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.

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

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

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

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

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

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

Q. 2. The vector $\vec{a} = a\hat{i} + 2\hat{j} + \beta\hat{K}$ lies in the plane of the vectors $\vec{b} = \hat{i} + \hat{j}\ and + \vec{c} = \hat{j} + \hat{k}$ 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.

$$As\ \vec{a}, \vec{b}\ and\ \vec{c}\ are\ coplanar$$
$$\therefore \left[\vec{a}\ \vec{b}\ \vec{c}\right] = 0$$
$$Or, \alpha + \beta = 2 \qquad (i)$$
$$Also\ \vec{a}\ bisects\ the\ angle\ between\ \vec{b}\ and\ \vec{c}$$
$$\therefore \vec{a} = \lambda\left(\vec{b} + \vec{c}\right)$$
$$or, \vec{a} = \lambda\left(\frac{\hat{i} + 2\vec{j} + \vec{k}}{\sqrt{2}}\right) \qquad (ii)$$
$$But\ \ \vec{a} = \alpha\,\vec{2} + 2\vec{j} + \beta\vec{k}$$
$$Hence\ \lambda = \sqrt{2}\ and\ \alpha = 1,\ \beta = 1$$
$$Which\ also\ satisfy \qquad (i)$$
$$\therefore Correct\ answer\ is\ (2)$$

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. π
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

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

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

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

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

$$or, 2+5b-5=17$$

$$or, b=4$$

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

$$or, 2a+5-5a=-13$$

$$or, a=6$$

$$\therefore \text{Correct answer is } (1)$$

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

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

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

$$or,\ k=-5, \ 5/2$$

$$\text{Integer is } -5 \text{ only}$$

$$\therefore \text{Correct answer is } (3)$$

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. $(x \quad 2)^2\, y'^2 = 25 \quad (y \quad 2)^2$
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

$$(x-a)^2 + (y-2)^2 = 25 \qquad (i)$$
differentiating we get
$$2(x-a) + 2(y-2)\, y' = 0$$
$$or,\ a = x + (y-2)\, y' \qquad (ii)$$
putting a in (i)
$$\{x - x - (y-2)\, y'\}^2 + (y-2)^2 = 25$$
$$or,\ (y-2)^2\, y'^2 = 25 - (y-2)^2$$
$\therefore$ *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.

$$x = cy + bz \Rightarrow x - cy - bz = 0 \qquad (i)$$
$$y = az + bx \Rightarrow bx - y + az = 0 \qquad (ii)$$
$$z = bx + ay \Rightarrow bx + ay - z = 0 \qquad (iii)$$
Eliminating x, y, z *from* $(i), (ii)$ *and* (iii) *weget*
$$\begin{vmatrix} 1 & -c & -b \\ c & -1 & a \\ b & a & -1 \end{vmatrix} = 0$$
$$or,\ a^2 + b^2 + c^2 + 2abc = 1.$$
$\therefore$ *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. $If\ \det A = \pm 1, then\ A^{-1}\ exist\ and\ all\ its\ entries\ are\ non-integers$

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.

$$Let\ the\ roots\ of\ x^2 - 6x + a = 0$$
$$be\ \alpha\ and\ 4\beta\ and\ that\ of\ x^2 - cx + 6 = 0\ be\ \alpha\ and\ 3\beta$$
$$\therefore \alpha + 4\beta = 6 \qquad (i)$$
$$4\alpha\beta = a \qquad (ii)$$
$$\alpha + 3\beta = c \qquad (iii)$$
$$3\alpha\beta = 6 \qquad (iv)$$
Using (ii) & (iv)
$$\frac{4}{3} = \frac{a}{6} \Rightarrow a = 8$$
$$Then \quad x^2 - 6x + a = 0$$
$$reduces\ to$$
$$x^2 - 6x + 8 = 0$$
$$x = \frac{6 \pm \sqrt{36 - 32}}{2}$$
$$= \frac{6 \pm 2}{2} = 4, 2$$
$$\therefore \alpha = 2, \beta = 1$$
$$\therefore Correct\ answer\ is\ (2)$$

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

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

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

$$\therefore\ Total\ no.\ of\ ways = 7\ {}^6C_4 \qquad {}^8C_4$$
$$\therefore\ Correct\ answer\ is\ (2)$$

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.

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

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

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

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

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

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

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

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

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

$$\therefore Correct\ answer\ is\ (4)$$

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

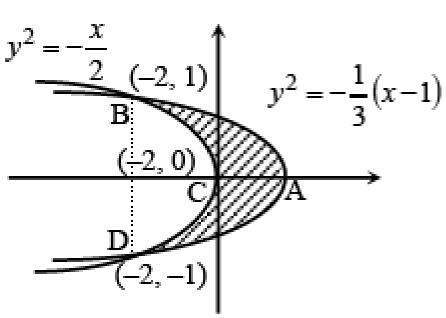
i. $\frac{2}{3}$

ii. $\frac{4}{3}$

iii. $\frac{5}{3}$

iv. $\frac{1}{3}$

Sol.



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

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

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

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

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

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

$$or, \quad x = -2$$

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

Area of the region BCA

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

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

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

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

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)