Speed, Velocity and Acceleration

Goals for this class:

- to understand the difference between speed and velocity
- to perform calculations involving speed, velocity or acceleration

Once we understand position, distance and displacement, we can explore how those things change over time.

A car travels 30 km [E] followed by 40 km [W].

a) What is the distance traveled by the car?

$\Delta d = 30\,km + 40\,km$

$= 70\,km$

b) If this trip takes the car 1 hour, what is the car's average speed?

$speed = v = \frac{\Delta d}{\Delta t} = \frac{70\,km}{1\,h} = 70\,km/h$

c) If this trip takes the car 1 hour, what is the car's **average** speed?

d) What is the displacement of the car?

$$\text{displacement} = \vec{\Delta d} = 30\text{ km [E]} + 40\text{ km [W]}$$
$$= -30\text{ km [W]} + 40\text{ km [W]}$$
$$= 10\text{ km [W]}$$

e) If this trip takes the car 1 hour, what is the car's **average** velocity?

$$\text{velocity} = \vec{v} = \frac{\vec{\Delta d}}{\Delta t} = \frac{10\text{ km [W]}}{1\text{ h}} = 10\text{ km/h [W]}$$

Speed vs Velocity

scalar

vector

average speed = $\frac{\text{distance}}{\text{time}}$

average velocity = $\frac{\text{displacement}}{\text{time}}$

$v_{av} = \frac{\Delta d}{\Delta t}$

$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t}$

A cyclist rides 26 km [N] and then 24 km [E] in two hours.

a) What is the average speed of the cyclist?

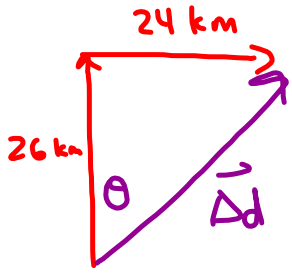
$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{26\text{ km} + 24\text{ km}}{2\text{ h}} = \frac{50\text{ km}}{2\text{ h}} = 25\text{ km/h}$$

b) What is the average velocity of the cyclist?

$$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t}$$

$$= \frac{35.4\text{ km [N42.7°E]}}{2\text{ h}}$$

$$= 17.7\text{ km/h [N42.7°E]}$$



$$\sqrt{26^2 + 24^2} = 35.4\text{ km}$$

$$\theta = \tan^{-1}\left(\frac{24}{26}\right) = 42.7°$$

$$\vec{\Delta d} = 35.4\text{ km [N42.7° E]}$$

A car travels 150 km for 1.5 hours, stops for 30 minutes, then continues to travel 200 km in 1 hour and 45 minutes. What is the average speed of the car for the entire trip?

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

$= \frac{350\ km}{3.75\ h}$

$= 93.3\ km/h$

$\Delta d = 150\ km + 200\ km$

$= 350\ km$

$\Delta t = 1.5 + 0.5 + 1.75\ h$

$= 3.75\ h$

What about speeding up and slowing down?

Acceleration

in physics this does not technically describe speeding up/slowing down

Acceleration describes the rate of change in velocity

Acceleration: $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

A car accelerates from zero to 15 m/s [W] in 5 seconds. What is the average acceleration?

$$\vec{a} = \frac{15\ m/s\ [W] - 0}{5\ s} = \frac{15\ m/s\ [W]}{5\ s} = 3\ m/s/s\ [W]$$

$$= 3\ m/s^2\ [W]$$