

## 2.4.23

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**Question:**

Do the points  $(3, 2)$ ,  $(-2, -3)$ , and  $(2, 3)$  form a triangle? If so, name the type of triangle formed.

**Solution:**

Given points,

$$A = \begin{pmatrix} 3 \\ 2 \end{pmatrix}, \quad B = \begin{pmatrix} -2 \\ -3 \end{pmatrix}, \quad C = \begin{pmatrix} 2 \\ 3 \end{pmatrix} \quad (1)$$

*1. Collinearity check (using rank)*

Form the matrix:

$$M = \begin{pmatrix} 3 & 2 & 1 \\ -2 & -3 & 1 \\ 2 & 3 & 1 \end{pmatrix} \quad (2)$$

Apply row operations:

$$R_2 \leftarrow R_2 + 2R_1, \quad R_3 \leftarrow 3R_3 - 2R_1 \Rightarrow \begin{pmatrix} 3 & 2 & 1 \\ 4 & 1 & 3 \\ 0 & 5 & 1 \end{pmatrix} \quad (3)$$

$$R_2 \leftarrow 3R_2 - 4R_1 \Rightarrow \begin{pmatrix} 3 & 2 & 1 \\ 0 & -5 & 5 \\ 0 & 5 & 1 \end{pmatrix} \quad (4)$$

$$R_3 \leftarrow R_3 + R_2 \Rightarrow \begin{pmatrix} 3 & 2 & 1 \\ 0 & -5 & 5 \\ 0 & 0 & 6 \end{pmatrix} \quad (5)$$

Since all three rows are nonzero:

$$\text{rank}(M) = 3 \quad (6)$$

$\Rightarrow$  Points are not collinear, so they form a triangle.

*2. Right-angle check*

$$\overrightarrow{AB} = B - A = \begin{pmatrix} -5 \\ -5 \end{pmatrix}, \quad \overrightarrow{AC} = C - A = \begin{pmatrix} -1 \\ 1 \end{pmatrix} \quad (7)$$

$$\overrightarrow{AB} \cdot \overrightarrow{AC} = (-5)(-1) + (-5)(1) = 0 \quad (8)$$

$$\Rightarrow \overrightarrow{AB} \perp \overrightarrow{AC}$$

So, the triangle is right-angled at

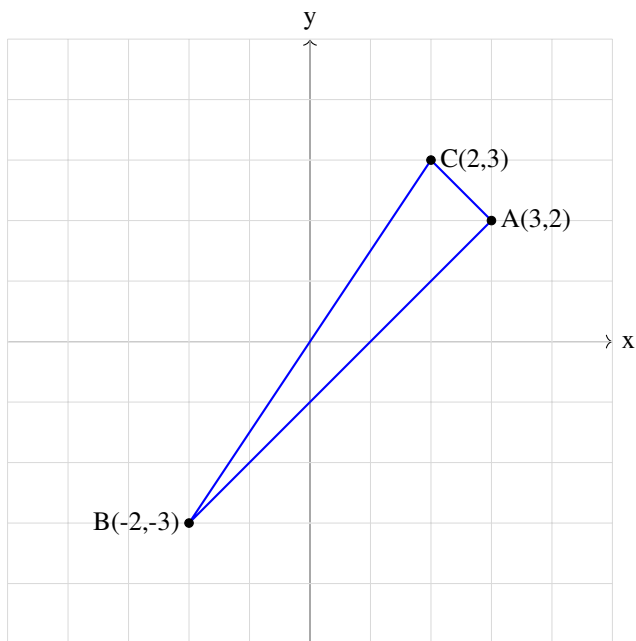
$$A = \begin{pmatrix} 3 \\ 2 \end{pmatrix} \quad (9)$$

### 3. Final Answer

The given points form a triangle (rank = 3). (10)

The triangle is right-angled at  $A = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ . (11)

### Graphical Representation:



**Fig. 0**