constant

UNIFORM MOTION = constant speed / velocity!

- **Vectors** have both magnitude (ie. a value) and direction
  - Directions indicated by + or -
- **Scalars** only have magnitude
- **Displacement ($\vec{d}$):** a change in the distance and direction away from a reference point (ie. a change in position) of an object
  - Standard international (SI) units are meters, *m*
  - Vector quantity
  - Distance versus displacement

$d = 3.0\,m$ $\qquad$ $\vec{d} = 1.0\,m$, right

- **Velocity ($\vec{v}$):** *rate* of change in an objects' position. *Rate* means over time, so velocity is a change in an object's position over time
  - SI units are meters/second (m/s)
  - Vector quantity

"Δ" (delta) → means "change"

$$\vec{v} = \frac{\Delta d}{\Delta t} \quad \text{or} \quad \vec{v} = \frac{d}{t}$$

where $\vec{v}$ is velocity (m/s)
$\vec{d}$ is displacement (m)
t is the time interval (s)

- **Speed** is similar to velocity, just the *scalar* version

$$\text{speed} = \frac{\text{distance}}{\text{time}} \quad \text{vs} \quad \text{velocity} = \frac{\text{displacement}}{\text{time}}$$

$$v = \frac{d}{t} \qquad \vec{v} = \frac{\vec{d}}{t}$$

$\vec{v} = d/t$ (vector)

EXAMPLE: An object travels at a uniform velocity of 25.0 m/s west. What is the displacement of the object after 10.0 minutes?

$\vec{v} = 25.0\ m/s$

$\vec{d} = ?$

$t = 10.0\ min \times \left(\frac{60\ s}{1\ min}\right)$

$t = 600\ s$

$\vec{v} = \frac{\vec{d}}{t} \Rightarrow \vec{d} = \vec{v}t$

$\vec{d} = (25.0\ m/s)(600\ s) = 15000\ m$

$\vec{d} = 1.50 \times 10^4\ m$, west

- Sometimes it is useful to also calculate the *average* speed or velocity

$\vec{v}_{avg} = \frac{d_{total}}{t_{total}}$ ← displacement OR $v = \frac{d_{total}}{t_{total}}$ ← distance

EXAMPLES:

1. A runner goes for a run and ends up going 5.72 m north and 2.00 m south over a time interval of 3.75 s. Calculate the runner's
   a. average speed ⇒ scalar
   b. average velocity ⇒ vector

a.) $v_{avg} = \frac{d_{total}}{t_{total}} = \frac{5.72m + 2.00m}{3.75s} = 2.0586\overline{6}\ m/s$

$v_{avg} = 2.06\ m/s$

b.) $\vec{v}_{avg} = \frac{\vec{d}_{total}}{t_{total}} = \frac{(5.72m) + (-2.00m)}{3.75s} = +0.992\ m/s$

$\vec{v}_{avg} = 0.992\ m/s$, north

#1

2. In a high speed car chase, the felon is driving at 12 m/s east for 7.0 minutes. He pulls on his emergency brake and does a complete 180° turn. He then proceeds to travel at 18 m/s west for 15 minutes before arriving at his destination.

#2
   a. Calculate the average speed of the vehicle. ⇒ scalar
   b. Calculate the average velocity of the vehicle. ⇒ vector

a.) $v_{avg} = \frac{d_{total}}{t_{total}}$ ② → × need to find the distance traveled! ①

#1

$v_1 = 12\ m/s$

$t_1 = 7.0\ min \times \left(\frac{60\ s}{1\ min}\right)$

$t_1 = 420\ s$

#2

$v_2 = 18\ m/s$

$t_2 = 15\ min \times \left(\frac{60\ s}{1\ min}\right)$

$t_2 = 900\ s$

① $v = \frac{d}{t} \Rightarrow d = vt$

$d_1 = (12\ m/s)(420\ s)$

$d_1 = 5040\ m$

$d_2 = (18\ m/s)(900\ s)$

$d_2 = 16200\ m$

② $\therefore v_{avg} = \frac{(5040\ m + 16200\ m)}{(420\ s + 900\ s)} = 16.\overline{09}\ m/s$

$\boxed{v_{avg} = 16\ m/s}$

b.) $\vec{v}_{avg} = \frac{\vec{d}_{total}}{t_{total}} = \frac{(5040\ m) + (-16200\ m)}{(420\ s + 900\ s)} = -8.\overline{45}\ m/s$

$\boxed{\vec{v}_{avg} = 8.5\ m/s,\ west}$

*****Now try pg. 23 #2, 4, 7, 12-14 (acceptable), 15-17 (intermediate), 10 (challenger)*****

Uniform Motion Review

1. Trevor is walking to school from home. He leaves and travels 58 m before he forgets his lunch. He turns around, goes back home and grabs his lunch. He then walks 236 m before he gets to school.

   a. What is the distance Trevor travelled?
   b. What is the displacement Trevor travelled?

a.) $d = 58m + 58m + 236m$

$\boxed{d = 352m}$

b.) $\vec{d} = 58m + (-58m) + 236m$

$\boxed{\vec{d} = 236m, \text{ to school}}$

v_1 ; t_1

2. A car travels at 100 km/h for 1.5 hours heading east. However there is an accident on the highway, so traffic is re-directed. The car travels west for 0.5 h at a reduced speed of 60 km/h before the car reaches a secondary highway and gets re-routed. ↳ v_2 ; t_2
   a. What is the average speed of the car?
   b. What is the average velocity of the car?

a.) $v = \frac{d}{t} \Rightarrow vt = d$

$d_1 = vt = (100\,km/h)(1.5\,hrs) = 150\,km$

$d_2 = vt = (60\,km/h)(0.5\,hr) = 30\,km$

$v_{avg} = \frac{d_{total}}{t_{total}} = \frac{(150\,km + 30\,km)}{(1.5\,hr + 0.5\,hr)} \Rightarrow \boxed{v_{avg} = 90\,km/hr}$

b.) $\vec{v}_{avg} = \frac{\vec{d}_{total}}{t_{total}} = \frac{150 + (-30\,km)}{(1.5\,hr + 0.5\,hr)} \Rightarrow \boxed{\vec{v}_{avg} = 60\,km/hr,\ east}$