# Ch. 10: Motion Unit
# Integrated Science I

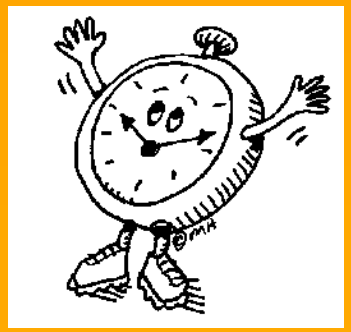
## Motion in One Dimension

# Motion in One Dimension

- One-dimensional motion is the simplest form of motion. To picture this form of motion, think of a train moving along a straight track.

# More motion…

- Motion takes place over time and depends on the frame of reference.
- The frame of reference is a system for specifying the precise location of objects in space and time.
- If an object is not moving, it has a fixed frame of reference.



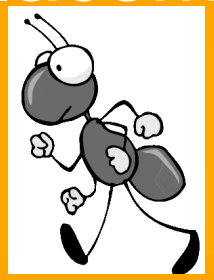
# Displacement

- Displacement is the change in position of an object.
- To find Displacement:
  - Change in position = final position – start position
  - Or $\Delta x = x_f - x_i$ ($\Delta$ = change)
- Displacement can also be used vertically
  - Such as $\Delta y = y_f - y_i$

# DISPLACEMENT PRACTICE PROBLEM!

- An ant walking on a ruler begins at the 10 cm mark, and stops walking at the 50 cm mark. What is the ant's displacement?





- Displacement = $x_f - x_i$, 50 cm – 10 cm = 40 cm.
- Answer! 40 cm. Final position = 50 cm, initial position = 10 cm.

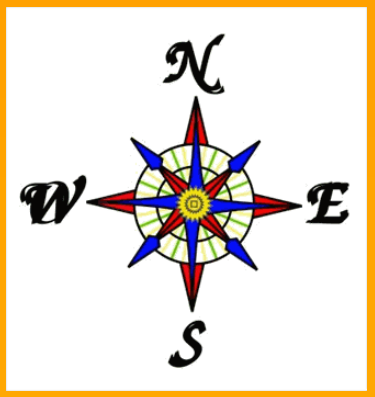
# Tricky business!


- Displacement is not always equal to the distance traveled!
- FOR EXAMPLE…

  A dog stands up from his bed, walks 5 meters, stops, walks back, and goes back to sleep. The dog's displacement is ZERO, because his final position and his initial position were both equal, being as they were the same spot. Subtracting two equal numbers gets you zero!
- Can you think of any other examples when displacement is zero?

# Displacement can be positive or negative

- Movement to the right, or east, is considered positive.
- Movement to the left, or west, is considered negative.
- When using displacement vertically, upward or northern movement is positive and downward or southern movement is negative.



# VELOCITY

- **Average velocity:** the total displacement divided by the time the displacement occurred.
- The label of velocity is meters per second, or **m/s**.
- Average velocity = change in position / change in time

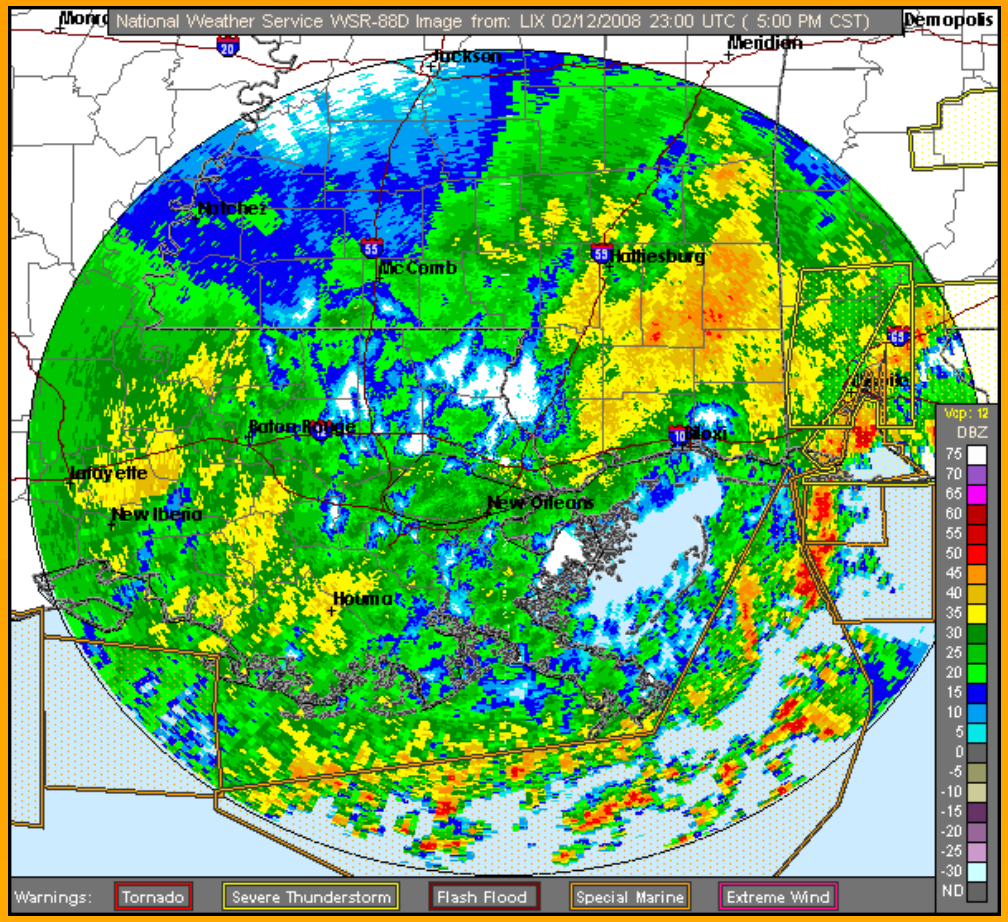
$$V_{avg} = (x_f - x_i) / (t_f - t_i)$$

# Velocity is not the same as speed!

- Average speed
  - distance traveled / time of travel
- Average velocity
  - displacement / time of travel
- The main difference between the two is that velocity values give a direction, while speed does not.

# Why Velocity is Important When Predicting Weather

- What is Important to Know When a Storm is Coming?
  - How strong
  - How fast it is coming
  - From what direction it is coming



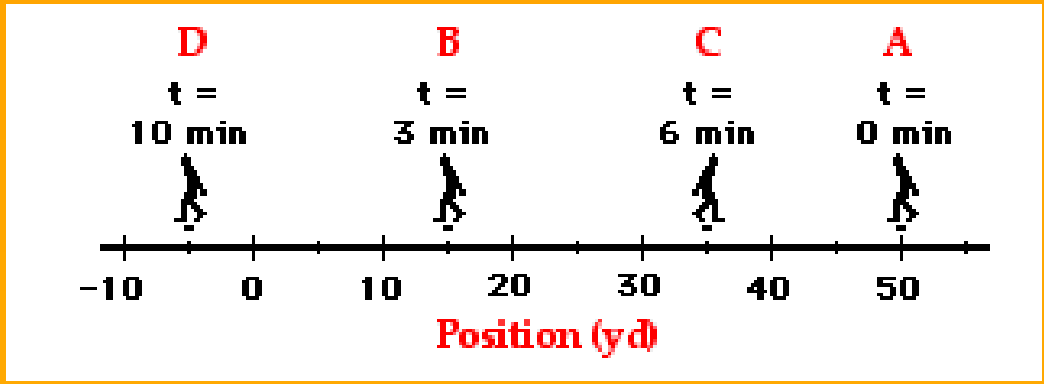
# AVERAGE VELOCITY PRACTICE PROBLEM!

- A student walks 10 km east to school in 2.3 hours. What is his average velocity?

- $V_{avg} = \Delta_x/\Delta_t$ = 10 km/2.3 hrs = 4.35 km/hr
- ANSWER. 4.35 km/hr to the east!

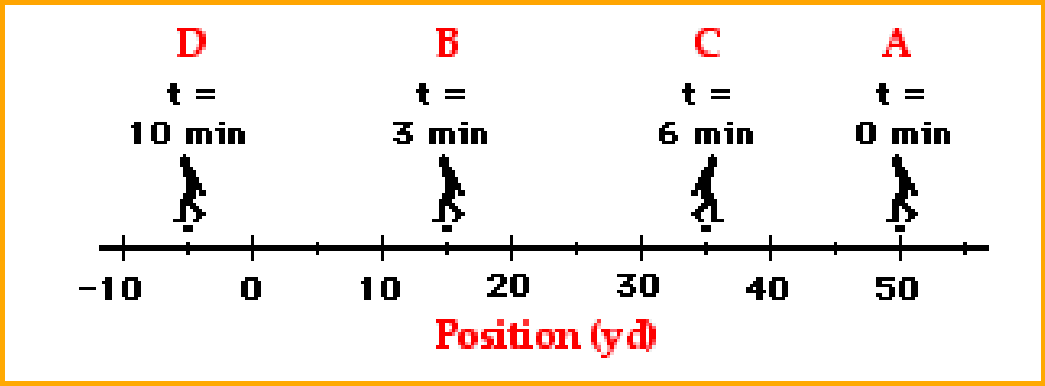
# MORE AVERAGE VELOCITY PRACTICE

- Coach Ross paces back and forth along the sidelines. At each marked position, the coach makes a "U-turn" and moves in the opposite direction. In other words, the coach moves from position A to B to C to D.
- What is the Coach Ross's average speed and average velocity?



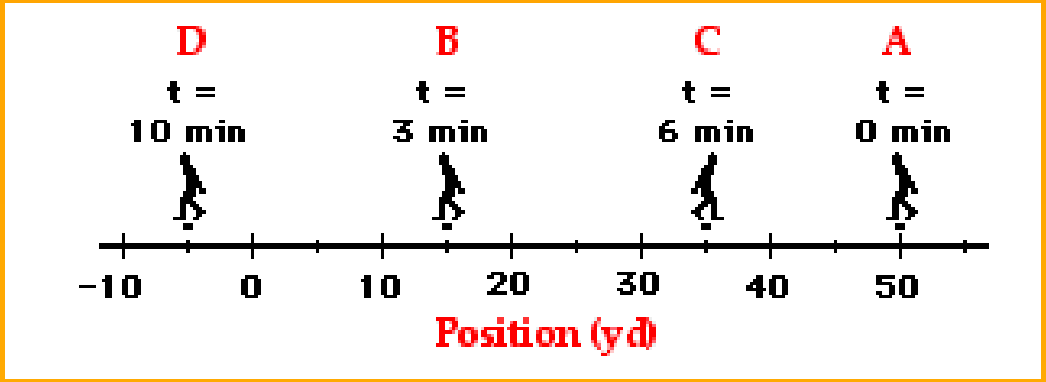
# Let's Do Average Speed First

- Average Speed = distance/time
  - A to B = 35 yd, 3 min
  - B to C = 20 yd, 3 min
  - C to D = 40 yd, 4 min
- Total Distance = 95 yd
- Total Time = 10 min
- Average Speed = 9.5 yd/min



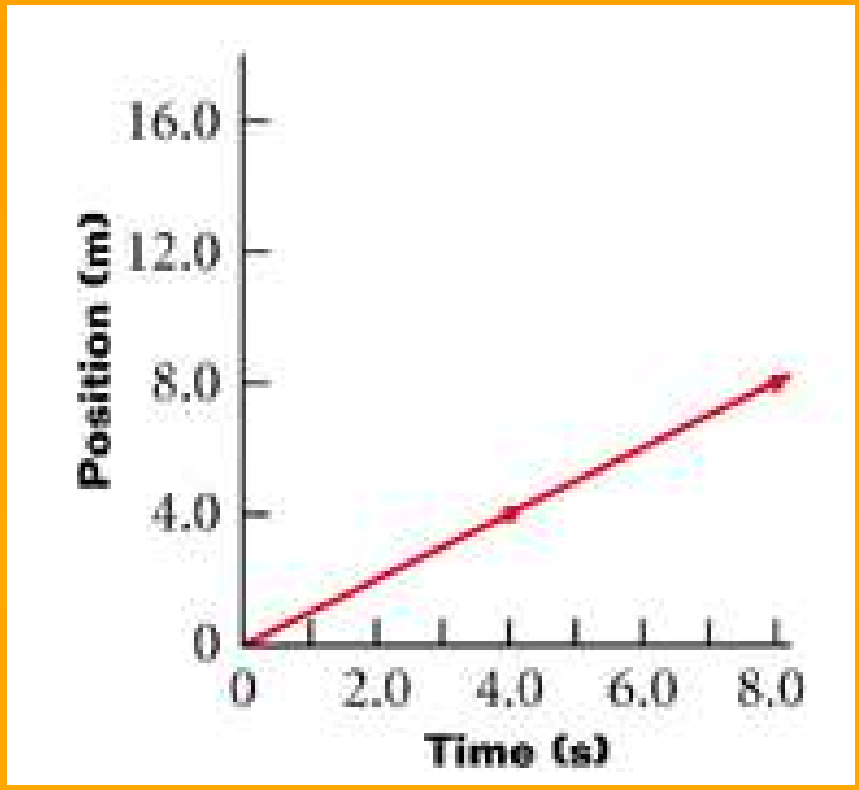
# Now to Find Average Velocity

- Average Velocity = displacement/time
- Displacement = 55 yd to the west
- Time = 10 min
- Average Velocity = 5.5 yd min to the west

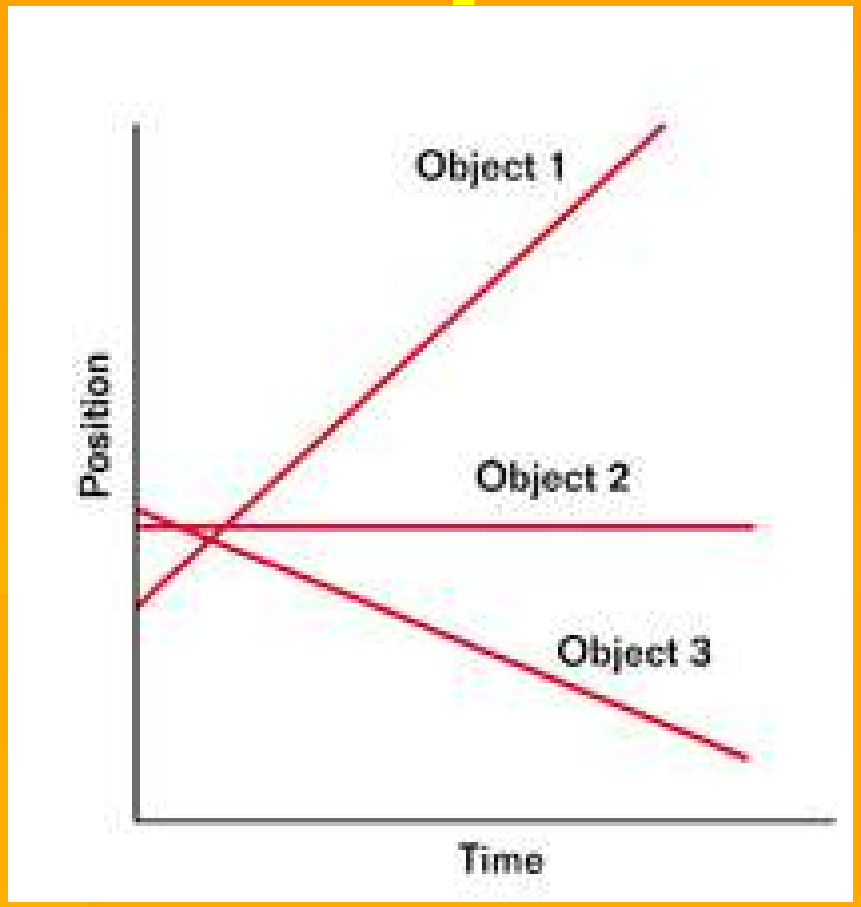


# Velocity can be interpreted graphically

- Slope = rise / run
- Change in vertical coordinates / change in horizontal coordinates



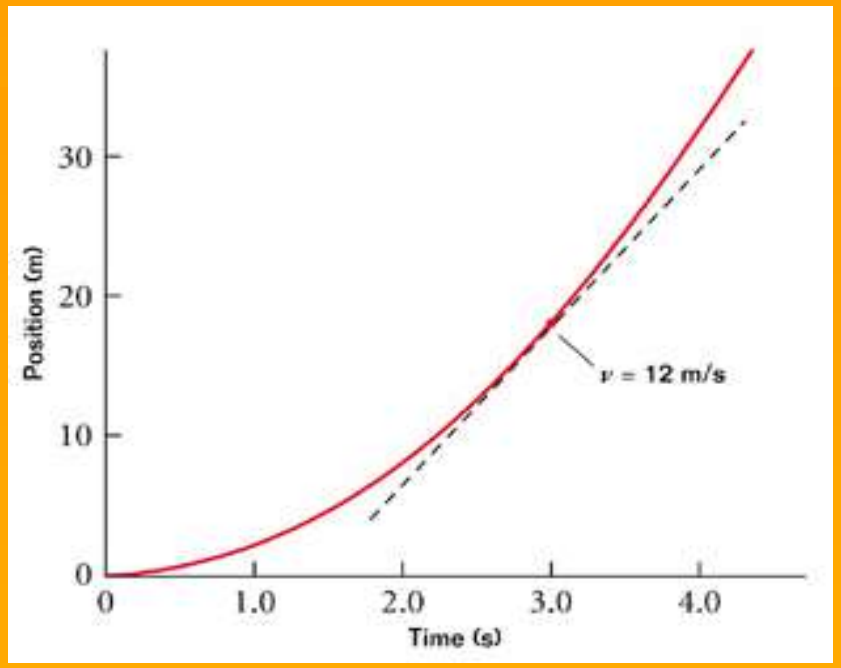
# Position versus time graph example…




- Velocity graphs show straight lines
- Object 1…moving at a constant positive velocity.
  - Example: a car on cruise control traveling at 55 mph.
  - Position is changing the same amount each second away from the start
- Object 2…at rest.
  - Example: a parked car.
  - Position does not change each second
- Object 3…moving with a constant negative velocity
  - Example: a car in cruise control in REVERSE going 20 mph.
  - Position is changing the same amount each second towards the start

# Instantaneous Velocity

- Definition: the velocity of an object at some instant or at a specific point in the object's path
- Picking one point on a graph shows instantaneous velocity
- For example, you look at your speedometer for your speed at that instant




# Acceleration!

- Acceleration is the rate at which velocity changes over time.
- An object accelerates if its speed, direction, or both change.
- Average acceleration = change in velocity / time required for change
  - $A_{avg} = (v_f - v_i) / (t_f - t_i)$
  - Labeled as $m/s^2$

# AVERAGE ACCELEARTION PRACTICE PROBLEM!

- A roller coaster starts at rest and speeds up to 50 m/s over the course of 17 seconds. What is the average acceleration of the roller coaster?
- Show your work!
  - $A_{avg} = \Delta v / \Delta t$
  - Velocity final = 50 m/s
  - Velocity start = 0 m/s
  - Time = 17 seconds
- (50 m/s) / (17 sec) = 2.9 $m/s^2$
- ANSWER. 2.9 $m/s^2$

# Acceleration can be read as a graph too

- Acceleration = a curved line
- **Remember, velocity is a straight line*
- The graph to the right shows a car starting to slow down then slamming on their brakes to slow down quickly.