# 2023-I NDA/NA Solved Paper

## Paper I: Mathematics

**1.** If ω is a non-real cube root of 1, then what is the value of $\left|\frac{1-\omega}{\omega+\omega^2}\right|$?

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

**2.** What is the number of 6-digit numbers that can be formed only by using 0, 1, 2, 3, 4 and 5 (each once); and divisible by 6?

(*a*) 96 (*b*) 120 (*c*) 192 (*d*) 312

**3.** What is the binary number equivalent to decimal number 1011?

(*a*) 1011 (*b*) 111011 (*c*) 11111001 (*d*) 111110011

**4.** Let $A$ be a matrix of order 3 × 3 and $|A| = 4$. If $|2\ adj(3A)| = 2^{\alpha}3^{\beta}$, then what is the value of $(\alpha + \beta)$ ·

(*a*) 12 (*b*) 13 (*c*) 17 (*d*) 24

**5.** If α and β are the distinct roots of equation $x^2 - x + 1 = 0$, then what is the value of $\left|\frac{\alpha^{100}+\beta^{100}}{\alpha^{100}-\beta^{100}}\right|$?

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

**6.** Let $A$ and $B$ be symmetric matrices of same order, then which one of the following is correct regarding $(AB - BA)$?

1. Its diagonal entries are equal but nonzero
2. The sum of its non-diagonal entries is zero

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

**7.** Consider the following statements in respect of square matrices $A$, $B$, $C$ each of same order $n$:

1. $AB = AC \Rightarrow B = C$ if $A$ is non-singular
2. If $BX = CX$ for every column matrix $X$ having n rows then $B = C$.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

**8.** The system of linear equations

$x + 2y + z = 4$, $2x + 4y + 2z = 8$ and $3x + 6y + 3z = 10$ has

(*a*) a unique solution (*b*) infinite many solutions
(*c*) no solution (*d*) exactly three solutions

**9.** Let $AX = B$ be a system of 3 linear equations with 3-unknowns. Let $X_1$ and $X_2$ be its two distinct solutions. If the combination $aX_1 + bX_2$ is a solution of $AX = B$; where $a$, $b$ are real numbers, then which one of the following is correct?

(*a*) $a = b$ (*b*) $a + b = 1$
(*c*) $a + b = 0$ (*d*) $a - b = 1$

**10.** What is the sum of the roots of the equation $\begin{vmatrix} 0 & x-a & x-b \\ 0 & 0 & x-c \\ x+b & x+c & 1 \end{vmatrix} = 0$?

(*a*) $a + b + c$ (*b*) $a - b + c$
(*c*) $a + b - c$ (*d*) $a - b - c$

**11.** If $2 - i\sqrt{3}$, where $i = \sqrt{-1}$ is a root of the equation $x^2 + ax + b = 0$, then what is the value of $(a + b)$?

(*a*) –11 (*b*) –3
(*c*) 0 (*d*) 3

**12.** If $z = \frac{1+i\sqrt{3}}{1-i\sqrt{3}}$ where $i = \sqrt{-1}$, then what is the argument of $z$?

(*a*) $\frac{\pi}{3}$ (*b*) $\frac{2\pi}{3}$ (*c*) $\frac{4\pi}{3}$ (*d*) $\frac{5\pi}{6}$

**13.** If $a$, $b$, $c$ are in AP, then what is $\begin{vmatrix} x+1 & x+2 & x+3 \\ x+2 & x+3 & x+4 \\ x+a & x+b & x+3 \end{vmatrix}$ equal to?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) 2

**14.** If $\log_x a$, $a^x$ and $\log_b x$ are in GP, then what is $x$ equal to?

(*a*) $\log_a(\log_b a)$ (*b*) $\log_b(\log_a b)$
(*c*) $\frac{\log_a(\log_b a)}{2}$ (*d*) $\frac{\log_b(\log_a b)}{2}$

**15.** If $2^{\frac{1}{c}}, 2^{\frac{b}{ac}}, 2^{\frac{1}{a}}$ are in GP, then which one of the following is correct?

(*a*) $a$, $b$, $c$ are in AP (*b*) $a$, $b$, $c$ are in GP
(*c*) $a$, $b$, $c$ are in HP (*d*) $ab$, $bc$, $ca$ are in AP

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**16.** The first and the second terms of an AP are $\frac{5}{2}$ and $\frac{23}{12}$ respectively.

If $n^{th}$ term is the largest negative term, what is the value of $n$?

(a) 5 (b) 6

(c) 7 (d) $n$ cannot be determined

**17.** For how many integral values of $k$, the equation $x^2 - 4x + k = 0$, where $k$ is an integer has real roots and both of them lie in the interval (0, 5)?

(a) 3 (b) 4 (c) 5 (d) 6

**18.** In an $AP$, the first term is $x$ and the sum of the first $n$ terms is zero. What is the sum of next $m$ terms?

(a) $\frac{mx(m+n)}{n-1}$ (b) $\frac{mx(m+n)}{1-n}$

(c) $\frac{nx(m+n)}{m-1}$ (d) $\frac{nx(m+n)}{1-m}$

**19.** Consider the following statements:

1. (25)! + 1 is divisible by 26
2. (6)! + 1 is divisible by 7

Which of the above statements is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

**20.** If $z$ is a complex number such that $\frac{z-1}{z+1}$ is purely imaginary, then what is $|z|$ equal to?

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

**21.** How many real numbers satisfy the equation $|x-4| + |x-7| = 15$?

(a) Only one (b) Only two

(c) Only three (d) Infinitely many

**22.** A mapping $f: A \to B$ defined as $f(x) = \frac{2x+3}{3x+5}, x \in A$. If $f$ is to be onto, then what are A and B equal to?

(a) $A = R \setminus \left\{-\frac{5}{3}\right\}$ and $B = R \setminus \left\{-\frac{2}{3}\right\}$

(b) $A = R$ and $B = R \setminus \left\{-\frac{5}{3}\right\}$

(c) $A = R \setminus \left\{-\frac{3}{2}\right\}$ and $B = R \setminus \{0\}$

(d) $A = R \setminus \left\{-\frac{5}{3}\right\}$ and $B = R \setminus \left\{\frac{2}{3}\right\}$

**23.** $\alpha$ and $\beta$ are distinct real roots of the quadratic equation $x^2 + ax + b = 0$. Which of the following statements is/are sufficient to find $\alpha$?

1. $\alpha + \beta = 0, \alpha^2 + \beta^2 = 2$
2. $\alpha\beta^2 = -1, a = 0$

Select the correct answer using the code given below:

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

**24.** If the sixth term in the binomial expansion of $\left(x^{-\frac{8}{3}} + x^2 \log_{10} x\right)^8$ is 5600, then what is the value of $x$?

(a) 6 (b) 8 (c) 9 (d) 10

**25.** How many terms are there in the expansion of $(3x - y)^4 (x + 3y)^4$?

(a) 9 (b) 12 (c) 15 (d) 17

**26.** $p, q, r$ and $s$ are in AP such that $p + s = 8$ and $qr = 15$. What is the difference between largest and smallest numbers?

(a) 6 (b) 5 (c) 4 (d) 3

**27.** Consider the following statements for a fixed natural number $n$:

1. $C(n, r)$ is greatest if $n = 2r$
2. $C(n, r)$ is greatest if $n = 2r - 1$ and $n = 2r + 1$

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

**28.** $m$ parallel lines cut $n$ parallel lines giving rise to 60 parallelograms. What is the value of $(m + n)$?

(a) 6 (b) 7 (c) 8 (d) 9

**29.** Let $x$ be the number of permutations of the word 'PERMUTATIONS' and $y$ be the number of permutations of the word 'COMBINATIONS'. Which one of the following is correct?

(a) $x = y$ (b) $y = 2x$ (c) $x = 4y$ (d) $y = 4x$

**30.** 5-digit numbers are formed using the digits 0, 1, 2, 4, 5 without repetition. What is the percentage of numbers which are greater than 50,000?

(a) 20% (b) 25% (c) $\frac{100}{3}\%$ (d) $\frac{110}{3}\%$

**Consider the following for the next two (02) items that follow:**

Let $\sin\beta$ be the GM of $\sin\alpha$ and $\cos\alpha$; $\tan\gamma$ be the AM of $\sin\alpha$ and $\cos\alpha$.

**31.** What is $\cos 2\beta$ equal to?

(a) $(\cos\alpha - \sin\alpha)^2$ (b) $(\cos\alpha + \sin\alpha)^2$

(c) $(\cos\alpha - \sin\alpha)^3$ (d) $\frac{(\cos\alpha - \sin\alpha)^2}{2}$

**32.** What is the value of $\sec 2\gamma$?

(a) $\frac{3 - \sin 2\alpha}{5 + 2\sin 2\alpha}$ (b) $\frac{5 + \sin 2\alpha}{3 - \sin 2\alpha}$

(c) $\frac{3 - 2\sin 2\alpha}{4 + \sin 2\alpha}$ (d) $\frac{3 - \sin 2\alpha}{4 + 3\sin 2\alpha}$

**Consider the following for the next two (02) items that follow:**

A flagstaff 20 m long standing on a pillar 10 m high subtends an angle $\tan^{-1}(0.5)$ at a point $P$ on the ground. Let $\theta$ be the angle subtended by the pillar at this point $P$.

**33.** If $x$ is the distance of $P$ from bottom of the pillar, then consider the following statements:

1. $x$ can take two values which are in the ratio 1: 3
2. $x$ can be equal to height of the flagstaff

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

**34.** What is a possible value of $\tan\theta$?

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

**Consider the following for the next two (02) items that follow:**

The perimeter of a triangle $ABC$ is 6 times the AM of sine of angles of the triangle. Further $BC = \sqrt{3}$ and $CA = 1$.

**35.** What is the perimeter of the triangle?

(a) $\sqrt{3} + 1$ (b) $\sqrt{3} + 2$ (c) $\sqrt{3} + 3$ (d) $2\sqrt{3} + 1$

**36.** Consider the following statements:

1. $ABC$ is right angled triangle
2. The angles of the triangle are in AP

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

**Consider the following for the next two (02) items that follow:**

Let $x = \frac{\sin^2 A + \sin A + 1}{\sin A}$ where $0 < A \leq \frac{\pi}{2}$

**37.** What is the minimum value of $x$?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

**38.** At what value of $A$ does $x$ attain the minimum value?

(*a*) $\frac{\pi}{6}$ (*b*) $\frac{\pi}{4}$ (*c*) $\frac{\pi}{3}$ (*d*) $\frac{\pi}{2}$

**Consider the following for the next two (02) items that follow:**

In the triangle $ABC$, $a^2 + b^2 + c^2 = ac + \sqrt{3}bc$

**39.** What is the nature of the triangle?

(*a*) Equilateral
(*b*) Isosceles
(*c*) Right angled triangle
(*d*) Scalene but not right angled

**40.** If $c = 8$, what is the area of the triangle?

(*a*) $4\sqrt{3}$ (*b*) $6\sqrt{3}$ (*c*) $8\sqrt{3}$ (*d*) $12\sqrt{3}$

**Consider the following for the next two (02) items that follow:**

Consider the function $f(x) = |x - 2| + |3 - x| + |4 - x|$, where $x \in R$.

**41.** At what value of $x$ does the function attain minimum value?

(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 0

**42.** What is the minimum value of the function?

(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 0

**Consider the following for the next two (02) items that follow:**

Consider the sum
$S = 0! + 1! + 2! + 3! + 4! + ... + 100!$

**43.** If the sum $S$ is divided by 8, what is the remainder?

(*a*) 0 (*b*) 1
(*c*) 2 (*d*) Cannot be determined

**44.** If the sum $S$ is divided by 60, what is the remainder?

(*a*) 1 (*b*) 3 (*c*) 17 (*d*) 34

**Consider the following for the next two (02) items that follow:**

In a triangle $PQR$, $P$ is the largest angle and $\cos P = \frac{1}{3}$. Further the in-circle of the triangle touches the sides $PQ$, $QR$ and $RP$ at $N$, $L$ and $M$ respectively such that the lengths $PN$, $QL$ and $RM$ are $n$, $n + 2$, $n + 4$ respectively where $n$ is an integer.

**45.** What is the value of $n$?

(*a*) 4 (*b*) 6 (*c*) 8 (*d*) 10

**46.** What is the length of the smallest side?

(*a*) 12 (*b*) 14 (*c*) 16 (*d*) 18

**Consider the following for the next two (02) items that follow:**

Given that
$\sin x + \cos x + \tan x + \cot x + \sec x + \operatorname{cosec} x = 7$

**47.** The given equation can be reduced to

(*a*) $\sin^2 2x - 44\sin 2x + 36 = 0$ (*b*) $\sin^2 2x + 44\sin 2x - 36 = 0$
(*c*) $\sin^2 2x - 22\sin 2x + 18 = 0$ (*d*) $\sin^2 2x + 22\sin 2x - 18 = 0$

**48.** If $\sin 2x = a - b\sqrt{c}$, where $a$ and $b$ are natural numbers and $c$ is prime number, then what is the value of $a - b + 2c$?

(*a*) 0 (*b*) 14 (*c*) 21 (*d*) 28

**Consider the following for the next two (02) items that follow:**

A quadratic equation is given by
$\left(3 + 2\sqrt{2}\right)x^2 - \left(4 + 2\sqrt{3}\right)x + \left(8 + 4\sqrt{3}\right) = 0$

**49.** What is the HM of the roots of the equation?

(*a*) 2 (*b*) 4 (*c*) $2\sqrt{2}$ (*d*) $2\sqrt{3}$

**50.** What is the GM of the roots of the equation?

(*a*) $\sqrt{2}\left(\sqrt{6} - \sqrt{3} + \sqrt{2} - 1\right)$ (*b*) $\sqrt{2}\left(\sqrt{6} + \sqrt{3} - \sqrt{2} - 1\right)$

(*c*) $\left(\sqrt{6} - \sqrt{3} + \sqrt{2} - 1\right)$ (*d*) $\left(\sqrt{6} + \sqrt{3} + \sqrt{2} - 1\right)$

**Consider the following for the next two (02) items that follow:**

Let $\Delta(a, b, c, \alpha) = \begin{vmatrix} a & b & a\alpha + b \\ b & c & b\alpha + c \\ a\alpha + b & b\alpha + c & 0 \end{vmatrix}$

**51.** If $\Delta(a, b, c, \alpha) = 0$ for every $\alpha > 0$, then which one of the following is correct?

(*a*) $a$, $b$, $c$ are in AP (*b*) $a$, $b$, $c$ are in GP
(*c*) $a$, $2b$, $c$ are in AP (*d*) $a$, $2b$, $c$ are in GP

**52.** If $\Delta(7, 4, 2, \alpha) = 0$, then $\alpha$ is a root of which one of the following equations?

(*a*) $7x^2 + 4x + 2 = 0$ (*b*) $7x^2 - 4x + 2 = 0$
(*c*) $7x^2 + 8x + 2 = 0$ (*d*) $7x^2 - 8x + 2 = 0$

**Consider the following for the next two (02) items that follow:**

Given that $m(\theta) = \cot^2\theta + n^2 \tan^2\theta + 2n$, where $n$ is a fixed positive real number.

**53.** What is the least value of $m(\theta)$?

(*a*) $n$ (*b*) $2n$ (*c*) $3n$ (*d*) $4n$

**54.** Under what condition does $m$ attain the least value?

(*a*) $n = \tan^2\theta$ (*b*) $n = \cot^2\theta$ (*c*) $n = \sin^2\theta$ (*d*) $n = \cos^2\theta$

**Consider the following for the next two (02) items that follow:**

A quadrilateral is formed by the lines $x = 0$, $y = 0$, $x + y = 1$ and $6x + y = 3$.

**55.** What is the equation of diagonal through origin?

(*a*) $3x + y = 0$ (*b*) $2x + 3y = 0$
(*c*) $3x - 2y = 0$ (*d*) $3x + 2y = 0$

**56.** What is the equation of other diagonal?

(*a*) $x + 2y - 1 = 0$ (*b*) $x - 2y - 1 = 0$
(*c*) $2x + y + 1 = 0$ (*d*) $2x + y - 1 = 0$

**Consider the following for the next two (02) items that follow:**

$P(x, y)$ is any point on the ellipse $x^2 + 4y^2 = 1$. Let $E$, $F$ be the foci of the ellipse.

**57.** What is $PE + PF$ equal to?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

**58.** Consider the following points:

1. $\left(\frac{\sqrt{3}}{2}, 0\right)$ 2. $\left(\frac{\sqrt{3}}{2}, \frac{1}{4}\right)$ 3. $\left(\frac{\sqrt{3}}{2}, -\frac{1}{4}\right)$

Which of the above points lie on latus rectum of ellipse?

(*a*) 1 and 2 only (*b*) 2 and 3 only
(*c*) 1 and 3 only (*d*) 1, 2 and 3

**Consider the following for the next two (02) items that follow:**

The line $y = x$ partitions the circle $(x - a)^2 + y^2 = a^2$ in two segments.

**59.** What is the area of minor segment?

(*a*) $\frac{(\pi-2)a^2}{4}$ (*b*) $\frac{(\pi-1)a^2}{4}$

(*c*) $\frac{(\pi-2)a^2}{2}$ (*d*) $\frac{(\pi-1)a^2}{2}$

**60.** What is the area of major segment?

(*a*) $\frac{(3\pi-2)a^2}{4}$ (*b*) $\frac{(3\pi+2)a^2}{4}$

(*c*) $\frac{(3\pi-2)a^2}{2}$ (*d*) $\frac{(3\pi+2)a^2}{2}$

**Consider the following for the next two (02) items that follow:**

Let $A(1, -1, 2)$ and $B(2, 1, -1)$ be the end points of the diameter of the sphere.

$$x^2 + y^2 + z^2 + 2ux + 2vy + 2wz - 1 = 0$$

**61.** What is $u + v + w$ equal to?

(*a*) –2 (*b*) –1 (*c*) 1 (*d*) 2

**62.** If $P(x, y, z)$ is any point on the sphere, then what is $PA^2 + PB^2$ equal to?

(*a*) 15 (*b*) 14 (*c*) 13 (*d*) 6.5

**Consider the following for the next two (02) items that follow:**

Consider two lines whose direction ratios are (2, –1, 2) and (*k*, 3, 5). They are inclined at angle $\frac{\pi}{4}$.

**63.** What is the value of *k*?

(*a*) 4 (*b*) 2 (*c*) 1 (*d*) –1

**64.** What are the direction ratios of a line which is perpendicular to both the lines?

(*a*) (1, 2, 10) (*b*) (–1, –2, 10)

(*c*) (11, 12, –10) (*d*) (11, 2, –10)

**Consider the following for the next two (02) items that follow:**

Let $\vec{a} = 3\hat{i} + 3\hat{j} + 3\hat{k}$ and $\vec{c} = \hat{j} - \hat{k}$. Let $\vec{b}$ be such that $\vec{a} \cdot \vec{b} = 27$ and $\vec{a} \times \vec{b} = 9\vec{c}$

**65.** What is $\vec{b}$ equal to?

(*a*) $3\hat{i} + 4\hat{j} + 2\hat{k}$ (*b*) $5\hat{i} + 2\hat{j} + 2\hat{k}$

(*c*) $5\hat{i} - 2\hat{j} + 6\hat{k}$ (*d*) $3\hat{i} + 3\hat{j} + 4\hat{k}$

**66.** What is the angle between $(\vec{a} + \vec{b})$ and $\vec{c}$?

(*a*) $\frac{\pi}{2}$ (*b*) $\frac{\pi}{3}$ (*c*) $\frac{\pi}{4}$ (*d*) $\frac{\pi}{6}$

**Consider the following for the next two (02) items that follow:**

Let a vector $\vec{a} = 4\hat{i} - 8\hat{j} + \hat{k}$ make angles $\alpha$, $\beta$, $\gamma$ with the positive directions of $x, y, z$ axes respectively.

**67.** What is $\cos\alpha$ equal to?

(*a*) $\frac{1}{3}$ (*b*) $\frac{4}{9}$ (*c*) $\frac{5}{9}$ (*d*) $\frac{2}{3}$

**68.** What is $\cos 2\beta + \cos 2\gamma$ equal to?

(*a*) $-\frac{32}{81}$ (*b*) $-\frac{16}{81}$ (*c*) $\frac{16}{81}$ (*d*) $\frac{32}{81}$

**Consider the following for the next two (02) items that follow:**

The position vectors of two points *A* and *B* are $\hat{i} - \hat{j}$ and $\hat{j} + \hat{k}$ respectively.

**69.** Consider the following points:

1. (–1, –3, 1)
2. (–1, 3, 2)
3. (–2, 5, 3)

Which of the above points lie on the line joining *A* and *B*?

(*a*) 1 and 2 only (*b*) 2 and 3 only

(*c*) 1 and 3 only (*d*) 1,2 and 3

**70.** What is the magnitude of $\overrightarrow{AB}$?

(*a*) 2 (*b*) 3 (*c*) $\sqrt{6}$ (*d*) $\sqrt{3}$

**Consider the following for the next three (03) items that follow:**

Let $f(x) = Pe^x + Qe^{2x} + Re^{3x}$, where *P, Q, R* are real numbers. Further $f(0) = 6$, $f'(\ln 3) = 282$ and $\int_0^{\ln 2} f(x)dx = 11$

**71.** What is the value of *Q*?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

**72.** What is the value of *R*?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

**73.** What is $f'(0)$ equal to?

(*a*) 18 (*b*) 16 (*c*) 15 (*d*) 14

**Consider the following for the next two (02) items that follow:**

Suppose *E* is the differential equation representing family of curves $y^2 = 2cx + 2c\sqrt{c}$ where *c* is a positive parameter.

**74.** What is the order of the differential equation?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

**75.** What is the degree of the differential equation?

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) Degree does not exist

**Consider the following for the next three (03) items that follow:**

Let $f(x) = \begin{vmatrix} \cos x & x & 1 \\ 2\sin x & x^2 & 2x \\ \tan x & x & 1 \end{vmatrix}$

**76.** What is $f(0)$ equal to?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) 2

**77.** What is $\lim_{x\to 0}\frac{f(x)}{x}$ equal to?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) 2

**78.** What is $\lim_{x\to 0}\frac{f(x)}{x^2}$ equal to?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) 2

**Consider the following for the next two (02) items that follow:**

Let $f(x) = \sin[\pi^2]x + \cos[-\pi^2]x$ where [.] is a greatest integer function

**79.** What is $f\left(\frac{\pi}{2}\right)$ equal to?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) 2

**80.** What is $f\left(\frac{\pi}{4}\right)$ equal to?

(*a*) $-\frac{1}{\sqrt{2}}$ (*b*) –1 (*c*) 1 (*d*) $\frac{1}{\sqrt{2}}$

**Consider the following for the next three (03) items that follow:**

Let $I_1 = \int_0^{\pi} \frac{x}{1+\cos^2 x}dx$ and $I_2 = \int_0^{\pi} \frac{1}{1+\sin^2 x}dx$

**81.** What is the value of $\frac{I_1 + I_2}{I_1 - I_2}$ ?

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

**82.** What is the value of $8I_1^2$ ?

(*a*) $\pi$ (*b*) $\pi^2$ (*c*) $\pi^3$ (*d*) $\pi^4$

**83.** What is the value of $I_2$?

(*a*) $\frac{\pi}{\sqrt{2}}$ (*b*) $\frac{\pi}{2\sqrt{2}}$ (*c*) $\frac{3\pi}{2\sqrt{2}}$ (*d*) $\frac{\pi}{4\sqrt{2}}$

**Consider the following for the next two (02) items that follow:**

Let $I = \int_a^b \frac{|x|}{x}dx,\ a < b$

**84.** What is *I* equal to when $a < 0 < b$?

(*a*) $a + b$ (*b*) $a - b$ (*c*) $b - a$ (*d*) $\frac{(a+b)}{2}$

**85.** What is *I* equal to when $a < b < 0$?

(*a*) $a + b$ (*b*) $a - b$ (*c*) $b - a$ (*d*) $\frac{(a+b)}{2}$

**Consider the following for the next three (03) items that follow:**

Let $f(x) = |\ln x|,\ x \neq 1$

**86.** What is the derivative of $f(x)$ at $x = 0.5$?

(*a*) –2 (*b*) –1 (*c*) 1 (*d*) 2

**87.** What is the derivative of $f(x)$ at $x = 2$?

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

**88.** What is the derivative of $f \circ f(x)$, where $1 < x < 2$?

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

**Consider the following for the next two (02) items that follow:**

Let $f(x) = \begin{cases} x+6, x \leqslant 1 \\ px+q, 1 < x < 2 \\ 5x, x \geqslant 2 \end{cases}$ and $f(x)$ is continuous

**89.** What is the value of *p*?

(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 5

**90.** What is the value of *q*?

(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 5

**91. Consider the following statements:**

1. $f(x) = \ln x$ is increasing in $(0, \infty)$
2. $g(x) = e^x + e^{\frac{1}{x}}$ is decreasing in $(0, \infty)$

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

**92.** What is the derivative of $\sin^2 x$ with respect to $\cos^2 x$?

(*a*) –1 (*b*) 1 (*c*) $\sin 2x$ (*d*) $\cos 2x$

**93.** For what value of *m* with $m < 0$, is the area bounded by the lines $y = x$, $y = mx$ and $x = 2$ equal to 3?

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

**94.** What is the derivative of $\operatorname{cosec}(x^\circ)$ ?

(*a*) $-\operatorname{cosec}(x^\circ)\cot(x^\circ)$ (*b*) $-\frac{\pi}{180}\operatorname{cosec}(x^\circ)\cot(x^\circ)$

(*c*) $\frac{\pi}{180}\operatorname{cosec}(x^\circ)\cot(x^\circ)$ (*d*) $-\frac{\pi}{180}\operatorname{cosec}(x)\cot(x)$

**95.** A solution of the differential equation $\left(\frac{dy}{dx}\right)^2 - x\frac{dy}{dx} = 0$ is

(*a*) $y = 2x$ (*b*) $y = 2x + 4$

(*c*) $y = x^2 - 1$ (*d*) $y = \frac{(x^2-2)}{2}$

**96.** If $f(x) = x^2 + 2$ and $g(x) = 2x - 3$, then what is $(fg)(1)$ equal to?

(*a*) 3 (*b*) 1 (*c*) –2 (*d*) –3

**97.** What is the range of the function $f(x) = x + |x|$ if the domain is the set of real numbers?

(*a*) $(0, \infty)$ (*b*) $[0, \infty)$ (*c*) $(-\infty, \infty)$ (*d*) $[1, \infty)$

**98.** If $f(x) = x(4x^2 - 3)$, then what is $f(\sin\theta)$ equal to?

(*a*) $-\sin 3\theta$ (*b*) $-\cos 3\theta$ (*c*) $\sin 3\theta$ (*d*) $-\sin 4\theta$

**99.** What is $\lim_{x \to 5} \frac{5-x}{|x-5|}$ equal to?

(*a*) –1 (*b*) 0
(*c*) 1 (*d*) Limit does not exist

**100.** What is $\lim_{x \to 1} \frac{x^9 - 1}{x^3 - 1}$ equal to?

(*a*) –1 (*b*) –3
(*c*) 3 (*d*) Limit does not exist

**101.** The mean and variance of five observations are 14 and 13.2 respectively. Three of the five observations are 11, 16 and 20. What are the other two observations?

(*a*) 8 and 15 (*b*) 9 and 14 (*c*) 10 and 13 (*d*) 11 and 12

**102.** Let *A* and *B* be two independent events such that $P(\bar{A}) = 0.7, P(\bar{B}) = k, P(A \cup B) = 0.8$. What is the value of *k*?

(*a*) $\frac{5}{7}$ (*b*) $\frac{4}{7}$ (*c*) $\frac{2}{7}$ (*d*) $\frac{1}{7}$

**103.** A biased coin with the probability of getting head equal to $\frac{1}{4}$ is tossed five times. What is the probability of getting tail in all the first four tosses followed by head?

(*a*) $\frac{81}{512}$ (*b*) $\frac{81}{1024}$
(*c*) $\frac{81}{256}$ (*d*) $\frac{27}{1024}$

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**104.** A coin is biased so that heads comes up thrice as likely as tails. In four independent tosses of the coin, what is probability of getting exactly three heads?

(*a*) $\frac{81}{256}$ (*b*) $\frac{27}{64}$ (*c*) $\frac{27}{256}$ (*d*) $\frac{9}{256}$

**105.** Let $X$ and $Y$ be two random variables such that $X + Y = 100$.If $X$ follows Binomial distribution with parameters $n = 100$ and $p = \frac{4}{5}$, what is the variance of $Y$?

(*a*) 1 (*b*) $\frac{1}{2}$ (*c*) 16 (*d*) $\frac{1}{16}$

**106.** If two lines of regression are $x + 4y + 1 = 0$ and $4x + 9y + 7 = 0$, then what is the value of $x$ when $y = -3$?

(*a*) –13 (*b*) –5 (*c*) 5 (*d*) 7

**107.** The central angles $p$, $q$, $r$ and $s$ (in degrees) of four sectors in a Pie Chart satisfy the relation $9p = 3q = 2r = 6s$. What is the value of $4p - q$?

(*a*) 12 (*b*) 24 (*c*) 30 (*d*) 36

**108.** The observations 4, 1, 4, 3, 6, 2, 1, 3, 4, 5, 1, 6 are outputs of 12 dices thrown simultaneously. If $m$ and $M$ are means of lowest 8 observations and highest 4 observations respectively, then what is $(2m+M)$ equal to?

(*a*) 10 (*b*) 12 (*c*) 17 (*d*) 21

**109.** A bivariate data set contains only two points (–1,1) and (3,2). What will be the line of regression of $y$ on $x$?

(*a*) $x - 4y + 5 = 0$ (*b*) $3x + 2y - 1 = 0$

(*c*) $x + 4y + 1 = 0$ (*d*) $5x - 4y + 1 = 0$

**110.** A die is thrown 10 times and obtained the following outputs:

1, 2, 1, 1, 2, 1, 4, 6, 5, 4

What will be the mode of data so obtained?

(*a*) 6 (*b*) 4 (*c*) 2 (*d*) 1

**111.** Consider the following frequency distribution:

| x | 1 | 2 | 3 | 5 |
|---|---|---|---|---|
| $f$ | 4 | 6 | 9 | 7 |

What is the value of median of the distribution?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 3.5

**112.** For data –1, 1, 4, 3, 8, 12, 17, 19, 9, 11; if $M$ is the median of first 5 observations and $N$ is the median of last five observations, then what is the value of $4M - N$?

(*a*) 7 (*b*) 4 (*c*) 1 (*d*) 0

**113.** Let $P$, $Q$, $R$ represent mean, median and mode. If for some distribution $5P = 4Q = \frac{R}{2}$, then what is $\frac{P+Q}{2P+0.7R}$ equal to?

(*a*) $\frac{1}{12}$ (*b*) $\frac{1}{7}$ (*c*) $\frac{2}{9}$ (*d*) $\frac{1}{4}$

**114.** If $G$ is the geometric mean of numbers $1, 2, 2^2, 2^3, \ldots, 2^{n-1}$, then what is the value of $1 + 2\log_2 G$?

(*a*) 1 (*b*) 4 (*c*) $n - 1$ (*d*) $n$

**115.** If $H$ is the harmonic mean of numbers $1, 2, 2^2, 2^3, \ldots, 2^{n-1}$, then what is $n / H$ equal to?

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

**116.** Let $P$ be the median, $Q$ be the mean and $R$ be the mode of observations $x_1, x_2, x_3, \ldots x_n$. Let $S = \sum_{i=1}^{n} (2x_i - a)^2$. $S$ takes minimum value, when $a$ is equal to

(*a*) $P$ (*b*) $\frac{Q}{2}$ (*c*) $2Q$ (*d*) $R$

**117.** One bag contains 3 white and 2 black balls, another bag contains 2 white and 3 black balls. Two balls are drawn from the first bag and put it into the second bag and then a ball is drawn from the second bag. What is the probability that it is white?

(*a*) $\frac{6}{7}$ (*b*) $\frac{33}{70}$ (*c*) $\frac{3}{10}$ (*d*) $\frac{1}{70}$

**118.** Three dice are thrown. What is the probability that each face shows only multiples of 3?

(*a*) $\frac{1}{9}$ (*b*) $\frac{1}{18}$ (*c*) $\frac{1}{27}$ (*d*) $\frac{1}{3}$

**119.** What is the probability that the month of December has 5 Sundays?

(*a*) 1 (*b*) $\frac{1}{4}$ (*c*) $\frac{3}{7}$ (*d*) $\frac{2}{7}$

**120.** A natural number $n$ is chosen from the first 50 natural numbers. What is the probability that $n + \frac{50}{n} < 50$?

(*a*) $\frac{23}{25}$ (*b*) $\frac{47}{50}$ (*c*) $\frac{24}{25}$ (*d*) $\frac{49}{50}$

# Paper II: General Ability

## PART-A

### Ordering of Words in a Sentence

**Directions:** Each of the following items in this section consists of a sentence, the parts of which have been jumbled. These parts have been labelled P, Q, R and S. Given below each sentence are four sequences namely (*a*), (*b*), (*c*) and (*d*). You are required to re-arrange the jumbled parts of the sentence correctly and mark your response accordingly.

**1.** because I feel

P

you remember it better

Q

when you write something,

R

I make at least three drafts of a song

S

The correct sequence should be:

(*a*) SPRQ

(*b*) RQPS

(*c*) QRSP

(*d*) PRSQ

**2.** for hours in the shop
P
a gunman who held
Q
a hostage
R
demanded ransom of ₹ 10 lakh
S
The correct sequence should be:
(*a*) SPRQ (*b*) RQPS (*c*) QRPS (*d*) PRSQ

**3.** living in Russia
P
country immediate
Q
Ukraine has urged its citizens
R
to leave the
S
The correct sequence should be:
(*a*) SPRQ (*b*) RPSQ (*c*) RSQP (*d*) PRSQ

**4.** ripping roofs off houses and raising fears of
P
coast of Madagascar in the early hours,
Q
cyclone Emnati crashed into the southeastern
R
flooding and food shortages in the region
S
The correct sequence should be:
(*a*) SPRQ (*b*) RPSQ (*c*) RQPS (*d*) PRSQ

**5.** ecology is protected and aquatic life thrives
P
we need to utilize the resources of water
Q
for different purposes while
R
ensuring that its natural
S
The correct sequence should be:
(*a*) SPRQ (*b*) RQPS (*c*) QRSP (*d*) PRSQ

**6.** very difficult
P
the poor visibility
Q
made the movement of traffic
R
due to fog
S
The correct sequence should be:
(*a*) SPRQ (*b*) RQPS (*c*) QRPS (*d*) QSRP

**7.** avenues for the patients to indict
P
but rarely is it the other way round
Q
there are multiple legal
R
the doctors
S
The correct sequence should be:
(*a*) SPRQ (*b*) RPSQ (*c*) QRPS (*d*) QSRP

**8.** flight, and each person
P
her own journey
Q
life is a solo
R
makes his or
S
The correct sequence should be:
(*a*) SPRQ (*b*) RPQS (*c*) RPSQ (*d*) PQRS

**9.** made it evolve
P
technologies and equipment has
Q
into a rare centre of excellence
R
adoption of the latest
S
The correct sequence should be:
(*a*) PQRS (*b*) RPQS
(*c*) SQPR (*d*) QSRP

**10.** please mark the same
P
be made in response to this notice
Q
if you have any complaint to
R
to the concerned authority
S
The correct sequence should be:
(*a*) PQRS (*b*) RPQS (*c*) SQPR (*d*) RQPS

### Idioms and Phrases

**Directions:** Given below are some idioms/phrases followed by four alternative meanings for each. Choose the most appropriate answer from among the options (*a*), (*b*) (*c*) or (*d*).

**11.** The lion's share
(*a*) A portion of something
(*b*) The largest and the best part of something
(*c*) An important decision
(*d*) An aggressive statement

**12.** Spill the beans
(*a*) Reveal a secret
(*b*) Forced to leave belongings
(*c*) Share the news
(*d*) Take offence at someone's rude behaviour

**13.** Cook someone's goose
(*a*) To assist others (*b*) Hypnotize other's mind
(*c*) To spoil other's plans (*d*) Inviting misfortune

**14.** Disappear into thin air
(*a*) Lost forever (*b*) Become forgetful
(*c*) Become uncaring (*d*) Disappear suddenly

**15.** Put the screws on
(*a*) Forcing someone to do what you want
(*b*) Never letting go of things
(*c*) Keep the past alive
(*d*) Using someone's trick for own benefit

**16.** Sit on the fence
(*a*) Avoid meeting someone (*b*) Waiting patiently
(*c*) Avoid taking sides (*d*) Hiding from someone

**17.** Be as sharp as a tack
(*a*) A talkative person (*b*) A shrewed person
(*c*) A clumsy person (*d*) A clever person

**18.** From pillar to post
(*a*) Upside down
(*b*) Keep moving from one place to another
(*c*) Constructing a huge building
(*d*) Jumping from the top of the mountain

**19.** Health Robinson
(*a*) Very complicated system or machine for doing a simple task
(*b*) Treating everyone as enemy, when they are not
(*c*) Sleeping all day, doing nothing
(*d*) Very lazy person, slow in action

**20.** As thick as thieves
(*a*) Dumb person
(*b*) Good for nothing
(*c*) Someone who uses everyone for personal gain
(*d*) Very close friends who are looked upon with suspicion

### Synonyms

**Directions:** Each item in this section consists of a sentence with an underlined word followed by four options, (*a*), (*b*), (*c*) and (*d*). Select the option that is nearest in meaning to the underlined word and mark your response in your Answer Sheet accordingly.

**21.** During the pandemic the **indigent** people had to suffer a lot.
(*a*) very poor (*b*) opulent (*c*) solvent (*d*) prosperous

**22.** She had no idea what made him angry in one minute and **jovial** the next.
(*a*) aggrieved (*b*) melancholic
(*c*) doleful (*d*) mirthful

**23.** It is sheer **lunacy** to drive a car in this frosty weather.
(*a*) prudence (*b*) normalcy (*c*) insanity (*d*) sanity

**24.** Operating on a child with cancer needs **meticulous** planning and teamwork.
(*a*) strong (*b*) long (*c*) playful (*d*) scrupulous

**25.** The thrill of over-speeding the vehicle can be **exhilarating,** but it is important not to take the consequences lightly.
(*a*) humdrum (*b*) dreary (*c*) exciting (*d*) agitating

**26.** The **redemption** will now depend on his new strategy of inclusiveness.
(*a*) retrieval (*b*) forfeiture
(*c*) corporation (*d*) desecration

**27.** Only three candidates are now in **contention** for the title.
(*a*) involved in dispute (*b*) in agreement with each other
(*c*) chance of winning (*d*) amiable to each other

**28.** All my fishing **paraphernalia** is in the car.
(*a*) boxes (*b*) accessories (*c*) fuel (*d*) food

**29.** The public watched in **astonishment** as he took a sudden jump from the bridge.
(*a*) anticipation (*b*) hurriedly
(*c*) wonderment (*d*) calmness

**30.** Drinking **inordinate** amount of liquor is not good for health.
(*a*) temperate (*b*) exorbitant (*c*) moderate (*d*) regular

### Spotting Errors

**Directions:** Each item in this section has a sentence with three underlined parts labelled (*a*), (*b*) and (*c*). Read each sentence to find out whether there is any error in any underlined part. Indicate your response in the Answer Sheet against the corresponding latter i.e., (*a*) or (*b*) or (*c*). If you find no error, your response should be indicated as (*d*).

**31.** (*a*) Over long periods of time
(*b*) layers of sediments builds up
(*c*) to a height of a few kilometers,
(*d*) No Error

**32.** (*a*) When a gas is
(*b*) cooled down it turns into a liquid
(*c*) from a process called condensation
(*d*) No Error

**33.** (*a*) If you want (*b*) to know the news
(*c*) you can read a newspaper (*d*) No Error

**34.** (*a*) Columbus made his
(*b*) first voyage from Europe to America
(*c*) on 1492
(*d*) No Error

**35.** (*a*) Whenever the sky is (*b*) clear, you can see
(*c*) the stars in the night (*d*) No Error

**36.** (*a*) I'm not working tomorrow,
(*b*) so I don't had to
(*c*) get up early,
(*d*) No Error

**37.** (*a*) She didn't (*b*) tell anybody
(*c*) about her plans, (*d*) No Error

**38.** (*a*) She wouldn't have (*b*) has an accident,
(*c*) if she had driven carefully (*d*) No Error

**39.** (*a*) I will watch film (*b*) if I finish the work
(*c*) in time (*d*) No Error

**40.** (*a*) In 1989, the government
(*b*) did an about-face and I an restored
(*c*) it's family planning program,
(*d*) No Error

**Antonyms**

**Directions:** Each item in this section consists of a sentence with an underlined word followed by four options, (*a*), (*b*), (*c*) and (*d*). Select the option that is **opposite in meaning** to the underline word and mark your response in your Answer Sheet accordingly.

**41.** The parental support can **fortify** a child's learning.
(*a*) weaken (*b*) encourage (*c*) brace (*d*) strengthen

**42.** Now we can have another **dazzling** thought, as an outcome of my brilliant research!
(*a*) splendid (*b*) murky (*c*) dazing (*d*) fulgent

**43.** The group held some **clandestine** meetings to resolve the matter.
(*a*) secret (*b*) covert (*c*) sneaky (*d*) public

**44.** In the winters, the countryside view is **bleak** and the house is drafty.
(*a*) cheerless (*b*) verdant (*c*) desolate (*d*) bare

**45.** Amid **commotion** the leader and his supporters remained passive.
(*a*) quietude (*b*) uproar (*c*) tempest (*d*) stir

**46.** He had the **audacity** to blame him.
(*a*) boldness (*b*) vigour (*c*) temerity (*d*) politeness

**47.** They are making plans for the **abatement** of the nuisance within a specified time.
(*a*) subsidence (*b*) ebbing
(*c*) accumulation (*d*) mitigation

**48.** There is **exponential** growth in the development of the scientific researches in the recent few decades.
(*a*) aggressive (*b*) rampant (*c*) meager (*d*) augmented

**49.** He was known for his **sagacity**.
(*a*) prudence (*b*) wisdom (*c*) ignorance (*d*) sapience

**50.** The river Ganges **culminates** in the Bay of Bengal.
(*a*) concludes (*b*) flows (*c*) originates (*d*) merges

**PART-B**

**51.** Which one of the following statements is true?
(*a*) The force of gravity of the Earth on the Moon is greater than the force of gravity of the Moon on the Earth.
(*b*) The force of gravity of the Moon on the Earth is greater than the force of gravity of the Earth on the Moon.
(*c*) The force of gravity of the Earth o the Moon and of the Moon on the Earth are equal in magnitude and are in the same direction.
(*d*) The force of gravity of the Earth on the Moon and of the Moon on the Earth are equal in magnitude but are in opposite directions.

**52.** An electric bulb is rated as 220 V and 80 W. When it is operated on 110 V, the power rating would be:
(*a*) 80 W (*b*) 60 W (*c*) 40 W (*d*) 20 W

**53.** In the dispersion of white light by a common glass prism, which one among the following is correct?
(*a*) Red light deviates the most because red light has highest speed in prism
(*b*) Blue light deviates the most because blue light has highest speed in prism
(*c*) Red light deviates the most because red light has lowest speed in prism
(*d*) Blue light deviates the most because blue light has lowest speed in prism

**54.** Which one among the following is true for the speed of sound in a given medium?
(*a*) Speed of sound remains same at all frequencies
(*b*) Speed of sound is faster at higher frequencies
(*c*) Speed of sound is slower at higher frequencies
(*d*) Speed of sound is slower at higher wavelengths

**55.** Which one of the following telescopes contains only mirors?
(*a*) Galilean telescope (*b*) Keplerian telescope
(*c*) Newtonian telescope (*d*) Schmidt telescope

**56.** Which among the following is the correct arrangement of halogens in the increasing order of their oxidizing nature?
(*a*) F, Cl, Br, I (*b*) Cl, Fr, F, I
(*c*) Br, I, Cl, F (*d*) I, Br, Cl, F

**57.** Copper sulphate crystals available in the market are blue coloured crystals. By careful heating, they turn to white colour. Which one of the following is responsible for the blue colour?
(*a*) Oxygen (*b*) Nitrogen (*c*) Water (*d*) Hydrogen

**58.** Equal volume of all gases, when measured at the same temperature and pressure, contain an equal number of particles. Who proposed the above law?
(*a*) Charles (*b*) Boyle (*c*) Avogadro (*d*) Lussac

**59.** Airbags work on the principle of a chemical reaction triggered by the impact producing a gaseous product that causes a sudden volume change. Which one among the following chemical conversions is responsible for this ?
(*a*) Sodium azide into nitrogen gas
(*b*) Solid carbon dioxide into gaseous carbon dioxide
(*c*) Carbon dioxide into carbon monoxide
(*d*) Sudden conversion of gaseous carbon dioxide into carbon monoxide

**60.** Sand falls vertically on a conveyor belt at a rate of 0.1 kg/s. In order to keep the belt moving at a uniform speed of 2 m/s, the force required tobe applied on the belt is:
(*a*) 0 N (*b*) 0.2 N (*c*) 1.0 N (*d*) 2.0 N

**61.** The power required to lift a mass of 8.0 kg up a vertical distance of 4 m in 2 s is (taking acceleration due to gravity as 10 $m/s^2$):
(*a*) 80 W (*b*) 160 W (*c*) 320 W (*d*) 640 W

**62.** One block of 2.0 kg mass is placed on top of another block of 3.0 kg mass. The coefficient of static friction between the two blocks is 0.2. The bottom block is pulled with a horizontal force F such that both the blocks move together without slipping. Taking acceleration due to gravity as 10 $m/s^2$, the maximum value of the frictional force is:
(*a*) 50 N (*b*) 30 N (*c*) 4 N (*d*) 10 N

**63.** A mass is attached to a spring that hangs vertically. The extension produced in the spring is 6 cm on Earth. The acceleration due to gravity on the surface of the Moon is one-sixth of its value on the surface of the Earth. The extension of the spring on the Moon would be:
(*a*) 6 cm (*b*) 1 cm (*c*) 0 cm (*d*) 36 cm

**64.** Which one of the following is an example of Second Class Lever?
(*a*) A pair of scissors (*b*) A bottle opener
(*c*) A cricket bat (*d*) A bow and arrow

**65.** In an electric circuit, a wire of resistance 10 Ω is used. If this wire is stretched to a length double of its original value, the current in the circuit would become:
(*a*) half of tis original value
(*b*) double of its original value
(*c*) one-fourth of its original value
(*d*) four times of its original value

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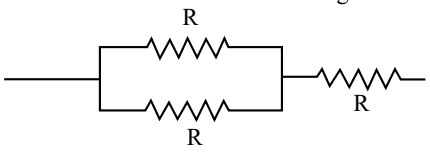
**66** What is the total resistance in the following circuit element?




(*a*) R/2 (*b*) 3R (*c*) 3R/2 (*d*) 2R/3

**67.** One advantage of sexual reproduction over asexual reproduction is that it helps species to survive over long evolutionary time. This is because sexual reproduction produces:

(*a*) more offspring in each reproductive cycle.

(*b*) robust and healthy offspring.

(*c*) genetically similar offspring.

(*d*) more variation in offspring.

**68.** Which one of the following structures or components is ***not*** always present in living cells?

(*a*) Cell wall (*b*) Plasma membrane

(*c*) Cytoplasm (*d*) Genetic material

**69.** Browning of the chopped apple can be minimized by:

(*a*) using table sugar

(*b*) preserving in a container

(*c*) using lemon juice

(*d*) using milk of magnesia

**70.** Which of the hydrocarbons are arranged as per the increasing order of their boiling points?

(*a*) Methane, Butane, Propane, Heptane

(*b*) Propane, Butane, Pentane, Octane

(*c*) Propane, Butane, Heptane, Methane

(*d*) Octane, Ethane, Methane, Propane

**71.** Which one of the following apparatus is used for separating benzene and water mixture?

(*a*) Round bottom flask

(*b*) Conical flask

(*c*) Separating funnel

(*d*) Dean and Stark apparatus

**72.** An iron nail dipped in copper sulphate solution turns brown. This is due to which one of the following types of reactions?

(*a*) Addition reaction

(*b*) Decomposition reaction

(*c*) Substitution reaction

(*d*) Displacement reaction

**73.** Among the following, which is ***not*** the correct method for keeping the curd?

(*a*) Keeping in stainless steel vessel

(*b*) Keeping in copper vessel

(*c*) Keeping in plastic vessel

(*d*) Keeping in glass vessel

**74.** Toothpaste prevents tooth decay by:

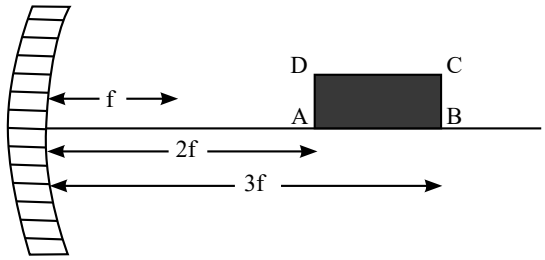
(*a*) neutralizing the excess acidity.

(*b*) means of emulsification.

(*c*) the action of fluoride.

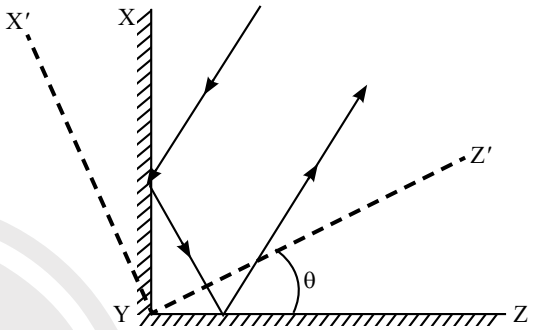
(*d*) making a coat of calcium over the teeth surface.

**75.** A rectangle ABCD is kept in front of a concave mirror of focal length f with its corners A and B being, respectively, at distances 2f and 3f from the mirror with AB along the principal axis as shown in the figure. It forms an image A′B′C′D′ in front of the mirror. What is the ratio of B′C′ to A′D′?




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

**76.** Shown in the figure are two plane mirrors XY and YZ (XY ⊥ YZ) joined at their edge. Also shown is a light ray falling on one of the mirrors and reflected back parallel to its original path as a result of this arrangement. The two mirrors are now rotated by an angle θ to their new position X′YZ′, as shown. As a result the new reflected ray is at an angle α from the original reflected ray. Then:




(*a*) $\alpha = 0$ (*b*) $\alpha = \theta$ (*c*) $\alpha = 2\theta$ (*d*) $\alpha = 4\theta$

**77.** A railway wagon (open at the top) of mass $M_1$ is moving with speed $v_1$ along a straight track. As a result of rain, after some time it gets partially filled with water so that the mass of the wagon becomes $M_2$ and speed becomes $v_2$. Taking the rain to be falling vertically and water stationary inside the wagon, the relation between the two speed $v_1$ and $v_2$ is:

(*a*) $v_1 = v_2$ (*b*) $\frac{1}{2}M_1v_1^2 < \frac{1}{2}M_2v_2^2$

(*c*) $M_1v_1 = M_2v_2$ (*d*) $M_1v_1 < M_2v_2$

**78.** Which one of the following statements is ***not*** true for a flute, a musical instrument?

(*a*) Momentum of waves on the blowing jet determines the loudness of the produced note.

(*b*) Arrival time of the waves on the blowing jet determines the pitch of the produced note.

(*c*) Sound comes from a vibrating column of air inside the flute.

(*d*) Sound comes from a vibrating column of air inside as well as outside the flute.

**79.** A positive charge is moving towards south in a space where magnetic field is pointing in the north direction. The moving charge will experience:

(*a*) a deflecting force towards north direction.

(*b*) a deflecting force towards east direction.

(*c*) a deflecting force towards east direction.

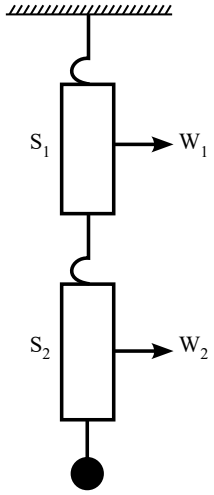
(*d*) no deflecting force.

**80.** Which one of the following is ***not*** a main greenhouse gas?

(*a*) Water vapour (*b*) Oxygen

(*c*) Carbon dioxide (*d*) Methane

**81.** Two identical spring balances $S_1$ and $S_2$ are connected one after the other and are held vertically as shown in the figure. A mass of 10 kg is hanging from $S_2$. If the readings on $S_1$ and $S_2$ are $W_1$ and $W_2$ respectively, then:




(*a*) $W_1 = 5$ kg and $W_2 = 10$ kg (*b*) $W_1 = 10$ kg and $W_2 = 5$ kg
(*c*) $W_1 = 5$ kg and $W_2 = 5$ kg (*d*) $W_1 = 10$ kg and $W_2 = 10$ kg

**82.** A stone is thrown horizontally from the top of a 20 m high building with a speed of 12 m/s. It hits the ground at a distance R from the building. Taking g = 10 m/s$^2$ and neglecting air resistance will give:

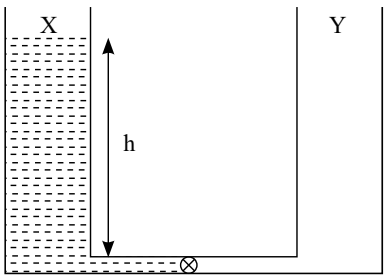
(*a*) R = 12 m (*b*) R = 18 m (*c*) R = 24 m (*d*) R = 30 m

**83.** A sphere of volume V is made of a material with lower density than water. While on Earth, it floats on water with its volume $f_1$V ($f_1 < 1$) submerged. On the other hand, on a spaceship accelerating with acceleration $a < g$ ($g$ is the acceleration due to gravity on Earth) in outer space, its submerged volume in water is $f_2$V. Then:

(*a*) $f_2 = f_1$ (*b*) $f_2 = \left(1 - \frac{a}{g}\right) f_1$

(*c*) $f_2 > f_1$ (*d*) $f_2 = \frac{a}{g} f_1$

**84.** Two identical containers X and Y are connected at the bottom by a thin tube of negligible volume. The tube has a valve in it, as shown in the figure. Initially container X has a liquid filled up to height h in it and container Y is empty. When the valve is opened, both containers have equal amount of liquid in equilibrium. If the initial (before the valve is opened) potential energy of the liquid is $P_1$ and the final potential energy is $P_2$ then:




(*a*) $P_1 = P_2$ (*b*) $P_1 = 4P_2$ (*c*) $P_1 = 2P_2$ (*d*) $P_1 = 8P_2$

**85.** A particle is moving in a circle of radius R with a constant speed v. Its average acceleration over the time when it moves over half the circle is:

(*a*) $\frac{v^2}{R}$ (*b*) $\frac{\pi v^2}{2R}$ (*c*) $\frac{2v^2}{\pi R}$ (*d*) 0

**86.** Two forces of 5.0 N each are acting on a point mass. If the angle between the forces is 60°, then the net force acting on the point mass has magnitude close to :

(*a*) 8.6 N (*b*) 4.3 N (*c*) 5.0 N (*d*) 6.7 N

**87.** Consider the following statements regarding cell wall composition:

1. Bacterial cell wall is made of peptidoglycan.
2. Fungal cell wall is made of cellulose.
3. Animals lack cell wall and have extracellular matrix made up of sugar and proteins.

Select the correct answer using the code given below:

(*a*) 2 only (*b*) 1 and 2 only
(*c*) 1 and 3 only (*d*) 1, 2 and 3

**88.** Which one of the following structures is ***not*** present in a prokaryotic cell?

(*a*) Cell wall (*b*) Ribosomes
(*c*) Nucleus (*d*) Plasma membrane

**89.** In a plant cell, which one of the following contains their own DNA?

(*a*) Nucleus and Endoplasmic Reticulum
(*b*) Ribosome and Golgi apparatus
(*c*) Mitochondria and Chloroplast
(*d*) Chloroplast and Vacuoles

**90.** Which one of the following statements about X-rays is ***not*** true?

(*a*) They have wavelengths of about 1 Å.
(*b*) These can be generated by bombarding a metal target by high energy electrons.
(*c*) Due to their wavelengths being shorter, these can be used for radar systems.
(*d*) These are also used for the treatment of certain forms of cancer.

**91.** Organisms capable of using $CO_2$ as principal carbon source are called:

(*a*) Autotrophs (*b*) Heterotrophs
(*c*) Parasites (*d*) Decomposers

**92.** When yeast cells are $O_2$ starved, fermentation serves as the source of energy. This results in the production of:

(*a*) ATP + $CO_2$ + Ethanol (*b*) ATP + $O_2$ + Pyruvate
(*c*) ATP + $CO_2$ + Lactic acid (*d*) ATP + $O_2$ + Acetaldehyde

**93.** During a laboratory experiment, a student immerses epidermal leaf peel in a hypertonic solution. After some time, the student examined the cells under a microscope and observed that:

(*a*) the cells swelled.
(*b*) the cells were plasmolysed.
(*c*) the cells built up turgor pressure.
(*d*) the cells size was unaffected.

**94.** Which one of the following is ***not*** a characteristic feature of fungi?

(*a*) Cell wall is made of chitin
(*b*) Filamentous mycelium is present
(*c*) Can carry out photosynthesis
(*d*) Asexual spores are produced

**95.** Which one of the following statements about bryophytes is ***not*** correct?

(*a*) The plant body is a gametophyte
(*b*) They are also called the amphibians of plant kingdom.
(*c*) The plant body is attached to the substratum by rhizoids.
(*d*) Specialized water-conducting tissues are present.

**96.** What is the specific purpose of using potassium hydroxide during the saponification process?

(*a*) To obtain soaps which are hard on the skin

(*b*) To obtain soaps which are soft on the skin

(*c*) To obtain natural fragrance

(*d*) To make the saponification very economical

**97.** Which one of the following is the correct arrangement of metals in the decreasing order of their reactivity?

(*a*) Iron, Sodium, Silver, Copper

(*b*) Silver, Copper, Iron, Sodium

(*c*) Sodium, Copper, Silver, Iron

(*d*) Sodium, Iron, Copper, Silver

**98.** Which among the following statements is ***not*** correct with respect to allotropes of Carbon?

(*a*) Graphite is a good conductor of electricity.

(*b*) Diamond is the hardest substance known.

(*c*) Fullerence is one of the allotropes of carbon.

(*d*) Next to diamond, graphite is the second hardest known substance.

**99.** Which among the following is the popular method for manufacture of ammonia?

(*a*) Ostwald's process (*b*) Haber-Bosch process

(*c*) Electric furnace process (*d*) Electrolysis process

**100.** For manufacturing of glass, which among the following is used as a source of silica?

(*a*) Fine clay soil (*b*) Wood powder

(*c*) Conconut shell (*d*) Sand

**101.** The Counter Insurgency and Jungle Warfare School of Indian Army is situated at:

(*a*) Dehradun (*b*) Vairengte

(*c*) Gulmarg (*d*) Mhow

**102.** In the soil-formign regime, which one of the following occurs in a region where evaptranspiration exceeds precipitation significatly?

(*a*) Calcification (*b*) Laterization

(*c*) Podsolization (*d*) Gleization

**103.** Which one of the following is found in the innermost part of the Earth?

(*a*) Conrad discontinuity (*b*) Moho discontinuity

(*c*) Guttenberg discontinuity (*d*) Lehmann discontinuity

**104.** Which of the following ree species is/are found on Himalayas?

1. Oak
2. Rhododendron
3. Rosewood

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 and 3

(*c*) 1 and 3 (*d*) 1 and 2

**105.** Which one of the following is the lowermost/innermost intrusive igneous rock?

(*a*) Laccolith (*b*) Batholith

(*c*) Lopolith (*d*) Phacolith

**106.** If it is 12 noon in New Delhi, what will be the time in London, UK?

(*a*) 6:30 AM (*b*) 6:30 PM

(*c*) 5:30 AM (*d*) 5:30 PM

**107.** Which of the following positions of Sun, Earth and Moon is/are suitable for Spring Tide?

1. SYZYGY Conjunction
2. SYZYGY Opposition
3. Quadrature

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) 1 and 2 (*d*) 1 and 3

**108.** Which Renaissance artist painted 'The Last Supper'?

(*a*) Michelangelo (*b*) Donatello

(*c*) Botticelli (*d*) Leonardo da Vinci

**109.** Which one of the following European explorer conquered Mexico?

(*a*) Vasco da Gama (*b*) Bartholomew Diaz

(*c*) Magellan (*d*) Hernan Cortes

**110.** Near which one of the following cities in India have large statues of Kushana rulers been discovered?

(*a*) Karnal (*b*) Ropar

(*c*) Hisar (*d*) Mathura

**111.** The Treaty of Yandabo was concluded as part of which one of the following wars?

(*a*) First Anglo-Burmese War

(*b*) Second Anglo-Burmese War

(*c*) Anglo-Kuki War

(*d*) Anglo-Maratha War

**112.** Plan allocation in agriculture and irrigation as percentage of total plan outlay was highest in:

(*a*) Seventh Five-Year Plan (*b*) Third Five-Year Plan

(*c*) First Five-Year Plan (*d*) Second Five-Year Plan

**113.** The UN COP-27 Summit relates to:

(*a*) Russia-Ukraine war

(*b*) Terrorism and counter-terrorism

(*c*) Climate change

(*d*) Interpol

**114.** Which one of the following tribes from India's North-East had the earliest known association with cultivation and production of tea?

(*a*) Khasis (*b*) Garos

(*c*) Singphos (*d*) Jayantias

**115.** By which one of the following amendments, was Articles 51A, relating to the Fundamental Duties, inserted into the Constitution of India?

(*a*) The Constitution (42$^{nd}$ Amendment) Act

(*b*) The Constitution (44$^{th}$ Amendment) Act

(*c*) The Constitution (85$^{th}$ Amendment) Act

(*d*) The Constitution (92$^{nd}$ Amendment) Act

**116.** Which one among the following districts of Eastern India held a referendum in 1947 to decide whether or not to join Pakistan?

(*a*) Sylhet (*b*) Goalpara

(*c*) Cachar (*d*) Jalpaiguri

**117.** Which one of the following statements about Rabatak inscription is ***not*** correct?

(*a*) It throws important light on Kushana genealogy.

(*b*) It refers to Kanishka as 'a king of kings and a son of God'.

(*c*) The 23-line inscription is written in Gandhari language.

(*d*) It mentions names of States which were part of Kanishka's empire.

**118.** Who among the following was the author of the famous Sanskrit work 'Mrichchhakatika'?

(*a*) Kalidasa (*b*) Bhasa

(*c*) Valmiki (*d*) Shudraka

**119.** Yashovarman was ruler of which one of the following kingdoms?

(*a*) Kannauj (*b*) Mewar

(*c*) Marwar (*d*) Kalinga

**120.** Which one among the following rulers established Pataliputra as the capital of the Magadhan Empire?

(*a*) Bimbisara (*b*) Bindusara

(*c*) Ajatahatru (*d*) Ashoka

**121.** Which one of the following astronomers proved that the Earth and other plants revolve around the Sun?

(*a*) Copernicus (*b*) Kepler

(*c*) Galileo (*d*) Newton

**122.** Which of the following scheme(s) is/are included under *Bharatmala Pariyojana?*

1. Develop the road connectivity to border areas
2. Development of coastal roads
3. Improvement in the efficiency of National Corridors

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 3 only

(*c*) 2 and 3 only (*d*) 1, 2 and 3

**123.** Deendayal Port was earlier known as:

(*a*) Paradip Port (*b*) Tuticorin Port

(*c*) Kandla Port (*d*) Visakhapatnam Port

**124.** Freedom fighter Kanaklata Barua was martyred in :

(*a*) Sepoy Mutiny

(*b*) Quit India Movement

(*c*) Non-Cooperation Movement

(*d*) Peasant Uprising of 1893 – 1894

**125.** Which one among the following statements about the Mansabdar system is correct?

(*a*) All army troopers were allotted mansabs.

(*b*) Mansabs were usually assigned on the basis of ancestry.

(*c*) Position and salary of mansabdars were indicated by a numerical designation called zat.

(*d*) Mansabdars were never paid in cash.

**126.** Which Governor General of Bengal underwent impeachment proceedings in the British Parliament?

(*a*) Robert Clive (*b*) Henry Vansittart

(*c*) Warren Hastings (*d*) Lord Cornwallis

**127.** Who among the following composed the 'Prayag Prashasti' of Samudragupta?

(*a*) Harishena (*b*) Chand Bardai

(*c*) Vishakhadatta (*d*) Kalidasa

**128.** Which one of the following kingdoms was founded by the two brothers Harihara and Bukka?

(*a*) Bahmani (*b*) Vijayanagara

(*c*) Malwa (*d*) Maratha

**129.** At which one of the following places did the Danis establish their settlement in India?

(*a*) Chinsura (*b*) Karaikal

(*c*) Mahe (*d*) Tranquebar

**130.** Which one of the following is ***not*** an igneous rock ?

(*a*) Granite (*b*) Slate

(*c*) Basalt (*d*) Gabbro

**131.** Which of the following statements is/are correct?

1. Hypocenter is the point on the surface of the Earth, nearest to the focus.
2. Velocity of earthquake waves is higher in denser materials.
3. P waves move faster and are the first to arrive at the surface of the Earth.

Select the correct answer using the code given below:

(*a*) 1 and 2 (*b*) 2 and 3

(*c*) 1 and 3 (*d*) 3 only

**132.** In terms of geological time scale, the quaternary period consists of two epochs. They are:

(*a*) Pleistocene and Pliocene

(*b*) Holocene and Pleistocene

(*c*) Pleistocene and Miocene

(*d*) Holocene and Eocene

**133.** Which one of the following is the correct sequence of arrangement of the given planets in descending order of their density (in $gm/cm^3$)?

(*a*) Earth > Jupiter > Venus > Saturn

(*b*) Jupiter > Earth > Saturn > Venus

(*c*) Earth > Venus > Jupiter > Saturn

(*d*) Earth > Venus > Saturn > Jupiter

**134.** Which one of the following is ***not*** a cold current?

(*a*) Western Australian Current

(*b*) Eastern Australian Current

(*c*) Benguela Current

(*d*) Peru Current

**135.** The process of Podsolization is predominantly found in:

(*a*) Equatorial forest (*b*) Monsoon forest

(*c*) Taiga forest (*d*) Mediterranean forest

**136.** Joint Military exercise 'Keen Sword 23' was conducted between:

(*a*) India and Japan (*b*) India and USA

(*c*) USA and Japan (*d*) Japan and Taiwan

**137.** The Battle of Rezang La, an epic battle in hostile conditions, was fought by the Indian Army in:

(*a*) 1948 (*b*) 1956

(*c*) 1962 (*d*) 1972

**138.** Consider the following statements about 'Exercise Sea Vigil-22':

1. Its aim is to assess India's preparedness in the domain of Maritime security and coastal defence.
2. Naval forces of USA and Japan also took part in the exercise.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

**139.** Consider the following statements:

1. England is the only country that won the ICC T20 World Cup twice.
2. Virat Kohli is the only player to be adjudged as the Player of the Series in the ICC T20 World Cup twice.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

**140.** Who among the following is ***not*** a recipient of Nobel Prize in Chemistry in 2022?

(*a*) Carolyn R. Bertozzi (*b*) Benjamin List
(*c*) Morten Meldal (*d*) K. Barry Sharpless

**141.** Which one among the following is the northernmost geographical location?

(*a*) New Delhi (*b*) Kathmandu
(*c*) Thimphu (*d*) Dhaka

**142.** Consider the following statements:

1. Distance between the longitudes becomes zero on North Pole and South Pole.
2. Distance between the longitudes is maximum on the Equator.
3. Number of longitudes in more than number of latitudes.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only (*c*) 1 and 3 only (*d*) 1, 2 and 3

**143.** Which one among the following states is the leading producer of Manganese in India?

(*a*) Madhya Pradesh (*b*) Jharkhand
(*c*) Rajasthan (*d*) Karnataka

**144.** Mica is mainly used in:

(*a*) food and beverage industry.
(*b*) iron and steel industry.
(*c*) aluminium industry.
(*d*) electrical and electronic industries.

**145.** According to Koppen's climatic classifications, the Great Nortern Plains of India have which one of the following climates?

(*a*) Aw climate (*b*) Cwg climate
(*c*) Amw climate (*d*) Dfc climate

**146.** Which of the following statements about Lachit Borphukan is/are correct?

1. He was a General of the Ahom Force.
2. He is known for his leadership in the Battle of Saraighat.
3. Lachit Borphukan Gold Medal is given to the best cadet at the National Defence Academy.

Select the correct anser using the code given below:

(*a*) 1, 2 and 3 (*b*) 2 and 3 only
(*c*) 1 only (*d*) 2 only

**147.** The 4$^{th}$ edition of joint military exercise 'DUSTLIK' between the Indian Army and the Uzbekistan Army was held in:

(*a*) Ranikhet (*b*) Gangtok
(*c*) Pithoragarh (*d*) Leh

**148.** Which of the following is India's first privately developed rocket launched by ISRO recently?

(*a*) Skyroot (*b*) Prarambh
(*c*) Bazoomq (*d*) Vikram-S

**149.** Which one among the following villages was recently declared as India's first 24 × 7 solar-powered village?

(*a*) Mawlynnong, Meghalaya
(*b*) Modhera, Gujarat
(*c*) Ziro village, Arunachal Pradesh
(*d*) Malana, Himachal Pradesh

**150.** Tableaux of which one of the following States was adjudged the best in the Republic Day Parade, 2023?

(*a*) Uttarakhand (*b*) Punjab
(*c*) Gujarat (*d*) Uttar Pradesh

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# ANSWER KEY

## Paper I: Mathematics

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** (*a*) | **2.** (*d*) | **3.** (*) | **4.** (*b*) | **5.** (*d*) | **6.** (*b*) | **7.** (*a*) | **8.** (*b*) | **9.** (*b*) | **10.** (*b*) |
| **11.** (*d*) | **12.** (*b*) | **13.** (*) | **14.** (*c*) | **15.** (*a*) | **16.** (*b*) | **17.** (*a*) | **18.** (*b*) | **19.** (*b*) | **20.** (*c*) |
| **21.** (*b*) | **22.** (*d*) | **23.** (*c*) | **24.** (*d*) | **25.** (*c*) | **26.** (*a*) | **27.** (*c*) | **28.** (*d*) | **29.** (*c*) | **30.** (*b*) |
| **31.** (*a*) | **32.** (*b*) | **33.** (*a*) | **34.** (*c*) | **35.** (*c*) | **36.** (*c*) | **37.** (*c*) | **38.** (*d*) | **39.** (*c*) | **40.** (*c*) |
| **41.** (*b*) | **42.** (*a*) | **43.** (*c*) | **44.** (*d*) | **45.** (*c*) | **46.** (*d*) | **47.** (*a*) | **48.** (*d*) | **49.** (*b*) | **50.** (*c*) |
| **51.** (*b*) | **52.** (*c*) | **53.** (*d*) | **54.** (*b*) | **55.** (*c*) | **56.** (*d*) | **57.** (*b*) | **58.** (*d*) | **59.** (*a*) | **60.** (*b*) |
| **61.** (*a*) | **62.** (*b*) | **63.** (*a*) | **64.** (*d*) | **65.** (*b*) | **66.** (*a*) | **67.** (*b*) | **68.** (*a*) | **69.** (*b*) | **70.** (*c*) |
| **71.** (*b*) | **72.** (*c*) | **73.** (*d*) | **74.** (*a*) | **75.** (*b*) | **76.** (*b*) | **77.** (*b*) | **78.** (*a*) | **79.** (*b*) | **80.** (*d*) |
| **81.** (*) | **82.** (*d*) | **83.** (*a*) | **84.** (*a*) | **85.** (*b*) | **86.** (*a*) | **87.** (*c*) | **88.** (*b*) | **89.** (*b*) | **90.** (*c*) |
| **91.** (*a*) | **92.** (*a*) | **93.** (*a*) | **94.** (*b*) | **95.** (*d*) | **96.** (*d*) | **97.** (*b*) | **98.** (*a*) | **99.** (*d*) | **100.** (*c*) |
| **101.** (*c*) | **102.** (*c*) | **103.** (*b*) | **104.** (*b*) | **105.** (*c*) | **106.** (*c*) | **107.** (*d*) | **108.** (*a*) | **109.** (*a*) | **110.** (*d*) |
| **111.** (*c*) | **112.** (*d*) | **113.** (*d*) | **114.** (*d*) | **115.** (*b*) | **116.** (*a*) | **117.** (*) | **118.** (*c*) | **119.** (*c*) | **120.** (*b*) |

## Paper II: General Ability

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** (*a*) | **2.** (*c*) | **3.** (*b*) | **4.** (*c*) | **5.** (*c*) | **6.** (*d*) | **7.** (*b*) | **8.** (*c*) | **9.** (*c*) | **10.** (*d*) |
| **11.** (*b*) | **12.** (*a*) | **13.** (*c*) | **14.** (*d*) | **15.** (*a*) | **16.** (*c*) | **17.** (*b*) | **18.** (*b*) | **19.** (*a*) | **20.** (*d*) |
| **21.** (*a*) | **22.** (*d*) | **23.** (*c*) | **24.** (*d*) | **25.** (*c*) | **26.** (*a*) | **27.** (*c*) | **28.** (*b*) | **29.** (*c*) | **30.** (*b*) |
| **31.** (*b*) | **32.** (*c*) | **33.** (*c*) | **34.** (*c*) | **35.** (*c*) | **36.** (*b*) | **37.** (*b*) | **38.** (*b*) | **39.** (*c*) | **40.** (*c*) |
| **41.** (*a*) | **42.** (*b*) | **43.** (*d*) | **44.** (*b*) | **45.** (*a*) | **46.** (*d*) | **47.** (*c*) | **48.** (*c*) | **49.** (*c*) | **50.** (*c*) |
| **51.** (*d*) | **52.** (*d*) | **53.** (*) | **54.** (*a*) | **55.** (*c*) | **56.** (*d*) | **57.** (*c*) | **58.** (*c*) | **59.** (*a*) | **60.** (*b*) |
| **61.** (*b*) | **62.** (*c*) | **63.** (*b*) | **64.** (*b*) | **65.** (*c*) | **66.** (*c*) | **67.** (*d*) | **68.** (*a*) | **69.** (*c*) | **70.** (*b*) |
| **71.** (*c*) | **72.** (*d*) | **73.** (*b*) | **74.** (*a*) | **75.** (*c*) | **76.** (*c*) | **77.** (*c*) | **78.** (*d*) | **79.** (*d*) | **80.** (*b*) |
| **81.** (*d*) | **82.** (*c*) | **83.** (*a*) | **84.** (*c*) | **85.** (*c*) | **86.** (*a*) | **87.** (*c*) | **88.** (*c*) | **89.** (*c*) | **90.** (*c*) |
| **91.** (*a*) | **92.** (*a*) | **93.** (*b*) | **94.** (*c*) | **95.** (*d*) | **96.** (*b*) | **97.** (*d*) | **98.** (*d*) | **99.** (*b*) | **100.** (*d*) |
| **101.** (*b*) | **102.** (*c*) | **103.** (*d*) | **104.** (*d*) | **105.** (*b*) | **106.** (*a*) | **107.** (*c*) | **108.** (*d*) | **109.** (*d*) | **110.** (*d*) |
| **111.** (*a*) | **112.** (*c*) | **113.** (*c*) | **114.** (*c*) | **115.** (*a*) | **116.** (*a*) | **117.** (*c*) | **118.** (*d*) | **119.** (*a*) | **120.** (*) |
| **121.** (*a*) | **122.** (*d*) | **123.** (*c*) | **124.** (*b*) | **125.** (*c*) | **126.** (*c*) | **127.** (*a*) | **128.** (*b*) | **129.** (*d*) | **130.** (*b*) |
| **131.** (*b*) | **132.** (*b*) | **133.** (*c*) | **134.** (*b*) | **135.** (*c*) | **136.** (*c*) | **137.** (*c*) | **138.** (*a*) | **139.** (*b*) | **140.** (*b*) |
| **141.** (*a*) | **142.** (*d*) | **143.** (*a*) | **144.** (*d*) | **145.** (*b*) | **146.** (*b*) | **147.** (*c*) | **148.** (*d*) | **149.** (*b*) | **150.** (*a*) |

# EXPLANATION

## Paper I: Mathematics

1. (*a*) Since, ω is a cube root of unity

$\therefore 1 + \omega + \omega^2 = 0 \Rightarrow \omega + \omega^2 = -1$

Hence, $\left|\frac{1-\omega}{-1}\right| = |\omega - 1| = \left|\frac{-1}{2} + i\frac{\sqrt{3}}{2} - 1\right|$

$= \left|\frac{-3}{2} + i\frac{\sqrt{3}}{2}\right| = \sqrt{\frac{9}{4} + \frac{3}{4}} = \sqrt{3}$

**2.** (*d*) No. divisible by 6 is the number divisible by both 2 and 3. Any 6 digit number formed by given digits is always divisible by 3.

If 0 is at last place then total numbers $= 5 \times 4 \times 3 \times 2 \times 1$

$= 120$

If 2 is at last place then total numbers $= 4 \times 4 \times 3 \times 2 \times 1 = 96$

If 4 is at last place then total numbers $= 4 \times 4 \times 3 \times 2 \times 1$

$= 96$

Hence, total 6 digit numbers divisible by 6 = 120 + 96 + 96

$= 312$

**3.** (*)

| | | |
|---|---|---|
| 2 | 1011 | |
| 2 | 505 | 1 |
| 2 | 252 | 1 |
| 2 | 126 | 0 |
| 2 | 63 | 0 |
| 2 | 31 | 1 |
| 2 | 15 | 1 |
| 2 | 7 | 1 |
| 2 | 3 | 1 |
| | 1 | 1 |

Binary equivalent of 1011 is $(1111110011)_2$

**4.** (*b*) Since, adj$(kA) = k^{n-1}$ (adj $A$)

Therefore, $|2 \text{ adj}(3A)|$

$= |2 \times 3^2 \text{ adj } A| = (2 \times 3^2)^3 |\text{adj } (A)|$

$= (2 \times 3^2)^3 |A|^{3-1}$

$= 2^3 \times 3^6 \times 4^2$

$= 2^7 \times 3^6$

Hence, $\alpha = 7$ and $\beta = 6$

$\therefore \alpha + \beta = 13$

**5.** (*d*) $x^2 - x + 1 = 0$

Roots are $\frac{1 \pm i\sqrt{3}}{2}$ that are cube roots of unity.

$\therefore 1 + \omega + \omega^2 = 0$ and $\omega^{3n} = 1$

Hence, $\left|\frac{\alpha^{100} + \beta^{100}}{\alpha^{100} - \beta^{100}}\right| = \left|\frac{\alpha^{99}\alpha + \beta^{99}\beta}{\alpha^{99}\alpha - \beta^{99}\beta}\right|$

$= \left|\frac{\alpha + \beta}{\alpha - \beta}\right| = \left|\frac{1}{i\sqrt{3}}\right| = \left|\frac{i\sqrt{3}}{-3}\right| = \frac{1}{\sqrt{3}}$

**6.** (*b*) $(AB - BA)^T = (AB)^T - (BA)^T$

$= B^T A^{\mathrm{T}} - A^T B^{\mathrm{T}}$

$= BA - AB$ (skew symmetric matrix)

Hence, only (*b*) is correct

**7.** (*a*) Statement 1: $AB = AC$

$\Rightarrow A^{-1} AB = A^{-1} AC$

$\Rightarrow B = C$

We know, inverse of matrix is only possible when its determinant is non-zero.

Statement 2: Since, inverse of column matrix is not possible. Therefore, second statement is false.

**8.** (*b*) $\Delta = \begin{vmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 3 & 6 & 3 \end{vmatrix} = 0$

$\Delta_1 = \begin{vmatrix} 4 & 2 & 1 \\ 8 & 4 & 2 \\ 10 & 6 & 3 \end{vmatrix} = 0$

$\Delta_2 = \begin{vmatrix} 1 & 4 & 1 \\ 2 & 8 & 2 \\ 3 & 10 & 3 \end{vmatrix} = 0$

$\Delta_3 = \begin{vmatrix} 1 & 2 & 4 \\ 2 & 4 & 8 \\ 3 & 6 & 10 \end{vmatrix} = 0$

Hence, the system of linear equations has infinitely many solutions.

**9.** (*b*) Since $X_1$ and $X_2$ be its two distinct solution.

$\therefore AX_1 = B$ ... (i)

Also, $AX_2 = B$ ... (ii)

$aX_1 + bX_2$ is also its solution.

$A(aX_1 + bX_2) = B$

$Aa X_1 + Ab X_2 = B$

$aB + bB = B$ [From (i) and (ii)]

$a + b = 1$

**10.** (*b*) Expanding along $C_1$, we get

$(x + b)(x - a)(x - c) = 0$

$\therefore$ Roots are $a$, $-b$ or $c$.

sum of roots $= a - b + c$.

**11.** (*d*) If $2 - i\sqrt{3}$ is a root of equation $x^2 + ax + b$, then another, root should be $2 + i\sqrt{3}$

Hence, sum of roots $= -a$

$4 = -a \Rightarrow a = -4$

Product of roots $= 6$

$\left(2 - i\sqrt{3}\right)\left(2 + i\sqrt{3}\right) = b$

$\Rightarrow b = 7$

$\therefore a + b = 3$

**12.** (*b*) $z = \frac{1 + i\sqrt{3}}{1 - i\sqrt{3}} \times \frac{1 + i\sqrt{3}}{1 + i\sqrt{3}}$

$= \frac{1^2 + \left(i\sqrt{3}\right)^2 + 2i\sqrt{3}}{1 - \left(i\sqrt{3}\right)^2}$

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

$\arg(z) = \pi - \tan^{-1}\left(\frac{-\frac{\sqrt{3}}{2}}{\frac{1}{2}}\right) = \pi - \frac{\pi}{3} = \frac{2\pi}{3}$

**13.** (*)

**14.** (*c*) $(a^x)^2 = \log_x a \times \log_b x$

$\Rightarrow (a^x)^2 = \log_b a$

Taking log on both sides

$2x \log_a a = \log a (\log_b a)$

$\Rightarrow x = \frac{\log_a(\log_b a)}{2}$

**15.** (*a*) $\left(2^{\frac{b}{ac}}\right)^2 = 2^{\frac{1}{c}} \cdot 2^{\frac{1}{a}}$

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

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

$\Rightarrow 2b = a + c$

**16.** (*b*) $a=\frac{5}{2}$

$a+d=\frac{23}{12}$

$\Rightarrow d=\frac{23}{12}-\frac{5}{2}=-\frac{7}{12}$

First largest negative term

$a+(n-1)\,d<0$

$\Rightarrow \frac{5}{2}+(n-1)\left(\frac{-7}{12}\right)<0$

$\Rightarrow (n-1)\left(\frac{-7}{12}\right)<-\frac{5}{2}$

$\Rightarrow n-1>\frac{5}{2}\times\frac{12}{7}$

$\Rightarrow n-1>\frac{60}{14}$

$\Rightarrow n>\frac{74}{14}$

$\Rightarrow n>5$

Hence, $6^{th}$ term is first negative.

**17.** (*a*) For real roots of $x^2-4x+k=0$

$(-4)^2-4k\geq 0$

$\Rightarrow -4k\geq -16$

$\Rightarrow k\leq 4$

Roots must lie between 0 and 5.

$0<\frac{4\pm\sqrt{16-4k}}{2}<5$

$\Rightarrow 0<2\pm\sqrt{4-k}<5$

$\Rightarrow -2<\pm\sqrt{4-k}<3$

$\Rightarrow 0<4-k<9$

$\Rightarrow -4<-k<5$

$\Rightarrow 4>k>-5$

Also, $f(0)>0$

$\Rightarrow k>0$

Hence, $k$ can take the values of 1, 2 and 3.

**18.** (*b*) First term = $x$

$S_n=\frac{n}{2}\left[2x+(n-1)d\right]=0$

$\Rightarrow d=\frac{-2x}{n-1}=\frac{2x}{1-n}$

$S_{m+n}=\frac{m+n}{2}\left[2x+(m+n-1)\frac{2x}{1-n}\right]$

$=\frac{m+n}{2}\times 2x\left[\frac{1-n+m+n-1}{1-n}\right]$

$=x(m+n)\left(\frac{m}{1-n}\right)=\frac{mx(m+n)}{1-n}$

**19.** (*b*) Statement 1: $\frac{25!+1}{26}=\frac{25!}{26}+\frac{1}{26}$

25! is divided by 26 completely. But 1 remain as remainder.

Statement 2: 6!+1 = 721 is divisible by 7

Hence, only statement 2 is correct.

**20.** (*c*) Let $z=x+iy$

$\frac{z-1}{z+1}=\frac{x-1+iy}{x+1+iy}\times\frac{x+1-iy}{x+1-iy}$

$=\frac{x^2+y^2-1}{(x+1)^2+y^2}+\frac{2iy}{(x+1)^2+y^2}$

For purely imaginary,

$x^2+y^2-1=0$

$\Rightarrow x^2+y^2=1$

$\Rightarrow |z|^2=1$

$\Rightarrow |z|=1$

**21.** (*b*) **Case-I:** $x<4$

$-(x-4)-(x-7)=15$

$\Rightarrow -x+4-x+7=15$

$\Rightarrow -2x=4$

$x=-2$

**Case-II:** $4<x<7$

$(x-4)-(x-7)=15$

$\Rightarrow x-4-x+7=15$

$\Rightarrow 3\neq 15$

$\therefore$ No solution exist.

**Case-III:** $x>7$

$(x-4)+(x-7)+15$

$\Rightarrow 2x-11=15$

$\Rightarrow x=\frac{26}{2}=13$

Hence, two solution exists.

**22.** (*d*) Put $f(x)=\frac{2x+3}{3x+5}$ to get domain,

$\Rightarrow 3x+5=0$

$\Rightarrow x=-\frac{5}{3}$

Hence, domain = $R-\left\{-\frac{5}{3}\right\}$

Now, $f^{-1}(x)=\frac{3-5x}{3x-2}$

Hence, Range = $R-\left\{\frac{2}{3}\right\}$

**23.** (*c*) Statement 1: $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$

$\Rightarrow 2=-2\alpha\beta$

$\Rightarrow \alpha=-1/\beta$

Now, we can find $\alpha$ by substituting it in equation $\alpha+\beta=0$

Statement 2: Given a = 0 i.e., $\alpha+\beta=0$

$\Rightarrow \beta=-\alpha$

Also, $\alpha\beta^2=-1$

$\alpha^3=-1$

$\Rightarrow \alpha=-1$

We can find the value of $\alpha$ through statement 2 also.

**24.** (*d*) $T_6={}^8C_5\,(x^{-8/3})^3\,(x^2\log_{10}{}^x)^5$

$\Rightarrow 5600=56\times x^{-8}\times x^{10}\times(\log_{10}{}^x)^5$

$\Rightarrow 100=x^2\,(\log_{10}{}^x)^5$

$\Rightarrow x=10$

**25.** (*c*) $(3x-y)^4\,(x+3y)^4=\{(3x-y)\,(x+3y)\}^4$

$=(3x^2+8xy-3y^2)^4$

Now, number of terms

$={}^{4+3-1}C_{3-1}={}^6C_2=15$

**26.** (*a*) **Hint:** $p$, $q$, $r$ and $s$ must be 1, 3, 5 and 7.

**27.** (*c*) Statement 1: ${}^nC_{n/2}$ is greatest when $n$ is even.

Hence, $n=2r$ is given.

$\therefore {}^{2r}C_r$ is greatest

Statement 2: ${}^nC_{\frac{n+1}{2}}$ and ${}^nC_{\frac{n-1}{2}}$ is greatest

when $n$ is odd.

Hence, both statements are true.

**28.** (*d*) ${}^mC_2\times{}^nC_2=60$

$\Rightarrow \frac{m(m-1)}{2}\times\frac{n(n-1)}{2}=60$

$\Rightarrow m\,(m-1)\times n\,(n-1)=240$

$\Rightarrow m\,(m-1)\times n\,(n-1)=5\times 4\times 4\times 3$

$\therefore m=5$ and $n=4$

Hence, $m+n=9$

**29.** (*c*) Permutations of word

"PERMUTATIONS" $=\frac{12!}{2!}=x$

Permutations of word

"COMBINATIONS" $=\frac{12!}{2!2!2!}=y$

**30.** (*b*) For number to be greater than 50,000, 5 should be at extreme left position.

Number of numbers greater than 50000 = 4 × 3 × 2 × 1

= 24

Total 5 digit numbers = $\boxed{4}\boxed{4}\boxed{3}\boxed{2}\boxed{1}=96$

$\therefore$ percentage $=\frac{24}{96}\times 100=25\%$

**31.** (*a*) Given, $\sin\beta=\sqrt{\sin\alpha\cos\alpha}$

$\Rightarrow 2\sin^2\beta=2\sin\alpha\cos\alpha$

$\Rightarrow 2\sin^2\beta-1=\sin 2\alpha-1$

$\Rightarrow \cos 2\beta=1-\sin 2\alpha$

$\Rightarrow \cos 2\beta=(\cos\alpha-\sin\alpha)^2$

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**32.** (*b*) Given $\tan\gamma = \dfrac{\sin\alpha + \cos\alpha}{2}$

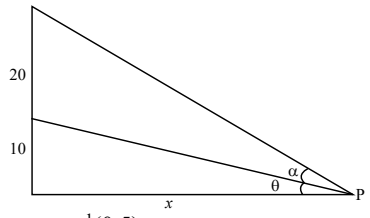
$$\cos 2\gamma = \frac{1-\tan^2\gamma}{1+\tan^2\gamma}$$

$$= \frac{4-(1+\sin 2\alpha)}{4+(1+\sin 2\alpha)}$$

$$= \frac{3-\sin 2\alpha}{5+\sin 2\alpha}$$

Hence, $\sec 2\gamma = \dfrac{5+\sin 2\alpha}{3-\sin 2\alpha}$

**33.** (*a*)




$\alpha = \tan^{-1}(0.5)$

$\tan\theta = \dfrac{10}{x}; \tan(\alpha+\theta) - \dfrac{30}{x}$

$\therefore \tan(\alpha+\theta) = \dfrac{\tan\alpha + \tan\theta}{1 - \tan x \tan\theta}$

$$\Rightarrow \quad \frac{30}{x} = \frac{\frac{1}{2}+\frac{10}{x}}{1-\frac{1}{2}\times\frac{10}{x}} = \frac{x+20}{2x-10}$$

$\Rightarrow \quad 60x - 300 = x^2 + 20x$

$\Rightarrow \quad x^2 - 40x + 300 = 0$

$\Rightarrow \quad x = 10$ or $30$

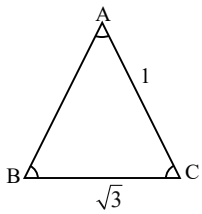
Hence, statement 1 is true and statement 2 is false.

**34.** (*c*) Since, $x = 10$ or $30$

Therefore, possible value of $\tan\theta = \dfrac{10}{10}$ or $\dfrac{10}{30}$

i.e., $\tan\theta = 1$ or $\dfrac{1}{3}$

**35.** (*c*)




Given, $AB + BC + AC$

$$= \frac{\sin A + \sin B + \sin C}{3} \times 6$$

$\Rightarrow AB + BC + AC = 2(\sin A + \sin B + \sin C)$

$\Rightarrow AB + \sqrt{3} + 1 = 2(\sqrt{3}\,k + k + AB(k))$ (using sine rule)

$\Rightarrow (AB + \sqrt{3} + 1) = 2k(\sqrt{3} + 1 + AB)$

$\Rightarrow \quad k = \dfrac{1}{2}$

$\therefore \quad \sin A = k\sqrt{3} = 60°$

$\sin B = k = 30°$

Hence, $\angle C = 180° - 90° = 90°$

$\sin C = k\,AB \Rightarrow AB = 2$

$\therefore$ Perimeter $= 2 + \sqrt{3} + 1 = 3 + \sqrt{3}$

**36.** (*c*) Angle $A$, $B$ and $C$ are 60°, 30° and 90°.

Hence, $ABC$ is right angled triangle. Also, the angles of a triangle are in $AP$.

Therefore, both statements are correct.

**37.** (*c*) Given $x = \dfrac{\sin^2 A + \sin A + 1}{\sin A}$

$$\Rightarrow x = \sin A + 1 + \frac{1}{\sin A} \qquad ...(i)$$

since, A.M $\geq$ G.M

$$\sin A + \frac{1}{\sin A} \geq 2 \qquad ...(ii)$$

Hence, minimum value of $\sin A + 1 + \dfrac{1}{\sin A} = 3$.

**38.** (*d*) The minimum value 3 will occurs at A $= \dfrac{\pi}{2}$

**39.** (*c*) $a^2 = b^2 + c^2 - 2bc\cos A$ ...(i)

$b^2 = a^2 + c^2 - 2ac\cos B$ ...(ii)

$c^2 = b^2 + a^2 - 2ba\cos C$ ...(iii)

On adding these 3 equations, we get

$2bc\cos A + 2ac\cos B + 2ba\cos C = a^2 + b^2 + c^2$ ...(iv)

On comparing the given equation with equation (iv), we get

$\cos C = 0 \Rightarrow \angle C = 90°$

$\cos A = \dfrac{\sqrt{3}}{2} \Rightarrow \angle A = 30°$

and $\angle B = 60°$

Hence, the given $\Delta$ is right angled $\Delta$.

**40.** (*c*) $\dfrac{a}{\sin A} = \dfrac{c}{\sin C}$

$$\Rightarrow a = \frac{8}{1}\times\frac{1}{2} = 4$$

$$\frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\Rightarrow b = \frac{8}{1}\times\frac{\sqrt{3}}{2}$$

$$\text{Area of } \Delta = \frac{1}{2}ab = \frac{1}{2}\times 4\times 8\times\frac{\sqrt{3}}{2} = 8\sqrt{3}$$

**41.** (*b*) At $x = 3$ function attains minimum value.

**42.** (*a*) $f(x) = |x-2| + |3-x| + |4-x|$

Put $x = 3$, we get

$f(x) = |3-2| + |3-3| + |4-3|$

$= |1| + |0| + |1| = 2$

**43.** (*c*) Given, $S = 0! + 1! + 2! + 3! + 4! + .... + 100!$

$S = 1 + 1 + 2 + 6 + 24 + .... + 100!$

$= 10 + 8k$

Sum, $S$ is divided by 8

Required remainder $= \dfrac{10+8k}{8}$

Now put $k = 1$

$\therefore$ Remainder when 18 is divided by $8 = 2$

**44.** (*d*) $S = 1 + 1 + 2 + 6 + 24 + 120 + 720 + .... + 100!$

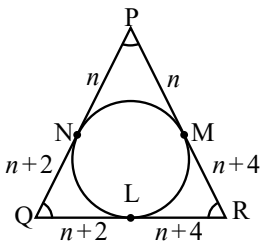
$= 34 + 60k$

$\because$ $S$ is divided by $60 = \dfrac{60k+34}{60}$

Put $k = 1$

$\therefore$ Remainder when 94 is divided by $60 = 34$

**45.** (*c*)




$\because \cos P = \dfrac{1}{3}$ [Given]

$$\Rightarrow \frac{(2n+4)^2 + (2n+2)^2 - (2n+6)^2}{2\times(2n+4)(2n+2)} = \frac{1}{3}$$

$\Rightarrow n = 8$

**46.** (*d*) Length of the smallest side $= PQ = 2n + 2$

$= 2 \times 8 + 2 = 18$

**47.** (*a*) $\sin x + \cos x + \dfrac{1}{\sin x\cos x} + \dfrac{\sin x + \cos x}{\sin x\cos x} = 7$

$\Rightarrow \sin x\cos x(\sin x + \cos x) + 1 + (\sin x + \cos x) = 7\sin x\cos x$

$\Rightarrow (\sin x + \cos x)(\sin x\cos x + 1) = 7\sin x\cos x - 1$

$\Rightarrow (\sin x + \cos x)$

$$\left(\frac{\sin 2x}{2} + 1\right) = \frac{7}{2}\sin 2x - 1$$

Squaring both sides, we get

$$\Rightarrow \left(\frac{\sin^2 2x}{4} + 1 + \sin 2x\right)(1 + \sin 2x)$$

$$= \frac{49}{4}\sin^2 2x$$

$+ 1 - 7\sin 2x$

Let $\sin 2x = t$

$\Rightarrow \left(\frac{t^2}{4}+t+1\right)(1+t)=\frac{49}{4}t^2-7t+1$

$\Rightarrow (t^2+4t+4)(1+t)=49t^2-28t+4$

$\Rightarrow t^3-44t^2+36t=0 \Rightarrow t(t^2-44t+36)=0$

$\Rightarrow t=0$ or $t^2-44t+36=0$

$\Rightarrow \sin^2 x=0$ or $\sin^2 2x-44\sin 2x+36=0$

**48.** (*d*) $\sin 2x=\frac{44\pm\sqrt{(44)^2-4\times 36}}{2}=22\pm 8\sqrt{7}$

$\Rightarrow \sin 2x=22-8\sqrt{7}=a-b\sqrt{c}$

$\Rightarrow a=22, b=8, c=7$

Hence, $a-b+2c=22-8+14=28$

**49.** (*b*) Let roots be $\alpha$ and $\beta$

$\alpha+\beta=\frac{4+2\sqrt{3}}{3+2\sqrt{2}}$, $\alpha\beta=\frac{8+4\sqrt{3}}{3+2\sqrt{2}}$

HM of roots $=\frac{2\alpha\beta}{\alpha+\beta}=\frac{2\left(\frac{8+4\sqrt{3}}{3+2\sqrt{2}}\right)}{\frac{4+2\sqrt{3}}{3+2\sqrt{2}}}$

$=\frac{2\times 2(4+2\sqrt{3})}{(4+2\sqrt{3})}=4$

**50.** (*c*) GM $=\sqrt{ab}=\sqrt{\frac{8+4\sqrt{3}}{3+2\sqrt{2}}}$

$=\frac{\sqrt{(\sqrt{3})^2+(1)^2+2\sqrt{3}}}{\sqrt{(\sqrt{2}+1)^2}}=\sqrt{\left(\frac{\sqrt{3}+1}{\sqrt{2}+1}\right)^2}$

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

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

**51.** (*b*) Given $\Delta(a, b, c, \alpha)=0$

$$\begin{vmatrix} a & b & a\alpha+b \\ b & c & b\alpha+c \\ a\alpha+b & b\alpha+c & 0 \end{vmatrix}=0$$

It implies that any one row or one column's element will be zero

Hence, $a\alpha+b=0 \Rightarrow \alpha=-\frac{b}{a}$

$b\alpha+c=0 \Rightarrow \alpha=-\frac{c}{b}$

$\therefore -\frac{b}{a}=-\frac{c}{b} \Rightarrow b^2=ac$

Hence, $a$, $b$, $c$ are in G.P.

**52.** (*c*) Here $a=7, b=4, c=2$

Given $\Delta(7, 4, 2, \alpha)=0$

$$\therefore \begin{vmatrix} 7 & 4 & 7\alpha+4 \\ 4 & 2 & 4\alpha+2 \\ 7\alpha+4 & 4\alpha+2 & 0 \end{vmatrix}=0$$

$\Rightarrow 7\alpha^2+8\alpha+2=0$

Hence, a is root of $7x^2+8x+2=0$

**53.** (*d*) Given $m(\theta)=\cot^2\theta+n^2\tan^2\theta+2n$

$\because$ minimum value of $a\tan^2\theta+b\cot^2\theta = 2\sqrt{ab}$

Hence minimum value of $\cot^2+n^2\tan^2\theta+2n$

$=2\sqrt{1\times n^2}+2n=2n+2n=4n$

**54.** (*b*) Given $m(\theta)=\cot^2\theta+n^2\tan^2\theta+2n$

$\frac{dm(\theta)}{d\theta}=-2\cot\theta\,\text{cosec}^2\theta+n^2\times 2\tan\theta\sec^2\theta=0$

For maxima or minima, $\frac{dm(\theta)}{d\theta}=0$

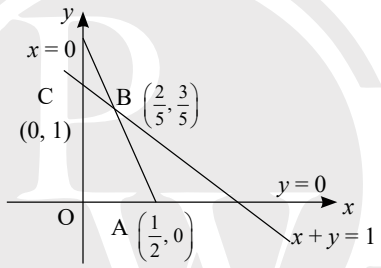
$\Rightarrow n^2=\cot^4\theta \Rightarrow n=\cot^2\theta$

at $n=\cot^2\theta$ $\frac{d^2m(\theta)}{d\theta^2}>0$ (minima)

Hence, m attain the least value at $n=\cot^2\theta$.

**55.** (*c*) Diagonal BO : $y=\frac{3}{2}x$

$\Rightarrow 3x-2y=0$




**56.** (*d*) AC : $y-0=\frac{0-1}{\frac{1}{2}-0}\left(x-\frac{1}{2}\right)$

$\Rightarrow y=-2\left(x-\frac{1}{2}\right)$

$\Rightarrow y=-2x+1$

$\Rightarrow 2x+y-1=0$

**57.** (*b*) Given $x^2+4y^2=1 \Rightarrow \frac{x^2}{1}+\frac{y^2}{1/4}=1$

Here $a^2=1 \Rightarrow a=1$

$\therefore$ PE + PF $=2a$

$=2\times 1=2$

**58.** (*d*) Equation of Latus rectum $x=\pm ae$

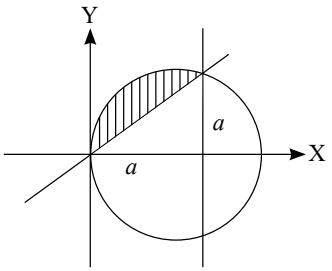
Now $e=\sqrt{1-\frac{b^2}{a^2}}=\sqrt{1-\frac{1}{4}}=\frac{\sqrt{3}}{2}$

Equation of Latus rectum $x=\pm\frac{\sqrt{3}}{2}$

End point of Latus rectum

$=\left(ae, \pm\frac{b^2}{a}\right)=\left(\frac{\sqrt{3}}{2}, \pm\frac{1}{4}\right)$

**59.** (*a*) Area of minor segment




$=\frac{\pi a^2}{4}-\frac{1}{2}\times a\times a$

$=\frac{\pi a^2}{4}-\frac{a^2}{2}$

$=\frac{(\pi-2)a^2}{4}$

**60.** (*b*) Area of major segment $=\pi a^2-\frac{(\pi-2)a^2}{4}$

$=\frac{(3\pi+2)a^2}{4}$

**61.** (*a*) $A(1, -1, 2)$ & $B(2, 1, -1)$

Centre $=\left(\frac{3}{2}, 0, \frac{1}{2}\right)=(-U, -V, -W)$

$\therefore U=\frac{-3}{2}, V=0, W=\frac{-1}{2}$

$\therefore u+v+w=-2$

**62.** (*b*) $PA^2+PB^2=AB^2$

$=(2-1)^2+(1+1)^2+(-1-2)^2$

$=1+4+9$

$=14$

**63.** (*a*) $\cos\frac{\pi}{4}=\frac{2k-3+10}{\sqrt{9}\cdot\sqrt{34+k^2}}$

$\Rightarrow \frac{1}{\sqrt{2}}=\frac{2k+7}{3\cdot\sqrt{34+k^2}}$

$\Rightarrow \frac{1}{2}=\frac{4k^2+49+28k}{9(34+k^2)}$

$\Rightarrow 306+9k^2=8k^2+98+56k$

$\Rightarrow k^2-56k+208=0$

$\Rightarrow k^2-52k-4k+208=0$

$\Rightarrow k(k-52)-4(k-52)=0$

$\Rightarrow k=4$ & $k=52$

**64.** (*d*) Let d.r's is $(a, b, c)$

then $2a+(-b)+2c=0$

$\Rightarrow 2a-b+2c=0$ ...(i)

$\Rightarrow 4a+3b+5c=0$ ...(ii)

On solving, we get

$\Rightarrow \frac{a}{-5-6}=\frac{-b}{10-8}=\frac{c}{6+4}$

$\Rightarrow \frac{a}{-11}=\frac{b}{-2}=\frac{c}{10}$

So, d.r's is $(11, 2, -10)$

**65.** (*b*) $\vec{a} = 3\hat{i} + 3\hat{j} + 3\hat{k}$

$\vec{c} = \hat{j} - \hat{k}$

Let $\vec{b} = a\hat{i} + b\hat{j} + c\hat{k}$

$\vec{a} \cdot \vec{b} = 27$

$\Rightarrow 3a + 3b + 3c = 27$

$\Rightarrow a + b + c = 9$ ...(i)

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 3 & 3 \\ a & b & c \end{vmatrix}$$

$= \hat{i}(3c - 3b) - \hat{j}(3c - 3a) + \hat{k}(3b - 3a)$

$\Rightarrow \vec{a} \times \vec{b} = 9\vec{c}$

$\Rightarrow 3\{\hat{i}(c - b) - \hat{j}(c - a) + \hat{k}(b - a)\}$

$= 9(\hat{j} - \hat{k})$

On compairing, we get

$c - b = 0, -(c - a) = 3, b - a = -3$

$\Rightarrow b = c, a - c = 3, b - a = -3$

$\Rightarrow a = 3 + c$

From equation (i)

$\Rightarrow 3 + c + c + c = 9$

$\Rightarrow 3c = 6$

$\Rightarrow c = 2, b = 2$ & $a = 5$

So, $\vec{b} = 5\hat{i} + 2\hat{j} + 2\hat{k}$

**66.** (*a*) $\because (\vec{a} + \vec{b}) = 8\hat{i} + 5\hat{j} + 5\hat{k}$

$\vec{c} = \hat{j} - \hat{k}$

Let angle is θ between $(\vec{a} + \vec{b})$ and $\vec{c}$

$(\vec{a} + \vec{b}) \cdot \vec{c} = (\vec{a} + \vec{b}) \cdot \vec{c}$

$= (8\hat{i} + 5\hat{j} + 5\hat{k})(\hat{j} - \hat{k})$

$= 5 - 5 = 0 \Rightarrow (\vec{a} + \vec{b}) \perp \vec{c}$

Hence, $\theta = \dfrac{\pi}{2}$

**67.** (*b*) $\cos\alpha = \dfrac{4}{\sqrt{(4)^2 + (-8)^2 + (1)^2}} = \dfrac{4}{\sqrt{81}} = \dfrac{4}{9}$

**68.** (*a*) $\cos 2\beta + \cos 2\gamma = 2\cos^2\beta - 1 + 2\cos^2\gamma - 1$

$= 2\left(\dfrac{-8}{9}\right)^2 - 1 + 2\left(\dfrac{1}{9}\right)^2 - 1$

$= \dfrac{2 \times 64}{81} - 1 + \dfrac{2}{81} - 1$

$= \dfrac{128 + 2}{81} - 2 = \dfrac{-32}{81}$

**69.** (*b*) A(1, –1, 0), B(0, 1, 1)

Equation of Line AB :

$\dfrac{x-1}{0-1} = \dfrac{y+1}{1+1} = \dfrac{z-0}{1-0}$

Here (–1, 3, 2) and (–2, 5, 3) satisfy the above equation of line.

**70.** (*c*) $\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$

$= (\hat{j} + \hat{k}) - (\hat{i} - \hat{j})$

$= -\hat{i} + 2\hat{j} + \hat{k}$

Magnitude of

$\overrightarrow{AB} = |\overrightarrow{AB}| = \sqrt{(-1)^2 + (2)^2 + (1)^2}$

$= \sqrt{6}$

**71.** (*b*) $f(x) = pe^x + Q\,e^{2x} + Re^{3x}$

$f(0) = 6 \Rightarrow P + Q + R = 6$ ..... (i)

$f'(x) = Pe^x + 2Qe^{2x} + 3R\,e^{3x}$

$f'(ln3) = 3P + 18Q + 81R = 282$

$\Rightarrow P + 6Q + 27R = 94$ ..... (ii)

$\int_0^{\ln 2} f(x)\,dx = \int_0^{\ln 2} \left(Pe^x + Qe^{2x} + \mathrm{Re}^{3x}\right) dx$

$= \left[Pe^x + \dfrac{Qe^{2x}}{2} + \dfrac{\mathrm{Re}^{3x}}{3}\right]_0^{\ln 2}$

$= 2P + 2Q + \dfrac{8R}{3} - \left(P + \dfrac{Q}{2} + \dfrac{R}{3}\right)$

$= P + \dfrac{3Q}{2} + \dfrac{7}{3}R$

$= \dfrac{6P + 9Q + 14R}{6}$

$\Rightarrow 6P + 9Q + 14R = 66$ ... (iii)

By solving (i), (ii) and (iii)

$Q = 2$, $R = 3$ and $P = 1$

**72.** (*c*)

**73.** (*d*) $f'(x) = Pe^x + 2Qe^{2x} + 3Re^{3x}$

$f'(0) = P + 2Q + 3R$

$= 1 + 4 + 9$

$= 14$

**74.** (*a*) $y^2 = 2cx + 2c\sqrt{c}$

$\Rightarrow 2y \cdot \dfrac{dy}{dx} = 2c \Rightarrow c = y.y'$

So, $y^2 = 2x \cdot yy' + 2yy'\sqrt{yy'}$

$\Rightarrow y = 2xy' + 2y'\sqrt{yy'}$

$\Rightarrow (y - 2xy') = 2y'\sqrt{yy'}$

By squaring both side,

$\Rightarrow y^2 + 4x^2(y')^2 - 4xyy' = 4(y')^2\,y.y'$

$\Rightarrow 4y.(y')^3 - 4x^2(y')^2 + 4xyy' - y^2 = 0$

So, order = 1

**75.** (*b*) degree = 3.

**76.** (*b*) $f(x) = \begin{vmatrix} \cos x & x & 1 \\ 2\sin x & x^2 & 2x \\ \tan x & x & 1 \end{vmatrix}$

$\Rightarrow f(x) = x\begin{vmatrix} \cos x & 1 & 1 \\ 2\sin x & x & 2x \\ \tan x & 1 & 1 \end{vmatrix}$

$\Rightarrow f(x) = x\begin{vmatrix} \cos x & 1 & 0 \\ 2\sin x & x & x \\ \tan x & 1 & 0 \end{vmatrix} \{C_3 = C_3 - C_2\}$

$\Rightarrow f(x) = x^2\{-x(\cos x - \tan x)\}$

$\Rightarrow f(x) = x^2(\tan x - \cos x)$

$\Rightarrow x = 0 \Rightarrow f(0) = 0$

**77.** (*b*) $\lim\limits_{x\to 0} \dfrac{f(x)}{x} = \lim\limits_{x\to 0} \dfrac{x^2(\tan x - \cos x)}{x}$

$= \lim\limits_{x\to 0} x(\tan x - \cos x)$

$= 0$

**78.** (*a*) $\lim\limits_{x\to 0} \dfrac{f(x)}{x^2} = \lim\limits_{x\to 0} \dfrac{x^2(\tan x - \cos x)}{x^2}$

$= -1$

**79.** (*b*) $f(x) = \sin 9x + \cos(-10x)$

$\Rightarrow f(x) = \sin 9x + \cos 10x$

$\Rightarrow f\left(\dfrac{\pi}{2}\right) = \sin\dfrac{9\pi}{2} + \cos\dfrac{10\pi}{2}$

$= 1 + (-1)$

$= 0$

**80.** (*d*) $f\left(\dfrac{\pi}{4}\right) = \sin\left(\dfrac{9\pi}{4}\right) + \cos\left(\dfrac{10\pi}{4}\right)$

$= \sin\left(2\pi + \dfrac{\pi}{4}\right) + \cos\left(\dfrac{5\pi}{2}\right)$

$= \sin\dfrac{\pi}{4} + 0$

$= \dfrac{1}{\sqrt{2}}$

**81.** (*) Here $I_1 = \int_0^{\pi} \dfrac{x\,dx}{1 + \cos^2 x}$ ...(i)

Using $\int_a^b f(x)\,dx = \int_a^b f(a + b - x)\,dx$

$I_1 = \int_0^{\pi} \dfrac{(\pi - x)\,dx}{1 + \cos^2(\pi - x)}$

$= \int_0^{\pi} \dfrac{(\pi - x)\,dx}{1 + \cos^2 x}$ ...(ii)

from equation (i) + (ii)

$2I_1 = \pi\int_0^{\pi} \dfrac{dx}{1 + \cos^2 x}$

$\Rightarrow 2I_1 = 2\pi\int_0^{\pi/2} \dfrac{dx}{1 + \cos^2 x}$

$\Rightarrow I_1 = \pi\int_0^{\pi/2} \dfrac{dx}{1 + \sin^2 x}$

$I_2 = \int_0^{\pi} \dfrac{1}{1 + \sin^2 x}\,dx$

$I_2 = 2\int_0^{\pi/2} \dfrac{1}{1 + \sin^2 x}\,dx$

Here $\dfrac{I_1}{I_2} = \dfrac{\pi}{2}$

CLICK HERE To Discover more

$$\therefore \frac{I_1+I_2}{I_1-I_2}=\frac{\frac{I_1}{I_2}+1}{\frac{I_1}{I_2}-1}=\frac{\frac{\pi}{2}+1}{\frac{\pi}{2}-1}=\frac{\pi+2}{\pi-2}$$

**82.** (*d*) $8I_1^{\,2}=8\left(\frac{\pi^2}{2\sqrt{2}}\right)^2=\frac{8\pi^4}{8}=\pi^4$

**83.** (*a*) $I_2=2\int_0^{\pi/2}\frac{1}{\sin^2 x}dx=2\left(\frac{\pi}{2\sqrt{2}}\right)=\frac{\pi}{\sqrt{2}}$

**84.** (*a*) $I=\int_a^b\frac{|x|}{x}dx,\quad a<0<b$

$=\int_a^0\frac{|x|}{x}dx,+\int_0^b\frac{|x|}{x}dx$

$=\int_a^0(-1)dx+\int_0^b 1\,dx$

$=[-x]_a^0+[x]_0^b=0-(-a)+b-0=a+b$

**85.** (*b*) $I=\int_a^b\frac{|x|}{x}dx,\quad a<b<0$

$=\int_a^b\frac{-x}{x}dx=\int_a^b(-1)dx$

$=[-x]_a^b=a-b$

**86.** (*a*) We have $f(x)$

$=|lnx|, x\neq 1$

$=\begin{cases}-lnx, & x\in(0,1)\\ lnx, & x\in(1,\infty)\end{cases}$

$\Rightarrow f'(x)=\begin{cases}-\frac{1}{x}, & x\in(0,1)\\ \frac{1}{x}, & x\in(1,\infty)\end{cases}$

$\therefore f'(0.5)=-\frac{1}{0.5}=-2$

**87.** (*c*) $f'(2)=\frac{1}{2}$ (using equation from above solution)

**88.** (*b*) $f(x)=lnx,\quad 1<x<2$

$\Rightarrow fof(x)=f(f(x))=f(lnx)=ln(lnx),$ $1<x<2$

$\therefore f'(x)=\frac{1}{lnx}\times\frac{1}{x}=\frac{1}{xlnx},\quad 1<x<2$

**89.** (*b*) We have

$$f(x)=\begin{cases}x+6, & x\le 1\\ px+q, & 1<x<2\\ 5x, & x\ge 2\end{cases}$$

$\because f(x)$ is continuous

$\Rightarrow f(x)$ is continuous at $x=1$ and $x=2$.

So, $f(1)=\lim_{x\to 1^+}f(x)$ & $f(2)=\lim_{x\to 2^-}f(x)$

$\Rightarrow 1+6=p+q$ & $5\times 2=2p+q$

$\Rightarrow 7=p+q$ ...(i)

$10=2p+q$ ...(ii)

Now, (ii) – (i) $\Rightarrow p=3$

$\Rightarrow q=4$

**90.** (*c*) Hence, $q=4$

**91.** (*a*)

**92.** (*a*) $\frac{d\sin^2 x}{dx}=\frac{1}{2}\frac{d2\sin^2 x}{dx}=\frac{1}{2}\frac{d}{dx}(1-\cos 2x)$

$=\frac{1}{2}(0+2\sin 2x)=\sin 2x$

$\frac{d\cos^2 x}{dx}=2\cos x\cdot(-\sin x)=-\sin 2x$

Derivative of $\sin^2 x$ *w.r.t.*

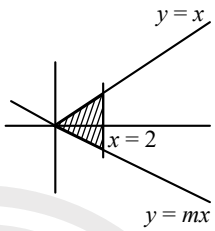
$\cos^2 x=\frac{\frac{d\sin^2 x}{dx}}{\frac{d\cos^2 x}{dx}}=\frac{\sin 2x}{-\sin 2x}=-1$

**93.** (*a*) Required area $=\int_0^2(x-mx)dx$

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

$=\left(\frac{4}{2}-m\frac{4}{2}\right)-0$

$= 2\,(1-m)$




$\because$ Area is given 3.

$\Rightarrow 2\,(1-m)=3\Rightarrow 1-m=\frac{3}{2}$

$\Rightarrow m=1-\frac{3}{2}=-\frac{1}{2}$

**94.** (*b*) Let $f(x)=\text{cosec}\,(x^\circ)$

$\because x^\circ=\frac{\pi}{180}\cdot x$

$\therefore f(x)=\text{cosec}\left(\frac{\pi}{180}x\right)$

$\Rightarrow f'(x)=-\text{cosec}\left(\frac{\pi}{180}x\right)\cdot$

$\cot\left(\frac{\pi}{180}x\right)\times\frac{\pi}{180}$

$=-\frac{\pi}{180}\text{cosec}\,x^\circ\cdot\cot x^\circ$

**95.** (*d*) We have, $\left(\frac{dy}{dx}\right)^2-x\cdot\frac{dy}{dx}=0$

$\Rightarrow\left(\frac{dy}{dx}\right)\left(\frac{dy}{dx}-x\right)=0$

$\Rightarrow\frac{dy}{dx}=0$ *or* $\frac{dy}{dx}=x$

$\Rightarrow y=\frac{x^2}{2}+C$

So, $y=\frac{(x^2-2)}{2}=\frac{x^2}{2}-1$ is solution of the given differential equation by taking $C=-1$.

**96.** (*d*) Given, $f(x)=x^2+2$ & $g(x)=2x-3$

Now, $(fg)(x)=(x^2+2)(2x-3)$

$=2x^3-3x^2+4x-6$

$\therefore\quad (fg)(1)=2\times 1^3-3\times 1^2+4\times 1-6$

$=-3$

**97.** (*b*) We have, $f(x)=x+|x|$

For $x\in(-\infty,0)$

Range of $f(x)$ = Range of $(x-x)$ = Range of $0=\{0\}$

For $x\in[0,\infty)$

Range of $(f(x))$ = Range of $(x+x)$ = Range of $(2x)$

$=2$(Range of $x$) $=2\times(0,\infty)=(0,\infty)$

So, Range of $f(x)=\{0\}\cup(0,\infty)$

$=[0,\infty)$

**98.** (*a*) $f(x)=x(4x^2-3)=4x^3-3x$

$\therefore f(\sin\theta)=4\sin^3\theta-3\sin\theta=-\sin 3\theta$

**99.** (*d*) We have, $f(x)=\frac{5-x}{|x-5|}$

L.H.L

$=\lim_{x\to 5^-}f(x)=\lim_{x\to 5^-}\frac{5-x}{|x-5|}=\lim_{x\to 5^-}\left(-\frac{5-x}{x-5}\right)$

$=\lim_{x\to 5^-}(-(-1))=\lim_{x\to 5^-}1=1$

R.H.L

$=\lim_{x\to 5^+}f(x)=\lim_{x\to 5^+}\frac{5-x}{|x-5|}=\lim_{x\to 5^+}\frac{5-x}{x-5}$

$=\lim_{x\to 5^+}(-1)=-1$

Thus, L.H.L $\neq$ R.H.L at $x=5$

$\therefore$ Limit does not exist at $x=5$.

**100.** (*c*) $\lim_{x\to 1}\frac{x^9-1}{x^3-1}=\lim_{x\to 1}\frac{\left(x^3-1\right)\left(\left(x^3\right)^2+x^3\times 1+1^2\right)}{\left(x^3-1\right)}$

$=\lim_{x\to 1}\left(x^6+x^3+1\right)=1+1+1=3$

**101.** (*c*) We have, $\frac{n}{x}=5$

$\bar{x}=14$, var. $\sigma^2=13.2$

$x_1=11, x_2=16$ and $x_3=20$.

Let other two observations are $x_4$ and $x_5$

Then, $\because\bar{x}=14$

$\Rightarrow\frac{11+16+20+x_4+x_5}{5}=14$

$\Rightarrow x_4+x_5=23$ ... (i)

Also, $\sigma^2=\frac{\sum(x_i-\bar{x})^2}{N}$

$\Rightarrow\sigma^2\times N=\sum(x_i-\bar{x})^2$

$\Rightarrow 13.2\times 5=(11-14)^2+(16-14)^2+(20-14)^2+(x_4-14)^2+(x_5-14)^2$

$\Rightarrow 66=49+x_4^2-28x_4+196+x_5^2-28x_5+196$

$\Rightarrow x_4^2 + x_5^2 = 28\,(x_4 + x_5) - 375$

$\Rightarrow x_4^2 + x_5^2 = 28 \times 23 - 375 = 269$ (from (i)) ... (ii)

From (i)

$x_4^2 + x_5^2 + 2x_4x_5 = 529$ ... (iii)

Now,

(iii) – (ii) $\Rightarrow x_4x_5 = 130$

$\Rightarrow x_4 = 10$ and $x_5 = 13$ (from options)

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

$P(\overline{A}) = 0.7$, $p(\overline{B}) = k$ & $P(A \cup B) = 0.8$

Now, $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$\Rightarrow 0.8 = 1 - P(\overline{A}) + 1 - P(\overline{B}) - P(A) \times P(B)$

($\because$ A & B independent $\Rightarrow P(A \cap B) = P(A) \times P(B)$)

$= (1 - 0.7) + (1 - k) - 0.3 \times (1 - k)$

$\Rightarrow 0.8 = 0.3 + 1 - k - 0.3 + 0.3k$

$\Rightarrow 0.7k = 0.2 \Rightarrow k = \dfrac{2}{7}$

**103.** (*b*) Probability of getting head, $p = \dfrac{1}{4}$

and probability of getting tail, $q = 1 - p$

$= 1 - \dfrac{3}{4} = \dfrac{1}{4}$

So, Probability of getting tail in all the 1st four tosses followed by head = $q^{(n-1)}p$

$= \left(\dfrac{3}{4}\right)^{5-4} \times \dfrac{1}{4} = \dfrac{3^4}{4^5} = \dfrac{81}{1024}$

**104.** (*b*) Let $p$ = probability of occuring head

$q$ = probability of occuring tail

$\Rightarrow p = 3q \Rightarrow p = 3(1 - p)$

$\Rightarrow 4p = 3 \Rightarrow p = \dfrac{3}{4}$ & $q = 1 - \dfrac{3}{4} = \dfrac{1}{4}$

Now, n =4

$\therefore$ Probability of getting exactly three heads

$= {}^4C_3\, p^3 \times q^{4-3} = 4 \times \left(\dfrac{3}{4}\right)^3 \times \dfrac{1}{4} = \dfrac{27}{64}$

**105.** (*c*) Given $p = \dfrac{4}{5}$ and $n = 100$

$q = 1 - p = 1 - \dfrac{4}{5} = \dfrac{1}{5}$

Variance of $Y = npq = 100 \times \dfrac{4}{5} \times \dfrac{1}{5} = 16$

**106.** (*c*) Given lines are $x + 4y + 1 = 0$ ...(i)

and $4x + 9y + 7 = 0$ ...(ii)

Now, first check which of the line (i) & (ii) is line of regression $y$ on $x$ and $x$ on $y$.

Let $x + 4y + 1 = 0$ be the line of regression $x$ on $y$, then other be the line of regression $y$ on $x$.

$\therefore$ from (i), $x = -4y - 1$

$\therefore \quad b_{xy} = -4$

we have, $y = -\dfrac{4x}{9} - \dfrac{7}{9}$

$\therefore \quad b_{yx} = -\dfrac{4}{9}$

Now $r^2 = b_{xy} \cdot b_{yx} = -4 \times -\dfrac{4}{9} = \dfrac{16}{9}$

$|r| = \dfrac{4}{3}$

which is not possible as $0 \le r^2 \le 1$, So our assumption is wrong.

And $x + 4y + 1 = 0$ be the line of regression $y$ on $x$ and $4x + 9y + 7 = 0$ be the line of regression $x$ on $y$.

$\therefore \quad 4x + 9y + 7 = 0$

$\Rightarrow x = -\dfrac{9y}{4} - \dfrac{7}{4}$

Put $y = -3$

Hence $x = \dfrac{-9 \times -3}{4} - \dfrac{7}{4}$

$= \dfrac{27 - 7}{4} = \dfrac{20}{4} = 5$

**107.** (*d*) $\because p + q + r + s = 360°$

We have $9p = 3q = 2r = 6s$

$\therefore q = 3p, r = \dfrac{9p}{2}, s = \dfrac{3p}{2}$

$\therefore p + 3p + \dfrac{9p}{2} + \dfrac{3p}{2} = 360°$

$\Rightarrow p + 3p + 6p = 360°$

$\Rightarrow 10p = 360° \Rightarrow p = 36°$

When $p = 36°, q = 3 \times 36° = 108$

Hence, $4p - q = 4 \times 36° - 108°$

$= 144° - 108° = 36°$

**108.** (*a*) We have,

4, 1, 4, 3, 6, 2, 1, 3, 4, 5, 1, 6

Rewriting : 1, 1, 1, 2, 3, 3, 4, 4, 4, 5, 6, 6

Lowest 5 observations : 1, 1, 1, 2, 3, 3, 4, 4

$\therefore m = \dfrac{1+1+1+2+3+3+4+4}{8} = \dfrac{19}{8}$

Greatest 4 observations : 4, 5, 6, 6

$\therefore M = \dfrac{4+5+6+6}{4} = \dfrac{21}{4}$

$\therefore 2m + M = \dfrac{19}{8} \times 2 + \dfrac{21}{4} = \dfrac{40}{4} = 10$

**109.** (*a*) Here, (–1,1) and (3,2) satisfies $x - 4y + 5 = 0$

**110.** (*d*) We have, 1, 2, 1, 1, 2, 1, 4, 6, 5, 4

It can be re-written as.

1, 1, 1, 1, 2, 2, 4, 4, 5, 6

$\because$ 1 appears highest no. of times.

So, mode = 1

**111.** (*c*)

| $x$ | $f$ | $cf$ |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 6 | 10 |
| 3 | 9 | 19 |
| 5 | 7 | 26 |
| | $\Sigma f = 26$ | |

Location for median $= \dfrac{\Sigma f}{2} = \dfrac{26}{2} = 13^{th}$

So, the median is 3.

**112.** (*d*) 1st five: –1, 1, 4, 3, 8

Rewriting: –1, 1, 3, 4, 8

$\therefore$ Median = 3 (= M)

Last five: 12, 17, 19, 9, 11

Rewriting: 9, 11, 12, 17, 19

$\therefore$ Median = 12 (= N)

$\therefore$ 4 M – N = 4 × 3 – 12 = 0

**113.** (*d*) We have,

$5P = 4Q = \dfrac{R}{2}$

$\Rightarrow Q = \dfrac{5}{4}P$ and $R = 10P$

Now,

$\dfrac{P+Q}{2P+0.7R} = \dfrac{P+\frac{5}{4}P}{2P+0.7\times 10P} = \dfrac{\frac{9}{4}}{9} = \dfrac{1}{4}$

**114.** (*d*) $G = \left(1 \times 2 \times 2^2 \times 2^3 \times \ldots\ldots \times 2^{n-1}\right)^{\frac{1}{n}}$

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

Now,

$1 + 2\log_2 G = 1 + \log_2 G^2$

$= 1 + \log_2 \left(2^{\left(\frac{n-1}{2}\right)}\right)^2$

$= 1 + \log_2 2^{n-1}$

$= 1 + (n-1) = n$

**115.** (*b*) $\because$ Harmonic mean of $x_1, x_2, \ldots x_n$ is given by

$H = \dfrac{n}{\sum_{i=1}^{n}\left(\frac{1}{x_i}\right)}$

$\Rightarrow \dfrac{H}{n} = \dfrac{1}{\sum_{i=1}^{n}\left(\frac{1}{x_i}\right)}$

$\Rightarrow \dfrac{n}{H} = \sum_{i=1}^{n}\left(\dfrac{1}{x_i}\right) = 1 + \dfrac{1}{2} + \dfrac{1}{2^2} + \dfrac{1}{2^3} + \ldots + \dfrac{1}{2^{n-1}}$

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

**116.** (*a*) Here, median, mean and mode be P, Q, and R.

Given $S = \sum_{i=1}^{n}(2x_i - a)^2$

we know, total deviations from median is least and this is also valid for square of total deviations from median.

So, when $a = P$, $S$ takes minimum value,

**117.** (*)

**118.** (*c*) $n(S) = 6 \times 6 \times 6 = 216$

E = event of getting multiplies of 3 on each face.

$\Rightarrow n(E) = 2 \times 2 \times 2 = 8$

$$\therefore P(E) = \frac{n(E)}{n(S)} = \frac{8}{216} = \frac{1}{27}$$

**119.** (*c*) Total no. of days in December = 31 = 28 + 3 = 4 week + 3

$\because$ Every week contains one sunday.

So, 4 sundays are confirmed in 28 days.

Now,

Out of the remaining 3 days if we get a sunday then the month will contain 5 sundays.

$\because$ Required probability

$$= \frac{3}{\text{Total days in a week}} = \frac{3}{7}$$

**120.** (*b*) We have,

$$n + \frac{50}{n} < 50$$

$\Rightarrow n^2 - 50n + 50 < 0$

$\Rightarrow \left(n-\left(25-5\sqrt{2^3}\right)\right)\left(n-\left(25+5\sqrt{2^3}\right)\right) < 0$

$\Rightarrow (n-1.02)(n-48.97) < 0$

$\Rightarrow (n-1.02) < 0$ and $(n-48.97) > 0$

or

$(n - 1.02) > 0$ and $(n - 48.97) < 0$

$\Rightarrow n < 1.02$ and $n > 48.97$ (No solution)

or

$n > 1.02$ and $n < 48.97$

$\Rightarrow 2 \le n \le 48$

$\Rightarrow$ Total no. of $n$ such that

$$n + \frac{50}{n} < 50 = 47$$

So, Required probability $= \frac{47}{50}$

# Paper II: General Ability

**1.** (*a*) PR is the mandatory pair of segments and segment should be in beginning the sentence. So, SPRQ is the correct sequence.

**2.** (*c*) QR is the mandatory pair of segments and segment S should be at last. So, QRPS is the correct sequence.

**3.** (*b*) RP is the mandatory pair of segments. So, RPSQ is the correct sequence as per the options.

**4.** (*c*) R is the beginning segment and PRQ is the mandatory pair of segments. As per the options, RQPS is the correct sequence.

**5.** (*c*) Segment Q is the beginning one. So, QRSP is the correct sequence.

**6.** (*d*) QS is the mandatory pair of segments and segment P should be at length. So, QSRP is the correct sequence.

**7.** (*b*) PR is the mandatory pair of segments and segment R should be in the beginning. So, RPSQ is the correct sequence.

**8.** (*c*) SQ is the mandatory pair of segments. So, RPSQ is the correct seqence.

**9.** (*c*) SQ is the mandatory pair of segments and segment R should be at last. So, SQPR is the correct sequence.

**10.** (*d*) PS is the mandatory pair and segment R should begin the sentence. So, RQPS is the correct sequence.

**11.** (*b*) 'The lion's share' means 'The largest and the best part of something'.

**12.** (*a*) 'Spill the beans' means 'Reveal a Secret'.

**13.** (*c*) 'Cook someone's goose' means 'To spoil someone's plans'.

**14.** (*d*) 'Disappear into this air means 'Disappear completely in a way that is mysterious/ disappear suddenly'.

**15.** (*a*) 'Put the screws on' means 'Forcing someone to do what you want'.

**16.** (*c*) 'Sit on the fence' means 'Avoid saying which side of an argument you support (Avoid taking sides).

**17.** (*b*) 'Be as sharp as a tack' means 'A shrewd (clever) person'.

**18.** (*b*) 'From pillar to post' means 'keep moving from one place to another'.

**19.** (*a*) 'Health Robinson' means 'Very complicated system or machine for doing a simple task'.

**20.** (*d*) 'As thick as thieves' means 'Very close friends who are looked upon with suspicion'.

**21.** (*a*) The synonym of 'indigent' is 'very poor'.

**22.** (*d*) 'Jovial' means 'cheerful'. So, mirthful is the synonym of 'Jovial'.

**23.** (*c*) 'Insanity' is the synonym of 'lunacy'.

**24.** (*d*) The synonym of 'meticulous' is 'scrupulous' which means careful.

**25.** (*c*) 'exciting' is the correct synonym of exhilarating'.

**26.** (*a*) 'Redemption' means 'retrieval'.

**27.** (*c*) 'Contention' means 'chance of winning'.

**28.** (*b*) 'Paraphernalia' means 'accessories' i.e. equipments.

**29.** (*c*) 'Wonderment' is the correct synonym of 'astonishment'.

**30.** (*b*) 'Inordinate means 'excessive'. So, exorbitant' is the appropriate synonym of inordinate.

**31.** (*b*) According to subject-verb agreement, 'builds' should not be used here as 'layers' is in plural. 'Build' will be the correct answer.

**32.** (*c*) The error is in option (*c*) as 'through a process' will be grammatically correct.

**33.** (*c*) Article 'a' should not be used before 'Newspaper'.

**34.** (*c*) The correct preposition in option (*c*) should be 'in'.

**35.** (*c*) The correct preposition usage should be 'at the night', not 'in the night'.

**36.** (*b*) The error is a option (*b*). 'I don't had to' is grammatically incorrect. As the sentence is talking about 'future', using the past form 'had' will be incorrect. 'So I don't have to' will be grammatically correct.

**37.** (*b*) The correct sentence should be: 'She didn't tell anyone about her plans.' While 'anyone' and 'anybody' have no difference in meaning, anyone is mostly used to denote a single person whereas 'anybody' denotes a random person.

**38.** (*b*) The error is in option (*d*). Have + had will be the correct usage. Have and has can not come together as they both are present form of the verb 'to have'.

**39.** (*c*) 'In time' has an error. The correct usage should be 'on time'.

**40.** (*c*) The error is in option (*c*). It's is the contraction of 'it + is' or 'it + has'. Here, the correct word should be 'its'.

**41.** (*a*) Fortify is to strengthen. The correct meaning is option (*a*) weaken which is the opposite of strengthen.

**42.** (*b*) Dazzling means bright or brilliant. The word opposite in meaning is option (*b*) murky.

**43.** (*d*) Clandestine means secretive, which is similar to secret, covert and sneaky. Hence, option (*d*) 'public' will be the correct antonym here.

**44.** (*b*) Bleak is bare or deserted which is similar to cheerless and desolate. Thus, verdant, which is green and grassy is the antonym here.

**45.** (*a*) Commotion is a state of confusion; uproar, tempest and stir are similar in meaning. Hence, quietude is the antonym here.

**46.** (*d*) Audacity is the willingness to make bold risks. Boldness, vigour, temerity are all synonyms. Hence, 'politeness' is the antonym.

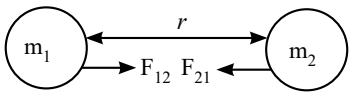
**47.** (*c*) Abatement means lessening or ending, subsidence means sinking, ebbing means to diminish, mitigation is reduction or lessening. Thus option (*c*) 'accumulation' i.e. collection or gathering is the antonym.

**48.** (*c*) The word 'exponential' relates to increase or rapid. The words 'aggressive', 'rampant' and 'augmented' are related in meaning. Hence, option (*c*) 'meager' is an antonym which means 'limited'.

**49.** (*c*) Sagacity means intelligence. Words-prudence, wisdom and sapience also relate to intelligence. The correct antonym would be option (*c*) 'ignorance'

**50.** (*c*) Culminate means reach a climax; originate means arise or begin. Hence, option (*c*) is the correct antonym.

**51.** (*d*) $F_{gravity} = \frac{Gm_1m_2}{r^2}$




$F_{12} = -F_{21}$ (–ve sign shows opposite direction)

**52.** (*d*) $\because\ P = \frac{V^2}{R} \Rightarrow P \propto V^2$

$$\therefore \frac{P_2}{P_1} = \left(\frac{V_2}{V_1}\right)^2 \Rightarrow \frac{P_2}{80} = \frac{(110)^2}{(220)^2}$$

$\Rightarrow P_2 = 20$ W

**53.** (*) When white light is passed through a glass prism it splits into its spectrum of colours (in orders violet, indigo, blue, green, yellow, orange and red). Violet bends the most while red bends the least. Also red light travels the fastest. Hence, no option is correct.
(Bonus question).

**54.** (*a*) Speed of sound is nearly independent of frequency.

**55.** (*c*) Newtonian telescope contains only mirrors.

**56.** (*d*) Fluorine has strong oxidizing nature because of its small size and high electronegativity. On going from top to bottom, oxidizing nature decreases because of decrease in nuclear pull on the outer electrons.

**57.** (*c*) Crystals of copper sulphate contain water of crystallization which give blue colour to it. On heating, molecules of water get removed and hence, colour of crystals becomes white.

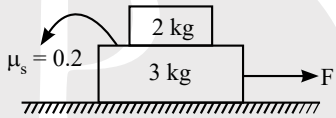
**58.** (*c*) According to Avogadro law "Equal volumes of all gases at constant temperature and pressure contain an equal number of molecules."

**59.** (*a*) Airbags inflators contain small amount of toxic molecule called sodium azide ($NaN_3$). The heat generated will decompose sodium azide into sodium metal and nitrogen gas.

**60.** (*b*) $F = \frac{d(mv)}{dt} = \frac{vdm}{dt} = 2 \times 0.1 = 0.2$ N

**61.** (*b*) $P = \frac{mgh}{t} = \frac{8 \times 10 \times 4}{2} = 160$ W

**62.** (*c*)




$\because$ there is no slipping between blocks

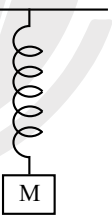
$\therefore\ f_r = \mu mg = 0.2 \times 2 \times 10 = 4$ N

**63.** (*b*) $kx = mg$

$\Rightarrow\ x \propto g$

$$\therefore \frac{x_{moon}}{x_{earth}} = \frac{g_{moon}}{g_{earth}}$$

$$\Rightarrow\ x_{moon} = \frac{1}{6} \times 6 = 1 \text{ cm}$$




**64.** (*b*) Examples of second class lever are staplers, doors or gates, bottle openers, nail clippers, etc.

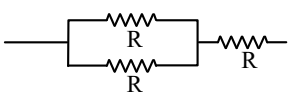
**65.** (*c*) $I = \frac{V}{R} = \frac{V}{\rho\frac{l}{A}} = \frac{V}{\frac{\rho l \times l}{Vol}} = \frac{V \times Vol}{\rho l^2}$

$$I \propto \frac{1}{l^2}$$

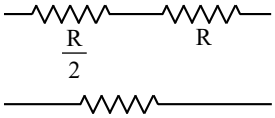
$$\frac{I_2}{I_1} = \frac{l_1^2}{l_2^2} \Rightarrow I_2 = \left(\frac{l_1}{2l_1}\right)^2 \times I_1$$

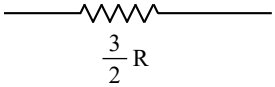
$$\Rightarrow I_2 = \frac{I_1}{4}$$

**66.** (*c*)




$$\frac{1}{R_{eff}} = \frac{1}{R} + \frac{1}{R} \Rightarrow R_{eff} = \frac{R}{2}$$




$$R_{net} = R + \frac{R}{2} = \frac{3}{2}R$$

**67.** (*d*) Sexual reproduction is the better mode of reproduction over asexual one, as it increase genetic variability due to crossing over. The offspring produced by sexual reproduction have a greater survival rate and are better adapted to changing environment due to genetic variations.

**68.** (*a*) All living cells contain nucleus and cytoplasm. Nucleus contains the genetic material of the cell. Cytoplasm in the cell is enclosed by a plasma membrane. Cell wall is the non-living covering to plant cell so, it is not always present in living cell as animal cell lack cell wall.

**69.** (*c*) On applying the lemon juice on the cut apple, it lowers the pH of the surface of apple and hence prevents the oxidation reaction.

**70.** (*b*) Larger the surface area, larger will be the boiling point. So, the correct order is:

Propane< butane< pentane< octane

**71.** (*c*) A separating funnel is used to separate mixture of benzene and water. These both are immiscible liquids.

**72.** (*d*) Fe being more reactive will displace Cu from its solution and becomes brown in colour. This is known as displacement reaction.

**73.** (*b*) When curd is stored in copper containers, the lactic acid in the curd reacts with the copper, causing corrosion and the formation of poisonous ions that are not digestible.

**74.** (*a*) Toothpastes are basic in nature. They neutralise the action of acids, preventing tooth decay.

**75.** (*c*) Let BC = AD = *h*

We know that, $V = \frac{\mu f}{\mu - f}$

$$\therefore\ V_{B'C'} = \frac{3f \times (-f)}{-3f - (-f)} = \frac{-3}{2}f$$

Also, $m = \frac{h_i}{h_o} = \frac{-v}{u}$

$$\Rightarrow \frac{h_i(B'C')}{h} = \frac{-\left(\frac{-3}{2}f\right)}{-3f}$$

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$\Rightarrow h_i(B'C') = \frac{-h_o}{2}$

Since AD is at $2f$

$\therefore \quad V_{A'D'} = 2f$ and $h_i(A'D') = h_o$

$\therefore \quad \frac{h_i(B'C')}{h_i(A'D')} = \frac{1}{2}$

**76.** (*c*)

**77.** (*c*) Momentum will be conserved.

$\therefore \quad M_1v_1 = M_2v_2$

**78.** (*d*) Sound comes from a vibrating column of air not only from inside the flute but from outside of the flute also.

**79.** (*d*) ↑ Magnetic field

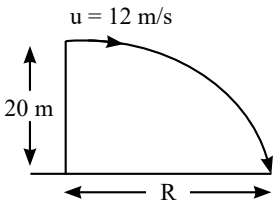
↓ Current

There will be no deflecting force - since angle is 180°.

**80.** (*b*) Carbon dioxide, methane and water vapour are greenhouse gases. But the main constituents of the atmosphere, nitrogen and oxygen are not greenhouse gases.

**81.** (*d*) Both the balances show the same reading indicating that both the action and reaction forces are equal and opposite.

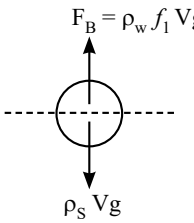
**82.** (*c*) Time of flight (t) = $\sqrt{\frac{2\times 20}{10}} = 2s$



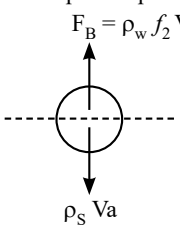

$\therefore \quad R = u \times t$

$= 12 \times 2 = 24$ m

**83.** (*a*) On Earth $\rho_w f_1 Vg = \rho_s Vg$ ...(i)




On a spaceship




$\rho_w f_2 Va = \rho_s Va$ ...(ii)

From equation (i) and (ii), we get

$f_1 = f_2$

**84.** (*c*) $P_1 = \rho gh$

After attaining the equilibrium, both column will have water with equal heights.

So, $h' = \frac{h}{2}$

$P_2 = \rho g \frac{h}{2}$

$\therefore \quad P_1 = 2P_2$

**85.** (*c*) $\Delta v = v - (-v) = 2v$

Time taken ($t$) = $\frac{\pi R}{v}$

$\therefore$ Average acceleration = $\frac{2v}{\frac{\pi R}{v}} = \frac{2v^2}{\pi R}$

**86.** (*a*) $F_{net} = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$

$= \sqrt{5^2 + 5^2 + 2\times 5\times 5\cos 60°}$

$= \sqrt{75}$

$= 8.6$ N

**87.** (*c*) Fungal cell wall in made up to chitin.

**88.** (*c*) Prokaryotes are single-celled micro-organisms, in which true nucleus and membrane-bound organelles are absent. The genetic material in prokaryotic cell is located in an area with an irregular form called a nucleoid, which is a nucleus like structure.

**89.** (*c*) Within the plant cell, the mitochondria and chloroplast have their own DNA and ribosomes because of which they are able to synthesize their own proteins and replicate independent of the nucleus.

**90.** (*c*)

**91.** (*a*) Autotrophic organisms (chemo-autotrophs, photosynthetic bacteria and algae and green plants) derive carbon dioxide ($CO_2$) as principal carbon source.

**92.** (*a*) When yeast cells are $O_2$ starved, fermentation (anaerobic respiration) serves as the source of energy. This results in the production of ATP + $CO_2$ + Ethanol.

**93.** (*b*) When a student immerses epidermal leaf peel in a hypertonic solution, then after some time the cells would be plasmolysed as water moves out of the cell and the cell membrane of a plant cell shrinks away from its cell wall.

**94.** (*c*) Following are the characteristics feature of fungi:

(i) Cell wall is made up of chitin;

(ii) Filamentous mycelium is present and

(iii) Asexual spores (Like conidia or sporangiospores or zoospores) are produced.

Fungi don't perform the process of photosynthesis.

**95.** (*d*) The specialized water-conducting tissues (xylem and phloem) are absent in bryophytes. Unlike vascular plants, they lack xylem and absorbs water and nutrients mainly through their body surfaces.

**96.** (*b*) KOH is used in saponification process to make the soaps softer as its solubility is more than NaOH.

**97.** (*d*) According to reactivity series of metals, The decreasing order of reactivity is

Sodium > Iron > Copper > Silver

**98.** (*d*) Graphite is made up of layers of carbon atoms and these layers are held together by weak Van der Waal's forces, which make graphite soft and slippery.

**99.** (*b*) Ammonia is obtained from the Haber's process.

The reaction involved is

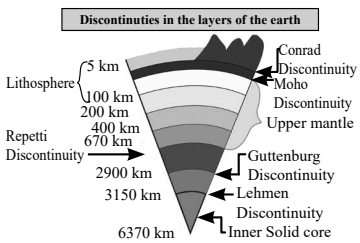
$N_2 + 3H_2 \rightarrow 2NH_3$

**100.** (*d*) The sand commonly used to make glass is comprised of small grains of quartz crystals, made up of molecules of silicon dioxide, which is also known as silica.

**101.** (*b*) The Counter Insurgency and Jungle Warfare School of Indian Army is situated at Vairengte, Mizoram. It was established in year 1967 and it is a 'Centre of Excellence' for imparting quality training for conduct of counter-insurgency and counter-terrorist operations.

**102.** (*c*) Podzolization is a dominant soil forming process, with organic acids leaching iron (Fe) and Al from surficial mineral soil layers (eluviation) and depositing them as organic Fe and Al complexes in lower mineral soil layers (illuviation).

**103.** (*d*)




**104.** (*d*) **Rhododendron trees:** These broadleaf evergreens are known for their showy, colorful flowers and leathery leaves. They are found at high elevations in the Himalayas. **Oak trees:** These deciduous trees are known for their thick, sturdy trunks and lobed leaves. They are found at moderate elevations in the Himalayas.

**105.** (*b*) Among the given options, Batholith is the lowermost intrusive igneous rock. These are huge mass of igneous rocks, usually of granite, formed due to cooling down and solidification of hot magma inside the earth. They appear on the surface only after the denudation processes remove the overlying materials and may be exposed on the surface after erosion.

**106.** (*a*) London is 4:30 hours behind of New Delhi. If it is 12 noon in New Delhi, the time in London, UK will be 6.30 A.M

**107.** (*c*) Both SYZYGY conjunction and SYZYGY opposition causes spring tide. Spring tide is defined as the tide of maximal range which is close to the time of new and full moon if the sun and moon are in syzygy. That is oriented with the earth.

**108.** (*d*) Among the given options, The Last Supper was painted by Leonardo da Vinci. It was probably painted between 1495 and 1498 for the Dominican monastery Santa Maria delle Grazie in Milan.

**109.** (*d*) Among the given options, European explorer Hernan Cortes conquered Mexico.

**110.** (*d*) Huge statues of Kushana emperors have been discovered erected at a sanctuary at Mat, close to Mathura (Uttar Pradesh).

**111.** (*a*) The treaty of Yandabo was concluded as part of First Anglo-Burmese War. It was signed in February 1826 and was signed by Gen. Campbell from the British side and Governor of Legaing Maha Min Hla Kyaw Htin from the Burmese side.

**112.** (*c*) Plan allocation in agriculture and irrigation as percentage of total plan outlay was highest during first five year plan (1951-56). The First Five Year Plan laid the thrust of economic development in India. It was based on the Harrod Domar Model and emphasised increasing savings.

**113.** (*c*) The UN COP-27 Summit relates to Climate Change. It was hosted by Egypt, on the coastal city of Sharm el-Sheikh, concluded with a historic decision to establish and operationalize a loss and damage fund.

**114.** (*c*) While experimenting to introduce tea in India, British colonists noticed that tea plants with thicker leaves also grew in Assam, and these, when planted in India, responded very well. The same plants had long been cultivated by the Singphos tribe of Assam, and chests of tea supplied by the tribal ruler Ningroola.

**115.** (*a*) 42nd Amendment Act of 1976 added 10 Fundamental Duties to the Indian Constitution. 86th Amendment Act 2002 later added 11th Fundamental Duty to the list. Swaran Singh Committee in 1976 recommended Fundamental Duties, the necessity of which was felt during the internal emergency of 1975-77

**116.** (*a*) The 1947 Sylhet referendum was held in the Sylhet District of the Assam Province of British India to decide whether the district would remain in Undivided Assam and therefore within the post-independence Dominion of India, or leave Assam for East Bengal and consequently join the newly-created Dominion of Pakistan.

**117.** (*c*) The inscription of Rabatak was found in 1993 near an ancient hill in the north part of Baghlan in Afghanistan. The Rabatak inscription includes 23 lines in Bactrian language and a Greco-Bactrian script.

**118.** (*d*) Among the given options, Shudraka is the author of famous book It is a ten-act Sanskrit drama that revolves around the passionate love between the protagonist, Carudatta-a prominent but poor Brahmin merchant of Ujjain-and the veritably beautiful Ganika, a courtesan but with a noble mind of the same city.

**119.** (*a*) Yashovarman was a medieval Indian ruler of Kannauj who founded the Varman dynasty of Kannauj. The city (then known as Kanyakubja) had previously been ruled by Harsha, who died without an heir and thus created a power vacuum.

**120.** (*) King Udayin was the Indian ruler of the Haryanka dynasty who ruled over Magadha from 460 BCE to 440 BCE. He was the son of Ajatashatru and he first established Pataliputra as the capital of Magadha.

**121.** (*a*) In 1543, Nicolaus Copernicus detailed his radical theory of the Universe in which the Earth, along with the other planets, rotated around the Sun.

**122.** (*d*) Bharatmala Pariyojana was launched on July 31, 2015. It is Second-largest highways construction project in India after National Highways Development Project. The project focuses on optimising efficiency of freight and passenger movement across the country, by bridging critical infrastructure gaps through effective interventions like development of economic corridors, inter-corridors and feeder routes, national corridor efficiency improvement, border and international connectivity roads, coastal and port connectivity roads and greenfield expressways.

**123.** (*c*) Kandla Port, also known as the Deendayal Port is a seaport in Kutch District of Gujarat state in the western India, near the city of Gandhidham. Located on the Gulf of Kutch, it is one of major ports on the western coast.

**124.** (*b*) Kanaklata Barua, also called Birbala and Shaheed (martyr), was an Indian independence activist and AISF leader who was shot dead by the Indian Imperial Police of the British Raj while leading a procession bearing the National Flag during the Quit India Movement of 1942.

**125.** (*c*) The Mansabdari system was the administrative system introduced by Akbar in Mughal Empire during 1571. "Zat" rank was an indicator of a Mansabdar's position in the imperial hierarchy and the salary of the Mansabdar.

**126.** (*c*) Among the given options, Warren Hastings underwent impeachment proceedings in the British Parliament. He was impeached in the year 1787 on the charges of administrative excess.

**127.** (*a*) The Prayaga Prashasti (also known as the Allahabad Pillar Inscription) was composed by Harisena. Harisena was the court poet of Samudragupta while Banabhatta was the court poet of Harshavardhana.

**128.** (*b*) The Vijayanagara empire was based in the Deccan, in peninsular and southern India, from 1336 onwards. It was founded by Harihara, also known as Hakka, and his brother Bukka Raya. It is named after its capital city (now ruined) of Vijayanagara, in modern Karnataka, India.

**129.** (*d*) The Danish East India Company established their first factory at Tranquebar in Tamil Nadu in 1620 and Serampur in Bengal in 1676.

**130.** (*b*) Slate is a fine-grained, foliated, homogeneous metamorphic rock. Rocks formed as a result of cooling, solidification and crystallisation of molten magma (molten rock within the earth surface) and lava (molten rock when erupted) are known as Igneous rocks.

**131.** (*b*) Hypocenter or the focus is the point where an earthquake or an underground explosion originates.

**132.** (*b*) The Quaternary Period is divided into two epochs, from youngest to oldest: the Holocene and Pleistocene. We are living in the Holocene.

**133.** (*c*) Planets according to their density (Decreasing Order)-

Earth, Mercury, Venus, Mars, Neptune, Jupiter, Uranus Saturn.

**134.** (*b*) The East Australian Current (EAC) is a warm, southward, western boundary current that is formed from the South Equatorial Current (SEC) crossing the Coral Sea and reaching the eastern coast of Australia.

**135.** (*c*) A cold and humid climate is most favorable for podzolization.

**136.** (*c*) Exercise Keen Sword is a joint and bilateral field training exercise between the US military and the Japan Self-Defence Force. It is held once in two years to boost the preparedness and interoperability between the military personnel of Japan and the United States.

**137.** (*c*) The Battle of Rezang La, fought between Indian and Chinese troops on the icy mountain tops on the southeastern ridge of the Chushul Valley, is often remembered as a show of great Indian strength during the war in 1962.

**138.** (*a*) This national-level exercise provides the opportunity at the apex level to assess India's preparedness in the maritime security domain and the coastal defence.

**139.** (*b*) West Indies is the only country that won the ICC T20 World Cup twice (2012 & 2016) and India, Pakistan, England, & Sri Lanka won it once. Virat Kohli is indeed the only player to be adjudged as Player of the Series twice in the T20 World Cup.

**140.** (*b*) Among the given options, Benjamin List is not the recipient of Nobel Prize in Chemistry in 2022. He was awarded by Nobel Prize in 2021.

**141.** (*a*) Among the given options, New Delhi is the northernmost geographical location.

**142.** (*d*) The distance between the longitude is the maximum at 69miles in the equator. The total number of latitudes is 180 and the total number of longitudes is 360.

**143.** (*a*) Madhya Pradesh is the largest producer of manganese in India. Currently, India is one of the major importers of manganese ore.

**144.** (*d*) Mica is used principally in the electronic and electrical industries. Its usefulness in these applications is derived from its unique electrical and thermal properties and its mechanical properties, which allow it to be cut, punched, stamped, and machined to close tolerances.

**145.** (*b*) The correct answer is Cwg Climate. This type of climate is found in most parts of the Northern Ganga Plains. In this type of climate, the summer temperature rises to 40°C which falls to 27°C in winter. Most of the rainfall occurs in summer and winter is dry.

**146.** (*b*) Lachit Borphukan was an Ahom commander, known for his leadership in the Battle of Saraighat that thwarted an invasion by Mughal forces under the command of Ramsingh I.

**147.** (*c*) The fourth iteration of the biennial training exercise DUSTLIK (2023) held in Pithoragarh, Uttarakhand, as part of a military-to-military exchange programme between the Indian Army and the Uzbekistan Army.

**148.** (*d*) India's first privately developed rocket, Vikram-S, was launched into space on 15 November, from the launchpad at Sriharikota of the Indian Space Research Organisation (ISRO).

**149.** (*b*) The Prime Minister of India declared Modhera, a village in the Mehsana district of Gujarat as India›s first solar-powered village.

**150.** (*a*) The tableau of Uttrakhand, based on the theme 'Manaskhand', was given away the best tableau award mong the 17 states/union territories tableaux.