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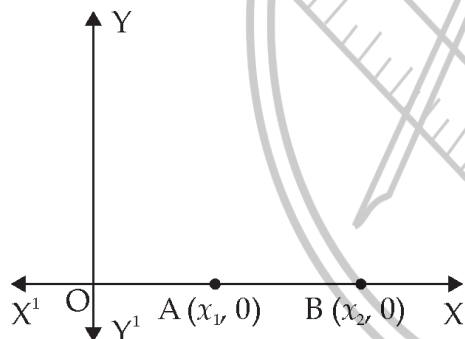
Co-ordinate Geometry

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**Points to Remember:**

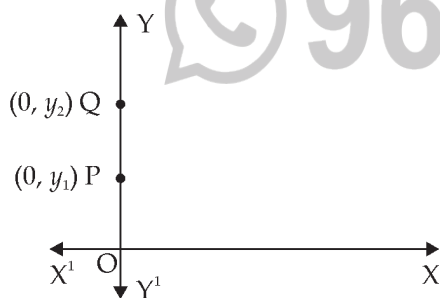
- (1) To find distance any two points on an axis.
 (i) To find distance between two points on X-axis.



In the above figure, points $A(x_1, 0)$ and $B(x_2, 0)$ are on X-axis such that, $x_2 > x_1$

$$\therefore d(A, B) = x_2 - x_1$$

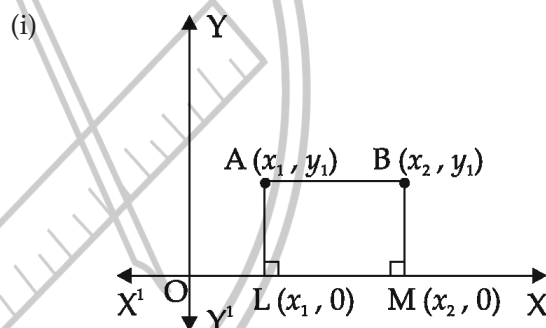
- (ii) To find distance between two points on Y-axis.



In the above figure, points $P(0, y_1)$ and $Q(0, y_2)$ are on Y-axis such that, $y_2 > y_1$

$$\therefore d(P, Q) = y_2 - y_1$$

- (2) To find the distance between two points if the segment joining these point is parallel to any axis in the XY plane.



In the figure, seg AB is parallel to X-axis.

$\therefore$ y co-ordinates of points A and B are equal.

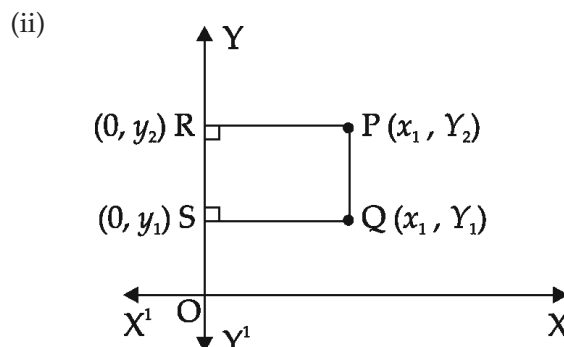
Draw seg AL and seg BM perpendicular to X-axis.

$\therefore$ $\square$ ABML is a rectangle.

$\therefore$ $AB = LM$

But, $LM = x_2 - x_1$

$$d(A, B) = x_2 - x_1$$



In the figure, seg PQ is parallel to Y-axis.

∴ x co-ordinates of points P and Q are equal.

Draw seg PR and seg QS perpendicular to Y-axis.

∴ □ABML is a rectangle.

∴ PQ = RS

But, RS = $y_2 - y_1$

d(P, Q) = $y_2 - y_1$

Distance Formula :

If A (x_1 , y_1) and (x_2 , y_2) are two points, then distance between these points is given by the following formula :

$$d(A, B) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

or

$$d(A, B) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Note : If P (x , y) is a point, then its distance from the origin is given by

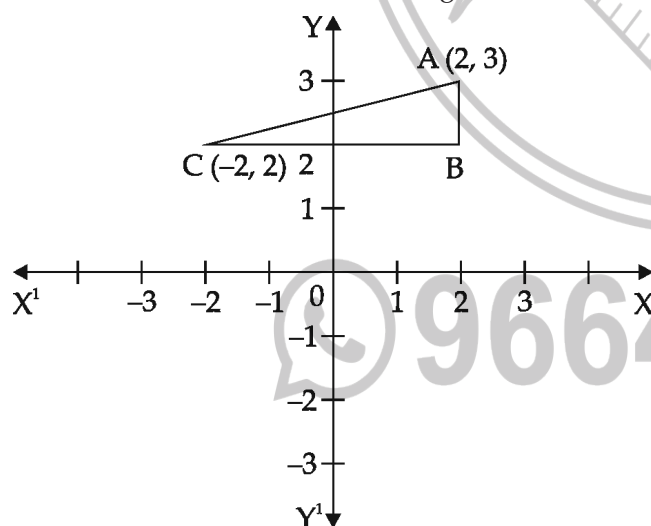
$$d(O, P) = \sqrt{x^2 + y^2}$$

Activity - I (Textbook page no. 102)

In the figure given below, seg AB || y - axis, seg CB || x - axis.

Coordinates of points A and C are given.

To find AC, fill in the following boxes



According to Pythagoras theorem,

$$(AB)^2 + (BC)^2 = \boxed{AC^2}$$

First find coordinates of B to find lengths AB and BC.

CB || X - axis ∴ y coordinate of B = $\boxed{2}$

BA || Y - axis ∴ x coordinate of B = $\boxed{2}$

$$\therefore AB = \boxed{3} - \boxed{2} = \boxed{1}$$

$$BC = \boxed{2} - \boxed{-2} = \boxed{4}$$

$$\therefore AC^2 = \boxed{(1)^2} + \boxed{4^2} = \boxed{1 + 16} = \boxed{17}$$

$$\therefore AC = \boxed{\sqrt{17}}$$

MASTER KEY QUESTION SET - 5

Practice Set - 5.1 (Textbook Page No. 107)

(1) Find the distance between each of the following pairs of the points. (2 marks each)

(i) A(2, 3), B(4, 1)

Solution :

$$A(2, 3) = (x_1, y_1)$$

$$B(4, 1) = (x_2, y_2)$$

By distance formula,

$$d(A, B) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$= \sqrt{(4 - 2)^2 + (1 - 3)^2}$$

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

$$= \sqrt{4 + 4}$$

$$= \sqrt{8}$$

$$= \sqrt{4 \times 2}$$

$$\therefore d(A, B) = \boxed{2\sqrt{2} \text{ units}}$$

(ii) P(-5, 7), Q(-1, 3)

Solution :

$$P(-5, 7) = (x_1, y_1)$$

$$Q(-1, 3) = (x_2, y_2)$$

By distance formula,

$$d(P, Q) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$= \sqrt{[-1 - (-5)]^2 + (3 - 7)^2}$$

$$= \sqrt{(-1 + 5)^2 + (-4)^2}$$

$$= \sqrt{(4)^2 + 16}$$

$$= \sqrt{16 + 16}$$

$$= \sqrt{32}$$

$$= \sqrt{16 \times 2}$$

$$\therefore d(P, Q) = \boxed{4\sqrt{2} \text{ units}}$$

(iii) $R(0, -3), S(0, \frac{5}{2})$

Solution :

$$R(0, -3) = (x_1, y_1)$$

$$S(0, \frac{5}{2}) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(R, S) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(0 - 0)^2 + \left(\frac{5}{2} - (-3)\right)^2} \\ &= \sqrt{(0)^2 + \left(\frac{5}{2} + 3\right)^2} \\ &= \sqrt{0 + \left(\frac{11}{2}\right)^2} \\ &= \sqrt{\frac{121}{4}} \end{aligned}$$

$$\therefore d(R, S) = \frac{11}{2} \text{ units}$$

(iv) $L(5, -8), M(-7, -3)$

Solution :

$$L(5, -8) = (x_1, y_1)$$

$$M(-7, -3) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(L, M) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(-7 - 5)^2 + [-3 - (-8)]^2} \\ &= \sqrt{(-12)^2 + (-3 + 8)^2} \\ &= \sqrt{(-12)^2 + 5^2} \\ &= \sqrt{144 + 25} \\ &= \sqrt{169} \end{aligned}$$

$$\therefore d(L, M) = 13 \text{ units}$$

(v) $T(-3, 6), R(9, -10)$

Solution :

$$T(-3, 6) = (x_1, y_1)$$

$$R(9, -10) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(T, R) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{[9 - (-3)]^2 + (-10 - 6)^2} \\ &= \sqrt{(9 + 3)^2 + (-16)^2} \\ &= \sqrt{(12)^2 + 256} \end{aligned}$$

$$= \sqrt{144 + 256}$$

$$= \sqrt{400}$$

$$\therefore d(T, R) = 20 \text{ units}$$

(vi) $W\left(\frac{-7}{2}, 4\right), X(11, 4)$

Solution :

$$W\left(\frac{-7}{2}, 4\right) = (x_1, y_1)$$

$$X(11, 4) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(W, X) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{\left[11 - \left(\frac{-7}{2}\right)\right]^2 + (4 - 4)^2} \\ &= \sqrt{\left(11 + \frac{7}{2}\right)^2 + 0^2} \\ &= \sqrt{\left(\frac{22 + 7}{2}\right)^2 + 0} \\ &= \sqrt{\left(\frac{29}{2}\right)^2} \end{aligned}$$

$$\therefore d(W, X) = \frac{29}{2} \text{ units}$$

Problem Set - 5 (Textbook Pg No. 122)

(6) Find the distance between the following pairs of points. (2 marks each)

(i) $A(a, 0), B(0, a)$

Solution :

$$\text{Let } A(a, 0) = (x_1, y_1)$$

$$B(0, a) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(A, B) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(0 - a)^2 + (a - 0)^2} \\ &= \sqrt{(-a)^2 + a^2} \\ &= \sqrt{a^2 + a^2} \\ &= \sqrt{2a^2} \end{aligned}$$

$$\therefore d(A, B) = \sqrt{2a} \text{ units}$$

(ii) $P(-6, -3), Q(-1, 9)$

Solution :

$$\text{Let } P(-6, -3) = (x_1, y_1)$$

$$Q(-1, 9) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(P, Q) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{[-1 - (-6)]^2 + [-9 - (-3)]^2} \\ &= \sqrt{(-1 + 6)^2 + (-9 + 3)^2} \\ &= \sqrt{(5)^2 + (-6)^2} \\ &= \sqrt{25 + 36} \\ &= \sqrt{61} \end{aligned}$$

$$\therefore d(P, Q) = 13 \text{ units}$$

(iii) $R(-3a, a)$, $S(a, -2a)$

Solution :

$$\text{Let } R(-3a, a) = (x_1, y_1)$$

$$S(a, -2a) = (x_2, y_2)$$

By distance formula,

$$\begin{aligned} d(R, S) &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{[a - (-3a)]^2 + (-2a - a)^2} \\ &= \sqrt{(a + 3a)^2 + (-3a)^2} \\ &= \sqrt{(4a)^2 + (-3a)^2} \\ &= \sqrt{16a^2 + 9a^2} \\ &= \sqrt{25a^2} \end{aligned}$$

$$\therefore d(R, S) = 5a \text{ units}$$

Practice Set - 5.1 (Textbook Page No. 107)

(3) Find the point on X-axis which is equidistant from $A(-3, 4)$ and $B(1, -4)$. (2 marks)

Solution :

Let $P(x, 0)$ be a point on X axis which is equidistant from $A(-3, 4)$ and $B(1, -4)$.

$$\therefore d(P, A) = d(P, B)$$

By distance formula,

$$\sqrt{[x - (-3)]^2 + (0 - 4)^2} = \sqrt{(x - 1)^2 + [0 - (-4)]^2}$$

$$\therefore \sqrt{(x + 3)^2 + (-4)^2} = \sqrt{(x - 1)^2 + (4)^2}$$

Squaring both the sides we get,

$$(x + 3)^2 + 16 = (x - 1)^2 + 16$$

$$\therefore x^2 + 6x + 9 + 16 = x^2 - 2x + 1 + 16$$

$$\therefore x^2 + 6x - x^2 + 2x = 1 - 9$$

$$\therefore 8x = -8$$

$$\therefore x = -1$$

$$\therefore P(-1, 0) \text{ is the required point.}$$

Problem Set - 5 (Textbook Pg No. 122)

(5) Find a point on X-axis which is equidistant from $P(2, -5)$ and $Q(-2, 9)$. (2 marks)

Solution :

Let $A(a, 0)$ be a point equidistant from $P(2, -5)$ and $Q(-2, 9)$.

$$\therefore d(P, A) = d(Q, A)$$

Using distance formula,

$$\sqrt{(a - 2)^2 + [0 - (-5)]^2} = \sqrt{[a - (-2)]^2 + (0 - 9)^2}$$

Squaring both the sides we get,

$$(a - 2)^2 + 5^2 = (a + 2)^2 + (-9)^2$$

$$\therefore a^2 - 4a + 4 + 25 = a^2 + 4a + 4 + 81$$

$$\therefore a^2 - 4a - a^2 - 4a = 81 - 25$$

$$\therefore -8a = 56$$

$$\therefore a = \frac{56}{-8}$$

$$\therefore a = -7$$

$(-7, 0)$ is a point on X-axis equidistant from $P(2, -5)$ and $Q(-2, 9)$.

Practice Set - 5.1 (Textbook Page No. 107)

(4) Verify that points $P(-2, 2)$, $Q(2, 2)$ and $R(2, 7)$ are vertices of a right angled triangle. (3 marks)

Solution :

$P(-2, 2)$, $Q(2, 2)$ and $R(2, 7)$ be the vertices of a triangle

Using distance formula,

$$d(P, Q) = \sqrt{(-2 - 2)^2 + (2 - 2)^2}$$

$$= \sqrt{(-4)^2 + 0^2}$$

$$= \sqrt{16}$$

$$\therefore d(P, Q) = 4 \text{ units}$$

$$\text{i.e. } PQ = 4 \text{ units}$$

$$d(Q, R) = \sqrt{(2 - 2)^2 + (2 - 7)^2}$$

$$= \sqrt{0^2 + (-5)^2}$$

$$d(Q, R) = \sqrt{25}$$

$$\therefore QR = 5 \text{ units}$$

$$d(P, R) = \sqrt{(-2 - 2)^2 + (2 - 7)^2}$$

$$= \sqrt{(-4)^2 + (-5)^2}$$

$$= \sqrt{16 + 25}$$

$$\therefore d(P, R) = \sqrt{41} \text{ units}$$

$$\text{i.e. } PR = \sqrt{41} \text{ units}$$

$$PR^2 = 41 \quad \dots(i)$$

$$PQ^2 + QR^2 = 4^2 + 5^2$$

$$\therefore PQ^2 + QR^2 = 16 + 25 = 41 \quad \dots(ii)$$

$$\therefore PR^2 = PQ^2 + QR^2 \quad \dots[\text{From (i) and (ii)}]$$

$\therefore \triangle PQR$ is a right angled triangle
 $\dots(\text{Converse of Pythagoras theorem})$

- (6) A(-4, -7), B(-1, 2), C(8, 5) and D(5, -4) are the vertices of rhombus ABCD. (3 marks)

Solution :

A(-4, -7), B(-1, 2), C(8, 5) and D(5, -4) are the vertices of a quadrilateral

By distance formula,

$$\begin{aligned} d(A, B) &= \sqrt{[-4 - (-1)]^2 + (-7 - 2)^2} \\ &= \sqrt{(-3)^2 + (-9)^2} \\ &= \sqrt{9 + 81} \end{aligned}$$

$$\therefore d(A, B) = \sqrt{90} \text{ units} \quad \dots(i)$$

$$\begin{aligned} d(B, C) &= \sqrt{(-1 - 8)^2 + (2 - 5)^2} \\ &= \sqrt{(-9)^2 + (-3)^2} \\ &= \sqrt{81 + 9} \end{aligned}$$

$$\therefore d(B, C) = \sqrt{90} \text{ units} \quad \dots(ii)$$

$$\begin{aligned} d(C, D) &= \sqrt{(8 - 5)^2 + [5 - (-4)]^2} \\ &= \sqrt{(3)^2 + (5 + 4)^2} \\ &= \sqrt{9 + 81} \end{aligned}$$

$$\therefore d(C, D) = \sqrt{90} \text{ units} \quad \dots(iii)$$

$$\begin{aligned} d(A, D) &= \sqrt{(-4 - 5)^2 + [-7 - (-4)]^2} \\ &= \sqrt{(-9)^2 + (-3)^2} \\ &= \sqrt{81 + 9} \end{aligned}$$

$$\therefore d(A, D) = \sqrt{90} \text{ units} \quad \dots(iv)$$

$$\therefore AB = BC = CD = AD \quad \dots[\text{From (i), (ii), (iii) and (iv)}]$$

$\therefore \square ABCD$ is a rhombus. $\dots(\text{By Definition})$

- (7) Find x if distance between points L(x , 7) and M(1, 15) is 10. (2 marks)

Solution :

L(x , 7) and M(1, 15)

By distance formula,

$$d(L, M) = \sqrt{(x - 1)^2 + (7 - 15)^2}$$

$$\therefore 10 = \sqrt{(x - 1)^2 + (-8)^2}$$

Squaring both the sides we get,

$$100 = (x - 1)^2 + 64$$

$$\therefore 100 - 64 = (x - 1)^2$$

$$\therefore (x - 1)^2 = 36$$

$$\therefore x - 1 = \pm 6 \quad \dots(\text{Taking square roots})$$

$$\therefore x - 1 = 6 \quad \text{or} \quad x - 1 = -6$$

$$\therefore x = 6 + 1 \quad \text{or} \quad x = -6 + 1$$

$$\therefore x = 7 \quad \text{or} \quad x = -5$$

$$\therefore \boxed{x = 7 \text{ or } x = -5}$$

- (8) Show that the points A(1, 2), B(1, 6) and C(1 + 2√3, 4) are the vertices of an equilateral triangle. (3 marks)

Solution :

A(1, 2), B(1, 6) and C(1 + 2√3, 4) be the vertices of triangle

Using distance formula,

$$\begin{aligned} d(A, B) &= \sqrt{(1 - 1)^2 + (2 - 6)^2} \\ &= \sqrt{0^2 + (-4)^2} \\ &= \sqrt{0 + 16} \\ &= \sqrt{16} \end{aligned}$$

$$\therefore d(A, B) = 4 \text{ units} \quad \dots(i)$$

$$\begin{aligned} d(B, C) &= \sqrt{(1 + 2\sqrt{3} - 1)^2 + (4 - 6)^2} \\ &= \sqrt{(2\sqrt{3})^2 + (-2)^2} \\ &= \sqrt{12 + 4} \end{aligned}$$

$$\therefore d(B, C) = \sqrt{16}$$

$$d(B, C) = 4 \text{ units} \quad \dots(ii)$$

$$\begin{aligned} d(A, C) &= \sqrt{(1 + 2\sqrt{3} - 1)^2 + (4 - 2)^2} \\ &= \sqrt{(2\sqrt{3})^2 + (2)^2} \\ &= \sqrt{12 + 4} \\ &= \sqrt{16} \end{aligned}$$

$$\therefore d(A, C) = 4 \text{ units} \quad \dots(iii)$$

$$\therefore AB = BC = AC \quad \dots[\text{From (i), (ii) and (iii)}]$$

$\therefore \triangle ABC$ is an equilateral triangle
 $\dots(\text{By Definition})$

Problem Set - 5 (Textbook Pg No. 123)

- (8) In the following examples, can the segment joining the given points form a triangle? If triangle is formed, state the type of the triangle considering sides of the triangle. (3 marks each)

- (i) L(6, 4), M(-5, -3), N(-6, 8)

Solution :

Let L(6, 4), M(-5, -3), N(-6, 8) be the given points

Using distance formula,

$$\begin{aligned}
 d(L, M) &= \sqrt{[6 - (-5)]^2 + [4 - (-3)]^2} \\
 &= \sqrt{(6+5)^2 + (4+3)^2} \\
 &= \sqrt{11^2 + 7^2} \\
 &= \sqrt{121 + 49}
 \end{aligned}$$

$$\therefore d(L, M) = \sqrt{170} \text{ units} \quad \dots(i)$$

$$\begin{aligned}
 d(M, N) &= \sqrt{[-6 - (-5)]^2 + [8 - (-3)]^2} \\
 &= \sqrt{(-6+5)^2 + (8+3)^2} \\
 &= \sqrt{(-1)^2 + (11)^2}
 \end{aligned}$$

$$\therefore d(M, N) = \sqrt{122} \text{ units} \quad \dots(ii)$$

$$\begin{aligned}
 d(L, N) &= \sqrt{[6 - (-6)]^2 + (4 - 8)^2} \\
 &= \sqrt{(6+6)^2 + (-4)^2} \\
 &= \sqrt{12^2 + 16^2} \\
 &= \sqrt{144 + 16}
 \end{aligned}$$

$$\therefore d(L, N) = \sqrt{160} \text{ units} \quad \dots(iii)$$

$$\therefore d(L, M) \neq d(L, N) + d(M, N)$$

$\therefore$ Points L, M and N are non-collinear points.

$\therefore$ We can construct a triangle using above points.

As none of the sides of triangle are equal, it is a scalene triangle.

(ii) P(-2, -6), Q(-4, -2), R(-5, 0)

Solution :

Let P(-2, -6), Q(-4, -2), R(-5, 0) be the given points

Using distance formula,

$$\begin{aligned}
 d(P, Q) &= \sqrt{[-4 - (-2)]^2 + [-2 - (-6)]^2} \\
 &= \sqrt{(-4+2)^2 + (-2+6)^2} \\
 &= \sqrt{(-2)^2 + (4)^2} \\
 &= \sqrt{4 + 16} \\
 &= \sqrt{20}
 \end{aligned}$$

$$\therefore d(P, Q) = 2\sqrt{5} \text{ units} \quad \dots(i)$$

$$\begin{aligned}
 d(Q, R) &= \sqrt{[-5 - (-4)]^2 + [0 - (-2)]^2} \\
 &= \sqrt{(-5+4)^2 + (0+2)^2} \\
 &= \sqrt{(-1)^2 + (2)^2} \\
 &= \sqrt{1 + 4}
 \end{aligned}$$

$$\therefore d(Q, R) = \sqrt{5} \text{ units} \quad \dots(ii)$$

$$d(P, R) = \sqrt{[-2 - (-5)]^2 + (-6 - 0)^2}$$

$$\begin{aligned}
 &= \sqrt{(-2+5)^2 + (-6)^2} \\
 &= \sqrt{(3)^2 + 36} \\
 &= \sqrt{9 + 36}
 \end{aligned}$$

$$d(P, R) = \sqrt{45} \text{ units} \quad \dots(iii)$$

$$\therefore d(P, R) \neq d(P, Q) + d(Q, R)$$

$\therefore$ Points P, Q and R are non-collinear points.

$\therefore$ We can construct a triangle using above points.

As none of the sides of triangle are equal, triangle is a scalene triangle.

(iii) A($\sqrt{2}, \sqrt{2}$), B($-\sqrt{2}, -\sqrt{2}$), C($-\sqrt{6}, \sqrt{6}$)

Solution :

Let A($\sqrt{2}, \sqrt{2}$), B($-\sqrt{2}, -\sqrt{2}$), C($-\sqrt{6}, \sqrt{6}$)

be the given points

By distance formula,

$$\begin{aligned}
 d(A, B) &= \sqrt{[\sqrt{2} - (-\sqrt{2})]^2 + [\sqrt{2} - (-\sqrt{2})]^2} \\
 &= \sqrt{[\sqrt{2} + \sqrt{2}]^2 + [\sqrt{2} + \sqrt{2}]^2} \\
 &= \sqrt{(2\sqrt{2})^2 + (2\sqrt{2})^2} \\
 &= \sqrt{8 + 8} \\
 &= \sqrt{16}
 \end{aligned}$$

$$\therefore d(A, B) = 4 \text{ units} \quad \dots(i)$$

$$\begin{aligned}
 d(B, C) &= \sqrt{[-\sqrt{2} - (-\sqrt{6})]^2 + [-\sqrt{2} - \sqrt{6}]^2} \\
 &= \sqrt{(-\sqrt{2} + \sqrt{6})^2 + (-1)^2 (\sqrt{2} + \sqrt{6})^2} \\
 &= \sqrt{2 - 2\sqrt{12} + 6 + 2 + 2\sqrt{12} + 6} \\
 &= \sqrt{16}
 \end{aligned}$$

$$\therefore d(B, C) = 4 \text{ units} \quad \dots(ii)$$

$$\begin{aligned}
 d(A, C) &= \sqrt{[\sqrt{2} - (-\sqrt{6})]^2 + (\sqrt{2} - \sqrt{6})^2} \\
 &= \sqrt{(\sqrt{2} + \sqrt{6})^2 + (\sqrt{2} - \sqrt{6})^2} \\
 &= \sqrt{2 + 2\sqrt{12} + 6 + 2 - 2\sqrt{12} + 6} \\
 &= \sqrt{16}
 \end{aligned}$$

$$d(A, C) = 4 \text{ units} \quad \dots(iii)$$

$$\therefore d(AB) \neq d(BC) + d(AC)$$

$\therefore$ Points A, B and C are non-collinear points.

$\therefore$ We can construct a triangle using above three points.

$$AB = BC = AC \quad \dots[\text{From (i), (ii) and (iii)}]$$

$\therefore \triangle ABC$ is an equilateral triangle.

Problem Set - 5.1 (Textbook Pg No. 122)

- (15) Show that A(4, -1), B(6, 0), C(7, -2) and D(5, -3) are vertices of a square. (4 marks)

Solution :

A(4, -1), B(6, 0), C(7, -2) and D(5, -3) be the vertices of a quadrilateral

Using distance formula,

$$\begin{aligned} d(A, B) &= \sqrt{(4-6)^2 + (-1-0)^2} \\ &= \sqrt{(-2)^2 + (-1)^2} \\ &= \sqrt{4+1} \end{aligned}$$

$$\therefore d(A, B) = \sqrt{5} \text{ units} \quad \dots(i)$$

$$\begin{aligned} d(B, C) &= \sqrt{(6-7)^2 + [0-(-2)]^2} \\ &= \sqrt{(-1)^2 + (2)^2} \\ &= \sqrt{1+4} \end{aligned}$$

$$\therefore d(B, C) = \sqrt{5} \text{ units} \quad \dots(ii)$$

$$\begin{aligned} d(C, D) &= \sqrt{(7-5)^2 + [-2-(-3)]^2} \\ &= \sqrt{(2)^2 + (-2+3)^2} \\ &= \sqrt{4+(1)^2} \\ &= \sqrt{4+1} \end{aligned}$$

$$\therefore d(C, D) = \sqrt{5} \text{ units} \quad \dots(iii)$$

$$\begin{aligned} d(A, D) &= \sqrt{(4-5)^2 + [-1-(-3)]^2} \\ &= \sqrt{(-1)^2 + (-1+3)^2} \\ &= \sqrt{1+(2)^2} \\ &= \sqrt{1+4} \end{aligned}$$

$$\therefore d(A, D) = \sqrt{5} \text{ units} \quad \dots(iv)$$

In $\square ABCD$,

$$AB = BC = CD = AD \dots [\text{From (i), (ii), (iii) and (iv)}]$$

$$\therefore \square ABCD \text{ is a rhombus} \quad \dots(v) \text{ [Definition]}$$

Now, we shall find length of each diagonal.

Using distance formula,

$$\begin{aligned} d(A, C) &= \sqrt{(4-7)^2 + [-1-(-2)]^2} \\ &= \sqrt{(-3)^2 + (-1+2)^2} \\ &= \sqrt{9+1} \\ &= \sqrt{10} \end{aligned}$$

$$\therefore d(A, C) = \sqrt{10} \text{ units} \quad \dots(vi)$$

$$d(B, D) = \sqrt{(6-5)^2 + [0-(-3)]^2}$$

$$\begin{aligned} &= \sqrt{(1)^2 + (0+3)^2} \\ &= \sqrt{1+9} \\ &= \sqrt{10} \end{aligned}$$

$$\therefore d(B, D) = \sqrt{10} \text{ units} \quad \dots(vii)$$

In rhombus ABCD,

diagonal AC $\cong$ diagonal BD

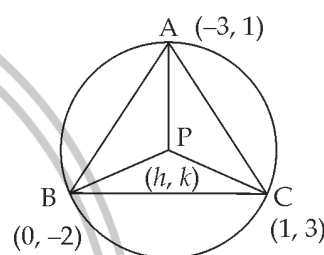
...[From (v), (vi) and (vii)]

$$\therefore \square ABCD \text{ is a square}$$

...(A rhombus is a square if its diagonals are congruent)

- (7) Find the coordinates of circumcentre of a triangle whose vertices are (-3, 1), (0, -2) and (1, 3) (4 marks)

Solution :



Let A(-3, 1), B(0, -2) and C(1, 3)

and circum centre be p (h, k) be the

vertices of a triangle

$$\therefore PA = PB = PC \quad \dots(i) \quad (\text{Radii of same circle})$$

$$PA = PB$$

...[From (i)]

Using distance formula,

$$\begin{aligned} \sqrt{[h-(-3)]^2 + (k-1)^2} &= \sqrt{(h-0)^2 [k-(-2)]^2} \\ \therefore \sqrt{(h+3)^2 + (k-1)^2} &= \sqrt{h^2 + (k+2)^2} \end{aligned}$$

Squaring both the sides we get,

$$\begin{aligned} (h+3)^2 + (k-1)^2 &= h^2 + (k+2)^2 \\ \therefore h^2 + 6h + 9 + k^2 - 2k + 1 &= h^2 + k^2 + 4k + 4 \end{aligned}$$

$$\therefore 6h - 2k = 4 - 9 - 1$$

$$\therefore 6h - 6k = -6$$

$$\therefore h - k = -1 \quad \dots(ii)$$

...(Dividing both sides by 6)

$$PB = PC$$

...[From (i)]

Using distance formula,

$$\begin{aligned} \sqrt{(h-0)^2 + [k-(-2)]^2} &= \sqrt{(h-1)^2 + (k-3)^2} \\ \therefore \sqrt{h^2 + (k+2)^2} &= \sqrt{(h-1)^2 + (k-3)^2} \end{aligned}$$

Squaring both the sides we get,

$$\begin{aligned} \therefore h^2 + (k+2)^2 &= (h-1)^2 + (k-3)^2 \\ \therefore h^2 + k^2 + 4k + 4 &= h^2 - 2h + 1 + k^2 - 6k + 9 \\ \therefore h^2 + k^2 + 4k - h^2 + 2h - k^2 + 6k &= 10 - 4 \\ \therefore 2h + 10k &= 6 \end{aligned}$$

$$\therefore h + 5k = 3 \quad \dots(iii)$$

(Dividing both sides by 2)

Subtracting (ii) from (iii),

$$h + 5k = 3$$

$$h - k = -1$$

$$\begin{array}{r} (-) \quad (+) \quad (+) \\ \hline \end{array}$$

$$6k = 4$$

$$\therefore k = \frac{4}{6}$$

$$\therefore k = \frac{2}{3}$$

Substituting $k = \frac{2}{3}$ in equation (i)

$$h - \frac{2}{3} = -1$$

$$\therefore h = -1 + \frac{2}{3}$$

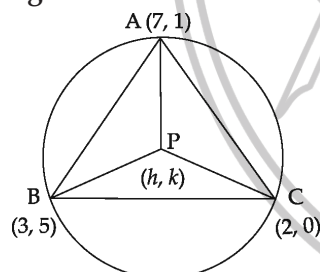
$$\therefore h = \frac{-3+2}{3}$$

$$\therefore h = \frac{-1}{3}$$

$$\therefore P\left(\frac{-1}{3}, \frac{2}{3}\right) \text{ is the circumcentre of } \triangle ABC$$

- (16) Find the co-ordinates of circumcentre and radius of a circumcircle of $\triangle ABC$, if $A(7, 1)$, $B(3, 5)$ and $C(2, 0)$ are given. (4 marks)

Solution :



Let $P(h, k)$ be the circumcentre of $\triangle ABC$.

$$PA = PB = PC \quad \dots(i) \quad (\text{Radii of same circle})$$

$$\therefore PA = PB \quad \dots[\text{From (i)}]$$

Using distance formula,

$$\sqrt{(h-7)^2 + (k-1)^2} = \sqrt{(h-3)^2 + (k-5)^2}$$

Squaring both the sides we get,

$$\therefore (h-7)^2 + (k-1)^2 = (h-3)^2 + (k-5)^2$$

$$\therefore h^2 - 14h + 49 + k^2 - 2k + 1 = h^2 - 6h + 9 + k^2 - 10k + 25$$

$$\therefore h^2 - 14h + k^2 - 2k - h^2 + 6h - k^2 + 10k = 25 + 9 - 49 - 1$$

$$\therefore -8h + 8k = -16$$

$$\therefore h - k = 2 \quad \dots(ii)$$

...(Dividing throughout by -8)

$$PB = PC \quad \dots[\text{From (i)}]$$

Using distance formula,

$$\sqrt{(h-3)^2 + (k-5)^2} = \sqrt{(h-2)^2 + (k-0)^2}$$

Squaring both the sides we get,

$$(h-3)^2 + (k-5)^2 = (h-2)^2 + (k)^2$$

$$\therefore h^2 - 6h + 9 + k^2 - 10k + 25 = h^2 - 4h + 4 + k^2$$

$$\therefore h^2 - 6h + k^2 - 10k - h^2 + 4h - k^2 = 4 - 9 - 25$$

$$\therefore -2h - 10k = -30$$

$$\therefore h + 5k = 15 \quad \dots(iii)$$

(dividing both sides by -2)

Subtracting (iii) from (ii),

$$h - k = 2$$

$$h + 5k = 15$$

$$\begin{array}{r} (-) \quad (-) \quad (-) \\ \hline \end{array}$$

$$-6k = -13$$

$$\therefore k = \frac{-13}{-6}$$

$$\therefore k = \frac{13}{6}$$

Substituting $k = \frac{13}{6}$ in (ii),

$$h - k = 2$$

$$\therefore h - \frac{13}{6} = 2$$

$$\therefore h = 2 + \frac{13}{6}$$

$$\therefore h = \frac{25}{6}$$

$$\therefore P\left(\frac{25}{6}, \frac{13}{6}\right) \text{ are the co-ordinates of circumcentre.}$$

Using distance formula,

$$\text{Radius} = d(P, A) = \sqrt{\left(7 - \frac{25}{6}\right)^2 + \left(1 - \frac{13}{6}\right)^2}$$

$$= \sqrt{\left(\frac{42-25}{6}\right)^2 + \left(\frac{6-13}{6}\right)^2}$$

$$= \sqrt{\left(\frac{17}{6}\right)^2 + \left(\frac{-7}{6}\right)^2}$$

$$= \sqrt{\frac{289}{36} + \frac{49}{36}}$$

$$= \sqrt{\frac{338}{36}}$$

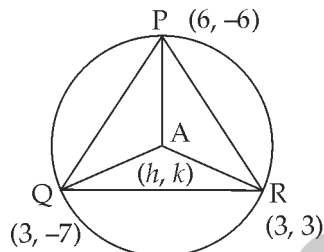
$$= \sqrt{\frac{169 \times 2}{36}}$$

$$= \frac{13}{6} \sqrt{2}$$

$$\therefore \text{Radius of circumcircle} = \frac{13}{6}\sqrt{2} \text{ units}$$

- (20) Find the co-ordinates of the centre of the circle passing through the point. P(6, -6), Q(3, -7) and R(3, 3) (4 marks)

Solution :



Let A(h, k) be the centre of the circle.

$$PA = QA = RA \quad \dots(i) \quad (\text{Radii of same circle})$$

$$\text{i.e. } PA = QA \quad \dots[\text{From (i)}]$$

Using distance formula,

$$\sqrt{(h-6)^2 + [k-(-6)]^2} = \sqrt{(h-3)^2 + [k-(-7)]^2}$$

$$\therefore \sqrt{(h-6)^2 + (k+6)^2} = \sqrt{(h-3)^2 + (k+7)^2}$$

Squaring both the sides,

$$h^2 - 12h + 36 + k^2 + 12k + 36 = h^2 - 6h + 9 + k^2 + 14k + 49$$

$$\therefore h^2 - 12h + k^2 + 12k - h^2 + 6h - k^2 - 14k = 9 + 49 - 36 - 36$$

$$\therefore -6h - 2k = -14$$

$$\therefore 3h + k = 7 \quad \dots(ii)$$

...(Dividing both sides by -2)

$$QA = RA \quad \dots[\text{From (i)}]$$

Using distance formula,

$$\therefore \sqrt{(h-3)^2 + [k-(-7)]^2} = \sqrt{(h-3)^2 + (k-3)^2}$$

$$\therefore \sqrt{(h-3)^2 + (k+7)^2} = \sqrt{(h-3)^2 + (k-3)^2}$$

Squaring both the sides,

$$(h-3)^2 + (k+7)^2 = (h-3)^2 + (k-3)^2$$

$$k^2 + 14k + 49 = k^2 - 6k + 9$$

$$\therefore k^2 + 14k - k^2 + 6k = 9 - 49$$

$$\therefore 20k = -40$$

$$\therefore k = \frac{-40}{20}$$

$$\therefore k = -2$$

Substituting $k = -2$ in equation $\dots(ii)$

$$3h - 2 = 7$$

$$\therefore 3h = 7 + 2$$

$$\therefore h = \frac{9}{3}$$

$$\therefore h = 3$$

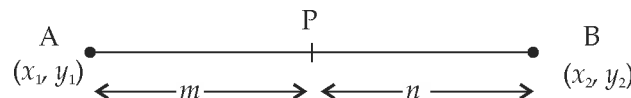
$$\therefore \text{A(3, -2) is the centre of the circle}$$



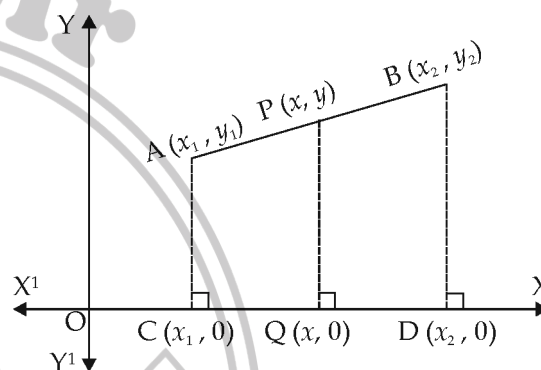
Points to Remember:

Section formula for division of a line segment :

If P(x, y) divides segment joining A(x₁, y₁) and B(x₂, y₂) in the ratio m : n, then



$$x = \frac{mx_2 + nx_1}{m+n}; \quad y = \frac{my_2 + ny_1}{m+n}$$



In the above figure, in XY plane point P on the seg AB, divides seg AB in the ratio m : n.

Let A(x₁, y₁), B(x₂, y₂) and P(x, y)

seg AC, seg PQ and seg BD are perpendicular to X-axis

$\therefore$ Let C(x₁, 0), Q(x, 0) and D(x₂, 0).

$$\therefore \begin{cases} CQ = x - x_1 \\ \text{and } QD = x_2 - x \end{cases} \quad \dots(i)$$

seg AC || seg PQ || seg BD.

$\therefore$ By the property of intercepts of three parallel

$$\text{lines, } \frac{AP}{PB} = \frac{CQ}{QD} = \frac{m}{n}$$

From the figure CQ = x - x₁ and QD = x₂ - x $\dots[\text{From (i)}]$

$$\therefore \frac{x - x_1}{x_2 - x} = \frac{m}{n}$$

$$\therefore n(x - x_1) = m(x_2 - x)$$

$$\therefore nx - nx_1 = mx_2 - mx$$

$$\therefore mx + nx = mx_2 + nx_1$$

$$\therefore x(m + n) = mx_2 + nx_1$$

$$\therefore x = \frac{mx_2 + nx_1}{m+n}$$

Similarly drawing perpendiculars from points A,

P and B to Y-axis, we get $y = \frac{my_2 + ny_1}{m+n}$

$\therefore$ The co-ordinates of point, which divides the line

segment joining the points $A(x_1, y_1)$ and $B(x_2, y_2)$

in the ratio $m : n$ are given by $\left(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n}\right)$

Practice Set - 5.2 (Textbook Page No.)

- (1) Find the co-ordinates of point P if P divides the line segment joining the points $A(-1, 7)$ and $B(4, -3)$ in the ratio $2 : 3$. (2 marks)

Solution :

$P(x, y)$ divides seg AB in the ratio $2 : 3$.

$$A(-1, 7) = (x_1, y_1)$$

$$B(4, -3) = (x_2, y_2)$$

$$m : n = 2 : 3$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n}; \quad \text{and} \quad y = \frac{my_2 + ny_1}{m+n}$$

$$= \frac{2 \times 4 + 3 \times (-1)}{2+3} \quad \text{and} \quad = \frac{2 \times (-3) + 3 \times (7)}{2+3}$$

$$= \frac{8-3}{5} \quad \text{and} \quad = \frac{-6+21}{5}$$

$$= \frac{5}{5} \quad \text{and} \quad = \frac{15}{5}$$

$$x = 1 \quad \text{and} \quad y = 3$$

$\therefore$ The coordinates of point P are $(1, 3)$.

- (2) In each of the following examples find the co-ordinates of point A which divides segment PQ in the ratio $a : b$. (2 marks each)

- (i) $P(-3, 7), Q(1, -4), a : b = 2 : 1$

Solution :

$A(x, y)$ divides seg PQ in the ratio $2 : 1$.

$$P(-3, 7) = (x_1, y_1)$$

$$Q(1, -4) = (x_2, y_2)$$

$$a : b = 2 : 1 = m : n$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n}; \quad \text{and} \quad y = \frac{my_2 + ny_1}{m+n}$$

$$= \frac{2 \times 1 + 1 \times (-3)}{2+1} \quad \text{and} \quad = \frac{2 \times (-4) + 1 \times (7)}{2+1}$$

$$= \frac{2-3}{3} \quad \text{and} \quad = \frac{-8+7}{3}$$

$$x = \frac{-1}{3} \quad \text{and} \quad y = \frac{-1}{3}$$

$\therefore A \equiv \left(-\frac{1}{3}, -\frac{1}{3}\right)$

- (ii) $P(-2, -5), Q(4, 3), a : b = 3 : 4$

Solution :

$A(x, y)$ divides seg PQ in the ratio $3 : 4$.

$$P(-2, -5) = (x_1, y_1)$$

$$Q(4, 3) = (x_2, y_2)$$

$$a : b = 3 : 4 = m : n$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n}; \quad \text{and} \quad y = \frac{my_2 + ny_1}{m+n}$$

$$= \frac{3 \times 4 + 4 \times (-2)}{3+4} \quad \text{and} \quad = \frac{3 \times 3 + 4 \times (-5)}{3+4}$$

$$= \frac{12-8}{7} \quad \text{and} \quad = \frac{9-20}{7}$$

$$x = \frac{4}{7} \quad \text{and} \quad y = \frac{-11}{7}$$

$$\therefore A\left(\frac{4}{7}, \frac{-11}{7}\right)$$

- (iii) $P(2, 6), Q(-4, 1), a : b = 1 : 2$

Solution :

$A(x, y)$ divides seg PQ in the ratio $1 : 2$.

$$P(2, 6) = (x_1, y_1)$$

$$Q(-4, 1) = (x_2, y_2)$$

$$a : b = 1 : 2 = m : n$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n}; \quad \text{and} \quad y = \frac{my_2 + ny_1}{m+n}$$

$$= \frac{1 \times (-4) + 2 \times 2}{1+2} \quad \text{and} \quad = \frac{1 \times 1 + 2 \times 6}{1+2}$$

$$= \frac{-4+4}{3} \quad \text{and} \quad = \frac{1+12}{3}$$

$$x = \frac{0}{3} \quad \text{and} \quad y = \frac{13}{3}$$

$$\therefore x = \left(0, \frac{13}{3}\right)$$

- (3) Find the ratio in which point $T(-1, 6)$ divides the line segment joining the points $P(-3, 10)$ and $Q(6, -8)$. (2 marks)

Solution :

Let point T divides seg PQ in the ratio $m : n$.

$$T(-1, 6) = (x, y)$$

$$P(-3, 10) = (x_1, y_1)$$

$$Q(6, -8) = (x_2, y_2)$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n};$$

$$-1 = \frac{m \times 6 + n(-3)}{m+n}$$

$$\therefore -1(m+n) = 6m - 3n$$

$$\therefore -m - n = 6m - 3n$$

$$\therefore -m - 6m = -3n + n$$

$$\therefore -7m = -2n$$

$$\therefore 7m = 2n$$

$$\therefore \frac{m}{n} = \frac{2}{7}$$

$$\text{i.e. } m : n = 2 : 7$$

$\therefore$ Point T divides seg PQ in the ratio 2 : 7.

- (5) Find the ratio in which point P(k, 7) divides the segment joining A(8, 9) and B(1, 2). Also find k. (3 marks)

Solution :

$$A(8, 9) = (x_1, y_1)$$

$$B(1, 2) = (x_2, y_2)$$

$$P(k, 7) = (x, y)$$

Let point P divide seg AB in the ratio $m : n$.

By Section formula,

$$y = \frac{my_2 + ny_1}{m+n}$$

$$7 = \frac{m \times 2 + n \times 9}{m+n}$$

$$\therefore 7(m+n) = 2m + 9n$$

$$\therefore 7m + 7n = 2m + 9n$$

$$\therefore 7m - 2m = 9n - 7n$$

$$\therefore 5m = 2n$$

$$\therefore \frac{m}{n} = \frac{2}{5}$$

$$\therefore m : n = 2 : 5$$

$$x = \frac{mx_2 + nx_1}{m+n}$$

$$\therefore k = \frac{2 \times 1 + 5 \times 8}{2+5}$$

$$\therefore k = \frac{2+40}{7}$$

$$\therefore k = \frac{42}{7}$$

$$\therefore k = 6$$

Problem Set - 5 (Textbook Pg No. 122)

- (4) Find the ratio in which the line segment joining the points A(3, 8) and B(-9, 3) is divided by the Y-axis. (2 marks)

Solution :

$$A(3, 8) = (x_1, y_1)$$

$$B(-9, 3) = (x_2, y_2)$$

Let point P(0, a) be a point on Y-axis

which divides seg AB in the ratio $m : n$.

$$P(0, a) = (x, y)$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n}$$

$$0 = \frac{m \times (-9) + n(3)}{m+n}$$

$$\therefore 0 \times (m+n) = -9m + 3n$$

$$\therefore 0 = -9 + 3n$$

$$\therefore 9m = 3n$$

$$\therefore \frac{m}{n} = \frac{3}{9}$$

$$\therefore \frac{m}{n} = \frac{1}{3}$$

$$\therefore m : n = 1 : 3$$

$\therefore$ Y-axis divides segment joining points A and B in the ratios 1 : 3

- (17) Given A(4, -3), B(8, 5). Find the co-ordinates of the point that divides segment AB in the ratio 3 : 1. (2 marks)

Solution :

Let P(x, y) be the point which divides seg AB in the ratio 3 : 1.

$$A(4, -3) = (x_1, y_1)$$

$$B(8, 5) = (x_2, y_2)$$

$$P(x, y)$$

$$m : n = 3 : 1$$

By Section formula,

$$x = \frac{mx_2 + nx_1}{m+n}; \quad \text{and} \quad y = \frac{my_2 + ny_1}{m+n}$$

$$= \frac{3 \times 8 + 1 \times 4}{3+1} \quad \text{and} \quad = \frac{3 \times 5 + 1 \times (-3)}{3+1}$$

$$= \frac{24+4}{4} \quad \text{and} \quad = \frac{15-3}{4}$$

$$= \frac{28}{4} \quad \text{and} \quad = \frac{12}{4}$$

$$x = 7 \quad \text{and} \quad y = 3$$

$$\therefore P(7, 3) \text{ divides seg AB in the ratio } 3 : 1$$



Points to Remember:

(Mid-point formula)

If $M(x, y)$ is the midpoint of segment joining $A(x_1, y_1)$ and $B(x_2, y_2)$, then

$$x = \frac{x_1 + x_2}{2} \text{ and } y = \frac{y_1 + y_2}{2}$$

If point P is the midpoint of segment AB and $P(x, y)$, $A(x_1, y_1)$, $B(x_2, y_2)$ then $m = n$ and values of x and y can be written as

$$\begin{aligned} x &= \frac{mx_2 + nx_1}{m+n} & y &= \frac{my_2 + ny_1}{m+n} \\ &= \frac{mx_2 + mx_1}{m+m} (\because m=n) & &= \frac{my_2 + my_1}{m+m} (\because m=n) \\ &= \frac{m(x_2 + x_1)}{2m} & &= \frac{m(y_2 + y_1)}{2m} \\ &= \frac{x_1 + x_2}{2} & &= \frac{y_1 + y_2}{2} \end{aligned}$$

$\therefore$ Co-ordinates of midpoint P are $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

This is called as midpoint formula.

In the previous standard we have shown that $\frac{a+b}{2}$ is the midpoint of two rational numbers a and b which are on the number line. That conclusion is the special case of the above midpoint formula.

Practice Set - 5.2 (Textbook Page No. 115)

- (6) Find the coordinates of the midpoint of the segment joining the points $(22, 20)$ and $(0, 16)$ (2 marks)

Solution :

Let $A(22, 20) = (x_1, y_1)$ and

$B(0, 16) = (x_2, y_2)$

Let $M(x, y)$ be the midpoint of seg AB .

By midpoint formula,

$$x = \frac{x_1 + x_2}{2} \text{ and } y = \frac{y_1 + y_2}{2}$$

$$x = \frac{22 + 0}{2} \text{ and } y = \frac{20 + 16}{2}$$

$$\begin{aligned} x &= \frac{22}{2} & \text{and} & & y &= \frac{36}{2} \\ x &= 11 & \text{and} & & y &= 18 \end{aligned}$$

$$\therefore \text{M}(11, 18)$$

- (4) Point P is the centre of the circle and AB is a diameter. Find the co-ordinates of point B if co-ordinates of point A and P are $(2, -3)$ and $(-2, 0)$ respectively. (2 marks)

Solution :

$$P(-2, 0) = (x, y)$$

$$A(2, -3) = (x_1, y_1)$$

$$B(x_2, y_2)$$

P is the centre of the circle ... (Given)

Point P is the midpoint of diameter AB .

By midpoint formula,

$$x = \frac{x_1 + x_2}{2} \text{ and } y = \frac{y_1 + y_2}{2}$$

$$-2 = \frac{2 + x_2}{2} \text{ and } 0 = \frac{-3 + y_2}{2}$$

$$\therefore -2 \times 2 = 2 + x_2 \text{ and } 0 \times 2 = -3 + y_2$$

$$\therefore -4 - 2 = x_2 \text{ and } 0 + 3 = y_2$$

$$\therefore x_2 = -6 \text{ and } y_2 = 3$$

$$\therefore \text{B}(-6, 3)$$

Problem Set - 5 (Textbook Pg No. 122)

- (3) Find the coordinates of the midpoint of the line segment joining $P(0, 6)$ and $Q(12, 20)$ (2 marks)

Solution :

$$P(0, 6) = (x_1, y_1) \text{ and}$$

$$Q(12, 20) = (x_2, y_2)$$

Let $M(x, y)$ be the midpoint of seg PQ .

By midpoint formula,

$$x = \frac{x_1 + x_2}{2} \text{ and } y = \frac{y_1 + y_2}{2}$$

$$x = \frac{0 + 12}{2} \text{ and } y = \frac{6 + 20}{2}$$

$$x = \frac{12}{2} \text{ and } y = \frac{26}{2}$$

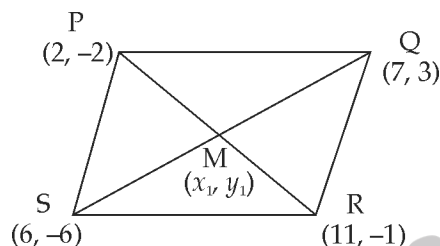
$$x = 6 \text{ and } y = 13$$

$\therefore$ **M(6, 13) is the midpoint of segment joining $P(0, 6)$ and $Q(12, 20)$**

Practice Set - 5.1 (Textbook Page No. 108)

- (5) P(2, -2) Q(7, 3), R(11, -1) and S(6, -6) are the vertices of a parallelogram. (4 marks)

Solution :



Let M (x_1, y_1) be the midpoint of diagonal PR.

By midpoint formula,

$$x_1 = \frac{2+11}{2} ; \quad y_1 = \frac{-2-1}{2}$$

$$x_1 = \frac{13}{2} ; \quad y_1 = \frac{-3}{2}$$

M $\left(\frac{13}{2}, \frac{-3}{2}\right)$ is the midpoint of diagonal PR ... (i)

Let N (x_2, y_2) be the midpoint of diagonal QS.

By midpoint formula,

$$x_2 = \frac{7+6}{2} ; \quad y_2 = \frac{3+(-6)}{2}$$

$$x_2 = \frac{13}{2} ; \quad y_2 = \frac{-3}{2}$$

N $\left(\frac{13}{2}, \frac{-3}{2}\right)$ is the midpoint of diagonal QS ... (ii)
[From (i) and (ii)]

Midpoint of diagonal PR and diagonal QS is the same.

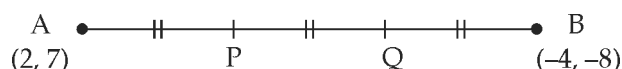
i.e. Diagonals PR and QS bisect each other.

- ∴ □ PQRS is a parallelogram ... (A quadrilateral is a parallelogram if its diagonals bisect each other.)

Practice Set - 5.2 (Textbook Page No. 116)

- (10) Find the coordinates of points of trisection of the line segment AB with A(2, 7) and B(-4, -8) (4 marks)

Solution :



Let point P and Q be two points which divide seg AB in three equal parts.

Point P divides seg AB in the ratio 1 : 2

By Section formula,

$$P \left(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n} \right)$$

$$P \left(\frac{1 \times (-4) + 2 \times 2}{1+2}, \frac{1 \times (-8) + 2 \times 7}{1+2} \right)$$

$$\therefore P \left(\frac{-4+4}{3}, \frac{-8+14}{3} \right)$$

$$\therefore P \left(\frac{0}{3}, \frac{6}{3} \right)$$

$$\therefore P(0, 2)$$

Also, PQ = QB

∴ Point Q is midpoint of seg PB.

By midpoint formula,

$$\therefore Q \left(\frac{0+(-4)}{2}, \frac{2+(-8)}{2} \right)$$

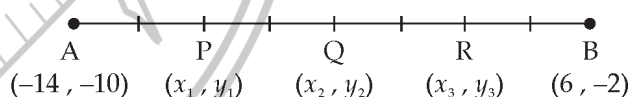
$$\therefore Q \left(\frac{-4}{2}, \frac{-6}{2} \right)$$

$$\therefore Q(-2, -3)$$

∴ **P(0, 2) and Q(-2, -3) are points which trisect seg AB**

- (11) If A (-14, -10), B(6, -2) is given, find the coordinates of the points which divide segment AB into four equal parts. (4 marks)

Solution :



Let point P(x_1, y_1), Q (x_2, y_2) and R(x_3, y_3) be the three points which divides seg AB in four equal parts.

Point Q is the midpoint of seg AB.

By midpoint formula,

$$x_2 = \frac{-14+6}{2} \quad \text{and} \quad y_2 = \frac{-10+(-2)}{2}$$

$$x_2 = \frac{-8}{2} \quad \text{and} \quad y_2 = \frac{-12}{2}$$

$$x_2 = -4 \quad \text{and} \quad y_2 = -6$$

$$\therefore Q(-4, -6)$$

$$AP = PQ$$

...[From (i)]

∴ P is the midpoint of seg AQ.

By midpoint formula,

$$x_1 = \frac{-14+(-4)}{2} \quad \text{and} \quad y_1 = \frac{-10+(-6)}{2}$$

$$x_1 = \frac{-18}{2} \quad \text{and} \quad y_1 = \frac{-16}{2}$$

$$x_1 = -9 \quad \text{and} \quad y_1 = -8$$

$$\therefore P(-9, -8)$$

$$\therefore QR = BR \quad \dots[\text{From (i)}]$$

R is the midpoint of seg BQ.

By midpoint formula,

$$x_3 = \frac{-4+6}{2} \quad \text{and} \quad y_3 = \frac{-6+(-2)}{2}$$

$$\therefore x_3 = \frac{2}{2} \quad \text{and} \quad y_3 = \frac{-8}{2}$$

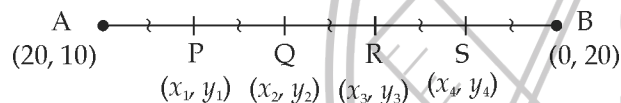
$$x_3 = 1 \quad \text{and} \quad y_3 = -4$$

$$\therefore R(1, -4)$$

P(-9, -8), Q(-4, -6) and R(1, -4) divides seg AB in four equal parts.

- (12)** If A(20, 10), B(0, 20) are given, find the coordinates of the points which divide segment AB into five congruent parts. (4 marks)

Solution :



Let point P(x_1, y_1), Q(x_2, y_2), R(x_3, y_3) and S(x_4, y_4) be four points which divide seg AB into five congruent parts.

Point P divides seg AB in the ratio 1 : 4.

By section formula,

$$x_1 = \frac{1 \times 0 + 4 \times 20}{1+4} \quad \text{and} \quad y_1 = \frac{1 \times 20 + 4 \times 10}{1+4}$$

$$\therefore x_1 = \frac{80}{5} \quad \text{and} \quad y_1 = \frac{20+40}{5} = \frac{60}{5}$$

$$\therefore x_1 = 16 \quad \text{and} \quad y_1 = 12$$

$$\therefore P(16, 12)$$

$$AP = PQ \quad \dots[\text{From (i)}]$$

$\therefore$ P is the midpoint of seg AQ.

By midpoint formula,

$$16 = \frac{20+x_2}{2} \quad \text{and} \quad 12 = \frac{10+y_2}{2}$$

$$\therefore 16 \times 2 = 20 + x_2 \quad \text{and} \quad 12 \times 2 = 10 + y_2$$

$$\therefore 32 - 20 = x_2 \quad \text{and} \quad 24 - 10 = y_2$$

$$\therefore x_2 = 12 \quad \text{and} \quad y_2 = 14$$

$$\therefore Q(12, 14)$$

$$PQ = QR \quad \dots[\text{From (i)}]$$

$\therefore$ Q is the midpoint of seg PR.

By midpoint formula,

$$12 = \frac{16+x_3}{2} \quad \text{and} \quad 14 = \frac{12+y_3}{2}$$

$$\therefore 24 = 16 + x_3 \quad \text{and} \quad 28 = 12 + y_3$$

$$\therefore x_3 = 24 - 16 \quad \text{and} \quad y_3 = 28 - 12$$

$$\therefore x_3 = 8 \quad \text{and} \quad y_3 = 16$$

$$\therefore R(8, 16)$$

$$RS = BS$$

$\dots[\text{From (i)}]$

$\therefore$ S is the midpoint of seg RB.

By midpoint formula,

$$x_4 = \frac{0+8}{2} \quad \text{and} \quad y_4 = \frac{16+20}{2}$$

$$x_4 = \frac{8}{2} \quad \text{and} \quad y_4 = \frac{36}{2}$$

$$\therefore x_4 = 4 \quad \text{and} \quad y_4 = 18$$

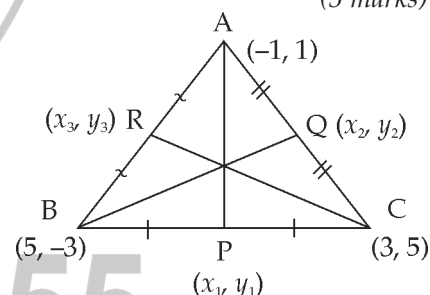
$$\therefore S(4, 18)$$

P(16, 12), Q(12, 14), R(8, 16) and S(4, 18) divides seg AB in five equal parts.

Problem Set - 5 (Textbook Pg No. 123)

- (13)** Find the lengths of the medians of a triangle whose vertices are A(-1, 1), B(5, -3) and C(3, 5). (5 marks)

Solution :



Let A(-1, 1), B(5, -3) and C(3, 5) be the vertices of triangle.

Let points P, Q and R be the midpoint of side BC, side AC and side AB respectively.

P is the midpoint of seg BC

$\therefore$ By midpoint formula,

$$x_1 = \frac{5+3}{2} \quad \text{and} \quad y_1 = \frac{-3+5}{2}$$

$$\therefore x_1 = \frac{8}{2} \quad \text{and} \quad y_1 = \frac{2}{2}$$

$$\therefore x_1 = 4 \quad \text{and} \quad y_1 = 1$$

$$\therefore P(4, 1)$$

Q is the midpoint of seg AC.

∴ By midpoint formula,

$$x_2 = \frac{-1+3}{2} \quad \text{and} \quad y_2 = \frac{1+5}{2}$$

$$x_2 = \frac{2}{2} \quad \text{and} \quad y_2 = \frac{6}{2}$$

$$x_2 = 1 \quad \text{and} \quad y_2 = 3$$

∴ Q(1, 3)

R is the midpoint of seg AB.

∴ By midpoint formula,

$$x_3 = \frac{-1+5}{2} \quad \text{and} \quad y_3 = \frac{1-3}{2}$$

$$x_3 = \frac{4}{2} \quad \text{and} \quad y_3 = \frac{-2}{2}$$

$$x_3 = 2 \quad \text{and} \quad y_3 = -1$$

∴ R(2, -1)

A(-1, 1), P(4, 1)

Using distance formula,

$$\begin{aligned} d(A, P) &= \sqrt{(4-(-1))^2 + (1-1)^2} \\ &= \sqrt{(4+1)^2 + 0^2} \\ &= \sqrt{5^2} \end{aligned}$$

∴ d(A, P) = 5 units

∴ d(AP) = 5 units

B(5, -3), Q(1, 3)

Using distance formula,

$$\begin{aligned} d(B, Q) &= \sqrt{(5-1)^2 + (-3-3)^2} \\ &= \sqrt{4^2 + (-6)^2} \\ &= \sqrt{16+36} \\ &= \sqrt{52} \\ &= \sqrt{13 \times 4} \end{aligned}$$

∴ d(B, Q) = $2\sqrt{13}$ units

C(3, 5), R(2, -1)

Using distance formula,

$$\begin{aligned} \therefore d(C, R) &= \sqrt{(3-2)^2 + [5-(-1)]^2} \\ &= \sqrt{(1)^2 + (6)^2} \\ &= \sqrt{1+36} \\ &= \sqrt{37} \end{aligned}$$

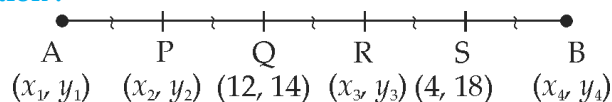
∴ d(C, R) = $\sqrt{37}$ units

∴ d(CR) = $\sqrt{37}$ units

∴ **Length of three medians are 5 units, $2\sqrt{13}$ units, $\sqrt{37}$ units.**

*** (19) The line segment AB is divided into five congruent parts at P, Q, R and S such that A-P-Q-R-S-B. If point (12, 14) and S(4, 18) are given find the co-ordinates of A, P, R and B. (5 marks)**

Solution :



Points P, Q, R and S divides seg AB into five equal parts.

$$\therefore AP = PQ = QR = RS = SB \quad \dots(i)$$

Let A(x_1, y_1), P(x_2, y_2), R(x_3, y_3) and B(x_4, y_4)

$$QR = RS \quad \dots[\text{From (i)}]$$

∴ Point R is the midpoint of seg QS.

∴ By midpoint formula,

$$x_3 = \frac{12+4}{2} \quad \text{and} \quad y_3 = \frac{14+18}{2}$$

$$\therefore x_3 = \frac{16}{2} \quad \text{and} \quad y_3 = \frac{32}{2}$$

$$\therefore x_3 = 8 \quad \text{and} \quad y_3 = 16$$

∴ R(8, 16)

$$RS = SB \quad \dots[\text{From (i)}]$$

Point S is the midpoint of seg RB.

∴ By midpoint formula,

$$4 = \frac{8+x_4}{2} \quad \text{and} \quad 18 = \frac{16+y_4}{2}$$

$$\therefore 8 = 8+x_4 \quad \text{and} \quad 36 = 16+y_4$$

$$\therefore x_4 = 8-8 \quad \text{and} \quad 36-16 = y_4$$

$$\therefore x_4 = 0 \quad \text{and} \quad y_4 = 20$$

∴ B(0, 20)

$$PQ = QR \quad \dots[\text{From (i)}]$$

∴ Q is the midpoint of seg PR

∴ By midpoint formula,

$$12 = \frac{x_2+8}{2} \quad \text{and} \quad 14 = \frac{y_2+16}{2}$$

$$\therefore 12 \times 2 = x_2 + 8 \quad \text{and} \quad 14 \times 2 = y_2 + 16$$

$$\therefore 24 - 8 = x_2 \quad \text{and} \quad 28 - 16 = y_2$$

$$\therefore x_2 = 16 \quad \text{and} \quad y_2 = 12$$

∴ P(16, 12)

$$AP = PQ \quad \dots[\text{From (i)}]$$

∴ P is the midpoint of seg AQ

∴ By midpoint formula,

$$16 = \frac{x_1+12}{2} \quad \text{and} \quad 12 = \frac{y_1+14}{2}$$

$$\therefore 32 = x_1 + 12 \quad \text{and} \quad 24 = y_1 + 14$$

$$\therefore 32 - 12 = x_1 \quad \text{and} \quad 24 - 14 = y_1$$

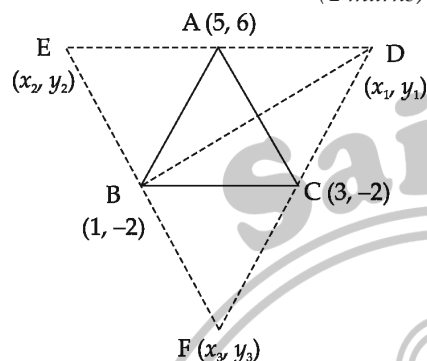
$$\therefore x_1 = 20 \text{ and } y_1 = 10$$

$$\therefore A(20, 10)$$

$$\therefore \boxed{A(20, 10), P(16, 12), R(8, 16) \text{ and } B(0, 20)}$$

- * (21) Find the possible pairs of co-ordinates of the fourth vertex D of the parallelogram, if three of its vertices are A(5, 6), B(1, -2) and C(3, -2).**

(4 marks)

Solution :


Let A (5, 6), B(1, -2) and C(3, -2) be the three vertices of a parallelogram.

Fourth vertex can be point D or point E or point F as shown in the above figure.

For parallelogram ABCD, let D (x_1, y_1) be the fourth vertex. Diagonals of a parallelogram bisect each other.

- $\therefore$ Diagonal AC and diagonal BD have the same midpoint.

Using midpoint formula,

$$\left(\frac{5+3}{2}, \frac{6+(-2)}{2} \right) = \left(\frac{1+x_1}{2}, \frac{-2+y_1}{2} \right)$$

$$\frac{8}{2} = \frac{1+x_1}{2} \quad \text{and} \quad \frac{6-2}{2} = \frac{-2+y_1}{2}$$

$$\therefore x_1 = 8 - 1 \quad \text{and} \quad 4 = -2 + y_1$$

$$\therefore x_1 = 7 \quad \text{and} \quad y_1 = 6$$

$$\therefore \boxed{D(7, 6)}$$

For parallelogram ACBE, let E(x_2, y_2) be the fourth vertex. Diagonals of a parallelogram bisect each other.

- $\therefore$ Diagonal AB and diagonal CE have the same midpoint.

By midpoint formula,

$$\left(\frac{3+x_2}{2}, \frac{-2+y_2}{2} \right) = \left(\frac{5+1}{2}, \frac{6+(-2)}{2} \right)$$

$$\therefore \frac{3+x_2}{2} = \frac{6}{2} \quad \text{and} \quad \frac{-2+y_2}{2} = \frac{6-2}{2}$$

$$\therefore x_2 = 6 - 3 \quad \text{and} \quad y_2 = 4 + 2$$

$$\therefore x_2 = 3 \quad \text{and} \quad y_2 = 6$$

$$\therefore \boxed{E(3, 6)}$$

For parallelogram ABFC, let F(x_3, y_3) be the fourth vertex. Diagonals of a parallelogram bisect each other.

- $\therefore$ Diagonal AF and diagonal BC have the same midpoint

Using midpoint formula,

$$\left(\frac{5+x_3}{2}, \frac{6+y_3}{2} \right) = \left(\frac{1+3}{2}, \frac{-2+(-2)}{2} \right)$$

$$\therefore \frac{x_3+5}{2} = \frac{1+3}{2} \quad \text{and} \quad \frac{y_3+6}{2} = \frac{-2-2}{2}$$

$$\therefore x_3 = 4 - 5 \quad \text{and} \quad y_3 = -4 - 6$$

$$\therefore x_3 = -1 \quad \text{and} \quad y_3 = -10$$

$$\therefore \boxed{F(-1, -10)}$$



Points to Remember:

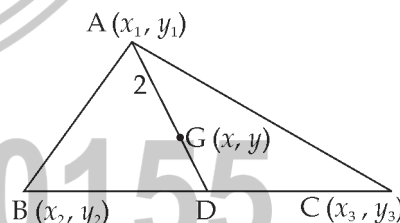
Centroid formula

Now we will see by using section formula how the co-ordinates of centroid are found if the co-ordinates of vertices of a triangle are given

In $\triangle ABC$, point G is a centroid

A(x_1, y_1), B(x_2, y_2) and C(x_3, y_3).

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$



If A (x_1, y_1), B (x_2, y_2), C (x_3, y_3) are vertices of $\triangle ABC$ and seg AD is median of $\triangle ABC$, G (x, y) is the centroid of this triangle.

D is the mid point of the line segment BC.

- $\therefore$ Co-ordinates of point D are

$$x = \frac{x_2 + x_3}{2}, y = \frac{y_2 + y_3}{2} \dots (\text{By midpoint theorem})$$

Point G (x, y) is centroid of triangle $\triangle ABC$.

- $\therefore$ AG : GD = 2 : 1

- $\therefore$ According to section formula,

$$x = \frac{2\left(\frac{x_2 + x_3}{2}\right) + 1(x_1)}{2 + 1} = \frac{x_2 + x_3 + x_1}{3} = \frac{x_1 + x_2 + x_3}{3}$$

$$y = \frac{2\left(\frac{y_2 + y_3}{2}\right) + 1(y_1)}{2 + 1} = \frac{y_2 + y_3 + y_1}{3} = \frac{y_1 + y_2 + y_3}{3}$$

co-ordinates of centroid of a triangle whose vertices are (x_1, y_1) , (x_2, y_2) and (x_3, y_3) are

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

This is called as centroid formula.

Practice Set - 5.2 (Textbook Page No. 115)

- (7) In each of the following vertices of a triangles are given. Find the coordinates of centroid of each triangle. (2 marks each)

- (i) $(-7, 6)$, $(2, -2)$, $(8, 5)$

Solution :

Let $A(-7, 6) = (x_1, y_1)$ be the vertices of ABC

$B(2, -2) = (x_2, y_2)$

$C(8, 5) = (x_3, y_3)$

Let $G(x, y)$ be the centroid of ABC.

By centroid formula,

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$

$$= \frac{-7 + 2 + 8}{3} \quad \text{and} \quad = \frac{6 - 2 + 5}{3}$$

$$= \frac{3}{3} \quad \text{and} \quad = \frac{9}{3}$$

$$x = 1 \quad \text{and} \quad y = 3$$

$$\therefore \boxed{G(1, 3)}$$

- (ii) $(3, -5)$, $(4, 3)$, $(11, -4)$

Solution :

Let $A(3, -5) = (x_1, y_1)$

$B(4, 3) = (x_2, y_2)$

$C(11, -4) = (x_3, y_3)$ be the vertices of ABC

Let $G(x, y)$ be the centroid of ABC.

By centroid formula,

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$

$$= \frac{3 + 4 + 11}{3} \quad \text{and} \quad = \frac{-5 + 3 - 4}{3}$$

$$= \frac{18}{3} \quad \text{and} \quad = \frac{-6}{3}$$

$$x = 6 \quad \text{and} \quad y = -2$$

$$\therefore \boxed{G(6, -2)}$$

- (iii) $(4, 7)$, $(8, 4)$, $(7, 11)$

Solution :

Let $A(4, 7) = (x_1, y_1)$

$B(8, 4) = (x_2, y_2)$

$C(7, 11) = (x_3, y_3)$ be the vertices of ABC

Let $G(x, y)$ be the centroid of ABC.

By centroid formula,

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$

$$= \frac{4 + 8 + 7}{3} \quad \text{and} \quad = \frac{7 + 4 + 11}{3}$$

$$x = \frac{19}{3} \quad \text{and} \quad y = \frac{22}{3}$$

$$\therefore \boxed{G\left(\frac{19}{3}, \frac{22}{3}\right)}$$

- (8) In ABC, $G(-4, -7)$ is the centroid. If $A(-14, -19)$ and $B(3, 5)$ then find co-ordinates of C. (2 marks)

Solution :

$A(-14, -19) = (x_1, y_1)$

$B(3, 5) = (x_2, y_2)$

Let $C(x_3, y_3)$

$G(-4, -7) = (x, y)$

Point G is the centroid of ABC.

By centroid formula,

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$

$$-4 = \frac{-14 + 3 + x_3}{3} \quad \text{and} \quad -7 = \frac{-19 + 5 + y_3}{3}$$

$$\therefore -4 \times 3 = -14 + x_3 \quad \text{and} \quad -7 \times 3 = -14 + y_3$$

$$\therefore -12 + 14 = x_3 \quad \text{and} \quad -21 + 14 = y_3$$

$$\therefore x_3 = -1 \quad \text{and} \quad y_3 = -7$$

$$\therefore \boxed{C(-1, -7)}$$

- (9) $A(h, -6)$, $B(2, 3)$ and $C(-6, k)$ are the co-ordinates of vertices of a triangle whose centroid is $G(1, 5)$. find h and k . (2 marks)

Solution :

Let $A(h, -6) = (x_1, y_1)$

$B(2, 3) = (x_2, y_2)$

and $C(-6, k) = (x_3, y_3)$

$G(1, 5) = (x, y)$

Point G is the centroid of ABC.

By centroid formula,

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$

$$1 = \frac{h + 2 - 6}{3} \quad \text{and} \quad 5 = \frac{-6 + 3 + k}{3}$$

$$\therefore 1 \times 3 = h - 4 \quad \text{and} \quad 5 \times 3 = -3 + k$$

$$\therefore 3 + 4 = h \quad \text{and} \quad 15 + 3 = k$$

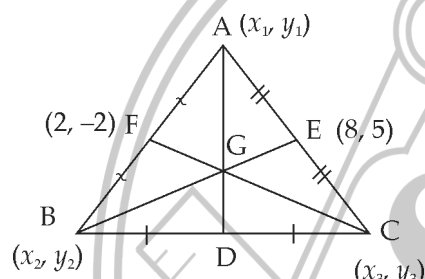
$$\therefore h = 7 \quad \text{and} \quad k = 18$$

$$\therefore \boxed{h = 7 \text{ and } k = 18}$$

Problem Set - 5 (Textbook Pg No. 123)

- * (14)** Find the co-ordinates of centroid of the triangles if points D (-7, 6), E(8, 5) and F(2, -2) are the mid points of the sides of that triangle. (4 marks)

Solution :



In $\triangle ABC$, seg AD, seg BE and seg CE are the medians.

Point G is the centroid.

D(-7, 6), E(8, 5), F(2, -2)

Let G(x, y), A(x₁, y₁), B(x₂, y₂) and C(x₃, y₃)

D is the midpoint of seg BC.

By midpoint formula,

$$-7 = \frac{x_2 + x_3}{2} \quad \text{and} \quad 6 = \frac{y_2 + y_3}{2}$$

$$\therefore -14 = x_2 + x_3 \quad \dots(i) \quad \text{and} \quad 12 = y_2 + y_3 \quad \dots(ii)$$

E is the midpoint of seg AC.

By midpoint formula,

$$8 = \frac{x_1 + x_3}{2} \quad \text{and} \quad 5 = \frac{y_1 + y_3}{2}$$

$$\therefore 8 \times 2 = x_1 + x_3 \quad \text{and} \quad 5 \times 2 = y_1 + y_3$$

$$\therefore 16 = x_1 + x_3 \quad \dots(iii) \quad \text{and} \quad 10 = y_1 + y_3 \quad \dots(iv)$$

F is the midpoint of side AB.

By midpoint formula,

$$2 = \frac{x_1 + x_2}{2} \quad \text{and} \quad -2 = \frac{y_1 + y_2}{2}$$

$$\therefore 4 = x_1 + x_2 \quad \dots(v) \quad \text{and} \quad -4 = y_1 + y_2 \quad \dots(vi)$$

$\therefore$ Adding (i), (iii) and (v) we get,

$$2x_1 + 2x_2 + 2x_3 = 6$$

$$\therefore x_1 + x_2 + x_3 = 3 \quad \dots(vii)$$

$\therefore$ Adding (ii), (iv) and (vi) we get,

$$2y_1 + 2y_2 + 2y_3 = 18$$

$$\therefore y_1 + y_2 + y_3 = 9 \quad \dots(viii)$$

G is the centroid of $\triangle ABC$.

By centroid formula,

$$x = \frac{x_1 + x_2 + x_3}{3} \quad \text{and} \quad y = \frac{y_1 + y_2 + y_3}{3}$$

$$\therefore x = \frac{3}{3} \quad \text{and} \quad y = \frac{9}{3} \quad \dots[\text{From (vii) and (viii)}]$$

$$\therefore x = 1 \quad \text{and} \quad y = 3$$

$$\therefore \boxed{G(1, 3) \text{ is the centroid of } \triangle ABC.}$$

[Note : G (1, 3) is also the centroid of $\triangle DEF$]



Points to Remember:

Slope of Line

(A) Using inclination:

Inclination of a line

Angle formed by a line with positive X-axis is called inclination of a line.

It is represented by ' θ '

$$\text{Slope of a line} = \tan \theta.$$

Slope of Line - Using ratio in trigonometry

In the adjoining figure, point P (x₁, y₁) and Q (x₂, y₂) are two points on line l.

Line l intersects X axis in point T.

seg QS $\perp$ X - axis, seg PR $\perp$ seg QS

$\therefore$ seg PR $\parallel$ seg TS $\dots$ (Correspondence angle test)

$\therefore$ QR = y₂ - y₁ and PR = x₂ - x₁

$$\therefore \frac{QR}{PR} = \frac{y_2 - y_1}{x_2 - x_1} \quad \dots(i)$$

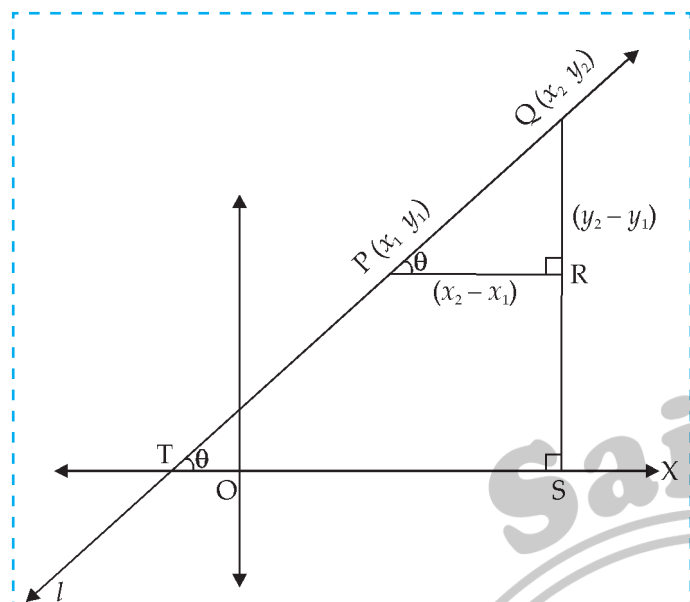
Line TQ makes an angle θ with the X - axis and seg PR $\parallel$ line TS.

$$\therefore \frac{QR}{PR} = \tan \theta \quad \dots(ii)$$

$$\therefore \text{From (i) and (ii), } \frac{y_2 - y_1}{x_2 - x_1} = \tan \theta$$

$$\therefore m = \tan \theta$$

$$\therefore \angle QPR = \angle QTS \dots(\text{Correspondence angle theorem})$$



From this we can define slope as this way. Then the ratio of the angle made by the line with the positive direction of X - axis is called as slope of that line.

When any two lines have same slope, these lines make equal angles with the positive direction of X - axis.

∴ These two lines are parallel.

$$= \tan 60^\circ$$

$$\text{Slope} = \sqrt{3}$$

(iii) Inclination of the line (θ) = 90°

$$\text{Slope} = \tan \theta$$

$$= \tan 90^\circ$$

$$\text{Slope} = \text{Not defined}$$

Points to Remember:

(B) Slope of line;

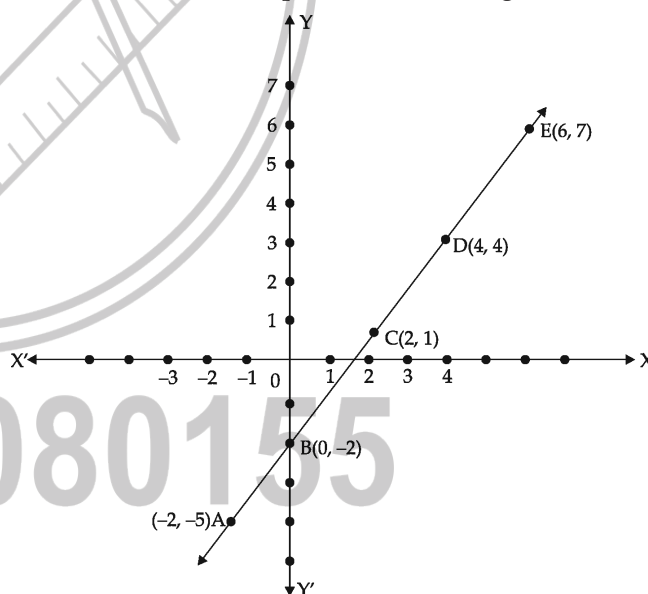
If $A(x_1, y_1)$ $B(x_2, y_2)$ are two points, then slope of line passing through points A and B can be given by,

$$\text{Slope of line AB} = \frac{y_2 - y_1}{x_2 - x_1} \text{ or}$$

$$\text{Slope of line AB} = \frac{y_1 - y_2}{x_1 - x_2}$$

Activity:

As in the figure below, points $A(-2, -5)$ $B(0, -2)$, $C(2, 1)$, $D(4, 4)$ and $E(6, 7)$ lie on line l . Using these coordinates, complete the following table.



Practice Set - 5.3 (Textbook Page No.)

(1) Angles made by the line with the positive direction of X-axis are given. Find the slope of these lines.

(2 marks)

(i) 45° (ii) 60° (iii) 90°

Solution :

(i) Inclination of the line (θ) = 45°

$$\text{Slope} = \tan \theta$$

$$= \tan 45^\circ$$

$$\text{Slope} = 1$$

(ii) Inclination of the line (θ) = 60°

$$\text{Slope} = \tan \theta$$

Sr. No.	First Point	Second Point	Coordinates of first point	Coordinates of second point	$\frac{y_2 - y_1}{x_2 - x_1}$
1	C	E	(2, 1)	(6, 7)	$\frac{7 - 1}{6 - 2} = \frac{6}{4} = \frac{3}{2}$
2	A	D	(-2, -5)	(4, 4)	$\frac{4 - (-5)}{4 - (-2)} = \frac{9}{6} = \frac{3}{2}$

3	D	A	(4, 4)	(-2, -5)	$\frac{-5-4}{-2-4} = \frac{-9}{-6} = \frac{3}{2}$
4	B	C	(0, -2)	(2, 1)	$\frac{1-(-2)}{2-0} = \frac{3}{2}$
5	C	A	(2, 1)	(-2, -5)	$\frac{-5-1}{-2-2} = \frac{-6}{-4} = \frac{3}{2}$
6	A	C	(-2, -5)	(2, 1)	$\frac{1-(-5)}{2-(-2)} = \frac{6}{4} = \frac{3}{2}$

From the above table we can say that for any two points on line l , $\frac{y_2 - y_1}{x_2 - x_1}$ remains the same.

$\frac{y_2 - y_1}{x_2 - x_1}$ is called the slope of line l and it is denoted

by letter m

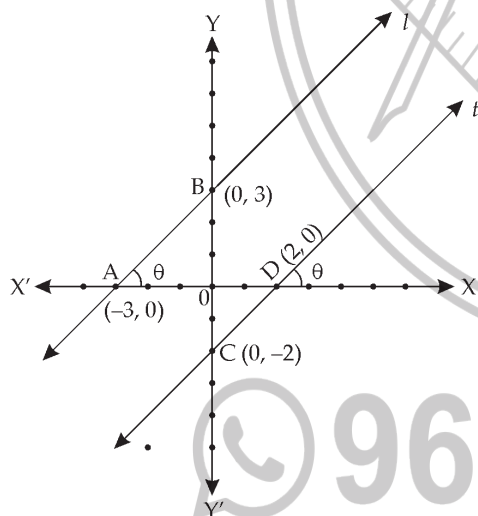
$$\therefore m = \frac{y_2 - y_1}{x_2 - x_1}$$

Note: (1) Slope of X-axis is 0.

(2) Slope of Y-axis cannot be determined.

Slope of Parallel lines

As given in the figure, line l and line t makes an angle θ with the positive x axis.



line $l \parallel$ line t (alternate angles test)

Point A(-3, 0) and Point B(0, 3) lie on line l

$$\therefore \text{Slope of line } l = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 0}{0 - (-3)} = \frac{3}{3} = 1$$

Similarly, take any two points on line t and find the slope of line t .

Let the point be C(0, -2) and D(2, 0).

$$\therefore \text{Slope of CD} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 0}{0 - 2} = \frac{-2}{-2} = 1$$

$\therefore$ Slope of line AB = Slope of line CD

$\therefore$ Slopes of parallel lines are equal hence proved.

Pracitce Set - 5.3 (Textbook Page No. 121)

(2) Find the slopes of lines passing through the given point. (2 marks each)

(i) A(2, 3) and B(4, 7)

Solution :

$$A(2, 3) = (x_1, y_1)$$

$$B(4, 7) = (x_2, y_2)$$

$$\begin{aligned} \text{Slope} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{7 - 3}{4 - 2} \\ &= \frac{4}{2} \end{aligned}$$

$\therefore$ Slope of line AB = 2

(ii) P(-3, 1) and Q(5, -2)

Solution :

$$P(-3, 1) = (x_1, y_1)$$

$$Q(5, -2) = (x_2, y_2)$$

$$\begin{aligned} \text{Slope} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-2 - 1}{5 - (-3)} \\ &= \frac{-3}{5 + 3} = \frac{-3}{8} \end{aligned}$$

$\therefore$ Slope of line PQ = $\frac{-3}{8}$

(iii) C(5, -2) and D(7, 3)

Solution :

$$C(5, -2) = (x_1, y_1)$$

$$D(7, 3) = (x_2, y_2)$$

$$\begin{aligned}\text{Slope of line CD} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{3 - (-2)}{7 - 5} \\ &= \frac{3 + 2}{2} = \frac{5}{2}\end{aligned}$$

$$\therefore \text{Slope of line CD} = \frac{5}{2}$$

(iv) L(-2, -3) and M(-6, -8)

Solution :

$$L(-2, -3) = (x_1, y_1)$$

$$M(-6, -8) = (x_2, y_2)$$

$$\begin{aligned}\text{Slope of line LM} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-8 - (-3)}{-6 - (-2)} \\ &= \frac{-8 + 3}{-6 + 2} \\ &= \frac{-5}{-4} = \frac{5}{4}\end{aligned}$$

$$\therefore \text{Slope of line LM} = \frac{5}{4}$$

(v) E(-4, -2) and F(6, 3)

Solution :

$$E(-4, -2) = (x_1, y_1)$$

$$F(6, 3) = (x_2, y_2)$$

$$\begin{aligned}\text{Slope of line EF} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{3 - (-2)}{6 - (-4)} \\ &= \frac{3 + 2}{6 + 4} \\ &= \frac{5}{10}\end{aligned}$$

$$\therefore \text{Slope of line EF} = \frac{1}{2}$$

(vi) T(0, -3) and S(0, 4)

Solution :

$$T(0, -3) = (x_1, y_1)$$

$$S(0, 4) = (x_2, y_2)$$

$$\begin{aligned}\text{Slope of line TS} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{4 - (-3)}{0 - 0} \\ &= \frac{4 + 3}{0} = \frac{7}{0}\end{aligned}$$

$$\therefore \text{Slope of line TS} = \text{Not defined}$$

Practice Set - 5.1 (Textbook Page No. 107)

(2) Determine whether the points are collinear.

(2 marks each)

(i) A(1, -3), B(2, -5) and C(-4, 7)

Solution :

$$A(1, -3) = (x_1, y_1)$$

$$B(2, -5) = (x_2, y_2)$$

$$C(-4, 7) = (x_3, y_3)$$

$$\begin{aligned}\text{Slope of line AB} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-5 - (-3)}{2 - 1} \\ &= \frac{-5 + 3}{1} \\ &= -2\end{aligned}$$

$$\therefore \text{Slope of line AB} = -2 \quad \dots(i)$$

$$\begin{aligned}\text{Slope of line BC} &= \frac{y_3 - y_2}{x_3 - x_2} \\ &= \frac{7 - (-5)}{-4 - 2} \\ &= \frac{7 + 5}{-6}\end{aligned}$$

$$\therefore \text{Slope of line BC} = \frac{12}{-6} = -2 \quad \dots(ii)$$

$$\therefore \text{Slope of line AB} = \text{Slope of line BC} \quad \dots[\text{From (i) and (ii)}]$$

Line AB and line BC have equal slopes and have a common point B.

$$\therefore \text{Points A, B and C are collinear.}$$

(ii) L(-2, 3), M(1, -3), N(5, 4)

Solution :

$$L(-2, 3) = (x_1, y_1)$$

$$M(1, -3) = (x_2, y_2)$$

$$N(5, 4) = (x_3, y_3)$$

$$\text{Slope of line LM} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\begin{aligned}
 &= \frac{-3-3}{1-(-2)} \\
 &= \frac{-6}{1+2} \\
 &= \frac{-6}{3} \\
 \therefore \text{Slope of line LM} &= -2 \quad \dots(i) \\
 \text{Slope of line MN} &= \frac{y_3 - y_2}{x_3 - x_2} \\
 &= \frac{4-(-3)}{5-1} \\
 &= \frac{4+3}{4} \\
 \therefore \text{Slope of line MN} &= \frac{7}{4} \quad \dots(ii) \\
 \therefore \text{Slope of line LM} &\neq \text{Slope of line MN} \\
 &\dots[\text{From (i) and (ii)}]
 \end{aligned}$$

$\therefore$ **Points L, M and N are not collinear.**

(iii) R(0, 3), D(2, 1) and S(3, -1)

Solution :

$$R(0, 3) = (x_1, y_1)$$

$$D(2, 1) = (x_2, y_2)$$

$$S(3, -1) = (x_3, y_3)$$

$$\begin{aligned}
 \text{Slope of line RD} &= \frac{y_2 - y_1}{x_2 - x_1} \\
 &= \frac{1-3}{2-0} \\
 &= \frac{-2}{2} \\
 \therefore \text{Slope of line RD} &= -1 \quad \dots(i)
 \end{aligned}$$

$$\begin{aligned}
 \text{Slope of line DS} &= \frac{y_3 - y_2}{x_3 - x_2} \\
 &= \frac{-1-1}{3-2} \\
 &= \frac{-2}{1} \\
 \therefore \text{Slope of line DS} &= -2 \quad \dots(ii)
 \end{aligned}$$

$\therefore$ **Points R, D and S are not collinear**

(iv) P(-2, 3), Q(1, 2), R(4, 1)

Solution :

$$P(-2, 3) = (x_1, y_1)$$

$$Q(1, 2) = (x_2, y_2)$$

$$R(4, 1) = (x_3, y_3)$$

$$\text{Slope of line PQ} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\begin{aligned}
 &= \frac{2-3}{1-(-2)} \\
 &= \frac{-1}{1+2} \\
 \therefore \text{Slope of line PQ} &= \frac{-1}{3} \quad \dots(i)
 \end{aligned}$$

$$\begin{aligned}
 \text{Slope of line QR} &= \frac{y_3 - y_2}{x_3 - x_2} \\
 &= \frac{1-2}{4-1} \\
 &= \frac{-1}{3} \quad \dots(ii)
 \end{aligned}$$

$\therefore$ Slope of line PQ = slope of line QR
 $\dots[\text{From (i) and (ii)}]$

Line PQ and line QR have equal slopes and have a common point Q.

$\therefore$ **Points P, Q and R are collinear**

Practice Set - 5.3 (Textbook Page No. 121)

(3) Determine whether following points are collinear. (3 marks)

(i) A(-1, -1), B(0, 1), C(1, 3)

Solution :

$$A(-1, -1) = (x_1, y_1)$$

$$B(0, 1) = (x_2, y_2)$$

$$C(1, 3) = (x_3, y_3)$$

$$\begin{aligned}
 \text{Slope of line AB} &= \frac{y_2 - y_1}{x_2 - x_1} \\
 &= \frac{1-(-1)}{0-(-1)} \\
 &= \frac{1+1}{0+1} \\
 \therefore \text{Slope of line AB} &= \frac{2}{1} \quad \dots(i)
 \end{aligned}$$

$$\begin{aligned}
 \text{Slope of line BC} &= \frac{y_3 - y_2}{x_3 - x_2} \\
 &= \frac{3-1}{1-0} \\
 &= \frac{2}{1} \quad \dots(ii)
 \end{aligned}$$

$\therefore$ Slope of line BC = Slope of line AB
 $\dots[\text{From (i) and (ii)}]$

Also, both lines have a common point B.

$\therefore$ **Points A, B and C are collinear points.**

(ii) D(-2, -3), E(1, 0), F(2, 1)

$$D(-2, -3) = (x_1, y_1)$$

$$E(1, 0) = (x_2, y_2)$$

$$F(2, 1) = (x_3, y_3)$$

Solution :

$$\begin{aligned} \text{Slope of line DE} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{0 - (-3)}{1 - (-2)} \end{aligned}$$

$$= \frac{0 + 3}{1 + 2}$$

$$= \frac{3}{3} = 1$$

$$\therefore \text{Slope of line DE} = 1 \quad \dots(i)$$

$$\begin{aligned} \text{Slope of line EF} &= \frac{y_3 - y_2}{x_3 - x_2} \\ &= \frac{1 - 0}{2 - 1} \end{aligned}$$

$$= \frac{1}{1}$$

$$\therefore \text{Slope of line EF} = 1 \quad \dots(ii)$$

$$\therefore \text{Slope of line DE} = \text{Slope of line EF} \quad \dots[\text{From (i) and (ii)}]$$

Also, both lines have a common point E.

 $\therefore$ **Points D, E and F are collinear points.**

(iii) L(2, 5), M(3, 3), N(5, 1)

Solution :

$$L(2, 5) = (x_1, y_1)$$

$$M(3, 3) = (x_2, y_2)$$

$$N(5, 1) = (x_3, y_3)$$

$$\begin{aligned} \text{Slope of line LM} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{3 - 5}{3 - 2} \end{aligned}$$

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

$$\therefore \text{Slope of line LM} = -2 \quad \dots(i)$$

$$\begin{aligned} \text{Slope of line MN} &= \frac{y_3 - y_2}{x_3 - x_2} \\ &= \frac{1 - 3}{5 - 3} \end{aligned}$$

$$= \frac{-2}{2}$$

$$\therefore \text{Slope of line MN} = -1 \quad \dots(ii)$$

$$\therefore \text{Slope of line LM} \neq \text{Slope of line MN} \quad \dots[\text{From (i) and (ii)}]$$

 $\therefore$ **Points L, M and N are non-collinear points.**

(iv) P(2, -5), Q(1, -3), R(-2, 3)

Solution :

$$P(2, -5) = (x_1, y_1)$$

$$Q(1, -3) = (x_2, y_2)$$

$$R(-2, 3) = (x_3, y_3)$$

$$\begin{aligned} \text{Slope of line PQ} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-3 - (-5)}{1 - 2} \end{aligned}$$

$$= \frac{-3 + 5}{-1}$$

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

$$\therefore \text{Slope of line PQ} = -2 \quad \dots(i)$$

$$\begin{aligned} \text{Slope of line QR} &= \frac{y_3 - y_2}{x_3 - x_2} \\ &= \frac{3 - (-3)}{-2 - 1} \end{aligned}$$

$$= \frac{3 + 3}{-3}$$

$$= \frac{6}{-3}$$

$$\therefore \text{Slope of line QR} = -2 \quad \dots(ii)$$

$$\therefore \text{Slope of line PQ} = \text{Slope of line QR}$$

 $\dots[\text{From (i) and (ii)}]$

Also, both lines have a common point Q.

 $\therefore$ **Points P, Q and R are collinear points.**

(v) R(1, -4), S(-2, 2), T(-3, 4)

Solution :

$$R(1, -4) = (x_1, y_1)$$

$$S(-2, 2) = (x_2, y_2)$$

$$T(-3, 4) = (x_3, y_3)$$

$$\begin{aligned} \text{Slope of line RS} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{2 - (-4)}{-2 - 1} \end{aligned}$$

$$= \frac{2 + 4}{-3}$$

$$= \frac{6}{-3}$$

$$\therefore \text{Slope of line RS} = -2 \quad \dots(i)$$

$$\begin{aligned} \text{Slope of line ST} &= \frac{y_3 - y_2}{x_3 - x_2} \\ &= \frac{4 - 2}{-3 - (-2)} \end{aligned}$$

$$= \frac{2}{-3+2}$$

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

$$\therefore \text{Slope of line ST} = -2 \quad \dots(\text{ii})$$

$$\therefore \text{Slope of line RS} = \text{Slope of line ST}$$

$$\dots[\text{From (i) and (ii)}]$$

Also, they have a common point S.

$$\therefore \text{Points R, S and T are collinear points.}$$

$$\text{(vi) } A(-4, 4), K(-2, \frac{5}{2}), N(4, -2)$$

Solution :

$$A(-4, 4) = (x_1, y_1)$$

$$K(-2, \frac{5}{2}) = (x_2, y_2)$$

$$N(4, -2) = (x_3, y_3)$$

$$\text{Slope of line AK} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{\frac{5}{2} - 4}{-2 - (-4)}$$

$$= \left(\frac{5-8}{2}\right) \div (-2+4)$$

$$= \frac{-3}{2} \div 2$$

$$= \frac{-3}{2} \times \frac{1}{2}$$

$$\therefore \text{Slope of line AK} = \frac{-3}{4} \quad \dots(\text{i})$$

$$\text{Slope of line AN} = \frac{y_3 - y_1}{x_3 - x_1}$$

$$= \frac{-2 - 4}{4 - (-4)}$$

$$= \frac{-6}{4+4}$$

$$= \frac{-6}{8}$$

$$\therefore \text{Slope of line AN} = \frac{-3}{4} \quad \dots(\text{ii})$$

$$\therefore \text{Slope of line AK} = \text{Slope of line AN}$$

$$\dots[\text{From (i) and (ii)}]$$

Also, they have a common point A.

$$\therefore \text{Points A, K and N are collinear points.}$$

Problem Set - 5 (Textbook Pg No. 122)

- (2) Determine whether the given points are collinear.
(2 marks each)

$$\text{(i) } A(0, 2), B(1, -0.5), C(2, -3)$$

Solution :

$$\text{Slope of line AB} = \frac{-0.5 - 2}{1 - 0}$$

$$= \frac{-2.5}{1}$$

$$\therefore \text{Slope of line AB} = -2.5 \quad \dots(\text{i})$$

$$\text{Slope of line AC} = \frac{-3 - 2}{2 - 0}$$

$$= \frac{-5}{2}$$

$$\therefore \text{Slope of line AC} = -2.5 \quad \dots(\text{ii})$$

$$\therefore \text{Slope of line AB} = \text{Slope of line AC}$$

$$\dots[\text{From (i) and (ii)}]$$

Also, they have a common point A.

$$\therefore \text{Points A, B and C are collinear points.}$$

$$\text{(ii) } P(1, 2), Q(2, \frac{8}{5}), R(3, \frac{6}{5})$$

Solution :

$$\text{Slope of line PQ} = \frac{\frac{8}{5} - 2}{2 - 1}$$

$$= \frac{8-10}{5}$$

$$= \frac{-2}{5}$$

$$\therefore \text{Slope of line PQ} = \frac{-2}{5} \quad \dots(\text{i})$$

$$\text{Slope of line QR} = \frac{\frac{6}{5} - \frac{8}{5}}{3 - 2}$$

$$= \frac{6-8}{5}$$

$$= \frac{-2}{5}$$

$$\therefore \text{Slope of line QR} = \frac{-2}{5} \quad \dots(\text{ii})$$

$$\therefore \text{Slope of line PQ} = \text{Slope of line QR}$$

$$\dots[\text{From (i) and (ii)}]$$

Also, they have a common point Q.

$$\therefore \text{Points P, Q and R are collinear points.}$$

$$\text{(iii) } L(1, 2), M(5, 3), N(8, 6)$$

Solution :

$$\text{Slope of line LM} = \frac{3 - 2}{5 - 1}$$

$$\therefore \text{Slope of line LM} = \frac{1}{4} \quad \dots(\text{i})$$

$$\text{Slope of line MN} = \frac{6 - 3}{8 - 5}$$

$$= \frac{3}{3}$$

$$\therefore \text{Slope of line MN} = 1 \quad \dots(\text{ii})$$

$$\therefore \text{Slope of line LM} \neq \text{Slope of line MN} \quad \dots[\text{From (i) and (ii)}]$$

$$\therefore \text{Points L, M and N are not collinear points}$$

Pracitce Set - 5.3 (Textbook Page No. 121)

- (4) If A(1, -1), B(0, 4), C(-5, 3) are vertices of a triangle, then find the slope of each side. (3 marks)

Solution :

$$A(1, -1), B(0, 4), C(-5, 3)$$

By using slope formula,

$$\begin{aligned} \text{Slope of AB} &= \frac{4 - (-1)}{0 - 1} \\ &= \frac{4 + 1}{-1} \\ &= \frac{5}{-1} \end{aligned}$$

$$\text{Slope of AB} = -5$$

$$\begin{aligned} \text{Slope of BC} &= \frac{3 - 4}{-5 - 0} \\ &= \frac{-1}{-5} \end{aligned}$$

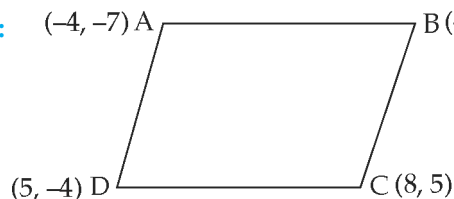
$$\text{Slope of BC} = \frac{1}{5}$$

$$\begin{aligned} \text{Slope of AC} &= \frac{3 - (-1)}{-5 - 1} \\ &= \frac{3 + 1}{-6} \\ &= \frac{4}{-6} \end{aligned}$$

$$\text{Slope of AC} = \frac{-2}{3}$$

- (5) Show that A(-4, -7), B(-1, 2), C(8, 5) and D(5, -4) are the vertices of a parallelogram. (4 marks)

Solution : (-4, -7) A B(-1, 2)



$$\begin{aligned} \text{Slope of AB} &= \frac{2 - (-7)}{-1 - (-4)} \\ &= \frac{2 + 7}{-1 + 4} \end{aligned}$$

$$\begin{aligned} \text{Slope of AB} &= \frac{9}{3} \\ &= 3 \quad \dots(\text{i}) \end{aligned}$$

$$\begin{aligned} \text{Slope of BC} &= \frac{5 - 2}{8 - (-1)} \\ &= \frac{3}{8 + 1} \\ &= \frac{3}{9} \\ &= \frac{1}{3} \quad \dots(\text{ii}) \end{aligned}$$

$$\begin{aligned} \text{Slope of AD} &= \frac{-4 - (-7)}{5 - (-4)} \\ &= \frac{-4 + 7}{5 + 4} \\ &= \frac{3}{9} \\ &= \frac{1}{3} \quad \dots(\text{iii}) \end{aligned}$$

$$\text{Slope of AD} = \frac{1}{3} \quad \dots(\text{iii})$$

$$\begin{aligned} \text{Slope of CD} &= \frac{-4 - 5}{5 - 8} \\ &= \frac{-9}{-3} \\ &= 3 \quad \dots(\text{iv}) \end{aligned}$$

$$\text{Slope of line AB} = \text{Slope of line CD} \quad \dots[\text{From (i) and (iv)}]$$

$$\therefore \text{Line AB} \parallel \text{Line CD} \quad \dots(\text{v})$$

$$\therefore \text{Slope of line BC} = \text{Slope of line AD} \quad \dots[\text{From (ii) and (iii)}]$$

$$\therefore \text{Line BC} \parallel \text{Line AD} \quad \dots(\text{vi})$$

$$\text{In } \square \text{ABCD, AB} \parallel \text{CD} \quad \dots[\text{From (v)}]$$

$$\text{BC} \parallel \text{AD} \quad \dots[\text{From (vi)}]$$

$$\therefore \square \text{ABCD is a parallelogram.} \quad \dots(\text{Definition})$$

- (6) Find k, if R(1, -1), S(-2, k) and slope of line RS is -2. (2 marks)

Solution :

$$R(1, -1) = (x_1, y_1)$$

$$S(-2, k) = (x_2, y_2)$$

$$\begin{aligned} \text{Slope of line RS} &= \frac{y_2 - y_1}{x_2 - x_1} \\ -2 &= \frac{k - (-1)}{-2 - 1} \end{aligned}$$

$$\therefore -2 = \frac{k + 1}{-3}$$

$$\therefore (-2) \times (-3) = k + 1$$

$$\therefore 6 = k + 1$$

$$\therefore k = 6 - 1$$

$$\therefore k = 5$$

- (7) Find k , if $B(k, -5)$, $C(1, 2)$ and slope of the line is 7. (2 marks)

Solution :

$$B(k, -5) = (x_1, y_1)$$

$$C(1, 2) = (x_2, y_2)$$

$$\text{Slope of line BC} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\therefore 7 = \frac{2 - (-5)}{1 - k}$$

$$\therefore 7(1 - k) = 2 + 5$$

$$\therefore 7(1 - k) = 7$$

$$\therefore 1 - k = \frac{7}{7}$$

$$\therefore 1 - k = 1$$

$$\therefore 1 - 1 = k$$

$$\therefore k = 0$$

- (8) Find k , if $PQ \parallel RS$ and $P(2, 4)$, $Q(3, 6)$, $R(3, 1)$ and $S(5, k)$. (2 marks)

Solution :

Line $PQ \parallel$ Line RS

...(Given)

$\therefore$ Slope of line PQ = Slope of line RS

$$\frac{6 - 4}{3 - 2} = \frac{k - 1}{5 - 3}$$

$$\therefore \frac{2}{1} = \frac{k - 1}{2}$$

$$\therefore 2 \times 2 = k - 1$$

$$\therefore 4 + 1 = k$$

$$\therefore k = 5$$

Problem Set - 5 (Textbook Pg No. 123)

- 9) Find k if the line passing through points $P(-12, -3)$ and $Q(4, k)$ has slope $\frac{1}{2}$. (2 marks)

Solution :

$P(-12, -3)$, $Q(4, k)$... (Given)

Slope of $PQ = \frac{1}{2}$... (Given)

Slope of $PQ = \frac{k - (-3)}{4 - (-12)}$... (Given)

$$\therefore \frac{1}{2} = \frac{k + 3}{4 + 12}$$

$$\therefore \frac{16}{2} = k + 3$$

$$\therefore k + 3 = 8$$

$$\therefore k = 8 - 3$$

$$\therefore k = 5$$

- (10) Show that the line joining the points $A(4, 8)$ and $B(5, 5)$ is parallel to the line joining the points $C(2, 4)$ and $D(1, 7)$ (2 marks)

Solution :

$A(4, 8)$

$B(5, 5)$

$$\text{Slope of line AB} = \frac{8 - 5}{4 - 5}$$

$$= \frac{3}{-1}$$

$$\therefore \text{Slope of line AB} = -3 \quad \dots(i)$$

$C(2, 4)$

$D(1, 7)$

$$\text{Slope of line CD} = \frac{7 - 4}{1 - 2}$$

$$= \frac{3}{-1}$$

$$\therefore \text{Slope of line CD} = -3 \quad \dots(ii)$$

$$\therefore \text{Slope of line AB} = \text{Slope of line CD}$$

...[From (i) and (ii)]

$$\therefore \text{Line AB} \parallel \text{Line CD}$$

- (11) Show that points $P(1, -2)$, $Q(5, 2)$, $R(3, -1)$, $S(-1, -5)$ are the vertices of a parallelogram. (4 marks)

Solution :



$P(1, -2)$, $Q(5, 2)$, $R(3, -1)$, $S(-1, -5)$

$$\text{Slope of line PQ} = \frac{2 - (-2)}{5 - 1} = \frac{2 + 2}{4} = \frac{4}{4} = 1 \quad \dots(i)$$

$$\text{Slope of line QR} = \frac{2 - (-1)}{5 - 3} = \frac{2 + 1}{2} = \frac{3}{2} \quad \dots(ii)$$

$$\text{Slope of line RS} = \frac{-1 - (-5)}{3 - (-1)} = \frac{-1 + 5}{3 + 1} = \frac{4}{4} = 1 \quad \dots(iii)$$

$$\text{Slope of line PS} = \frac{-2 - (-5)}{1 - (-1)} = \frac{-2 + 5}{1 + 1} = \frac{3}{2} \quad \dots(iv)$$

$$\text{Slope of line PQ} = \text{Slope of line RS}$$

...[From (i) and (iii)]

∴ Line PQ || Line RS ... (v)

Slope of line QR = Slope of line PS
...[From (ii) and (iv)]

∴ Line QR || Line PS ...[From (vi)]

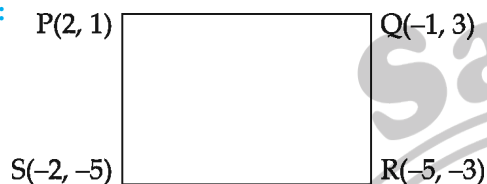
In □ PQRS, PQ || RS ...[From (v)]

QR || PS ...[From (vi)]

∴ □ PQRS is a parallelogram ... (Definition)

(12) Show that the □ PQRS formed by P(2, 1), Q(-1, 3), R(-5, -3), S(-2, -5) is a rectangle. (4 marks)

Solution :



P(2, 1), Q(-1, 3), R(-5, -3), S(-2, -5)

$$\text{Slope of line PQ} = \frac{3-1}{-1-2} = \frac{2}{-3} = -\frac{2}{3} \quad \dots(i)$$

$$\text{Slope of line QR} = \frac{3-(-3)}{-1-(-5)} = \frac{3+3}{-1+5} = \frac{6}{4} = \frac{3}{2} \quad \dots(ii)$$

$$\text{Slope of line RS} = \frac{-5-(-3)}{-2-(-5)} = \frac{-5+3}{-2+5} = \frac{-2}{3} \quad \dots(iii)$$

$$\text{Slope of line PS} = \frac{1-(-5)}{2-(-2)} = \frac{1+5}{2+2} = \frac{6}{4} = \frac{3}{2} \quad \dots(iv)$$

Slope of line PQ = Slope of line RS
...[From (i) and (iii)]

∴ Line PQ || Line RS ... (v)

∴ Slope of line QR = Slope of line PS
...[From (ii) and (iv)]

∴ Line QR || Line PS ... (vi)

In □ PQRS, side PQ || side RS ...[From (v)]

∴ side RS || side PS ...[From (vi)]

□ PQRS is a parallelogram ... (vii) (Definition)

Using distance formula,

$$\begin{aligned} d(P, R) &= \sqrt{[2-(-5)]^2 + [1-(-3)]^2} \\ &= \sqrt{(2+5)^2 + (1+3)^2} \\ &= \sqrt{7^2 + 4^2} \\ &= \sqrt{49 + 16} \end{aligned}$$

$$\therefore d(P, R) = \sqrt{65} \text{ units} \quad \dots(viii)$$

$$\begin{aligned} d(Q, S) &= \sqrt{[-1-(-2)]^2 + [3-(-5)]^2} \\ &= \sqrt{(-1+2)^2 + (3+5)^2} \\ &= \sqrt{1^2 + 8^2} \end{aligned}$$

$$= \sqrt{1+64}$$

$$\therefore d(Q, S) = \sqrt{65} \text{ units} \quad \dots(ix)$$

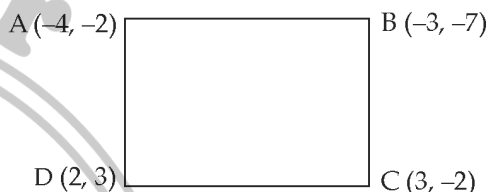
In parallelogram PQRS,

diagonal PR ≅ diagonal QS ...[From (viii) and (ix)]

∴ □ PQRS is a rectangle ... (A parallelogram is a rectangle if its diagonals are congruent)

***(18) Find the type of the quadrilateral if points A(-4, -2), B(-3, -7), C(3, -2) and D(2, 3) are joined serially. (4 marks)**

Solution :



A(-4, -2), B(-3, -7), C(3, -2), D(2, 3)

$$\text{Slope of line AB} = \frac{-7-(-2)}{-3-(-4)} = \frac{-7+2}{-3+4}$$

$$= \frac{-5}{1}$$

$$= -5$$

$$\therefore \text{Slope of line AB} = -5 \quad \dots(i)$$

$$\text{Slope of line BC} = \frac{-2-(-7)}{3-(-3)} = \frac{-2+7}{3+3}$$

$$= \frac{5}{6}$$

$$= \frac{5}{6}$$

$$\therefore \text{Slope of line BC} = \frac{5}{6} \quad \dots(ii)$$

$$\text{Slope of line CD} = \frac{-2-3}{3-2} = \frac{-5}{1} = -5$$

$$\text{Slope of line CD} = -5 \quad \dots(iii)$$

$$\text{Slope of line AD} = \frac{-2-3}{-4-2} = \frac{-5}{-6}$$

$$= \frac{5}{6}$$

$$\text{Slope of line AD} = \frac{5}{6} \quad \dots(iv)$$

Slope of line AB = Slope of line CD
...[From (i) and (iii)]

∴ Line AB || Line CD ... (v)

Slope of line BC = Slope of line AD

...[From (ii) and (iv)]

$\therefore$ Line BC $\parallel$ Line AD ... (vi)

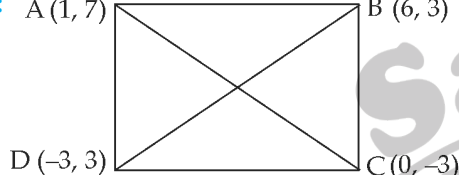
In $\square$ ABCD, AB $\parallel$ CD ... [From (v)]

BC $\parallel$ AD ... [From (vi)]

$\therefore \square$ ABCD is a parallelogram.

- (22) Find the slope of the diagonals of a quadrilateral with vertices A (1, 7), B(6, 3) C(0, -3) and D(-3, 3). (3 marks)

Solution : A (1, 7) B (6, 3)



A(1, 7), B(6, 3) C(0, -3) and D(-3, 3)

$\square$ ABCD has two diagonals seg AC and seg BD.

$$\begin{aligned}\text{Slope of AC} &= \frac{7 - (-3)}{1 - 0} \\ &= \frac{7 + 3}{1} \\ &= \frac{10}{1}\end{aligned}$$

$\therefore$ **Slope of AC = 10**

$$\begin{aligned}\text{Slope of BD} &= \frac{3 - 3}{6 - (-3)} \\ &= \frac{0}{6 + 3}\end{aligned}$$

Slope of BD = 0

$\therefore$ **Slope of BD = 0**

Problem Set - 5 (Textbook Pg No. 122)

MCQ's

- (1) Fill in the blanks using correct alternatives (1 mark each)
- (1) Seg AB is parallel to Y-axis and co-ordinates of point A are (1, 3) then co-ordinates of point B can be
- (A) (3, 1) (B) (5, 3) (C) (3, 0) (D) (1, -3)
- (2) Out of the following, point lies to the right of the origin on X-axis.
- (a) (-2, 0) (b) (0, 2) (c) (2, 3) (d) (2, 0)
- (3) Distance of point (-3, 4) from the origin is
- (A) 7 (B) 1 (C) 5 (D) -5

- (4) A line makes an angle of 30° with the positive direction of X-axis. So the slope of the line is

(A) $\frac{1}{2}$ (B) $\frac{\sqrt{3}}{2}$ (C) $\frac{1}{\sqrt{3}}$ (D) $\sqrt{3}$

Additional MCQ's

- (5) What is the slope of line with indination 60° ?
- (A) $\sqrt{3}$ (B) $\frac{1}{\sqrt{3}}$ (C) 1 (D) 0
- (6) Find the inclination of a line with slope 1.
- (A) 60° (B) 45° (C) 90° (D) Can't say
- (7) Line l is parallel to line m . It slopes of line l is $\frac{1}{2}$ then slope of line m is
- (A) -2 (B) 0 (C) $\frac{1}{2}$ (D) Can't say
- (8) What is slope of line passing through points (4, 6) and (1, -2).
- (A) $\frac{4}{3}$ (B) $\frac{3}{4}$ (C) $\frac{8}{5}$ (D) $\frac{8}{3}$
- (9) Slope of X - axis is
- (A) 0 (B) 1 (C) -1 (D) Not defined
- (10) Slope of Y - axis is
- (A) 0 (B) 1 (C) -1 (D) Not defined
- (11) Distance of point A (7, 24) from the origin is
- (A) 17 (B) -17 (C) 25 (D) Can not be found
- (12) Find the co-ordinates of the point P which bisects seg having co-ordinates (3, 2) and (5, -2)
- (A) (-3, 5) (B) (0, 4) (C) (4, 0) (D) (5, -3)
- (13) Find the co-ordinates of the point which divides line seg QR in the ratio 1 : 2 where Q (1, 1) and R(1, -2).
- (A) (-5, 3) (B) (1, 0) (C) (-3, 2) (D) (4, 0)
- (14) In what ratio does the point (1, 6) divide the line segment joining the points (3, 6) and (-5, 6).
- (A) 1 : 3 (B) 2 : 3 (C) 3 : 1 (D) 3 : 2

ANSWERS

- (1) (D) (1, -3) (2) (D) (2, 0) (3) (C) 5
- (4) (C) $\frac{1}{\sqrt{3}}$ (5) (A) $\sqrt{3}$ (6) (B) 45°

- (7) (C) $\frac{1}{2}$ (8) (D) $\frac{8}{3}$ (9) (A) 0
 (10) (D) Not defined (11) (C) 25 (12) (C) (4, 0)
 (13) (B) (1, 0) (14) (A) 1 : 3

PROBLEMS FOR PRACTICE

Based on Practice Set 5.1

- (1) Find the distance between the given points.
 (i) A (3, -4), B (-5, 6) (1 mark each)
 (ii) P (10, -8), Q (-3, -2)
 (iii) K (0, -5), L (-5, 0)
 (iv) I (3.5, 6.8), J (1.5, 2.8)
- (2) Show that the point (5, 11) is equidistant from the points (-5, 13) and (3, 1). (2 marks)
- (3) Check whether points (3, 3), (-4, -1) and (3, -5) are the vertices of an isosceles triangle. (2 marks)
- (4) Find the relation between x and y, where point (x, y) is equidistant from (2, -4) and (-2, 6). (3 marks)
- (5) Show that the point (0, 9) is equidistant from the point (-4, 1) and (4, 1). (2 marks)
- (6) Find the coordinates of the point on Y-axis which is equidistant from the points M(6, 5) and point N(-4, 3). (3 marks)
- (7) Using distance formula, check whether following points are collinear or not. (2 marks each)
 (i) L(4, -1) M(1, -3), N(-2, -5)
 (ii) A(-5, 4), B(-2, -2), C(3, -12)
- (8) Find the distance of point Z(-2.4, -1), from the origin. (2 marks)
- (9) Show that the points A(4, 7) B(8, 4) and C(7, 11) are the vertices of a right angled triangle. (3 marks)
- (10) Show that A(4, -1), B(6, 0), C(7, -2) and D(5, -3) are the vertices of a square. (4 marks)
- (11) Find the coordinates of the circumcentre of PQR if P(2, 7), Q(-5, 8) and R(-6, 1).
- (12) Show that the points (2, 4), (2, 6) and $(2 + \sqrt{3}, 5)$ are the vertices of an equilateral triangle. (3 marks)
- (13) Find the coordinates of the circumcentre of ABC, if A(2, 3), B(4, -1) and C(5, 2). Also, find circumradius. (3 marks)
- Based on Practice Set 5.2**
- (14) Show that points A(1, -5), B(-4, -8), C(-1, -13) and D(4, -10) are the vertices of a rhombus. (4 marks)

- (15) Find the coordinates of the point P which divides line segment QR in the ratio m : n in the following examples. (2 marks each)
 (i) Q(-5, 8), R(4, -4) $m : n = 2 : 1$
 (ii) Q(-2, 7), R(-2, -5) $m : n = 1 : 3$
 (iii) Q(1, 7), R(-3, 1) $m : n = 1 : 2$
 (iv) Q(6, -5), R(-10, 2) $m : n = 3 : 4$
 (v) Q(5, 8), R(-7, -8) $m : n = 4 : 1$
- (16) Find the coordinates of the midpoint of segment QR, if Q(2.5, -4.3) and R(-1.5, 2.7) (2 marks)
- (17) Find the coordinates of the midpoint P of seg AB, if A(3.5, 9.5) and B(-1.5, 0.5) (2 marks)
- (18) In what ratio does the point (1, 3) divide line segment joining the points (3, 6) and (-5, -6)? (3 marks)
- (19) Find the lengths of the median of ABC whose vertices are A(7, -3), B(5, 3), C(3, -1). (4 marks)
- (20) Show that the line segment joining the points (5, 7), (3, 9) and (8, 6), (0, 10) bisect each other. (4 marks)
- (21) Segments AB and CD bisect each other at point M. If A(4, 3), B(-2, 5), C(-3, 5), then find coordinates of D. (4 marks)
- (22) Find the ratio in which the line segment joining the points (6, 4) and (1, -7) is divided by X-axis. (3 marks)
- (23) Find the coordinates of the points which divide the line segment joining the points (-2, 2) and (6, -6) in four equal parts. (3 marks)
- (24) Find the coordinates of the points which divide segment AB into four equal parts, if A(5, 7) and B(-3, -1) (4 marks)
- (25) If A-P-Q-B, point P and Q trisect seg AB and A(3, 1), Q(-1, 3), then find coordinates of points B and P. (4 marks)
- (26) Find the coordinates of centroid G of ABC, if
 (i) A(8, 9), B(4, 5), C(6, 2) (3 marks each)
 (ii) A(11, 8), B(-6, 5), C(1, -28)
- (27) The origin 'O' is the centroid of ABC in which A(-4, 3) B(3, k) and C(h, 5). Find h and k. (4 marks)
- (28) Find the coordinates of the points dividing the segment joining A(-5, 7) and B(11, -1) into four equal parts. (4 marks)

Based on Practice Set 5.3

- (29) Find the slope of a line which makes an angle with the positive X-axis. (1 mark each)
(i) 0° (ii) 30° (iii) 45° (iv) 60° (v) 90°
- (30) Find the slope of the line passing through the points. (2 marks each)
(i) $(-1, 4)$ $(3, -7)$ (ii) $(5, 5)$, $(1, 6)$
(iii) $(1, 7)$ $(4, 8)$ (iv) $(4, 8)$, $(5, 5)$
(v) $(4, 1)$ $(2, -3)$ (vi) $(4, 4)$, $(3, 5)$
- (31) Using slope concept, check whether the following points are collinear. (2 marks each)
(i) $(-2, -1)$ $(4, 0)$ $(3, 3)$
(ii) $(-2, -3)$, $(\frac{33}{8}, 4)$ $(5, 5)$
(iii) $(4, 4)$ $(3, 5)$ $(-1, -1)$
(iv) $(2, 10)$, $(0, 4)$ $(3, 13)$
(v) $(5, 0)$ $(10, -3)$ $(-5, 6)$
(vi) $(2, 5)$, $(5, 7)$ $(8, 9)$
- (32) Find the value of k , if $(5, k)$, $(-3, 1)$ and $(-7, -2)$ are collinear. (3 marks)
- (33) Find the value of k , if $(2, 1)$ $(4, 3)$ and $(0, k)$ are collinear 1. (3 marks)
- (34) Find the value of k , if the slope of the line passing through $(2, 5)$ and $(k, 3)$ is 2. (2 marks)
- (35) $P(3, 4)$, $Q(7, 2)$ and $R(-2, -1)$ are the vertices of PQR. Write down the slope of each side of the triangle. (4 marks)
- (36) Show that line joining $(4, -1)$ and $(6, 0)$ is parallel to line joining $(7, -2)$ and $(5, -3)$. (4 marks)
- (37) Show that $\square ABCD$ is a parallelogram, if $A(-1, 2)$, $B(-5, -6)$ $C(3, -2)$ and $D(7, 6)$
- (38) Show that $P(3, 4)$, $Q(7, -2)$, $R(1, 1)$ and $S(-3, 7)$ are the vertices of a parallelogram.

ANSWERS

- (1) (i) $2\sqrt{41}$ (ii) $\sqrt{205}$ (iii) $5\sqrt{2}$ (iv) $2\sqrt{5}$
- (4) $5y = x + 5$ (6) $(0, 9)$
- (7) (i) collinear (ii) non-collinear
- (8) 2.6 units (11) $(-2, 4)$
- (13) $(3, 1)$ circumradius = $\sqrt{5}$ units
- (15) (i) $(1, 0)$ (ii) $(-2, 4)$ (iii) $(-\frac{1}{3}, 5)$
(iv) $(-\frac{6}{7}, -2)$ (v) $(\frac{23}{5}, -\frac{24}{5})$
- (16) $(0.5, -0.8)$ (17) $(1, 5)$ (18) $1 : 3$
- (19) $5, 5, \sqrt{10}$ (21) $(5, 3)$ (22) $4 : 7$
- (23) $(0, 0)$ $(2, -2)$ $(4, -4)$ (24) $(3, 5)$ $(1, 3)$ $(-1, 1)$
- (25) $(-3, 4)$ $(1, 2)$ (26) (i) $(6, 5.33)$ (ii) $(2, -5)$
- (27) $h = 1, k = -8$ (28) $(-1, 5)$ $(3, 3)$ $(7, 1)$
- (29) (i) 0 (ii) $\frac{1}{\sqrt{3}}$ (iii) 1 (iv) $\sqrt{3}$ (v) not defined
- (30) (i) $-1\frac{1}{4}$ (ii) $-\frac{1}{4}$ (iii) $\frac{1}{3}$ (iv) -3 (v) 2 (vi) -1
- (31) (ii), (iv), (v), (vi) are collinear.
- (32) 7 (33) -1 (34) 1 (35) $-\frac{1}{2}, \frac{1}{3}, 1$

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ASSIGNMENT - 5

Time : 1 Hr.

Marks : 20

Q.1. A. Choose the proper alternative answer for the questions given below:

(2)

- (1) Distance of point $(-3, 4)$ from the origin is
(A) 7 (B) 1 (C) 5 (D) -5
- (2) Line l is parallel to line m . If slope of line l is $\frac{1}{2}$ then slope of line m is
(A) -2 (B) 0 (C) $\frac{1}{2}$ (D) Can't say

Q.1. B. Solve the following questions:

(2)

- (1) Slope of a line is $\sqrt{3}$. Find its inclination.
- (2) Find the distance between $(2, 3)$ and $(4, 1)$.

Q.2. Perform any one of the following activities:

(2)

- (1) Seg AB is a diameter of a circle with centre P $(1, 2)$. If A $(-4, 2)$, then find the co-ordinates of point B.
- (2) If P - T - Q and P $(-3, 10)$, Q $(6, -8)$ and T $(-1, 6)$, then find the ratio in which point T divides seg PQ (Complete the following activity)

Let point T divides seg PQ in the ratio $m : n$

$$P(-3, 10) = (x_1, y_1) \quad Q(6, -8) = (x_2, y_2) \quad T(-1, 6) = (x, y)$$

By section formula,

$$x = \frac{\square \times \square + \square \times \square}{\square + \square}$$

$$\therefore -3 \left(\square + \square \right) = \square \times \square + \square \times \square$$

$$\therefore -3\square + -3\square = \square \times \square + \square \times \square$$

$$\therefore -3\square - \square \times \square = \square \times \square + 3\square$$

$$\therefore \square m = \square n$$

$$\therefore m : n = \square : \square$$

- (3) A $(-7, 6)$, B $(2, -2)$ and C $(8, 5)$ are co-ordinates of vertices of $\triangle ABC$. Find the co-ordinates of centroid of $\triangle ABC$.

Q.3. Solve any two of the following questions:

(6)

- (1) Decide $(2, 10)$, $(0, 4)$ and $(3, 13)$ are collinear or not.
- (2) Line PQ $\parallel$ Line RS. P $(2, 4)$, Q $(3, 6)$ R $(3, 1)$ and S $(5, K)$.
- (3) Prove that $(\sqrt{2}, \sqrt{2})$, $(-\sqrt{2}, -\sqrt{2})$ and $(-\sqrt{6}, \sqrt{6})$ are the vertices of an equilateral triangle.

Q.4. Attempt the following:

(8)

- (1) Find the co-ordinates of circumcentre of $\triangle ABC$ if A $(7, 1)$, B $(3, 5)$ and C $(2, 0)$
- (2) Find the possible co-ordinates of the fourth vertex of the parallelogram, if three of its vertices are $(5, 6)$, $(1, -2)$ and $(-3, 2)$.
- (3) Find the co-ordinates of the points which divide the line segment joining the points $(-2, 2)$ and $(6, -6)$ into four equal parts.

