Matter In Motion

Motion, Speed, Velocity & Acceleration

Introduction to Motion

- Matter is moving all around you
- **<u>Motion:</u>** when an object changes position over time, relative to a reference point
  - Common reference points:
    - Earth's surface
    - Non moving objects like trees, buildings, etc.
- Can be described with direction:
  - North, south, east, west, up, down

Speed

- Speed: the **rate** at which an object moves
- Speed = $\frac{\text{distance traveled}}{\text{time taken to travel}}$
- Metric unit = meters/second

Example: If you took two pictures of a balloon 10 seconds apart, and it traveled 50 meters between shots, what is the speed of the balloon?

50meters/10 seconds = 5meters/second

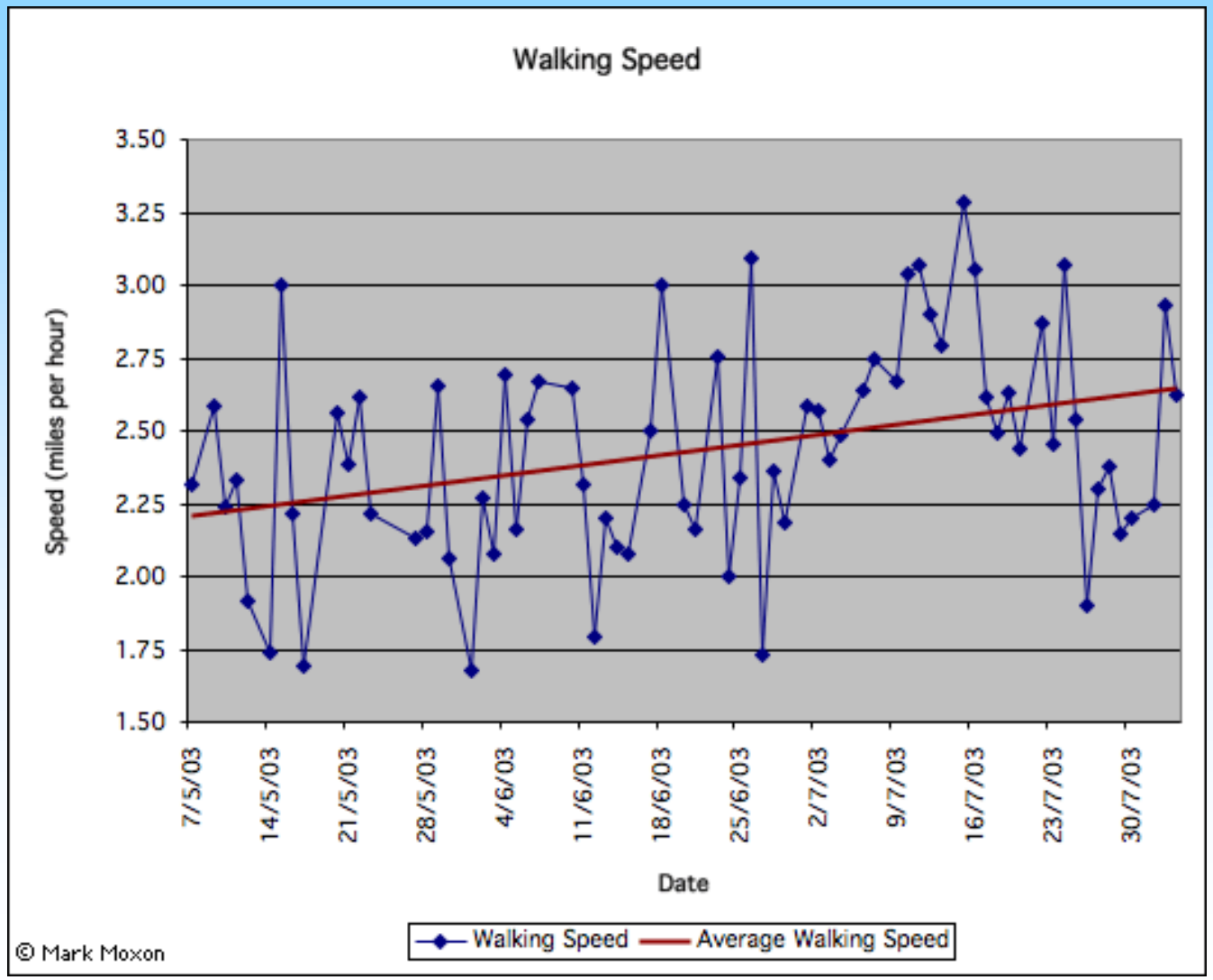
Finding Average Speed

- Most objects don't travel at a constant speed
- To calculate average speed, use this equation:

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}}$$

- Measured in meters/second

Average vs. Actual Speed Graph

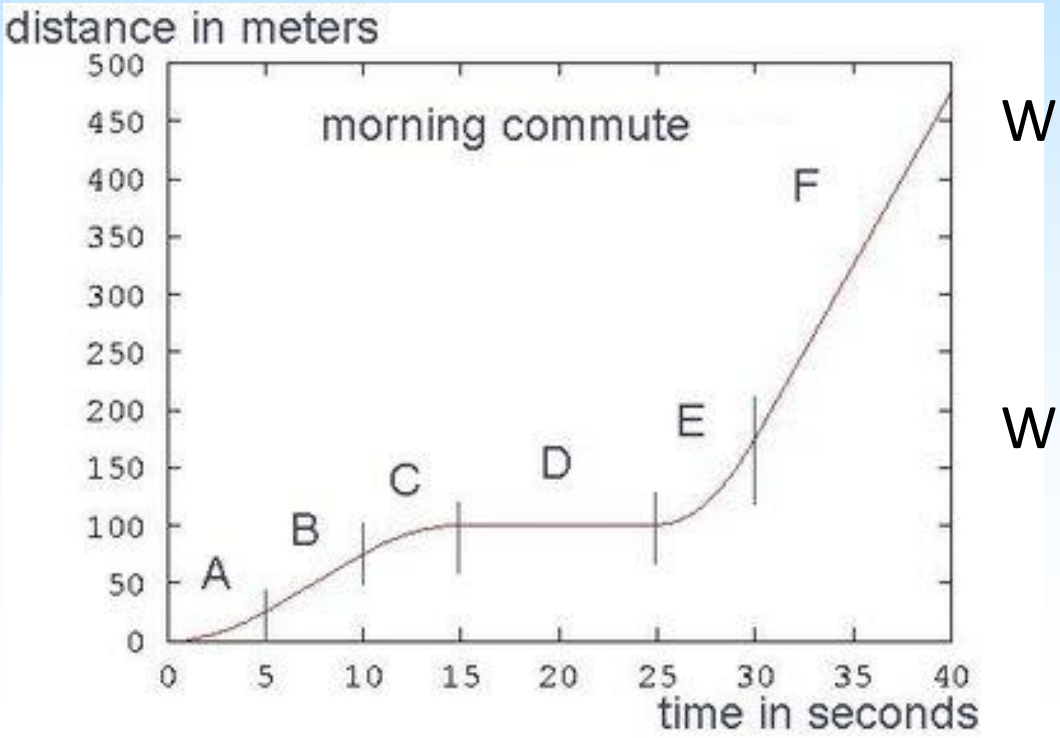


Velocity

- Velocity = the **speed and direction** of a moving object
  - Plane moving at 600m/s = speed
  - Plane moving at 600m/s west = velocity
- Velocity stays the same (constant) if speed AND direction stay the same
- Velocity changes if speed OR direction OR BOTH change

Reading Velocity Graphs

- **Constant Velocity** = straight line (could be flat or slanted)
- **Changing Velocity** = curved line (up or down)



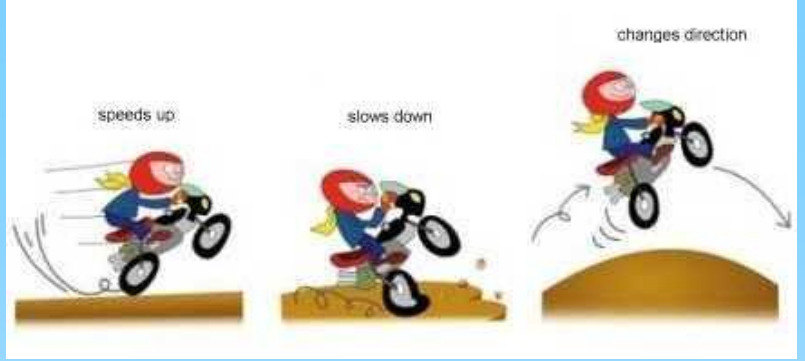
When is the velocity constant?

B, D, F

When is the velocity changing?

A, C, E

Acceleration



- **Acceleration** = the rate at which velocity changes over time
  - occurs if speed, direction or both change
  - Does NOT mean "Speeding up"!!

- **Positive Acceleration** – increase in velocity
- **Negative Acceleration** (Deceleration) – decrease in velocity
- The faster the velocity changes, the greater the acceleration/deceleration

Calculating Average Acceleration

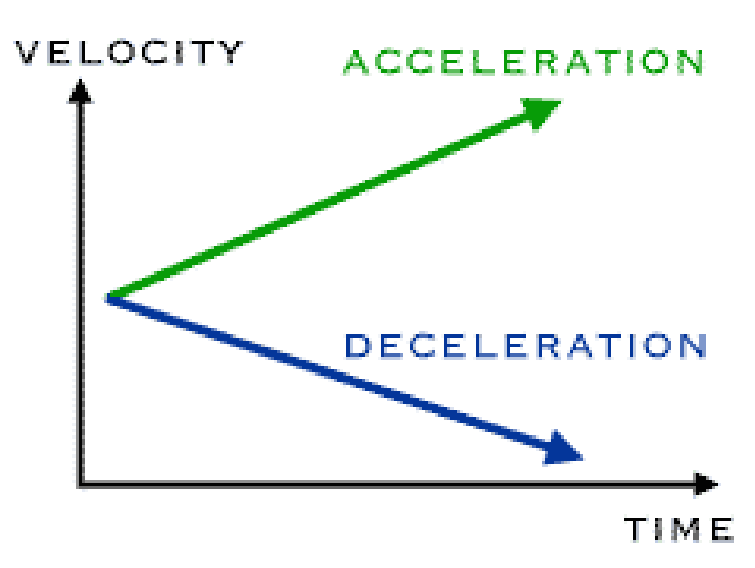
$$\text{Avg Acceleration} = \frac{\text{final velocity} - \text{starting velocity}}{\text{final time} - \text{starting time}}$$

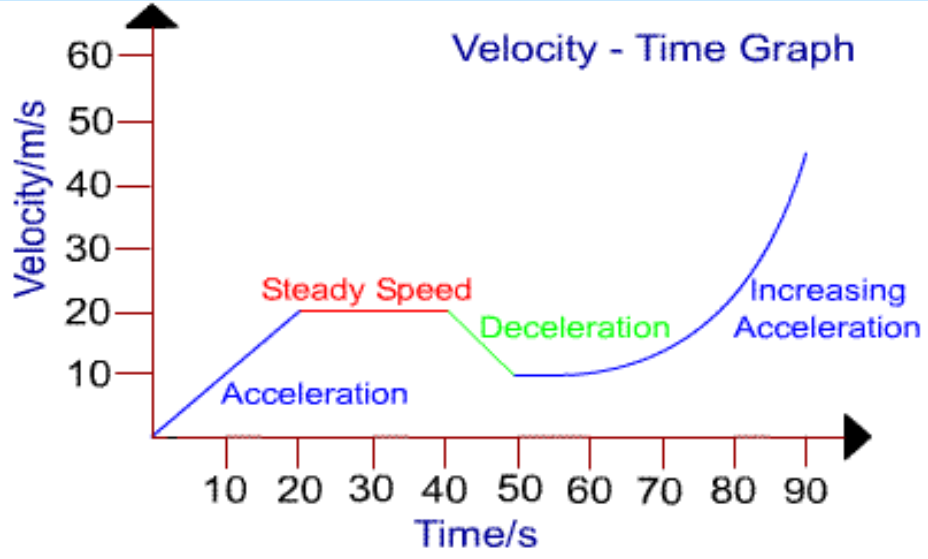
- Metric Units = (m/s)/s = **m/s^2**

- Example: A cyclist's southward velocity increases by 1m/s for 4 seconds. His starting velocity is 1m/s, and his final velocity is 5m/s after four seconds. What is his average acceleration?

$$\text{avg. acceleration} = \frac{5\text{m/s} - 1\text{m/s}}{5\text{s} - 1\text{s}} = 1\text{m/s}^2$$

Acceleration Graphs





Summary

- **Motion** is a change in position measured by distance and time.
- **Speed** tells us the rate at which an object moves.
- **Velocity** tells the speed and direction of a moving object.
- **Acceleration** tells us the rate that speed or direction changes.