

# Applications of Vectors



# Preliminaries and Objectives

## Preliminaries

- Vectors using rectangular coordinates
- Vectors using polar coordinates
- Adding vectors in rectangular coordinates

## Objectives

- Adding vectors given in polar coordinates

# Conversion between Rectangular and Polar Coordinates

If we know  $x$  and  $y$

$$r = \sqrt{x^2 + y^2}$$

$$\tan \theta = \frac{y}{x}$$

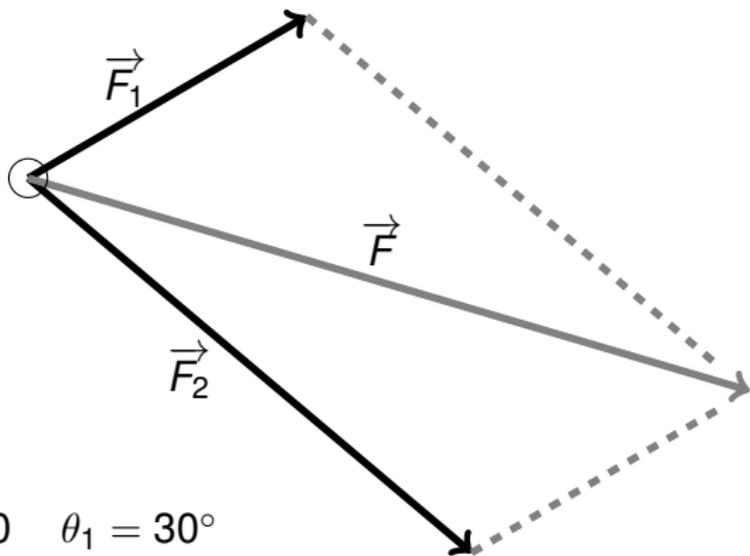
If we know  $r$  and  $\theta$

$$x = r \cos \theta$$

$$y = r \sin \theta$$

# Force Vectors

What is the magnitude of the total force on the object and in which direction is it pointed?



$$\|\vec{F}_1\| = 10 \quad \theta_1 = 30^\circ$$

$$\|\vec{F}_2\| = 18 \quad \theta_2 = 320^\circ$$

# Force Vectors

What is the magnitude of the total force on the object and in which direction is it pointed?

$$\|\vec{F}_1\| = 10, \theta_1 = 30^\circ \qquad \vec{F}_1 = \langle 8.66, 5.00 \rangle$$

$$\|\vec{F}_2\| = 18, \theta_2 = 320^\circ \qquad \vec{F}_2 = \langle 13.79, -11.57 \rangle$$

$$\|\vec{F}_1 + \vec{F}_2\| \approx 23.39 \qquad \vec{F}_1 + \vec{F}_2 = \langle 22.45, -6.57 \rangle$$

$$\theta \approx 343.7^\circ$$

$$\text{Note: } \tan^{-1} \left( \frac{-6.57}{22.45} \right) = -16.3^\circ; \qquad 343.7^\circ = 360^\circ - 16.3^\circ$$

# Navigational Vectors

A ship is moving through the water at 15 mph, on a heading of  $70^\circ$ . The current is flowing at a rate of 3 mph, on a heading of  $310^\circ$ . What is the speed of the ship and in what direction is it headed?

$$\|\vec{S}\| = 15, \theta_S = 70^\circ \qquad \vec{S} = \langle 5.13, 14.10 \rangle$$

$$\|\vec{C}\| = 3, \theta_C = 310^\circ \qquad \vec{C} = \langle 1.93, -2.30 \rangle$$

$$\|\vec{S} + \vec{C}\| \approx 13.74 \qquad \vec{S} + \vec{C} = \langle 7.06, 11.80 \rangle$$

$$\theta \approx 59.1^\circ$$

The ship is traveling 13.74 mph on a heading of  $59.1^\circ$

# Recap

To add vectors given in polar coordinates:

- 1 Convert to rectangular coordinates
- 2 Add the vectors
- 3 Convert back to polar coordinates