# VECTORS IN 2 DIMENSIONS

- **Vector notation:** $\vec{a} = [a_x, a_y]\ m/s^2$

- **Magnitude of a vector** - given by the Pythagorean theorem.
  - notation: $\| \ \|$

$$\|\vec{a}\| = \sqrt{a_x^2 + a_y^2}$$

- **Direction of a vector** - given by the inverse of the tangent ratio of the vertical and horizontal vector components.

$$\theta = \tan^{-1}\left(\frac{|a_y|}{|a_x|}\right)$$

- sketch a diagram
- find $\theta$

- **Vector components** are also vectors.
- Horizontal vector component:

$$\vec{a}_x = [a_x, 0]\ \frac{m}{s^2}$$

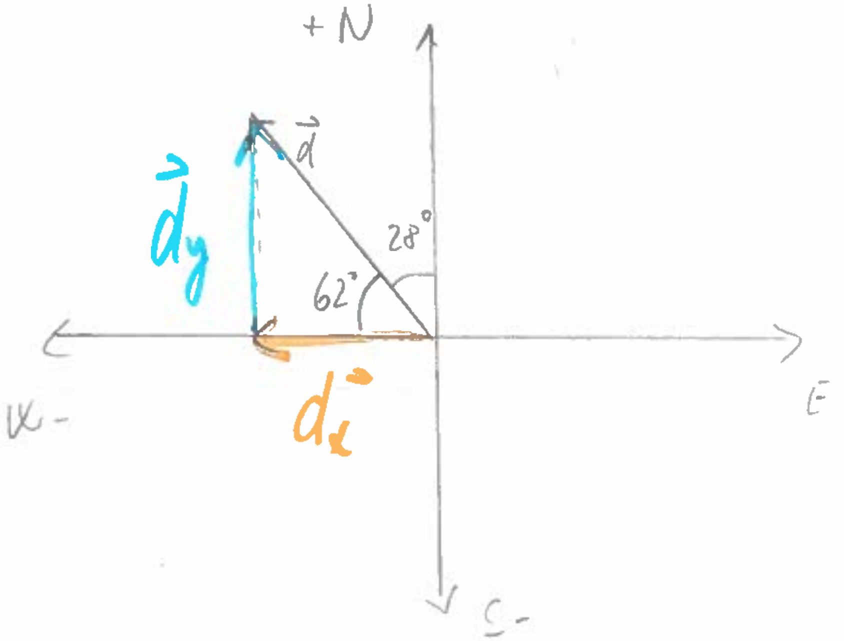
$$\vec{a}_x = \|\vec{a}\| \cdot \cos\theta$$

- Vertical vector component:

$$\vec{a}_y = [0, a_y]\ \frac{m}{s^2}$$

$$\vec{a}_y = \|\vec{a}\| \cdot \sin\theta$$

**Example 1:** Sketch a labeled diagram of a displacement vector $\vec{d} = 14$ m [N28°$W$]. Find the components of the vector and rewrite the vector using vector notation.




$\vec{d_x} = (-14)(\cos 62°)$

$\vec{d_x} \doteq 6.57$ m [W]

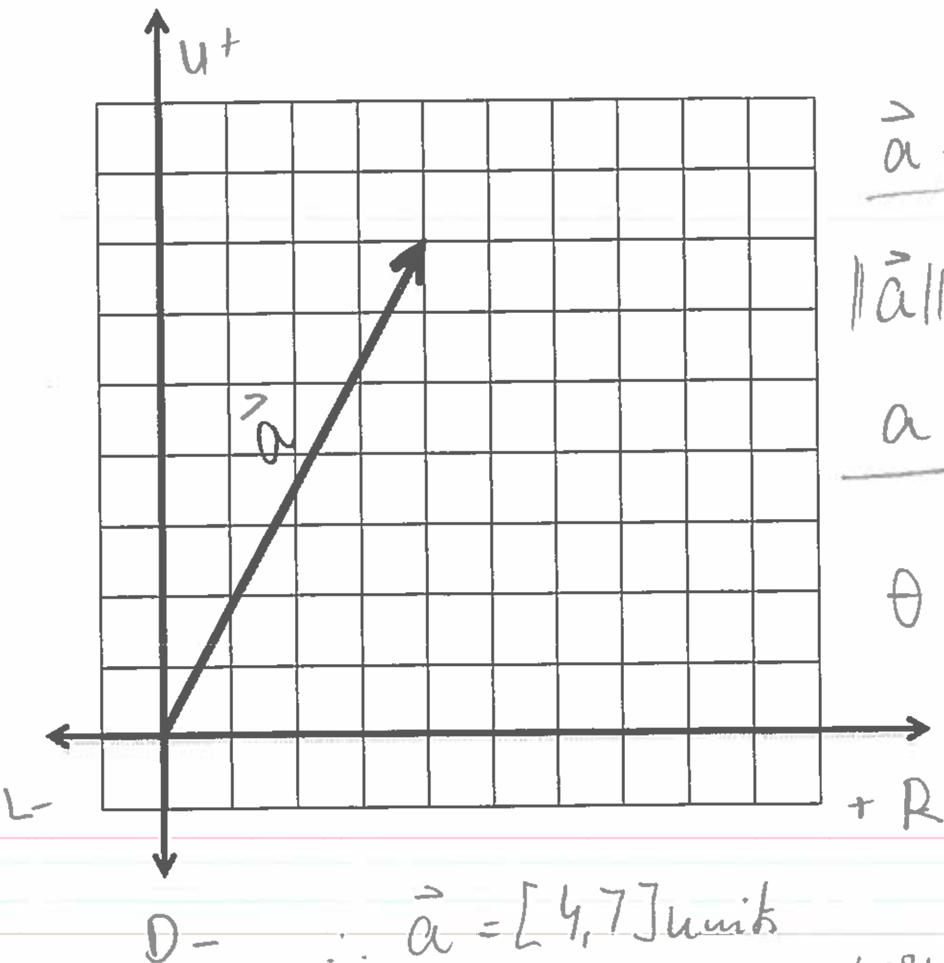
$\vec{d_x} = [-6.57, 0]$ m

$\vec{d_y} = (14)(\sin 62°)$

$\vec{d_y} \doteq 12.36$ m [N]

$\vec{d_y} = [0, 12.36]$ m

**Example 2:** Determine the magnitude and direction of each vector. Write the information about each vector in two different ways.




$\vec{a} = [4, 7]$ units

$\|\vec{a}\| = \sqrt{4^2 + 7^2}$

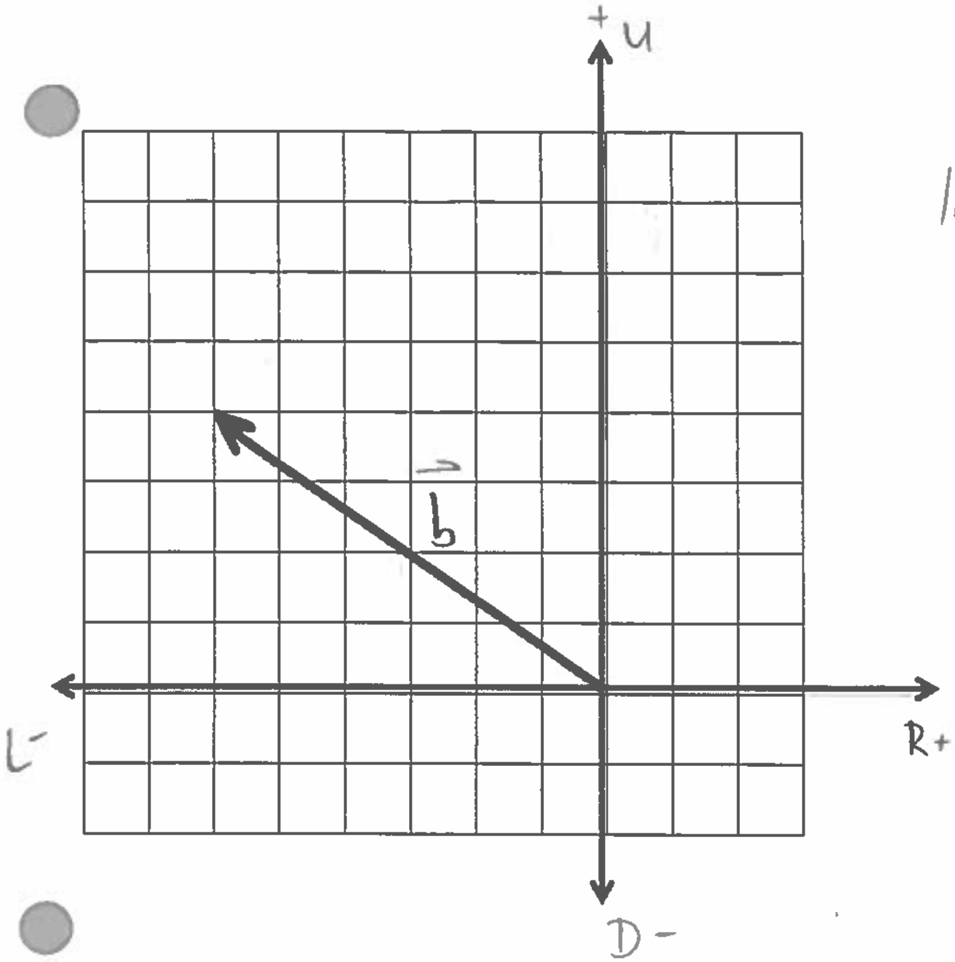
$a \doteq 8.06$ units

$\theta = \tan^{-1}\left(\frac{7}{4}\right)$

$\doteq 60°$

$\therefore \vec{a} = [4, 7]$ units

$\therefore \vec{a} = 8.06$ units R 60° U.




$\vec{b} = [-6, 4]$ units

$\|\vec{b}\| = \sqrt{(-6)^2 + 4^2}$

$b \doteq 7.21$ units

$\theta = \tan^{-1}\left(\frac{4}{6}\right)$

$\doteq 34^\circ$

$\therefore \vec{b} = [-6, 4]$ units

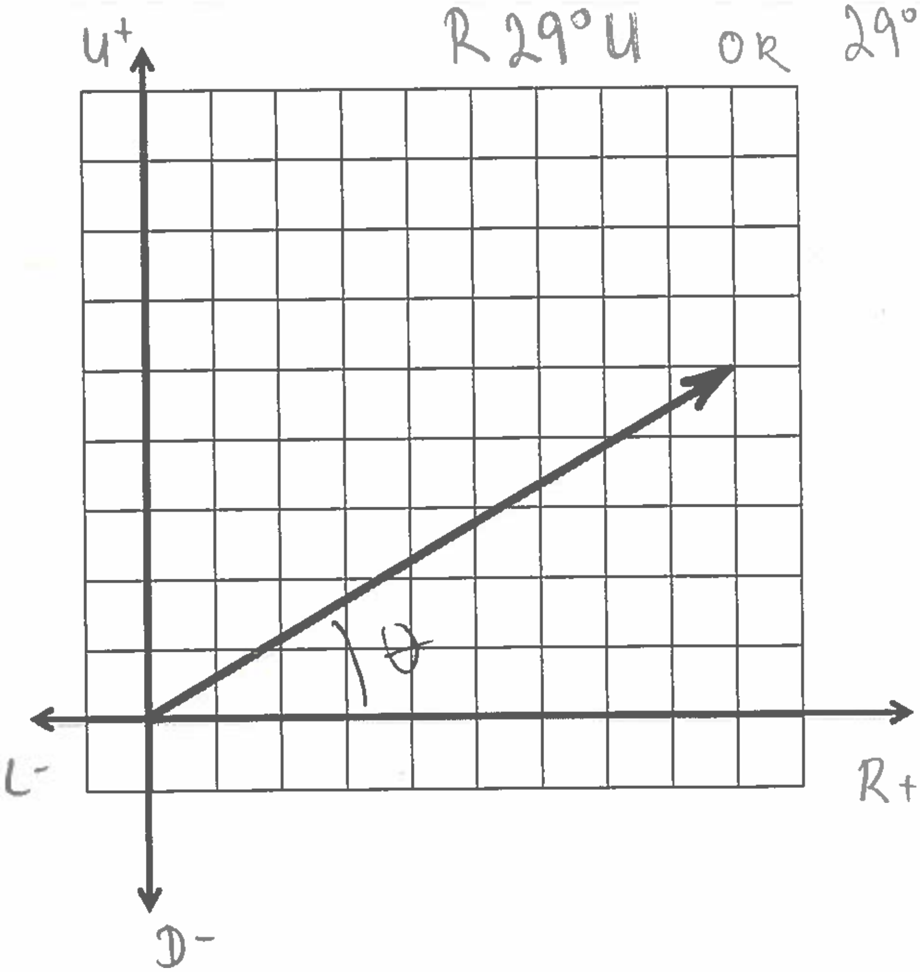
$\therefore \vec{b} = 7.21$ units $[L\ 34^\circ\ U]$

Practice:

1. Given the diagram of vector $\vec{m}$, determine the following:

- Vector notation of $\vec{m}$: $\vec{m} = [9, 5]$ units
- Vector components of $\vec{m}$: $\vec{m}_x = [9, 0]$ units or $\vec{m}_x = 9$ units [R]
  $\vec{m}_y = [0, 5]$ units or $\vec{m}_y = 5$ units [U]
- Magnitude of $\vec{m}$: $\|\vec{m}\| \doteq 10.30$ units
- Direction of $\vec{m}$: $\theta = 29°$

R 29° U OR 29° Up of Right



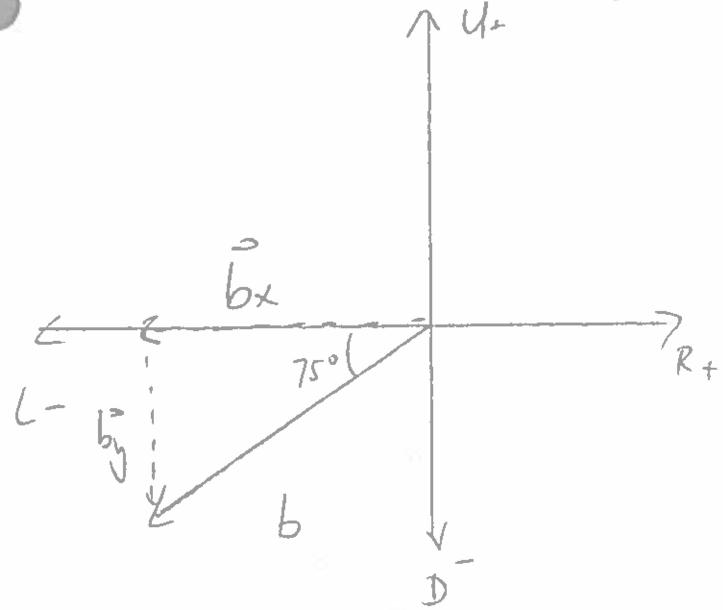

$\|\vec{m}\| = \sqrt{9^2 + 5^2}$

$\doteq 10.30$

$\theta = \tan^{-1}\left(\frac{5}{9}\right)$

$\theta \doteq 29°$

2. Determine vector components of $\vec{b} = 13cm[L75°D]$. Include a diagram in your solution.




$\vec{b}_x = -13 \cdot \cos 75°$

$= \underline{-3.36\ cm}$

$\vec{b}_y = -13 \sin 75°$

$= \underline{-12.56\ cm}$

3. Classify the given quantities as either a scalar of a vector.

| | |
|---|---|
| Mass | S |
| Volume | S |
| Force | V |
| Potential energy | S |
| Work | S |
| Kinetic energy | S |
| Time | S |
| Displacement | V |
| Temperature | S |
| Distance | S |
| Height | S |

| | |
|---|---|
| Momentum | V |
| Speed | S |
| Position | V |
| Velocity | V |
| Efficiency | S |
| Power | S |
| Acceleration | V |
| Tension | V |
| Impulse | V |
| Weight | S |
| Length | S |

## Review Math for Physics

- Conversion of units using dimensional analysis

**Example 1:** Express 25 m/s in km/h

$$\frac{25\,m}{s} \times \frac{1\,km}{1000\,m} \times \frac{3600\,s}{1\,h} = \underline{\underline{90\ km/h}}$$

**Example 2:** Express density of 3.5 g/cm³ in kg/m³

$$\frac{3.5\,g}{cm^3} \times \frac{1\,kg}{1000\,g} \times \frac{100^3\,cm^3}{1\,m^3} = \underline{\underline{3\,500}}\ kg/m^3$$

- Rounding: carry as many digits throughout your calculations as you reasonably can. Round at the very end and determine the number of digits needed based on the rules for significant digits and operations with numbers.

➢ **Addition and subtraction:** The result of addition or subtraction is permitted to have the same number of decimal places as the number with the least number of decimal places.

➢ **Multiplication and division:** The result of multiplication or division is permitted to have the same number of decimal places as the number with the least number of significant digits.

- <u>Scientific notation:</u> use it for all final answers.

- <u>Significant digits</u>

- Non-zero digits are also significant

- Zeros between non-zero digits are significant

- Zeros on the right of the decimal point when there is at least one non-zero digit to the left of them are significant

- Zeros on the right of the decimal point when there are no non-zero digits to the left of them are not significant

- Zeros at the end of an integer (=non-decimal number) may or may not be significant.