

CONCEPT: AVERAGE SPEED AND VELOCITY IN 2D

- Remember: Average speed & velocity measure **how FAST** something moves between two points.

Speed

(Magnitude only)

$$s = \frac{\text{distance}}{\text{time}} \Rightarrow \frac{d}{\Delta t}$$

- [SCALAR | VECTOR]

Velocity

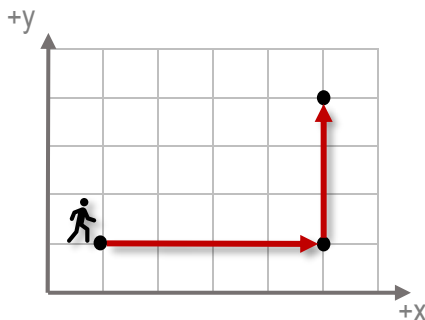
(Magnitude + Direction)

$$|\vec{v}_{avg}| = \frac{\text{displacement}}{\text{time}} \Rightarrow \frac{\Delta \vec{r}}{\Delta t} \quad \theta_v = \underline{\hspace{2cm}}$$

- [SCALAR | VECTOR]; always points in same direction as ____

EXAMPLE: You walk 40m in the +x-axis, then 30m in the +y-axis. The entire trip takes 10 seconds. Calculate

- your average speed
- the magnitude & direction of your velocity



PROBLEM: While following a treasure map, you start at an old oak tree. You first walk 85 m at 30.0° west of north, then walk 92 m at 67.0° north of east. You reach the treasure 2 minutes later. Calculate the magnitude of your average velocity for the entire trip.

- A) 1.11 m/s
- B) 1.48 m/s
- C) 1.40 m/s
- D) 1.32 m/s

2D SPEED / VELOCITY
EQUATIONS

$s \Rightarrow \frac{d}{\Delta t}$	$ \vec{v}_{avg} \Rightarrow \frac{\Delta r}{\Delta t}$
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PROBLEM: While following a treasure map, you start at an old oak tree. You first walk 85 m at 30.0° west of north, then walk 92 m at 67.0° north of east. You reach the treasure 2 minutes later. Calculate your average speed for the entire trip.

- A) 1.5 m/s
- B) 177m/s
- C) 88.5 m/s

2D SPEED / VELOCITY
EQUATIONS

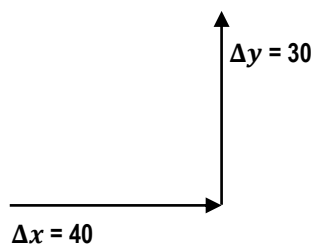
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CONCEPT: CALCULATING VELOCITY COMPONENTS

- If $\vec{v}_{avg}$ is 2D, it has x & y components. There are 2 sets of equations to go back & forth between $\vec{v}_{avg}$ & components:

1) Velocity Components $\leftrightarrow$ Displacement & Time

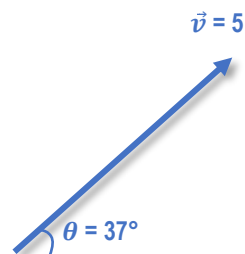
EXAMPLE: You walk 40 m right, then 30 m up in 10s. Calculate the velocity's magnitude and its x & y components.



$$\begin{aligned} |\vec{v}| &= \frac{\Delta r}{\Delta t} = \sqrt{\quad} & \vec{v}_x &= \quad = \quad \cos \theta \\ \theta_v &= \tan^{-1} \left(\frac{\quad}{\quad} \right) & \vec{v}_y &= \quad = \quad \sin \theta \end{aligned}$$

2) Velocity Components $\leftrightarrow$ Magnitude & Direction

EXAMPLE: You walk at 5m/s at an angle 37° above the x-axis. Calculate the x & y components of your velocity.



PROBLEM: A coastal breeze pushes your sailboat at constant velocity for 8 min. After checking your instruments, you determine you've been pushed 650 m west and 800 m south. What was the magnitude & direction of your average velocity?

- A) 2.15 m/s; 39.1° south of west
- B) 128.9 m/s; 50.9° south of west
- C) 2.15 m/s; 50.9° south of west

2D Velocity Vector

$$|\vec{v}| = \frac{\Delta r}{\Delta t} = \sqrt{v_x^2 + v_y^2} \quad \vec{v}_x = \frac{\Delta x}{\Delta t} = v \cos \theta$$

$$\theta_v = \tan^{-1} \left(\frac{|v_y|}{|v_x|} \right) \quad \vec{v}_y = \frac{\Delta y}{\Delta t} = v \sin \theta$$

PROBLEM: A ball moves on a tabletop. The ball has initial x & y coordinates (1.8m, 3.6m). The ball moves 10m/s at 53.1° above the x-axis for 4s. What are the x & y coordinates of the ball's final position?

- A) (11.8m, 13.6m)
- B) (25.8m, 35.6m)
- C) (41.8m, 43.6m)
- D) (33.8m, 27.6m)

2D Velocity Vector

$$|\vec{v}| = \frac{\Delta r}{\Delta t} = \sqrt{v_x^2 + v_y^2} \quad \vec{v}_x = \frac{\Delta x}{\Delta t} = v \cos \theta$$

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