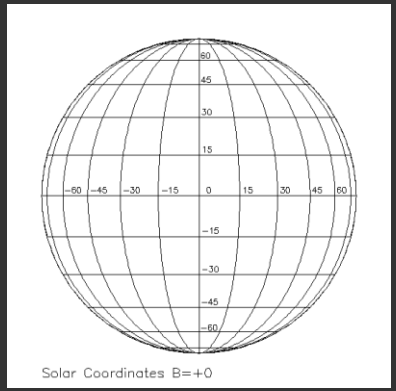
Ch 10 Motion

10.1 An object in motion changes position

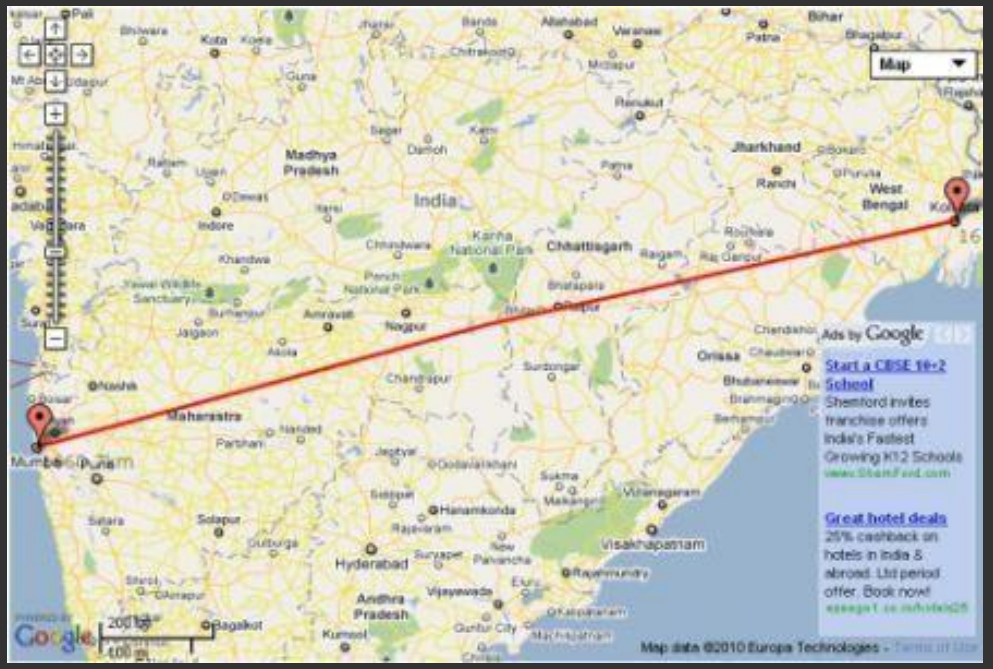
Position describes the location of an object



- Position (or location)—described relative to a reference point
- Example
  - City—can be located by measuring its direction & distance from another city (or by using a grid system like latitude/longitude)

2 ways to measure the distance an object has traveled:

1. Measure the length of the path the object followed
2. <u>Displacement of the object</u> method-- measure the straight-line distance of an object to its starting point

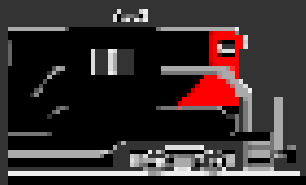


Motion is a change in position over time

- How quickly or slowly the position changes depends on the object's speed
- How motion is observed depends on the observer's point of view
  - By comparing the object's motion relative to the observer's frame of reference

Example

- Person throws a ball forward on a moving train
- Motion of the ball is measured differently by observers *on the train* and by those *on the ground*
- Observers on the ground would measure the motion of the ball to be much faster
- If the ball is thrown *backward on the train*, observers on the ground would measure the ball to be slower



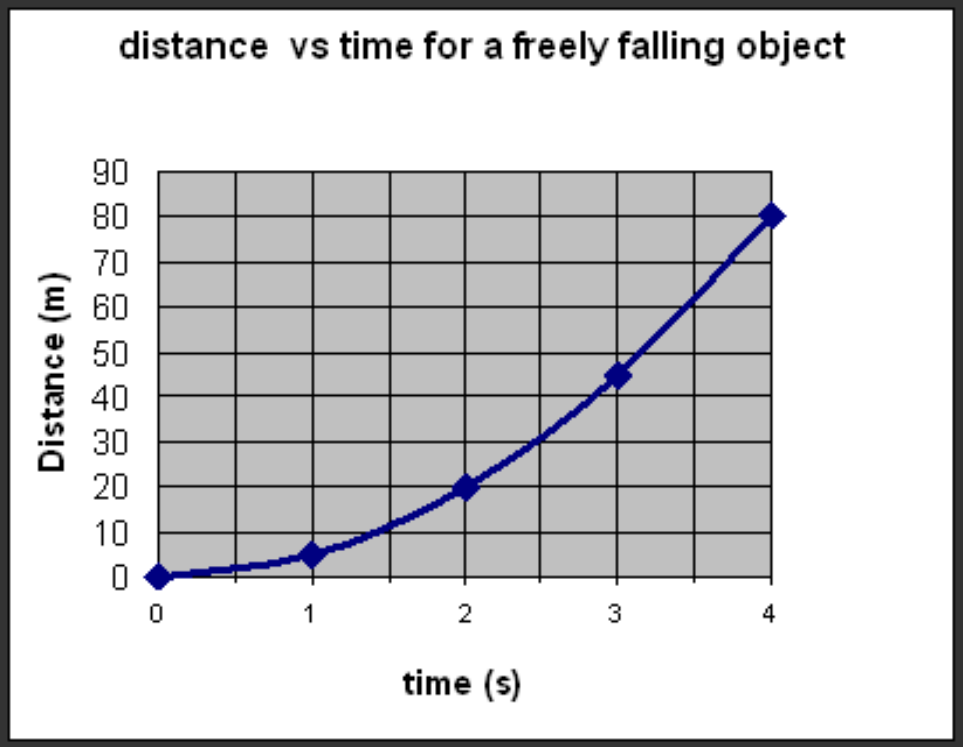
10.2 Speed measures how fast position changes

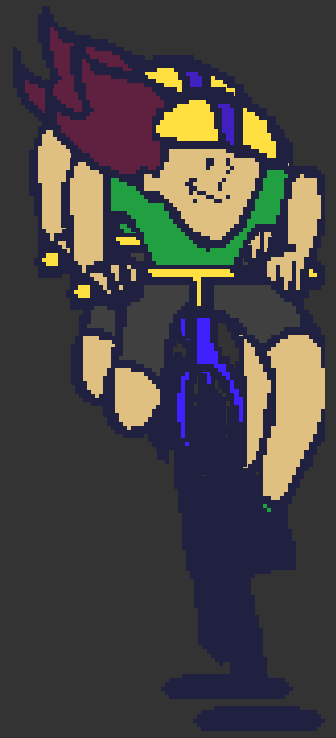
- Position can change at different rates
- Speed is a measure of how fast something moves through a particular distance over a given amount of time

$$Speed = \frac{distance}{time} \quad \text{or} \quad S = \frac{d}{t}$$

Average speed is the average of several instantaneous speeds whose measurements are taken over a specific period of time

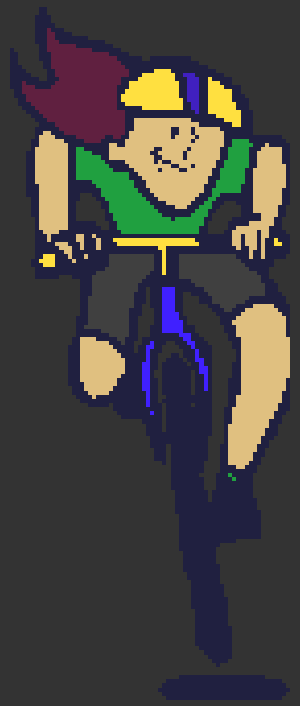
- A distance-time graph shows how both distance & speed change with time





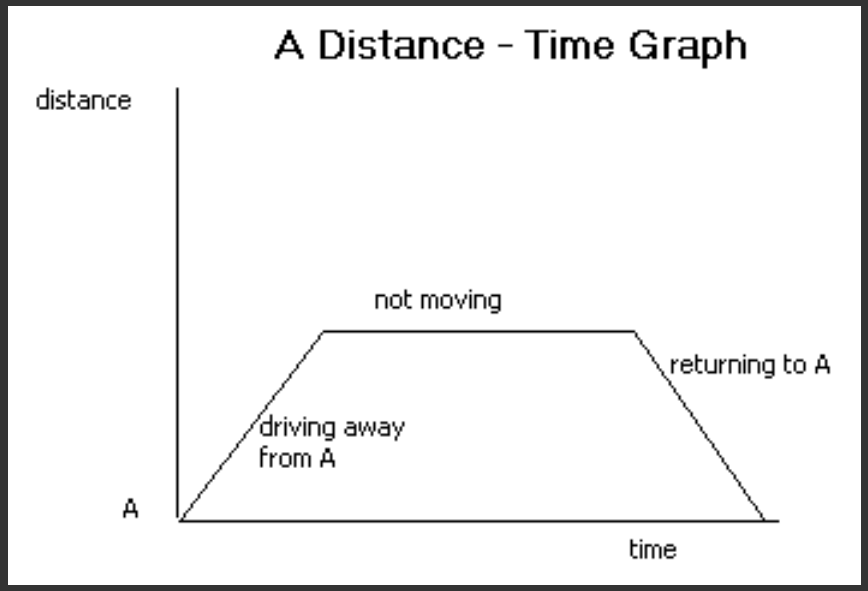
Calculating Speed from a distance/time graph

$$S = \frac{\text{ending distance} - \text{starting distance}}{\text{ending time} - \text{starting time}}$$

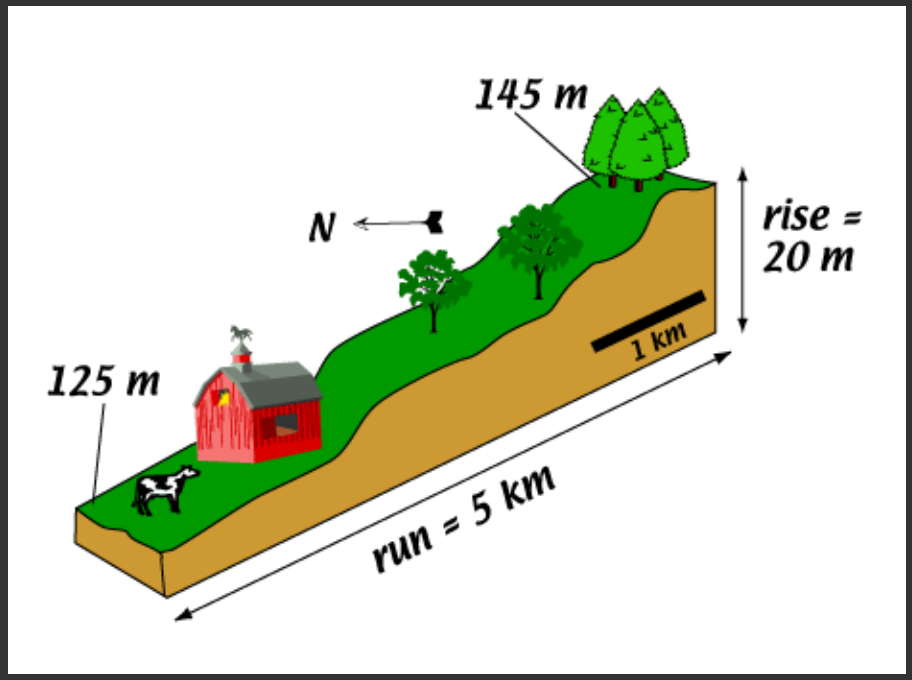


You can use these graphs to determine the speed of an object by calculating the slope of the line

- Positive slope—object is moving away from its starting point
- Negative slope—object is moving back toward its starting point



$$\text{slope} = \frac{\text{change in distance}}{\text{change in time}} = \text{speed}$$



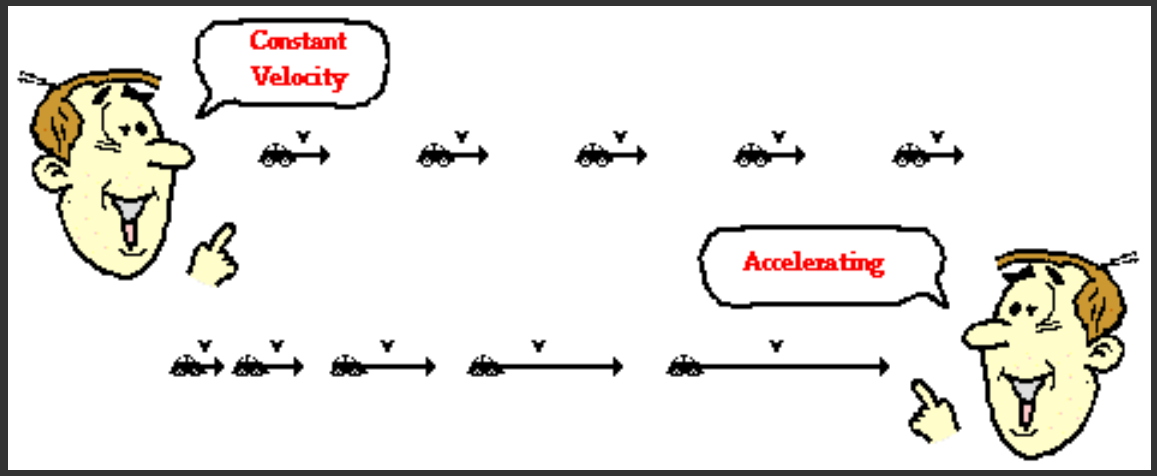
rise = change in distance

run = change in time

$$\text{slope} = \frac{\text{rise}}{\text{run}}$$

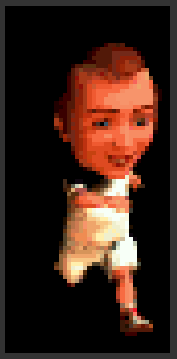
Velocity includes speed & direction

- Velocity—speed in a specific direction

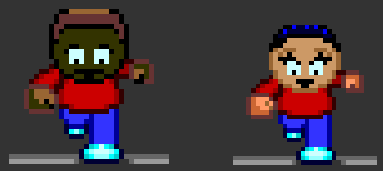


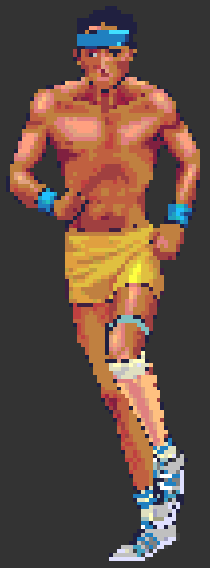
- Velocity is an example of a vector
- Vector—a quantity that has both size & direction
  - Shown by arrows
  - The longer the arrow, the faster the speed
  - Direction of arrow indicates direction of motion

Speed & Velocity are <u>not the same</u>



If 2 runners run at the same speed in *opposite directions*, they will have identical speed but *different* velocities





10.3 Acceleration measures how fast velocity changes

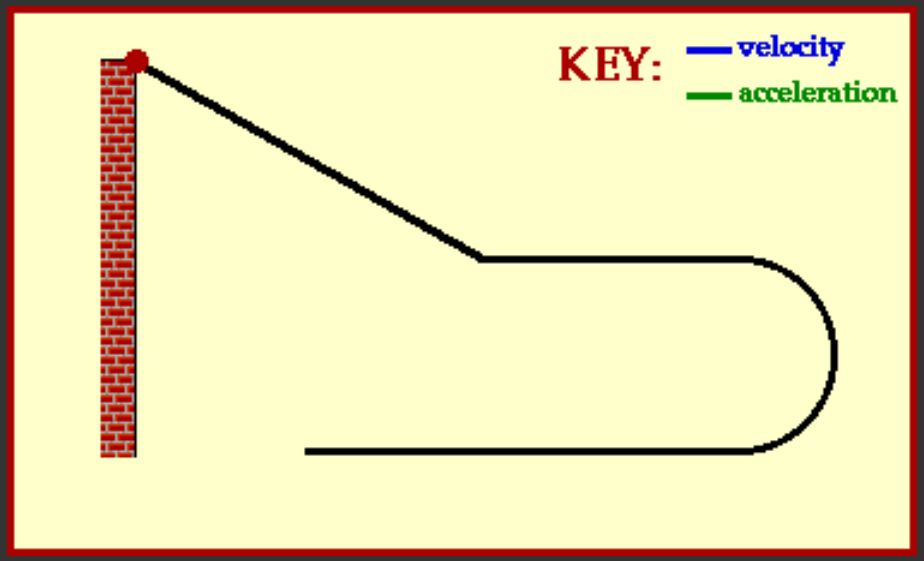
- Speed & direction can change with time
- Acceleration—rate at which velocity changes with time
  - Includes any change in velocity
  - Examples:
    - Speed increases
    - Speed decreases
    - Direction changes (regardless of speed)

Acceleration can be calculated from velocity and time

You determine acceleration from the change in velocity & how long the change took

$$a = \frac{V_{final} - V_{initial}}{t}$$

: A = Final Velocity - Original Velocity
time it took to make the change



Which one has constant speed?
Which one accelerates slowly?
Which one accelerates quickly?

Negative acceleration

- Decrease in velocity during a specific period of time
- Acceleration formula yields a negative result when the final velocity is <u>less</u> <u>than the initial velocity</u>

Velocity time graphs show how both velocity & acceleration change with time