

## MATHS

**Q. 1.** The mean of the numbers a, b, 8, 5, 10 is 6 and the variance is 6.80 . Then which one of the following gives possible values a and b?

- i. a = 1, b = 6
- ii. a = 3, b = 4
- iii. a = 0, b = 7
- iv. a = 5, b = 2

**Sol.**

$$\text{Mean} = \frac{\sum x}{n} = 6$$

$$\text{Variance} = \frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2 = 6.8$$

$$\Rightarrow \frac{a^2 + b^2 + 64 + 25 + 100}{5} - 36 = 6.8$$

$$\Rightarrow a^2 + b^2 + 189 - 180 = 34$$

$$\Rightarrow a^2 + b^2 = 25$$

Possible values of a and b is given by (2)

**Q. 2.** The vector  $\vec{a} = \alpha\vec{i} + 2\vec{j} + \beta\vec{k}$  lies in the plane of the vectors  $\vec{b} = \vec{i} + \vec{j}$  and  $\vec{c} = \vec{j} + \vec{k}$  and bisects the angle between  $\vec{b}$  and  $\vec{c}$  . Then which one of the following gives possible values of  $\alpha$  and  $\beta$  ?

- i.  $\alpha = 2, \beta = 1$
- ii.  $\alpha = 1, \beta = 1$
- iii.  $\alpha = 2, \beta = 2$
- iv.  $\alpha = 1, \beta = 2$

**Sol.**

As  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  are coplanar

$$\therefore [\vec{a} \vec{b} \vec{c}] = 0$$

$$\text{Or, } \alpha + \beta = 2 \quad (\text{i})$$

Also  $\vec{a}$  bisects the angle between  $\vec{b}$  and  $\vec{c}$

$$\therefore \vec{a} = \lambda (\vec{b} + \vec{c})$$

$$\text{or, } \vec{a} = \lambda \left( \frac{\hat{i} + 2\hat{j} + \hat{k}}{\sqrt{2}} \right) \quad (\text{ii})$$

$$\text{But } \vec{a} = \alpha \hat{i} + 2\hat{j} + \beta \hat{k}$$

$$\text{Hence } \lambda = \sqrt{2} \text{ and } \alpha = 1, \beta = 1$$

Which also satisfy (i)

$\therefore$  Correct answer is (2)

Q. 3.

The non-zero vectors  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  are related by  $\vec{a} = 8\vec{b}$  and  $\vec{c} = -7\vec{b}$

Then the angle between  $\vec{a}$  and  $\vec{c}$  is

- i.  $\frac{\pi}{2}$
- ii.  $\pi$
- iii. 0
- iv.  $\frac{\pi}{4}$

Sol. The sign of  $\vec{a}$  and  $\vec{c}$  are opposite. Hence they are parallel but directions are opposite.

Therefore angle between  $\vec{a}$  and  $\vec{c}$  is  $\pi$

$\therefore$  correct answer is (2)

Q. 4. The line passing through the points (5, 1, a) and (3, b, 1) crosses the yz-plane at the

point  $\left( 0, \frac{17}{2}, \frac{-13}{2} \right)$ . Then

- i. a = 6, b = 4
- ii. a = 8, b = 2
- iii. a = 2, b = 8
- iv. a = 4, b = 6

Sol. Equation of line through (5, 1, a) and (3, b, 1) is

$$\frac{x-5}{-2} = \frac{y-1}{b-1} = \frac{z-a}{1-a} = \lambda$$

any point on (i) is

$$\{5-2\lambda, 1+(b-1)\lambda, a+(1-a)\lambda\} \quad (ii)$$

$$\text{As } \left(0, \frac{17}{2}, -\frac{13}{2}\right) \text{ lies on (i)}$$

$$5-2\lambda=0 \Rightarrow \lambda = \frac{5}{2} \quad (iii)$$

$$1+(b-1) \times \frac{5}{2} = \frac{17}{2}$$

$$\text{or, } 2+5b-5=17$$

$$\text{or, } b=4$$

$$\text{and } a+(1-a) \times \frac{5}{2} = -\frac{13}{2}$$

$$\text{or, } 2a+5-5a=-13$$

$$\text{or, } a=6$$

$\therefore$  Correct answer is (1)

Q. 5. If the straight lines  $\frac{x-1}{k} = \frac{y-2}{2} = \frac{z-3}{3}$  and  $\frac{x-2}{3} = \frac{y-3}{k} = \frac{z-1}{2}$  intersect at a point, then the integer k is equal to

- i. 2
- ii. 2
- iii. 5
- iv. 5

Sol. As the given lines intersect

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

$$\text{Or, } \begin{vmatrix} 1 & 1 & 2 \\ k & 2 & 3 \\ 3 & k & 2 \end{vmatrix} = 0$$

$$\text{or, } k = -5, \frac{5}{2}$$

Integer is -5 only

$\therefore$  Correct answer is (3)

Q. 6. The differential of the family of circles with fixed radius 5 units and centre on the line  $y = 2$  is

- i.  $(y - 2)^2 y'^2 = 25 - (y - 2)^2$
- ii.  $(x - 2)^2 y'^2 = 25 - (y - 2)^2$
- iii.  $(x - 2) y'^2 = 25 - (y - 2)^2$
- iv.  $(y - 2) y'^2 = 25 - (y - 2)^2$

Sol. The required equation of circle is

$$(x - a)^2 + (y - 2)^2 = 25 \quad (i)$$

*differentiating we get*

$$2(x - a) + 2(y - 2)y' = 0$$

$$\text{or, } a = x + (y - 2)y' \quad (ii)$$

*putting a in (i)*

$$(x - x - (y - 2)y')^2 + (y - 2)^2 = 25$$

$$\text{or, } (y - 2)^2 y'^2 = 25 - (y - 2)^2$$

$\therefore$  The correct answer is (1)

Q. 7. Let a, b, c be any real numbers. Suppose that there are real numbers x, y, z not all zero such that  $x = cy + bz$ ,  $y = az + cx$  and  $z = bx + ay$ . Then  $a^2 + b^2 + c^2 + 2abc$  is equal to

- i. 0
- ii. 1
- iii. 2
- iv. -1

Sol.

$$x = cy + bz \Rightarrow x - cy - bz = 0 \quad (i)$$

$$y = az + bx \Rightarrow bx - y + az = 0 \quad (ii)$$

$$z = bx + ay \Rightarrow bx + ay - z = 0 \quad (iii)$$

*Eliminating x, y, z from (i), (ii) and (iii) we get*

$$\begin{vmatrix} 1 & -c & -b \\ c & -1 & a \\ b & a & -1 \end{vmatrix} = 0$$

$$\text{or, } a^2 + b^2 + c^2 + 2abc = 1.$$

$\therefore$  The correct answer is (2)

Q. 8. Let A be a square matrix all of whose entries are integers. Then which one of the following is true?

- i. If  $\det A = \pm 1$ , then  $A^{-1}$  exists and all its entries are integers
- ii. If  $\det A = \pm 1$ , then  $A^{-1}$  need not exist
- iii. If  $\det A = \pm 1$ , then  $A^{-1}$  exist but all its entries are not necessarily integers
- iv. If  $\det A = \pm 1$ , then  $A^{-1}$  exist and all its entries are non-integer

**Sol.** The obvious answer is (1).

**Q. 9.** The quadratic equations  $x^2 - 6x + a = 0$  and  $x^2 - cx + 6 = 0$  and have one root in common. The other roots of the first and second equations are integers in the ratio 4 : 3. Then the common root is

- i. 3
- ii. 2
- iii. 1
- iv. 4

**Sol.**

Let the roots of  $x^2 - 6x + a = 0$

be  $\alpha$  and  $4\beta$  and that of  $x^2 - cx + 6 = 0$  be  $\alpha$  and  $3\beta$ ,

$$\therefore \alpha + 4\beta = 6 \quad (i)$$

$$4\alpha\beta = a \quad (ii)$$

$$\alpha + 3\beta = c \quad (iii)$$

$$3\alpha\beta = 6 \quad (iv)$$

Using (ii) & (iv)

$$\frac{4}{3} = \frac{a}{6} \Rightarrow a = 8$$

Then  $x^2 - 6x + a = 0$

reduces to

$$x^2 - 6x + 8 = 0$$

$$x = \frac{6 \pm \sqrt{36 - 32}}{2}$$

$$= \frac{6 \pm 2}{2} = 4, 2$$

$$\therefore \alpha = 2, \beta = 1$$

$\therefore$  Correct answer is (2)

**Q. 10.** How many different words can be formed by jumbling the letters in the word MISSISSIPPI in which no two S are adjacent?

- i.  $6.8.{}^7C_4$
- ii.  $7.{}^6C_4.{}^8C_4$
- iii.  $8.{}^6C_4.{}^7C_4$
- iv.  $6.7.{}^8C_4$

Sol.  $M = 1, I = 4, P = 2$

These letters can be arranged by

$$\frac{(1+4+2)!}{1!4!2!} = 7.{}^6C_4 \text{ ways}$$

The remaining 8 gaps can be filled by 4 S by  ${}^8C_4$  ways

$$: \text{Total no. of ways} = 7.{}^6C_4.{}^8C_4$$

: Correct answer is (2)

Q. 11.

Let  $i = \int_0^1 \frac{\cos x}{\sqrt{x}} dx$ . Then which one of the following is true?

- i.  $I < \frac{2}{3}$  and  $J > 2$
- ii.  $I < \frac{2}{3}$  and  $J < 2$
- iii.  $I > \frac{2}{3}$  and  $J > 2$
- iv.  $I < \frac{2}{3}$  and  $J > 2$

Sol.

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We know  $\frac{\sin x}{x} < 1$ , when  $x \in (0, 1)$

$$\therefore \frac{\sin x}{\sqrt{x}} < \sqrt{x}$$

$$\Rightarrow \int_0^1 \frac{\sin x}{\sqrt{x}} dx < \int_0^1 \sqrt{x} dx$$

$$\Rightarrow \int_0^1 \frac{\sin x}{\sqrt{x}} dx < \frac{2}{3}$$

Also,  $\cos x < 1$ , when  $x \in (0, 1)$

$$\therefore \frac{\cos x}{\sqrt{x}} < \frac{1}{\sqrt{x}}$$

$$\Rightarrow \int_0^1 \frac{\cos x}{\sqrt{x}} dx < \int_0^1 \frac{1}{\sqrt{x}} dx$$

$$\int_0^1 \frac{\cos x}{\sqrt{x}} dx < 2$$

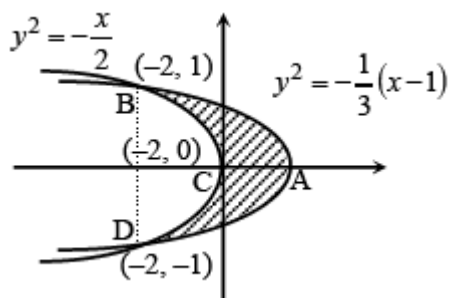
$$\therefore I < \frac{2}{3} \text{ and } J < 2$$

$\therefore$  Correct answer is (4)

Q. 12. The area of the plane region bounded by the curve  $x + 2y^2 = 0$  and  $3y^2 = 1$  is equal to

- i.  $\frac{2}{3}$
- ii.  $\frac{4}{3}$
- iii.  $\frac{5}{3}$
- iv.  $\frac{1}{3}$

Sol.



$$x + 2y^2 = 0 \Rightarrow y^2 = -\frac{x}{2}$$

$$x + 3y^2 = 1 \Rightarrow y^2 = -\frac{1}{3}(x-1)$$

$$\therefore -\frac{x}{2} = -\frac{1}{3}(x-1)$$

$$\text{or, } -\frac{x}{2} = -\frac{x}{3} + \frac{1}{3}$$

$$\text{or, } \frac{x}{3} - \frac{x}{2} = \frac{1}{3}$$

$$\text{or, } -\frac{x}{6} = \frac{1}{3}$$

$$\text{or, } x = -2$$

$$\therefore y^2 = 1 \Rightarrow y = \pm 1$$

Area of the region BCA

$$= \left| \int_0^1 \{(-2y^2) - (1 - 3y^2)\} dy \right|$$

$$= \left| \int_0^1 (y^2 - 1) dy \right|$$

$$= \left| \left[ \frac{y^3}{3} - y \right]_0^1 \right|$$

$$= \left| \frac{1}{3} - 1 \right| = \frac{2}{3}$$

Hence area of the region bounded by the curve is equal to  $2 \times \frac{2}{3} = \frac{4}{3}$

$\therefore$  Correct answer is (2)