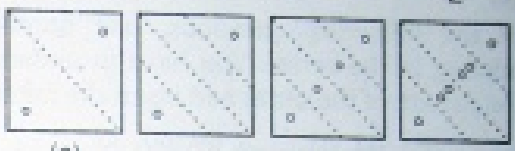
**Conclusions :**

(a) men generally serve their country
(b) These who serve their country are soldiers
(c) Some men who are soldiers serve their country
(d) Women do not serve their country because they are not soldiers.

**145.** In the following question, a set of three figures X, Y and Z showing a sequence in which a paper is folded and finally cut from a particular section. Below these figures a set of answer figures marked (a, b, c and d) showing the design which the paper actually acquires when it is unfolded. You have to select the answer figure which most closely resembls the unfolded piece of paper.



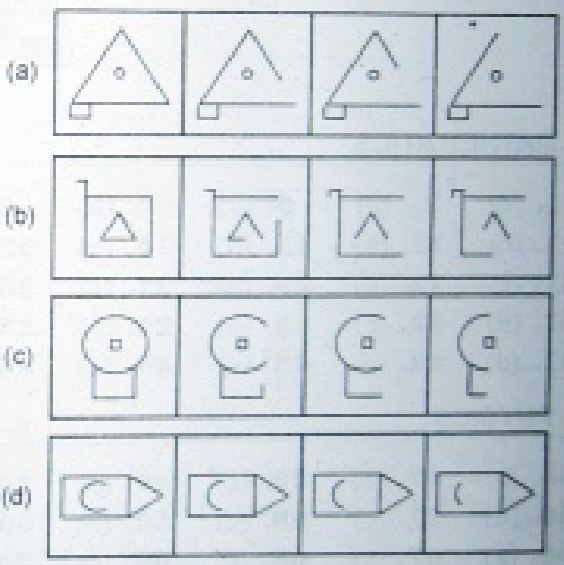
X Y Z



(a) (b) (c) (d)

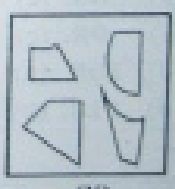
***Direction :*** *In the following question, choose the set of figures which follows the given rule.*

**146. Rule :** Closed figures become more and more open and open figures become more and more closed.

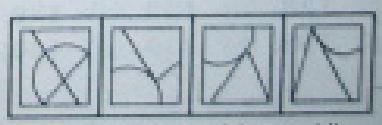



***Direction :*** *In the following question, find out which of the figures (a), (b), (c) and (d) can be formed from the pieces given in (x).*

**147.** In (X)

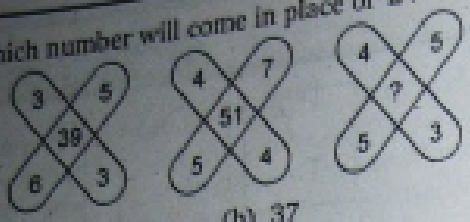


(X)



(a) (b) (c) (d)

**148.** Which number will come in place of '?'



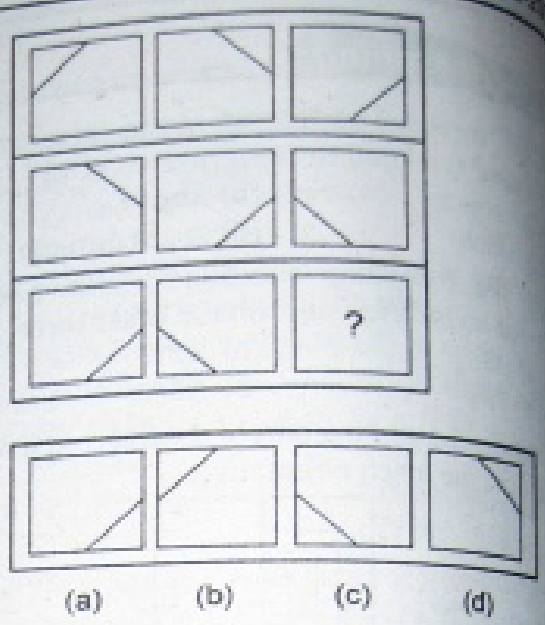

(a) 35 (b) 37
(c) 45 (d) 47

**149.** In the following questions, one number is missing in the series. You have to understand the pattern of the series and insert the number.

83, 82, 81,....., 69, 60, 33

(a) 73 (b) 80
(c) 77 (d) none of these

**150.** Select one alternative figure out of (a), (b), (c) and (d) which completes the given matrix.




# ANSWERS

## MATHEMATICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** (c) | **2.** (c) | **3.** (a) | **4.** (b) | **5.** (a) | **6.** (c) | **7.** (a) | **8.** (c) | **9.** (b) | **10.** (c) |
| **11.** (c) | **12.** (b) | **13.** (b) | **14.** (a) | **15.** (a) | **16.** (b) | **17.** (c) | **18.** (a) | **19.** (d) | **20.** (a) |
| **21.** (c) | **22.** (d) | **23.** (a) | **24.** (c) | **25.** (c) | **26.** (a) | **27.** (b) | **28.** (c) | **29.** (d) | **30.** (c) |
| **31.** (d) | **32.** (c) | **33.** (a) | **34.** (b) | **35.** (b) | **36.** (c) | **37.** (a) | **38.** (b) | **39.** (c) | **40.** (c) |
| **41.** (d) | **42.** (c) | **43.** (d) | **44.** (a) | **45.** (c) | | | | | |

## PHYSICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **46.** (a) | **47.** (b) | **48.** (c) | **49.** (a) | **50.** (c) | **51.** (c) | **52.** (a) | **53.** (a) | **54.** (a) | **55.** (b) |
| **56.** (d) | **57.** (c) | **58.** (c) | **59.** (b) | **60.** (d) | **61.** (a) | **62.** (a) | **63.** (c) | **64.** (c) | **65.** (a) |
| **66.** (a) | **67.** (c) | **68.** (c) | **69.** (c) | **70.** (a) | **71.** (b) | **72.** (b) | **73.** (d) | **74.** (c) | **75.** (b) |
| **76.** (c) | **77.** (b) | **78.** (d) | **79.** (d) | **80.** (b) | **81.** (d) | **82.** (b) | **83.** (a) | **84.** (a) | **85.** (b) |

## CHEMISTRY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **86.** (c) | **87.** (d) | **88.** (c) | **89.** (d) | **90.** (a) | **91.** (b) | **92.** (d) | **93.** (d) | **94.** (b) | **95.** (a) |
| **96.** (a) | **97.** (a) | **98.** (c) | **99.** (d) | **100.** (b) | **101.** (c) | **102.** (b) | **103.** (d) | **104.** (b) | **105.** (d) |
| **106.** (c) | **107.** (d) | **108.** (a) | **109.** (b) | **110.** (a) | **111.** (b) | **112.** (b) | **113.** (b) | **114.** (b) | **115.** (b) |
| **116.** (c) | **117.** (d) | **118.** (b) | **119.** (b) | **120.** (c) | **121.** (c) | **122.** (a) | **123.** (a) | **124.** (d) | **125.** (b) |

## ENGLISH

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **126.** (c) | **127.** (c) | **128.** (d) | **129.** (a) | **130.** (c) | **131.** (b) | **132.** (b) | **133.** (b) | **134.** (d) | **135.** (b) |
| **136.** (d) | **137.** (a) | **138.** (b) | **139.** (a) | **140.** (c) | | | | | |

## REASONING

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **141.** (b) | **142.** (d) | **143.** (b) | **144.** (c) | **145.** (c) | **146.** (b) | **147.** (b) | **148.** (b) | **149.** (c) | **150.** (b) |

# HINTS & SOLUTIONS

## Mathematics

**1.** Now, $\sqrt{2}+\sqrt{8}+\sqrt{18}+\sqrt{32}+\ldots$

$=1\times\sqrt{2}+2\sqrt{2}+3\sqrt{2}+4\sqrt{2}+\ldots$

$=\sqrt{2}(1+2+3+4+\ldots \text{ upto 24 terms})$

$=\sqrt{2}\times\frac{24\times25}{2}=300\sqrt{2}\left[\because \Sigma n=\frac{n(n+1)}{2}\right]$

**2.** Given that,

$$\sin A+\cos B=a \quad \ldots(i)$$

and $$\sin B+\cos A=b \quad \ldots(ii)$$

On squaring and adding Eqs. (i) and (ii), we get

$$\sin^2 A+\cos^2 B+2\sin A\cos B+\sin^2 B+\cos^2 A+2\sin B\cos A=a^2+b^2$$

$$\Rightarrow \quad 2\sin(A+B)+2=a^2+b^2$$

$$\Rightarrow \quad \sin(A+B)=\frac{a^2+b^2-2}{2}$$

**3.** Given that, $1+\sin x\sin^2\frac{x}{2}=0$

$$\therefore \quad 1+\sin x\left(\frac{1-\cos x}{2}\right)=0$$

$$\Rightarrow \quad 2+\sin x-\sin x\cos x=0$$

$$\Rightarrow \quad \sin 2x-2\sin x=4$$

Since, the maximum values of $\sin x$ and $\sin 2x$ are 1, which is not possible for any $x$ in $[-\pi,\pi]$.

**4.** Given that,

$$\Delta=\begin{vmatrix} C & 1 & 0\\ 1 & C & 1\\ 6 & 1 & C\end{vmatrix}=C(C^2-1)-1(C-6)$$

$$\Rightarrow \quad \Delta=2\cos\theta(4\cos^2\theta-1)-(2\cos\theta-6)$$

$(\because C=2\cos\theta \text{ given})$

$$=8\cos^3\theta-4\cos\theta+6$$

**5.** Now, $A^2=\begin{bmatrix}2 & -1\\ -1 & 2\end{bmatrix}\begin{bmatrix}2 & -1\\ -1 & 2\end{bmatrix}$

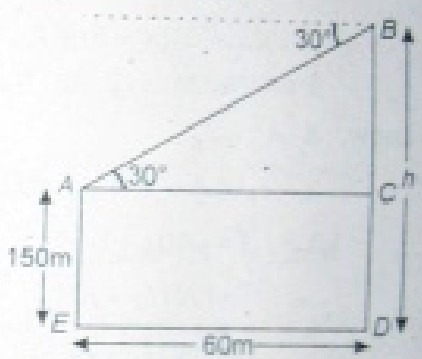
$$=\begin{bmatrix}4+1 & -2-2\\ -2-2 & 1+4\end{bmatrix}=\begin{bmatrix}5 & -4\\ -4 & 5\end{bmatrix}$$

Again now, $4A-3I=4\begin{bmatrix}2 & -1\\ -1 & 2\end{bmatrix}-\begin{bmatrix}3 & 0\\ 0 & 3\end{bmatrix}$

$$=\begin{bmatrix}5 & -4\\ -4 & 5\end{bmatrix}$$

$$\therefore \quad A^2=4A-3I$$

**6.** In $\Delta ABC$, $\tan 30^\circ=\frac{BC}{AC}$

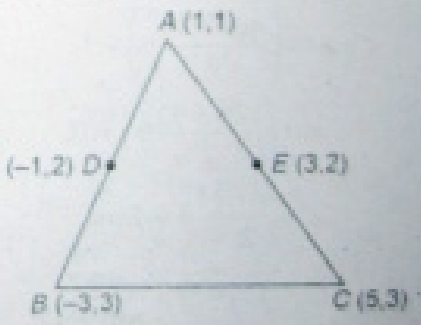



$$\Rightarrow \quad \frac{1}{\sqrt{3}}=\frac{h-150}{60}$$

$$\Rightarrow \quad h-150=\frac{60}{\sqrt{3}}$$

$$\Rightarrow \quad h=(150+20\sqrt{3})\text{m}$$

**7.** Let $D$ and $E$ are the mid points of $AB$ and $AC$. So, coordinates of $B$ and $C$ are $(-3, 3)$ and $(5, 3)$ respectively.




Centroid of triangle

$$=\left(\frac{x_1+x_2+x_3}{3},\frac{y_1+y_2+y_3}{3}\right)$$

$$=\left(\frac{1-3+5}{3},\frac{1+3+3}{3}\right)=\left(1,\frac{7}{3}\right)$$

**8.** Let $R = \{(1, 3), (4, 2), (2, 4), (2, 3), (3, 1)\}$ be a relation on the set $A = \{1, 2, 3, 4\}$, then

(a) Since, $(2, 4) \in R$ and $(2, 3) \in R$, so $R$ is not a function.

(b) Since $(1, 3) \in R$ and $(3, 1) \in R$ but $(1, 1) \notin R$, so $R$ is not transitive.

(c) Since $(2, 3) \in R$ but $(3, 2) \notin R$, so $R$ is not symmetric.

(d) Since $(1, 1) \notin R$, so $R$ is not relexive.

Hence, option (c) is correct.

**9.** Given that, $(x-1)(x^2-5x+7) < (x-1)$

$\therefore \quad (x-1)(x^2-5x+6) < 0$

$\Rightarrow \quad (x-1)(x-2)(x-3) < 0$

$\Rightarrow \quad x \in (-\infty, 1) \cup (2, 3)$

**10.** We know, $A \cdot A^T = I_n$

$\therefore \quad A - I_n = A - AA^T = A(I_n - A^T)$

$\Rightarrow \quad |A - I_n| = |A(I_n - A^T)|$

$= |A|\,|I_n - A^T|$

$= |A|\,|I_n - A|$

**11.** We have, $(\cos\theta + i\sin\theta)(\cos 2\theta + i\sin 2\theta)\ldots(\cos n\theta + i\sin n\theta) = 1$

$\therefore \quad \cos(\theta + 2\theta + 3\theta + \ldots + n\theta) + i\sin(\theta + 2\theta + 3\theta + \ldots + n\theta) = 1$

$\Rightarrow \quad \cos\left(\frac{n(n+1)}{2}\theta\right) + i\sin\left(\frac{n(n+1)}{2}\theta\right) = 1$

On comparing the coefficients of real and imaginary parts on both sides, we get

$$\cos\left(\frac{n(n+1)}{2}\theta\right) = 1$$

and $$\sin\left(\frac{n(n+1)}{2}\theta\right) = 0$$

$\therefore \quad \frac{n(n+1)}{2}\theta = 2m\pi$

$\Rightarrow \quad \theta = \frac{4m\pi}{n(n+1)}$

**12.** Let $\alpha$ and $\alpha^n$ be the roots of the equation, then

$\alpha + \alpha^n = -\frac{b}{a}$ and $\alpha \cdot \alpha^n = \frac{c}{a}$

$\Rightarrow \quad \alpha^{n+1} = \frac{c}{a}$

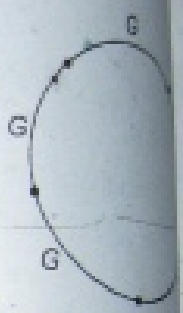
On eliminating $\alpha$, we get

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

$$\Rightarrow \quad a \cdot a^{-\frac{1}{n+1}} c^{\frac{1}{n+1}} + a \cdot a^{-\frac{n}{n+1}} c^{\frac{n}{n+1}} = -b$$

$$\Rightarrow \quad (a^n c)^{\frac{1}{n+1}} + (ac^n)^{\frac{1}{n+1}} = -b$$

**13.** First we fix the alternate position of the girls. Five girls can be seated around the circle in $(5-1)! = 4!$, 5 boys can be seated in five vacant place by 5!.



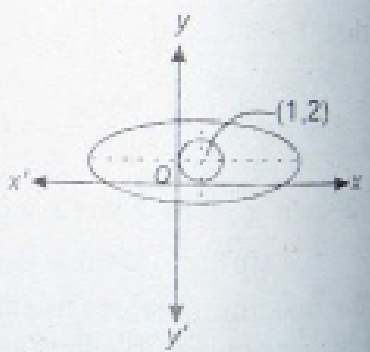

$\therefore$ Required number of ways $= 4! \times 5!$

**14.** Total number of favourable cases $= 6$

Total number of cases $= 216$

Required probability $= \frac{6}{216} = \frac{1}{36}$

**15.** It is clear from the figure that the two circles not intersect each other.




**16.** Given equation is comparing to $\frac{x^2}{a^2} - \frac{y^2}{b^2}$

we get

$a^2 = \cos^2\alpha$ and $b^2 = \sin^2\alpha$

$\therefore \quad \sin^2\alpha + \cos^2\alpha = a^2 + b^2$

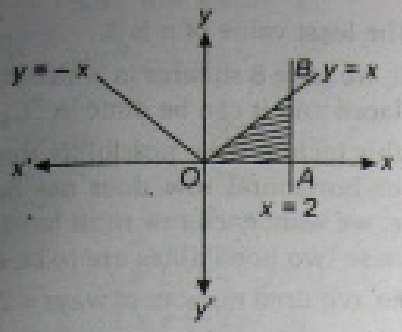
$\Rightarrow \quad 1 = a^2 + b^2$

Now, $$e = \sqrt{\frac{a^2 + b^2}{a^2}}$$

$$= \sqrt{\frac{1}{\cos^2\alpha}} = \frac{1}{\cos\alpha}$$

Now, foci $ae = \cos\alpha \cdot \frac{1}{\cos\alpha} = 1$

**17.** Required area = Area of shaded region $OAB$




$$= \int_0^2 y\,dx = \int_0^2 x\,dx = \left[\frac{x^2}{2}\right]_0^2$$

$= 2$ sq unit

**Alternate Solution**

Required area = Area of $\Delta OAB$

$$= \frac{1}{2} \times 2 \times 2$$

$= 2$ sq unit

**18.** Given Equation is $\frac{dy}{dx} + \frac{2yx}{(1+x^2)} = \frac{1}{(1+x^2)^2}$

It is comparing with linear differential equation $\frac{dy}{dx} + Py = Q$, we get

$$P = \frac{2x}{1+x^2} \quad \text{and} \quad Q = \frac{1}{(1+x^2)^2}$$

Now, $\text{IF} = e^{\int P\,dx} = e^{\int \frac{2x}{1+x^2}dx}$

$$= e^{\log(1+x^2)} = 1 + x^2$$

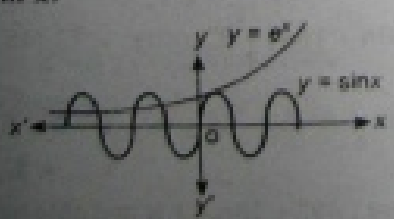
Solution of differential equation is

$$y(1+x^2) = \int \frac{1}{(1+x^2)^2}(1+x^2)\,dx + c$$

$$\Rightarrow\ y(1+x^2) = \int \frac{1}{1+x^2}\,dx + c$$

$$\Rightarrow\ y(1+x^2) = \tan^{-1} x + c$$

**19.** Given equation of curves are $y = e^x$ and $y = \sin x$.




It is clear from the figure that two curves intersect at infinite number of points.

**20.** Given that, $f(x) = \begin{cases} \frac{1-\cos x}{x}, & x \neq 0 \\ k, & x = 0 \end{cases}$

Now, $\lim_{x\to 0} f(x) = \lim_{x\to 0} \frac{1-\cos x}{x}$

$$= \lim_{x\to 0} \frac{2\sin^2 x/2}{4(x/2)^2} \cdot x = 0$$

and $f(0) = k$

Since, function is continuous at $x = 0$.

$\therefore \quad \lim_{x\to 0} f(x) = f(0)$

$\Rightarrow \quad k = 0$

**21.** $(a-b)^2 \cos^2\frac{C}{2} + (a+b)^2 \sin^2\frac{C}{2}$

$$= (a^2 + b^2 - 2ab)\cos^2\frac{C}{2} + (a^2 + b^2 + 2ab)\sin^2\frac{C}{2}$$

$$= (a^2 + b^2) + 2ab\left(\sin^2\frac{C}{2} - \cos^2\frac{C}{2}\right)$$

$$= a^2 + b^2 - 2ab\cos C = a^2 + b^2 - (a^2 + b^2 - c^2)$$

$$= c^2$$

**22.** Let $I = \int \frac{1+\tan^2 x}{1-\tan^2 x}\,dx = \int \frac{\sec^2 x}{1-\tan^2 x}\,dx$

Put $\tan x = t$

$\Rightarrow \quad \sec^2 x\,dx = dt$

$$\therefore \quad I = \int \frac{dt}{1-t^2} = \frac{1}{2\times 1}\log\left(\frac{1+t}{1-t}\right) + c$$

$$= \frac{1}{2}\log\left(\frac{1+\tan x}{1-\tan x}\right) + c$$

**23.** Let $I = \int_0^8 |x-5|\,dx$

$$= \int_0^5 -(x-5)\,dx + \int_5^8 (x-5)\,dx$$

$$= \left[-\frac{x^2}{2} + 5x\right]_0^5 + \left[\frac{x^2}{2} - 5x\right]_5^8$$

$$= \left[-\frac{25}{2} + 25 + 0\right] + \left[\frac{64}{2} - 40 - \left(\frac{25}{2} - 25\right)\right]$$

$$= \left(\frac{25}{2}\right) + \left(-\frac{16}{2} + \frac{25}{2}\right) = 25 - 8 = 17$$

**24.** Given that,

$I_1 = \int_0^1 x^3\,dx,\ I_2 = \int_0^1 x^2\,dx,\ I_3 = \int_1^2 x^2\,dx$

and $I_4 = \int_1^2 x^3\,dx$

$\because\quad x^3 < x^2,\ 0 < x < 1$ and $x^3 > x^2,\ x > 1$

$\therefore\quad I_4 > I_3$ and $I_2 < I_1$

**25.** Given equation is

$x^2 - 6xy + 9y^2 + 3x - 9y - 4 = 0$

Here $a = 1, b = 9, c = -4, h = -3, g = \frac{3}{2}$

Now, $h^2 = ab \Rightarrow 9 = 9$

Since, the lines are parallel.

$\therefore$ The distance between two parallel lines

$$= 2\sqrt{\frac{g^2 - ac}{a(a+b)}} = 2\sqrt{\frac{\left(\frac{9}{4}\right) - 1(-4)}{1(1+9)}}$$

$$= 2\sqrt{\frac{25/4}{10}} = \sqrt{\frac{5}{2}}$$

**26.** Given equation can be rewritten as

$x(x - 2y) - 3(x - 2y) = 0$

or $(x - 3)(x - 2y) = 0$

or $x = 3$ ...(i)

$x = 2y$ ...(ii)

Since, we know the normals always passing through the centre. Therefore the point of intersection of two normals are the coordinates of the centre.

$\therefore$ On solving Eqs. (i) and (ii), we get the required coordinates of centre are $\left(3, \frac{3}{2}\right)$.

**27.** Let $X$ be the number of heads getting in $n$ tossed. Therefore $X$ follows binomial distribution with parameters

$n,\ p = \frac{1}{2},\ q = \frac{1}{2}$

Given that $P(X \geq 1) \geq 0.8$

$\therefore\quad 1 - P(X = 0) \geq 0.8$

$\Rightarrow\quad P(X = 0) \leq 0.2$

$\Rightarrow\quad {}^nC_0\left(\frac{1}{2}\right)^n\left(\frac{1}{2}\right)^0 \leq 0.2$

$\Rightarrow\quad \frac{1}{2^n} \leq \frac{1}{5}$

$\Rightarrow\quad 2^n \geq 5$

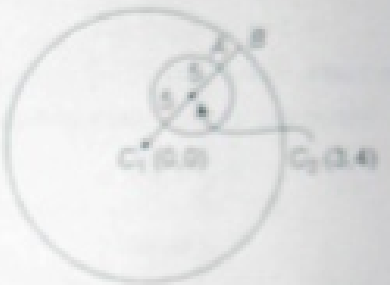
$\therefore$ The least value of $n$ is 3.

**28.** In all, we have 8 squares in which six 'X' have to be placed and it can be done in ${}^8C_6 = 28$ ways.

But this includes the possibility that either the top or horizontal row does not have any 'X'. Since, we want each row must have at least one 'X', these two possibilites are to be excluded.

Hence, required number of ways = 28 − 2 = 26.

**29.** The two circles whose centre and radius are $C_1(0, 0),\ r_1 = 12, C_2(3, 4),\ r_2 = 5$ and it passes through origin ie, the centre of $C_1$.




Now, $C_1C_2 = \sqrt{3^2 + 4^2} = 5$

and $r_1 - r_2 = 12 - 5 = 7$

$\therefore\quad C_1C_2 < r_1 - r_2$

Hence, circle $C_2$ lies inside the circle $C_1$.

From figure the minimum distance between them is

$AB = C_1B - C_1A = r_1 - 2r_2$

$= 12 - 10 = 2$

**30.** Now, $\log_{210} 63 = \log_{2^1 \times 3^1 \times 5^1 \times 7^1}(3 \times 3 \times 7)$

$$= \frac{\log_2(3 \times 3 \times 7)}{\log_2(2^1 \times 3 \times 5 \times 7)} = \frac{\log_2 3 + \log_2 3 + \log_2 7}{\log_2 2 + \log_2 3 + \log_2 5 + \log_2 7}$$

$$= \frac{2a + \frac{1}{c}}{2 + b + \frac{1}{c}} = \frac{2ac + 1}{2c + bc + 1}$$

**31.** Now, $49^n + 16n - 1 = (1 + 48)^n + 16n - 1$

$= 1 + {}^nC_1(48) + {}^nC_2(48)^2 + \ldots + {}^nC_n(48)^n + 16n - 1$

$= (48n + 16n) + {}^nC_2(48)^2 + {}^nC_3(48)^3 + \ldots + {}^nC_n(48)^n$

$= 64n + 8^2({}^nC_2 \cdot 6^2 + {}^nC_3 \cdot 6^3 \cdot 8 + {}^nC_4 \cdot 6^4 \cdot 8^2 + \ldots + {}^nC_n \cdot 6^n \cdot 8^{n-2})$

Hence, $49^n + 16n - 1$ is divisible by 64.

**32.** We have,

$$\sin^{-1} x = 2\tan^{-1} x$$

$$\therefore \quad \sin^{-1} x = \sin^{-1} \frac{2x}{1+x^2}$$

$$\Rightarrow \quad x = \frac{2x}{1+x^2}$$

$$\Rightarrow \quad x^3 - x = 0$$

$$\Rightarrow \quad x(x+1)(x-1) = 0$$

$$\Rightarrow \quad x \in \{-1, 1, 0\}$$

**33.** Given series is $1 \cdot 3^2 + 2 \cdot 5^2 + 3 \cdot 7^2 + \ldots \infty$,

This is an arithmetic-geometric series whose $n$th term is equal to

$$T_n = n(2n+1)^2 = 4n^3 + 4n^2 + n$$

$$\therefore \quad S_n = \sum_1^n T_n = \sum_1^n (4n^3 + 4n^2 + n)$$

$$= 4\sum_1^n n^3 + 4\sum_1^n n^2 + \sum_1^n n$$

$$= 4\left(\frac{n}{2}(n+1)\right)^2 + \frac{4}{6}n(n+1)(2n+1) + \frac{n}{2}(n+1)$$

$$= n(n+1)\left[n^2 + n + \frac{4}{6}(2n+1) + \frac{1}{2}\right]$$

$$= \frac{n}{6}(n+1)(6n^2 + 14n + 7)$$

**34.** Let $f(x) = 2x + 3y$

$$\therefore \quad f(x) = 2x + \frac{18}{x} \qquad (\because xy = 6 \text{ given})$$

On differentiating, we get

$$f'(x) = 2 - \frac{18}{x^2}$$

Put $f'(x) = 0$ for maximum or minima.

$$\Rightarrow \quad 0 = 2 - \frac{18}{x^2}$$

$$\Rightarrow \quad x = \pm 3$$

and $$f''(x) = \frac{36}{x^3}$$

$$\Rightarrow \quad f''(3) = \frac{36}{3^3} > 0$$

$\therefore$ At $x = 3$, $f(x)$ is minimum.

The minimum value is

$$f(3) = 2(3) + 3(2) = 12$$

**35.** Let $$p = \sin^{-1} \frac{2x}{1+x^2} = 2\tan^{-1} x$$

and $$q = \cos^{-1} \frac{1-x^2}{1+x^2} = 2\tan^{-1} x$$

$$\therefore \quad \frac{dp}{dx} = \frac{2}{1+x^2} = \text{ and } \frac{dq}{dx} = \frac{2}{1+x^2}$$

$$\Rightarrow \quad \frac{dp}{dq} = \frac{\frac{dp}{dx}}{\frac{dq}{dx}} = \frac{\frac{2}{1+x^2}}{\frac{2}{1+x^2}} = 1$$

**36.** Two sides $x - 3y = 0$ and $3x + y = 0$ are perpendicular to each other. Therefore, its orthocentre is the point of intersection of $x - 3y = 0$ and $3x + y = 0$ ie, $(0, 0)$.

So, the line $3x - 4y = 0$ passes through the orthocentre of triangle.

**37.** Let $(h, k)$ be the centre of a circle, then equation of circle is

$$(x-h)^2 + (y-k)^2 = 9$$

This centre lies on $x^2 + y^2 = 25$

$$\Rightarrow \quad h^2 + k^2 = 25$$

$\therefore$ $2 \le$ distance between the centres of the two circles $\le 8$

$$\Rightarrow \quad 2 \le \sqrt{(h-0)^2 + (k-0)^2} \le 8$$

$$\Rightarrow \quad 2 \le \sqrt{h^2 + k^2} \le 8$$

$$\Rightarrow \quad 4 \le h^2 + k^2 \le 64$$

$\therefore$ Locus of $(h, k)$ is $4 \le x^2 + y^2 \le 64$.

**38.** Given that, $\sin^{-1} x + \sin^{-1} y = \frac{\pi}{2}$

$$\therefore \quad \sin^{-1} x = \cos^{-1} y$$

$$\Rightarrow \quad y = \sqrt{1 - x^2}$$

On differentiating with respect to $x$, we get

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

**39.** Given that,

$$\lim_{x \to \infty}\left[\frac{x^3+1}{x^2+1} - (ax+b)\right] = 2$$

$$\Rightarrow \lim_{x \to \infty}\left[\frac{x^3(1-a) - bx^2 - ax + (1-b)}{x^2+1}\right] = 2$$

$$\Rightarrow \lim_{x\to\infty}\left[\frac{x(1-a)-b-\frac{a}{x}+\frac{(1-b)}{x^2}}{1+\frac{1}{x^2}}\right]=2$$

This limit will exist, if

$$1-a=0 \text{ and } b=-2$$

$$\Rightarrow a=1 \text{ and } b=-2$$

**40.** As we know, a vector caplanar to $\vec{a}$, $\vec{b}$ and orthogonal to $\vec{c}$ is $\lambda\{(\vec{a}\times\vec{b})\times\vec{c}\}$.

$\therefore$ A vector coplanar to $(2\hat{i}+\hat{j}+\hat{k})$, $(\hat{i}-\hat{j}+\hat{k})$ and orthogonal to $(3\hat{i}+2\hat{j}+6\hat{k})$

$$=\lambda[\{(2\hat{i}+\hat{j}+\hat{k})\times(\hat{i}-\hat{j}+\hat{k})\}\times(3\hat{i}+2\hat{j}+6\hat{k})]$$
$$=\lambda(-21\hat{j}+7\hat{k})$$

$\therefore$ A unit vector is $\pm\dfrac{(\vec{a}\times\vec{b})\times\vec{c}}{|(\vec{a}\times\vec{b})\times\vec{c}|}$

$$=\pm\frac{-21\hat{j}+7\hat{k}}{\sqrt{(-21)^2+(7)^2}}=\frac{\pm(3\hat{j}-\hat{k})}{\sqrt{10}}$$

**41.** Given that,

$$\vec{p}=\frac{\vec{b}\times\vec{c}}{[\vec{a}\,\vec{b}\,\vec{c}]},\ \vec{q}=\frac{\vec{c}\times\vec{a}}{[\vec{a}\,\vec{b}\,\vec{c}]} \text{ and } \vec{r}=\frac{\vec{a}\times\vec{b}}{[\vec{a}\,\vec{b}\,\vec{c}]}$$

$$\therefore \quad \vec{a}\cdot\vec{p}=\frac{\vec{b}\times\vec{c}}{[\vec{a}\,\vec{b}\,\vec{c}]}=\frac{\vec{a}\cdot(\vec{b}\times\vec{c})}{[\vec{a}\,\vec{b}\,\vec{c}]}=1$$

and $\vec{a}\cdot\vec{q}=\vec{a}\cdot\dfrac{\vec{c}\times\vec{a}}{[\vec{a}\,\vec{b}\,\vec{c}]}=\dfrac{\vec{a}\cdot(\vec{c}\times\vec{a})}{[\vec{a}\,\vec{b}\,\vec{c}]}=0$

Similarly, $\vec{b}\cdot\vec{q}=\vec{c}\cdot\vec{r}=1$

and $\vec{a}\cdot\vec{r}=\vec{b}\cdot\vec{p}=\vec{c}\cdot\vec{q}=\vec{c}\cdot\vec{p}=\vec{b}\cdot\vec{r}=0$

$\therefore$ $(\vec{a}+\vec{b})\cdot\vec{p}+(\vec{b}+\vec{c})\cdot\vec{q}+(\vec{c}+\vec{a})\cdot\vec{r}$

$$=\vec{a}\cdot\vec{p}+\vec{b}\cdot\vec{p}+\vec{b}\cdot\vec{q}+\vec{c}\cdot\vec{q}+\vec{c}\cdot\vec{r}+\vec{a}\cdot\vec{r}$$
$$=1+1+1=3$$

**42.** Let $A=(5,-4,2)$, $B=(4,-3,1)$, $C=(7,-6,4)$ and $D=(8,-7,5)$.

Now, $AB=\sqrt{(4-5)^2+(-3+4)^2+(1-2)^2}$

$$=\sqrt{1+1+1}=\sqrt{3}$$

$$BC=\sqrt{(7-4)^2+(-6+3)^2+(4-1)^2}$$
$$=\sqrt{9+9+9+}=3\sqrt{3}$$

$$CD=\sqrt{(8-7)^2+(-7+6)^2+(5-4)^2}$$
$$=\sqrt{1+1+1}=\sqrt{3}$$

and $AD=\sqrt{(8-5)^2+(-7+4)^2+(5-2)^2}$

$$=\sqrt{9+9+9}=3\sqrt{3}$$

Again Now, position vectors of

$$\overrightarrow{AB}=(4-5)\hat{i}+(-3+4)\hat{j}+(1-2)\hat{k}$$
$$=-\hat{i}+\hat{j}-\hat{k}$$

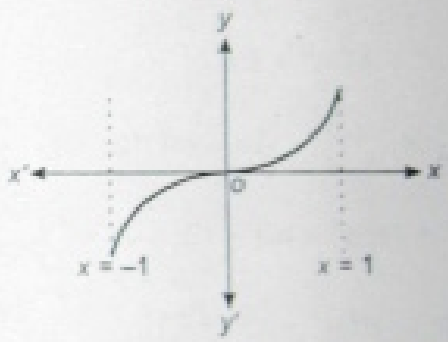
$$\overrightarrow{BC}=(7-4)\hat{i}+(-6+3)\hat{j}+(4-1)\hat{k}$$
$$=3\hat{i}-3\hat{j}+3\hat{k}$$

$\therefore$ $\overrightarrow{AB}\cdot\overrightarrow{BC}=(-\hat{i}+\hat{j}-\hat{k})\cdot(3\hat{i}-3\hat{j}+3\hat{k})$

$$=-3-3-3\neq 0$$

$\therefore$ $ABCD$ is a parallelogram.

**43.** $f(x)=x|x|=\begin{cases}x^2, & x\geq 0\\ -x^2, & x<0\end{cases}$




Since $-1\leq x\leq 1$, therefore $-1\leq f(x)\leq 1$

$\therefore$ Function is one-one onto.

**44.** Let $h$ and $r$ be the height and radius of cylinder.

Given that, $\dfrac{dr}{dt}=3$ m/s, $\dfrac{dh}{dt}=-4$ m/s

Also, $V=\pi r^2h$

On differentiating with respect to $t$, we get

$$\frac{dV}{dt}=\pi\left[r^2\frac{dh}{dt}+h\cdot 2r\frac{dr}{dt}\right]$$

At $r=4$m and $h=6$m

$\therefore$ $\dfrac{dV}{dt}=\pi[-64+144]=80\pi$ cu m/s

**45.** Given vertex of parabola $(h,k)=(1,1)$ and its focus $(a+h,k)=(3,1)$ or $a+h=3$

$$\Rightarrow a=2$$

Since, $y$-coordinate of vertex and focus are same, therefore axis of parabola is parallel to $x$-axis. Thus equation of parabola is

$$(y-k)^2=4a(x-h)$$

$$\Rightarrow (y-1)^2=8(x-1)$$

**46.** In given equation, $\frac{\alpha z}{k\theta}$ should be dimensionless.

$$\therefore \quad \alpha = \frac{k\theta}{z}$$

$$\Rightarrow \quad [a] = \frac{[ML^2T^{-2}K^{-1} \times K]}{[L]} = [MLT^{-2}]$$

and $$P = \frac{\alpha}{\beta}$$

$$\Rightarrow \quad [\beta] = \left[\frac{\alpha}{\rho}\right] = \frac{[MLT^{-2}]}{[ML^{-1}T^{-2}]} = [M^0L^2T^0]$$

**42.** Between time interval 20 s to 40 s, there is non-zero acceleration and retardation. Hence, distance travelled during this interval

= Area between time interval 20 s to 40 s

$$= \frac{1}{2} \times 20 \times 3 + 20 \times 1 = 30 + 20 = 50 \text{ m}$$

**48.** For $w$, 2 $w$, 3 $w$ apparent weight will be zero because the system is falling freely. So, the distances of the weights from the rod will be same.

**49.** Direction of velocity is always tangent to the path, so at the top of trajectory it is in horizontal direction and acceleration due to gravity is always in vertically downward direction.

Hence, $\vec{v}$ and $\vec{g}$ are perpendicular to each other.

**50.** $$\vec{F}\Delta t = m\Delta\vec{v}$$

$$\Rightarrow \quad \vec{F} = \frac{m\Delta\vec{v}}{t}$$

By doing so time of change in momentum increases and impulsive force on knees decreases.

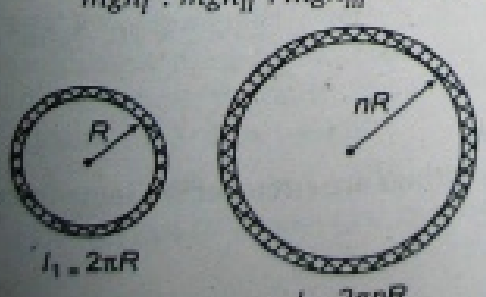
**51.** When the ball is released from the top of tower then ratio of distances covered by the ball in first, second and third second is

$h_I : h_{II} : h_{III} = 1 : 3 : 5$ [because $h_n \propto (2n-1)$]

$\therefore$ Ratio of work done

$$mgh_I : mgh_{II} : mgh_{III} = 1 : 3 : 5$$

**52.**




Ratio of moment of inertia of the rings

$$\frac{I_1}{I_2} = \left(\frac{M_1}{M_2}\right)\left(\frac{R_1}{R_2}\right)^2 = \left(\frac{\lambda L_1}{\lambda L_2}\right)\left(\frac{R_1}{R_2}\right)^2 = \left(\frac{2\pi R}{2\pi nR}\right)\left(\frac{R}{nR}\right)^2$$

[$\lambda$ = linear density of wire = constant]

$$\Rightarrow \quad \frac{I_1}{I_2} = \frac{1}{n^3} = \frac{1}{8} \text{ (given)}$$

$$\therefore \quad n^3 = 8 \quad \Rightarrow \quad n = 2$$

**53.** $v = \sqrt{2gR}$

$$\therefore \quad \frac{v_1}{v_2} = \sqrt{\frac{g_1}{g_2} \times \frac{R_1}{R_2}} = \sqrt{g \times K} = (Kg)^{1/2}$$

**54.** Speed of sound in a stretched string

$$v = \sqrt{\frac{T}{\mu}} \qquad \text{...(i)}$$

where $T$ is the tension in the string and $\mu$ is mass per unit length.

According to Hooke's law, $F \propto x$

$$\therefore \quad T \propto x \qquad \text{...(ii)}$$

From Eqs. (i) and (ii)

$$v \propto \sqrt{x}$$

$$\therefore \quad v' = \sqrt{1.5}\, v = 1.22v$$

**55.** The velocity of ball before entering the water surface

$$v = \sqrt{2gh} = \sqrt{2g \times 9}$$

When ball enters into water, due to upthrust of water the velocity of ball decreases (or retarded)

The retardation,

$$a = \frac{\text{apparent weight}}{\text{mass of ball}}$$

$$= \frac{V(\rho - \sigma)g}{V\rho} = \frac{(\rho - \sigma)g}{\rho}$$

$$= \left(\frac{0.4 - 1}{0.4}\right)g = -\frac{3}{2}g$$

It $h$ be the depth upto which ball sin $x$, then

$$0 - v^2 = 2 \times \left(\frac{-3}{2}g\right) \times h$$

$$\Rightarrow \quad 2g \times 9 = 3gh \quad \therefore \quad h = 6 \text{ cm.}$$

**56.** For all processes, change in internal energy $\Delta U$ $(-\Delta Q - \Delta W)$ does not change. It depends only on initial and final states.

**57.** Relative humidity at a given temperature ($R$)

$$= \frac{\text{Partial pressure of water vapour}}{\text{Vapour pressure of water}}$$

$$= \frac{0.012 \times 10^5}{0.016 \times 10^5} = 0.75 = 75\%$$

**58.** In the absence of intermolecular forces, there will be no stickiness of molecules. Hence, pressure will increase.

**59.** Time period is independent of mass of bob of pendulum.

**60.** $$v = \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

$$\Rightarrow \sin r = \sin 30^\circ \times \frac{2v}{v} \Rightarrow \sin r = \frac{1}{2} \times 2 \times 1$$

$$\Rightarrow r = 90^\circ$$

**61.** $$v = \frac{\text{coefficient of } t}{\text{coefficient of } x} = \frac{2\pi/0.01}{2\pi/0.3} = 30 \text{ m/s}$$

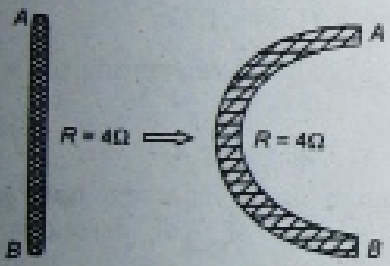
**62.** By using $W = Q(\vec{E} \Delta \vec{r})$

$$\Rightarrow W = Q[(e_1\hat{i} + e_2\hat{j} + e_3\hat{k}) \cdot (a\hat{i} + b\hat{j})]$$

$$= Q(e_1 a + e_2 b)$$

**63.** Charge will move along the circular line of force because $x^2 + y^2 = 1$ is the equation of circle in $xy$-plane.

**64.**




**65.** $$\sigma_i = \frac{\theta}{i} = \frac{\theta}{iG} \cdot G = \sigma_v G \Rightarrow \frac{\sigma_i}{G} = \sigma_v$$

**66.** $$M = iA \Rightarrow i = \frac{M}{A}$$

**67.** Work done, $W = MB_H(1 - \cos\theta)$

$$= 20 \times 0.3(1 - \cos 30^\circ)$$

$$= 6\left(1 - \frac{\sqrt{3}}{2}\right) = 3(2 - \sqrt{3})$$

**68.** $$i = i_0\left(1 - e^{-\frac{Rt}{L}}\right)$$

$$\Rightarrow \frac{di}{dt} = \frac{d}{dt} i_0 - \frac{d}{dt}\left(i_0 e^{-\frac{Rt}{L}}\right) = 0 + \frac{i_0 R}{L} e^{-\frac{Rt}{L}}$$

Initially, $t = 0$

$$\Rightarrow \frac{di}{dt} = \frac{i_0 \times R}{L} = \frac{E}{L} = \frac{5}{2} = 2.5 \text{ A/s}$$

**69.** $$\frac{1}{2} m v_{max}^2 = eV_0$$

$$\Rightarrow v_{max} = \sqrt{2\left(\frac{e}{m}\right)V_0} = \sqrt{2 \times 1.8 \times 10^{11} \times 9}$$

$$= 18 \times 10^5 \text{ m/s}$$

$$= 1.8 \times 10^6 \text{ m/s}$$

**70.** $$N = N_0\left(\frac{1}{2}\right)^{t/T_{1/2}}$$

$$\Rightarrow N_A = 10\left(\frac{1}{2}\right)^{t/1} \text{ and } N_B = 1\left(\frac{1}{2}\right)^{t/2}$$

Given $N_A = N_B$

$$\Rightarrow 10\left(\frac{1}{2}\right)^t = \left(\frac{1}{2}\right)^{t/2} \Rightarrow 10 = \left(\frac{1}{2}\right)^{-t/2}$$

$$\Rightarrow 10 = 2^{t/2}$$

Taking log on both the sides

$$\log_{10} 10 = \frac{t}{2}\log_{10} 2 \Rightarrow 1 = \frac{t}{2} \times 0.3010$$

$$\Rightarrow t = 6.62 \text{ years}$$

**71.** Optical path, $\mu x$ = constant

ie, $\mu_1 x_1 = \mu_2 x_2 \Rightarrow 1.53 \times 4 = \mu_2 \times 4.5$

$$\Rightarrow \mu_2 = \frac{1.53 \times 4}{4.5} = 1.36$$

**72.** Volume, $V = l \times b \times t = 12 \times 6 \times 2.45$

$$= 176.4 \text{ cm}^3$$

or $$V = 1.764 \times 10^2 \text{ cm}^3$$

Since, the minimum number of significant figure is one in breadth, hence volume will also contain only one significant figure. Hence, $V = 2 \times 10^2 \text{ cm}^3$.

**73.** $$P = \frac{F}{A} = \frac{n\{mv - (-mv)\}}{A} = \frac{2mnv}{A}$$

$$= \frac{2 \times 10^{-3} \times 10^4 \times 10^2}{10^{-4}} = 2 \times 10^7 \text{ N/m}^2$$

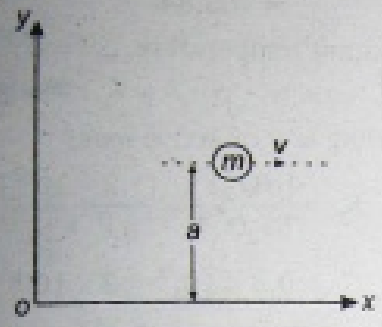
**74.** $$W = \frac{F^2}{2k}$$

If both springs are stretched by same force then $W \propto \frac{1}{k}$.

As $k_1 > k_2$ therefore, $W_1 < W_2$

ie, more work is done in case of second spring.

**75.** Angular moment of particle w.r.t., origin = linear momentum × perpendicular distance of line of action of linear momentum from origin




$= mv \times a = mva$ = constant

**76.** Apparent weight = actual weight − upthrust

$$Vdg' = Vdg - V\rho g$$

$$\Rightarrow \quad g' = \left(\frac{d-\rho}{d}\right)g$$

**77.** $A = \frac{c}{a+b-c}$ ; when $b = 0$, $a = c$

Amplitude $A \to \infty$, This corresponds to resonance.

**78.** If length of the foil is $l$ then

$$C = \frac{K\varepsilon_0(l \times b)}{d}$$

$$\Rightarrow 2 \times 10^{-6} = \frac{2.5 \times 8.85 \times 10^{-12}(l \times 400 \times 10^{-3})}{0.15 \times 10^{-3}}$$

$$\Rightarrow \quad l = 33.9 \text{ m}$$

**79.** Potential difference across $PQ$ *i.e.*, potential difference across the resistance of 20 Ω, which is $V = i \times 20$

and $\quad i = \frac{48}{(100 + 100 + 80 + 20)} = 0.16A$

$\therefore \quad V = 0.16 \times 20 = 3.2\text{V}$

**80.** Resistivity of the material of the rod

$$\rho = \frac{RA}{l} = \frac{3 \times 10^{-3} \times \pi(0.3 \times 10^{-2})^2}{1}$$

$$= 27 \times 10^{-9}\ \pi\ \Omega\text{m}$$

Resistance of disc,

$$R = \frac{\text{Resistivity of rod} \times \text{Thickness}}{\text{Area of corss-section}}$$

$$= 27 \times 10^{-9}\pi \times \frac{10^{-3}}{\pi \times (1 \times 10^{-2})^2}$$

$$= 2.7 \times 10^{-7}\ \Omega$$

**81.** Cyclotron frequency, $\nu = \frac{Bq}{2\pi m}$

$$\Rightarrow \quad \nu = \frac{1 \times 1.6 \times 10^{-19}}{2 \times 3.14 \times 9.1 \times 10^{-31}}$$

$$= 2.79 \times 10^{10}\ \text{Hz} = 28\ \text{GHz}$$

**82.** Transformation ratio, $k = \frac{N_s}{N_p} = \frac{V_s}{V_p}$

For step-up transformer,

$N_s > N_p$, *i.e.*, $V_s > V_p$, hence, $k > 1$.

**83.** Intensity or power per unit area of the radiations,

$$P = pv$$

$$\Rightarrow \quad p = \frac{P}{v} = \frac{0.5}{3 \times 10^8} = 0.166 \times 10^{-8}\ \text{N/m}^2$$

**84.** Area of half period zone is independent of order of zone. Therefore, $m$ is equal to zero in $n^m$.

**85.** $\frac{n}{t} = \frac{IA\lambda}{hc} = \frac{150 \times 10^{-3} \times 4 \times 10^{-4} \times 3 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^8}$

$$= 9 \times 10^{13}\ \text{s}$$

## Chemistry

**86.** Thermite is the mixture of $Fe_2O_3$ and Al. Due to great affinity of aluminium toward oxygen, it readily combines with oxygen. Hence, Goldsmith used Al to reduce metal oxides in extraction. In thermite, the ratio of $Fe_2O_3$ and Al is taken 3 : 1 by weight.

$$Fe_2O_3 \quad + \quad 2Al \longrightarrow 2Fe + Al_2O_3$$

$(2 \times 56 + 3 \times 16 = 160) \quad (2 \times 27 = 54)$

**87.** In a unit cell, W atoms at the corner $= \frac{1}{8} \times 8 = 1$

O-atoms at the centre of edge $= \frac{1}{4} \times 12 = 3$

Na atoms at the centre of the cube = 1

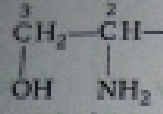
W : O : Na = 1 : 3 : 1

Hence, formula = $NaWO_3$

**88.** Anhydrous $CaCl_2$ is used for fast drying of neutral gases.

**89.** $H_2O_2$ is used as an oxidant for rocket fuel and has 90% concentration to be used in rockets.

**90.**



2-amino-3-hydroxy-propanoic acid

**91.** $(CH_3)_3C-OH \xrightarrow[-H_2O]{+H^+} (CH_3)_3\overset{+}{C}$

tertiary alcohol — 3° carbocation (more stable)

$$CH_2=CH-CH_2-CH_2OH \xrightarrow[-H_2O]{+H^+}$$

$$CH_2=CH-CH_2-\overset{+}{C}H_2$$

1° carbocation (less stable)

Increasing order of stability of carbocation.

1° carbocation < 2° carbocation < 3° carbocation

**92.** Due to small size of $Na^+$, it is heavily hydrated and become large molecule.

Ionic conductance increase down the group in alkali metals.

Order of ionic conductance

$$Na^+ < K^+ < Rb^+ < Cs^+$$

**93.** On hydration of Plaster of Paris, converts into Gypsum.

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + \frac{3}{2}H_2O \longrightarrow \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$$

**94.** Osmatic pressure $(\pi) = CRT$

Here, $C$ = concentration of solution

$$C = \frac{n}{V}$$

$$\therefore \quad n = \frac{w}{m} = \frac{\text{weight in gram of substance}}{\text{Mol. weight of substance}}$$

$V = 1$ litre

$$C = \frac{68.4}{342}$$

$$\pi = \frac{68.4}{342} \times 0.082 \times 273$$

$$= 4.48 \text{ atm}$$

**95.** Isothermally (at constant temperature) and reversible work.

$$w = 2.303\, nRT \log \frac{P_2}{P_1}$$

$$= 2.303 \times 1 \times 2 \times 300 \log \frac{10}{2}$$

$$= 2.303 \times 600 \times \log 5$$

$$= 965.84$$

at constant temperature, $\Delta E = 0$

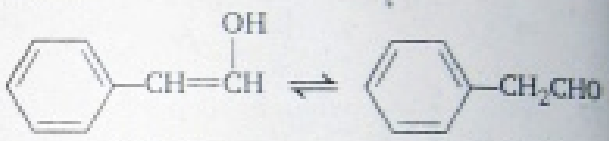
$$\Delta E = q + w, \quad q = -w = -965.84 \text{ cal}$$

**96.** According law of active mass

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{[1.2 \times 10^{-2}]^2}{4.8 \times 10^{-2}}$$

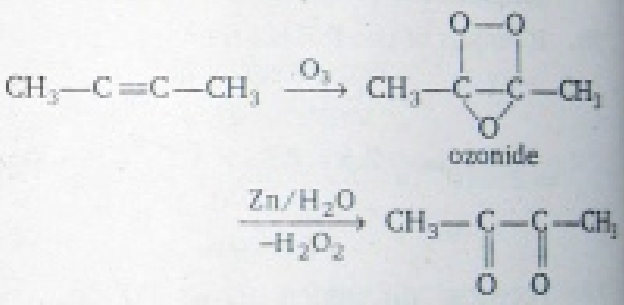
$$= 0.3 \times 10^{-2} = 3 \times 10^{-3}$$

**97.** **Tautomerism** It is functional isomerism in which the isomers are readily interchangeable and maintain a dynamic equilibrium with each other.



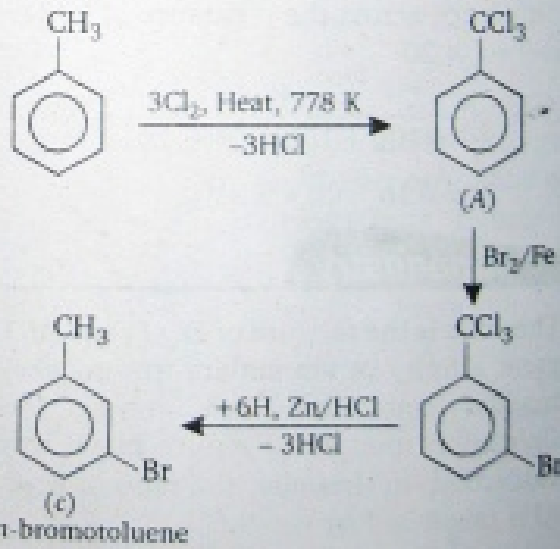
enol form — keto form

**98.**



ozonide

**99.**

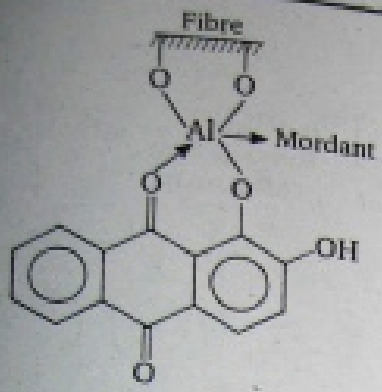


(A)

(C)

m-bromotoluene

**100.** Alizarin is Mordant dye. Alizarin gives a bright red colour with aluminium and a blue colour with barium.




**101.** 2,4-D or 2,4-dichlorophenoxyacetic acid is used as a herbicides.

**102.** Flint glass or lead glass has composition of $K_2O \cdot PbO \cdot 6SiO_2$. It is used in making electric bulb and optical instruments.

**103.** The +5 oxidation state of Bi is unstable due to inert pair effect. Thus, $BiF_5$ can not be formed.

**104.** $Na_2S_2O_3 \cdot 5H_2O$ (Hypo). It is called photographer's fixer because it removes the excess AgBr in the form of soluble silver complex.

**105.** $Cl_2O$ = 42 electrons

$ICl_2$ = 87 electrons

$Cl_2^-$ = 35 electrons

$IF_2^+$ = 70 electrons

$I_3^-$ = 160 electrons

$ClO_2$ = 33 electrons

$ClO_2^-$ = 34 electrons

$ClF_2^+$ = 34 electrons

$ClO_2^-$ and $ClF_2^+$ contain 34 electrons each hence they are isoelectronic.

**106.** These radioactive minerals have entrapped He atoms, produced from α-particle, which they give on heating in **Vacuo.**

**107.** $\underset{\text{acid}}{H_2PO_4^-} + H_2O \longrightarrow H_3O^+ + \underset{\text{Conjugated base}}{HPO_4^{2-}}$

$H_2PO_4^-$ gives $HPO_4^{2-}$ (conjugated base) in aqueous solution. It acts as proton donor.

**108.** $\Delta G^\circ = -nFE^\circ$

$$Fe^{2+} + 2e^- \longrightarrow Fe$$

$$\Delta G^\circ = -2 \times F \times (-0.440\ V) = 0.880\ F \quad ...(1)$$

$$Fe^{3+} + 3e^- \longrightarrow Fe$$

$$\Delta G^\circ = -3 \times F \times (-0.036)$$

$$= 0.108\ F \quad ...(2)$$

On substracting Eqs. (1) and (2)

$$Fe^{3+} + e^- \longrightarrow Fe^{2+}$$

$$\Delta G^\circ = 0.108F - 0.880F = -0.772F$$

$$E^\circ = -\frac{\Delta G^\circ}{nF} = \frac{-0.772\,F}{1 \times F} = +0.772\,V$$

**109.** $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$$\frac{d[H_2]}{dt} = -0.3 \times 10^{-4}\ Ms^{-1}$$

$$\text{Rate} = -\frac{1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt}$$

$$= \frac{d[NH_3]}{dt} = -\frac{2}{3}\frac{d[H_2]}{dt}$$

$$= -\frac{2}{3} \times (-0.3 \times 10^{-4})$$

$$= 0.2 \times 10^{-4}$$

**110.** $$V_{rms} = \sqrt{\frac{3RT}{M}}$$

$$V_{rms} \propto \sqrt{T}$$

$$\frac{v_{rms}}{v_{rms}} = \sqrt{\frac{T}{T'}}$$

$$\frac{1}{2} = \sqrt{\frac{T}{T'}}$$

$$T' = 4T$$

**111.** Specific conductivity $(K) = \frac{1}{R} \times$ cell constant

$$\text{Cell constant} = K \times R$$

$$= 0.0129 \times 100 = 1.29$$

**112.** Boiling point of HF is highest due to H-bonding. For other halogen acids b.p. increase in the order HCl < HBr < HI. Therefore, most volatile (with Lower b.pt.) is HCl

**113.** Value of magnetic moment depends upon number of unpaired electrons. All except $Ti^{3+}[3d^1]$ have either fully filled *d*-subshell (i.e., $Zn^{2+}$, $Cu^+$) or empty *d*-subshell (i.e., $Sc^{3+}$). As such only $Ti^{3+}$ has a net value of magnetic moment.

Magnetic moment of $Ti^{3+} = \sqrt{n(n+2)}$ BM

$= \sqrt{1(1+2)}$ BM

$= \sqrt{3} = 1.73$ BM

**114.** Cr(24) = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

**115.** $Ag_2SO_4$ contain $Ag^+[4d^{10}]$ and is colourless. $CuF_2$ contains $Cu^{2+}$ $(3d^9)$ and is coloured due to the presence of one unpaired electron is *d*-orbital of $Cu^{2+}$.
$MgF_2$ contains $Mg^{2+}$ and is colourless n/2 CuCl contains $Cu^+(3d^{10})$ and is colourless.

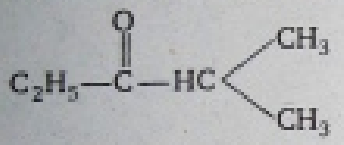
**116.** Effective atomic number = Electrons in $Cr^{3+}$ + electrons from $6NH_3$ ligands.

$$= 21 + 6 \times 2 = 33$$

**117.** Nessler's reagent gives brown ppt. of iodide of million base with ammonium salt.

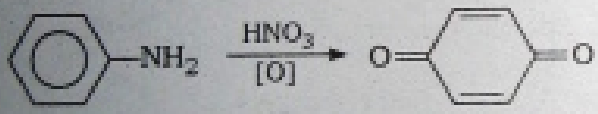
$$[HgI_4]^{2-} + NH_4Cl + 4OH^- \longrightarrow \underset{\text{Iodide of million base (Brown ppt.)}}{NH_2HgOHgI} + I^- + Cl^- + 3H_2O$$

**118.** All the ketones except ethyl isopropyl ketone gives iodoform test in this question.

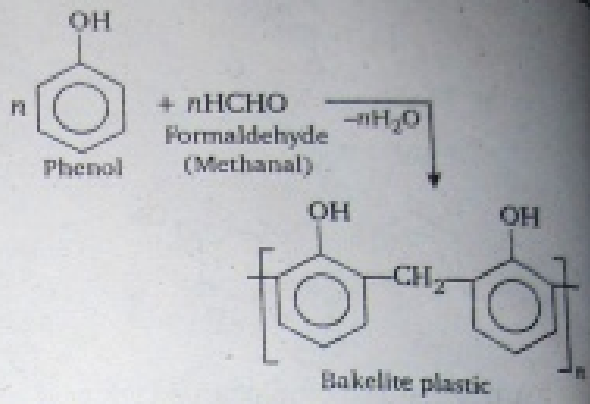


Ethyl isopropyl ketone

**119.** —NH— is stronger electron releasing group than $CH_3$ group, therefore bromination will take place at *p*-position with respect to —NH— group.

**120.** 

Benzoquinone

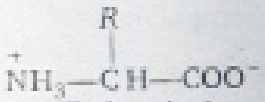
**121.** 

Bakelite plastic

**122.** Cellulose is a polymer of glucose-β-D(+) glucose units are attached to each other by $C_1$ to $C_4$ bonds through β-glycosidic linkage in structure of cellulose.

**123.** Iodine value is related to oils and fats. Iodine value measures the drying quality of an oil. More the unsaturation better is the drying quality of an oil. When on oil is treated with $I_2$, It adds to double bond. Iodine value is defined as the number of centigrams of $I_2$ that can be taken by 1g of the oil.

**124.** In aqueous solutions, amino acids mostly exist as zwitter ions.



(Zwitter ion)

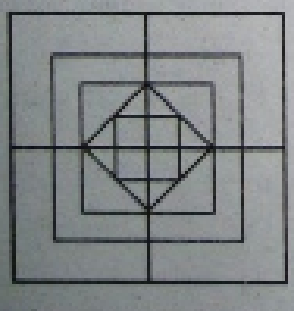
**125.** Gibb's free energy $G$, enthalpy $H$ and entropy $S$ are interrelated as

$$G = H - TS$$

## Reasoning

**141.** 'Tissue' is made up of 'cell' and 'organ' is made up of 'tissue'.

**142.** Sum of digits is 20.



**143.** It is clear that answer figure (b) complete the original figure. Which look like as shown in the adjacent figure. Hence, alternative (b) is the correct answer.

**148.** Here, $3 \times 3 + 6 \times 5 = 39$

$4 \times 4 + 5 \times 7 = 51$

and $4 \times 3 + 5 \times 5 = 37$

**149.** Series is written in reverse order with a difference of $1^3, 1^3, 2^2, 2^2, 2^3, 3^2, 3^3$, i.e., 1, 1, 4, 8, 9, 27.

**150.** The line inside the square moves from one corner to another clockwise, as we moves from left to right in a row.