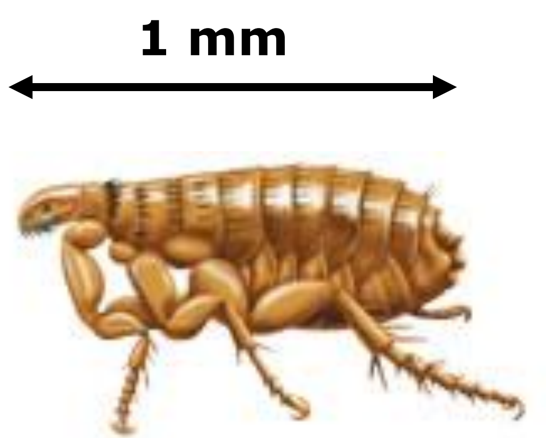
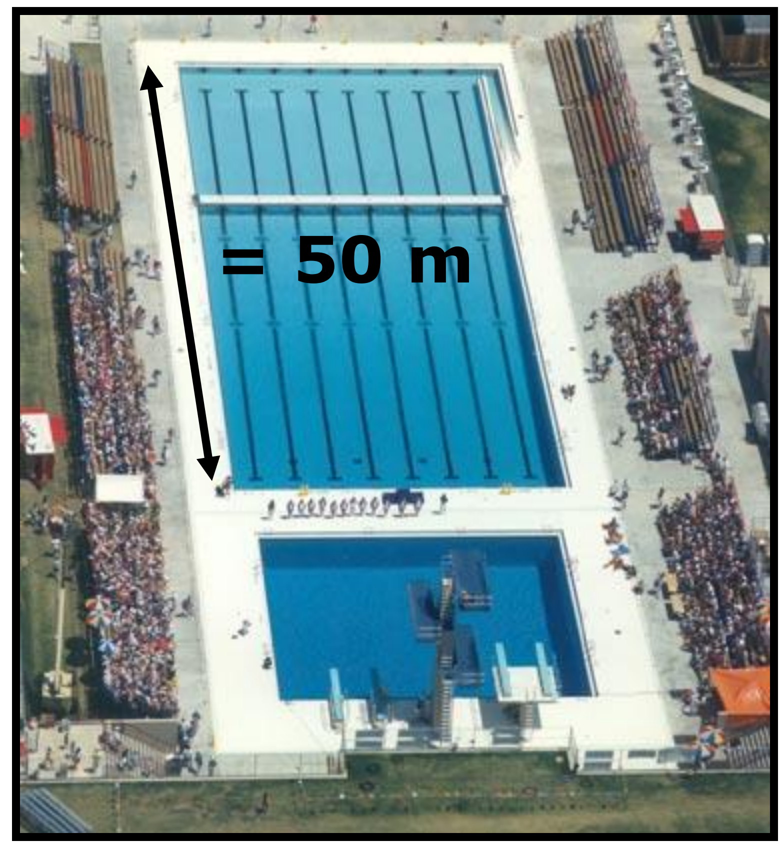
Speed and Acceleration

Measuring motion

Measuring Distance

- **Meter –** international unit for measuring distance.





Calculating Speed

- **Speed (S)** = distance traveled (d) / the amount of time it took (t).

$$\mathbf{S = d/t}$$

Units for speed

- Depends, but will always be a distance unit / a time unit
  - Ex. Cars: mi./h
  - Jets: km/h
  - Snails: cm/s
  - Falling objects: m/s

Calculating speed

$S = d/t$

- If I travel 100 kilometer in one hour then I have a speed of…
- **100 km/h**

- If I travel 1 meter in 1 second then I have a speed of….
- **1 m/s**

Average speed

- Speed is usually NOT CONSTANT
  - Ex. Cars stop and go regularly
  - Runners go slower uphill than downhill

- **Average speed** = total distance traveled/total time it took.

Calculating Average Speed

- It took me 1 hour to go 40 km on the highway. Then it took me 2 more hours to go 20 km using the streets.
- **Total Distance:**
  - 40 km + 20 km = 60 km
- **Total Time:**
  - 1 h + 2 h = 3 hr
- **Ave. Speed:**
  - total d/total t = 60 km/3 h = 20 km/h

$$Ave.\_Speed = \frac{Total\_Dist.}{Total\_time}$$

Question

- I travelled 25 km in 10 minutes. How many meters have I travelled?
  - A) 25000 m
  - B) .0112 m
  - C) .025 m
  - D) 2.5 m

25 km * 1000m/km = 25000 m

Question

- I ran 1000 m in 3 minutes. Then ran another 1000 m uphill in 7 minutes. What is my average speed?

Total Dist. = 1000 m + 1000 m = 2000 m

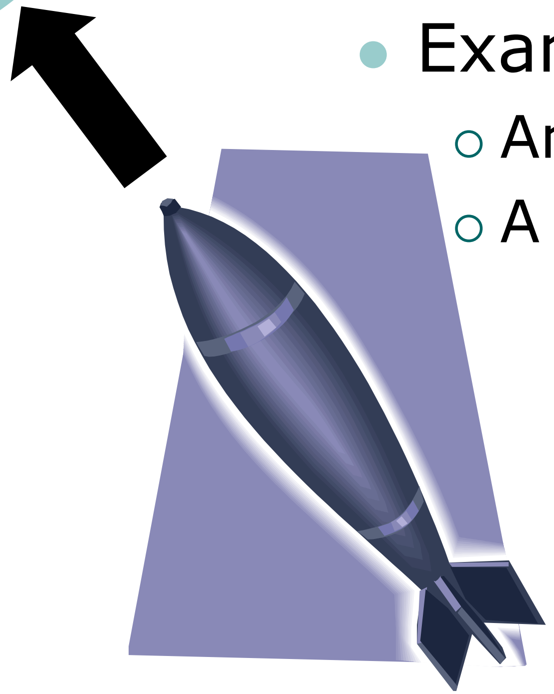
Total Time = 3 min + 7 min = 10 min

Ave speed = total dist/total time =

2000m/10 min = 200 m/min **= D**

Velocity

- **Velocity –** the SPEED and DIRECTION of an object.
  - Example:
    - An airplane moving North at 500 mph
    - A missile moving towards you at 200 m/s

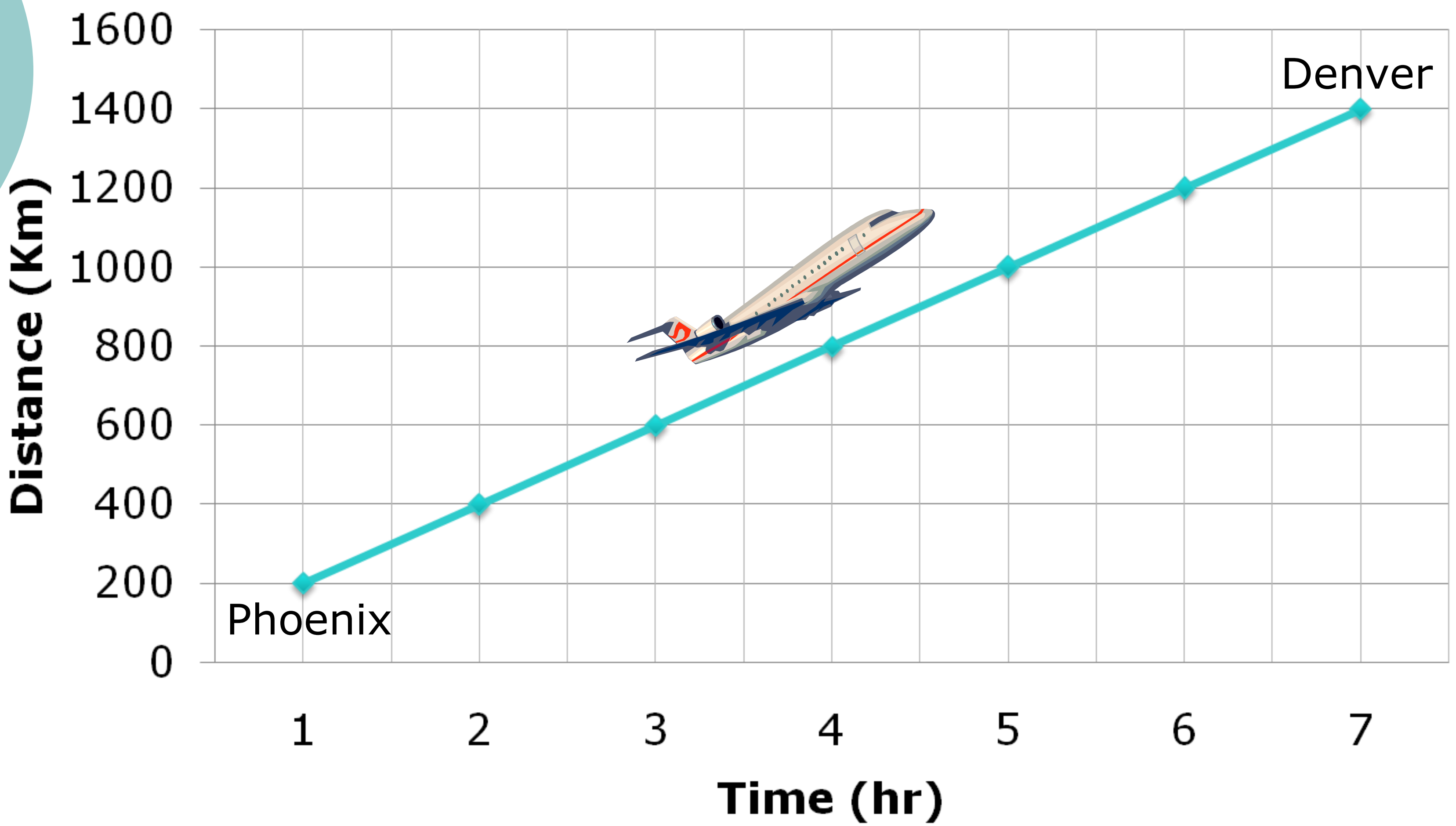


Question

- What is the difference between speed and velocity?

- Speed is just distance/time. Velocity includes direction as well.

Graphing Speed: Distance vs. Time Graphs



Graphing Speed: Distance vs. Time Graphs

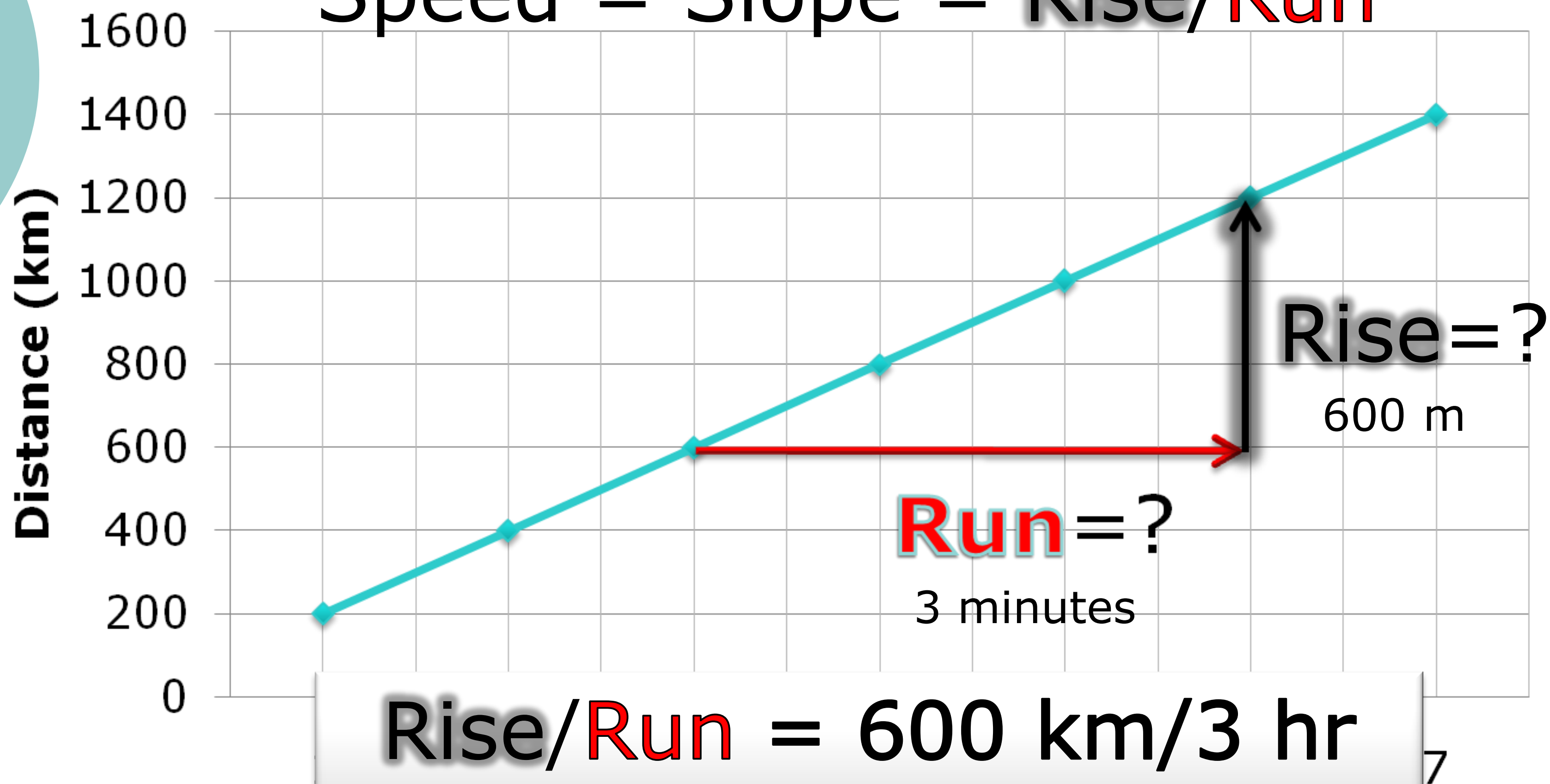
Speed = Slope = Rise/Run

Graphing Speed:
Distance vs. Time Graphs

Speed = Slope = Rise/Run

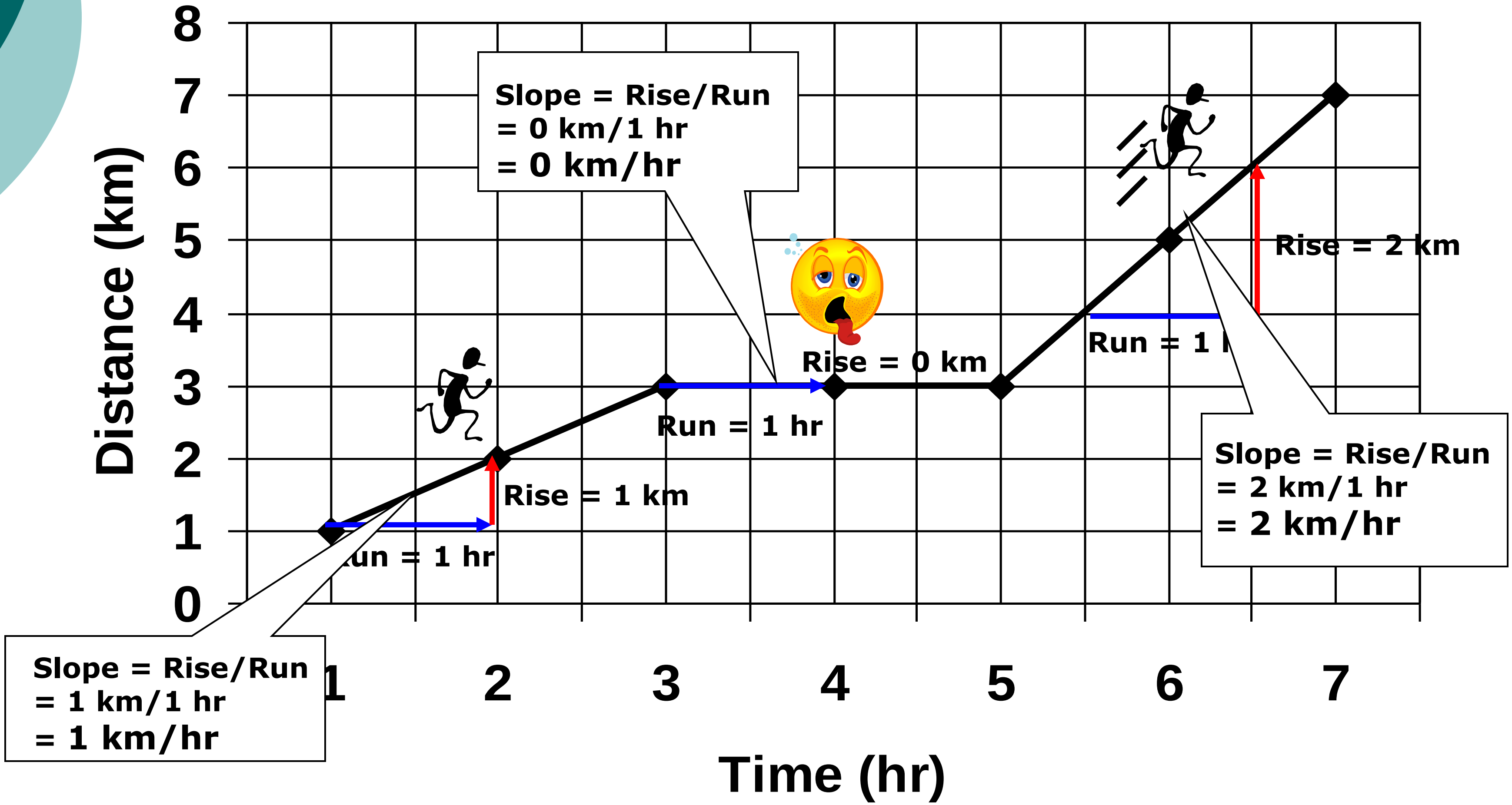
Graphing Speed:
Distance vs. Time Graphs

Speed = Slope = Rise/Run



Rise/Run = 600 km/3 hr
= 200 km/hr

Different Slopes



Question

Average Speed = Total distance/Total time = 12 km/6 hr

= **2 km/hr**

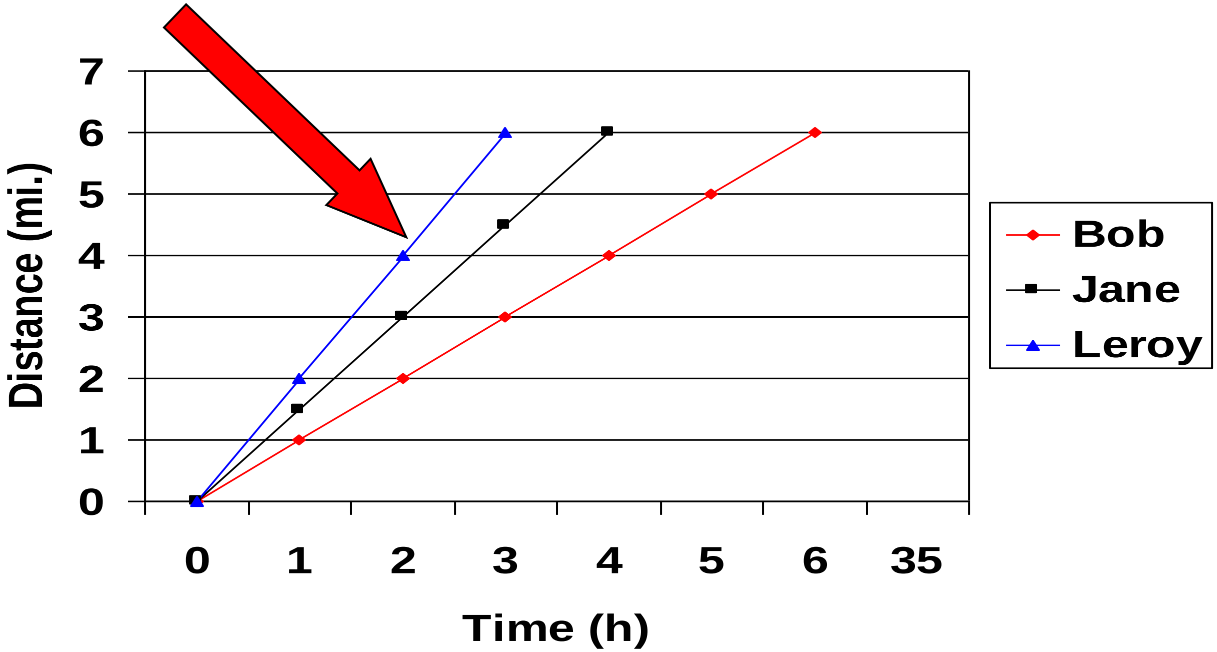
Question

- What does the slope of a distance vs. time graph show you about the motion of an object?

- It tells you the SPEED

Question

- Below is a distance vs. time graph for 3 runners. Who is the fastest?

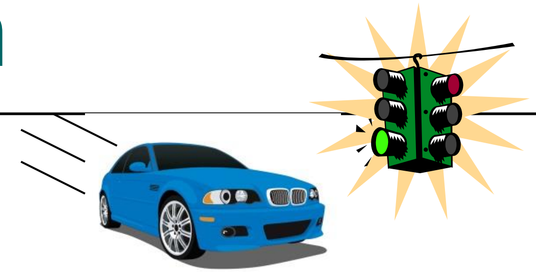


Leroy is the fastest. He completed the race in 3 hours

Acceleration

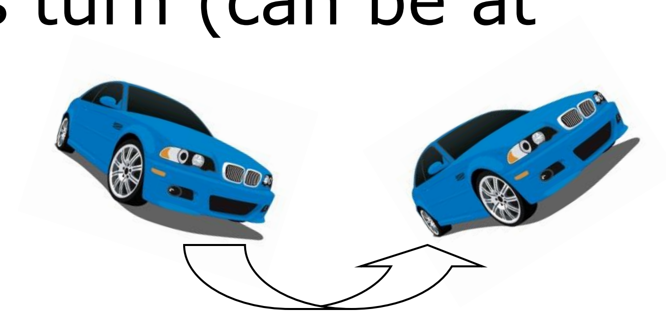
- **Acceleration =** speeding up
- **Acceleration –** the rate at which velocity changes
  - Can be an:
    - Increase in speed
    - Decrease in speed
    - Change in direction

Types of acceleration



- Increasing speed
  - Example: Car speeds up at green light

- Decreasing speed
  - Example: Car slows down at stop light
- Changing Direction
  - Example: Car takes turn (can be at **constant speed)**



Question

- How can a car be accelerating if its speed is a constant 65 km/h?
- If it is changing directions it is accelerating

Calculating Acceleration

- If an object is moving in a straight line

$$Acceleration = \frac{Velocity\_Final - Velocity\_Initial\_(m/s)}{Time\_(s)}$$

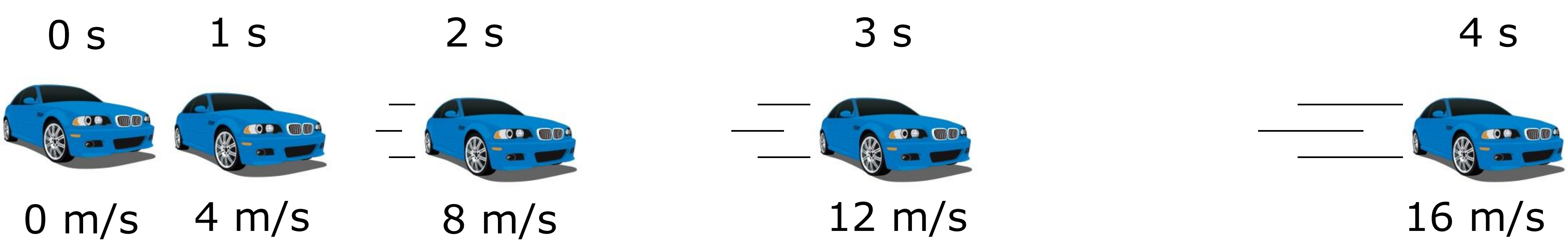
- Units of acceleration:
  - m/s^2

Calculating Acceleration

$$Acceleration = \frac{Velocity\_Final - Velocity\_Initial}{Time}$$

$$= \frac{16m/s - 0m/s}{4s}$$

$$= 4m/s^2$$



Question

- A skydiver accelerates from 20 m/s to 40 m/s in 2 seconds. What is the skydiver's average acceleration?

$$Accel = \frac{Velocity\_Final - Velocity\_Initial}{Time}$$

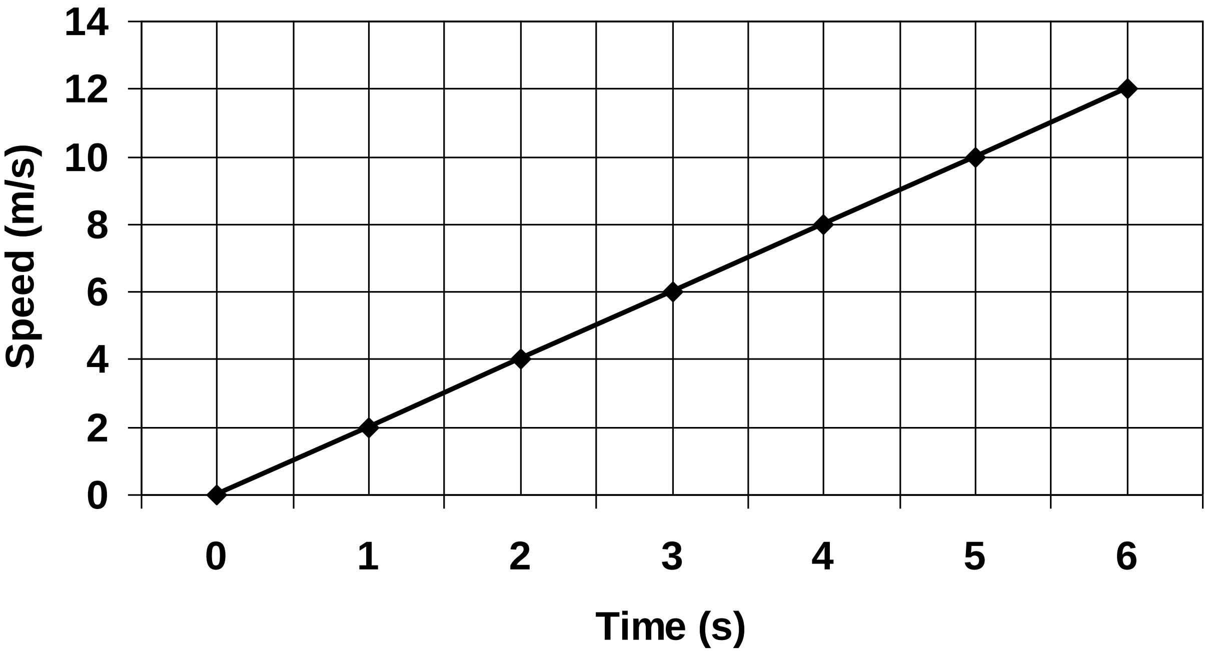
$$= \frac{40m/s - 20m/s}{2s} = \frac{20m/s}{2s}$$

$$= 10m/s^2$$

Graphing Acceleration

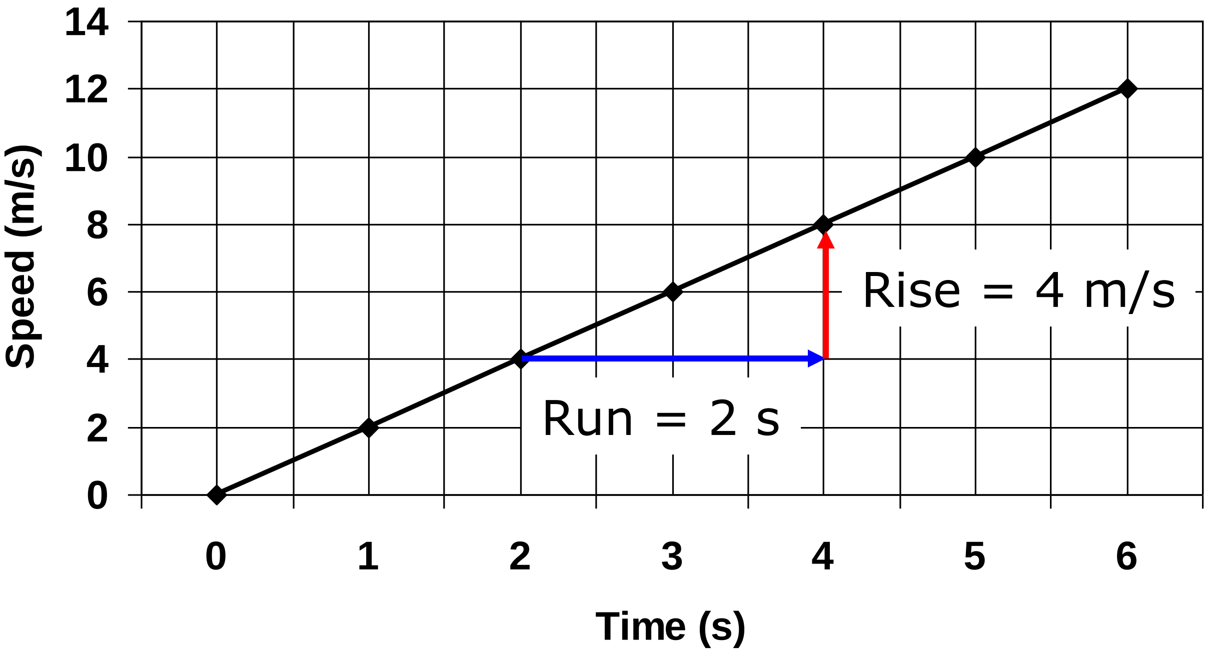
- Can use 2 kinds of graphs
  - Speed vs. time
  - Distance vs. time

Graphing Acceleration: Speed vs. Time Graphs



1) Speed is increasing with time = accelerating
2) Line is straight = acceleration is constant

Graphing Acceleration: Speed vs. Time Graphs

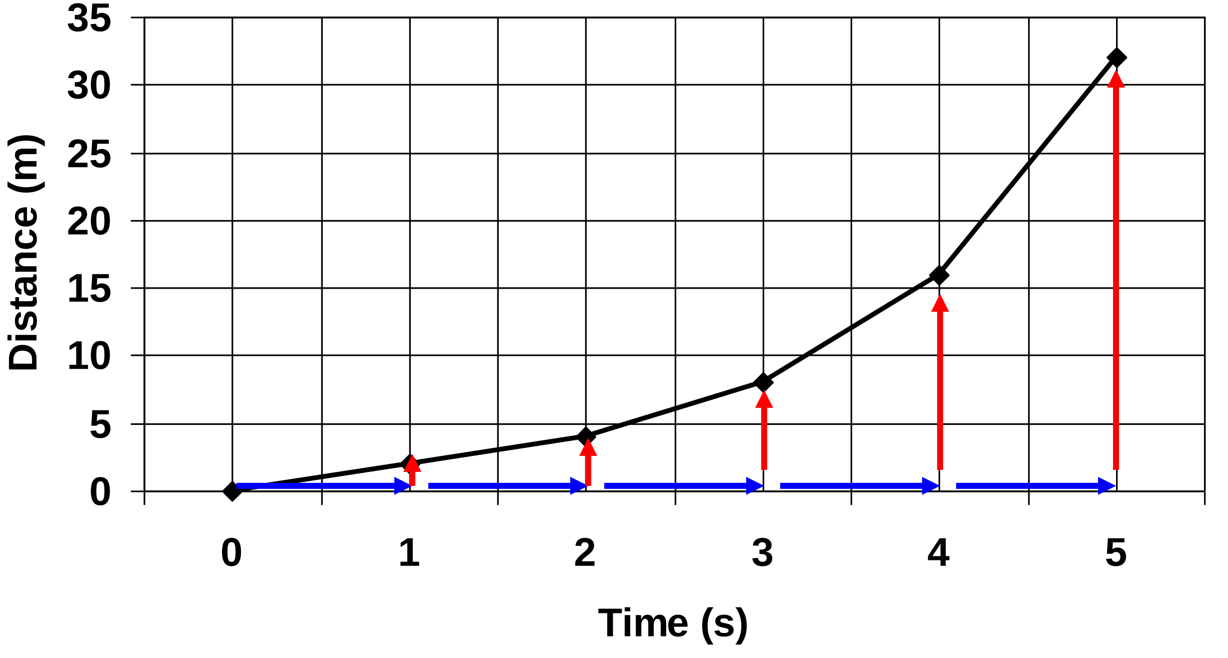


1) In Speed vs. Time graphs:

Acceleration = Rise/Run

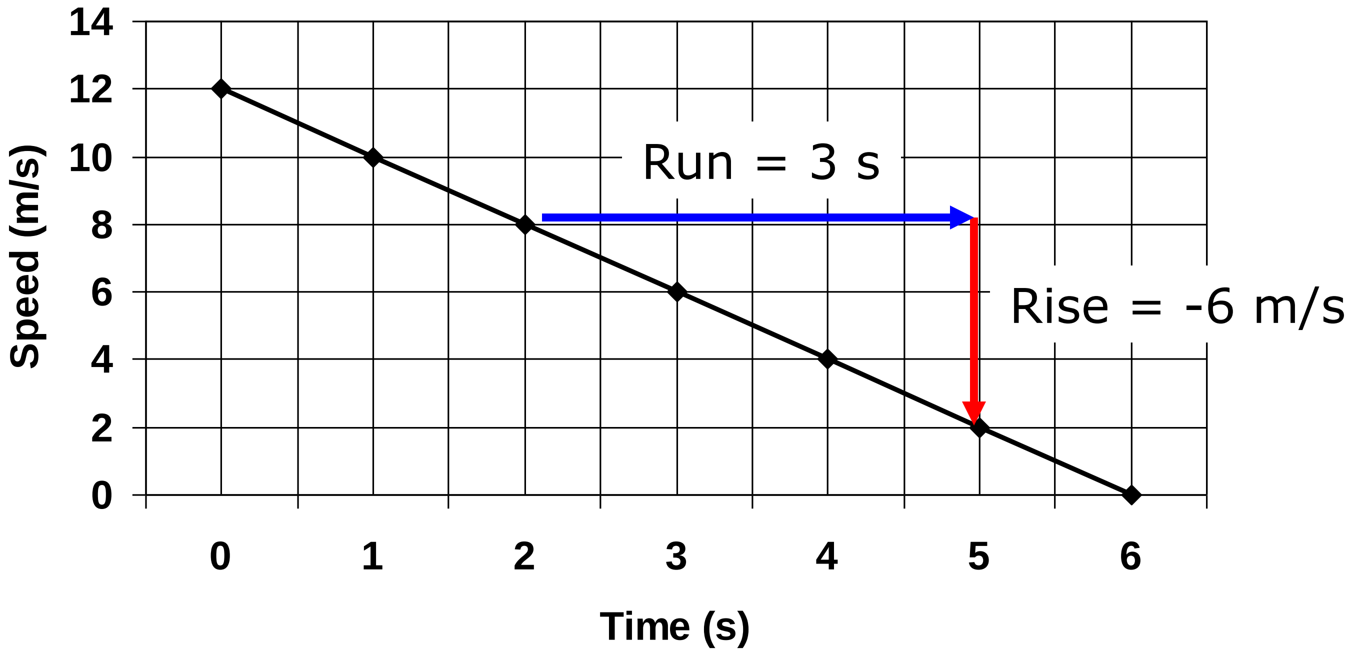
= 4 m/s ÷ 2 s = **2 m/s²**

Graphing Acceleration: **Distance** vs. Time Graphs



1) On Distance vs. Time graphs a curved line means the object is accelerating.
2) Curved line also means your speed is increasing. Remember slope = speed.

Question



Above is a graph showing the speed of a car over time.

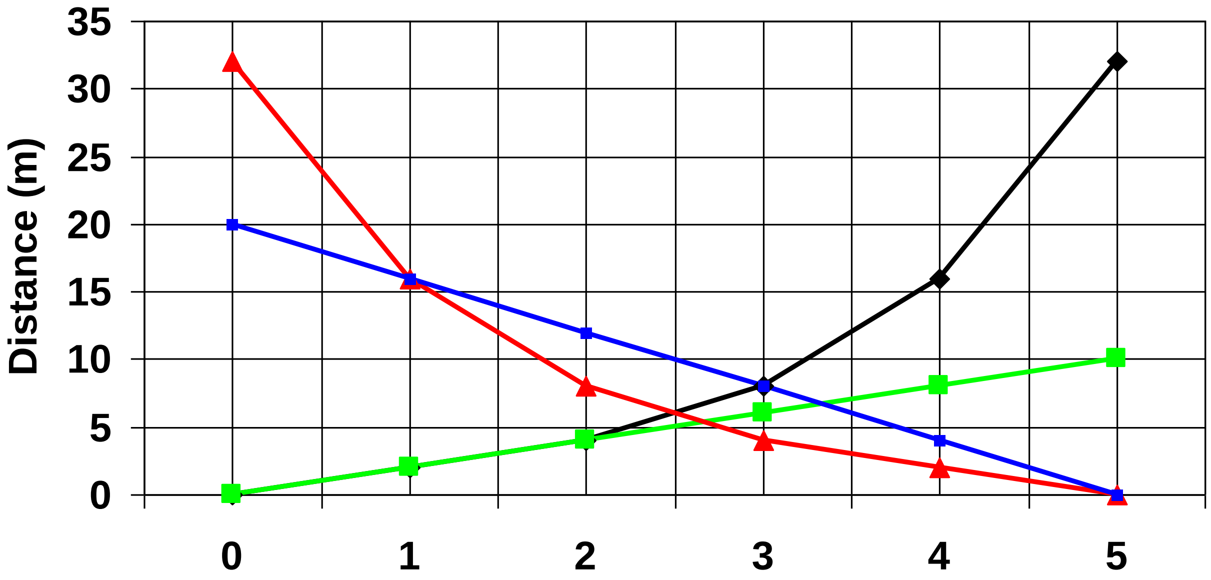
1) How is the speed of the car changing (speeding up, Slowing down, or staying the same)?

2) What is this car's acceleration?

1) The car is slowing down

2) Acceleration = rise/run = -6m/s ÷3s = **-2 m/s²**

Question:

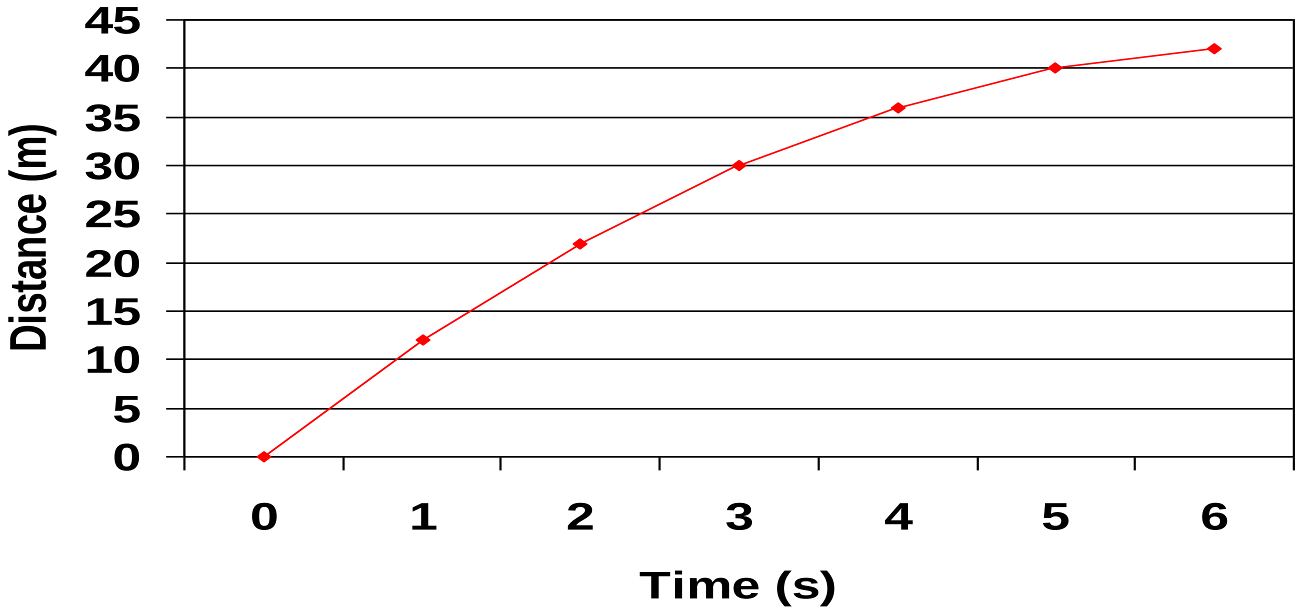


The **black and red lines** represent a objects that are accelerating. Black is going a greater distance each second, so it must be speeding up. Red is going less each second, so must be slowing down

Remember: in distance vs. time graphs:

curved line = accelerating, flat line = constant speed

Question: Hard one



Above is a graph showing the speed of a car over time.

1) What would a distance vs. time graph for this look like?