

MATHEMATICS • CLASS 11

CHAPTER 9

Straight Lines

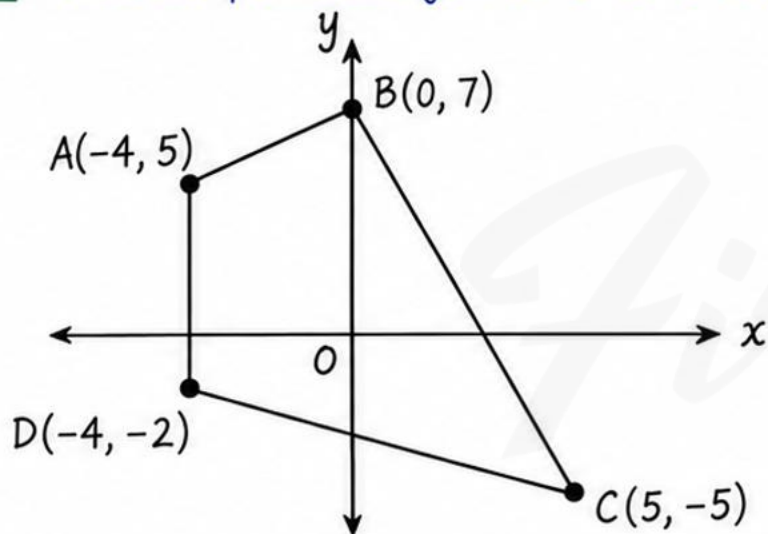
NCERT SOLUTIONS



EXERCISE 9.1 — QUESTIONS 1–2

Q1. The vertices of a quadrilateral taken in order are $A(-4, 5)$, $B(0, 7)$, $C(5, -5)$ and $D(-4, -2)$. Find the area of the quadrilateral.

Solution: Plot the points and join $A-B-C-D-A$.



Using the shoelace formula,

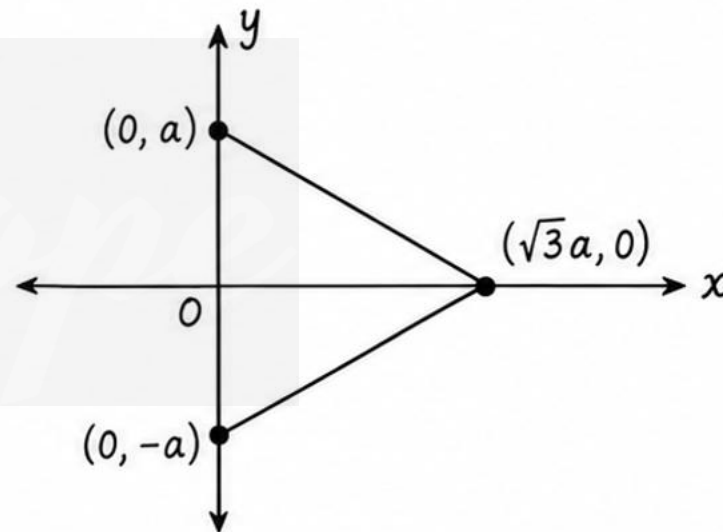
$$\begin{aligned}\sum x_i y_{i+1} &= (-4)(7) + (0)(-5) + (5)(-2) + (-4)(5) \\ &= -28 + 0 - 10 - 20 = -58\end{aligned}$$

$$\begin{aligned}\sum y_i x_{i+1} &= (5)(0) + (7)(5) + (-5)(-4) + (-2)(-4) \\ &= 0 + 35 + 20 + 8 = 63\end{aligned}$$

$$\begin{aligned}\text{Area} &= \frac{1}{2} |\sum x_i y_{i+1} - \sum y_i x_{i+1}| \\ &= \frac{1}{2} |-58 - 63| = \frac{1}{2} |-121| = \frac{121}{2} \text{ square units.}\end{aligned}$$

Q2. Find the co-ordinates of the vertices of an equilateral triangle of side $2a$, whose base is on the y -axis and midpoint of the base is at the origin.

Solution: Let the base endpoints be $(0, a)$ and $(0, -a)$.
Length of the base $= 2a$.



$$\begin{aligned}\text{Altitude of the triangle} &= \sqrt{(2a)^2 - a^2} \\ &= \sqrt{3}a.\end{aligned}$$

Hence, the third vertex is $(\sqrt{3}a, 0)$ or $(-\sqrt{3}a, 0)$.

The vertices are $(0, a)$, $(0, -a)$, $(\sqrt{3}a, 0)$ or $(0, a)$, $(0, -a)$, $(-\sqrt{3}a, 0)$.

EXERCISE 9.1 – QUESTIONS 3–5

Question 3:

For $P(x_1, y_1)$, $Q(x_2, y_2)$, find the conditions for PQ to be parallel to the coordinate axes and also find the distance between P and Q in each case.

Solution:

(i) PQ parallel to y -axis.

Then the x -coordinates are equal,
 $x_1 = x_2$.

Distance between P and Q is
 $|y_2 - y_1|$.

(ii) PQ parallel to x -axis.

Then the y -coordinates are equal,
 $y_1 = y_2$.

Distance between P and Q is
 $|x_2 - x_1|$.

Question 4:

Find the value of t for which the point $(t, 0)$ is equidistant from the points $(7, 6)$ and $(3, 4)$. Hence, find the point on the x -axis which is equidistant from $(7, 6)$ and $(3, 4)$.

Solution:

Since $(t, 0)$ is equidistant from $(7, 6)$ and $(3, 4)$,

$$(t - 7)^2 + 6^2 = (t - 3)^2 + 4^2.$$

$$t^2 - 14t + 49 + 36 = t^2 - 6t + 9 + 16$$

$$-14t + 85 = -6t + 25$$

$$-8t = -60$$

$$t = \frac{15}{2}.$$

Hence, the required point on the x -axis is
 $\left(\frac{15}{2}, 0\right)$.

Question 5:

Find the slope of the line drawn from the origin to the mid-point of the line segment joining the points $(0, -4)$ and $(8, 0)$.

Solution:

Let $A(0, -4)$ and $B(8, 0)$.

Midpoint of AB is

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

Slope of the line from the origin $(0, 0)$ to $(4, -2)$ is

$$m = \frac{-2 - 0}{4 - 0} = \frac{-2}{4} = -\frac{1}{2}.$$

EXERCISE 9.1 – QUESTIONS 6–8

Q6. $A(4, 4)$, $B(3, 5)$, $C(-1, -1)$.

Slope of AB is

$$m_{AB} = \frac{5 - 4}{3 - 4} = \frac{1}{-1} = -1.$$

Slope of AC is

$$m_{AC} = \frac{-1 - 4}{-1 - 4} = \frac{-5}{-5} = 1.$$

The product of the slopes is

$$m_{AB} \cdot m_{AC} = (-1)(1) = -1.$$

Hence, the angle at A is 90° ,
without using Pythagoras theorem.

Q7. A line makes an angle of 30° with the positive y -axis in the counterclockwise direction. Find its slope.

A line making 30° with the positive y -axis in the counterclockwise direction has inclination

$$90^\circ + 30^\circ = 120^\circ$$

from the positive x -axis.

Hence, its slope is

$$\tan 120^\circ = -\sqrt{3}.$$

Q8. $A(-2, -1)$, $B(4, 0)$, $C(3, 3)$, $D(-3, 2)$. Show that $ABCD$ is a parallelogram.

Slope of AB is

$$m_{AB} = \frac{0 - (-1)}{4 - (-2)} = \frac{1}{6} = +\frac{1}{6}.$$

Slope of CD is

$$m_{CD} = \frac{2 - 3}{-3 - 3} = \frac{-1}{-6} = +\frac{1}{6}.$$

Slope of BC is

$$m_{BC} = \frac{3 - 0}{3 - 4} = \frac{3}{-1} = -3.$$

Slope of DA is

$$m_{DA} = \frac{-1 - 2}{-2 - (-3)} = \frac{-3}{1} = -3.$$

The $+$ signs for AB and CD are essential.
Both opposite-side pairs are parallel,
so $ABCD$ is a parallelogram.

EXERCISE 9.1 — QUESTIONS 9–11

Q9. Find the inclination and the acute angle between the line through $(3, -1)$ and $(4, -2)$ and the x -axis.

Solution:

Slope of the line through $(3, -1)$ and $(4, -2)$ is

$$m = \frac{-2 - (-1)}{4 - 3} = \frac{-1}{1} = -1.$$

If θ is the inclination (measured anticlockwise from the positive x -axis), then $m = \tan \theta = -1$.

$$\text{So } \theta = 135^\circ.$$

The acute angle between the unoriented line and the x -axis is the smaller angle, so

$$\alpha = 45^\circ.$$

Thus, inclination = 135° and acute angle = 45° .

Q10. Two lines have slopes m and $2m$. Find the values of m if the acute angle between them has $\tan = \frac{1}{3}$.

Solution:

For the angle θ between the lines,

$$\begin{aligned}\tan \theta &= \left| \frac{m_2 - m_1}{1 + m_1 m_2} \right| = \left| \frac{2m - m}{1 + 2m^2} \right| \\ &= \left| \frac{m}{1 + 2m^2} \right| = \frac{1}{3}.\end{aligned}$$

$$\begin{aligned}\text{Thus } |m| &= \frac{1}{3}(1 + 2m^2) \\ \Rightarrow 2m^2 - 3|m| + 1 &= 0.\end{aligned}$$

Let $t = |m|$ ($t \geq 0$). Then

$$\begin{aligned}2t^2 - 3t + 1 &= 0 \\ \Rightarrow (2t - 1)(t - 1) &= 0 \\ \Rightarrow t &= 1 \text{ or } \frac{1}{2}.\end{aligned}$$

Hence $|m| = 1$ or $\frac{1}{2}$, so the positive pairs of slopes are $(1, 2)$ and $(\frac{1}{2}, 1)$. Their negative counterparts $(-1, -2)$ and $(-\frac{1}{2}, -1)$ also make the same acute angle. Changing both slopes to their negatives does not change the angle between the lines.

Q11. Show that the equation of a line through (x_1, y_1) and (h, k) with slope m can be written as $k - y_1 = m(h - x_1)$.

Solution:

The slope of the line through (x_1, y_1) and (h, k) is

$$m = \frac{k - y_1}{h - x_1} \quad (h \neq x_1).$$

Multiplying both sides by $(h - x_1)$, we get

$$k - y_1 = m(h - x_1).$$

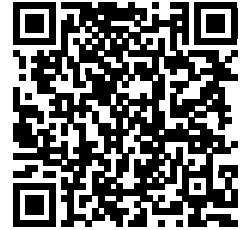


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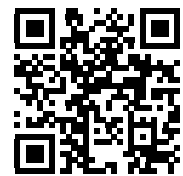


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