Describing Motion Using Equations

One of the most accurate ways of describing the motion of objects is to use mathematical equations and problem solving.

Problem Solving

G Given: Identify the information that is given in the problem statement.

R Required: Identify the information that is required. (need to find)

A Analyse: Figure out which equation applies to the problem.

S Substitute and Solve:
If using an equation, substitute the values given in the problem for the appropriate variables and then solve the equation.

P Paraphrase: make sense of your answer

Calculating Speed

We've already learned that speed is how fast an object is moving.

Average Speed, V_{av}, is: the distance (Δd) divided by the time (Δt).

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

Example: Calculate the average speed of a car that travels from Prince Albert to Saskatoon (141 km) in 1.25 hours.

Given: $d = 141$ Km, $t = 1.25$ hr Need: V_{av}

watch sd.

$$V_{av} = \frac{\Delta d}{\Delta t} = \frac{141\text{ Km}}{1.25\text{ hr}} = 112.8\frac{\text{Km}}{\text{hr}} = 113\text{ Km/hr}$$

Calculating Distance or Time

There will be times when the formula you are given will need to be rearranged (manipulated) to solve for another variable (e.g solving for distance or time).

The only rule to follow is: what you do to one side, you must do to the other side!

(to undo a math operation, perform the opposite one!)

Example: Calculate the distance traveled by a bicycle that traveled at 13 km/h for 1.6 hours.

Given: $V_{av} = 13\ km/hr$ Need: d

$t = 1.6\ hr$

$d = V_{av} \cdot t$

$t \cdot V_{av} = \frac{d}{t} \cdot t$

$d = V_{av} \cdot t$

$= 13\ \frac{km}{hr} \cdot 1.6\ hr$

$= 20.8\ km$ $= 21\ km$

Example: The Boeing 747, commonly called a jumbo jet, reaches cruising speeds of 885 km/hr. Calculate the time it would take a jumbo jet to fly at cruising speed from Regina to Orlando, Florida, a distance of 3714 km.

Given: $V_{av} = 885\ km/hr$ Need: t

$d = 3714\ km$

$t \cdot V_{av} = \frac{d}{t} \cdot t$ $t \cdot V_{av} = \frac{d}{V_{av}}$

$t = \frac{d}{V_{av}}$

$t = \frac{3714\ km}{885\ km/hr}$

$= 4.196\ hr$

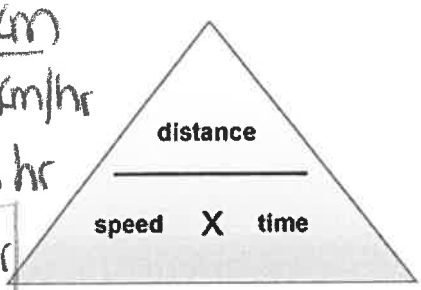
$= 4.20\ hr$

Speed Equations Summarized

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

$$\Delta d = V_{av}\ x\ \Delta t$$

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



You may find this triangle useful when rearranging the equation to get:
distance = speed x time
time = distance / speed

Velocity Equations

direction aware

The speed equations can also be used to find velocity. Just don't forget to:
include displacement rather than distance and include direction in your final answer.

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

$$\Delta \vec{d} = \vec{V}_{av} \, x \, \Delta t$$

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

10.0

Example: A cheetah runs with a velocity of 10 m/s [E] for 29 seconds. What is its displacement?

Given: $\vec{V}_{av}$ = 10m/s [E]
t = 29s

Need: $\vec{d}$

$\vec{d} = \vec{V}_{av} \cdot t$
$= \frac{10 m [E]}{s} \cdot 29 s$
$= 290 m [E]$

Vector so direction must be included