Chapter 11: Motion

A. Choosing a Frame of Reference

1. Frame of Reference - a system of objects that are not moving with respect to one another
   a. needed for accurate and complete description of motion
   b. Relative Motion - a movement in relation to a frame of reference
      e.g. Bus riders and people watching the bus

B. Measuring Distance

1. Distance - the length of a path between two points
   a. The SI unit for distance is the meter. However, if large distances are being measured, then the kilometer is used. Recall that:

      1000m = 1km

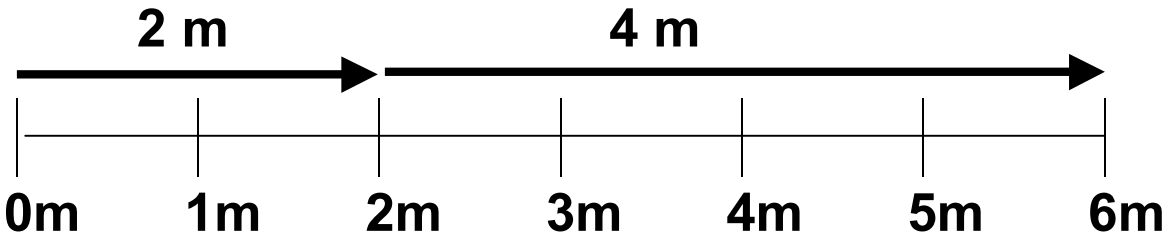
      e.g. instead of 6,385,000 use 6,385km
      instead of .09 m use 9cm

C. Measuring Displacement

1. Displacement - the <u>direction</u> from the starting point and a <u>straight line</u> from starting point to the ending point
   e.g. 5 blocks north of 5 miles east
2. A roller coaster ride would have distance but no displacement. Why?

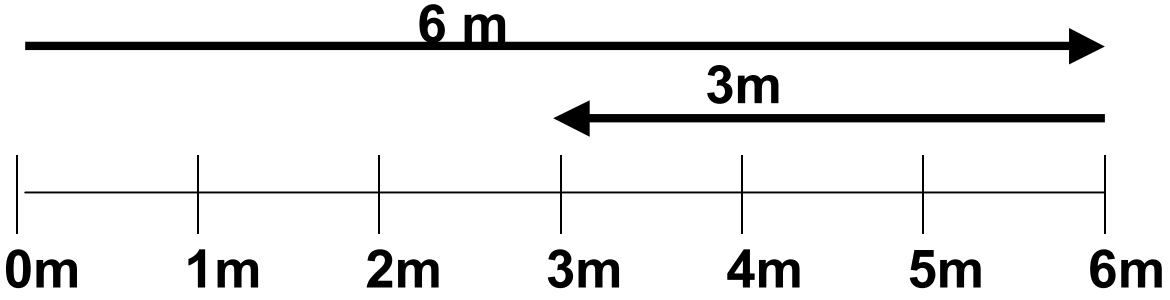
D. Combining Displacements

1. <u>Vector</u> - a quantity that has magnitude and direction. Therefore, displacement (direction and distance) is a vector.
2. The magnitude of vectors can be size, length or amount
   a. Arrows on graphs or maps are used to show vectors (p.330)
   b. The length of the arrow shows its magnitude.
   c. Vector additions are the combining of vector magnitudes and directions.
3. Displacement (direction and distance) along straight lines:
   a. addition



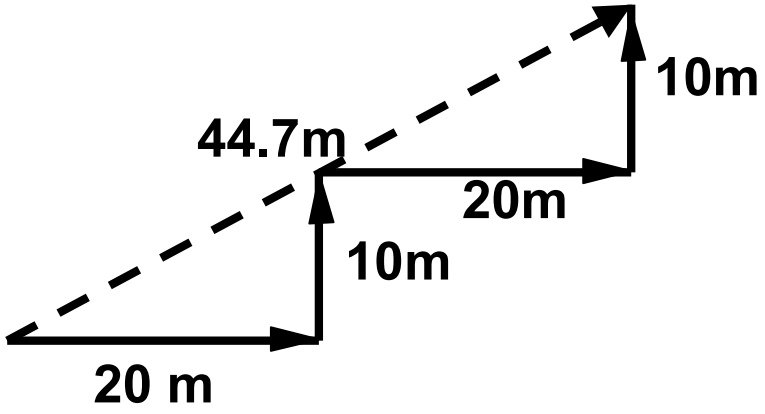
2m + 4m = 6m - displacement

b. subtraction



6m - 3m = 3m - total displacement

4. Displacement that isn't a straight path (p.331)



1. **Resultant Vector : (– – – ▸) : a vector sum of two or more vectors that points from the start directly to finish**
2. **Vector addition shows that the displacement is 44.7 meters North East while the distance is 60 meters.**

E. Speed - a ratio of the distance an object moves to the amount of time the object moves.

1. **SI unit is $\frac{\text{meters}}{\text{second}}$**
2. **Average Speed - total distance traveled by total time it takes to travel that distance**

$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time}}$$

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

- math practice p. 333

3. **Instantaneous Speed – the speed at which an object is moving at a given time; a speedometer gives instantaneous speed (p. 335)**

F. Graphing Motion p.334

1. **The slope of the line on a distance time graph is speed.**
2. **The steeper the slope, the higher the speed.**
3. **A flat line means that the object is at rest.**

G. Velocity is a description of speed and direction therefore it is a vector.

1. **There are 3 ways to change velocity:**
   a. **speed up**
   b. **slow down**
   c. **change direction**

H. Combining Velocity by vector addition p. 337

Acceleration

I. What is Acceleration?
   1. Acceleration – a change in speed, a change in direction, or change in both. Therefore, it is a vector.
   2. A change in speed, either positive or negative, is considered acceleration.
   3. Deceleration - slowing down of an object
   4. Free Fall - the positive acceleration that an object has as it falls to earth.
      a. Acceleration due to gravity is 9.8 meters per second every second, or 9.8 m/sec^2 : for every second an object falls, it will increase its speed by 9.8 m/s.
      b. Change of direction causes a vector change, therefore it is acceleration. A car traveling in circles and at constant speed is continuously accelerating.
   5. Constant Acceleration is a <u>steady</u> change in velocity.

J. Acceleration = $\frac{\text{Change in Velocity}}{\text{Total Time}}$

$$\frac{V_{final} - V_{initial}}{\text{Total Time}} \qquad \frac{V_F - V_I}{t}$$

Additional Acceleration Notes:

Acceleration due to gravity (Earth's only):

9.8 m/s/s or 9.8 m/s^2

Acceleration = $\frac{\Delta v}{t}$

Δ = Greek letter Delta, which means "change"
Δv then means "change in velocity"

Mathematically, $\Delta v = v_f - v_i$

$a = \frac{\Delta v}{t} \rightarrow \frac{v_f - v_i}{t}$

v_f = final velocity (end)
v_i = initial velocity (start)
t = total time

★ **Acceleration can be speeding up or slowing down. Mathematically, slowing down results in a <u>negative</u> acceleration (also known as deceleration). Acceleration can also be a change in direction.**

K. Graphs of Accelerated Motion

1. **The slope of a speed time graph is acceleration (change in speed divided by the change in time.) (p. 347, Fig. 16)**
2. **Constant acceleration is represented by a straight line (linear graph).**
3. **Constant speed is represented by a horizontal line.**
4. **Nonlinear (curved) distance time graph represents a change in speed.**

L. Instantaneous acceleration is how fast velocity is changing at a specific instant.