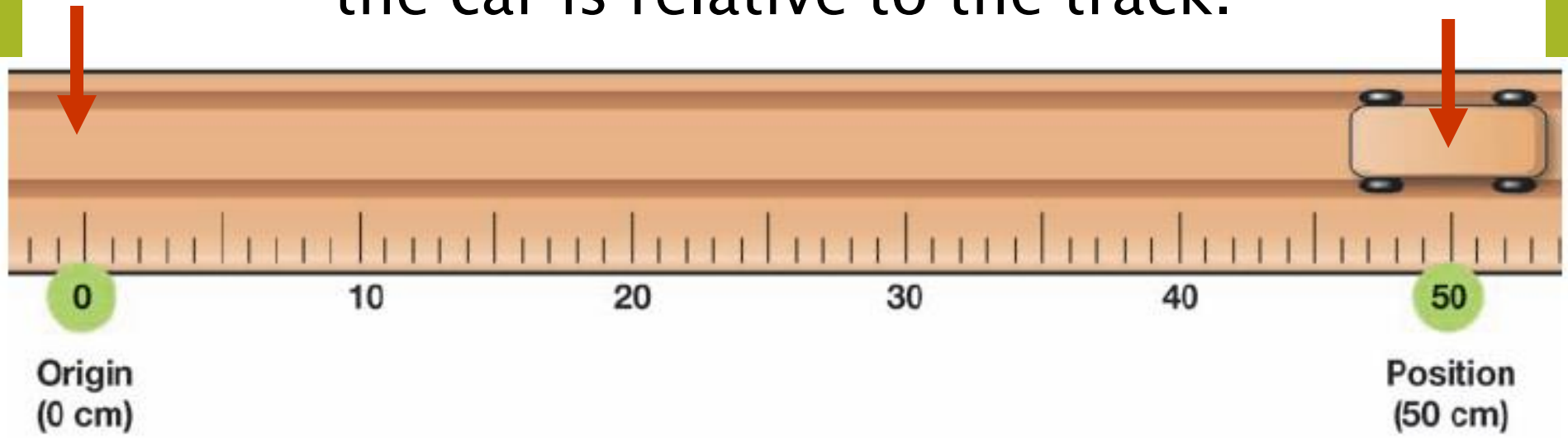
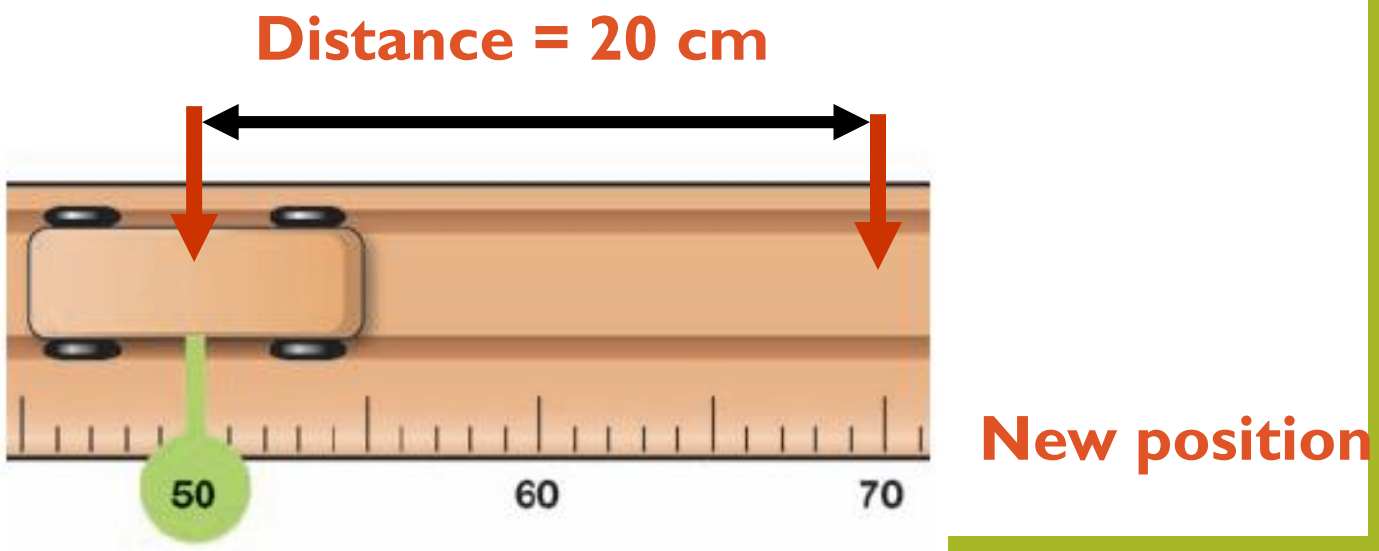
Position, Speed and Velocity

- Position is a variable that gives your location relative to an *origin*.
- The origin is the place where position equals 0.

The position of this car at 50 cm describes where the car is relative to the track.



- Position and distance are similar but not the same. Distance is the amount of space between two points.
- If the car moves a distance of 20 cm to the right, its new position will be 70 cm from its origin.



- The variable *speed* describes how quickly something moves.
- To calculate the speed of a moving object divide the distance it moves by the time it takes to move.

SPEED

$$\text{Speed (cm/s)}\ v = \frac{d}{t}$$

d — **Distance** (cm)

t — **Time** (s)

Solving Problems

How far do you go if you drive for two hours at a speed of 100 km/h?

1. Looking for:
   - …distance
2. Given:
   - …speed = 100 km/h time = 2 h
3. Relationships:
   - d = vt
4. Solution:
   - d = 100 km/h x 2 h =

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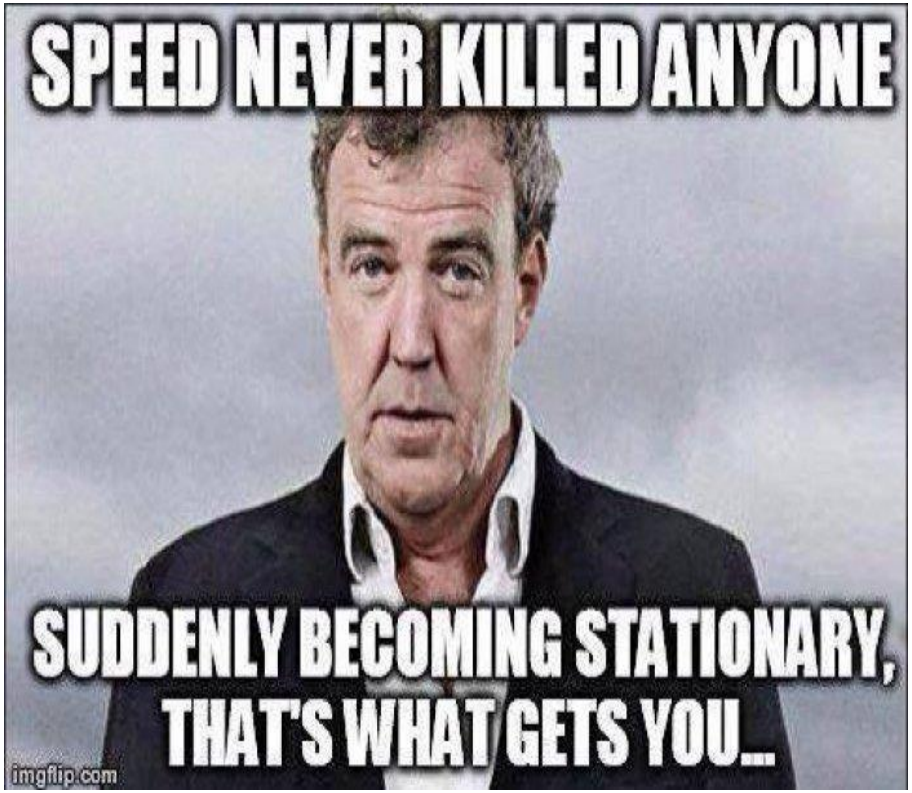
- Do YOUR TURN
- Show your work



Average speed

- When you divide the total distance of a trip by the time taken you get the *average speed*.
- In this example, the car traveled and average of 100 km/h.

Velocity

- Velocity is a variable that tells you both speed and direction

The difference between speed and velocity is that speed can only have a positive value or zero but velocity can be shown as a positive or negative number. The positive or negative sign will indicate if the object is moving forward or backward.

Solving Problems

A train travels at 100km/h heading east to reach a town in four hours. The train then reverses and heads west at 50 km/h for 4 hours. What is the train's position now?

1. You are given two velocities and times
2. Change in position = velocity x time
3. First change in position (+100 km/h) x (4 h) = +400 km/h

Second change in position (-50 km/h) x (4h) = -200

The final position is (+400 km/h) + (-200 km) = +200 km
Thus the train is 200 km from where it started.

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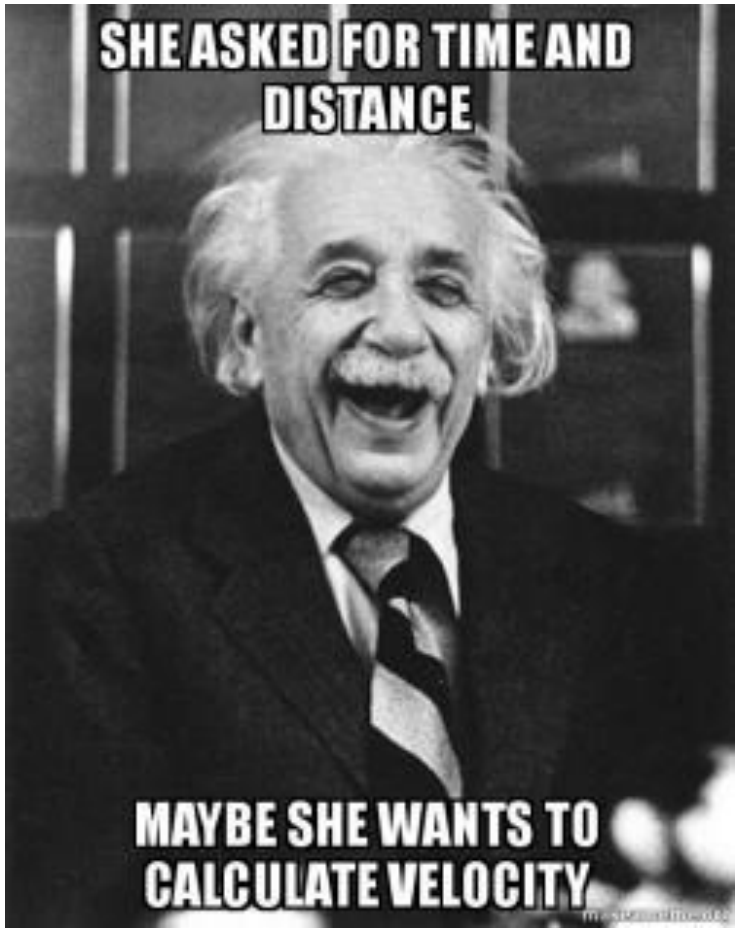
- Do Your Turn
- Show your work



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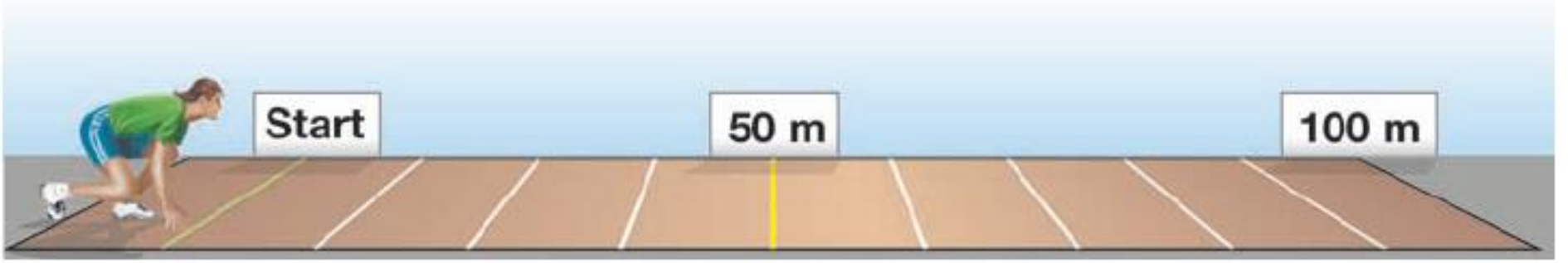
- Answers only
- Numbers 1, 3, 5

EXIT SLIP
How do velocity and speed differ?

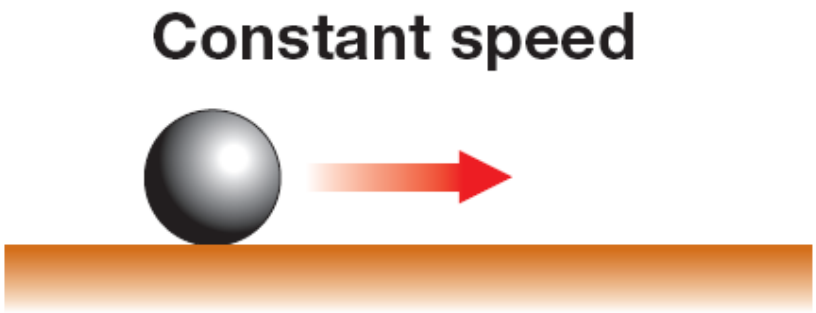
- Answers only and on the same piece of paper – turn in when done

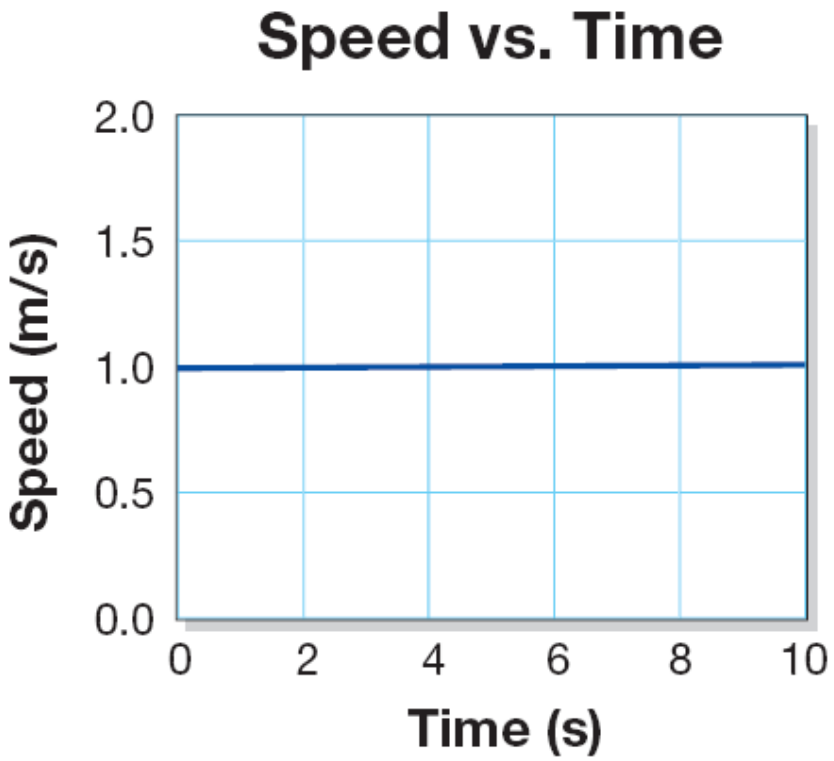
4.2 Graphs of Motion

- ***Constant speed*** **means the speed stays the same.**
- **An object moving at a constant speed always creates a graph that is a straight line.**
- **On a graph TIME WILL ALWAYS GO ON THE X AXIS**

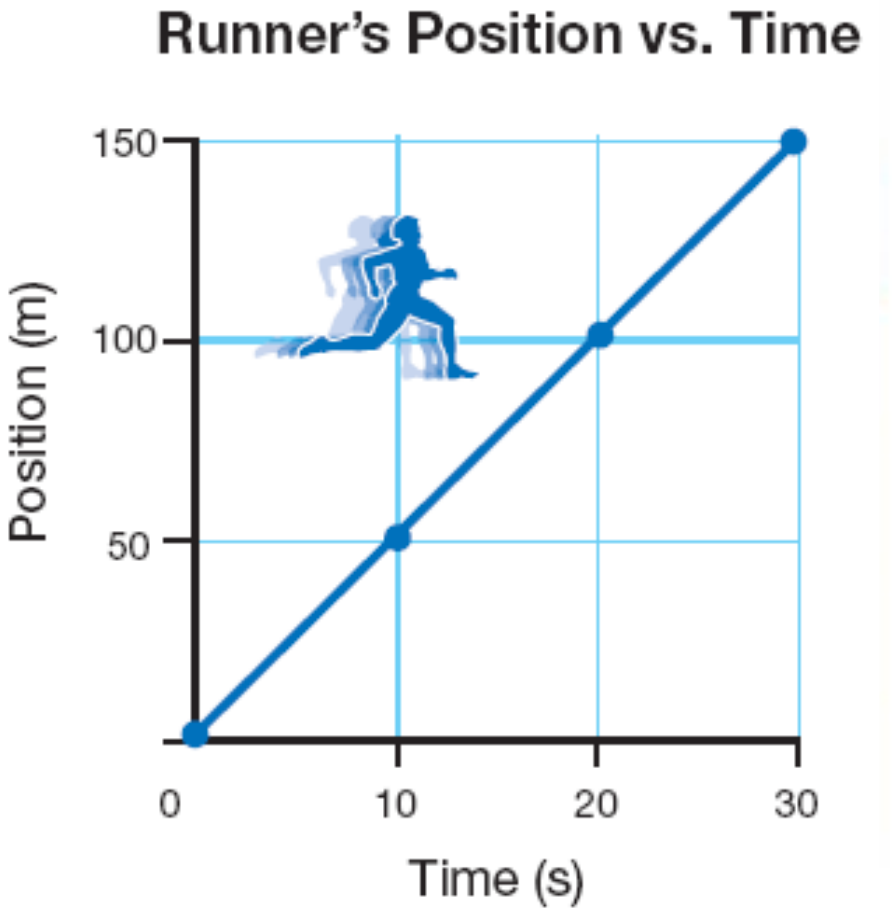


Drawing a Speed vs. Time Graph



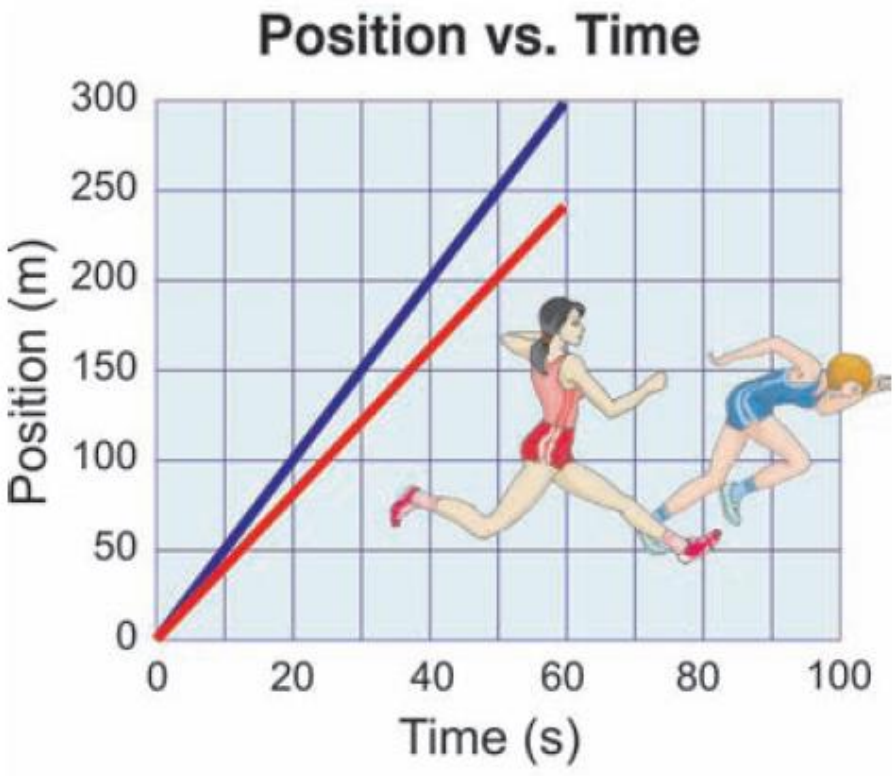


4.2 Graphs of Motion



- This data shows a runner took 10 seconds to run each 50-meter segment.
- Because the time was the same for each segment, you know the speed was the same for each segment.

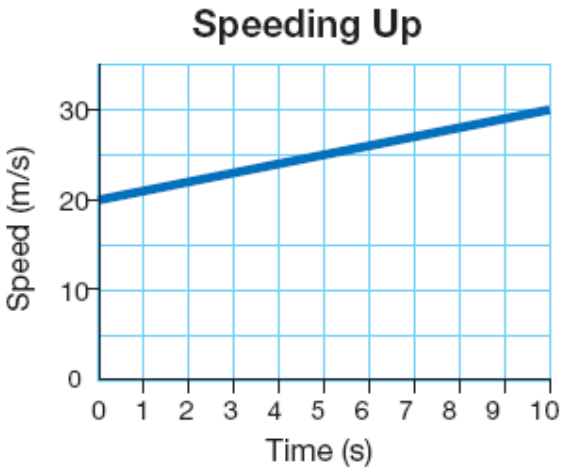
4.2 Graphs of Motion



- You can use position vs. time graphs to compare the motion of different objects.
- The steeper line on a position vs. time graph means a faster speed.

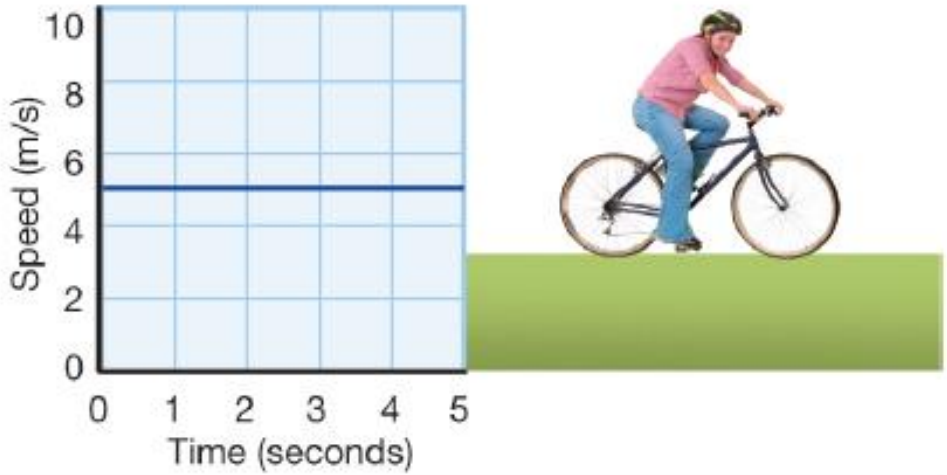
4.2 Graphs of changing motion

- Objects rarely move at the same speed for a long period of time.
- A speed vs. time graph is also useful for showing the motion of an object that is speeding up or slowing down.

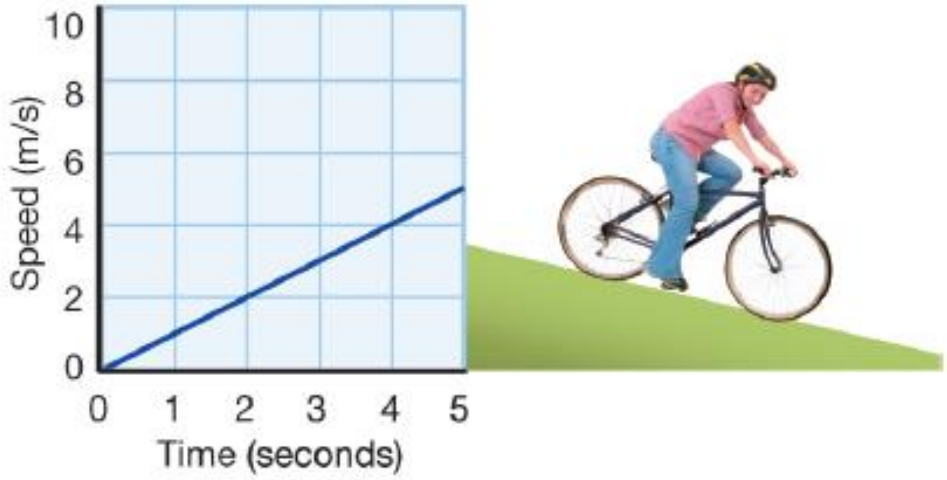


Speed vs. Time Graphs

Constant speed (accel = 0)

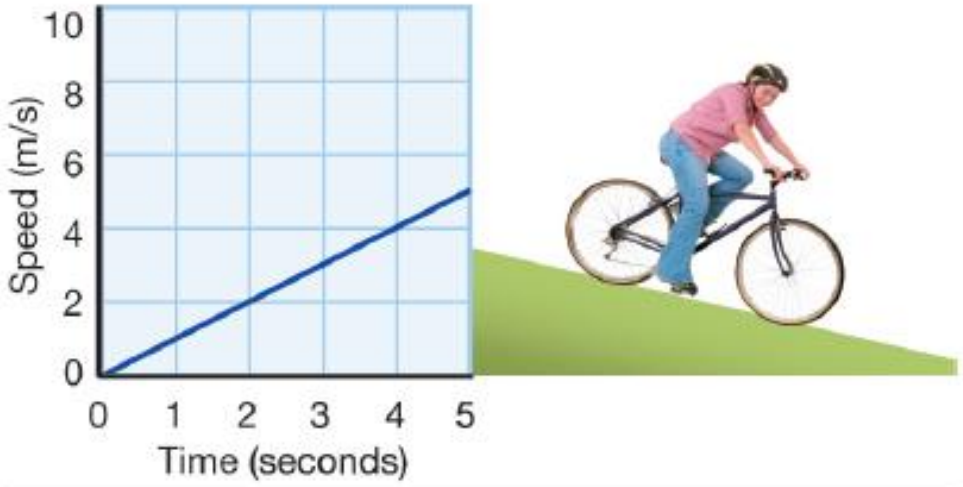


Acceleration of 1 m/s each second

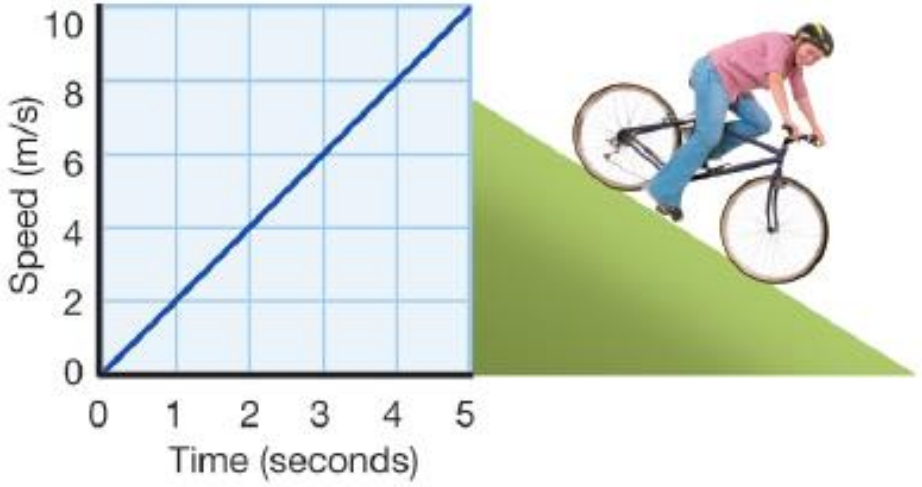


Speed vs. Time Graphs

Acceleration of 1 m/s each second



Acceleration of 2 m/s each second

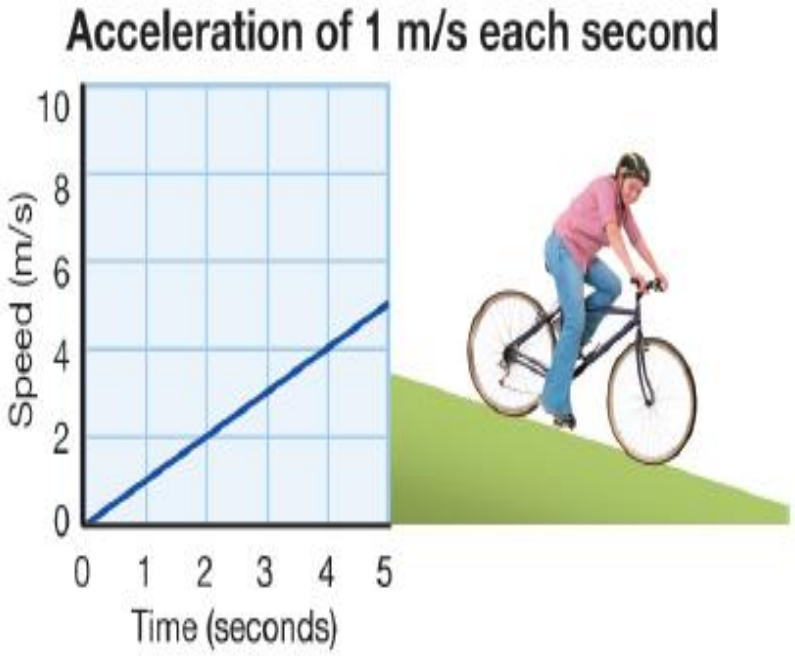


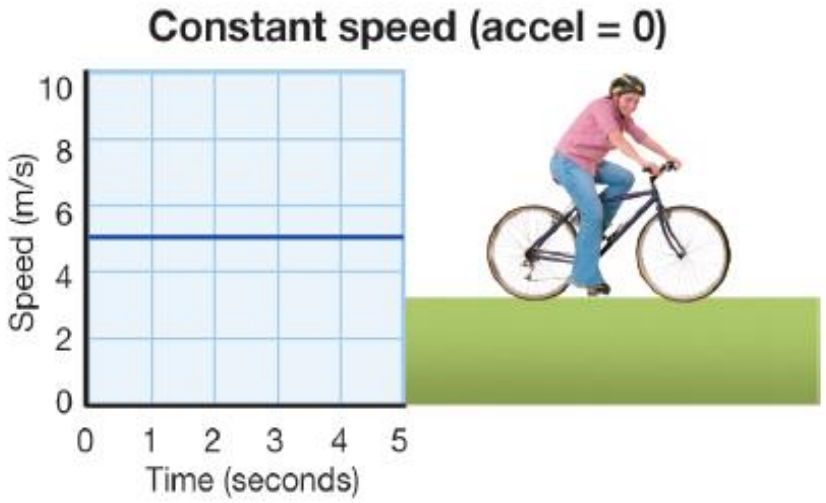
4.3 Acceleration

- **Acceleration** is the rate at which your speed (or velocity) changes; an object accelerates if its speed, DIRECTION or both changes.
- The word "acceleration" is used for any change in speed, up or down.
- Acceleration can be positive or negative.

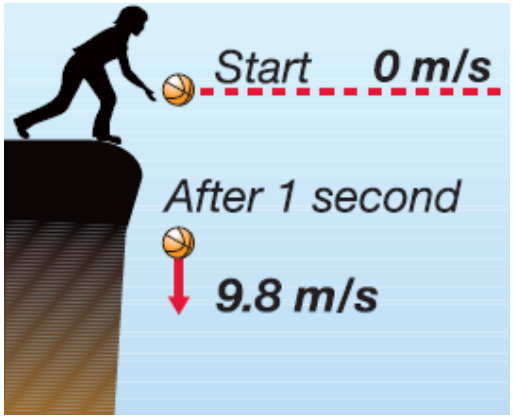
Acceleration causes the line to slope up on a speed vs. time graph.

There is zero acceleration at constant speed because the speed does not change.





4.3 Acceleration



- Speed and acceleration are not the same thing.
- You can be moving (non-zero speed) and have no acceleration (think *cruise control*).
- You can also be accelerating and not moving!
- A falling object begins accelerating the instant it is released.

- Acceleration describes how quickly speed changes.
- Acceleration is the change in speed divided by the change in time.

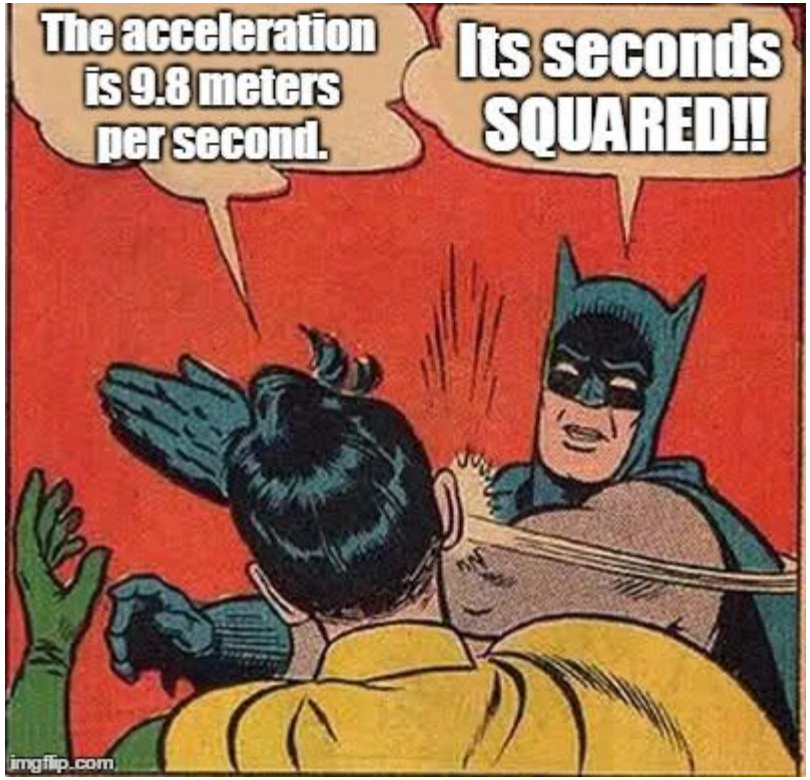
ACCELERATION

Acceleration (m/s^2) $a = \dfrac{v_{finish} - v_{start}}{t}$

Change in speed (m/s)

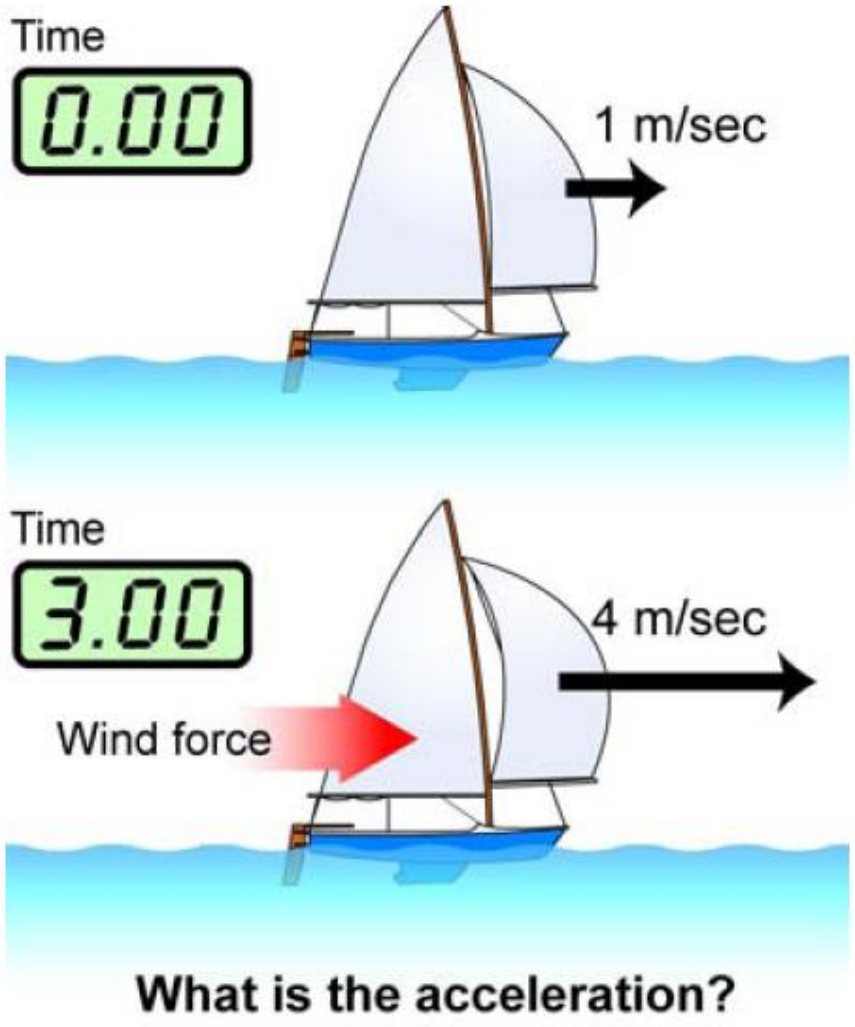
Time (s)

The units for time in acceleration are often expressed as "seconds squared" and written as s^2



Solving Problems

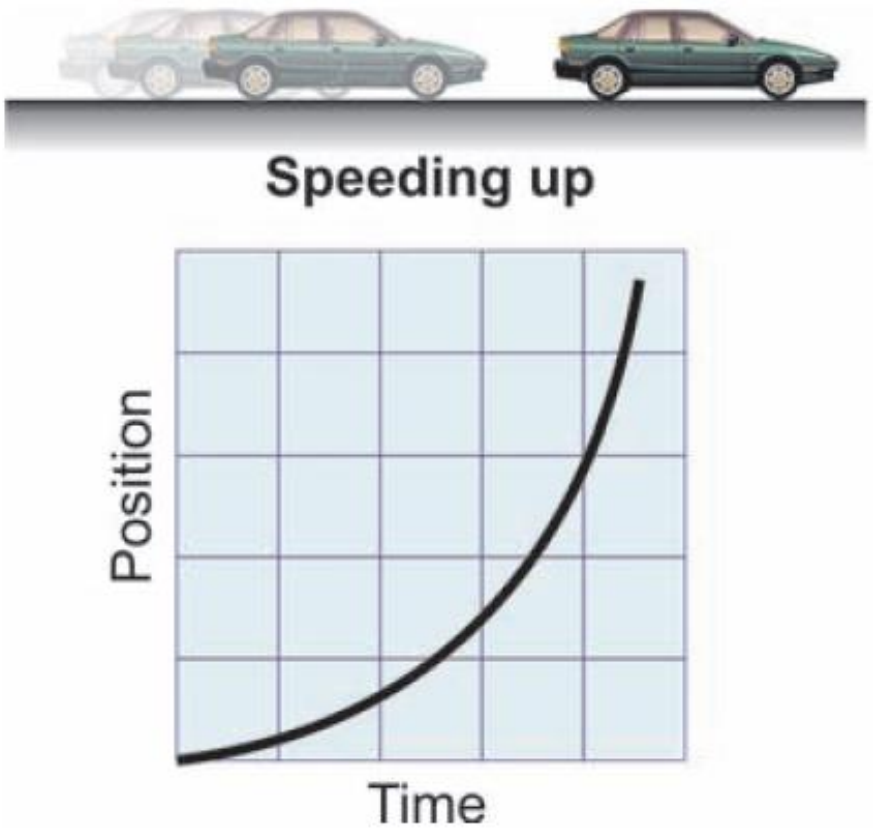
- A sailboat moves at 1 m/s.
- A strong wind increases its speed to 4 m/s in 3 s.
- Calculate acceleration.



Solving Problems

1. Looking for:
   - …acceleration of sailboat
2. Given:
   - …v_1 = 1 m/s; v_2 = 4 m/s; time = 3 s
3. Relationships:
   - $a = v_2 – v_1/t$
4. Solution:
   - a = (4 m/s – 1 m/s)/ 3 s

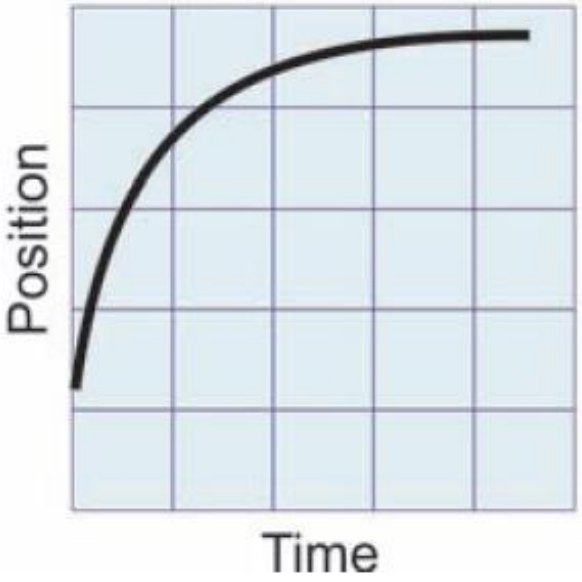
4.3 Acceleration on position-time graphs



- The position vs. time graph is a *curve* when there is acceleration.
- The car covers more distance each second, so the position vs. time graph gets steeper each second.

4.3 Acceleration on position-time graphs

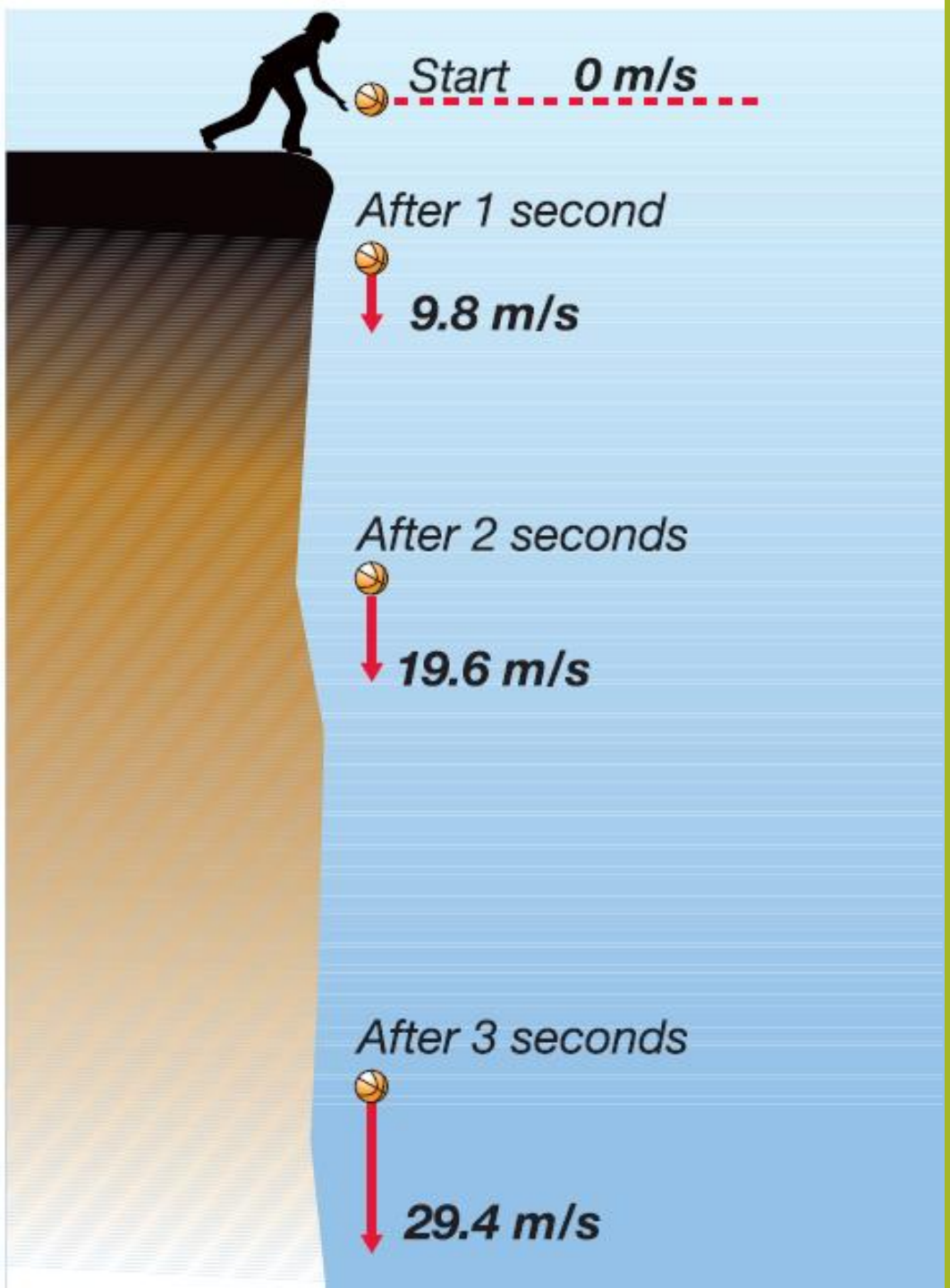
Slowing down



- When a car is slowing down, the speed decreases so the car covers less distance each second.
- The position vs. time graph gets shallower with time.

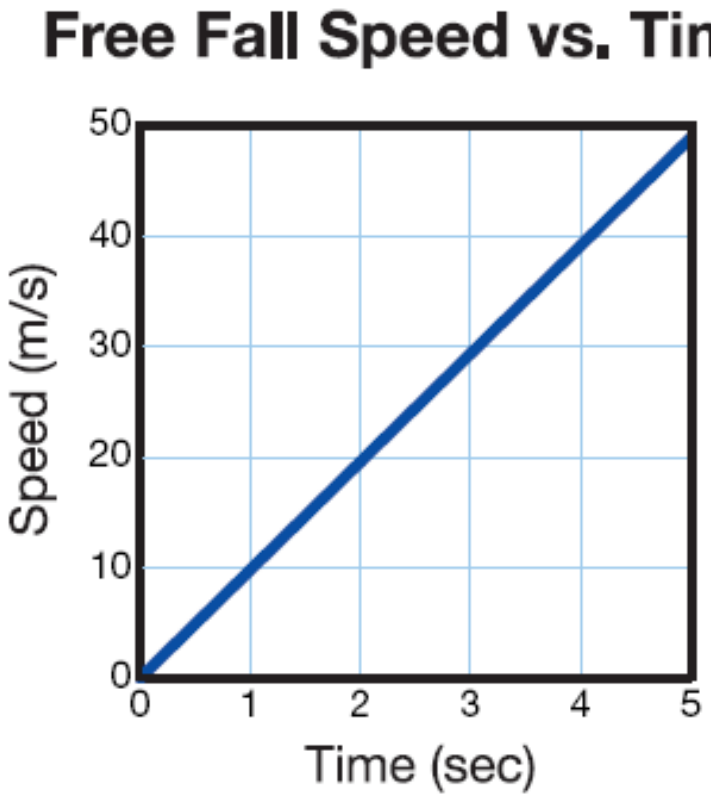
4.3 Free fall

- An object is in *free fall* if it is accelerating due to the force of gravity and no other forces are acting on it.



4.3 Free fall

- Falling objects increase their speed by 9.8 m/s every second, or 9.8 m/s^2
- The letter "g" is used for *acceleration due to gravity.*



Time (sec)	Speed (m/s)
0	0
1	9.8
2	19.6
3	29.4
4	39.2
5	49.0