Speed and Acceleration

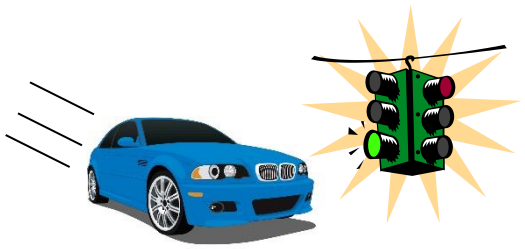
Measuring motion

Acceleration

- **Acceleration =** speeding up
- **Deceleration =** slowing down

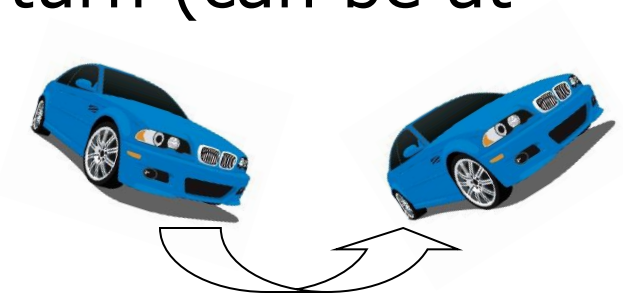
- ***Acceleration* –** the rate at which velocity changes
  - Can be an:
    - Increase in speed
    - Decrease in speed
    - Change in direction

Types of acceleration



- Increasing speed (Accelerating)
  - Example: Car speeds up at green light
- Decreasing speed (Decelerating)
  - 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

Velocity-Time Graphs

- A velocity-time (V-T) graph shows an object's velocity as a function of time.
  - A horizontal line = constant velocity.
  - A straight sloped line = constant acceleration.
    - Acceleration = change in velocity over time.
  - Positive slope = positive acceleration.
    - Not necessarily speeding up!
  - Negative slope = negative acceleration.
    - Not necessarily slowing down!

Calculating Acceleration

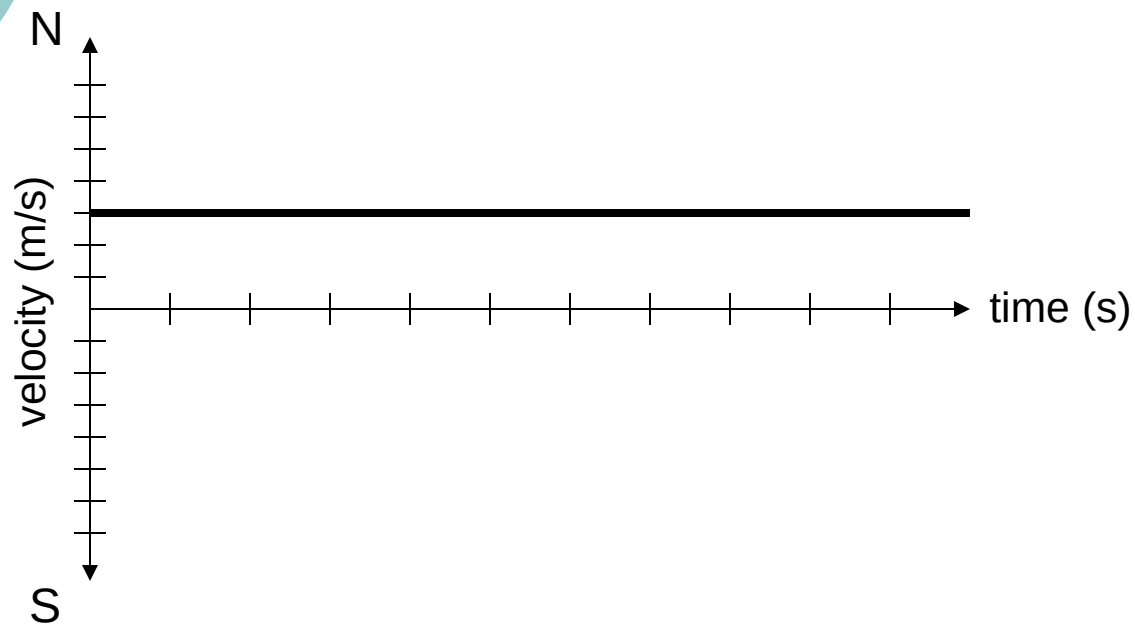
- If an object is moving in a straight line

$$Acceleration = \frac{Final\_speed - Initial\_Speed}{Time}$$

- Units of acceleration:
  - m/s^2

Velocity-Time Graphs

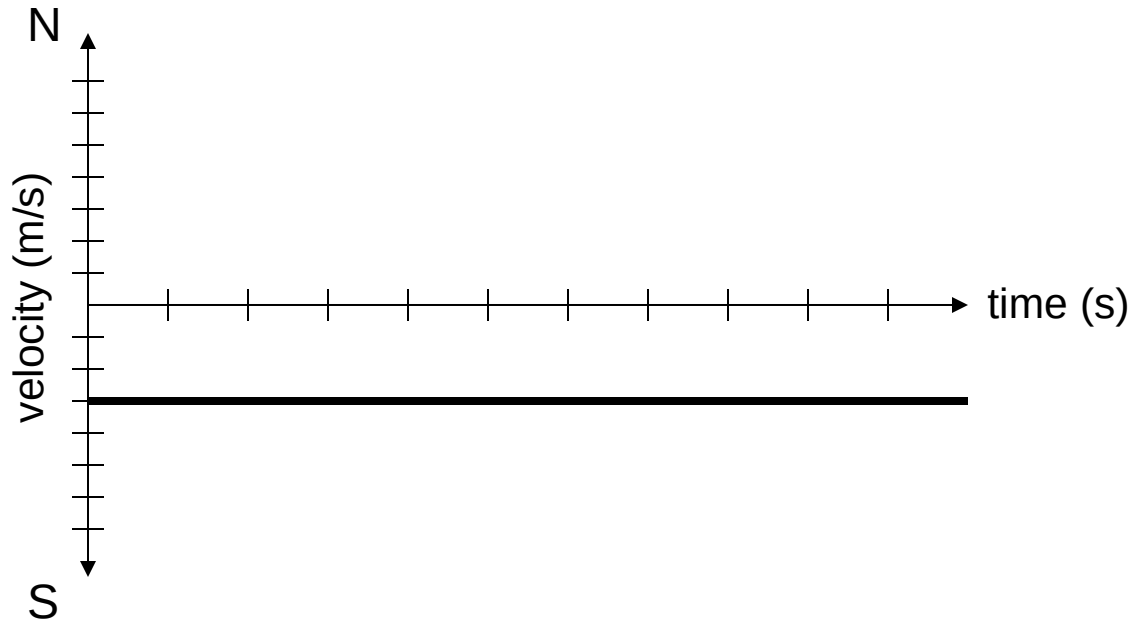
- A horizontal line on the V-T graph means constant velocity.



Object is moving at a constant velocity North.

Velocity-Time Graphs

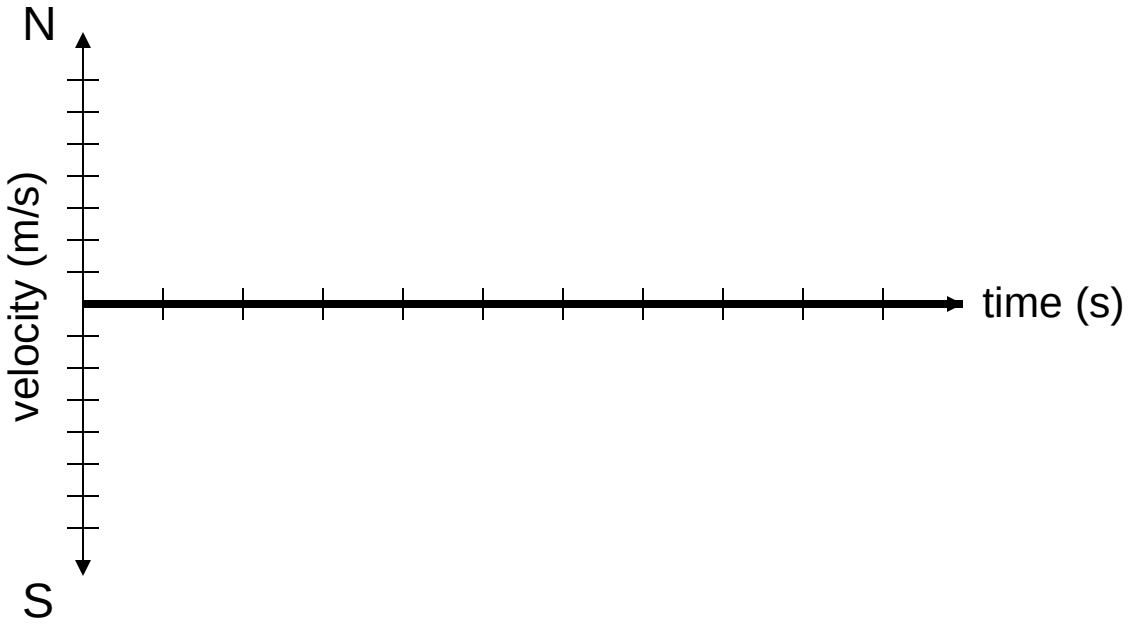
- A horizontal line on the V-T graph means constant velocity.



Object is moving at a constant velocity South.

Velocity-Time Graphs

- If an object isn't moving, its velocity is zero.



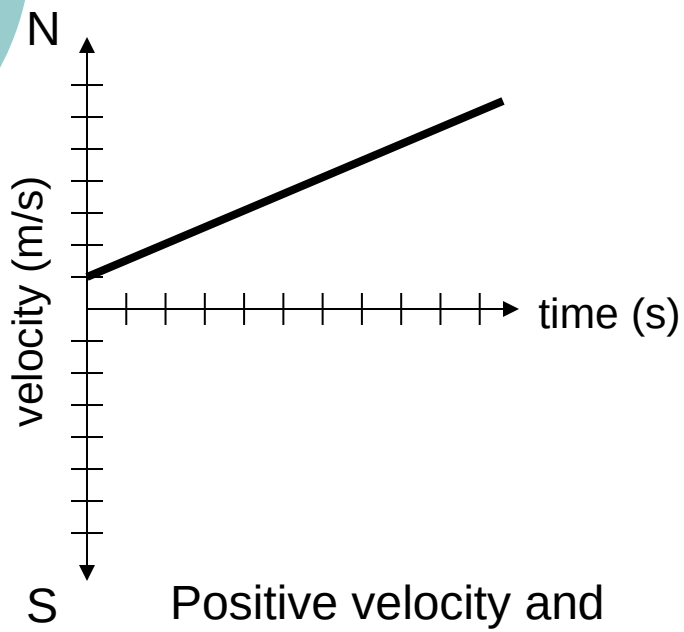
Object is at rest

Velocity-Time Graphs

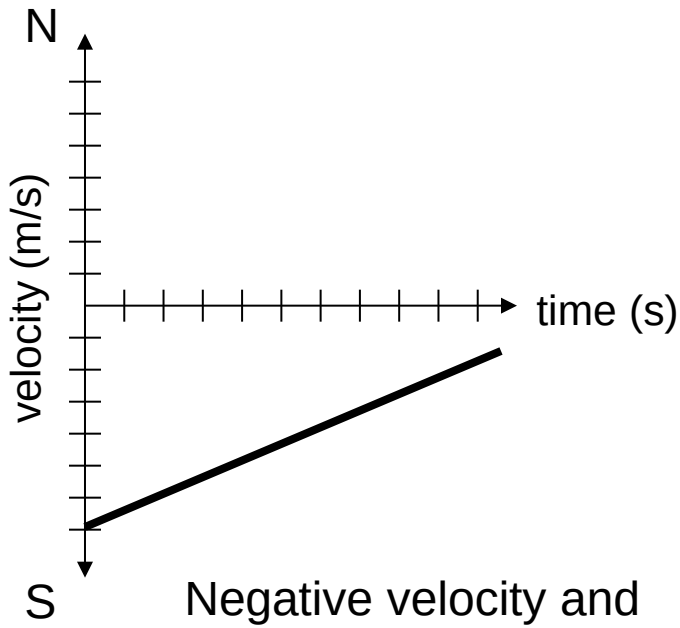
- If the V-T line has a positive slope, the object is undergoing acceleration in positive direction.
  - If v is positive also, object is speeding up.
  - If v is negative, object is slowing down.

Velocity-Time Graphs

- V-T graph has positive slope.



Positive velocity and positive acceleration: object is speeding up!



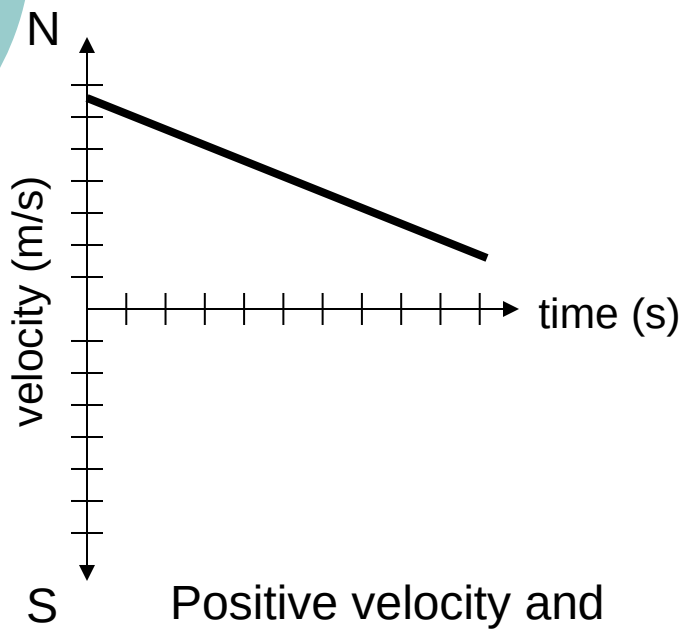
Negative velocity and positive acceleration: object is slowing down.

Velocity-Time Graphs

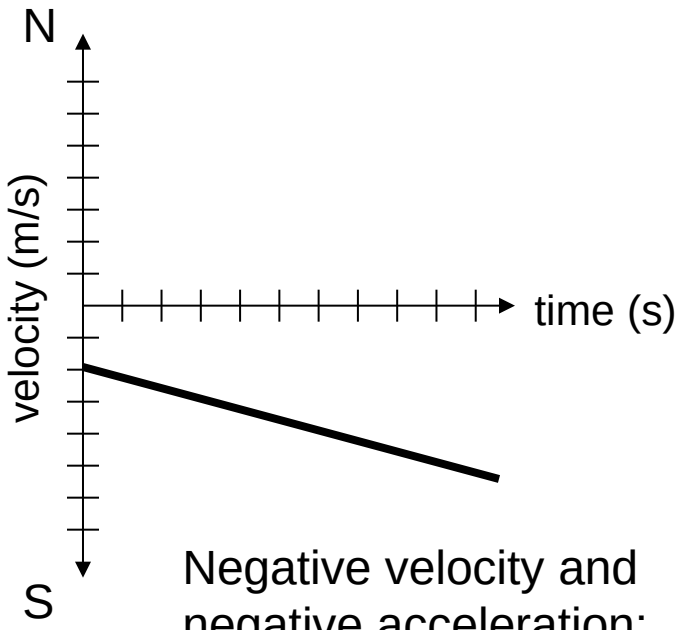
- If the V-T line has a negative slope, the object is undergoing acceleration in the negative direction.
  - If v is positive, the object is slowing down.
  - If v is negative also, the object is speeding up.

Velocity-Time Graphs

- V-T graph has negative slope.



Positive velocity and negative acceleration: object is slowing down,



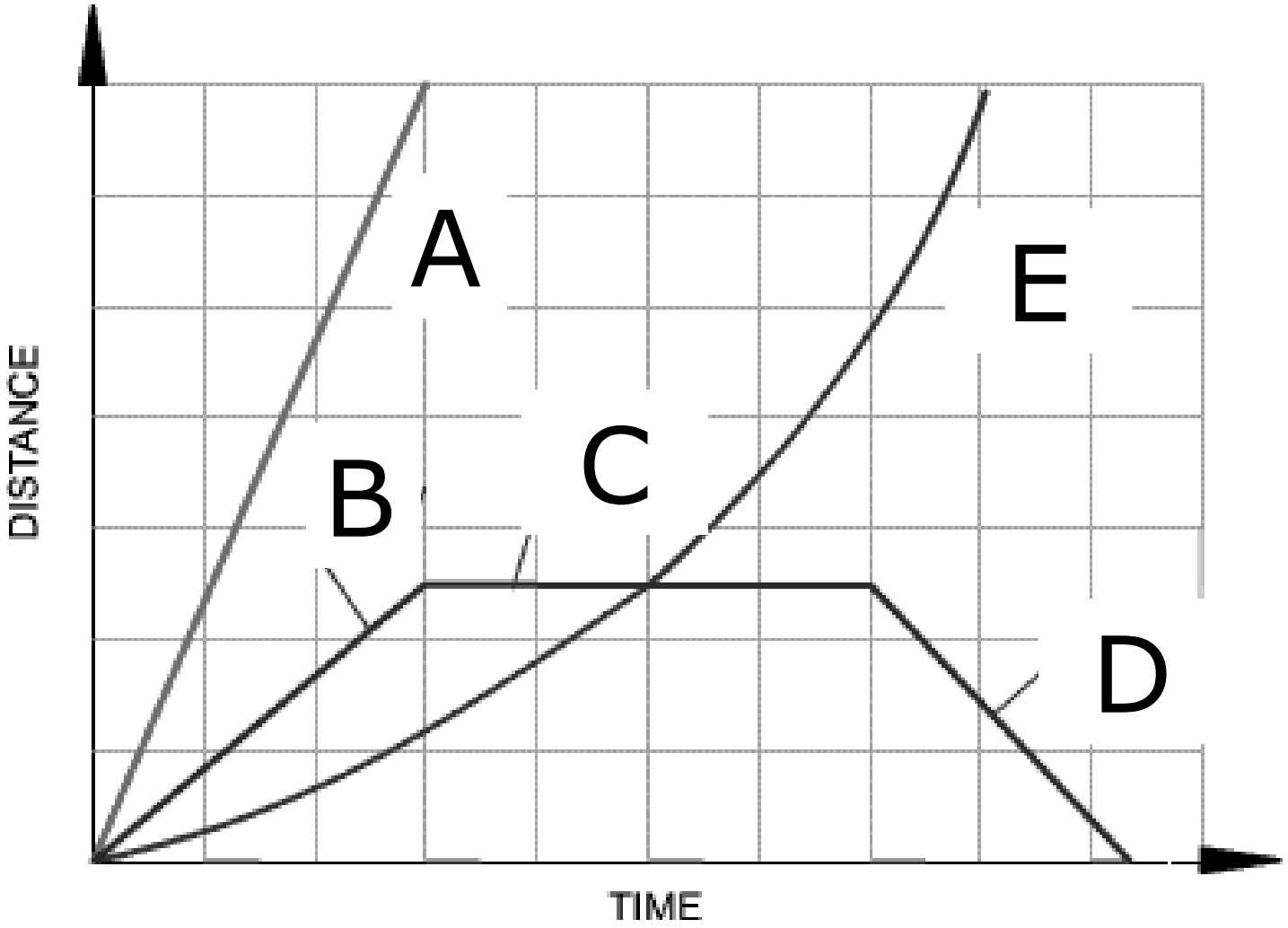
Negative velocity and negative acceleration: object is speeding up! (in negative direction)

Summary:

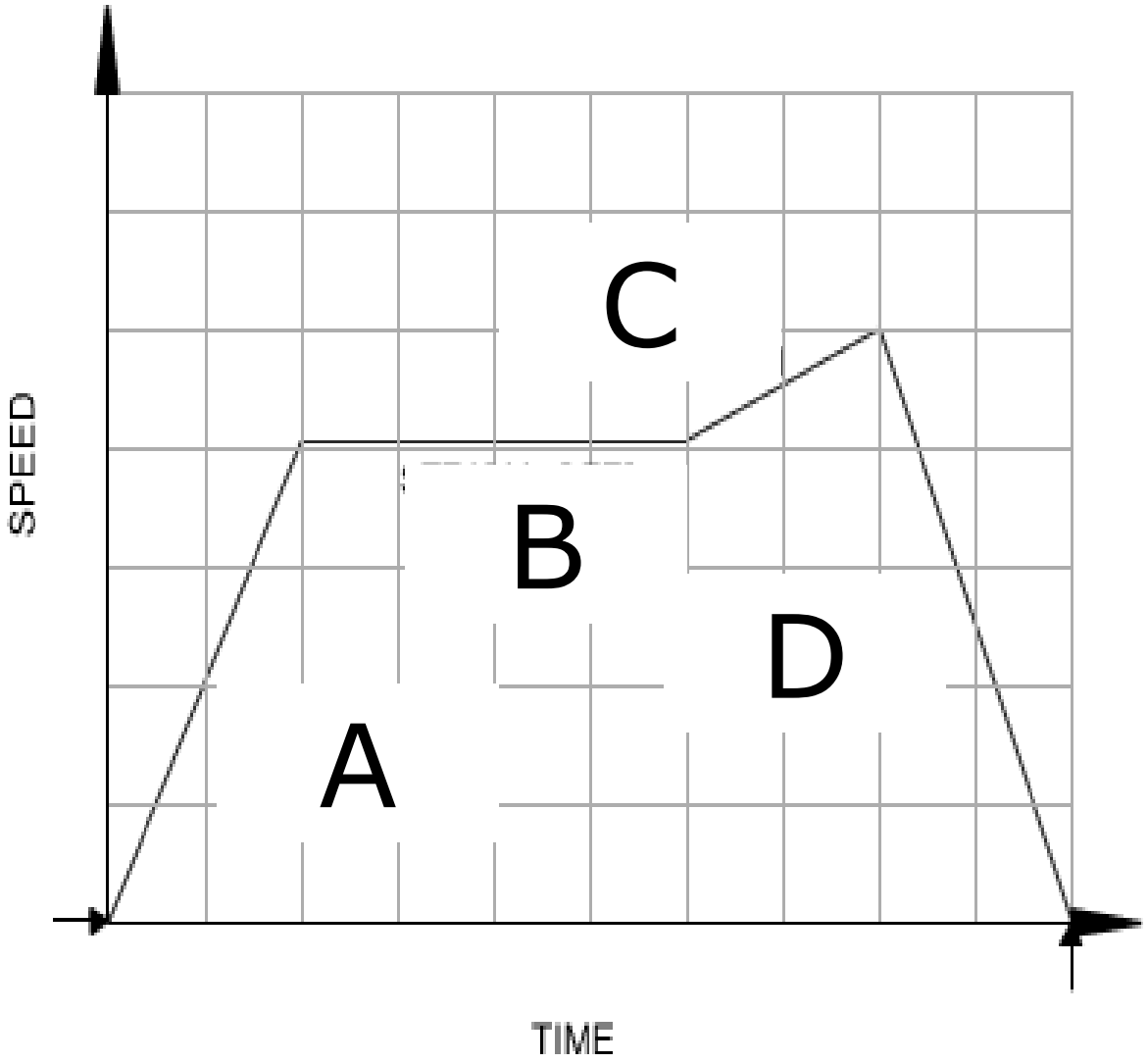
A speed - time graph shows us how the speed of a moving object changes with time.

- The steeper the graph, the greater the acceleration.
- A horizontal line means the object is moving at a constant speed.
- A downward sloping line means the object is slowing down.

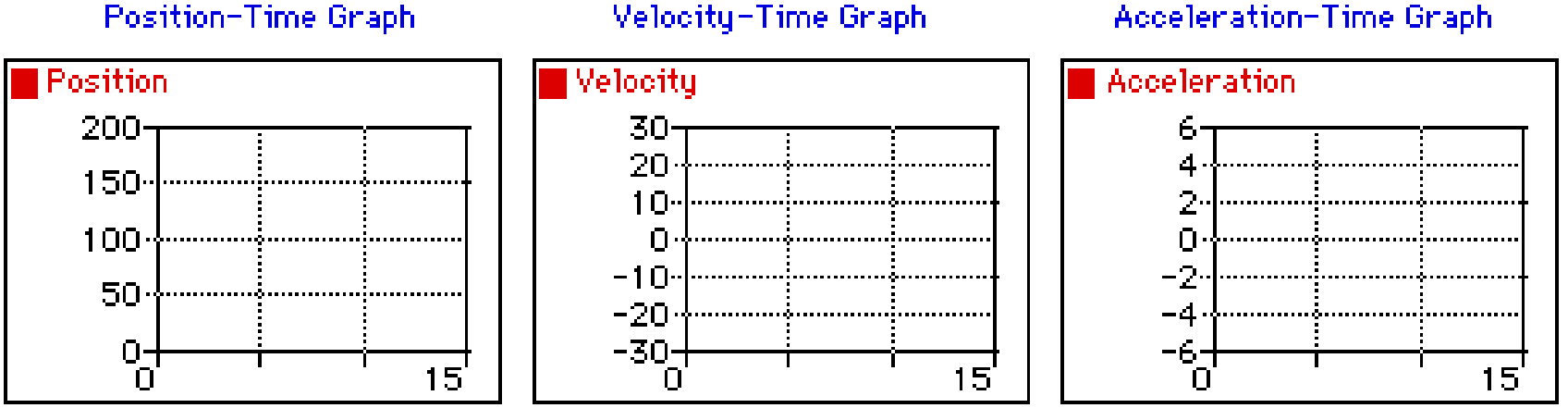
Distance/time graph



Speed(velocity)/time graph

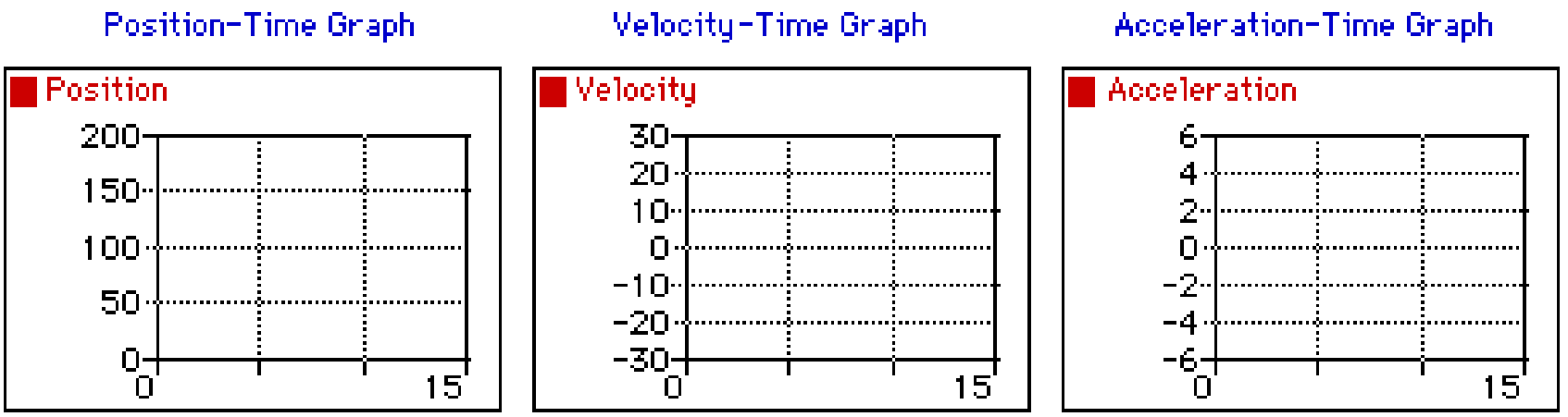


Positive Velocity
Positive Acceleration



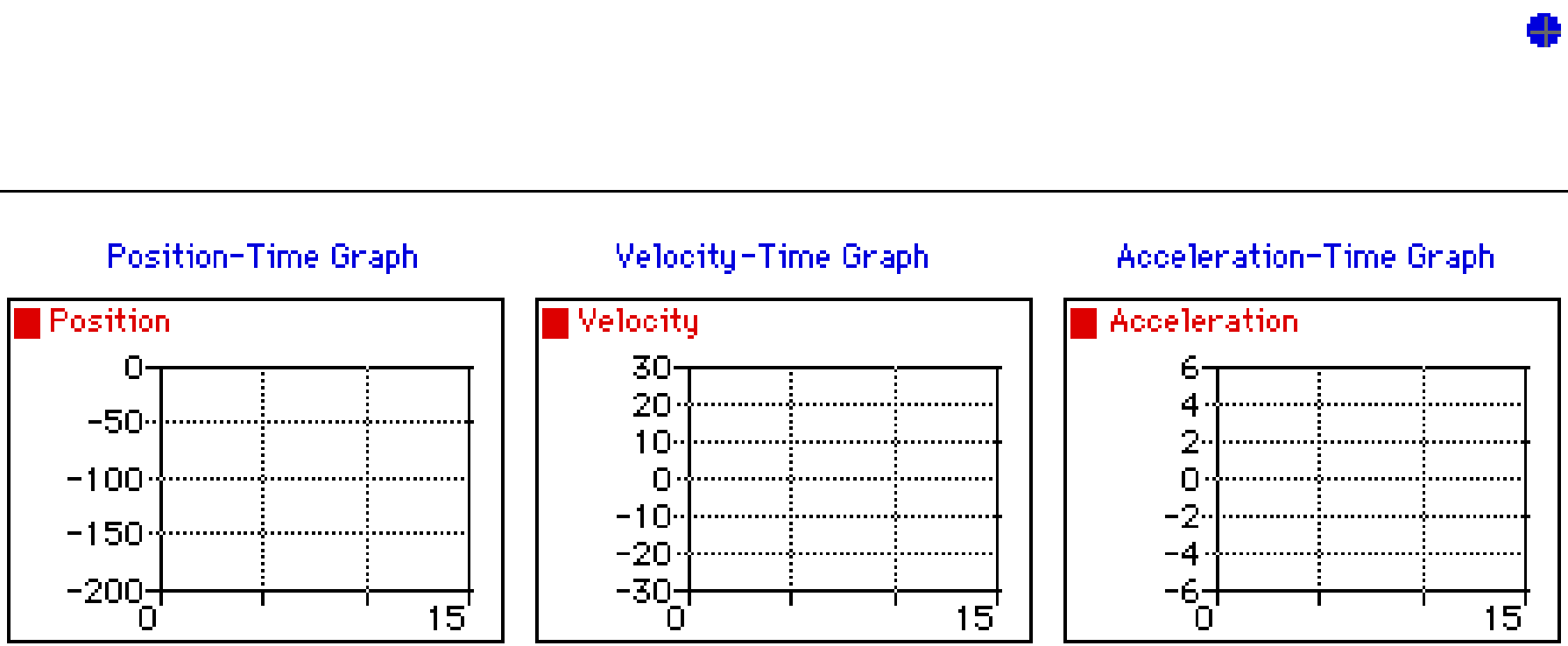
Graphics from Minds On Physics

Positive Velocity
Negative Acceleration



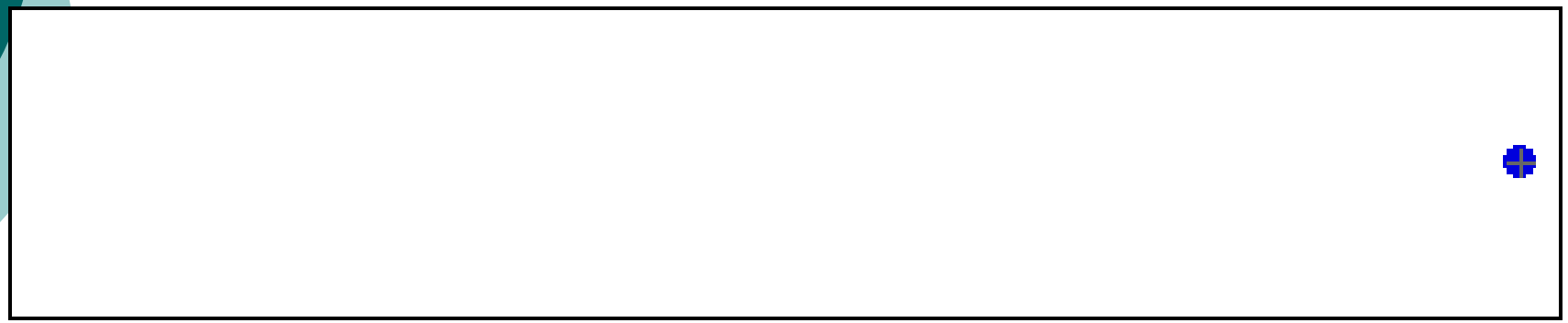
Graphics from Minds On Physics

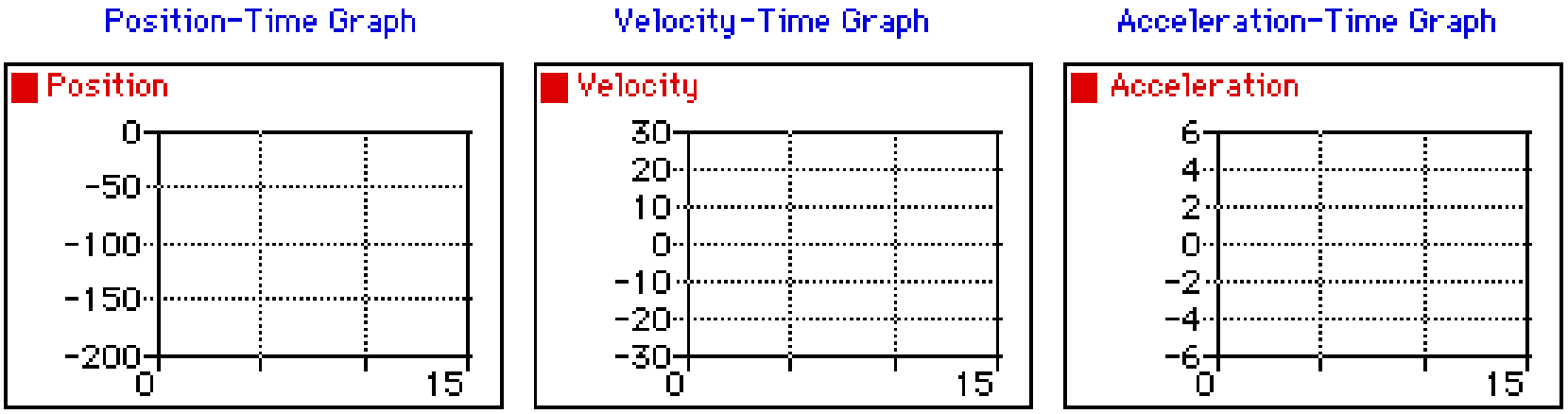
Negative Velocity
Negative Acceleration



Graphics from Minds On Physics

Negative Velocity
Positive Acceleration





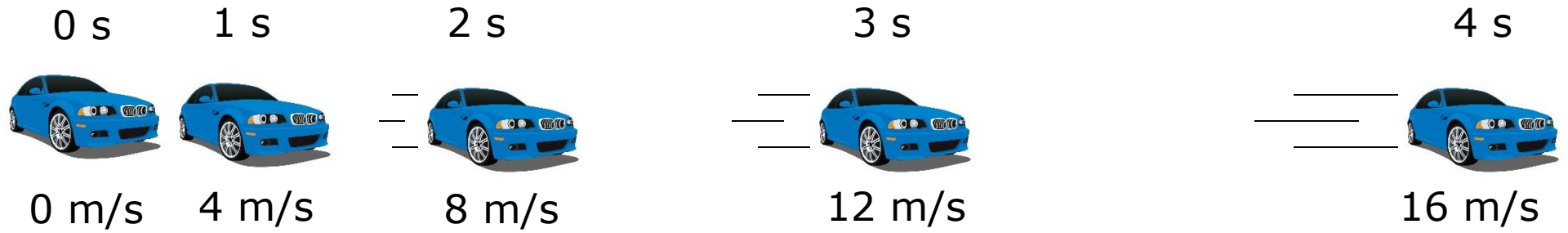
Graphics from Minds On Physics

Calculating Acceleration

$$Acceleration = \frac{Final\_Speed - Initial\_Speed}{Time}$$

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

$$= 4m/s^2$$



Question

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

$$Accel = \frac{Final\_speed - Initial\_speed}{Time}$$

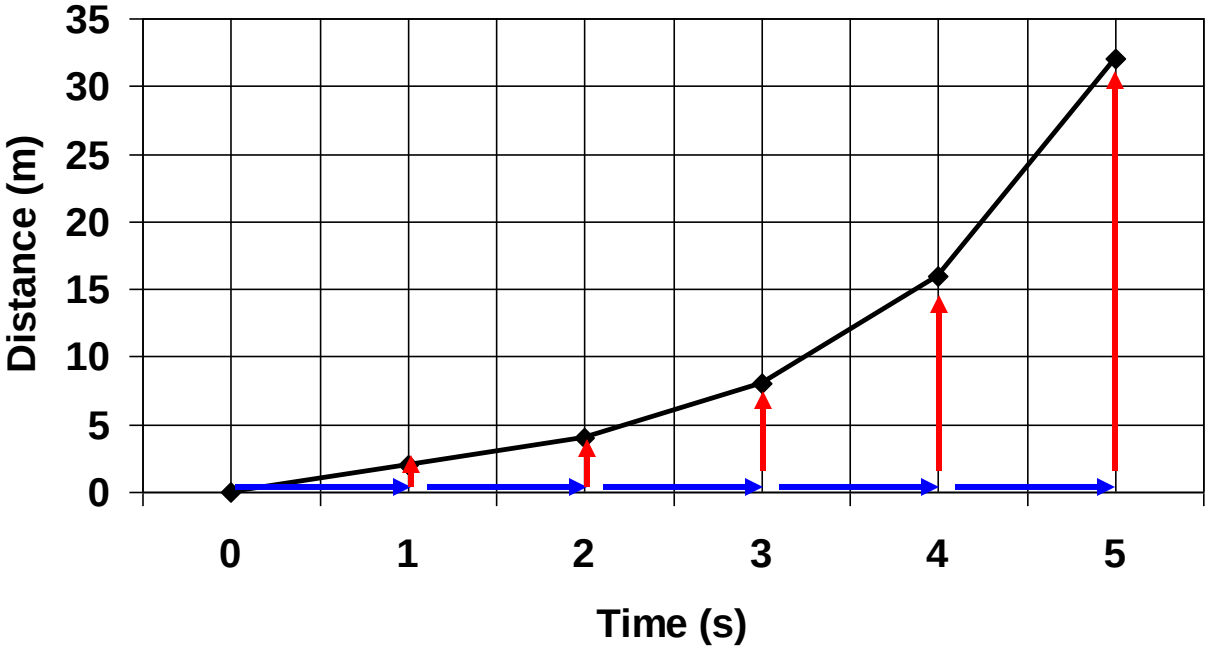
$$= \frac{40m/s - 20m/s}{2s} = \frac{20m/s}{2s}$$

$$= 10m/s^2$$

Graphing Acceleration

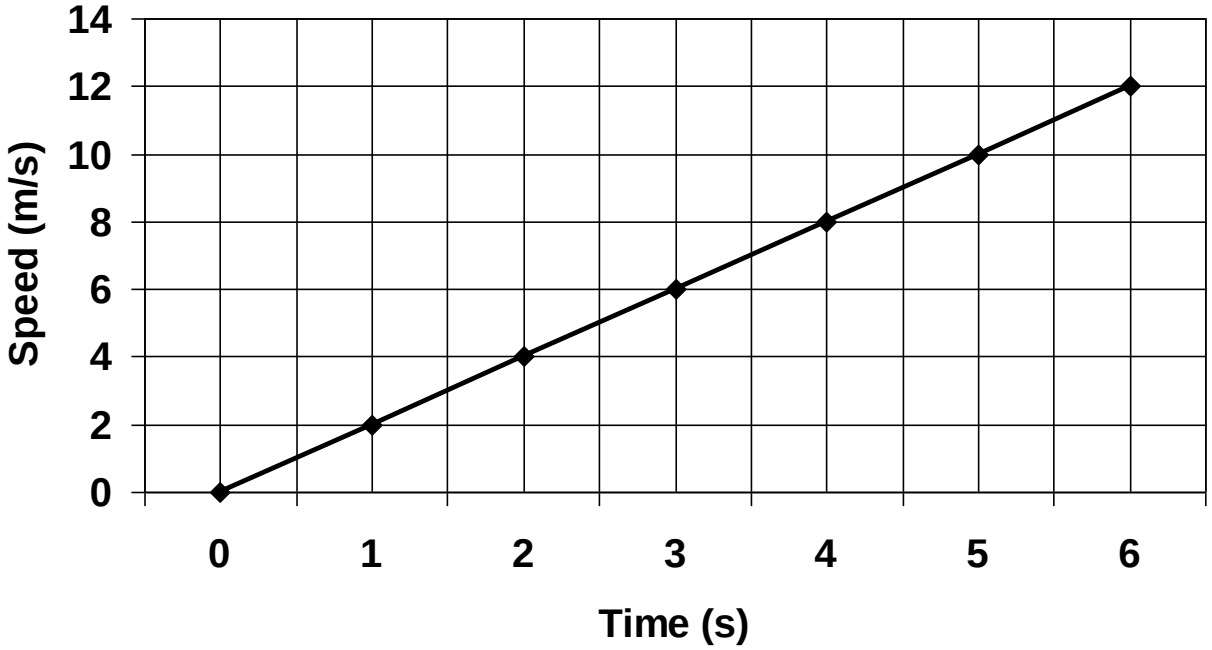
- Can use 2 kinds of graphs
  - Speed vs. time
  - Distance vs. time

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



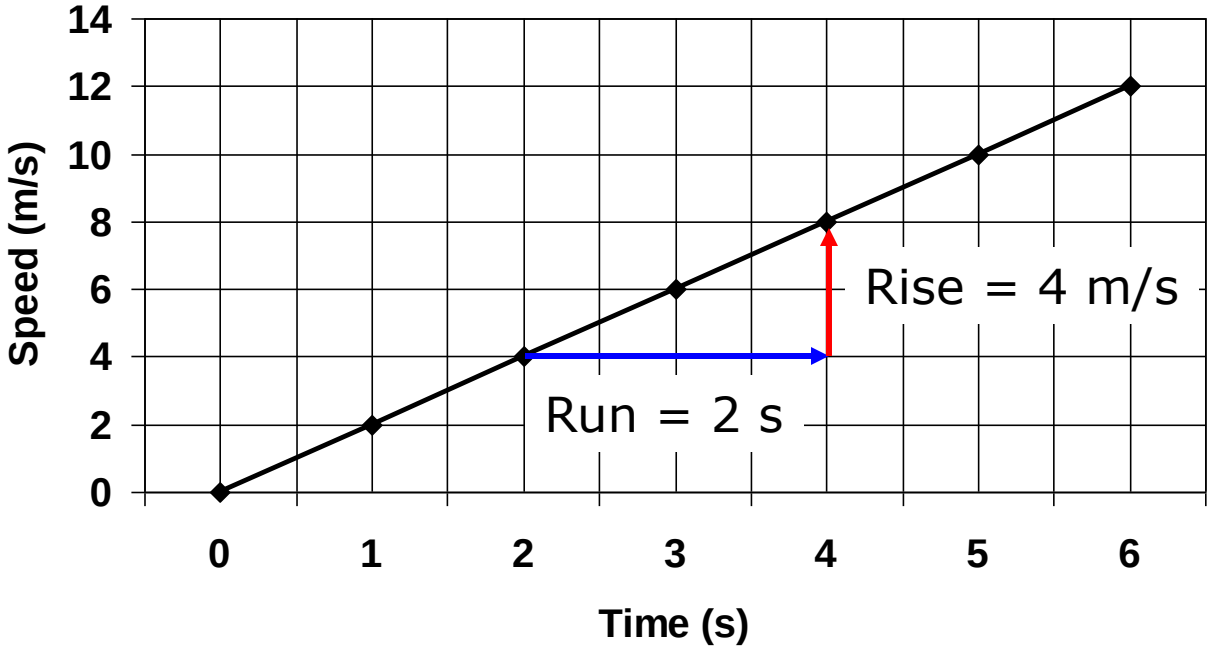
1) On Distance vs. Time graphs a curved line means the object is accelerating.
2) Curved line also means your speed is increasing. Remember slope = speed.

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

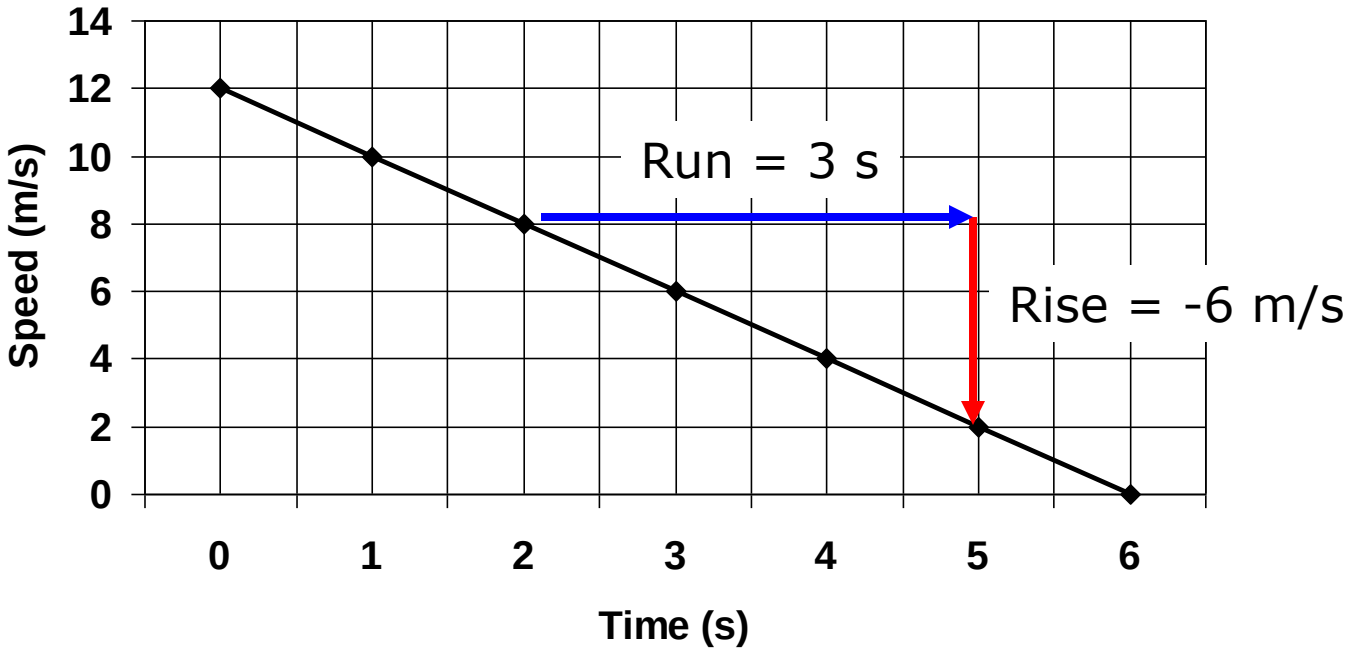


1)In Speed vs. Time graphs:

Acceleration = Rise/Run

= 4 m/s ÷ 2 s = **2 m/s²**

Question



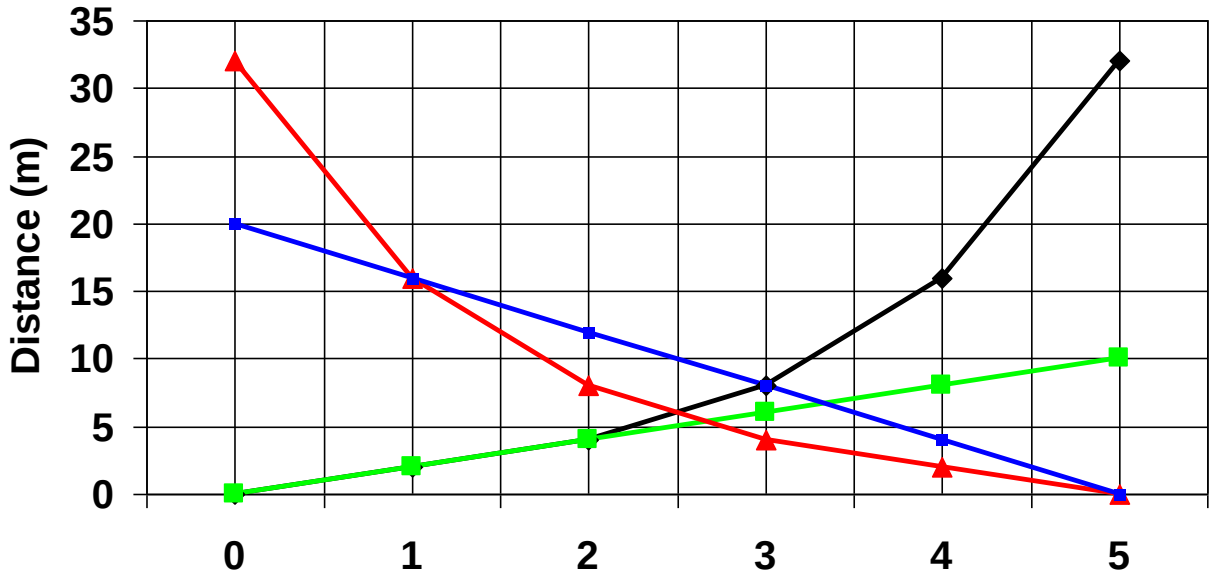
Above is a graph showing the speed of a car over time.

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