Vector Addition and Subtraction

Unit 3: Vectors and Projectile Motion

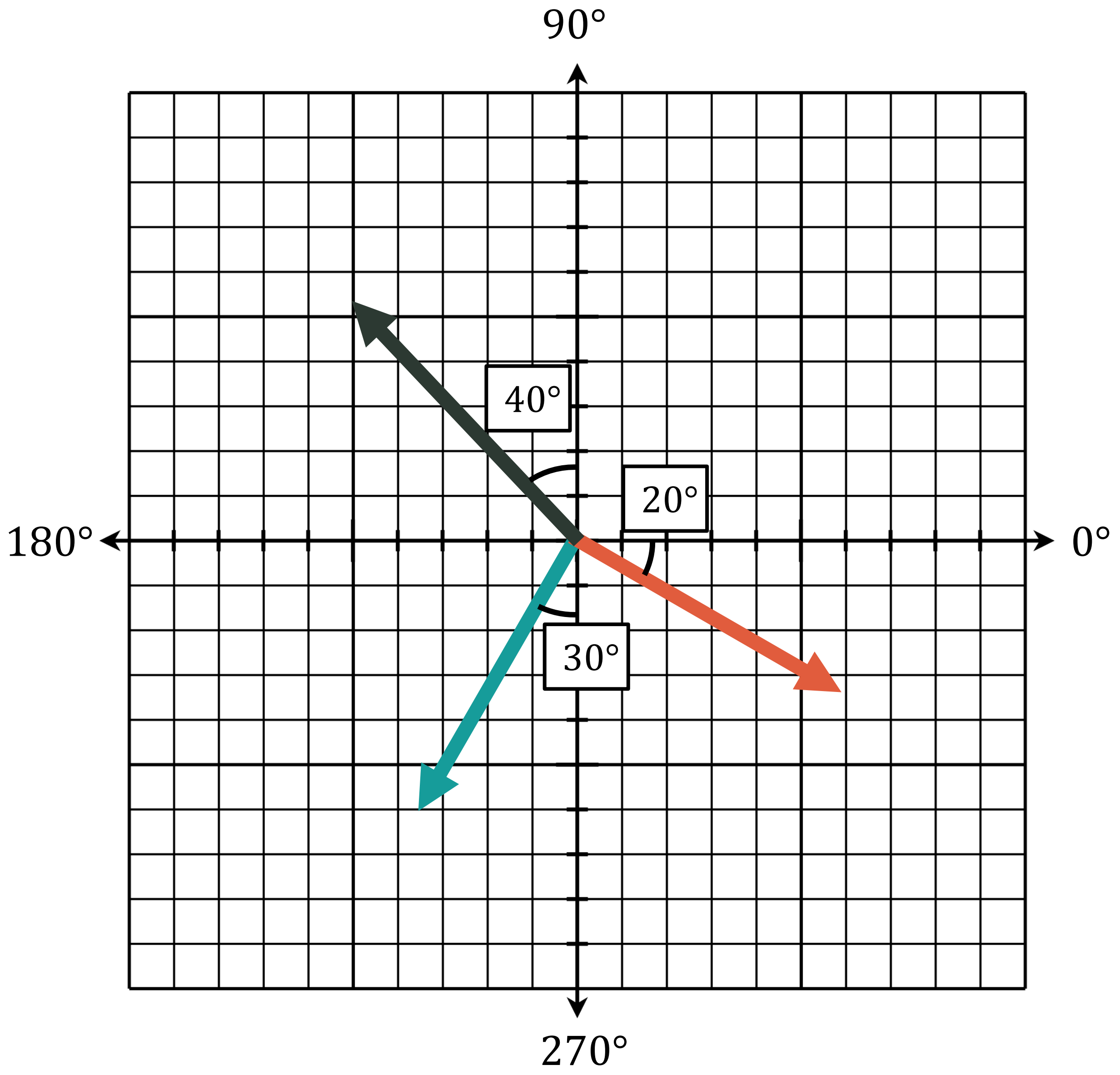
Vector Review: Is this a scalar, or a vector?

- A car costs $52,000.
  - **Scalar**
- It takes the car 3.9 seconds to reach 100 km/h.
  - **Scalar**
- The car is driving 90 km/h to the east.
  - **Vector**
- The car has 38 litres of gasoline.
  - **Scalar**
- The car drove on 256 kilometres of road from Montreal to Quebec.
  - **Scalar**
- Quebec is 232 kilometres northeast of Montreal.
  - **Scalar**

Vector Review: Vector Notation

The following vectors represent the wind's angle as indicated by a weathervane. Express these vectors' direction using the **trigonometric angle**.

1. $\theta = 270° - 30° = 240°$
2. $\theta = 360° - 20° = 340°$
3. $\theta = 90° + 40° = 130°$



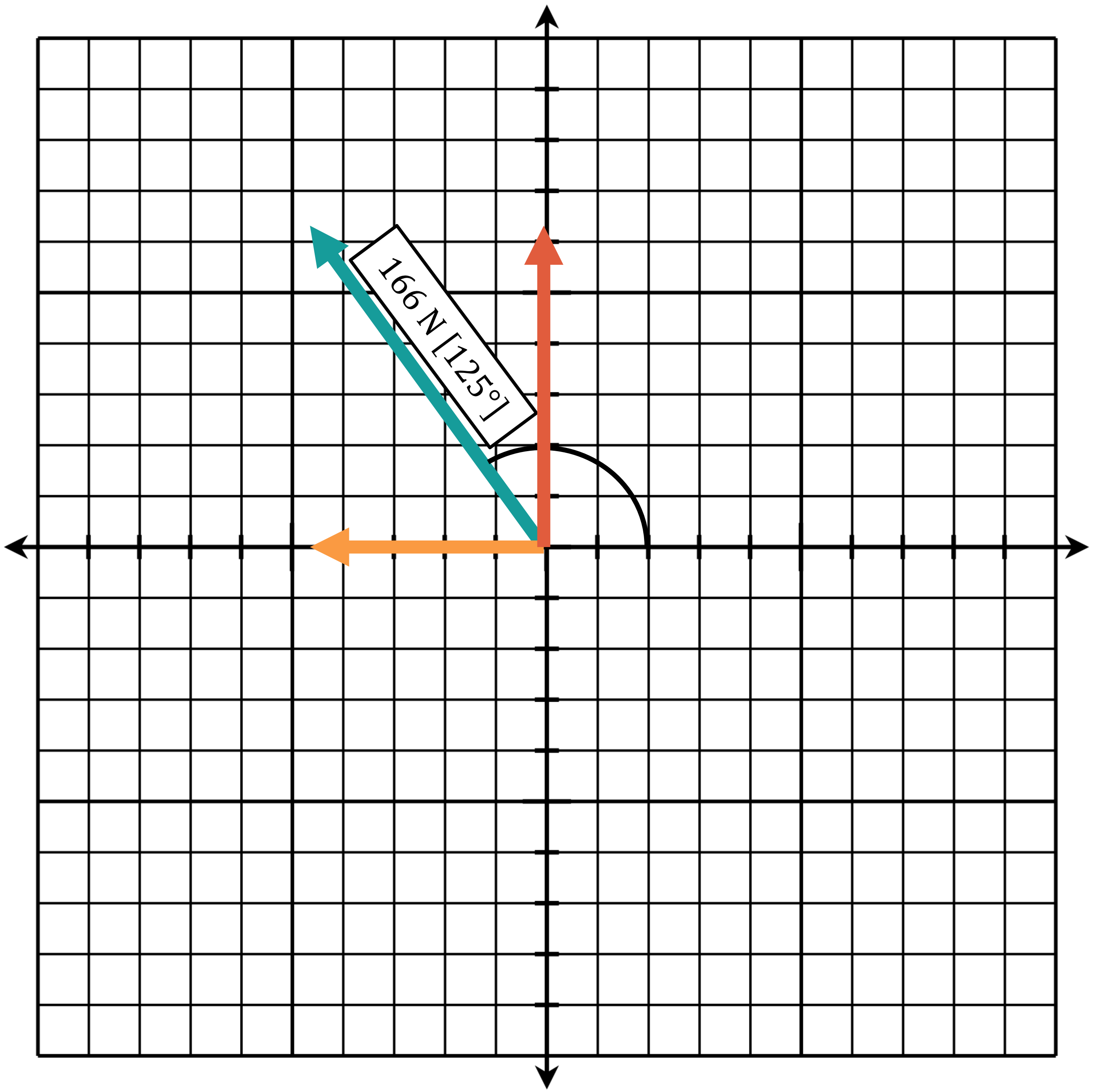
Vector Review: Components
Calculate the x and y components of the following force vectors!

$$\vec{F}_1 = 166\text{ N }[125°]$$

$$F_x = (166\text{ N})\cos 125°$$
$$= -95.2\text{ N}$$

$$F_y = (166\text{ N})\sin 125°$$
$$= 136\text{ N}$$

$$\therefore \vec{F}_1 = (\text{-}95.2\text{ N})\,\hat{\imath} + (136\text{ N})\,\hat{\jmath}$$



Vector Review: Components
Calculate the x and y components of the following force vectors!

$$\vec{F}_2 = 23.5 \text{ N [SW]}$$

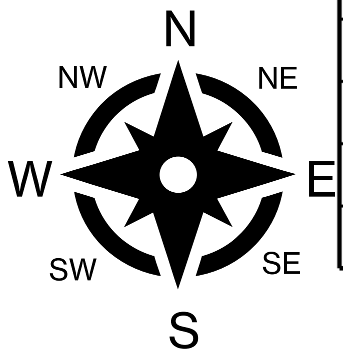
What angle is **southwest?**

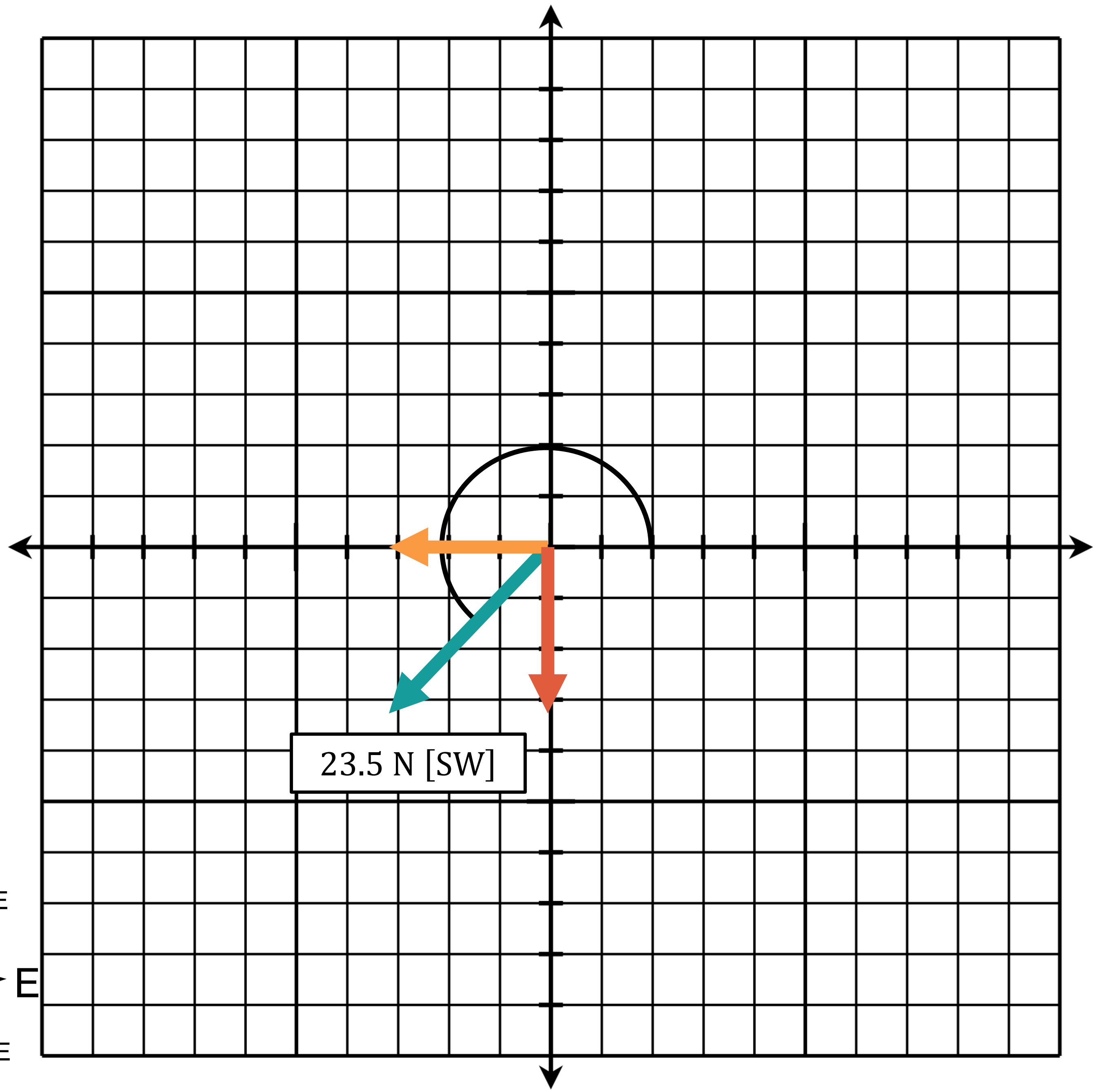
$$\theta = 180° + 45° = 225°$$

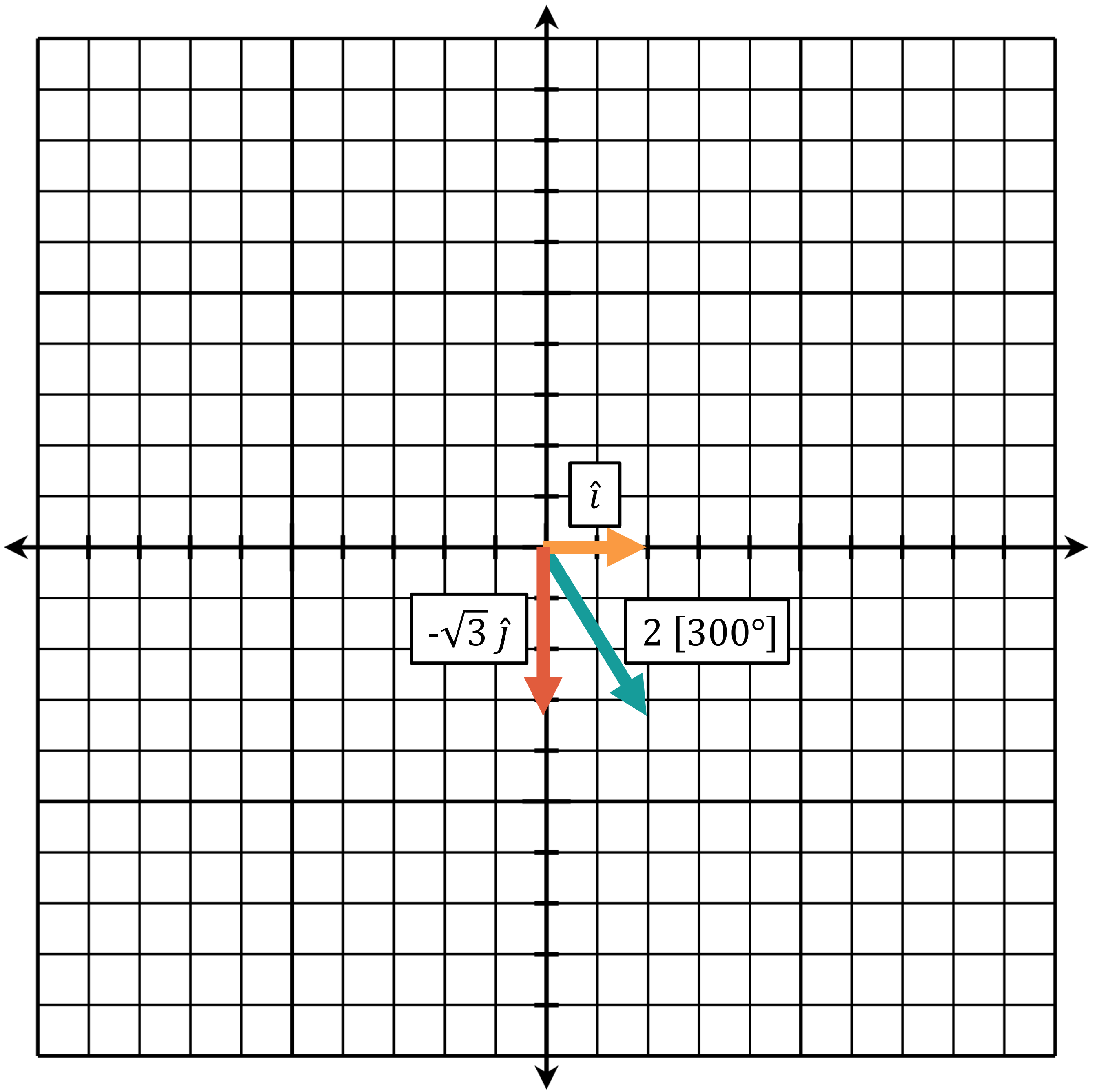
$$F_x = (23.5 \text{ N}) \cos 225°$$
$$= -16.6 \text{ N}$$

$$F_y = (166 \text{ N}) \sin 125°$$
$$= -16.6 \text{ N}$$

$$\therefore\ \vec{F}_2 = (\text{-}16.6 \text{ N})\hat{\imath} - (16.6 \text{ N})\hat{\jmath}$$







Summary: Vector Representation

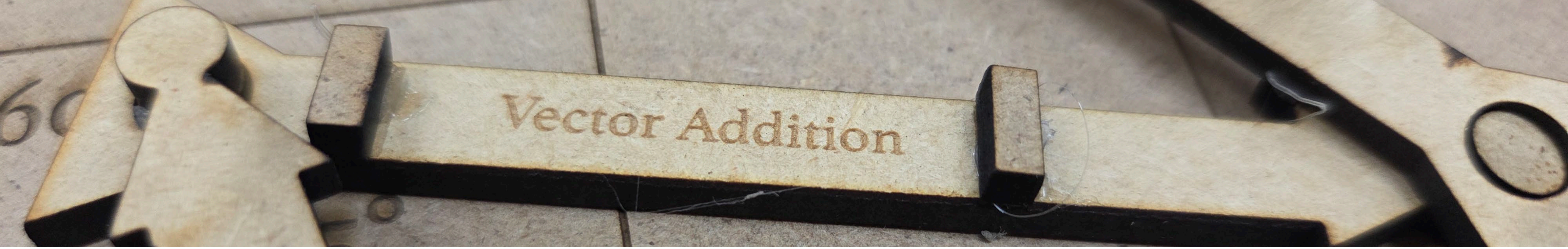
All of the following are representations of the same vector:

1. 2 [300°]
2. 2 [S30°E]
3. 2 [30° E of S]
4. $\hat{\imath} - \sqrt{3}\,\hat{\jmath}$
5. $(1, -\sqrt{3})$
6. $\langle 1, -\sqrt{3} \rangle$

Any of these formats are acceptable, but **4 and 1** are the best!

Adding Vectors

Activity



Activity

Each of these arrows represents a **unit vector**.

Starting from the **origin** in the centre of the board, multiple vectors can be combined together to make a **resultant vector**.

Experiment with different ways to find the **magnitude** and **angle** of the resultant vectors of the following additions (recall that for a unit vector, the magnitude is always equal to 1):

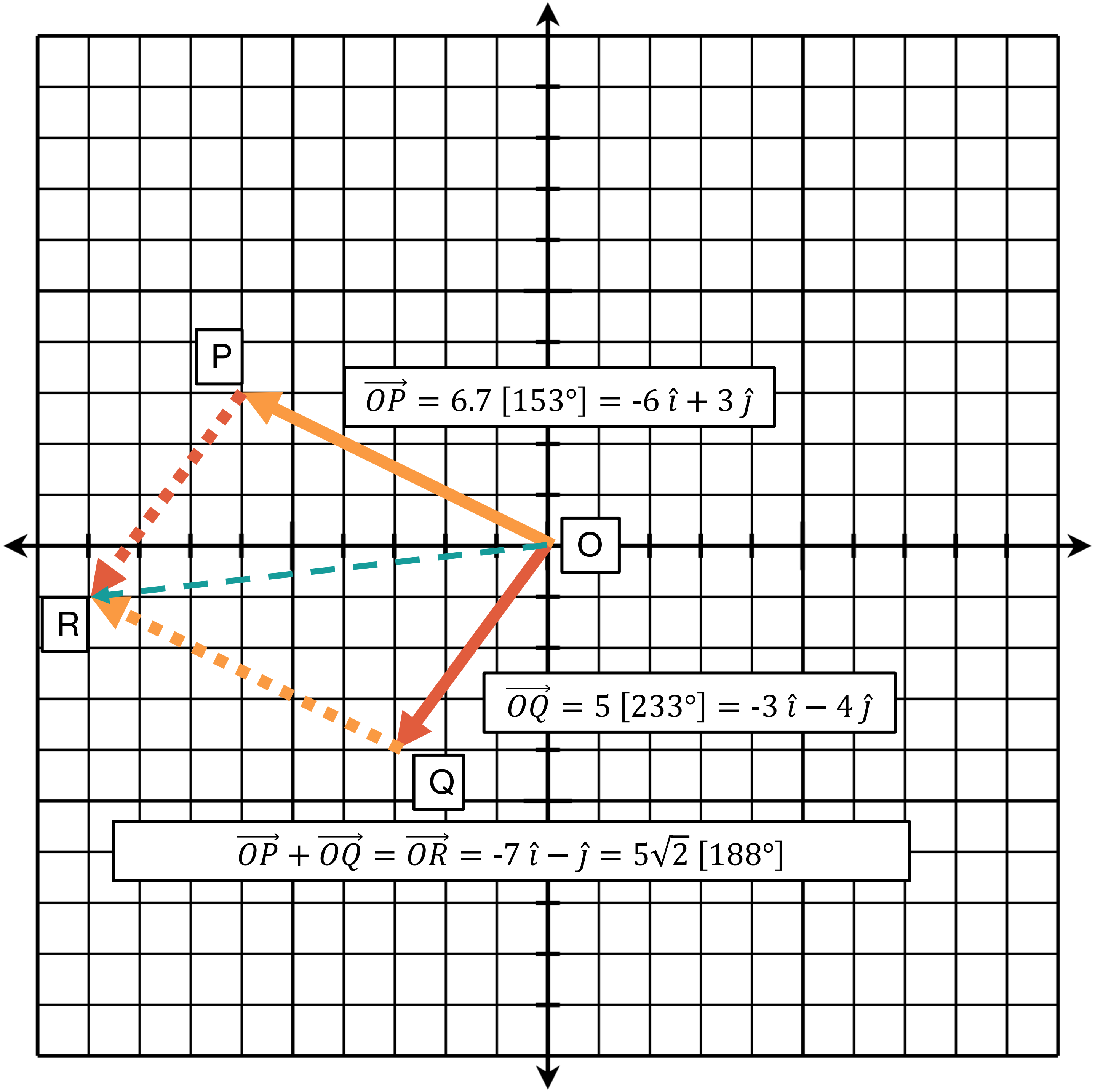
1. $\theta_1 = 0°,\ \theta_2 = 90°$
2. $\theta_3 = 30°,\ \theta_4 = 270°$
3. $\theta_5 = 135°,\ \theta_6 = 30°$
4. $\theta_7 = 180°,\ \theta_8 = 240°$
5. $\theta_9 = 0°,\ \theta_{10} = 0°$

How might you **subtract** a vector instead of adding?

Vector Addition: Methods

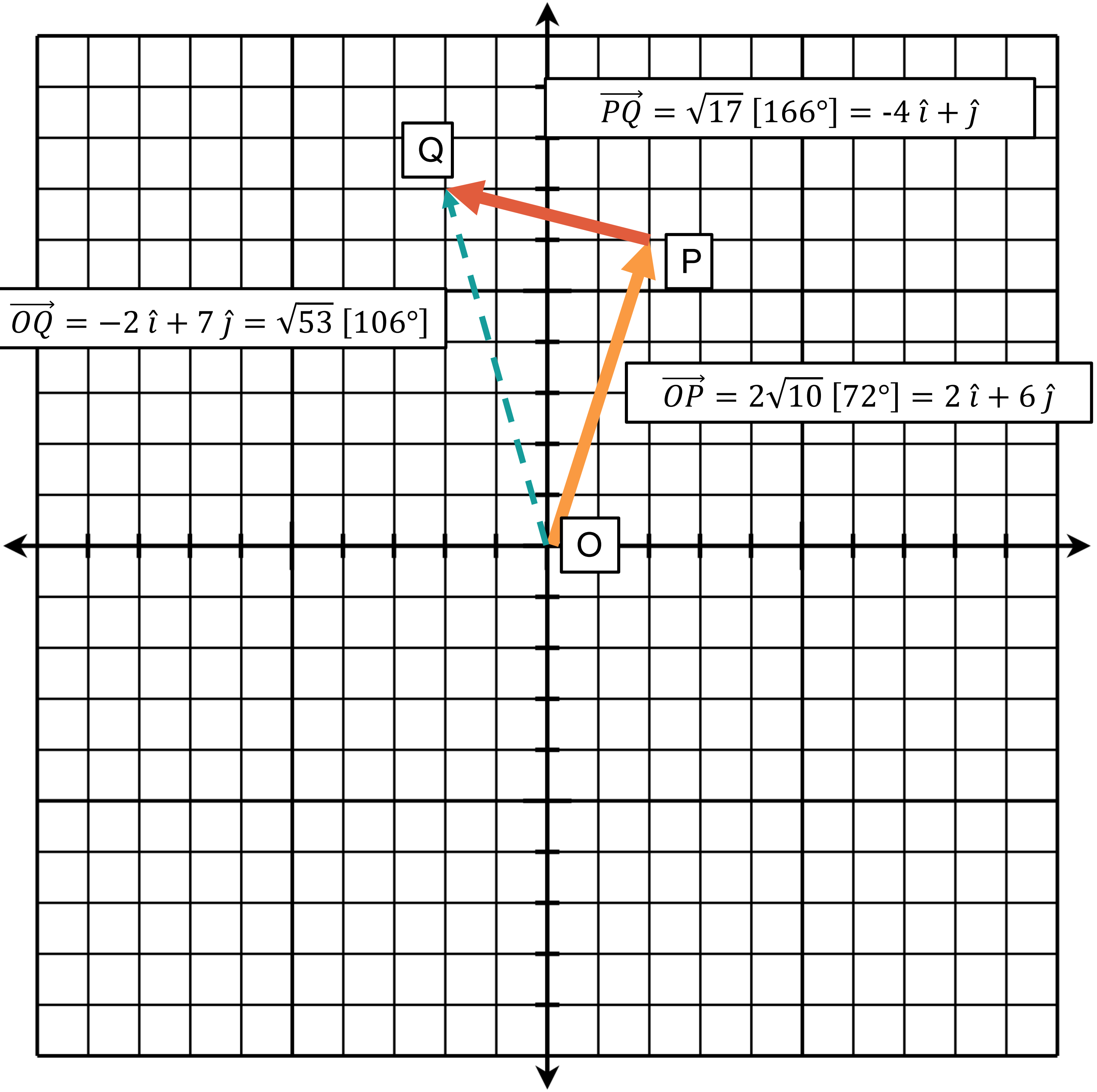
Method 1: Parallelogram

1. Put the vectors together, **tail to tail**.
2. Create a **parallelogram** using these two vectors.
3. Find the **diagonal** of the parallelogram. This is the **resultant vector** of the vector sum.



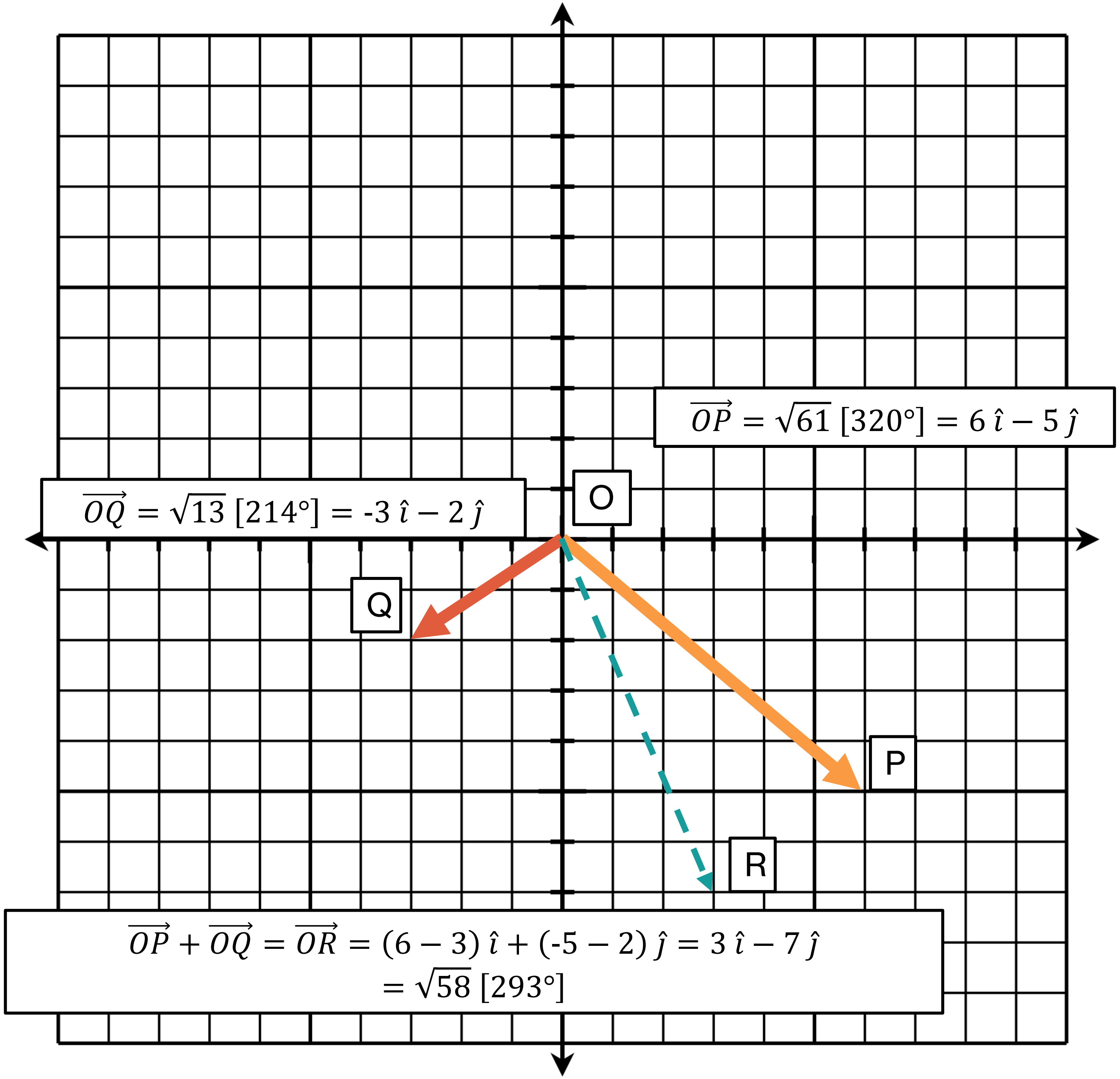
Method 2: Triangle

1. Put the vectors together, **tail to head**.
2. Create a **triangle** using these two vectors.
3. Find the **third side** of the triangle. This is the **resultant vector** of the vector sum.



Method 3: Components

1. Find the **components** of each vector.
2. Add the x and y components.
3. The sums of each component are the components of the **resultant vector**.



Vector Subtraction

How might **subtraction** of vectors work?

1. Find the **opposite vector** of the subtracted vector!
2. Find the sum of the **positive** vector and the **opposite** vector!