

MATHEMATICS • CLASS 11

CHAPTER 9

Straight Lines

CHAPTER NOTES



COORDINATES AND DISTANCE

Coordinate geometry joins algebra and geometry,
A point is located by its signed horizontal and vertical coordinates.

$$P(6, -4), \quad Q(3, 0)$$

The first point is six units right and four units below the origin.

The second lies on the positive horizontal axis.

Distance between two points

$$P(x_1, y_1), \quad Q(x_2, y_2)$$

$$PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Using the distance formula

Use the horizontal and vertical differences between the points.

$$\begin{aligned} PQ &= \sqrt{(3 - 6)^2 + (0 + 4)^2} \\ &= \sqrt{(9 + 16)} \\ &= \sqrt{25} \\ &= 5 \text{ units} \end{aligned}$$

Distance is a non-negative length.

SECTION FORMULA AND MIDPOINT

Internal division

$$A(x_1, y_1), \quad B(x_2, y_2), \quad AP:PB = m:n$$

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

Use the opposite endpoint's coordinates with each ratio weight.

Illustration

$$A(1, -3), \quad B(-3, 9), \quad AP:PB = 1:3$$

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

$$y = \frac{1(9) + 3(-3)}{1+3} = 0$$

$$P = (0, 0)$$

Midpoint

Equal ratio weights give the midpoint.

$$m = n$$

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

Average the horizontal coordinates and the vertical coordinates separately.

AREA AND COLLINEARITY

For a triangle with the given vertices, use the coordinate area formula.

$$A(x_1, y_1), \quad B(x_2, y_2), \quad C(x_3, y_3)$$

$$\text{Area} = \frac{1}{2} \left| x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2) \right|$$

The absolute value makes the area non-negative.

Illustration

$$A(4, 4), \quad B(3, -2), \quad C(-3, 16)$$

$$\begin{aligned} \text{Area} &= \frac{1}{2} \left| 4(-2 - 16) + 3(16 - 4) + (-3)(4 + 2) \right| \\ &= \frac{1}{2} \left| -72 + 36 - 18 \right| \\ &= \frac{1}{2} \left| -54 \right| = 27 \text{ square units} \end{aligned}$$

Collinearity

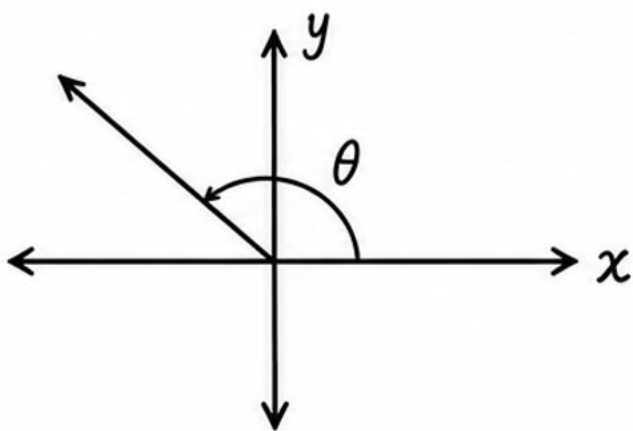
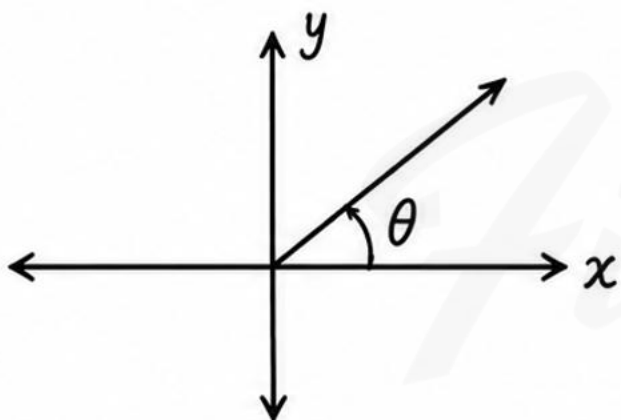
If the area is zero, the three points lie on the same straight line.

$$\text{Area} = 0 \Rightarrow A, B, C \text{ are collinear.}$$

INCLINATION AND SLOPE

Inclination is the angle measured anticlockwise from the positive horizontal axis to a line.

$$0^\circ \leq \theta < 180^\circ$$



Slope, also called gradient, is the tangent of the inclination.

$$m = \tan \theta, \quad \theta \neq 90^\circ$$

A line rising from left to right has positive slope.
A line falling from left to right has negative slope.

$$0^\circ < \theta < 90^\circ \Rightarrow m > 0$$

$$90^\circ < \theta < 180^\circ \Rightarrow m < 0$$

Horizontal line

$$\theta = 0^\circ, \quad m = 0$$

Vertical line

$$\theta = 90^\circ, \quad m \text{ is undefined.}$$

Undefined slope is not zero slope.



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