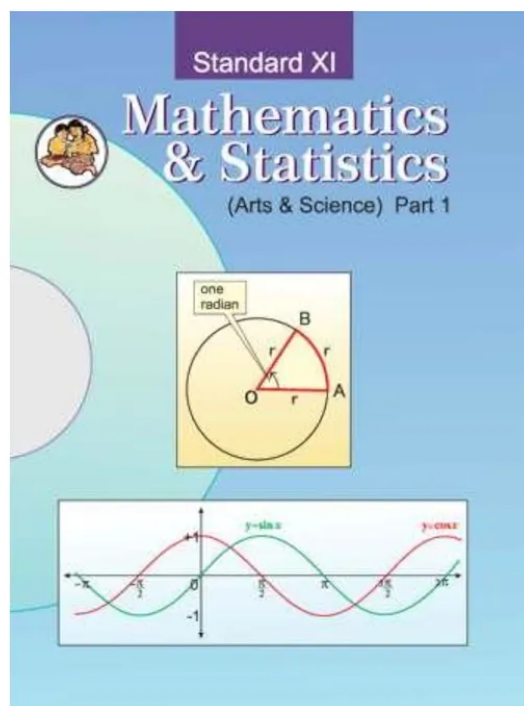


Maharashtra Board Solutions Class 11-Arts & Science Maths (Part 1): Chapter 5- Straight Line

Class 11 - Chapter 5 Straight Line



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Maharashtra Board Solutions Class 11-Arts & Science Maths (Part 1): Chapter 5- Straight Line

Class 11: Maths Chapter 5 solutions. Complete Class 11 Maths Chapter 5 Notes.

Maharashtra Board Solutions Class 11-Arts & Science Maths (Part 1): Chapter 5- Straight Line

Maharashtra Board 11th Maths Chapter 5, Class 11 Maths Chapter 5 solutions

Ex 5.1

Question 1.

If A(1, 3) and B(2, 1) are points, find the equation of the locus of point P such that PA = PB.

Solution:

Let P(x, y) be any point on the required locus.

Given, A(1, 3), B(2, 1) and

$$PA = PB$$

$$\therefore PA^2 = PB^2$$

$$\therefore (x - 1)^2 + (y - 3)^2 = (x - 2)^2 + (y - 1)^2$$

$$\therefore x^2 - 2x + 1 + y^2 - 6y + 9 = x^2 - 4x + 4 + y^2 - 2y + 1$$

$$-2x - 6y + 10 = -4x - 2y + 5$$

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$$\therefore 2x - 4y + 5 = 0$$

$\therefore$ The required equation of locus is $2x - 4y + 5 = 0$.

Question 2.

A(- 5,2) and B(4,1). Find the equation of the locus of point P, which is equidistant from A and B.

Solution:

Let P(x, y) be any point on the required locus.

P is equidistant from A(- 5, 2) and B(4, 1).

$$\therefore PA = PB$$

$$\therefore PA^2 = PB^2$$

$$\therefore (x + 5)^2 + (y - 2)^2 = (x - 4)^2 + (y - 1)^2$$

$$\therefore x^2 + 10x + 25 + y^2 - 4y + 4$$

$$= x^2 - 8x + 16 + y^2 - 2y + 1$$

$$\therefore 10x - 4y + 29 = -8x - 2y + 17$$

$$\therefore 18x - 2y + 12 = 0$$

$$\therefore 9x - y + 6 = 0$$

The required equation of locus is $9x - y + 6 = 0$.

Question 3.

If A(2, 0) and B(0, 3) are two points, find the equation of the locus of point P such that $AP = 2BP$.

Solution:

Let P(x, y) be any point on the required locus.

Given, A(2, 0), B(0, 3) and $AP = 2BP$

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$$\therefore AP^2 = 4BP^2$$

$$\therefore (x - 2)^2 + (y - 0)^2 = 4[(x - 0)^2 + (y - 3)^2]$$

$$\therefore x^2 - 4x + 4 + y^2 = 4(x^2 + y^2 - 6y + 9)$$

$$x^2 - 4x + 4 + y^2 = 4x^2 + 4y^2 - 24y + 36$$

$$\therefore 3x^2 + 3y^2 + 4x - 24y + 32 = 0$$

$\therefore$ The required equation of locus is

$$3x^2 + 3y^2 + 4x - 24y + 32 = 0.$$

[Note: Answer given in the textbook , is

$$'3x^2 + 3y^2 + 4x + 24y + 32 = 0']$$

However, as per our calculation it is ' $3x^2 + 3y^2 + 4x - 24y + 32 = 0$ '.]

Question 4.

If A(4,1) and B(5,4), find the equation of the locus of point P such that $PA^2 = 3PB^2$.

Solution:

Let P(x, y) be any point on the required locus. Given, A(4,1), B(5,4) and $PA^2 = 3PB^2$

$$\therefore (x - 4)^2 + (y - 1)^2 = 3[(x - 5)^2 + (y - 4)^2]$$

$$\therefore x^2 - 8x + 16 + y^2 - 2y + 1 = 3(x^2 - 10x + 25 + y^2 - 8y + 16)$$

$$\therefore x^2 - 8x + y^2 - 2y + 17 = 3x^2 - 30x + 75 + 3y^2 - 24y + 48$$

$$\therefore 2x^2 + 2y^2 - 22x - 22y + 106 = 0$$

$$\therefore x^2 + y^2 - 11x - 11y + 53 = 0$$

$\therefore$ The required equation of locus is

$$x^2 + y^2 - 11x - 11y + 53 = 0.$$

Question 5.

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A(2, 4) and B(5, 8), find the equation of the

locus of point P such that $PA^2 - PB^2 = 13$.

Solution:

Let P(x, y) be any point on the required locus. Given, A(2,4), B(5, 8) and $PA^2 - PB^2 = 13$

$$\therefore [(x-2)^2 + (y-4)^2] - [(x-5)^2 + (y-8)^2] = 13$$

$$\therefore (x^2 - 4x + 4 + y^2 - 8y + 16) - (x^2 - 10x + 25 + y^2 - 16y + 64) = 13$$

$$\therefore x^2 - 4x + y^2 - 8y + 20 - x^2 + 10x - y^2 + 16y - 89 = 13$$

$$\therefore 6x + 8y - 69 = 13$$

$$\therefore 6x + 8y - 82 = 0$$

$$\therefore 3x + 4y - 41 = 0$$

$\therefore$ The required equation of locus is $3x + 4y - 41 = 0$.

Question 6.

A(1, 6) and B(3, 5), find the equation of the locus of point P such that segment AB subtends right angle at P. ($\angle APB = 90^\circ$)

Solution:

Let P(x, y) be any point on the required locus. Given,

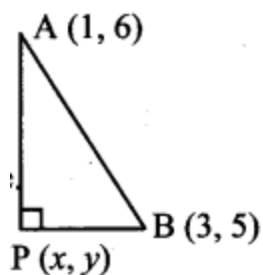
A(1, 6) and B(3, 5),

$$\angle APB = 90^\circ$$

$\therefore \Delta APB$ is a right angled triangle,

By Pythagoras theorem,

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$$AP^2 + PB^2 = AB^2 \quad P(x, y)$$

$$\therefore [(x-1)^2 + (y-6)^2] + [(x-3)^2 + (y-5)^2] = (1-3)^2 + (6-5)^2$$

$$\therefore x^2 - 2x + 1 + y^2 - 12y + 36 + x^2 - 6x + 9 + y^2 - 10y + 25 = 4 + 1$$

$$\therefore 2x^2 + 2y^2 - 8x - 22y + 66 = 0$$

$$\therefore x^2 + y^2 - 4x - 11y + 33 = 0$$

$$\therefore \text{The required equation of locus is } x^2 + y^2 - 4x - 11y + 33 = 0.$$

[Note: Answer given in the textbook is

$$'3x^2 + 4y^2 - 4x - 11y + 33 = 0']$$

However, as per our calculation it is ' $x^2 + y^2 - 4x - 11y + 33 = 0$ '

Question 7.

If the origin is shifted to the point $O'(2, 3)$, the axes remaining parallel to the original axes, find the new co-ordinates of the points

i. $A(1, 3)$ ii. $B(2, 5)$

Solution:

Origin is shifted to $(2, 3) = (h, k)$

Let the new co-ordinates be (X, Y) .

$$x = X + h \text{ and } y = Y + k$$

$$x = X + 2 \text{ and } y = Y + 3 \dots (i)$$

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i. Given, $A(x, y) = A(1, 3)$

$x = X + 2$ and $y = Y + 3$...[From(i)]

$\therefore 1 = X + 2$ and $3 = Y + 3$ $X = -1$ and $Y = 0$

$\therefore$ The new co-ordinates of point A are $(-1, 0)$.

ii. Given, $B(x, y) = B(2, 5)$

$x = X + 2$ and $y = Y + 3$...[From(i)]

$\therefore 2 = X + 2$ and $5 = Y + 3$

$\therefore X = 0$ and $Y = 2$

$\therefore$ The new co-ordinates of point B are $(0, 2)$.

Question 8.

If the origin is shifted to the point $O'(1, 3)$, the axes remaining parallel to the original axes, find the old co-ordinates of the points

i. $C(5, 4)$ ii. $D(3, 3)$

Solution:

Origin is shifted to $(1, 3) = (h, k)$

Let the new co-ordinates be (X, Y) .

$x = X + h$ and $y = Y + k$

$\therefore x = X + 1$ and $y = Y + 3$... (i)

i. Given, $C(X, Y) = C(5, 4)$

$x = X + 1$ and $y = Y + 3$...[From(i)]

$\therefore x = 5 + 1 = 6$ and $y = 4 + 3 = 7$

$\therefore$ The old co-ordinates of point C are $(6, 7)$.

ii. Given, $D(X, Y) = D(3, 3)$

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$$x = X + 1 \text{ and } y = Y + 3 \dots [\text{From (i)}]$$

$$\therefore x = 3 + 1 = 4 \text{ and } y = 3 + 3 = 6$$

$\therefore$ The old co-ordinates of point D are (4, 6).

Question 9.

If the co-ordinates A(5, 14) change to B(8, 3) by shift of origin, find the co-ordinates of the point, where the origin is shifted.

Solution:

Let the origin be shifted to (h, k).

$$\text{Given, } A(x, y) = A(5, 14), B(X, Y) = B(8, 3)$$

$$\text{Since } x = X + h \text{ and } y = Y + k,$$

$$5 = 8 + h \text{ and } 14 = 3 + k,$$

$$\therefore h = -3 \text{ and } k = 11$$

The co-ordinates of the point, where the origin is shifted are (-3, 11).

Question 10.

Obtain the new equations of the following loci if the origin is shifted to the point O'(2,2), the direction of axes remaining the same:

i. $3x - y + 2 = 0$

11. $x^2 + y^2 - 3x = 7$

iii. $xy - 2x - 2y + 4 = 0$

iv. $y^2 - 4x - 4y + 12 = 0$

Solution:

$$\text{Given, } (h, k) = (2, 2)$$

Let (X, Y) be the new co-ordinates of the point (x, y).

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$$\therefore x = X + \text{handy} = Y + k$$

$$\therefore x = X + 2 \text{ and } y = Y + 2$$

i. Substituting the values of x and y in the equation $3x - y + 2 = 0$, we get

$$3(X + 2) - (Y + 2) + 2 = 0$$

$$\therefore 3X + 6 - Y - 2 + 2 = 0$$

$$\therefore 3X - Y + 6 = 0, \text{ which is the new equation of locus.}$$

ii. Substituting the values of x and y in the equation

$$x^2 + y^2 - 3x = 7, \text{ we get}$$

$$(X + 2)^2 + (Y + 2)^2 - 3(X + 2) = 7$$

$$\therefore X^2 + 4X + 4 + Y^2 + 4Y + 4 - 3X - 6 = 7$$

$$\therefore X^2 + Y^2 + X + 4Y - 5 = 0, \text{ which is the new}$$

equation of locus.

iii; Substituting the values of x and y in the equation $xy - 2x - 2y + 4 = 0$, we get

$$(X + 2)(Y + 2) - 2(X + 2) - 2(Y + 2) + 4 = 0$$

$$\therefore XY + 2X + 2Y + 4 - 2X - 4 - 2Y - 4 + 4 = 0$$

$$\therefore XY = 0, \text{ which is the new equation of locus.}$$

iv. Substituting the values of x and y in the equation $y^2 - 4x - 4y + 12 = 0$, we get

$$(Y + 2)^2 - 4(X + 2) - 4(Y + 2) + 12 = 0$$

$$\therefore Y^2 + 4Y + 4 - 4X - 8 - 4Y - 8 + 12 = 0$$

$$\therefore Y^2 - 4X = 0, \text{ which is the new equation of locus.}$$

Ex 5.2

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Question 1.

Find the slope of each of the lines which passes through the following points:

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

ii. C(-2,3), D(5, 7)

iii. E(2,3), F(2, -1)

iv. G(7,1), H(-3,1)

Solution:

i. Here, A = (2, -1) and B = (4, 3)

$$\text{Slope of line AB} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - (-1)}{4 - 2} = \frac{4}{2} = 2$$

ii. Here, C = (-2, 3) and D = (5, 7)

$$\text{Slope of line CD} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{7 - 3}{5 - (-2)} = \frac{4}{7}$$

iii. Here, E = (2, 3) and F = (2, -1)

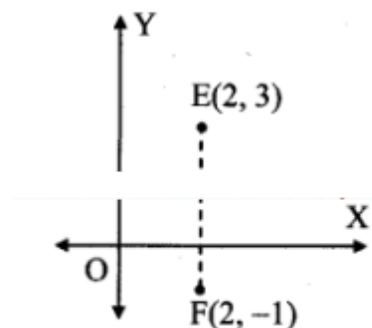
$$\text{Slope of line EF} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - 3}{2 - 2} = \frac{-4}{0}, \text{ which is not defined.}$$

Alternate Method:

Points E and F have same x co-ordinates i.e. 2.

Points E and F lie on a line parallel to Y-axis.

∴ The slope of EF is not defined.



iv. Here, $G = (7, 1)$ and $H = (-3, 1)$

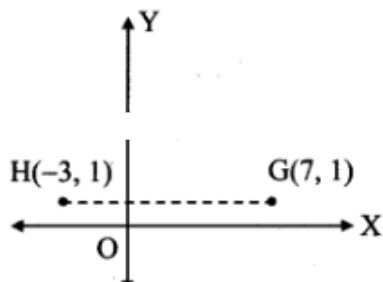
$$\text{Slope of line GH} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1 - 1}{-3 - 7} = 0$$

Alternate Method:

Points G and H have same y co-ordinate i.e. 1.

∴ Points G and H lie on a line parallel to the X-axis.

∴ The slope of GH is 0.



Question 2.

If the x and x-intercepts of line L are 2 and 3 respectively, then find the slope of line L.

Solution:

Given, x-intercept of line L is 2 and y-intercept of line L is 3

∴ The line L intersects X-axis at (2, 0) and Y-axis at (0, 3).

∴ The line L passes through (2, 0) and (0, 3).

$$\text{Slope of line L} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 0}{0 - 2} = \frac{-3}{2}$$

Question 3.

Find the slope of the line whose inclination is 30° .

Solution:

Given, inclination (θ) = 30°

$$\therefore \text{Slope of the line} = \tan \theta = \tan 30^\circ = \frac{1}{\sqrt{3}}$$

Question 4.

Find the slope of the line whose inclination is $\frac{\pi}{4}$

Solution:

Given, inclination (θ) = $\frac{\pi}{4}$

$$\therefore \text{Slope of the line} = \tan \theta = \tan \frac{\pi}{4} = 1$$

Question 5.

A line makes intercepts 3 and 3 on the co-ordinate axes. Find the inclination of the line.

Solution:

Given, x-intercept of line is 3 and y-intercept of line is 3

$\therefore$ The line intersects X-axis at (3, 0) and Y-axis at (0, 3).

$\therefore$ The line passes through (3, 0) and (0, 3).

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

But, slope of a line = $\tan \theta$

$$\therefore \tan \theta = -1$$

$$= -\tan \frac{\pi}{4}$$

$$= \tan\left(\pi - \frac{\pi}{4}\right) \dots [\tan(\pi - \theta) = -\tan \theta]$$

$$\tan \theta = \tan \frac{3\pi}{4}$$

$$\theta = \frac{3\pi}{4}$$

The inclination of the line is $\frac{3\pi}{4}$.

[Note: Answer given in the textbook is '-1' However, as per our calculation it is $\frac{3\pi}{4}$]

Question 6.

Without using Pythagoras theorem, show that points A (4, 4), B (3, 5) and C (-1, -1) are the vertices of a right-angled triangle.

Solution:

Given, A(4,4), B(3, 5), C (-1, -1).

$$\text{Slope of AB} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5-4}{3-4} = -1$$

$$\text{Slope of BC} = \frac{-1-5}{-1-3} = \frac{-6}{-4} = \frac{3}{2}$$

$$\text{Slope of AC} = \frac{-1-4}{-1-4} = 1$$

$$\text{Slope of AB} \times \text{slope of AC} = -1 \times 1 = -1$$

$\therefore$ side AB $\perp$ side AC

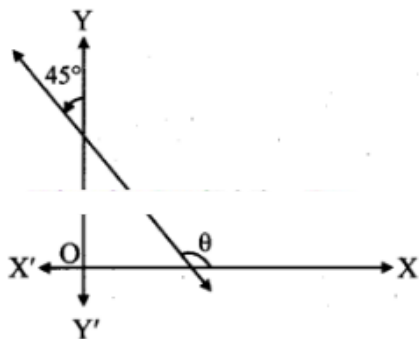
$\therefore$ $\triangle ABC$ is a right angled triangle right angled at A.

$\therefore$ The given points are the vertices of a right angled triangle.

Question 7.

Find the slope of the line which makes angle of 45° with the positive direction of the Y-axis measured anticlockwise.

Solution:



Since the line makes an angle of 45° with positive direction of Y-axis in anticlockwise direction,
 Inclination of the line $(\theta) = (90^\circ + 45^\circ)$
 $\therefore$ Slope of the line $= \tan(90^\circ + 45^\circ)$
 $= -\cot 45^\circ$
 $= -1$

Question 8.

Find the value of k for which the points P(k, -1), Q(2,1) and R(4,5) are collinear.

Solution:

Given, points P(k, -1), Q (2, 1) and R(4, 5) are collinear.

$\therefore$ Slope of PQ = Slope of QR .

$$\therefore \frac{1 - (-1)}{2 - k} = \frac{5 - 1}{4 - 2}$$

$$\therefore \frac{2}{2 - k} = \frac{4}{2}$$

$$\therefore 4 = 4 (2 - k)$$

$$\therefore 1 = 2 - k$$

$$\therefore k = 2 - 1 = 1$$

Question 9.

Find the acute angle between the X-axis and the line joining the points A(3, -1) and B(4, -2).

Solution:

Given, A (3, -1) and B (4, -2)

$$\text{Slope of AB} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - (-1)}{4 - 3} = -1$$

But, slope of a line = $\tan \theta$

$$\therefore \tan \theta = -1$$

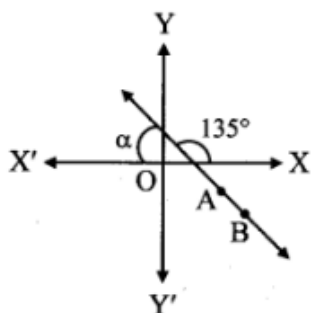
$$= -\tan 45^\circ$$

$$= \tan (180^\circ - 45^\circ)$$

$$\dots [\because \tan (180^\circ - \theta) = -\tan \theta]$$

$$= \tan 135^\circ$$

$$\therefore \theta = 135^\circ$$



Let α be the acute angle that line AB makes with X-axis.

$$\text{Then, } \alpha + 0 = 180^\circ$$

$$\alpha = 180^\circ - 135^\circ = 45^\circ$$

$\therefore$ The acute angle between the X-axis and the line joining the points A and B is 45° .

Question 10.

A line passes through points A(x₁, y₁) and B(h, k). If the slope of the line is m, then show that $k - y_1 = m(h - x_1)$.

Solution:

Given, A(x₁, y₁), B(h, k) and

slope of line AB = m

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

$$\therefore m = \frac{k - y_1}{h - x_1}$$

$$\therefore k - y_1 = m(h - x_1)$$

Question 11.

If the points A(h, 0), B(0, k) and C(a, b) lie on a line, then show that $\frac{a}{h} + \frac{b}{k} = 1$.

Solution:

Given, A(h, 0), B(0, k) and C(a, b)

Since the points A, B and C lie on a line, they are collinear.

$\therefore$ Slope of AB = slope of BC

$$\therefore \frac{k - 0}{0 - h} = \frac{b - k}{a - 0}$$

$$\therefore ak = -h(b - k)$$

$$\therefore \frac{a}{h} = \frac{k - b}{k}$$

$$\therefore \frac{a}{h} = 1 - \frac{b}{k}$$

$$\therefore \frac{a}{h} + \frac{b}{k} = 1$$

Ex 5.3

Question 1.

Write the equation of the line:

- parallel to the X-axis and at a distance of 5 units from it and above it.
- parallel to the Y-axis and at a distance of 5 units from it and to the left of it.
- parallel to the X-axis and at a distance of 4 units from the point (-2, 3).

Solution:

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i. Equation of a line parallel to X-axis is $y = k$. Since the line is at a distance of 5 units above X-axis, $k = 5$

∴ The equation of the required line is $y = 5$.

ii. Equation of a line parallel to Y-axis is $x = h$. Since the line is at a distance of 5 units to the left of Y-axis, $h = -5$

∴ The equation of the required line is $x = -5$.

[Note: Answer given in the textbook is ' $y = -5$ ']

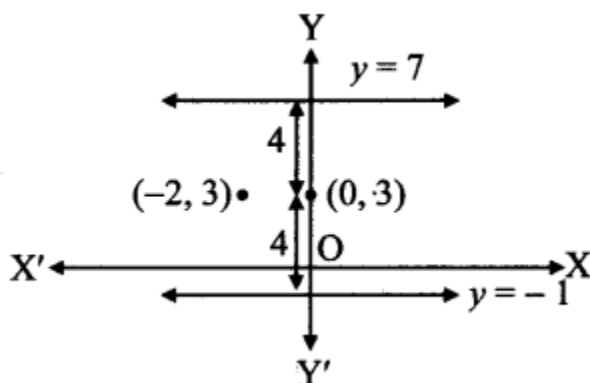
However, we found that ' $x = -5$ '.]

iii. Equation of a line parallel to the X-axis is of the form $y = k$ ($k > 0$ or $k < 0$).

Since the line is at a distance of 4 units from the point $(-2, 3)$,

$$k = 4 + 3 = 7 \text{ or } k = 3 - 4 = -1$$

∴ The equation of the required line is $y = 1$ or $y = -1$.



Question 2.

Obtain the equation of the line:

i. parallel to the X-axis and making an intercept of 3 units on the Y-axis.

ii. parallel to the Y-axis and making an intercept of 4 units on the X-axis.

Solution:

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i. Equation of a line parallel to X-axis with y-intercept 'k' is $y = k$.

Here, y-intercept = 3

∴ The equation of the required line is $y = 3$.

ii. Equation of a line parallel to Y-axis with x-intercept 'h' is $x = h$.

Here, x-intercept = 4

∴ The equation of the required line is $x = 4$.

Question 3.

Obtain the equation of the line containing the point:

i. A(2, -3) and parallel to the Y-axis.

ii. B(4, -3) and parallel to the X-axis.

Solution:

i. Equation of a line parallel to Y-axis is of the form $x = h$.

Since the line passes through A(2, -3), $h = 2$

∴ The equation of the required line is $x = 2$.

ii. Equation of a line parallel to X-axis is of the form $y = k$.

Since the line passes through B(4, -3), $k = -3$

∴ The equation of the required line is $y = -3$.

Question 4.

Find the equation of the line:

- i. passing through the points A(2, 0) and B(3,4)
- ii. passing through the points P(2, 1) and Q(2,-1)

Solution:

- i. The required line passes through the points A(2, 0) and B(3,4).

Equation of the line in two point form is $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$

Here, $(x_1, y_1) = (2, 0)$ and $(x_2, y_2) = (3, 4)$

∴ The equation of the required line is

$$\therefore \frac{y-0}{4-0} = \frac{x-2}{3-2}$$

$$\therefore \frac{y}{4} = \frac{x-2}{1}$$

$$\therefore y = 4(x-2)$$

$$\therefore y = 4x - 8$$

$$\therefore 4x - y - 8 = 0$$

- ii. The required line passes through the points P(2, 1) and Q(2,-1).

Since both the given points have same

x co-ordinates i.e. 2,

the given points lie on the line $x = 2$.

∴ The equation of the required line is $x = 2$.

Question 5.

Find the equation of the line:

- i. containing the origin and having inclination 60° .
 - ii. passing through the origin and parallel to AB, where A is (2,4) and B is (1,7).
-

- iii. having slope $1/2$ and containing the point $(3, -2)$
- iv. containing the point $A(3, 5)$ and having slope $2/3$
- v. containing the point $A(4, 3)$ and having inclination 120° .
- vi. passing through the origin and which bisects the portion of the line $3x + y = 6$ intercepted between the co-ordinate axes.

Solution:

i. Given, Inclination of line $= \theta = 60^\circ$

Slope of the line $(m) = \tan \theta = \tan 60^\circ$

$$= \sqrt{3}$$

Equation of the line having slope m and passing through origin $(0, 0)$ is $y = mx$.

$\therefore$ The equation of the required line is $y = \sqrt{3}x$

ii. Given, $A(2, 4)$ and $B(1, 7)$

$$\text{Slope of } AB = \frac{7-4}{1-2} = -3$$

Since the required line is parallel to line AB , slope of required line $(m) = \text{slope of } AB$

$\therefore m = -3$ and the required line passes through the origin.

Equation of the line having slope m and passing through origin $(0, 0)$ is $y = mx$.

$\therefore$ The equation of the required line is $y = -3x$

iii. Given, slope(m) = $-\frac{1}{2}$ and the line passes through $(3, -2)$.

Equation of the line in slope point form is

$$y - y_1 = m(x - x_1)$$

$\therefore$ The equation of the required line is

$$[y - (-2)] = -\frac{1}{2}(x - 3)$$

$$\therefore 2(y + 2) = x - 3$$

$$\therefore 2y + 4 = x - 3$$

$$\therefore x - 2y - 7 = 0$$

iv. Given, slope(m) = $\frac{2}{3}$ and the line passes through $(3, 5)$.

Equation of the line in slope point form is $y - y_1 = m(x - x_1)$

$\therefore$ The equation of the required line is $y - 5 = \frac{2}{3}(x - 3)$

$$\therefore 3(y - 5) = 2(x - 3)$$

$$\therefore 3y - 15 = 2x - 6$$

$$\therefore 2x - 3y + 9 = 0$$

v. Given, Inclination of line = $\theta = 120^\circ$

Slope of the line (m) = $\tan \theta = \tan 120^\circ$

$$= \tan (90^\circ + 30^\circ)$$

$$= -\cot 30^\circ$$

$$= -\sqrt{3}$$

and the line passes through $A(4, 3)$.

Equation of the line in slope point form is $y - y_1 = m(x - x_1)$

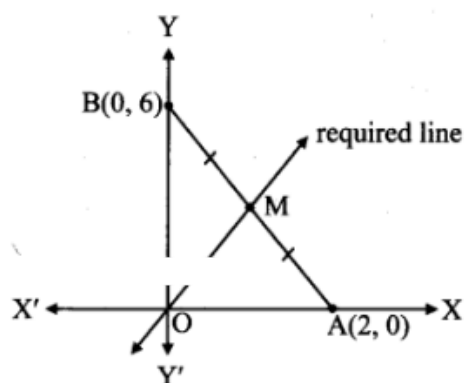
$\therefore$ The equation of the required line is

$$y - 3 = -\sqrt{3}(x - 4)$$

$$\therefore y - 3 = -\sqrt{3}x + 4\sqrt{3}$$

$$\therefore \sqrt{3}x + y - 3 - 4\sqrt{3} = 0$$

vi.



Given equation of the line is $3x + y = 6$.

$$\therefore \frac{x}{2} + \frac{y}{6} = 1$$

This equation is of the form $\frac{x}{a} + \frac{y}{b} = 1$,

where $a = 2$, $b = 6$

$\therefore$ The line $3x + y = 6$ intersects the X-axis and Y-axis at $A(2, 0)$ and $B(0, 6)$ respectively. Required line is passing through the midpoint of AB.

$$\therefore \text{Midpoint of AB} = \left(\frac{2+0}{2}, \frac{0+6}{2} \right) = (1, 3)$$

$\therefore$ Required line passes through $(0, 0)$ and $(1, 3)$.

Equation of the line in two point form is

$$\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$$

$\therefore$ The equation of the required line is

$$\frac{y-0}{3-0} = \frac{x-0}{1-0}$$

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

$$\therefore y = 3x$$

$$\therefore 3x - y = 0$$

Alternate Method:

Given equation of the line is $3x + y = 6$... (i)

Substitute $y = 0$ in (i) to get a point on X-axis.

$$\therefore 3x + 0 = 6$$

$$\therefore x = 2$$

Substitute $x = 0$ in (i) to get a point on Y-axis.

$$\therefore 3(0) + y = 6$$

$$\therefore y = 6$$

$\therefore$ The line $3x + y = 6$ intersects the X-axis and Y-axis at A(2,0) and B(0,6) respectively.

Let M be the midpoint of AB.

$$M = \left(\frac{2+0}{2}, \frac{0+6}{2} \right) = (1,3)$$

$$\text{Slope of OM (m)} = \frac{3-0}{1-0} = 3$$

Equation of OM is of the form $y = mx$.

$\therefore$ The equation of the required line is $y = 3x$

$$\therefore 3x - y = 0$$

Question 6.

Line $y = mx + c$ passes through the points A(2,1) and B(3,2). Determine m and c.

Solution:

Given, A(2, 1) and B(3,2)

Equation of the line in two point form is $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$

$\therefore$ The equation of the required line is

$$\begin{aligned} \frac{y-1}{2-1} &= \frac{x-2}{3-2} \\ \therefore \frac{y-1}{1} &= \frac{x-2}{1} \\ \therefore y-1 &= x-2 \end{aligned}$$

$$\therefore y = x - 1$$

Comparing this equation with $y = mx + c$, we get

$$m = 1 \text{ and } c = -1$$

Alternate Method:

Points A(2, 1) and B(3, 2) lie on the line $y = mx + c$.

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$\therefore$ They must satisfy the equation.

$$\therefore 2m + c = 1 \dots(i)$$

$$\text{and } 3m + c = 2 \dots(ii)$$

equation (ii) – equation (i) gives $m = 1$

Substituting $m = 1$ in (i), we get $2(1) + c = 1$

$$\therefore c = 1 - 2 = -1$$

Question 7.

Find the equation of the line having inclination 135° and making x-intercept 7.

Solution:

Given, Inclination of line $= \theta = 135^\circ$

$$\therefore \text{Slope of the line } (m) = \tan \theta = \tan 135^\circ$$

$$= \tan (90^\circ + 45^\circ)$$

$$= -\cot 45^\circ = -1 \text{ x-intercept of the required line is 7.}$$

$\therefore$ The line passes through $(7, 0)$.

Equation of the line in slope point form is $y - y_1 = m(x - x_1)$

$$\therefore \text{The equation of the required line is } y - 0 = -1(x - 7)$$

$$\therefore y = -x + 7$$

$$\therefore x + y - 7 = 0$$

Question 8.

The vertices of a triangle are A(3, 4), B(2, 0) and C(-1, 6). Find the equations of the lines containing

i. side BC

ii. the median AD

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iii. the midpoints of sides AB and BC.

Solution:

Vertices of AABC are A(3, 4), B(2, 0) and C(-1, 6).

i. Equation of the line in two point form is

$$\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$$

∴ The equation of the side BC is

$$\frac{y-0}{6-0} = \frac{x-2}{-1-2}$$

$$\frac{y}{6} = \frac{x-2}{-3}$$

$$\therefore -3y = 6x - 12$$

$$\therefore 6x + 3y - 12 = 0$$

$$\therefore 2x + y - 4 = 0$$

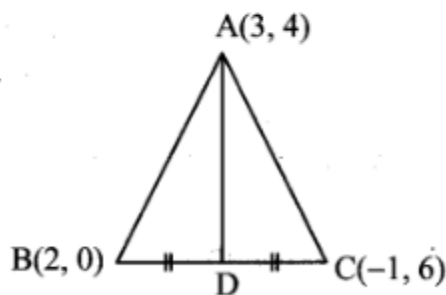
ii. Let D be the midpoint of side BC.

Then, AD is the median through A.

$$\therefore D = \left(\frac{2-1}{2}, \frac{0+6}{2} \right) = \left(\frac{1}{2}, 3 \right)$$

The median AD passes through the points

A(3,4) and D($\frac{1}{2}$, 3)



∴ The equation of the median AD is

$$\frac{y-4}{3-4} = \frac{x-3}{\frac{1}{2}-3}$$

$$\frac{y-4}{-1} = \frac{x-3}{-\frac{5}{2}}$$

$$\frac{5}{2}(y-4) = x-3$$

$$\therefore 5y - 20 = 2x - 6$$

$$\therefore 2x - 5y + 14 = 0$$

iii. Let D and E be the midpoints of side AB and side BC respectively.

The equation of the line DE is

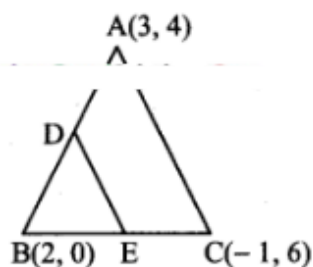
$$\therefore D = \left(\frac{3+2}{2}, \frac{4+0}{2} \right) = \left(\frac{5}{2}, 2 \right) \text{ and}$$

$$E = \left(\frac{2-1}{2}, \frac{0+6}{2} \right) = \left(\frac{1}{2}, 3 \right)$$

$\therefore$ The equation of the line DE is

$$\frac{y-2}{3-2} = \frac{x-\frac{5}{2}}{\frac{1}{2}-\frac{5}{2}}$$

$$\therefore \frac{y-2}{1} = \frac{2x-5}{-4}$$



$$\therefore -4(y-2) = 2x-5$$

$$\therefore 2x + 4y - 13 = 0$$

Question 9.

Find the x and y-intercepts of the following lines:

i. $\frac{x}{3} + \frac{y}{2} = 1$

ii. $\frac{3x}{2} + \frac{2y}{3} = 1$

iii. $2x - 3y + 12 = 0$

Solution:

i. Given equation of the line is $\frac{x}{3} + \frac{y}{2} = 1$

This is of the form $\frac{x}{a} + \frac{y}{b} = 1$,

where x-intercept = a, y-intercept = b

$\therefore$ x-intercept = 3, y-intercept = 2

ii. Given equation of the line is $\frac{3x}{2} + \frac{2y}{3} = 1$

$$\therefore \frac{x}{\left(\frac{2}{3}\right)} + \frac{y}{\left(\frac{3}{2}\right)} = 1$$

This is of the form $= \frac{x}{a} + \frac{y}{b} = 1$,

where x-intercept = a, y-intercept = b

$\therefore$ x-intercept = $\frac{2}{3}$ and y-intercept = $\frac{3}{2}$

iii. Given equation of the line is $2x - 3y + 12 = 0$

$$\therefore 2x - 3y = -12$$

$$\therefore \frac{2x}{(-12)} - \frac{3y}{(-12)} = 1$$

$$\therefore \frac{x}{-6} + \frac{y}{4} = 1$$

This is of the form $= 1$,

where x-intercept = a, y-intercept = b

$\therefore$ x-intercept = -6 and y-intercept = 4

Question 10.

Find equations of the line which contains the point A(1, 3) and the sum of whose intercepts on the co-ordinate axes is zero.

Solution:

Case I: Line not passing through origin.

Let the equation of the line be

$$\frac{x}{a} + \frac{y}{b} = 1 \dots\dots\dots(i)$$

Since, the sum of the intercepts of the line is zero.

$$\therefore a + b = 0$$

$$\therefore a + b = 0$$

$$\therefore b = -a$$

Substituting $b = -a$ in (i), we get

$$\frac{x}{a} + \frac{y}{(-a)} = 1$$

$$x - y = a \dots (ii)$$

Since, the line passes through $A(1, 3)$.

$$\therefore 1 - 3 = a$$

$$\therefore a = -2$$

Substituting the value of a in (ii), equation of the required line is

$$\therefore x - y = -2,$$

$$\therefore x - y + 2 = 0$$

Case II: Line passing through origin.

Slope of line passing through origin and

$$A(1, 3) \text{ is } m = \frac{3-0}{1-0} = 3$$

$\therefore$ Equation of the line having slope m and passing through origin $(0, 0)$ is $y = mx$.

$\therefore$ The equation of the required line is $y = 3x$

$$\therefore 3x - y = 0$$

Question 11.

Find equations of the line containing the point $A(3, 4)$ and making equal intercepts on the co-ordinate axes.

Solution:

Case I: Line not passing through origin.

Let the equation of the line be $\frac{x}{a} + \frac{y}{b} = 1 \dots\dots\dots(i)$

This line passes through $A(3, 4)$.

$$\therefore \frac{3}{a} + \frac{4}{b} = 1 \dots\dots\dots(ii)$$

Since, the required line make equal intercepts on the co-ordinate axes.

$$\therefore a = b \dots(iii)$$

Substituting the value of b in (ii), we get

$$\frac{3}{a} + \frac{4}{a} = 1$$

$$\therefore \frac{7}{a} = 1$$

$$\therefore a = 7$$

$$\therefore b = 7 \dots[From (iii)]$$

Substituting the values of a and b in (i), equation of the required line is

$$\frac{x}{7} + \frac{y}{7} = 1 = 1$$

$$\therefore x + y = 7$$

Case II: Line passing through origin.

$$\text{Slope of line passing through origin and } A(3,4) \text{ is } m = \frac{4-0}{3-0} = \frac{4}{3}$$

$\therefore$ Equation of the line having slope m and passing through origin (0, 0) is $y = mx$.

$\therefore$ The equation of the required line is 4

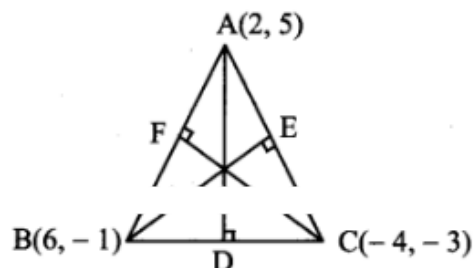
$$y = \frac{4}{3}x$$

$$\therefore 4x - 3y = 0$$

Question 12.

Find the equations of the altitudes of the triangle whose vertices are A(2, 5), B(6, - 1) and C(- 4, - 3).

Solution:



$A(2, 5)$, $B(6, -1)$, $C(-4, -3)$ are the vertices of $\triangle ABC$.

Let AD , BE and CF be the altitudes through the vertices A , B and C respectively of $\triangle ABC$.

$\therefore$ Slope of $AD = -5$... [$\because AD \perp BC$]

Since altitude AD passes through $(2, 5)$ and has slope -5 ,
equation of the altitude AD is $y - 5 = -5(x - 2)$

$$\therefore y - 5 = -5x + 10$$

$$\therefore 5x + y - 15 = 0$$

$$\text{Now, slope of } AC = \frac{-3-5}{-4-2} = \frac{-8}{-6} = \frac{4}{3}$$

$$\text{Slope of } BE = \frac{-3}{4}$$

... [$\because BE \perp AC$]

Since altitude BE passes through $(6, -1)$ and has slope $\frac{-3}{4}$,
equation of the altitude BE is

$$y - (-1) = \frac{-3}{4}(x - 6)$$

$$\therefore 4(y + 1) = -3(x - 6)$$

$$\therefore 4y + 4 = -3x + 18$$

$$\therefore 3x + 4y - 14 = 0$$

$$\text{Also, slope of } AB = \frac{-1-5}{6-2} = \frac{-6}{4} = \frac{-3}{2}$$

$\therefore$ Slope of $CF = \frac{2}{3}$... [$\because CF \perp AB$]

Since altitude CF passes through $(-4, -3)$ and has slope $\frac{2}{3}$,

Since altitude CF passes through $(-4, -3)$ and has slope, $\frac{2}{3}$

equation of the altitude CF is

$$y - (-3) = \frac{2}{3}[x - (-4)]$$

$$\therefore 3(y + 3) = 2(x + 4)$$

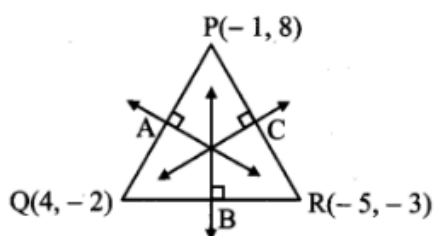
$$\therefore 3y + 9 = 2x + 8$$

$$\therefore 2x - 3y - 1 = 0$$

Question 13.

Find the equations of perpendicular bisectors of sides of the triangle whose vertices are $P(-1, 8)$, $Q(4, -2)$ and $R(-5, -3)$.

Solution:



Let A, B and C be the midpoints of sides PQ, QR and PR respectively of $\triangle PQR$.

A is the midpoint of side PQ.

$$\therefore A \equiv \left(\frac{-1+4}{2}, \frac{8-2}{2} \right) = \left(\frac{3}{2}, 3 \right)$$

$$\text{Slope of side PQ} = \frac{-2-8}{4-(-1)} = \frac{-10}{5} = -2$$

Slope of perpendicular bisector of PQ is $\frac{1}{2}$ and it passes through $\left(\frac{3}{2}, 3\right)$.

Equation of the perpendicular bisector of side PQ is

$$y - 3 = \frac{1}{2} \left(x - \frac{3}{2} \right)$$

$$y - 3 = \left(\frac{1}{2} \left(\frac{2x - 3}{2} \right) \right)$$

$$\therefore 4(y - 3) = 2x - 3$$

$$\therefore 4y - 12 = 2x - 3$$

$$\therefore 2x - 4y + 9 = 0$$

B is the midpoint of side QR

$$\therefore B = \left(\frac{4 - 5}{2}, \frac{-2 - 3}{2} \right) = \left(\frac{-1}{2}, \frac{-5}{2} \right)$$

$$\text{Slope of side QR} = \frac{-3 - (-2)}{-5 - 4} = \frac{-1}{-9} = \frac{1}{9}$$

$\therefore$ Slope of perpendicular bisector of QR is -9 and it passes through $\left(-\frac{1}{2}, -\frac{5}{2} \right)$

$\therefore$ Equation of the perpendicular bisector of side QR is

$$y - \left(-\frac{5}{2} \right) = -9 \left[x - \left(-\frac{1}{2} \right) \right]$$

$$\therefore \frac{2y + 5}{2} = -9 \left(\frac{2x + 1}{2} \right)$$

$$\therefore 2y + 5 = -18x - 9$$

$$\therefore 18x + 2y + 14 = 0$$

$$\therefore 9x + y + 7 = 0$$

C is the midpoint of side PR.

$$\therefore C = \left(\frac{-1 - 5}{2}, \frac{8 - 3}{2} \right) = \left(-3, \frac{5}{2} \right)$$

$$\text{Slope of side PR} = \frac{-3 - 8}{-5 - (-1)} = \frac{-11}{-4} = \frac{11}{4}$$

∴ Slope of perpendicular bisector of PR is $-\frac{4}{11}$

and it passes through $\left(-3, \frac{5}{2}\right)$.

Equation of the perpendicular bisector of PR is $y - \frac{5}{2} = -\frac{4}{11}(x + 3)$

$$\therefore 11\left(\frac{2y-5}{2}\right) = -4(x+3)$$

$$\therefore 11(2y-5) = -8(x+3)$$

$$\therefore 22y - 55 = -8x - 24$$

$$\therefore 8x + 22y - 31 = 0$$

Question 14.

Find the co-ordinates of the orthocentre of the triangle whose vertices are A(2, -2), B(1, 1) and C(-1, 0).

Solution:

Let O be the orthocentre of AABC.

Let AM and BN be the altitudes of sides BC and AC respectively.

$$\text{Now, slope of BC} = \frac{0-1}{-1-1} = \frac{-1}{-2} = \frac{1}{2}$$

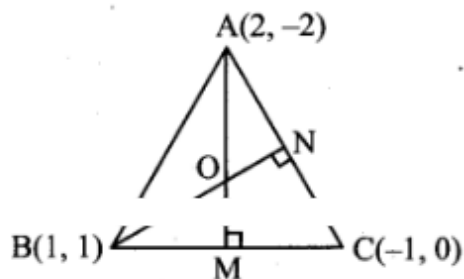
Slope of AM = -2, [∵ AM ⊥ BC]

Since AM passes through (2, -2) and has slope -2,

equation of the altitude AM is $y - (-2) = -2(x - 2)$

$$\therefore y + 2 = -2x + 4$$

$$\therefore 2x + y - 2 = 0 \dots(i)$$



Also, slope of AC = $\frac{0 - (-2)}{-1 - 2} = \frac{2}{-3}$

$\therefore$ Slope of BN = $\frac{3}{2}$... [$\because$ BN $\perp$ AC]

Since BN passes through (1,1) and has slope $\frac{3}{2}$, equation of the altitude BN is

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

$$\therefore 2y - 2 = 3x - 3$$

$$\therefore 3x - 2y - 1 = 0 \dots (ii)$$

To find co-ordinates of orthocentre, we have to solve equations (i) and (ii).

By (i) $\times$ 2 + (ii), we get

$$7x - 5 = 0$$

$$\therefore x = \frac{5}{7}$$

substituting $x = \frac{5}{7}$ in eq (i), we get

$$2\left(\frac{5}{7}\right) + y - 2 = 0$$

$$\therefore y = -2\left(\frac{5}{7}\right) + 2$$

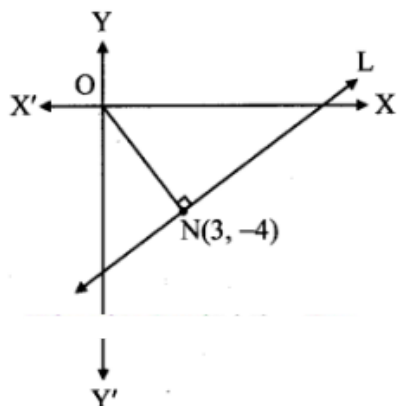
$$\therefore y = \frac{-10 + 14}{7} = \frac{4}{7}$$

$$\therefore \text{Coordinates of orthocentre O} = \left(\frac{5}{7}, \frac{4}{7}\right)$$

Question 15.

$N(3, -4)$ is the foot of the perpendicular drawn from the origin to line L. Find the equation of line L.

Solution:



$$\text{Slope of } ON = \frac{-4-0}{3-0} = \frac{-4}{3}$$

Since line $L \perp ON$,

slope of the line L is $\frac{3}{4}$ and it passes through point $N(3, -4)$.

Equation of the line in slope point form is $y - y_1 = m(x - x_1)$

Equation of line L is

$$y - (-4) = \frac{3}{4}(x - 3)$$

$$\therefore 4(y + 4) = 3(x - 3)$$

$$\therefore 4y + 16 = 3x - 9$$

$$\therefore 3x - 4y - 25 = 0$$

Ex 5.4

Question 1.

Find the slope, x-intercept, y-intercept of each of the following lines, i. $2x + 3y - 6 = 0$ ii. $3x - y - 9 = 0$ iii. $x + 2y = 0$

Solution:

i. Given equation of the line is $2x + 3y - 6 = 0$.

Comparing this equation with $ax + by + c = 0$,

we get

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$$a = 2, b = 3, c = -6$$

$$\therefore \text{Slope of the line} = \frac{-a}{b} = \frac{-2}{3}$$

$$x\text{-intercept} = \frac{-c}{a} = \frac{-(-6)}{2} = 3$$

$$y\text{-intercept} = \frac{-c}{b} = \frac{-(-6)}{3} = 2$$

ii. Given equation of the line is $3x - y - 9 = 0$.

Comparing this equation with $ax + by + c = 0$, we get

$$a = 3, b = -1, c = -9$$

$$\therefore \text{Slope of the line} = \frac{-a}{b} = \frac{-3}{-1} = 3$$

$$x\text{-intercept} = \frac{-c}{a} = \frac{-(-9)}{3} = 3$$

$$y\text{-intercept} = \frac{-c}{b} = \frac{-(-9)}{-1} = -9$$

iii. Given equation of the line is $x + 2y = 0$.

Comparing this equation with $ax + by + c = 0$, we get

$$a = 1, b = 2, c = 0$$

$$\therefore \text{Slope of the line} = \frac{-a}{b} = \frac{-1}{2}$$

$$x\text{-intercept} = \frac{-c}{a} = \frac{-0}{1} = 0$$

$$y\text{-intercept} = \frac{-c}{b} = \frac{-0}{2} = 0$$

Question 2.

Write each of the following equations in $ax + by + c = 0$ form.

i. $y = 2x - 4$

ii. $y = 4$

iii. $\frac{x}{2} + \frac{y}{4} = 1$

iv. $\frac{x}{3} - \frac{y}{2} = 0$

i. $y = 2x - 4$

$\therefore 2x - y - 4 = 0$ is the equation in $ax + by + c = 0$ form.

ii. $y = 4$

$\therefore 0x + 1y - 4 = 0$ is the equation in $ax + by + c = 0$ form.

iii. $\frac{x}{2} + \frac{y}{4} = 1$

$\therefore \frac{2x+y}{4}$

$\therefore 2x + y - 4 = 0$ is the equation in $ax + by + c = 0$ form.

iv. $\frac{x}{3} - \frac{y}{2} = 0$

$\therefore 2x - 3y = 0$

$\therefore 2x - 3y + 0 = 0$ is the equation in $ax + by + c = 0$ form.

[Note: Answer given in the textbook is ' $2x - 3y - 6 = 0$ '. However, as per our calculation it is ' $2x - 3y + 0 = 0$ '.]



Question 3.

Show that the lines $x - 2y - 7 = 0$ and $2x - 4y + 15 = 0$ are parallel to each other.

Solution:

Let m_1 be the slope of the line $x - 2y - 7 = 0$.

$$\therefore m_1 = \frac{-\text{coefficient of } x}{\text{coefficient of } y} = \frac{-1}{-2} = \frac{1}{2}$$

Let m_2 be the slope of the line $2x - 4y + 15 = 0$.

$$\therefore m_2 = \frac{-\text{coefficient of } x}{\text{coefficient of } y} = \frac{-2}{-4} = \frac{1}{2}$$

Since $m_1 = m_2$

the given lines are parallel to each other.

Question 4.

Show that the lines $x - 2y - 7 = 0$ and $2x + y + 1 = 0$ are perpendicular to each other. Find their point of intersection.

Solution:

Let m_1 be the slope of the line $x - 2y - 7 = 0$.

$$\therefore m_1 = \frac{-\text{coefficient of } x}{\text{coefficient of } y} = \frac{-1}{-2} = \frac{1}{2}$$

Let m_2 be the slope of the line $2x + y + 1 = 0$.

$$\therefore m_2 = \frac{-\text{coefficient of } x}{\text{coefficient of } y} = \frac{-2}{1} = -2$$

Since $m_1 \times m_2 = \frac{1}{2} \times (-2) = -1$,

the given lines are perpendicular to each other. Consider,

$$x - 2y - 7 = 0 \dots (i)$$

$$2x + y + 1 = 0 \dots (ii)$$

Multiplying equation (ii) by 2, we get

$$4x + 2y + 2 = 0 \dots (iii)$$

Adding equations (i) and (iii), we get

$$5x - 5 = 0$$

$$\therefore x = 1$$

Substituting $x = 1$ in equation (ii), we get

$$2 + y + 1 = 0$$

$$\therefore y = -3$$

$\therefore$ The point of intersection of the given lines is $(1, -3)$.

Question 5.

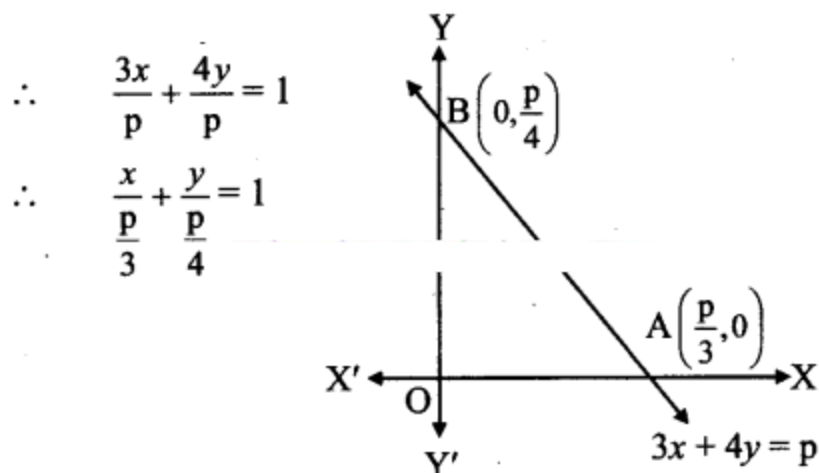
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If the line $3x + 4y = p$ makes a triangle of area 24 square units with the co-ordinate axes, then find the value of p .

Solution:

Let the line $3x + 4y = p$ cuts the X and Y axes at points A and B respectively.

$$3x + 4y = p$$



This equation is of the form $\frac{x}{a} + \frac{y}{b} = 1$,

where $a = \frac{p}{3}$ and $b = \frac{p}{4}$

$\therefore A(a, 0) \equiv (\frac{p}{3}, 0)$ and $B(0, b) = (0, \frac{p}{4})$

$\therefore OA = \frac{p}{3}$ and $OB = \frac{p}{4}$

Given, $A(\Delta OAB) = 24$ sq. units

$\therefore \left| \frac{1}{2} \times OA \times OB \right| = 24$

$\therefore \left| \frac{1}{2} \times \frac{p}{3} \times \frac{p}{4} \right| = 24$

$\therefore p^2 = 576$

$\therefore p = \pm 24$

Question 6.

Find the co-ordinates of the foot of the perpendicular drawn from the point $A(-2, 3)$ to the line $3x - y - 1 = 0$.

Solution:

Let M be the foot of perpendicular drawn from point $A(-2, 3)$ to the line

$3x - y - 1 = 0 \dots (i)$

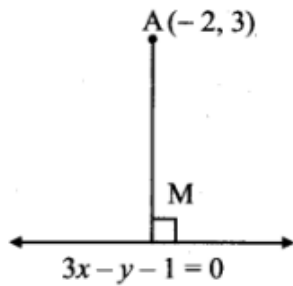
Slope of the line $3x - y - 1 = 0$ is $\frac{-3}{-1} = 3$.

Since $AM \perp$ to line (i),

slope of $AM = \frac{-1}{3}$

$\therefore$ Equation of AM is

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



$$\therefore 3(y - 3) = -1(x + 2)$$

$$\therefore 3y - 9 = -x - 2$$

$$\therefore x + 3y - 7 = 0 \dots\dots\dots(ii)$$

The foot of perpendicular i.e., point M, is the point of intersection of equations (i) and (ii).

By (i) $\times 3$ + (ii), we get $10x - 10 = 0$

$$\therefore x = 1$$

Substituting $x = 1$ in (ii), we get

$$1 + 3y - 7 = 0$$

$$\therefore 3y = 6$$

$$\therefore y = 2$$

$\therefore$ The co-ordinates of the foot of the perpendicular M are (1,2).

Question 7.

Find the co-ordinates of the circumcentre of the triangle whose vertices are A(-2, 3), B(6, -1), C(4, 3).

Solution:

Here, A(-2, 3), B(6, -1), C(4, 3) are the vertices of $\triangle ABC$.

Let F be the circumcentre of $\triangle ABC$.

Let FD and FE be the perpendicular bisectors of the sides BC and AC respectively.

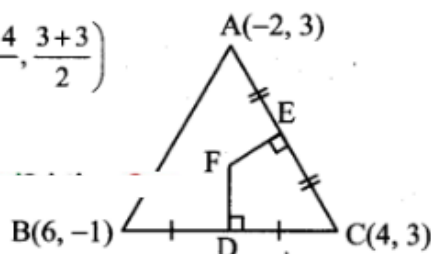
$\therefore$ D and E are the midpoints of side BC and AC respectively.

$$\therefore D \equiv \left(\frac{6+4}{2}, \frac{-1+3}{2} \right)$$

$$\therefore D = (5, 1)$$

$$\text{and } E \equiv \left(\frac{-2+4}{2}, \frac{3+3}{2} \right)$$

$$\therefore E = (1, 3)$$



$$\text{Now, slope of BC} = \frac{3 - (-1)}{4 - 6} = \frac{4}{-2} = -2$$

$$\therefore \text{Slope of FD} = \frac{1}{2} \quad \dots [\because FD \perp BC]$$

Since FD passes through (5, 1) and has slope 1/2 equation of FD is

$$y - 1 = \frac{1}{2}(x - 5)$$

$$\therefore 2(y - 1) = x - 5$$

$$\therefore 2y - 2 = x - 5$$

$$\therefore x - 2y - 3 = 0 \dots (i)$$

Since both the points A and C have same y co-ordinates i.e. 3,

the given points lie on the line $y = 3$.

Since the equation FE passes through E(1, 3),

the equation of FE is $x = 1$. $\dots (ii)$

To find co-ordinates of circumcentre, we have to solve equations (i) and (ii).

Substituting the value of x in (i), we get

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$$1 - 2y - 3 = 0$$

$$\therefore y = -1$$

$\therefore$ Co-ordinates of circumcentre $F \equiv (1, -1)$.

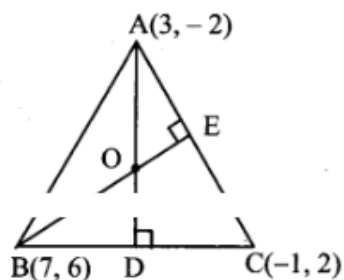
Question 8.

Find the co-ordinates of the orthocentre of the triangle whose vertices are A(3, -2), B(7,6), C(-1,2).

Solution:

Let O be the orthocentre of $\triangle ABC$.

Let AD and BE be the altitudes on the sides BC and AC respectively.



$$\text{Slope of side BC} = \frac{2-6}{-1-7} = \frac{-4}{-8} = \frac{1}{2}$$

$$\therefore \text{Slope of AD} = -2 \quad [\because \text{AD} \perp \text{BC}]$$

$\therefore$ Equation of line AD is

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

$$\therefore y + 2 = -2x + 6$$

$$\therefore 2x + y - 4 = 0 \dots (i)$$

$$\text{Slope of side AC} = \frac{-2-2}{3-(-1)} = \frac{-4}{4} = -1$$

$$\therefore \text{Slope of BE} = 1 \dots [\because \text{BE} \perp \text{AC}]$$

$\therefore$ Equation of line BE is

$$y - 6 = 1(x - 7)$$

$$\therefore y - 6 = x - 7$$

$$\therefore x = y + 1 \dots (ii)$$

Substituting $x = y + 1$ in (i), we get

$$2(y + 1) + y - 4 = 0$$

$$\therefore 2y + 2 + y - 4 = 0$$

$$\therefore 3y - 2 = 0$$

$\therefore y = \frac{2}{3}$ in (ii), we get Substituting $y = \frac{2}{3}$ in (ii), we get

$$x = \frac{2}{3} + 1 = \frac{5}{3}$$

$\therefore$ Co-ordinates of orthocentre, $O = \left(\frac{5}{3}, \frac{2}{3}\right)$

Question 9.

Show that the lines $3x - 4y + 5 = 0$, $7x - 8y + 5 = 0$ and $4x + 5y - 45 = 0$ are concurrent. Find their point of concurrence.

Solution:

The number of lines intersecting at a point are called concurrent lines and their point of intersection is called the point of concurrence. Equations of the given lines are

$$3x - 4y + 5 = 0 \dots(i)$$

$$7x - 8y + 5 = 0 \dots(ii)$$

$$4x + 5y - 45 = 0 \dots(iii)$$

By (i) $\times 2 -$ (ii), we get

$$-x + 5 = 0$$

$$\therefore x = 5$$

Substituting $x = 5$ in (i), we get

$$3(5) - 4y + 5 = 0$$

$$\therefore -4y = -20$$

$$\therefore y = 5$$

$$\therefore y = 5$$

$\therefore$ The point of intersection of lines (i) and (ii) is given by (5, 5).

Substituting $x = 5$ and $y = 5$ in L.H.S. of (iii), we get

$$\text{L.H.S.} = 4(5) + 5(5) - 45$$

$$= 20 + 25 - 45$$

$$= 0$$

$$= \text{R.H.S.}$$

$\therefore$ Line (iii) also passes through (5, 5).

Hence, the given three lines are concurrent and the point of concurrence is (5, 5).

Question 10.

Find the equation of the line whose x-intercept is 3 and which is perpendicular to the line $3x - y + 23 = 0$.

Solution:

Slope of the line $3x - y + 23 = 0$ is 3.

$\therefore$ Slope of the required line perpendicular to

$$3x - y + 23 = 0 \text{ is } -\frac{1}{3}$$

Since the x-intercept of the required line is 3, it passes through (3, 0).

$\therefore$ The equation of the required line is ‘

$$y - 0 = -\frac{1}{3}(x - 3)$$

$$\therefore 3y = x - 3$$

$$\therefore x + 3y = 3$$

Question 11.

Find the distance of the origin from the line $7x + 24y - 50 = 0$.

Solution:

Let p be the perpendicular distance of origin

from the line $7x + 24y - 50 = 0$

Here, $a = 7$, $b = 24$, $c = -50$

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$$\therefore p = \left| \frac{c}{\sqrt{a^2 + b^2}} \right|$$

$$\therefore p = \left| \frac{-50}{\sqrt{7^2 + 24^2}} \right| = \left| \frac{-50}{\sqrt{49 + 576}} \right| = \left| \frac{-50}{25} \right| = 2 \text{ units}$$

Question 12.

Find the distance of the point A(- 2, 3) from the line $12x - 5y - 13 = 0$.

Solution:

Let p be the perpendicular distance of the point A(- 2, 3) from the line $12x - 5y - 13 = 0$

Here, $a = 12$, $b = -5$, $c = -13$, $x_1 = -2$, $y_1 = 3$

$$\begin{aligned} \therefore p &= \left| \frac{ax_1 + by_1 + c}{\sqrt{a^2 + b^2}} \right| = \left| \frac{12(-2) - 5(3) - 13}{\sqrt{12^2 + (-5)^2}} \right| \\ &= \left| \frac{-24 - 15 - 13}{\sqrt{144 + 25}} \right| = \left| \frac{-52}{13} \right| = 4 \text{ units} \end{aligned}$$

Question 13.

Find the distance between parallel lines $4x - 3y + 5 = 0$ and $4x - 3y + 7 = 0$.

Solution:

Equations of the given parallel lines are $4x - 3y + 5 = 0$ and $4x - 3y + 1 = 0$

Here, $a = 4$, $b = -3$, $c_1 = 5$ and $c_2 = 7$

$\therefore$ Distance between the parallel lines

$$\begin{aligned} &= \left| \frac{c_1 - c_2}{\sqrt{a^2 + b^2}} \right| = \left| \frac{5 - 7}{\sqrt{4^2 + (-3)^2}} \right| \\ &= \left| \frac{-2}{\sqrt{16 + 9}} \right| = \left| \frac{-2}{5} \right| = \frac{2}{5} \text{ units} \end{aligned}$$

Question 14.

Find the distance between the parallel lines $9x + 6y - 7 = 0$ and $3x + 2y + 6 = 0$.

Solution:

Equations of the given parallel lines are $3x + 2y + 6 = 0$ and

Solution:

Equations of the given parallel lines are $3x + 2y + 6 = 0$ and

$9x + 6y - 1 = 0$ i.e., $3x + 2y - \frac{7}{3} = 0$

Here, $a = 3$, $b = 2$, $c_1 = 6$ and $c_2 = -\frac{7}{3}$

$\therefore$ Distance between the parallel lines

$$= \left| \frac{c_1 - c_2}{\sqrt{a^2 + b^2}} \right| = \left| \frac{6 - \left(-\frac{7}{3}\right)}{\sqrt{3^2 + 2^2}} \right|$$

$$= \left| \frac{6 + \frac{7}{3}}{\sqrt{9 + 4}} \right| = \frac{25}{3\sqrt{13}} \text{ units}$$

Question 15.

Find the points on the line $x + y - 4 = 0$ which are at a unit distance from the line $4x + 3y = 10$.

Solution:

Let $P(x_1, y_1)$ be a point on the line $x + y - 4 = 0$.

$$\therefore x_1 + y_1 - 4 = 0$$

$$\therefore y_1 = 4 - x_1 \dots (i)$$

Also, distance of P from the line $4x + 3y - 10 = 0$ is 1

$$\therefore 1 = \left| \frac{4x_1 + 3y_1 - 10}{\sqrt{4^2 + 3^2}} \right|$$

$$\therefore 1 = \left| \frac{4x_1 + 3(4 - x_1) - 10}{\sqrt{25}} \right| \quad \dots [\text{From (i)}]$$

$$\therefore 1 = \left| \frac{4x_1 + 12 - 3x_1 - 10}{5} \right|$$

$$\therefore 5 = |x_1 + 2|$$

$$\therefore x_1 + 2 = \pm 5$$

$$\therefore x_1 + 2 = 5 \text{ or } x_1 + 2 = -5$$

$$\therefore x_1 = 3 \text{ or } x_1 = -7$$

From (i), when $x_1 = 3$, $y_1 = 1$

and when $x_1 = -7$, $y_1 = 11$

$\therefore$ The required points are (3, 1) and (-7, 11).

[Note: The question has been modified]

Question 16.

Find the equation of the line parallel to the X-axis and passing through the point of intersection of lines $x + y - 2 = 0$ and $4x + 3y = 10$.

Solution:

Let $u = x + y - 2 = 0$ and $v = 4x + 3y - 10 = 0$

Equation of the line passing through the point of intersection of lines $u = 0$ and $v = 0$ is given by $u + kv = 0$.

$$\therefore (x + y - 2) + k(4x + 3y - 10) = 0 \dots (i)$$

$$\therefore x + y - 2 + 4kx + 3ky - 10k = 0$$

$$\therefore x + 4kx + y + 3ky - 2 - 10k = 0$$

$$\therefore (1 + 4k)x + (1 + 3k)y - 2 - 10k = 0$$

But, this line is parallel to X-axis.

$$\therefore \text{Its slope} = 0$$

$$\therefore \frac{-(1+4k)}{1+3k} = 0$$

$$\therefore 1 + 4k = 0$$

$$\therefore 1 + 4k = 0$$

$$\therefore k = \frac{-1}{4}$$

Substituting the value of k in (i), we get

$$(x + y - 2) + (4x + 3y - 10) = 0$$

$$\therefore 4(x + y - 2) - (4x + 3y - 10) = 0$$

$$\therefore 4x + 4y - 8 - 4x - 3y + 10 = 0$$

$$\therefore y + 2 = 0, \text{ which is the equation of the required line.}$$

[Note: Answer given in the textbook is $5y - 8 = 0$. However, as per our calculation it is $y + 2 = 0$.]



Question 17.

Find the equation of the line passing through the point of intersection of lines $x + y - 2 = 0$ and $2x - 3y + 4 = 0$ and making intercept 3 on the X-axis.

Solution:

Let $u \equiv x + y - 2 = 0$ and $v \equiv 2x - 3y + 4 = 0$

Equation of the line passing through the point of intersection of lines $u = 0$ and $v = 0$ is given by $u + kv = 0$.

$$\therefore (x + y - 2) + k(2x - 3y + 4) = 0 \dots (i)$$

But, x-intercept of line is 3.

$\therefore$ It passes through (3, 0).

Substituting $x = 3$ and $y = 0$ in (i), we get

$$(3 + 0 - 2) + k(6 - 0 + 4) = 0$$

$$\therefore 1 + 10k = 0$$

$$k = \frac{-1}{10}$$

Substituting the value of k in (i), we get $(x + y - 2) + \left(\frac{-1}{10}\right)(2x - 3y + 4) = 0$

$$\therefore 10(x + y - 2) - (2x - 3y + 4) = 0$$

$$\therefore 10x + 10y - 20 - 2x + 3y - 4 = 0$$

$$\therefore 8x + 13y - 24 = 0, \text{ which is the equation of the required line.}$$

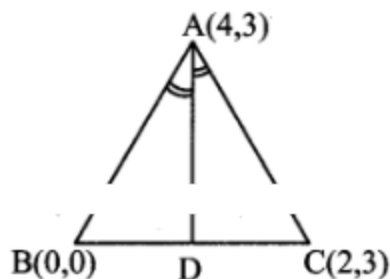
Question 18.

If $A(4, 3)$, $B(0, 0)$ and $C(2, 3)$ are the vertices of $\triangle ABC$, then find the equation of bisector of angle BAC.

Solution:

Let the bisector of $\angle BAC$ meets BC at point D.

$\therefore$ Point D divides seg BC in the ratio $l(AB) : l(AC)$



By distance formula,

$$l(AB) = \sqrt{(4-0)^2 + (3-0)^2} = \sqrt{25} = 5$$

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

∴ Point D divides BC internally in the ratio 5 : 2

$$\therefore D \equiv \left(\frac{5(2) + 2(0)}{5+2}, \frac{5(3) + 2(0)}{5+2} \right) \equiv \left(\frac{10}{7}, \frac{15}{7} \right)$$

∴ Equation of AD is

$$\frac{y-3}{\frac{15}{7}-3} = \frac{x-4}{\frac{10}{7}-4}$$

$$\therefore \frac{y-3}{\frac{-6}{7}} = \frac{x-4}{\frac{-18}{7}}$$

$$\therefore 18(y-3) = 6(x-4)$$

$$\therefore 3(y-3) = x-4$$

$$\therefore 3y-9 = x-4$$

$$\therefore x-3y+5 = 0$$

Question 19.

D(-1, 8), E(4, -2), F(-5, -3) are midpoints of sides BC, CA and AB of ΔABC . Find

i. equations of sides of ΔABC .

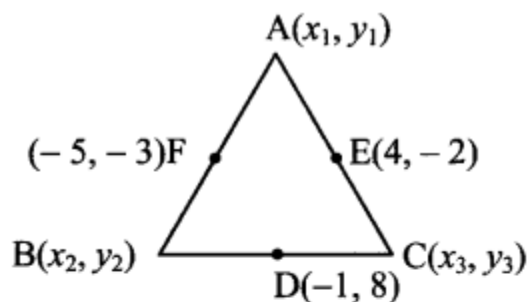
ii. co-ordinates of the circumcentre of ΔABC .

Solution:

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Let $A(x_1, y_1)$, $B(x_2, y_2)$ and $C(x_3, y_3)$ be the vertices of ΔABC .

Given, points D, E and F are midpoints of sides BC, CA and AB respectively of ΔABC .



$$D = \left(\frac{x_2 + x_3}{2}, \frac{y_2 + y_3}{2} \right)$$

$$\therefore (-1, 8) = \left(\frac{x_2 + x_3}{2}, \frac{y_2 + y_3}{2} \right)$$

$$\therefore x_2 + x_3 = -2 \quad \dots(i)$$

$$\text{and } y_2 + y_3 = 16 \quad \dots(ii)$$

$$\text{Also, } E = \left(\frac{x_1 + x_3}{2}, \frac{y_1 + y_3}{2} \right)$$

$$\therefore (4, -2) = \left(\frac{x_1 + x_3}{2}, \frac{y_1 + y_3}{2} \right)$$

$$\therefore x_1 + x_3 = 8 \quad \dots(iii)$$

$$\text{and } y_1 + y_3 = -4 \quad \dots(iv)$$

$$\text{Similarly, } F = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

$$\therefore (-5, -3) = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

$$\therefore x_1 + x_2 = -10 \quad \dots(v)$$

$$\text{and } y_1 + y_2 = -6 \quad \dots(vi)$$

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For x-coordinates:

Adding (i), (iii) and (v), we get

$$2x_1 + 2x_2 + 2x_3 = -4$$

$$\therefore x_1 + x_2 + x_3 = -2 \dots\dots\dots(vii)$$

Solving (i) and (vii), we get $x_1 = 0$

Solving (iii) and (vii), we get $x_2 = -10$

Solving (v) and (vii), we get $x_3 = 8$

For y-coordinates:

Adding (ii), (iv) and (vi), we get $2y_1 + 2y_2 + 2y_3 = 6$

$$y_1 + y_2 + y_3 = 3 \dots\dots\dots(viii)$$

Solving (ii) and (viii), we get $y_1 = -13$

Solving (iv) and (viii), we get $y_2 = 7$

Solving (vi) and (viii), we get $y_3 = 9$

$\therefore$ Vertices of AABC are A(0, -13), B(-10, 7), C(8, 9)

a. Equation of side AB is

$$\frac{y+13}{7+13} = \frac{x-0}{-10-0}$$

$$\therefore \frac{y+13}{20} = \frac{x}{-10}$$

$$\therefore \frac{y+13}{2} = -x$$

$$\therefore 2x + y + 13 = 0$$

b. Equation of side BC is

$$\frac{y-7}{9-7} = \frac{x+10}{8+10}$$

$$\therefore \frac{y-7}{2} = \frac{x+10}{18}$$

$$\therefore y - 7 = \frac{x+10}{9}$$

$$\therefore x - 9y + 73 = 0$$

c. Equation of side AC is

$$\frac{y+13}{9+13} = \frac{x-0}{8-0}$$

$$\therefore \frac{y+13}{22} = \frac{x}{8}$$

$$\therefore 8(y + 13) = 22x$$

$$\therefore 4(y + 13) = 11x$$

$$\therefore 11x - 4y - 52 = 0$$

ii. Here, A(0, -13), B(-10, 7), C(8, 9) are the vertices of ΔABC .

Let F be the circumcentre of ΔABC .

Let FD and FE be perpendicular bisectors of the sides BC and AC respectively.

D and E are the midpoints of side BC and AC.

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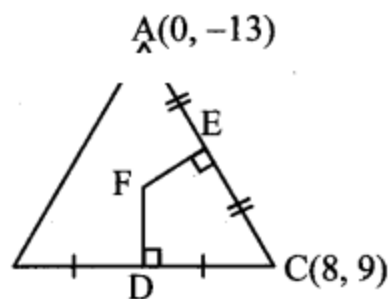
$$\therefore D \equiv \left(\frac{-10+8}{2}, \frac{7+9}{2} \right)$$

$$\therefore D = (-1, 8)$$

$$\text{and } E \equiv \left(\frac{0+8}{2}, \frac{-13+9}{2} \right)$$

$$\therefore E = (4, -2)$$

$$B(-10, 7)$$



$$\text{Now, slope of } BC = \frac{7-9}{-10-8} = \frac{1}{9}$$

$\therefore$ Slope of FD = -9 ... [$\because$ FD $\perp$ BC]

Since FD passes through (-1, 8) and has slope -9, equation of FD is

$$y - 8 = -9(x + 1)$$

$$\therefore y - 8 = -9x - 9$$

$$\therefore y = -9x - 1$$

$$\text{Also, slope of AC} = \frac{-13-9}{0-8} = \frac{11}{4}$$

$$\therefore \text{Slope of FE} = \frac{-4}{11} \quad [\because \text{FE} \perp \text{AC}]$$

Since FE passes through (4, -2) and has slope -4

$\frac{-4}{11}$, equation of FE is

$$(y + 2) = \frac{-4}{11} (x - 4)$$

$$\therefore 11(y + 2) = -4(x - 4)$$

$$\therefore 11y + 22 = -4x + 16$$

$$\therefore 4x + 11y = -6 \dots\dots\dots(ii)$$

To find co-ordinates of circumcentre, we have to solve equations (i) and (ii).

Substituting the value of y in (ii), we get

$$4x + 11(-9x - 1) = -6$$

$$\therefore 4x - 99x - 11 = -6$$

$$\therefore -95x = 5$$

$$\therefore x = \frac{-1}{19}$$

Substituting the value of x in (i), we get

$$y = -9\left(\frac{-1}{19}\right) - 1 = \frac{-10}{19}$$

$$\therefore \text{Co-ordinates of circumcentre F} \equiv \left(\frac{-1}{19}, \frac{-10}{19}\right)$$

Question 20.

O(0, 0), A(6, 0) and B(0, 8) are vertices of a triangle. Find the co-ordinates of the incentre of $\triangle OAB$.

Solution:

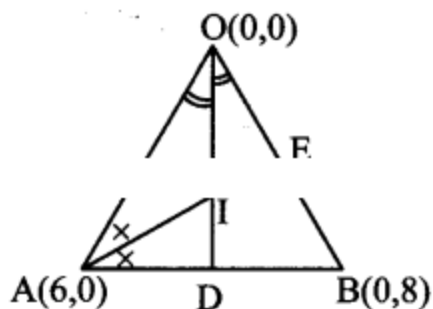
Let bisector of $\angle O$ meet AB at point D and bisector of $\angle A$ meet BO at point E

$\therefore$ Point D divides seg AB in the ratio l(OA): l(OB)

and point E divides seg BO in the ratio l(AB): l(AO)

and point E divides seg BO in the ratio l(AB): l(AO)

Let I be the incentre of $\angle OAB$.



By distance formula,

$$l(OA) = \sqrt{(0-6)^2 + (0-0)^2} = 6$$

$$l(OB) = \sqrt{(0-0)^2 + (0-8)^2} = 8$$

∴ Point D divides AB internally in 6 : 8

i.e. 3 : 4

$$\therefore D \equiv \left(\frac{3(0) + 4(6)}{3+4}, \frac{3(8) + 4(0)}{3+4} \right) \equiv \left(\frac{24}{7}, \frac{24}{7} \right)$$

$$\therefore \text{Equation of OD is } \frac{y-0}{\frac{24}{7}-0} = \frac{x-0}{\frac{24}{7}-0}$$

$$\therefore y = x \dots (i)$$

Now, by distance formula,

$$l(AB) = \sqrt{(6-0)^2 + (0-8)^2}$$

$$= \sqrt{36 + 64} = 10$$

$$l(AO) = \sqrt{(6-0)^2 + (0-0)^2} = 6$$

∴ Point E divides BO internally in 10 : 6 i.e. 5:3

$$\therefore E \equiv \left(\frac{5(0)+3(0)}{5+3}, \frac{5(0)+3(8)}{5+3} \right) \equiv (0, 3)$$

$$\therefore \text{Equation of AE is } \frac{y-0}{3-0} = \frac{x-6}{0-6}$$

$$\therefore \frac{y}{3} = \frac{x-6}{-6}$$

$$\therefore -2y = x - 6$$

$$\therefore x + 2y = 6 \dots (ii)$$

To find co-ordinates of incentre, we have to solve equations (i) and (ii).

Substituting $y = x$ in (ii), we get

$$x + 2x = 6$$

$$\therefore x = 2$$

Substituting the value of x in (i), we get

$$y = 2$$

∴ Co-ordinates of incentre $I \equiv (2, 2)$.

Alternate Method:

Let I be the incentre.

I lies in the 1st quadrant.

OPIR is a square having side length r .

Since $OA = 6$, $OP = r$,

Since $OA = 6$, $OP = r$,

$$PA = 6 - r$$

Since $PA = AQ$,

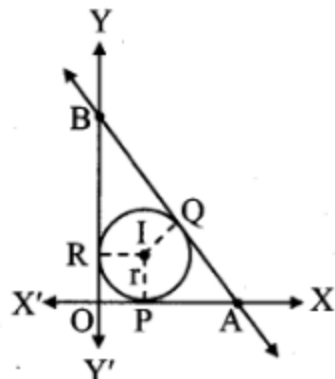
$$AQ = 6 - r \dots (i)$$

Since $OB = 8$, $OR = r$,

$$BR = 8 - r$$

$$\therefore BR = BQ$$

$$\therefore BQ = 8 - r \dots (ii)$$



$$AB = BQ + AQ$$

$$= \sqrt{OA^2 + OB^2}$$

$$\begin{aligned} \text{Also, } AB &= \sqrt{6^2 + 8^2} \\ &= \sqrt{100} = 10 \end{aligned}$$

$$\therefore BQ + AQ = 10$$

$$\therefore (8 - r) + (6 - r) = 10$$

$$\therefore 2r = 14 - 10 = 4$$

$$\therefore r = 2$$

$$\therefore I = (2, 2)$$



Maharashtra Board Solutions

Class 11 Arts & Science Maths

(Part 1)

- Chapter 1- Angle and its Measurement
- Chapter 2- Trigonometry – I
- Chapter 3- Trigonometry – II
- Chapter 4- Determinants and Matrices
- Chapter 5- Straight Line
- Chapter 6- Circle
- Chapter 7- Conic Sections
- Chapter 8- Measures of Dispersion
- Chapter 9- Probability

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About About Maharashtra State Board (MSBSHSE)

The Maharashtra State Board of Secondary and Higher Secondary Education or MSBSHSE (Marathi: महाराष्ट्र राज्य माध्यमिक आणि उच्च माध्यमिक शिक्षण मंडळ), is an **autonomous and statutory body established in 1965**. The board was amended in the year 1977 under the provisions of the Maharashtra Act No. 41 of 1965.

The Maharashtra State Board of Secondary & Higher Secondary Education (MSBSHSE), Pune is an independent body of the Maharashtra Government. There are more than 1.4 million students that appear in the examination every year. The Maha State Board conducts the board examination twice a year. This board conducts the examination for SSC and HSC.

The Maharashtra government established the Maharashtra State Bureau of Textbook Production and Curriculum Research, also commonly referred to as Ebalbharati, in 1967 to take up the responsibility of providing quality textbooks to students from all classes studying under the Maharashtra State Board. MSBHSE prepares and updates the curriculum to provide holistic development for students. It is designed to tackle the difficulty in understanding the concepts with simple language with simple illustrations. Every year around 10 lakh students are enrolled in schools that are affiliated with the Maharashtra State Board.

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Who developed the Maharashtra State board books?

As of now, the MSCERT and Balbharti are responsible for the syllabus and textbooks of Classes 1 to 8, while Classes 9 and 10 are under the Maharashtra State Board of Secondary and Higher Secondary Education (MSBSHSE).

How many state boards are there in Maharashtra?

The Maharashtra State Board of Secondary & Higher Secondary Education, conducts the HSC and SSC Examinations in the state of Maharashtra through its nine Divisional Boards located at Pune, Mumbai, Aurangabad, Nasik, Kolhapur, Amravati, Latur, Nagpur and Ratnagiri.

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