Speed

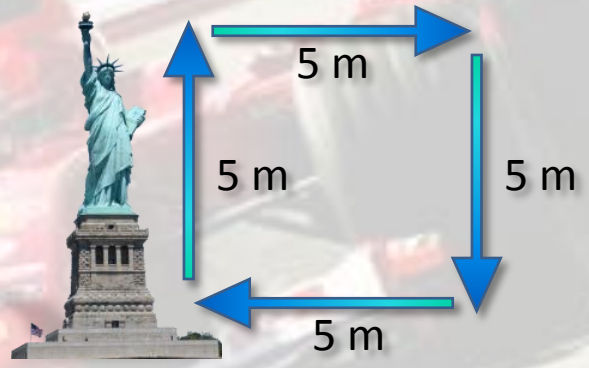
The Nature of Movement

- When something moves, it changes position.
  - Consider someone on a train reading a book.

  - As the train passes, someone on the platform sees the book moving by.
  - The passenger sees the book staying in place.
- Motion is relative to some reference point.

Distance vs. Displacement

- You take the following walk from the Statue of Liberty (your reference point).
  - First you walk 5 m north.
  - Then you walk 5 m east.
  - You head 5m south.
  - Finally, you go 5 m west.



- You walked a distance of 20 m, but you didn't go anywhere.
- Your distance from a reference point is your **displacement**.
- In this case, the displacement is 0 (zero).

Calculating Speed

- Examine the speed limit sign.
- Note the "MPH."
- MPH means *speed* in *miles per hour*.
  - "Miles" refers to distance.
  - "Per" means divided by.
  - "Hour" refers to time.

- $\text{speed} = \frac{\text{distance}}{\text{time}}$ *also* $s = \frac{d}{t}$ *or* $v = \frac{d}{t}$
- Definition: speed = the distance per unit of time.

More on Calculating Speed

- If $v = \frac{d}{t}$, then
  - $d = vt$; and
  - $t = \frac{d}{v}$

- These are the equations used to do calculations with respect to speed.

Sample Problems

- **Problem 1**: A 400. km trip takes 4 hours. What was the speed of the trip?

$$v = \frac{d}{t} = \frac{400.\ km}{4\ h} = 100\ {}^{km}/_{h}$$

- **Problem 2**: How long does it take to run a 500. m dash at a speed of 7.0 ${}^{m}/_{s}$?

$$t = \frac{d}{v} = \frac{500.\ m}{7.0\ {}^{m}/_{s}} = 71\ s$$

- **Problem 3**: How far can you go in 20 s at a speed of 35 ${}^{m}/_{s}$?

$$d = vt = (35\ {}^{m}/_{s})(20\ s) = 700\ m$$

Average Speed/Instantaneous Speed

- It's not likely that someone travelled at exactly 100 $^{km}/_{h}$ for 4 h as described in Problem 1.
- It is more reasonable to assume that 100 $^{km}/_{h}$ was the average speed or that it was the speed at some instant during the trip.

  - Average speed = total distance divided by total time.
  - Instantaneous speed = speed at a given instant in time.

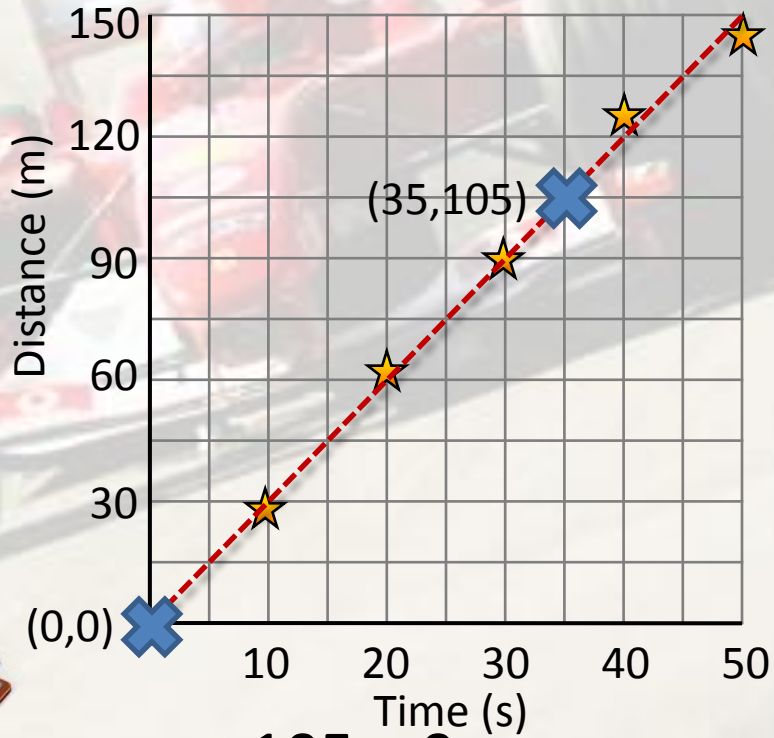
Graphing Speed

- A time-distance graph shows speed.

Time (s)	Distance (m)
10	29
20	61
30	90
40	122
50	148

- With time on the X-axis, and distance on the Y-axis, the slope is the speed.

- Plot the points.
- Draw the best line.
- Determine the slope



- $m = \frac{105 - 0}{35 - 0} = 3\ {}^{m}/_{s}$

Velocity

- Velocity = speed and direction of an object.
  - Speed is the magnitude or size of velocity.
  - That is why the speed formula is often written:

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

  - If the direction of a moving object changes, the velocity changes even if the speed remains the same.
- Speed and velocity are often used interchangeably even though speed is only part of velocity.