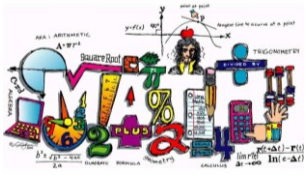
Describing Motion Using Equations

- One of the most accurate ways of describing the motion of objects is to use equations!
- Yes this means…!



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Describing Motion Using Equations

- 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) for a trip

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

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For example…

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

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$$V_{av} = \frac{141\ \text{km}}{1.25\ \text{h}}$$

5

For example…

6

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

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

BUT…you must consider significant digits!

$$V_{av} = \frac{141\ \text{km}}{1.25\ \text{h}} = 112.8\ \text{km/h}$$

6

For example…

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

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

There are 3 significant digits in the question…

$$V_{av} = \frac{141\ \text{km}}{1.25\ \text{h}} = 112.8\ \text{km/h}$$

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For example…

8

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

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

So we need to round to 3 s.d. in the answer.

$$V_{av} = \frac{141\ \text{km}}{1.25\ \text{h}} = 112.8\ \text{km/h}$$

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For example…

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

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

Our final answer is 113 km/h.

$$V_{av} = \frac{141\ \text{km}}{1.25\ \text{h}} = 112.8\ \text{km/h}$$

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Problem Solving

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- Sometimes, it will be difficult to figure out what the question is asking you to find.
- In these instances, it is helpful to use the GRASP method of problem solving.

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

R Required: Identify the information that is **REQUIRED**. (What are you trying to determine?)

A Analyse: **ANALYSE** (figure out) which equation, rule or principle applies to this type of 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: **PARAPHRASE** (write) your answer in a brief sentence that answers the problem.

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Problem Solving

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- Also, there will be times when the formula you are given will need to be rearranged (manipulated) to solve for another variable.

(For example, you may need to solve for time or distance!)

- The only rule to follow is: "Whatever you do to one side, you MUST do to the other!"

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For example…

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

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For example…

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- Calculate the distance traveled by a bicycle that traveled at 13 km/h for 1.6 hours.
- This means we need to solve for d.

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Remember to first ask yourself: *Which variable do I want to isolate?* In this case, we want to isolate ***d***. So we begin by working on moving all other variables to the other side:

1. Multiply both sides by t:

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

2. Cancel t's where appropriate:

$$v \times t = \frac{d}{\cancel{t}} \times \cancel{t}$$

The two steps above are exactly what you do when you cross-multiply. If you are more familiar (or comfortable) with doing it this way, please feel free to do so.

3. and you end with an equation for d:

$$v \times t = d$$

If you are more comfortable with the unknown being on the left, you can also rearrange it to read:

$$d = v \times t.$$

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For example…

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

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Speed Equations

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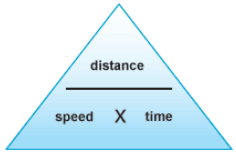
$$V_{av} = \frac{\Delta d}{\Delta t}$$

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

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



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

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Velocity Equations

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- The speed equations can also be used to find velocity.
- Just don't forget to include direction and use displacement rather than distance.

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

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

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

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These two ski gondolas have the same speed but have different velocities since they are travelling in opposite directions.

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Converting between m/s and km/h

- To convert from km/h to m/s
  - Change km to m: 1 km = 1000 m
  - Change h to s: 1 h = 3600 s
- Therefore multiply by 1000 and divide by 3600

or

- Divide the speed in km/h by 3.6 to obtain the speed in m/s.

For example, convert 75 km/h to m/s.

$$\frac{75km}{1h}\times\left(\frac{1000m}{1km}\right)\times\left(\frac{1h}{3600s}\right)=21m/s$$

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Converting between m/s and km/h

Try the following unit conversion problems yourself.

1. Convert 95 km/h to m/s.

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$$\frac{95\ km}{1hr}\times\frac{1000m}{1km}\times\frac{1hr}{3600s}=26\ m/s$$

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$$\frac{95\ km}{1hr}\times\frac{1000m}{1km}\times\frac{1hr}{3600s}=26\ m/s$$

2. A truck's displacement is 45 km north after driving for 1.3 hours. What was the truck's average velocity in km/h & m/s?

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$$\frac{95\ km}{1hr}\times\frac{1000m}{1km}\times\frac{1hr}{3600s}=26\ m/s$$

2. A truck's displacement is 45 km north after driving for 1.3 hours. What was the truck's average velocity in km/h & m/s?

$$\vec{v}_{av}=\frac{45km}{1.3hr}=35\ km/h\ N$$

or

$9.6\ m/s\ N$

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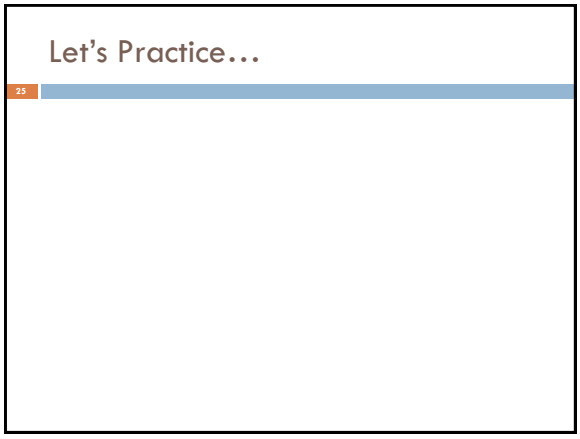

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