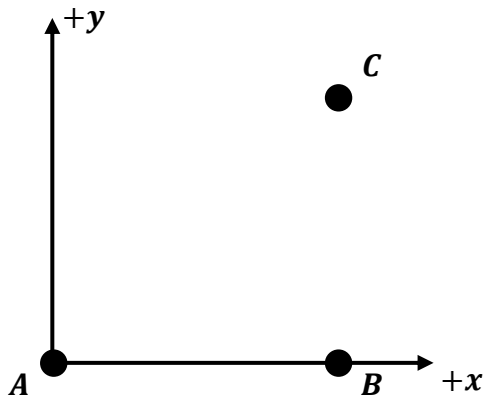
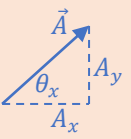


CONCEPT: INTRO TO MOTION IN 2D

- Motion at an angle (2D: $\mathbf{A} \rightarrow \mathbf{C}$) is just combining TWO straight-line motions (1D: $\mathbf{A} \rightarrow \mathbf{B}$ & $\mathbf{B} \rightarrow \mathbf{C}$), with vector equations.
 - Whenever motion is in 2D, **FIRST** break it down into X & Y (1D).



MOTION EQs	VECTOR EQs
$v_{avg} = \frac{\Delta x}{\Delta t}$ $a_{avg} = \frac{\Delta v}{\Delta t}$	
UAM (1) $v = v_0 + at$ (2) $v^2 = v_0^2 + 2a\Delta x$ (3) $\Delta x = v_0 t + \frac{1}{2}at^2$ (4)* $\Delta x = \frac{(v_0 + v)}{2}t$	$A = \sqrt{A_x^2 + A_y^2}$ $\theta_x = \tan^{-1}\left(\frac{ A_y }{ A_x }\right)$ $A_x = A \cos(\theta_x)$ $A_y = A \sin(\theta_x)$

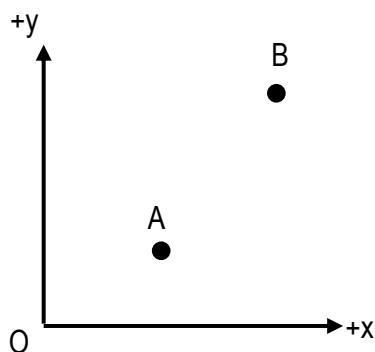
CONCEPT: POSITION AND DISPLACEMENT IN 2D

- If Position & Displacement are 2D vectors, use vector equations to jump between 2D vector $\Leftrightarrow$ X & Y components.

Position $\vec{r} \Leftrightarrow$ Components

Arrow from _____ $\rightarrow$ Point

EXAMPLE 1: At point **A**, your position is 3.6m @ 33.7°. You move to point **B**, where your position is 8.49m @ 45°. Calculate the x & y components of your position at **A** & **B**.



- Where you are / Coordinate (_____)

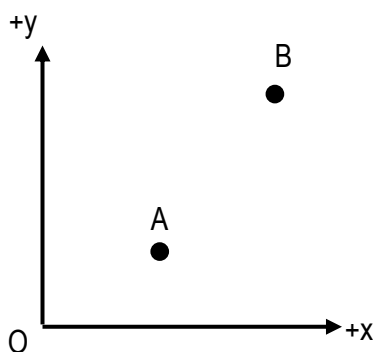
$$|\vec{r}| = \sqrt{x^2 + y^2} \quad \vec{x} = r \cos \theta$$

$$\theta = \tan^{-1} \left(\frac{|y|}{|x|} \right) \quad \vec{y} = r \sin \theta$$

Displacement Vector $\Delta \vec{r} \Leftrightarrow$ Components

Shortest path from Point $\rightarrow$ Point

EXAMPLE 2: Using Example 1, calculate the magnitude & direction of the displacement from **A** to **B**.



- _____ in position

$$|\Delta \vec{r}| = \sqrt{\Delta x^2 + \Delta y^2} \quad \Delta \vec{x} = \Delta r \cos \theta$$

$$\theta = \tan^{-1} \left(\frac{|\Delta y|}{|\Delta x|} \right) \quad \Delta \vec{y} = \Delta r \sin \theta$$

PROBLEM: At point **A**, a hiker is 10m east from the origin. After 35s, the hiker arrives at point **B** 40m at 60° north of east from the origin. Calculate the magnitude and direction of the hiker's displacement.

- A) 50m; 60° north of east
- B) 36m; 73.9° north of east
- C) 36m; 60° north of east
- D) 36m; 16.1° north of east

2D POSITION / DISPLACEMENT EQUATIONS

$$|\vec{r}| = \sqrt{x^2 + y^2} \quad \vec{x} = r \cos \theta$$

$$\theta = \tan^{-1} \left(\frac{|y|}{|x|} \right) \quad \vec{y} = r \sin \theta$$

$$|\Delta \vec{r}| = \sqrt{\Delta x^2 + \Delta y^2} \quad \Delta \vec{x} = \Delta r \cos \theta$$

$$\theta = \tan^{-1} \left(\frac{|\Delta y|}{|\Delta x|} \right) \quad \Delta \vec{y} = \Delta r \sin \theta$$

PROBLEM: Your initial position is 6.2 m from the origin, 25° below the x-axis. You then travel 9.9 m at an angle 78° above the positive x-axis, then 2.0 m in the negative x-direction. What is the magnitude & direction of your final position vector?

- A) 13.5m; 58° above +x-axis
- B) 18.1m; 78° above +x-axis
- C) 9.06m; 51.2° above +x-axis
- D) 10.4m; 42.6° above the x-axis

2D POSITION / DISPLACEMENT EQUATIONS

$$|\vec{r}| = \sqrt{x^2 + y^2} \quad \vec{x} = r \cos \theta$$

$$\theta = \tan^{-1} \left(\frac{|y|}{|x|} \right) \quad \vec{y} = r \sin \theta$$

$$|\Delta \vec{r}| = \sqrt{\Delta x^2 + \Delta y^2} \quad \Delta \vec{x} = \Delta r \cos \theta$$

$$\theta = \tan^{-1} \left(\frac{|\Delta y|}{|\Delta x|} \right) \quad \Delta \vec{y} = \Delta r \sin \theta$$