## CONCEPT: AVERAGE SPEED AND VELOCITY IN 2D

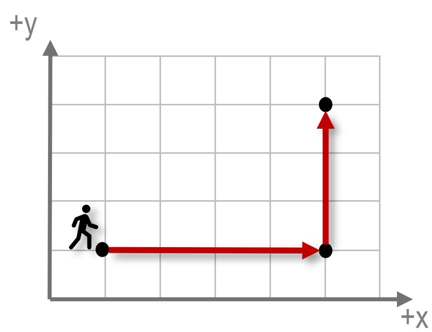
● Remember: Average speed & velocity measure **how FAST** something moves between two points.

| **Speed** (Magnitude only) | **Velocity** (Magnitude + Direction) |
|---|---|
| $s = \frac{\text{distance}}{\text{time}} \Rightarrow \frac{d}{\Delta t}$ | $\lvert\vec{v}_{avg}\rvert = \frac{\text{displacement}}{\text{time}} \Rightarrow \frac{\quad}{\Delta t}$ $\theta_v =$ _____ |
| **- [ SCALAR \| VECTOR ]** | **- [ 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

**a)** your average speed

**b)** 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.

**2D SPEED / VELOCITY EQUATIONS**

$s \Rightarrow \frac{\mathbf{d}}{\Delta t}$ $\quad$ $|\vec{v}_{avg}| \Rightarrow \frac{\Delta \mathbf{r}}{\Delta t}$

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

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**

$s \Rightarrow \frac{\mathbf{d}}{\Delta t}$ $\quad$ $|\vec{v}_{avg}| \Rightarrow \frac{\Delta \mathbf{r}}{\Delta t}$

**CONCEPT: CALCULATING VELOCITY COMPONENTS**

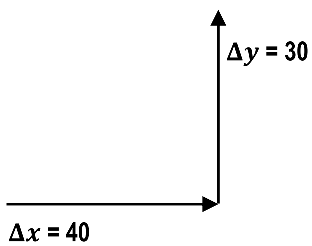
● If $\vec{v}_{avg}$ is 2D, it has x & y components. There are 2 sets of equations to go back & forth between $\vec{v}_{avg}$ & components:

**1)** Velocity Components ↔ **Displacement & Time**

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

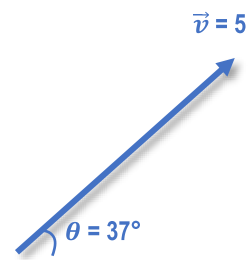
**2)** Velocity Components ↔ **Magnitude & Direction**

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




$|\vec{v}| = \frac{\Delta r}{\Delta t} = \sqrt{\qquad}$ $\qquad$ $\vec{v_x}$ = ______ = ___ cos $\theta$

$\theta_v = \tan^{-1}\left(\frac{|\quad|}{|\quad|}\right)$ $\qquad$ $\vec{v_y}$ = ______ = ___ sin $\theta$



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**

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

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