

Scalars and Vectors

A vector is a measurement with both magnitude and direction

A scalar does not have direction

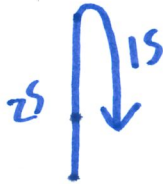
Displacement and Distance

Displacement is change in position from some reference point.

Distance is how far an object has travelled.

Displacement is a vector and distance is a scalar.

Example: Someone walks 25 m North, and then walks 15 m South. What distance did they travel? What is their displacement?



$$\text{distance} = 25\text{m} + 15\text{m} = 40\text{m} \approx 4.0 \times 10^1 \text{m}$$

$$\begin{aligned} \text{displacement} &= 10\text{m North} \\ &\approx 1.0 \times 10^1 \text{m North} \end{aligned}$$

Example: A ball rolls 15 cm, hits a wall and comes back to where it started. What distance did it travel? What is the displacement of the ball?

$$\begin{aligned} \text{distance} &= 15\text{cm} + 15\text{cm} = 30\text{cm} \\ &\approx 3.0 \times 10^1 \text{cm} \end{aligned}$$

$$\text{displacement} = 0$$

Speed and Velocity

Speed is the rate at which distance changes over time. It is a scalar

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

Velocity is the rate at which displacement changes over time. It is a vector

$$\text{Velocity} = \frac{\text{displacement}}{\text{time}}$$

Example: Someone walks 26 m North, and then 42 m South in a total time of 15 seconds. What is the distance they travelled? What is their displacement? What is their average speed? What is their average velocity?

distance: $26\text{m} + 42\text{m} = 68\text{m}$
 displacement: 16m South

26 | 42

speed = $\frac{68\text{m}}{15\text{sec}} = 4.5\text{m/s}$
 Velocity = $\frac{16\text{m South}}{15\text{sec}} = 1.1\text{m/s South}$

Example: A person runs with velocity of 6.3 m/s East for 27.5 seconds. They then stop and rest for 3.0 seconds, turn around walk West at 2.9 m/s for 15 seconds. What is their total distance? What is their total displacement? What is their average speed? What is their average velocity?

$v = \frac{d}{t}$
 $vt = d$

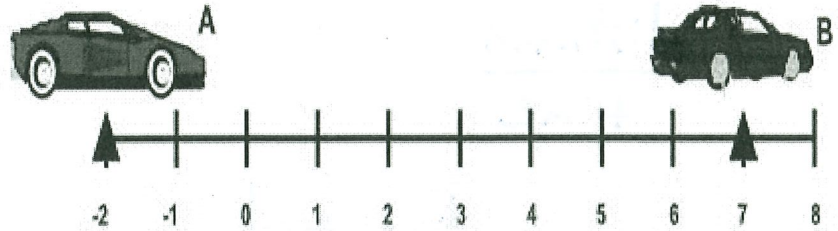
$(6.3 \frac{\text{m}}{\text{s}})(27.5\text{s}) = 173.25\text{m East}$
 $(2.9 \frac{\text{m}}{\text{s}})(15\text{sec}) = 43.5\text{m West}$

distance = $173.25 + 43.5 = 216.75\text{m} \approx 220\text{m}$
 displacement = $173.25 - 43.5 = 129.75\text{m E} \approx 130\text{m E}$

Speed = $\frac{216.75\text{m}}{45.5\text{sec}} \approx 4.8\text{m/s}$ | velocity $\frac{129.75}{45.5} = 2.9\text{m/s E}$

Practice

1. Consider the diagram to the right:



a. What is the distance between car A and car B?

9

b. What is the distance between car B and car A?

9

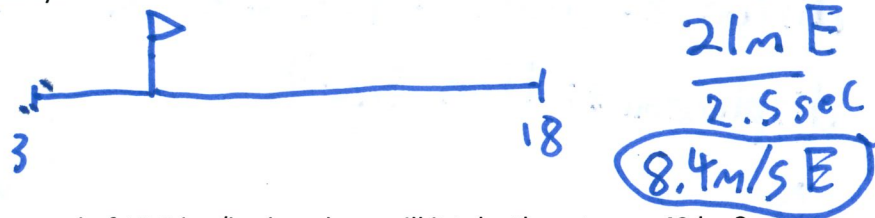
c. What is the displacement from car A to car B?

9

d. What is the displacement from car B to car A?

-9

2. A shopping cart moves from a point 3.0 m West of a flagpole to a point 18m East of a flagpole in 2.5 seconds. Find its average velocity.



3. If someone runs with average speed of 10.2 km/hr, how long will it take them to run 42 km?

$$d = st \rightarrow t = \frac{d}{s} = \frac{42\text{km}}{10.2\frac{\text{km}}{\text{hr}}} = 4.1\text{hr}$$

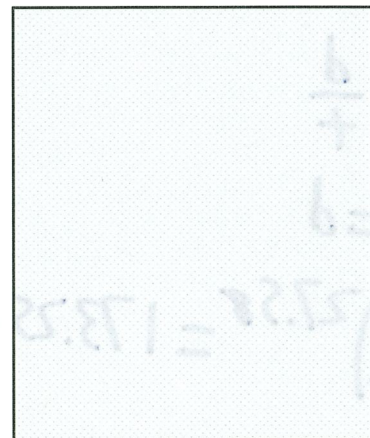
4. Sally takes her dog for a walk around the block shown.

a. What distance did she travel?

280m
 $2.80 \times 10^2 \text{ m}$

b. What is her displacement?

0



60.0m