MOTION

Science 10 – Ms. Hayduk

Position

- Position: an object's location based on a reference point
- Example: The house is 4.0 km south of Costco.

Scalar and Vector

- Scalar: a quantity (amount) described by a magnitude (number) only
- Vector: a quantity described by a magnitude and a direction

Examples:

I walked 50 m. _____

I walked 50 m North. _____

Example: Scalar or Vector?

1. 40 km
2. 2.8 km/h
3. 17 m south
4. The ball fell 60 cm straight down.
5. I walked 40 m.
6. I pushed the box 2 m up a 30° ramp.

Distance and Displacement

- Distance: how much an object has moved (scalar)
- Displacement: how far out of place an object is; overall change in position (vector)

Units

- Units are a way to show what kind of measurement is being taken
- Useful to compare measurements
- Position, distance and displacement are usually measured in **metres** (m)
- Other possible units: kilometres (km), millimetres (mm), centimetres (cm), feet (ft), inches (in), miles (mi)

Example: Units

Is this a distance measurement?

- 49 s
- 12 m/s
- 90 km
- 7 cm
- 48°

Distance

- Add all distances together to get total distance
- Don't forget units!

Displacement

- Split movement into "horizontal" (east-west, left-right) and "vertical" (north-south, up-down)
- Figure out change in horizontal and vertical directions
- Write displacement including units and direction

Example 1: Distance and Displacement

You take your dog for a walk in your neighbourhood. You walk 4.0 m east, 2.0 m south, 4.0 m west and 2.0 m north.

a. What is your total distance walked?

b. What is your displacement?

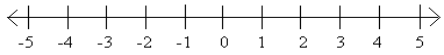
Example 2: Distance and Displacement

You take your dog for a walk in your neighbourhood. You walk 5.0 m east, 1.0 m south, 5.0 m west and 2.0 m north.

a. What is your total distance walked?

b. What is your displacement?

Example 3: Distance and Displacement



Speed

- Speed: how fast an object is moving
- Also, the amount of distance covered in a specific amount of time
- Scalar quantity (no direction)

Calculating Speed

- Given by:

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

- Where:
  - v is speed
  - d is distance
  - t is time

Units of Speed

- Units for distance: m, km, cm, ft, miles
- Units for time: s, min, h
- Units for speed can be any distance unit divided by any time unit, but most often m/s or km/h

Example 1: Calculating Speed

You run 5 km in 30 min. What is your speed in km/h?

Example 2: Calculating Speed

You drive to Saskatoon from Regina in 2.25 h at a speed of 110 km/h. How far did you drive, in kilometres?

Example 3: Calculating Speed

A cheetah can run 100.0 m in 5.62 s while hunting. What is the cheetah's hunting speed in km/h?

Average Speed

- Total distance divided by total time for a trip

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

- Δd is the change in position ($d_2 - d_1$)
- Δt is the change in time ($t_2 - t_1$)

Example: Average Speed

a. What is the runner's average speed for the first 200 m?
b. What is the runner's average speed in the second half of the race?
c. What is the runner's average speed for the whole race?

Distance (m)	Time (s)
0	0
100	15.2
200	29.8
300	41.7
400	64.5

Instantaneous and Constant Speed

- Instantaneous speed: speed of an object at one moment in time (e.g. speed read from a speedometer)
- Constant speed: instantaneous speed remains the same for a period of time

Representing Motion

- Mathematically (using numbers or equations)
- Qualitatively (using words)
- Graphically (using graphs)

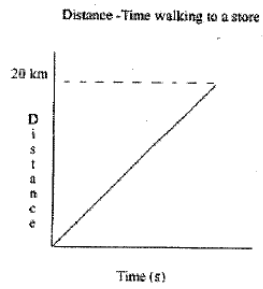
Distance-Time Graphs

- Time is <u>independent</u> (x-axis), distance is <u>dependent</u> (y-axis)
- Shows total distance travelled by object at specific times during its motion
- SLOPE = SPEED (think y = mx+b)

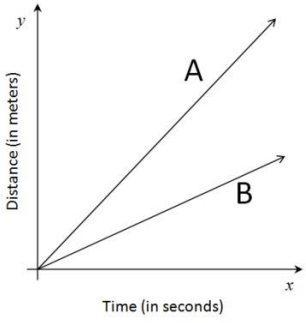
$$d_2 = v\Delta t + d_1$$

Distance-Time Graphs

- Imaging you walked from your house to the store at a constant speed, then back to your house. The store is 10 km away.
- The total distance travelled is 20 km.



Example: Distance-Time Graph



Example: Distance-Time Graph

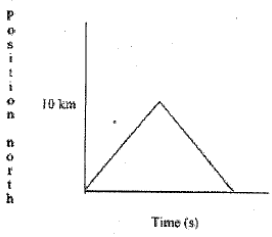
1. Which object travelled a greater distance?
2. Which object has a greater speed?
3. How would you calculate the average speed of each object?

Position-Time Graphs

- Time is <u>independent</u>, position is <u>dependent</u>
- Show the movement of an object relative to it's starting position
- Slope is speed the object is travelling; <u>however</u>, the speed will always be a positive number

Position-Time Graphs

- For the previous example of walking to the store, the position-time graph would look like this



Example: Position-Time Graph

Example: Position-Time Graph

1. What is Dan's speed for the first hour?
2. What is Dan's average speed for the first three hours?
3. For how long is Dan stopped in total?
4. What is Dan's total distance travelled?
5. What is Dan's total displacement?