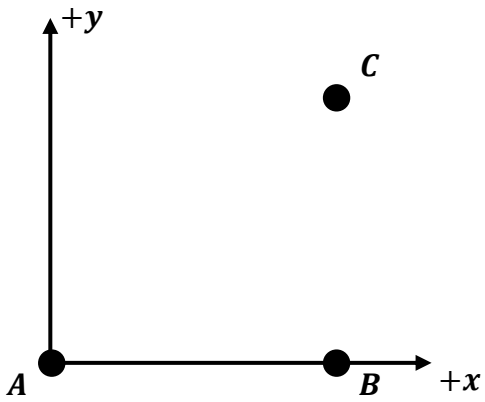
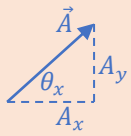
CONCEPT: INTRO TO MOTION IN 2D

- Motion at an angle (2D: **A**→**C**) is just combining *TWO* straight-line motions (1D: **A**→**B** & **B**→**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)* $\Delta x = \frac{(v_0+v)}{2}t$	$A = \sqrt{A_x^2 + A_y^2}$ $\theta_x = \tan^{-1}\left(\frac{\lvert A_y \rvert}{\lvert A_x \rvert}\right)$ $A_x = A\,cos(\theta_x)$ $A_y = A\,sin(\theta_x)$

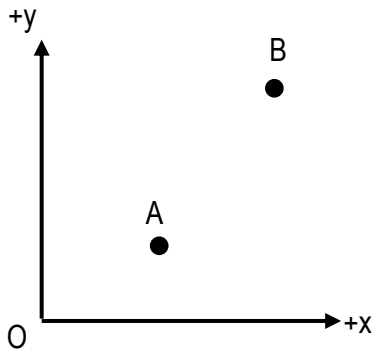
CONCEPT: POSITION AND DISPLACEMENT IN 2D

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

Position _____ $\vec{r}$ ⇔ Components

Arrow from _____ → 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 (_____)

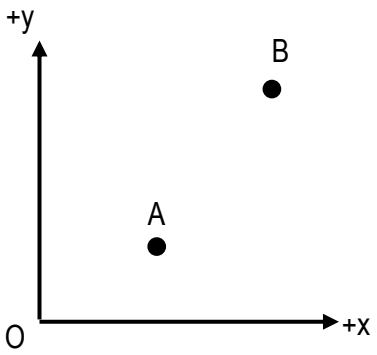
$|\vec{r}| = \sqrt{x^2 + y^2}$ $\quad \vec{x} = r \cos\theta$

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

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

Shortest path from Point → Point

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



- _____ in position

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

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

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

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

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

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

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

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

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

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

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

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