Force and Motion

What words come to mind when you think of force and motion?

Tsunamis

Tsunamis

How can a tsunami be related to the Force and Motion unit?

What Is Motion?

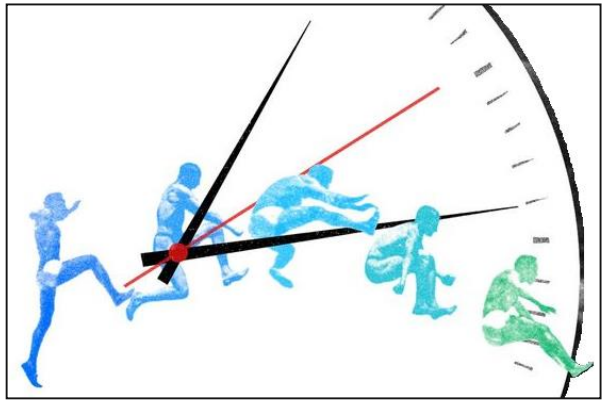
- Motion is when an object changes place or position. To properly describe motion, you need to use the following:
- Start and end position?
- Movement relative to what?
- How far did it go?
- In what direction did it go?

Speed

Speed

- Speed is a description of motion.
- It is how fast an object moves.

Speed is the distance traveled by an object divided by the time taken to travel that distance. Speed is measured in meters per second m/s.



- When dealing with varying speeds, the best way to describe speed is average speed.

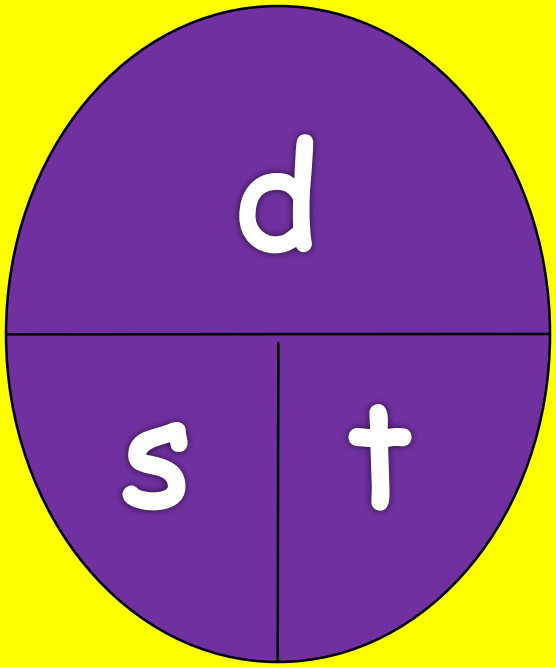
To calculate speed there is a simple formula.

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

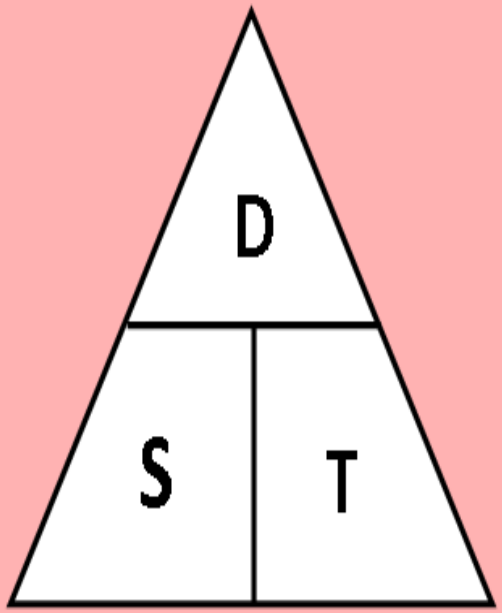
s = speed
d = distance
t = time

Standard units will be m/s

Remember to cover up the Letter you are solving for.



Speed Distance Time



$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

1. Calculate the speed for a car that went a distance of 130 miles in 2 hours time.

a. 75mph

b. 65 mph

c. 70 mph

d. 80 mph

2. How much time does it take for a car traveling east on I-20 going 45 miles per hour to travel a distance of 90 miles?

a. 1 hr.

b. 2 hrs.

c. 36 hrs.

d. 3 hrs.

1. Calculate the speed for a car that went a distance of 130 miles in 2 hours time.

b. 65mph S=d/t S=130mi/2hr S=65mph

2. How much time does it take for a car traveling east on I-20 going 45 miles per hour to travel a distance of 90 miles?

t=d/s t=90mi/45mph t=2hrs. B. 2hrs.

Speed Machines Practice Sheet

Ways To Calculate Speed

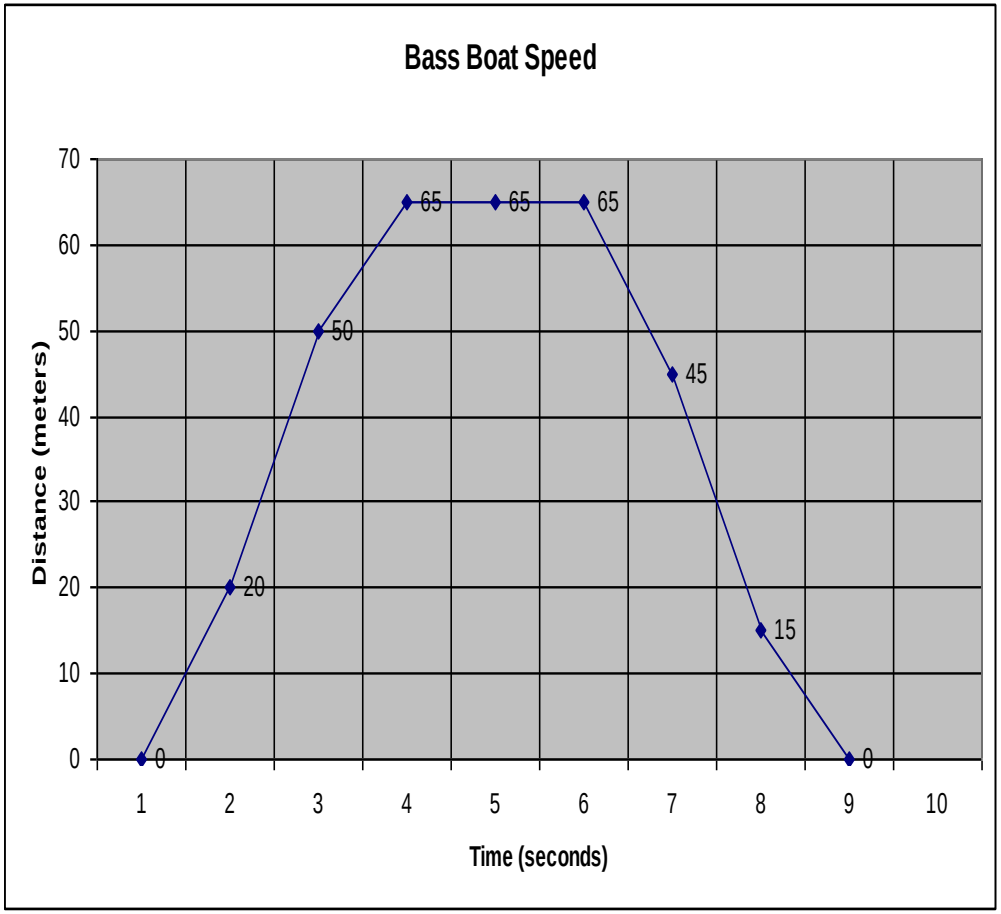
•**Constant speed** is when you are traveling at the same rate of speed, such as 55 mph constantly on a highway (Speed that does not vary over a period of time).

•**Average speed** is taking the total distance traveled, and dividing by the total time it takes. Used for calculations that involve changing speed.

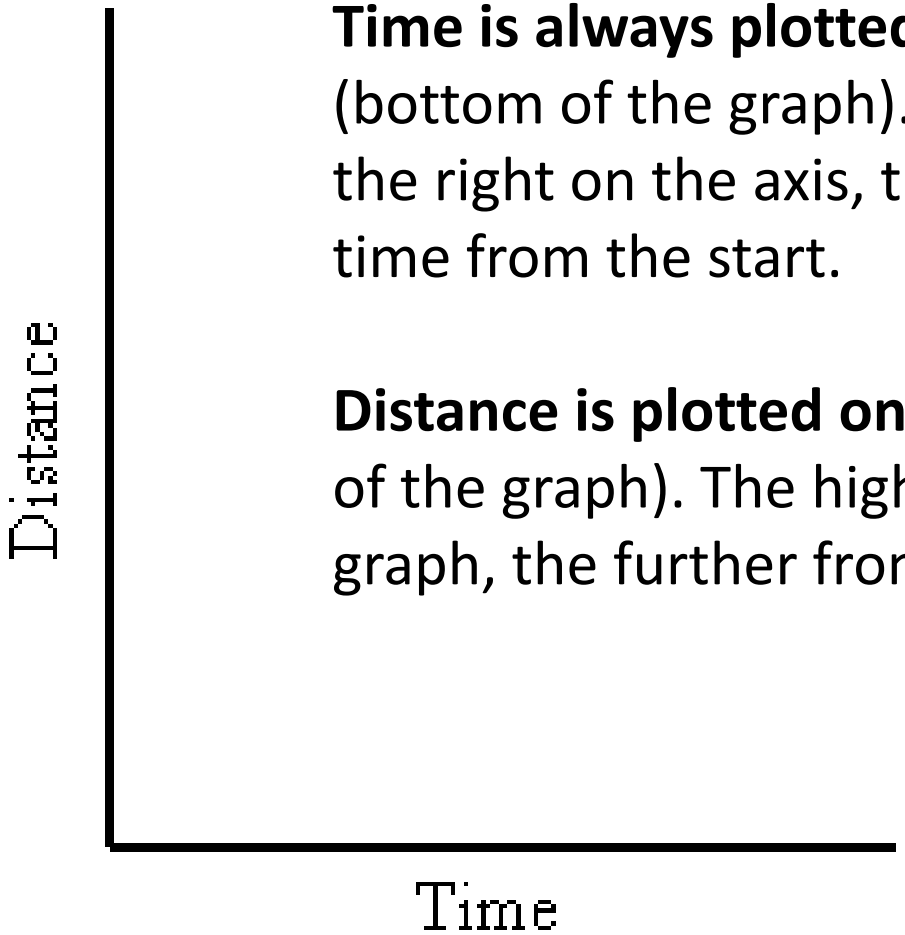
•**Instantaneous speed** is the speed at any one given point in time.

Graphing Speed

- Speed is usually graphed using a line graph, and it depicts the distance and time.
- Time is the independent variable, and thus is ALWAYS on the x-axis.
- Distance is the dependent variable, and is ALWAYS on the y-axis.



DISTANCE-TIME GRAPHS

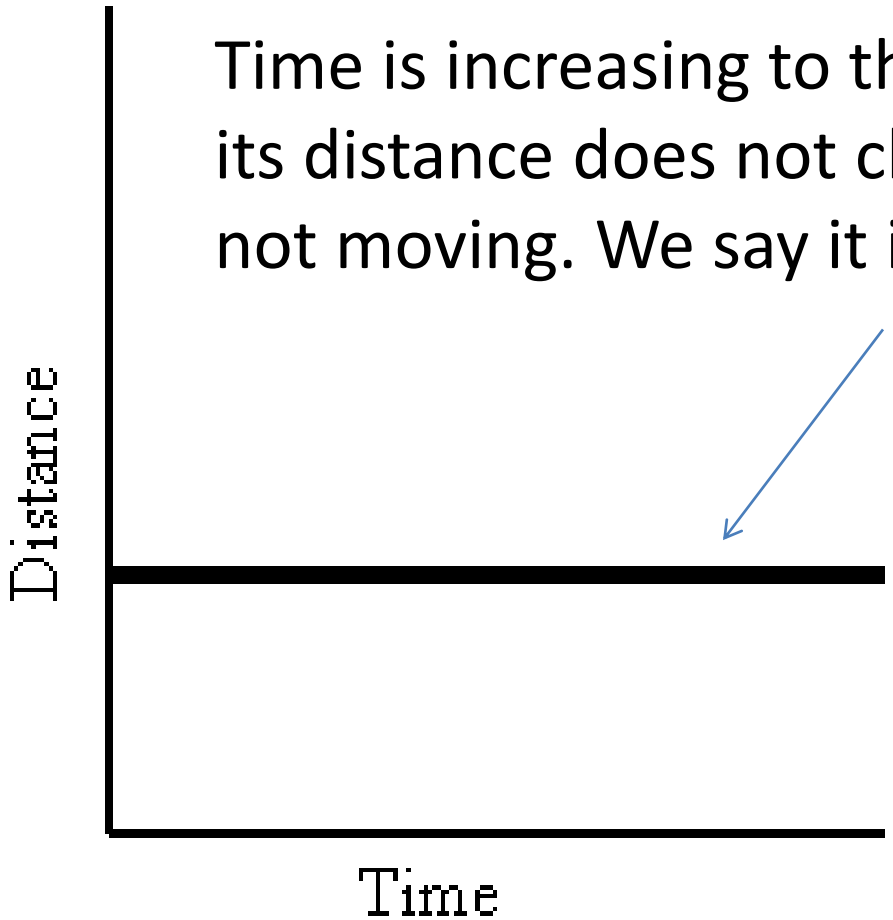


Time is always plotted on the X-axis (bottom of the graph). The further to the right on the axis, the longer the time from the start.

Distance is plotted on the Y-axis (side of the graph). The higher up the graph, the further from the start.

At Rest.

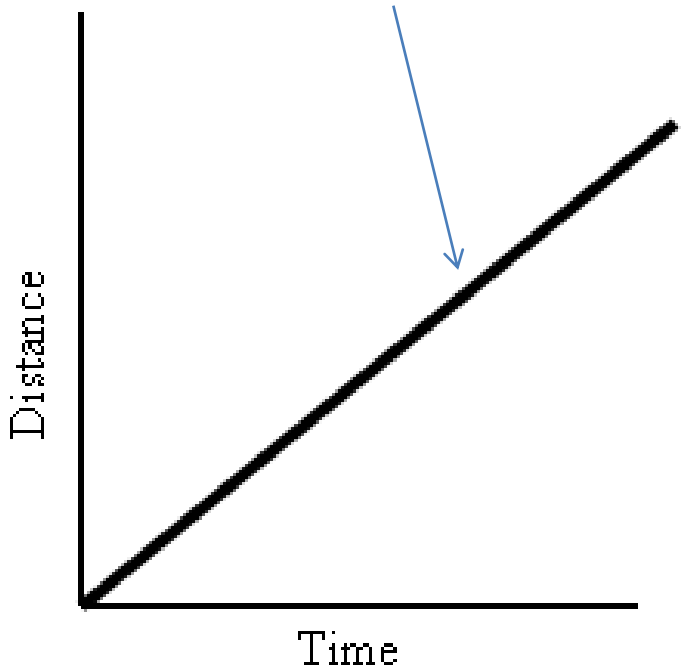
Time is increasing to the right, but its distance does not change. It is not moving. We say it is **At Rest**.



Constant Speed

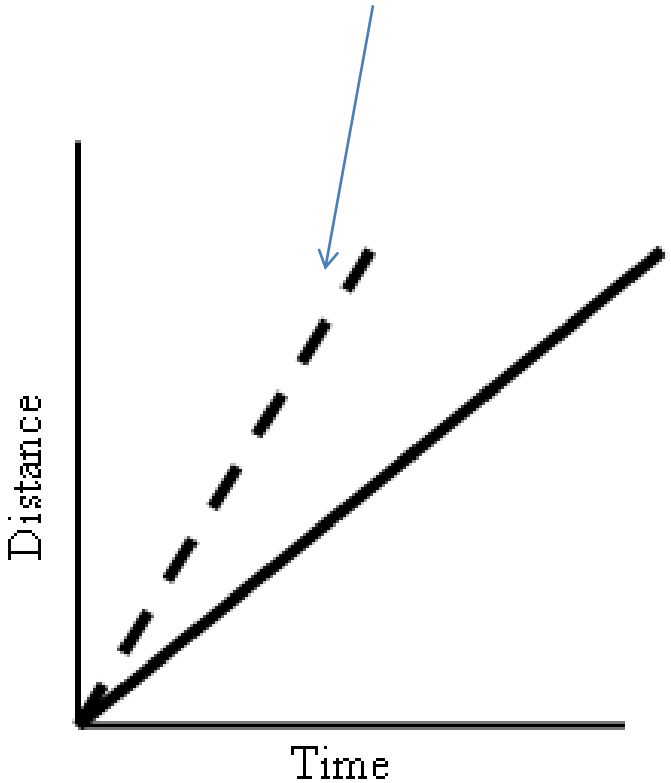
Time is increasing to the right, and distance is increasing constantly with time. The object moves at a **constant speed**.

Constant speed is shown by straight lines on a graph.



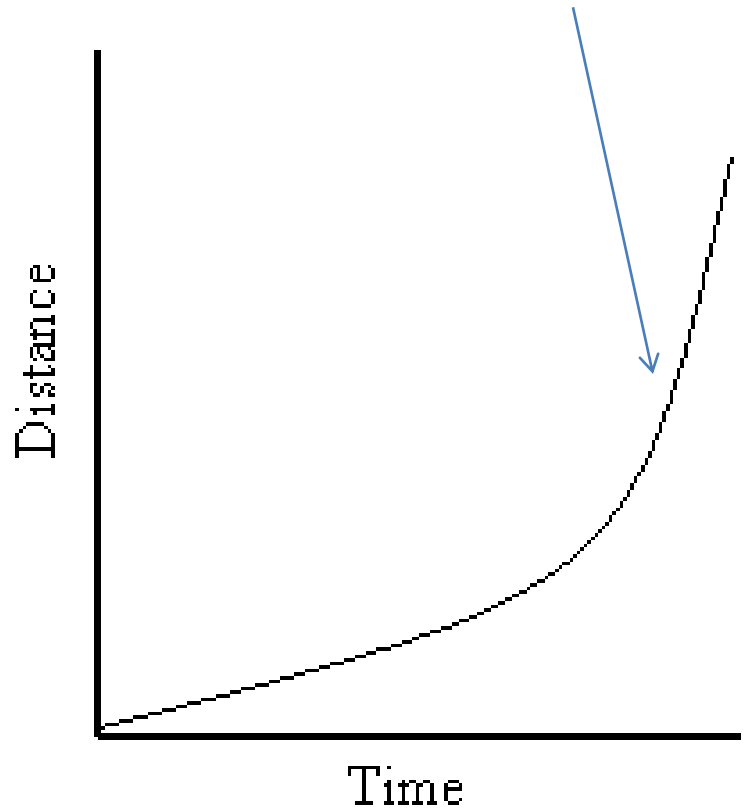
Steeper Line = Higher Speed

A steeper line indicates a larger distance moved in a given time. In other words, **higher speed**.

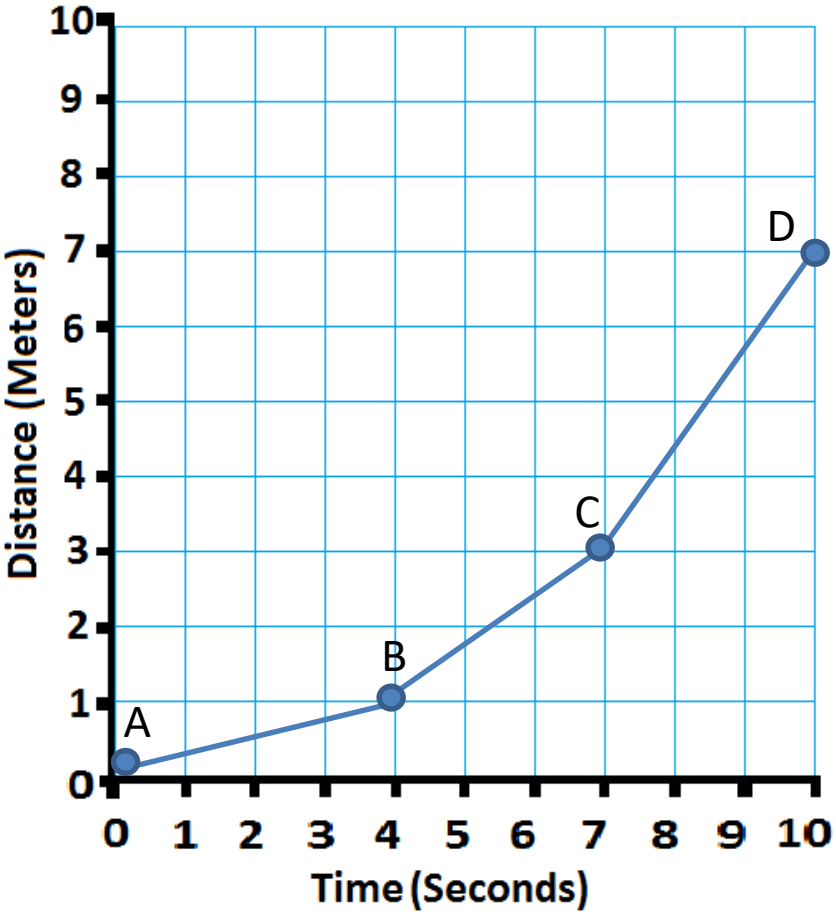


Upward curve = increase in speed

In a given time, the distance the object moves is changing (getting larger). It is **accelerating**.



Speed vs. Average Speed



Speed = Distance ÷ Time

- Between points C and D the speed is

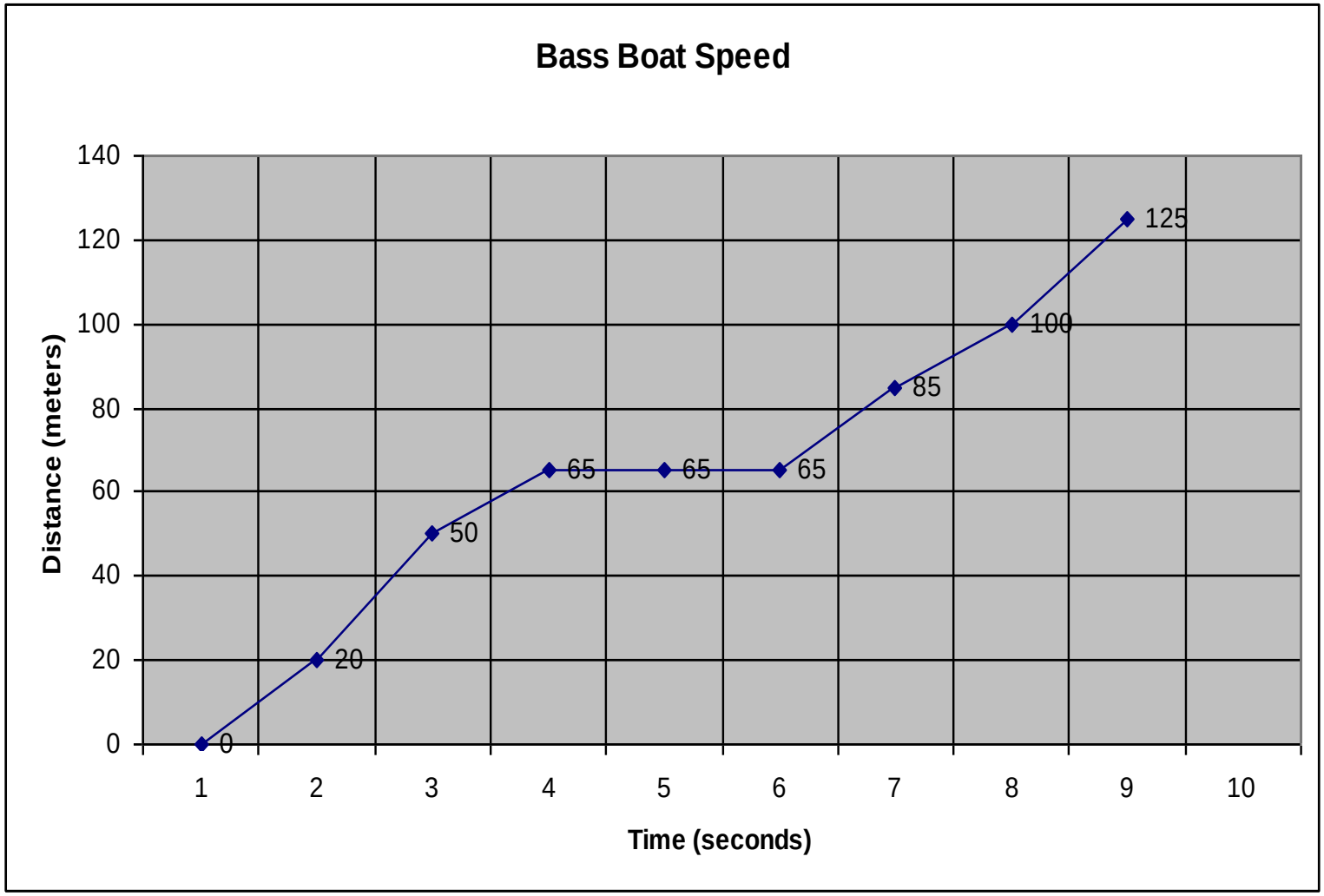
4 meters ÷ 3 seconds=1.33 m/sec

Average speed = Total distance ÷ Total time

- At point D the average speed was

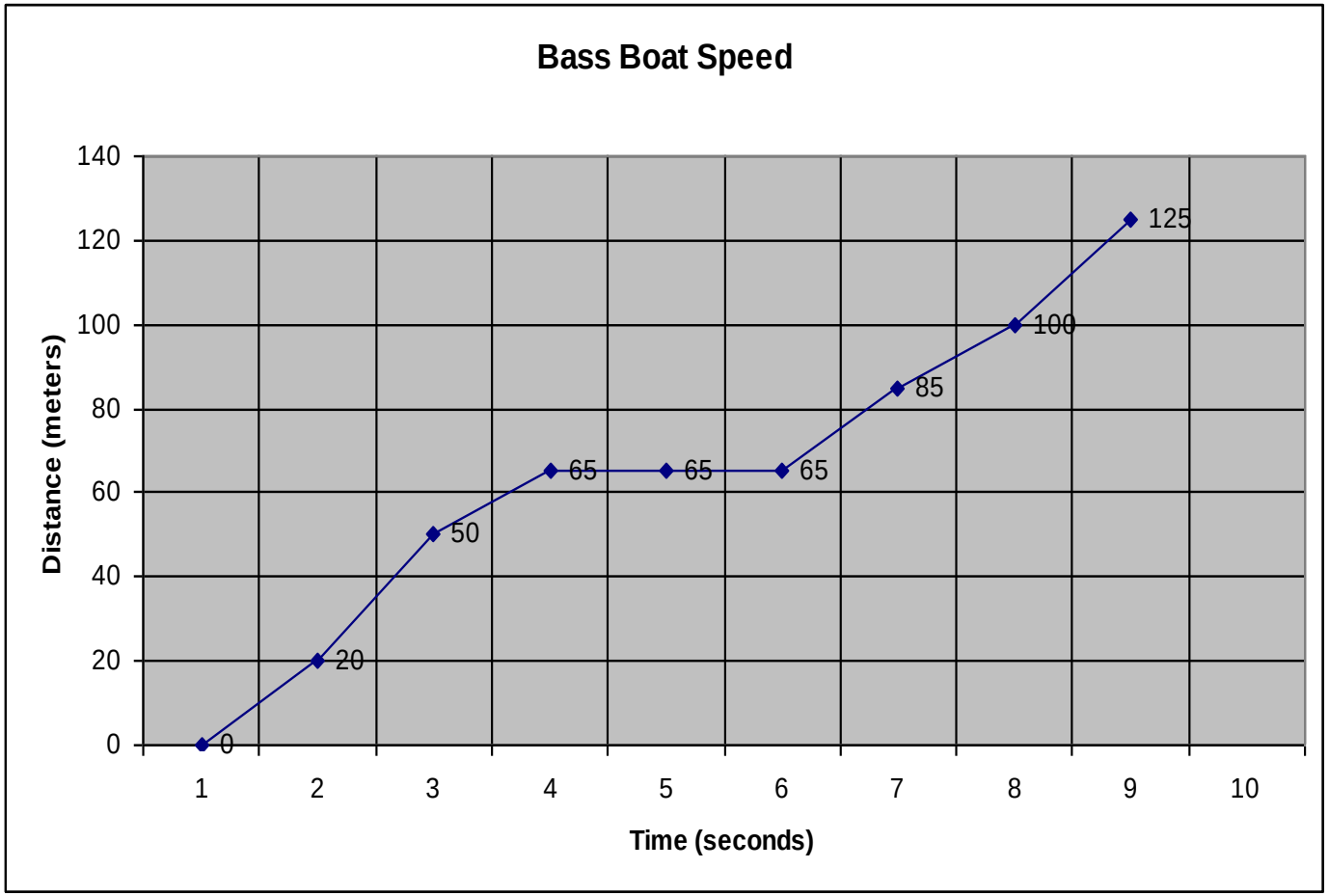
7 meters ÷ 10 seconds = 0.7 m/sec

Average Speed



What is the AVERAGE speed of the bass boat depicted in the graph?

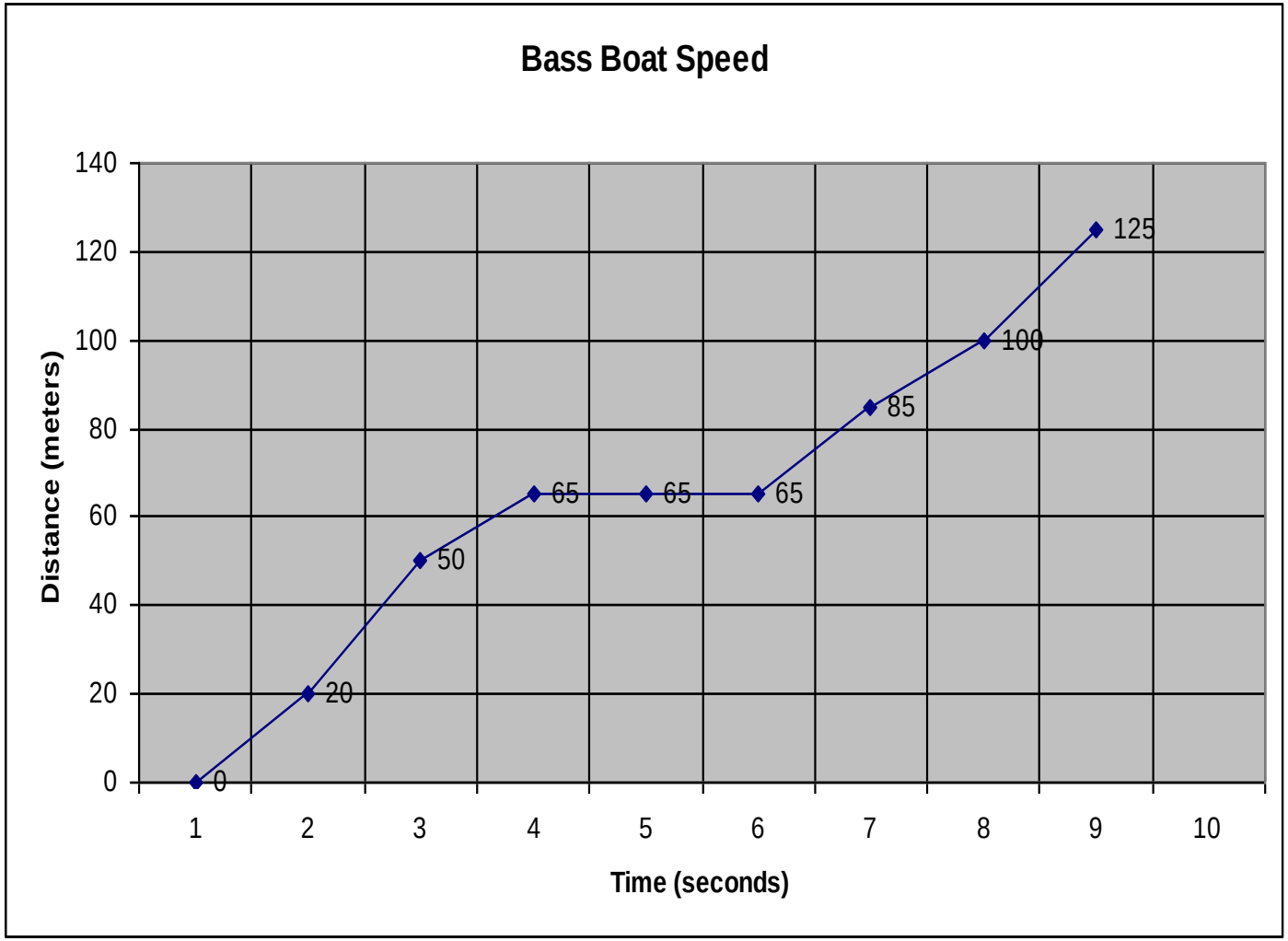
Average Speed



Average speed is taking the total distance traveled (0 to 125 meters), and dividing by the total time (1 to 9 seconds) it takes.

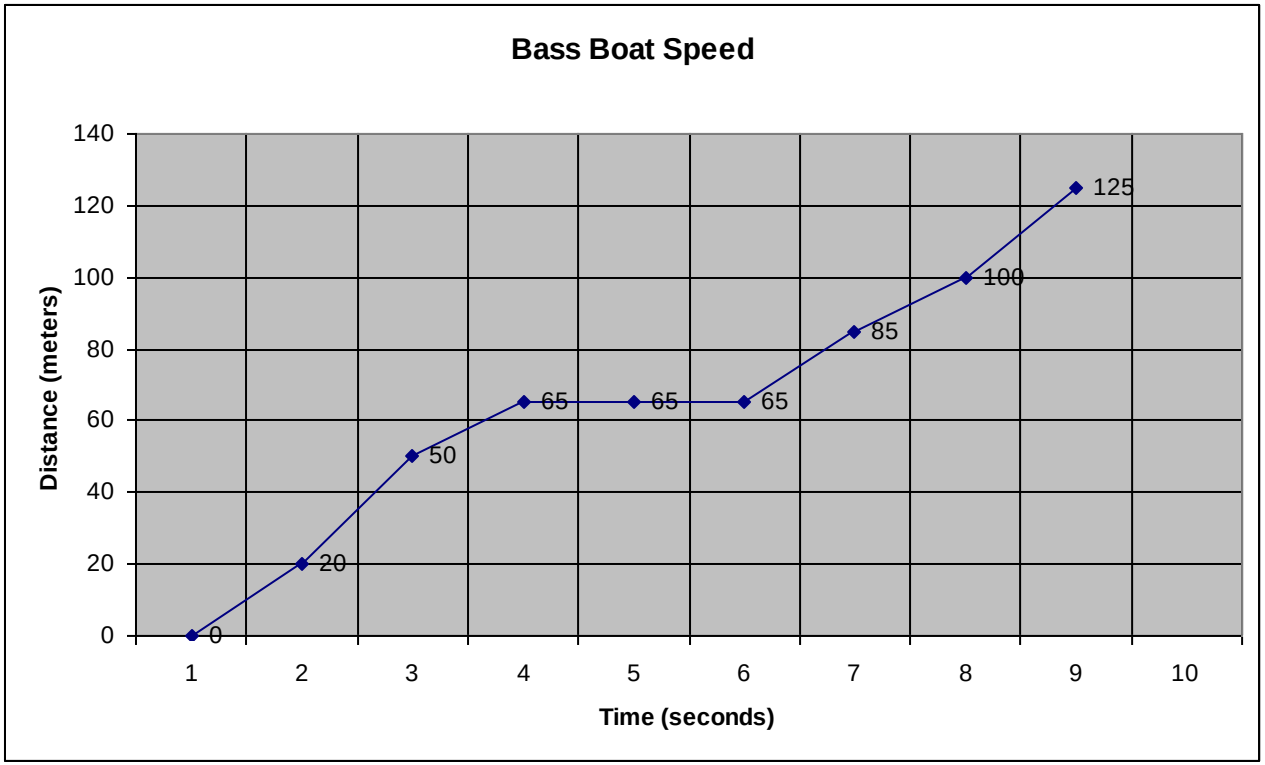
$$\text{Average Speed} = \frac{125 \text{ meters}}{8 \text{ seconds}} = 15.6 \text{ m/s}$$

Instantaneous Speed



What is the instantaneous speed of the bass boat at t=7 seconds?

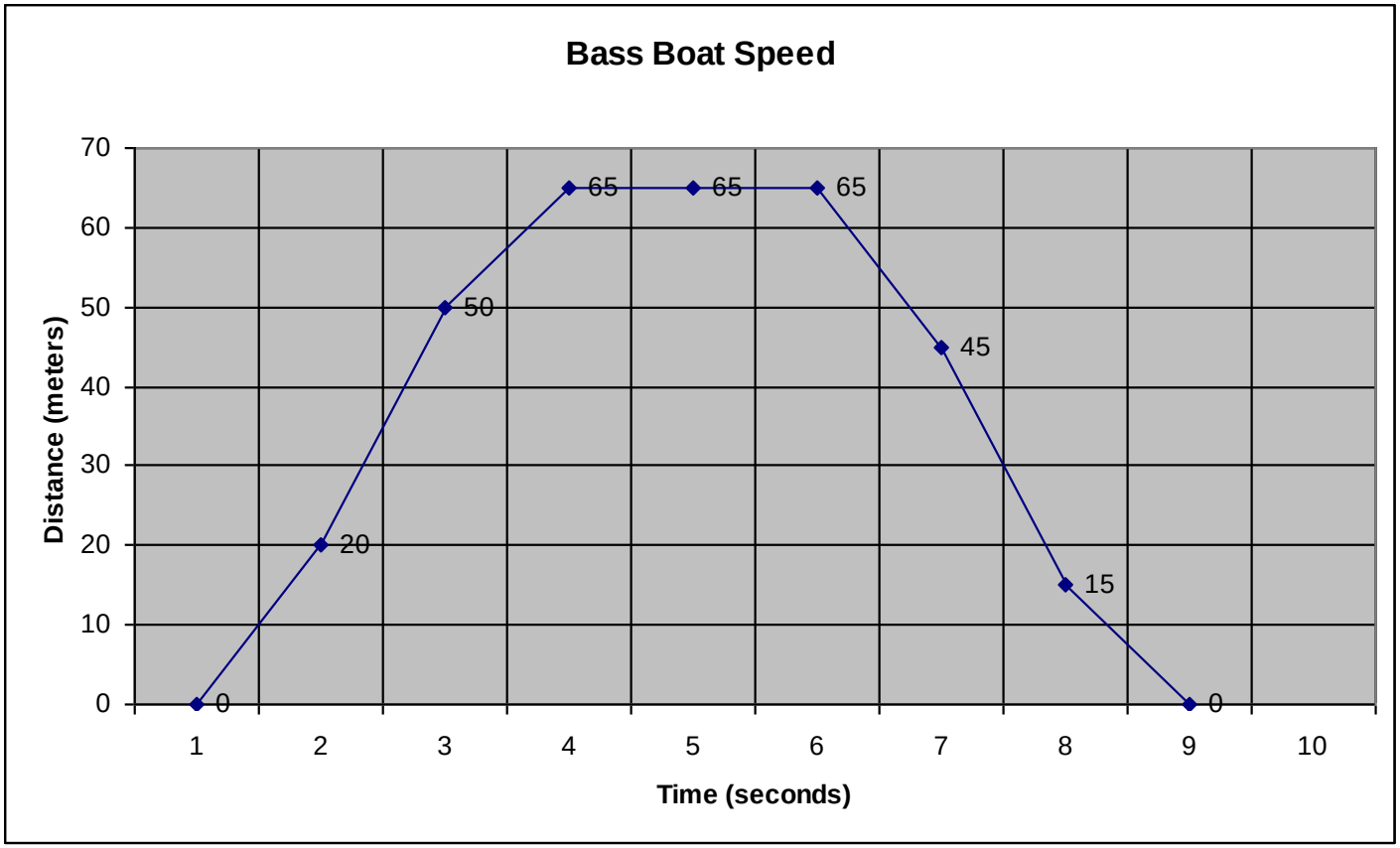
Instantaneous Speed



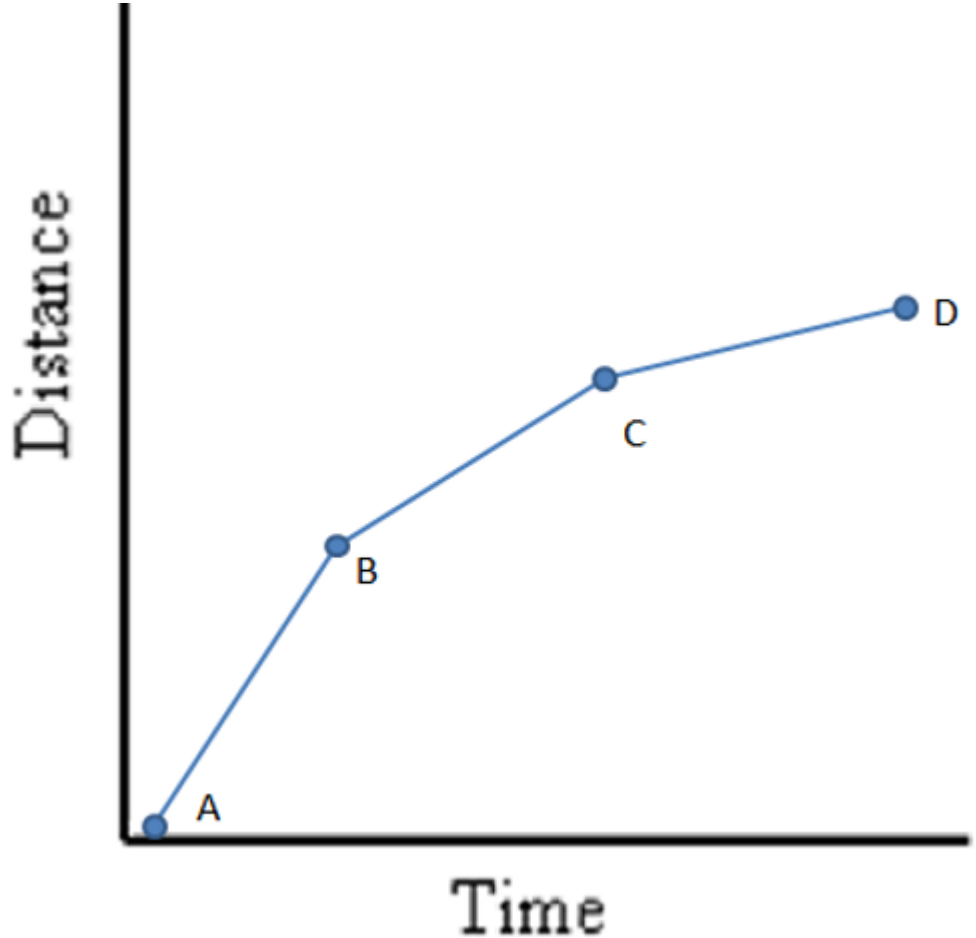
Instantaneous speed is speed at any given point in time. At 7 seconds, the distance is 85 meters; therefore the Int. speed is?

Instantaneous Speed = $\frac{\text{85 meters}}{\text{7 seconds}}$ = 12.1 m/s

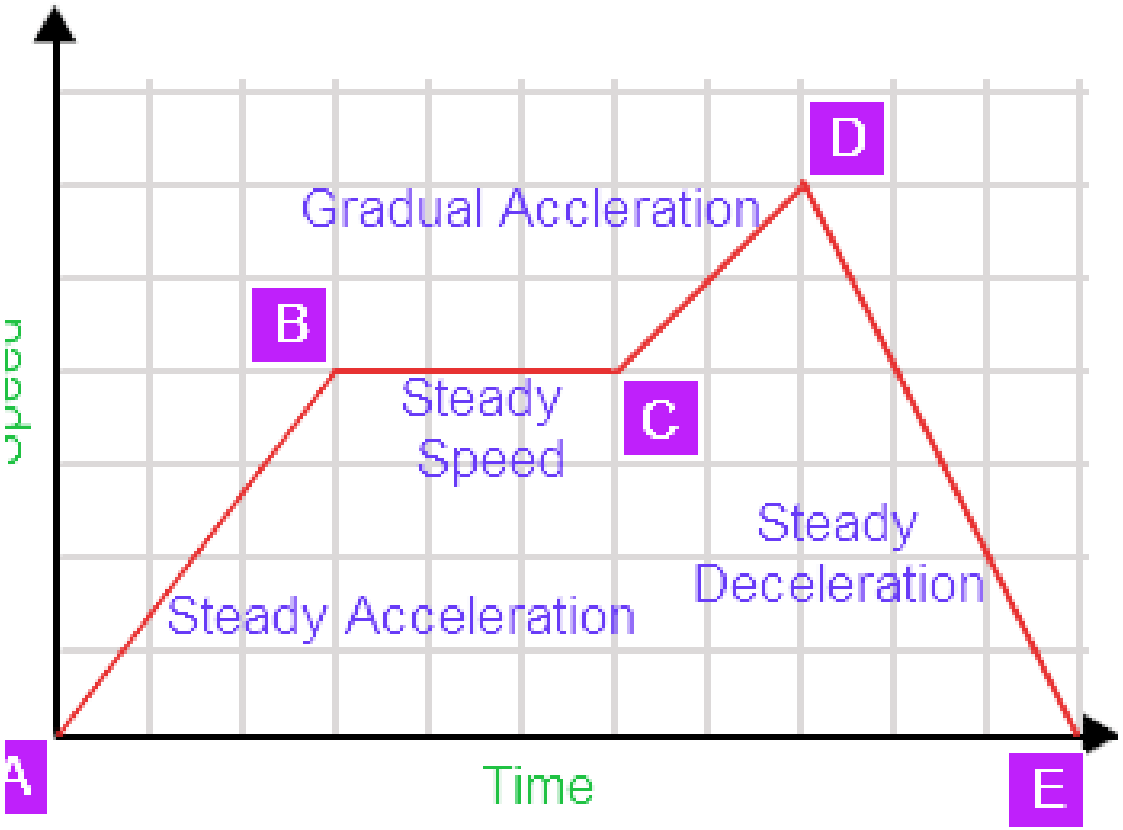
Speed Graphs

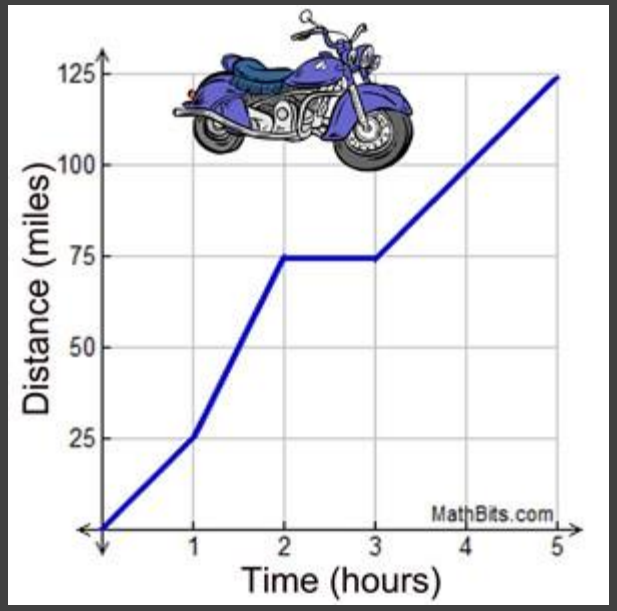


- In what time period is the bass boat speeding up?
- In what time period is the bass boat slowing down?
- When is the speed NOT changing?



Distance-Time Graphing





Distance-Time Graphing

Velocity & Acceleration

How are velocity and acceleration related to everyday life?

All matter in the universe is constantly in motion.

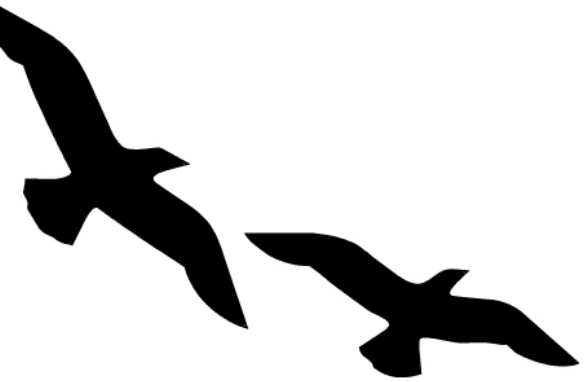
Turn to an elbow partner and describe an example of something in motion. Then, describe something that is in motion that we cannot see in motion.

How can the motion of objects be described?

Usually, we describe the motion of an object based on how fast the object is moving. What term would you use to describe how fast an object is moving?

SPEED

Is there another way we can describe the motion of objects?



Imagine that two birds leave the same tree at the same time. They both fly at 10 km/h for 5 minutes.

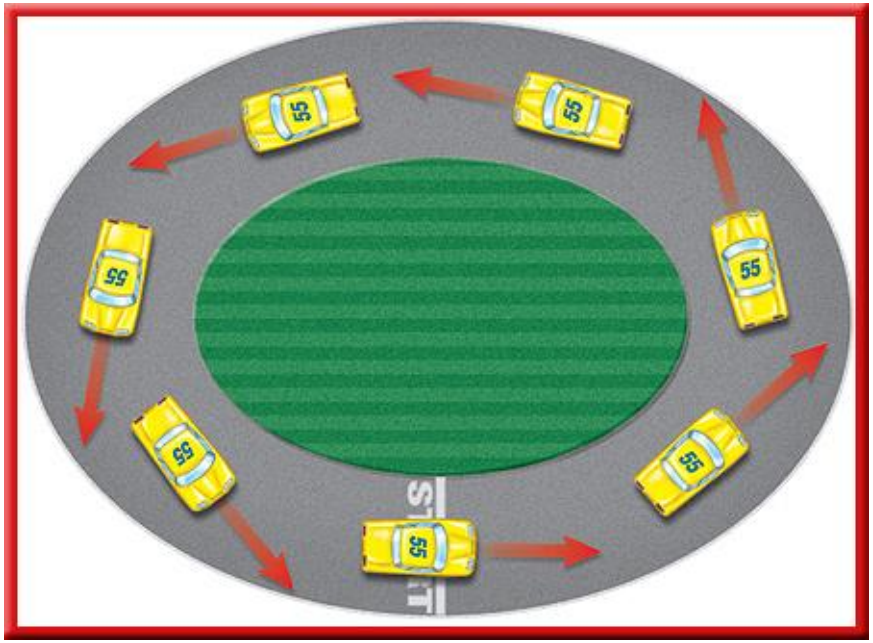
Why don’t they end up at the same place?

The birds went in different directions. Their speeds were the same, but they had different velocities.

Imagine you were visiting Clissold Park. A friend stopped by the park to spend the day with you. If you were at the Lodge House and your friend was coming in the Robinson Crusoe Gate, how would you give him/her directions? How would you know what time he/she might reach you?

You would use both direction and speed.

Velocity is the speed of an object in a particular direction.



The speed of these cars may be similar, but the velocity of the cars differ because the cars are going in different directions.

Speed Vs. Velocity

- Speed and Velocity both measure how fast an object is going
- Speed and Velocity are both measured in the same unit: meters/second (m/s)
- Velocity includes the direction of the motion, but Speed does not include direction.

Speed Vs. Velocity

With an elbow partner, read the following statements and determine whether they are examples of speed or velocity.

- **The plane is traveling 600 km/h (larger units)**
- **The bus is traveling 20 m/s south**
- **The bicycle is moving 3 m/s north**
- **The jogger is running 1 m/s**

Changing Velocity

- The velocity of an object can change if the object's speed changes, its direction changes, or they both change.
- If an object's speed and direction do not change, the object's velocity is said to be constant.
- Therefore, constant velocity is always motion along a straight line.

Suppose a car is traveling at a speed of 40 km/h north and then turns left at an intersection and continues on with a speed of 40 km/h. At what point did the velocity change?

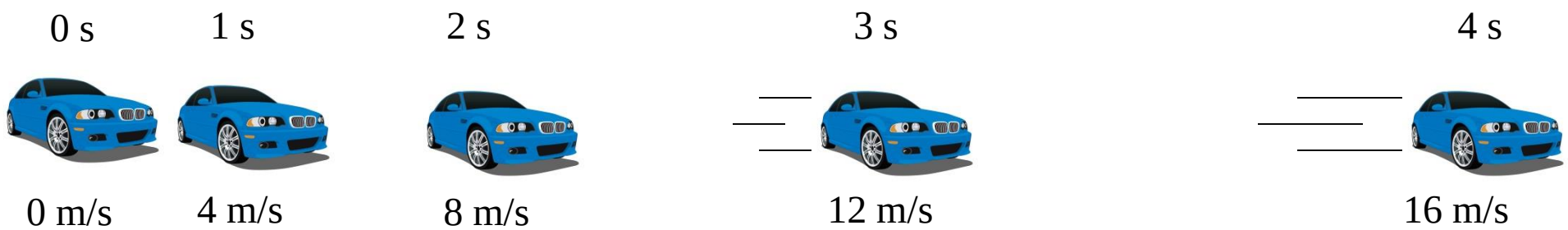
The speed of the car is constant at 40 km/h, but the velocity changes from 40 km/h north to 40 km/h west when the car turns.

With an elbow partner, read the scenario below. Identify the point(s) when velocity changes.

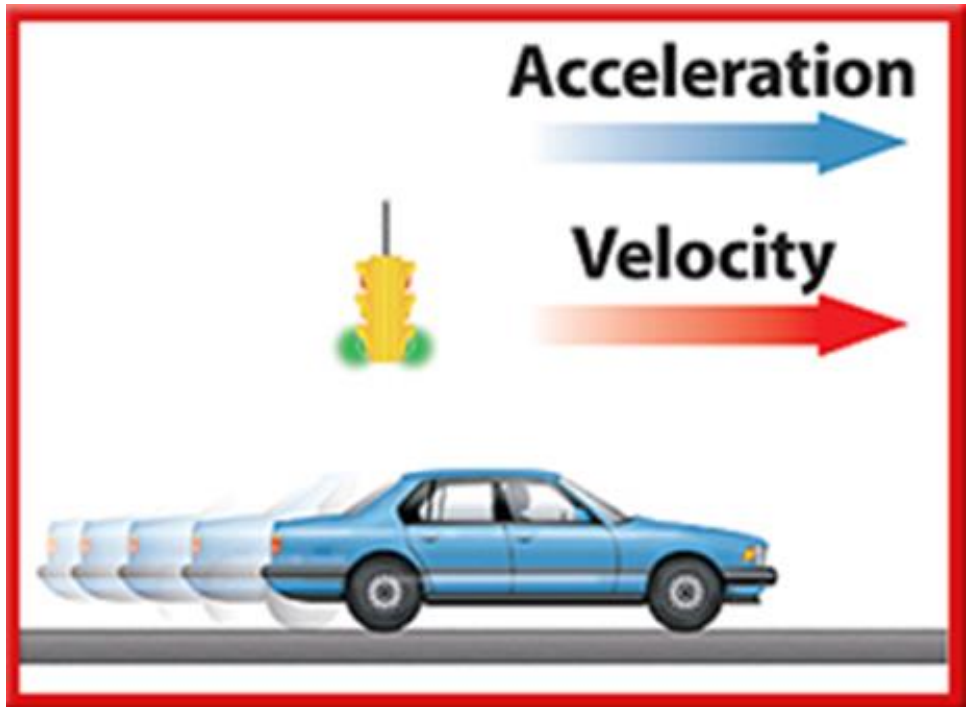
A bus traveling at 15 m/s south speeds up to 20 m/s south. The bus continues to travel at the same speed but changes direction to travel east. The bus slows down and swerves north to avoid a cat.

Acceleration is <u>the rate at which velocity changes</u>. So, an object accelerates if its speed, its direction, or both changes (unit is m/s^2).

Acceleration

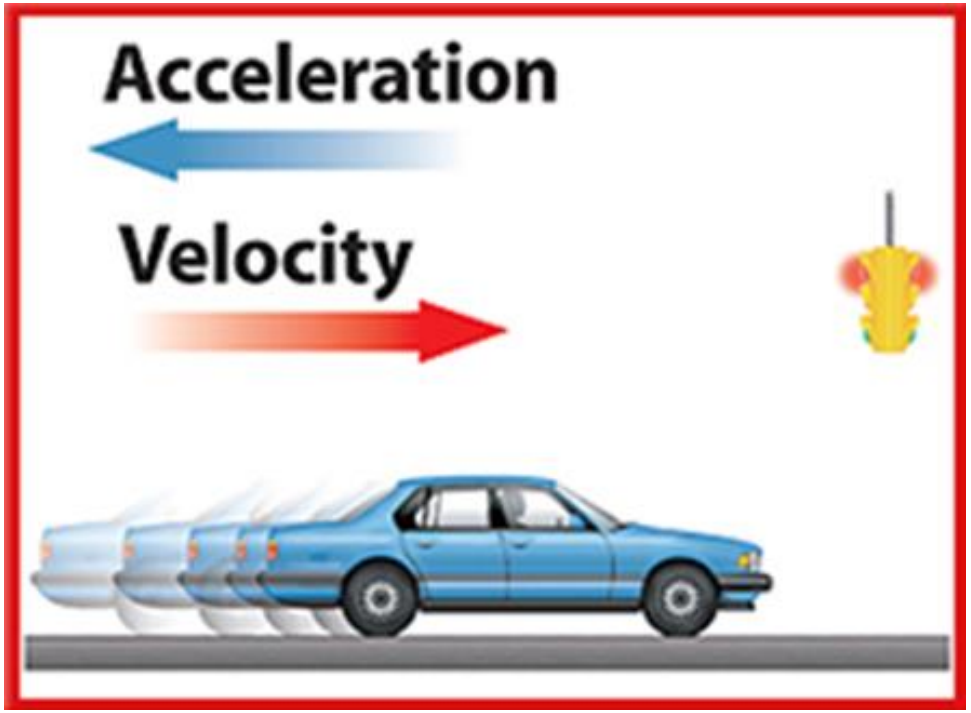


An increase in velocity is commonly called positive acceleration.

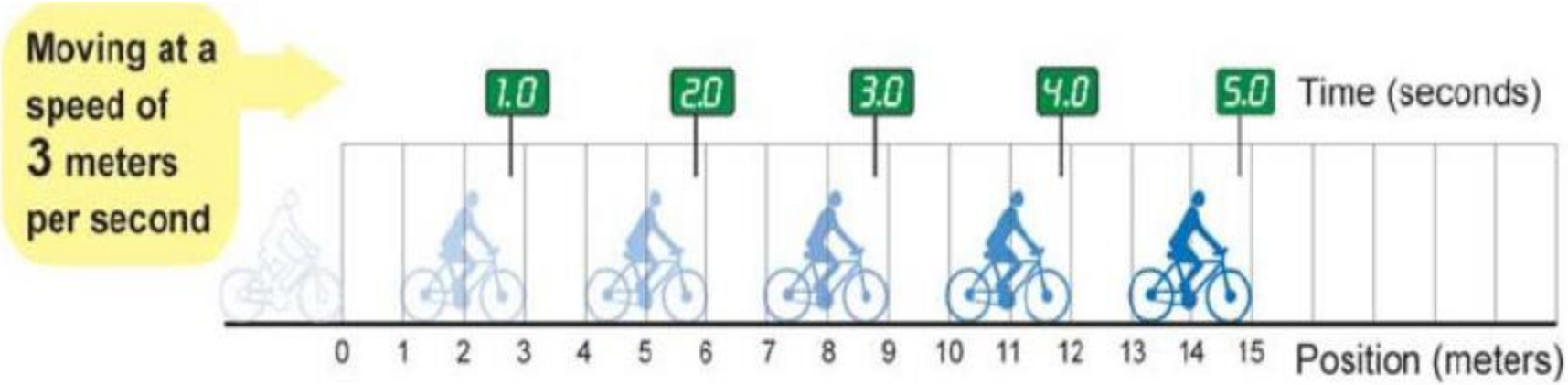


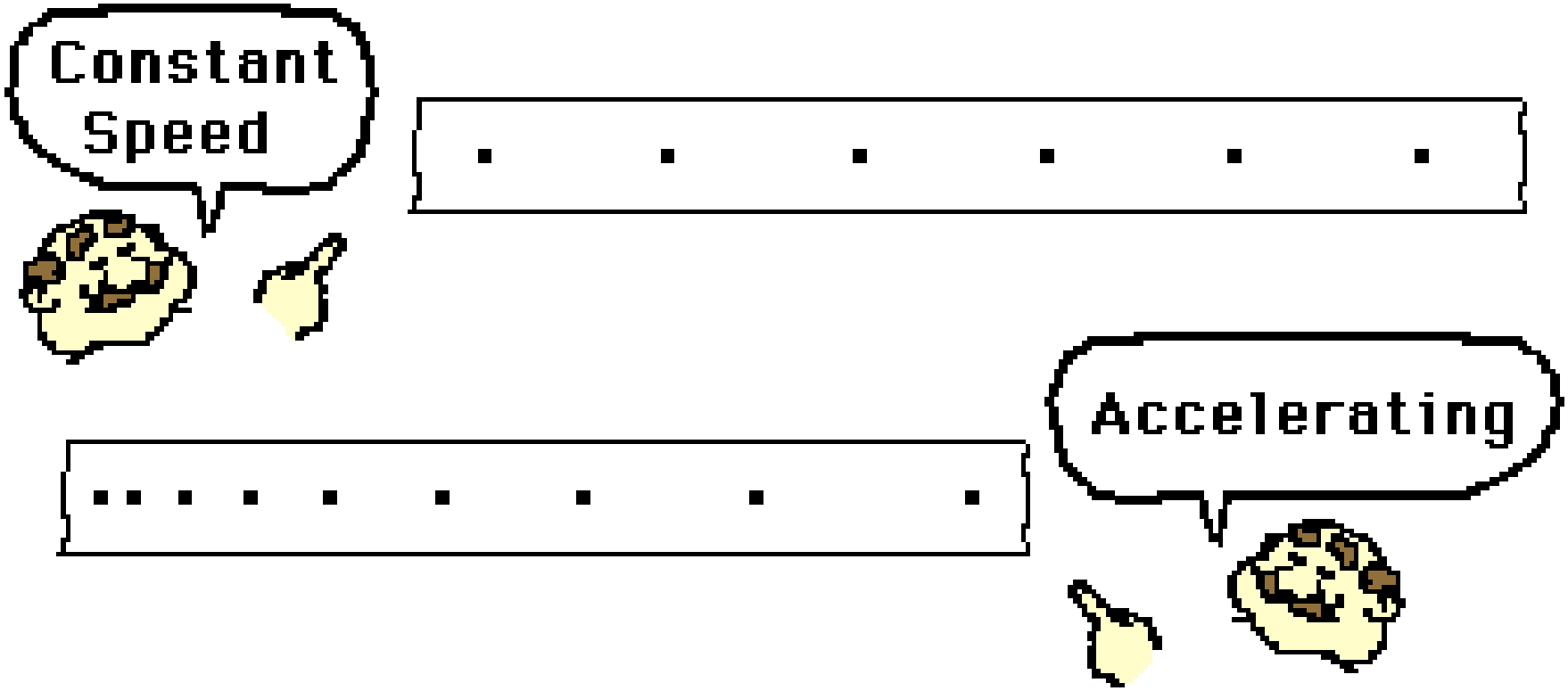
A decrease in velocity is commonly called negative acceleration, or deceleration.

When might deceleration occur?



When an object's velocity is at a constant speed (no change in speed or direction), the object has zero acceleration.




Constant Speed
Accelerating

Acceleration

With an elbow partner, discuss whether or not acceleration occurred and why in the situations below:

- **You are riding your bike at 9 km/h. Ten minutes later, your speed is 6 km/h.**
- **You ride your bike around the block at a constant speed of 11 km/h.**
- **You ride your bike in a straight line at a constant speed of 10 km/h.**

Acceleration

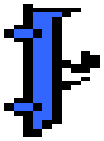
- You are riding your bike at 9 km/h. Ten minutes later, your speed is 6 km/h.
- You ride your bike around the block at a constant speed of 11 km/h.
- You ride your bike in a straight line at a constant speed of 10 km/h.

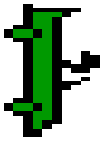
- Observe the animation of the three cars on the next screen.

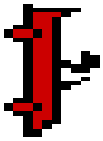
- Study each car individually in order t determine the answer.

- If necessary, review the definition of acceleration.

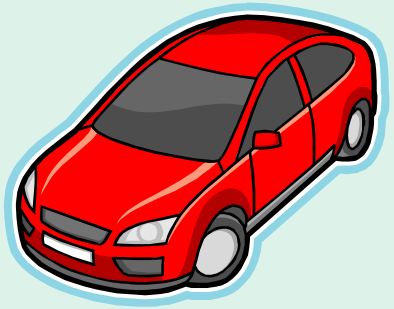
- Which car or cars (red, green, and/or blue) are undergoing an acceleration?

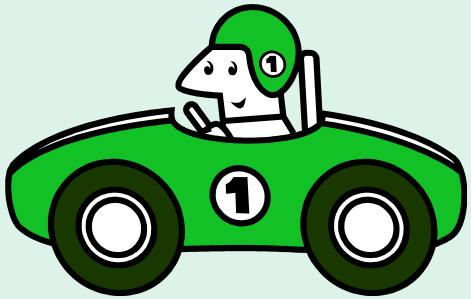


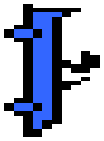


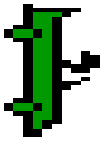


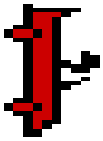
Now that you've answered the first question correctly, try this one: which car (red, green, or blue) experiences the greatest acceleration?







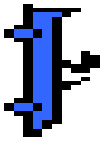


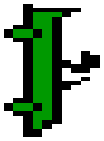


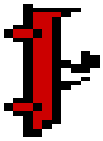
- As a final test of your understanding, consider the position-time graph on the next screen.

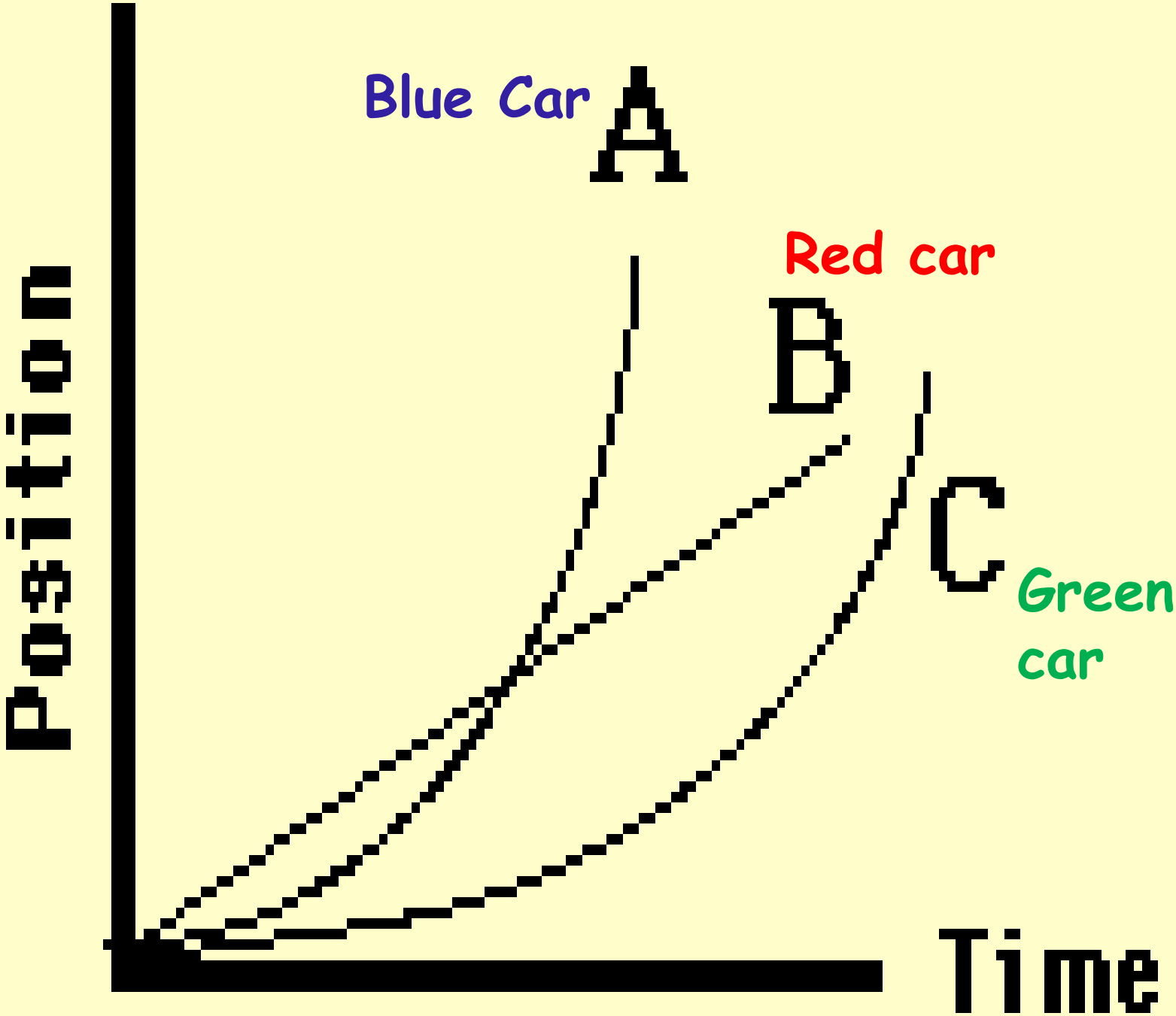
- Each one of the three lines on the position-time graph corresponds to the motion of one of the three cars.

- Match the appropriate line to the particular color of car.








Blue Car
A
Red car
B
C
Green car
Position
Time

Acceleration depends on both change in velocity and the time interval.

- Time interval is the amount of time that passed while the change in velocity was taking place.

$$a = \frac{V_f - V_i}{t}$$

a = acceleration
Vf = final velocity
Vi = initial velocity
t = time

Units will be m/s/s OR m/s^2

Acceleration Math Problem

- A jet starts at rest at the end of a runway and reaches a speed of 80 m/s in 20 s. What is its acceleration?

Acceleration Math Problem

- A jet starts at rest at the end of a runway and reaches a speed of 80 m/s in 20 s. What is its acceleration?

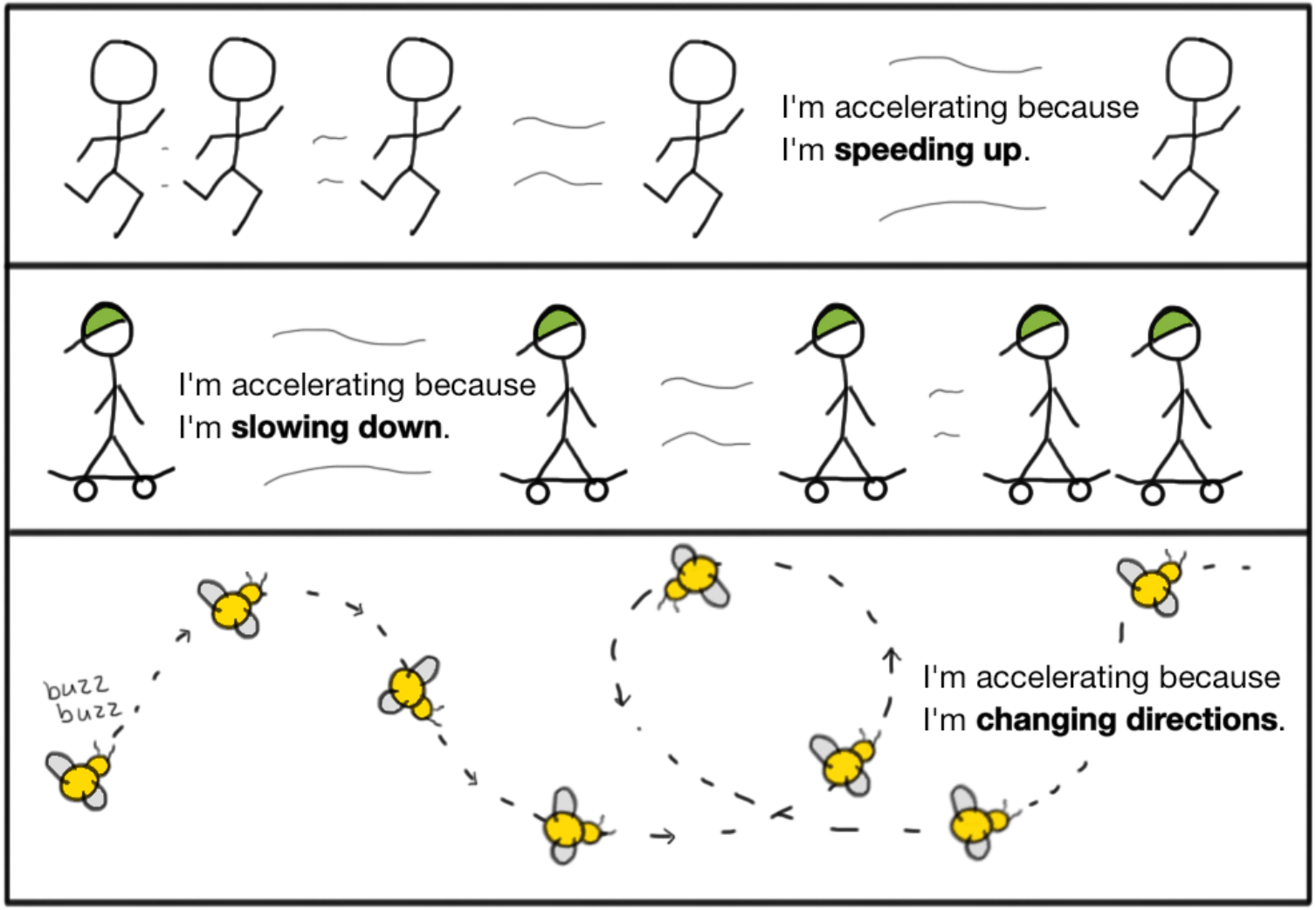
- Acceleration (a) = $\frac{\text{final velocity } (v_f) - \text{initial velocity } (v_i)}{\text{time (sec)}}$

- $a = \frac{80 \text{ m/s} - 0 \text{ m/s}}{20 \text{ sec}} = 4 \text{ m/s}^2$

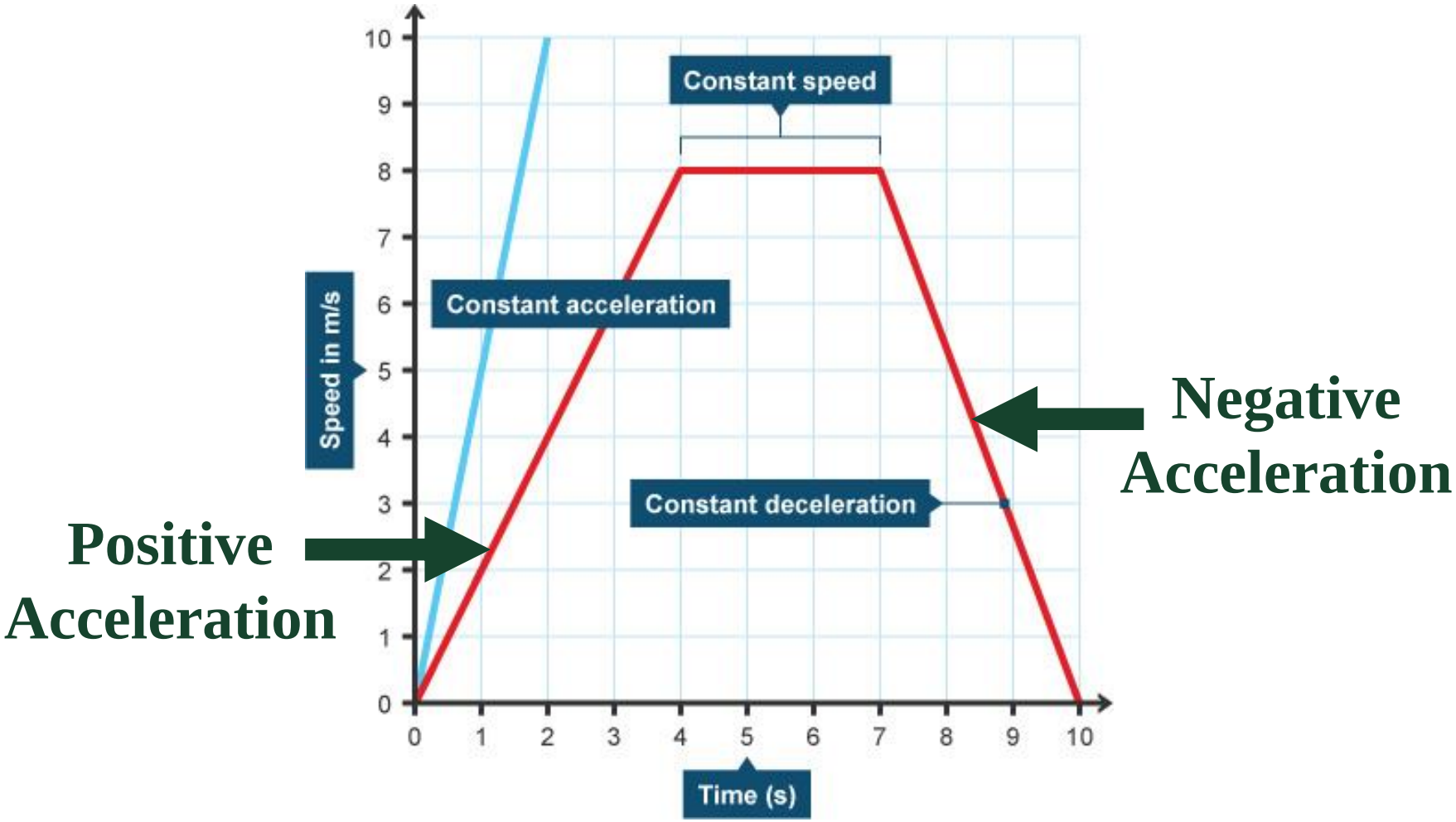
A skateboarder is moving in a straight line at a speed of 3 m/s and comes to a stop in 2 sec. What is his acceleration?

$$a = \frac{0\ m/s\ -\ 3\ m/s}{2\ m/s} = -1.5\ m/s^2$$

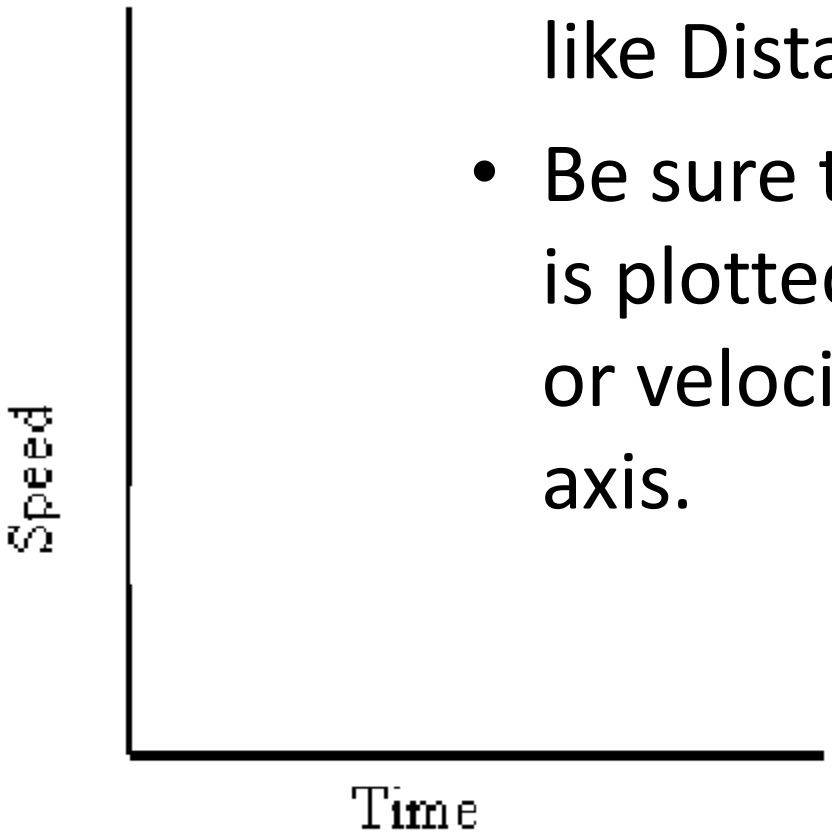
Acceleration Practice



A speed-time graph can be used to find acceleration.



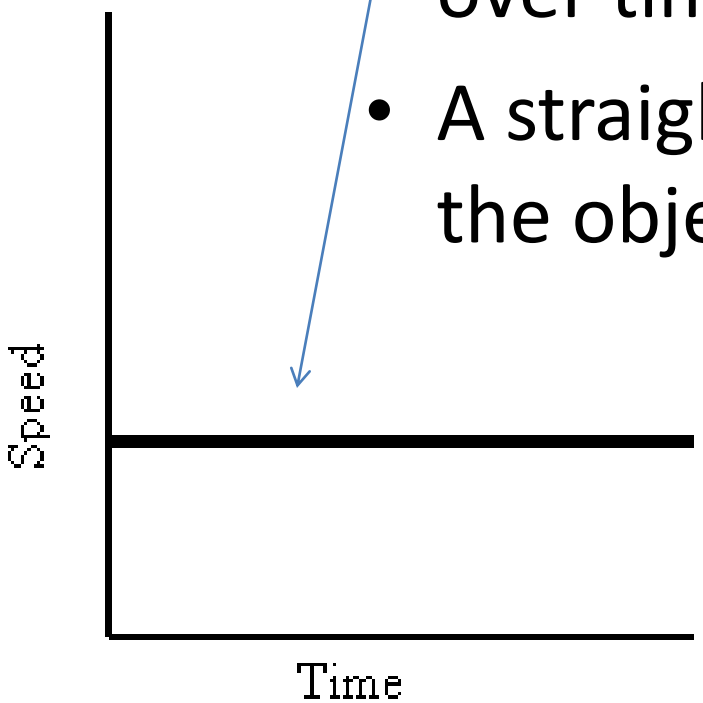
SPEED-TIME GRAPHS



- Speed-Time graphs look much like Distance- Time graphs.
- Be sure to read the labels!! Time is plotted on the X-axis. Speed or velocity is plotted on the Y-axis.

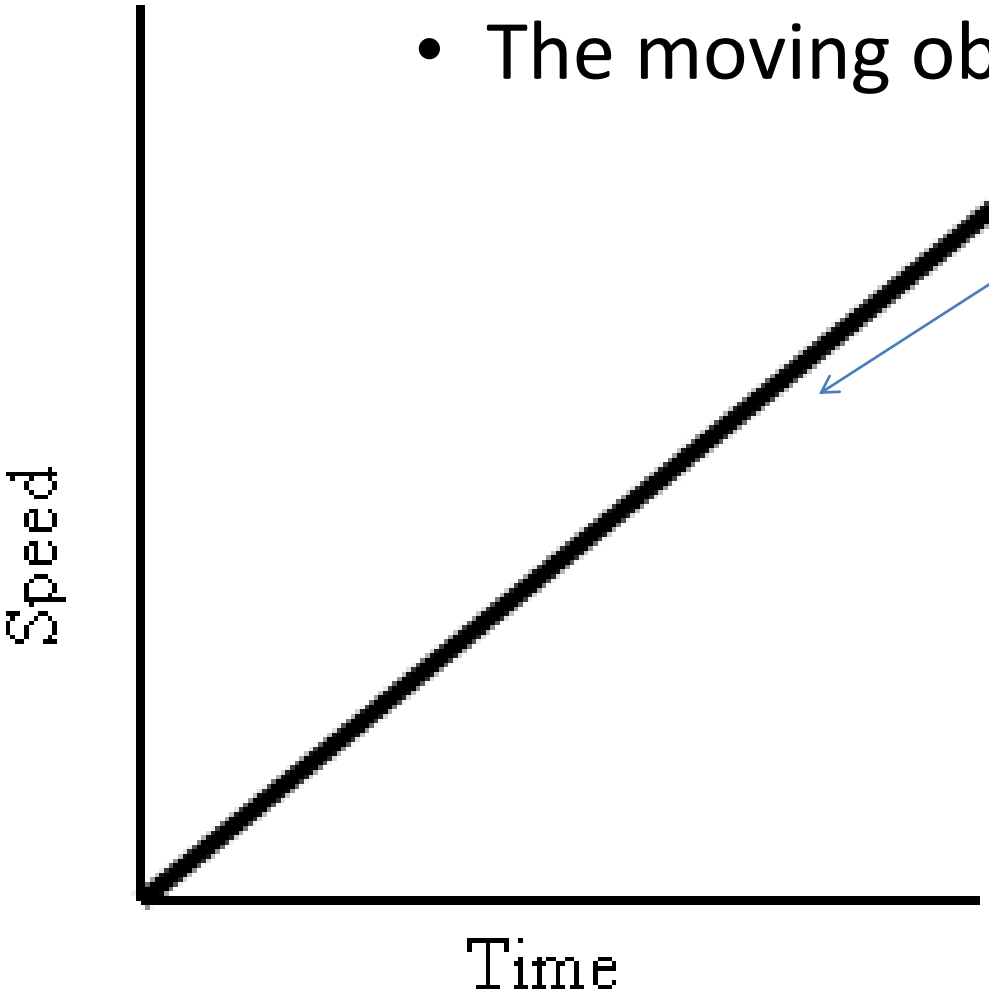
Constant Speed

- A straight horizontal line on a speed-time graph means that speed is constant. It is not changing over time.
- A straight line ***does not*** mean that the object is at rest!



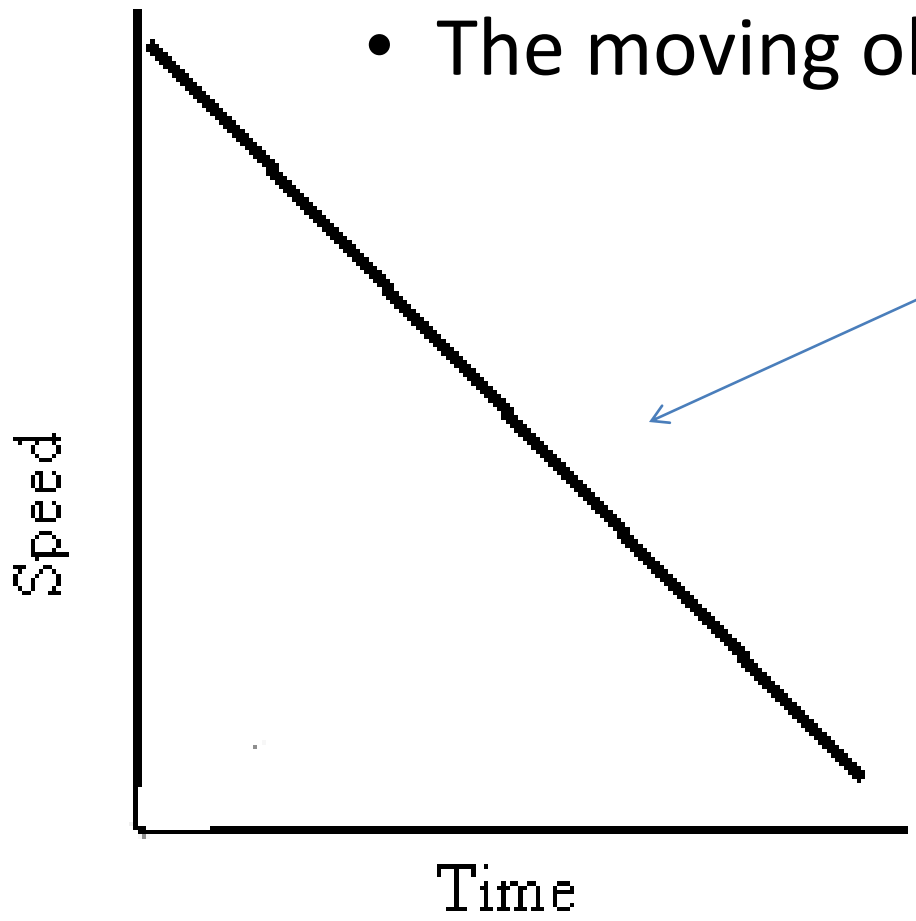
Constant acceleration

- This graph shows increasing speed.
- The moving object is **accelerating**

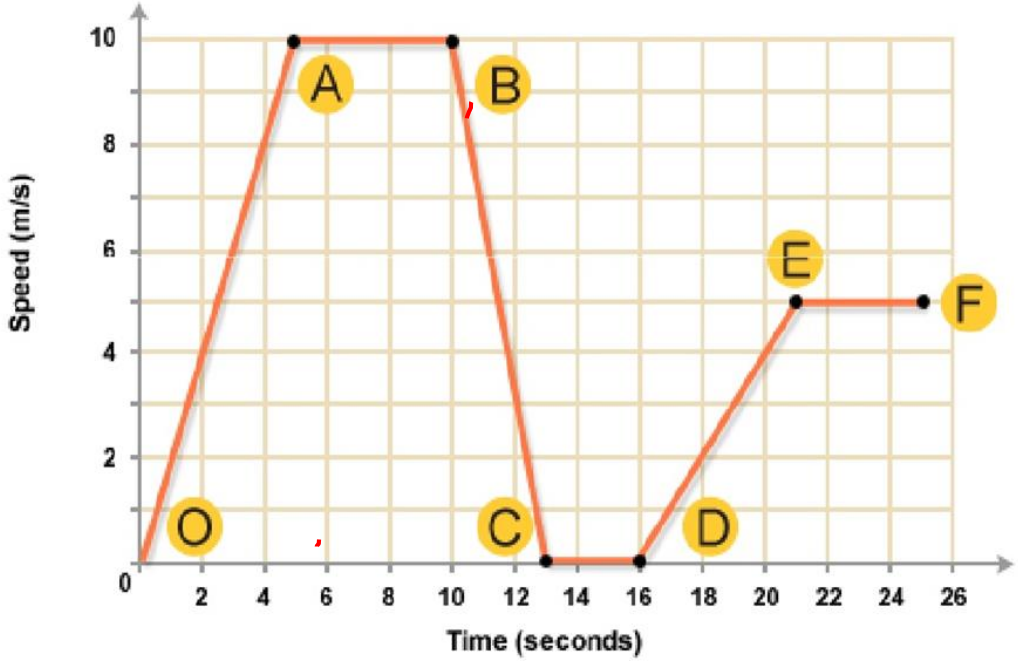


Deceleration

- This graph shows decreasing speed.
- The moving object is **decelerating**



Graphs represent speeds of objects. This graph shows a bus as it travels its route.



Between what points is the bus accelerating? _____ & _____

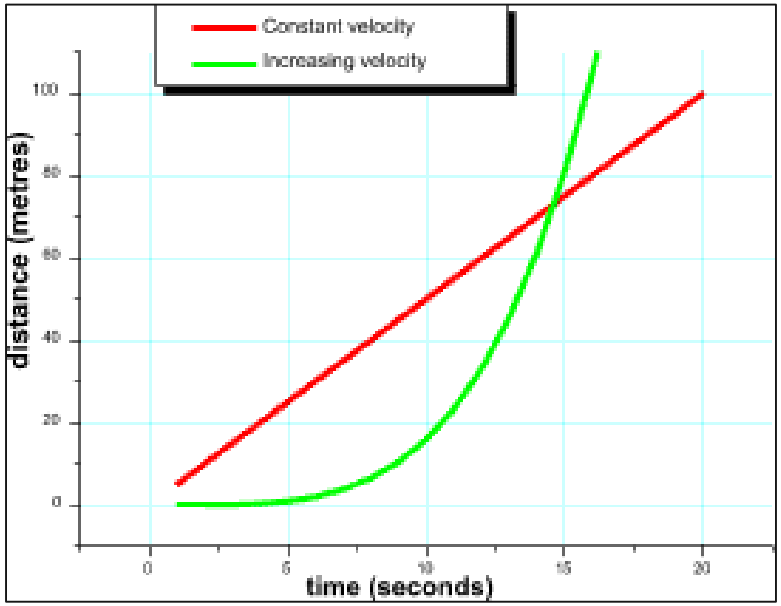
Between what points is the bus moving at a constant speed?

_____ & _____

Between what points is the bus stopped? _____

Between what points it the bus decelerating? _____

Other Examples



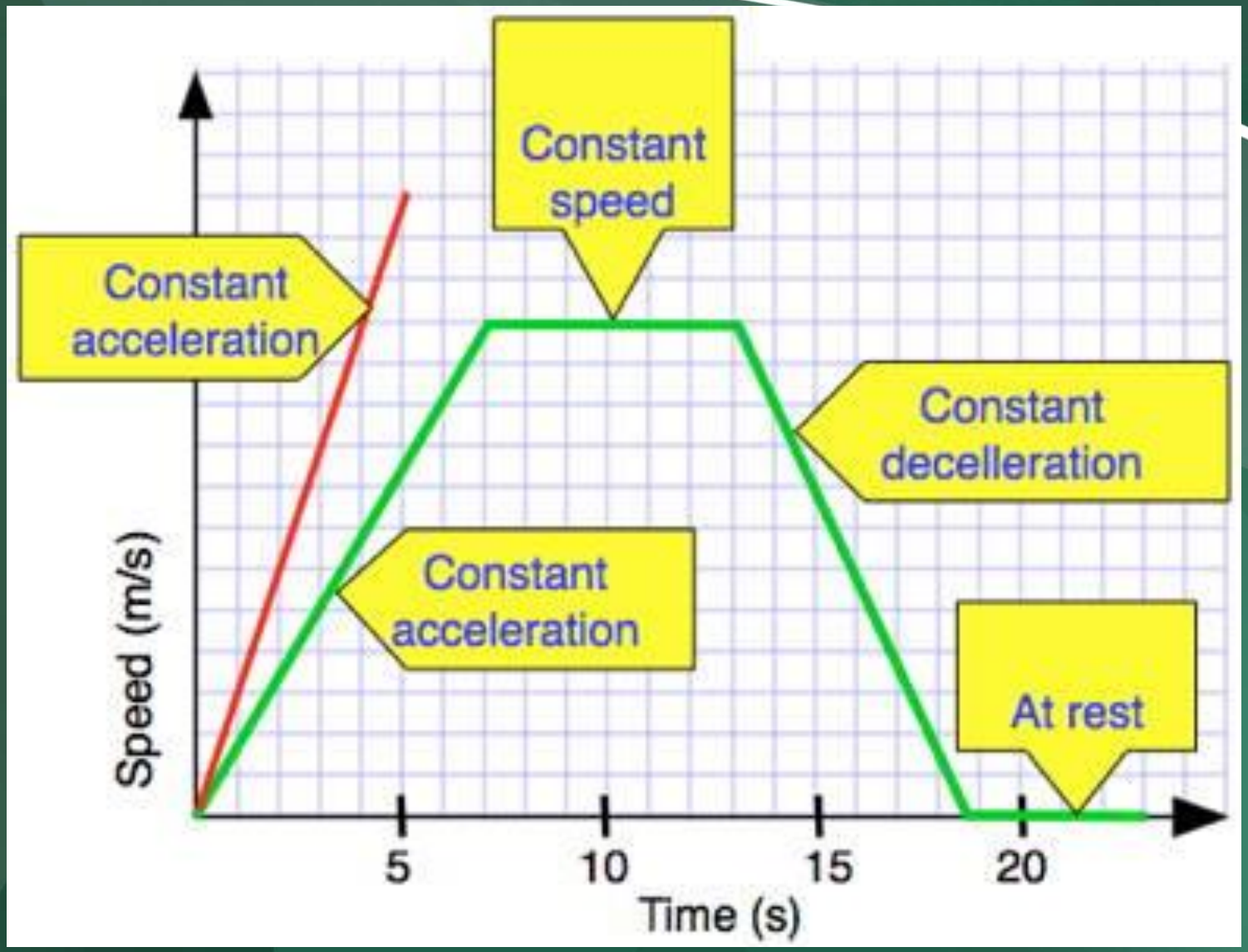
An object moving with a constant speed of 6 m/s

Time (s)	Position (m)
0	0
1	6
2	12
3	18
4	24

An object moving with a changing speed

Time (s)	Position (m)
0	0
1	1
2	4
3	9
4	16

Speed-time Graphing Activity



Speed-time Graphing Activity

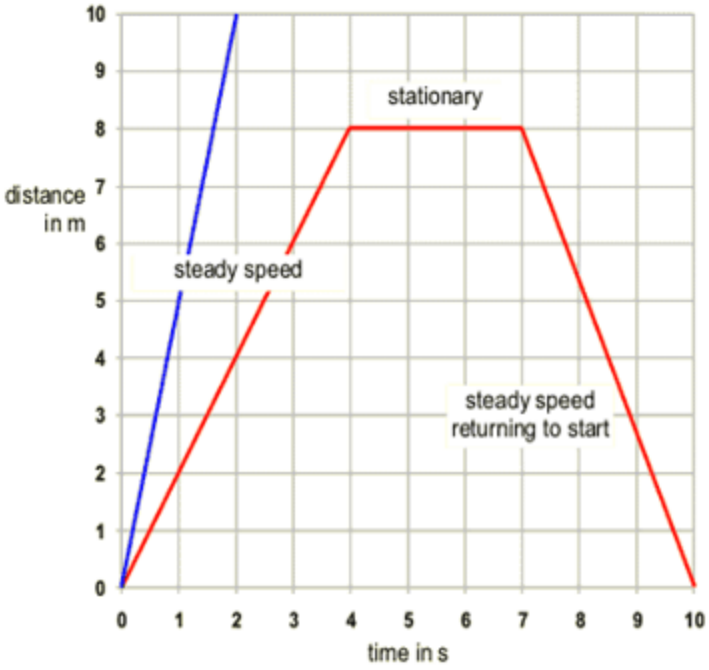
27 November, 2016

Speed – time graphs

LO: Learn how to interpret speed time graphs

Calculate:

1. The speed for the first part of the journey
2. The length of time stopped for
3. The speed for the last part of the journey



Acceleration is not only how much velocity changes, but also how fast velocity changes. The faster the velocity changes, the greater the acceleration.

What are some situations in which there would be faster changes in velocity?

How does the increase in an object's mass affect its acceleration?

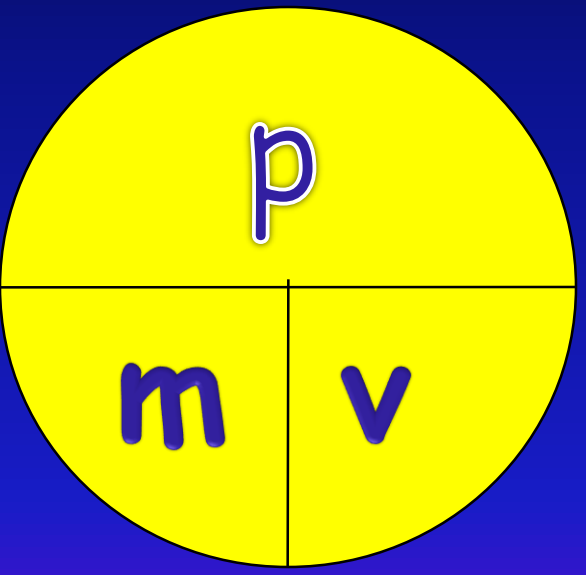
If an object's mass increases, then the acceleration of the object will decrease. Why?

MOMENTUM

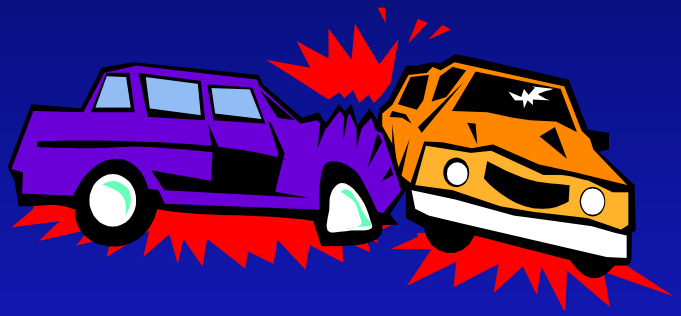
- If I were to roll a toy truck towards you, you could easily stop it.
- However, if I were to start a semi-truck rolling towards you at the same speed, it would be more difficult to stop even though they are rolling at the same speed. WHY?

Momentum is the property a moving object has due to its mass and velocity.

Formula for Momentum: $p = mv$



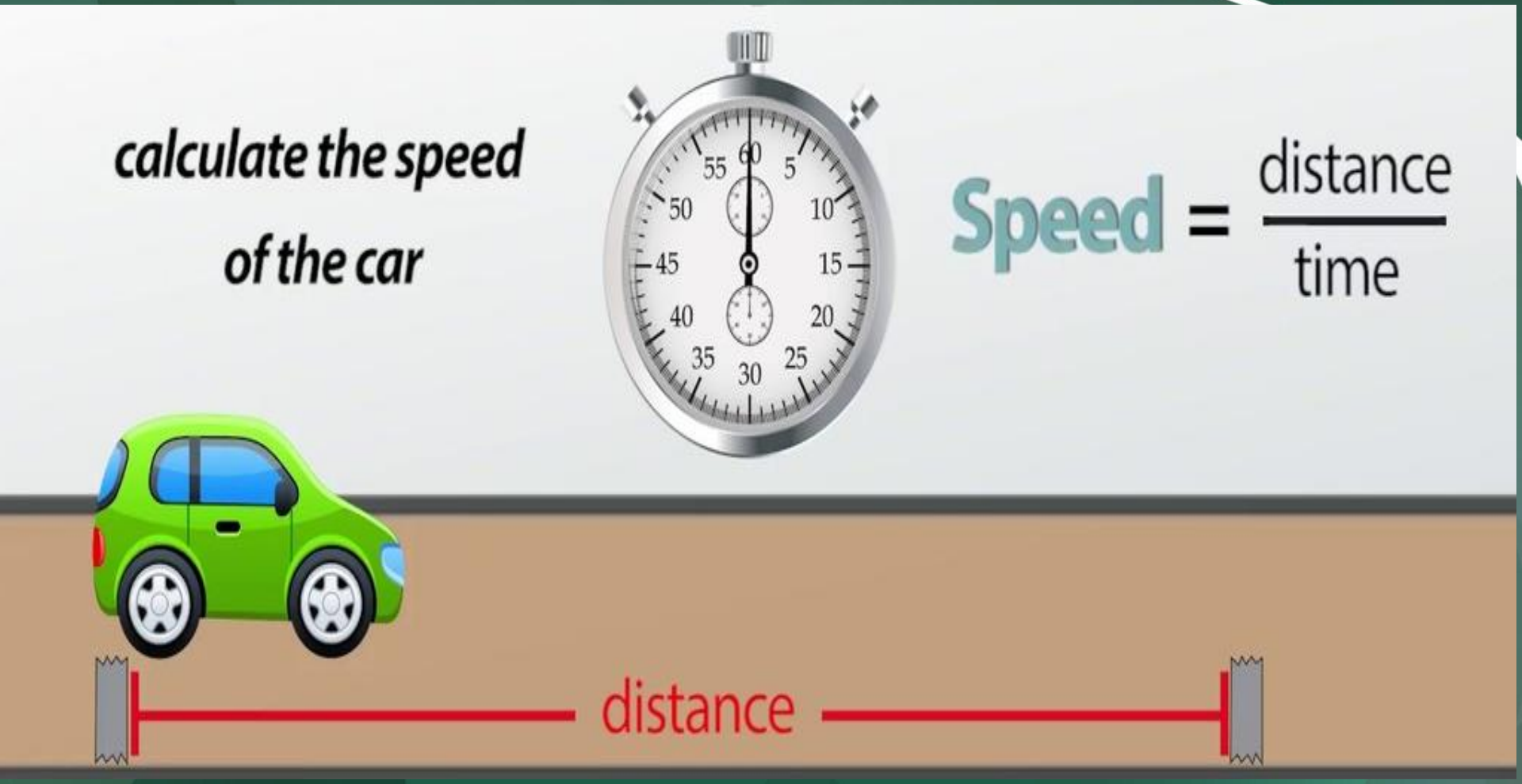
p = momentum
m = mass
v = velocity



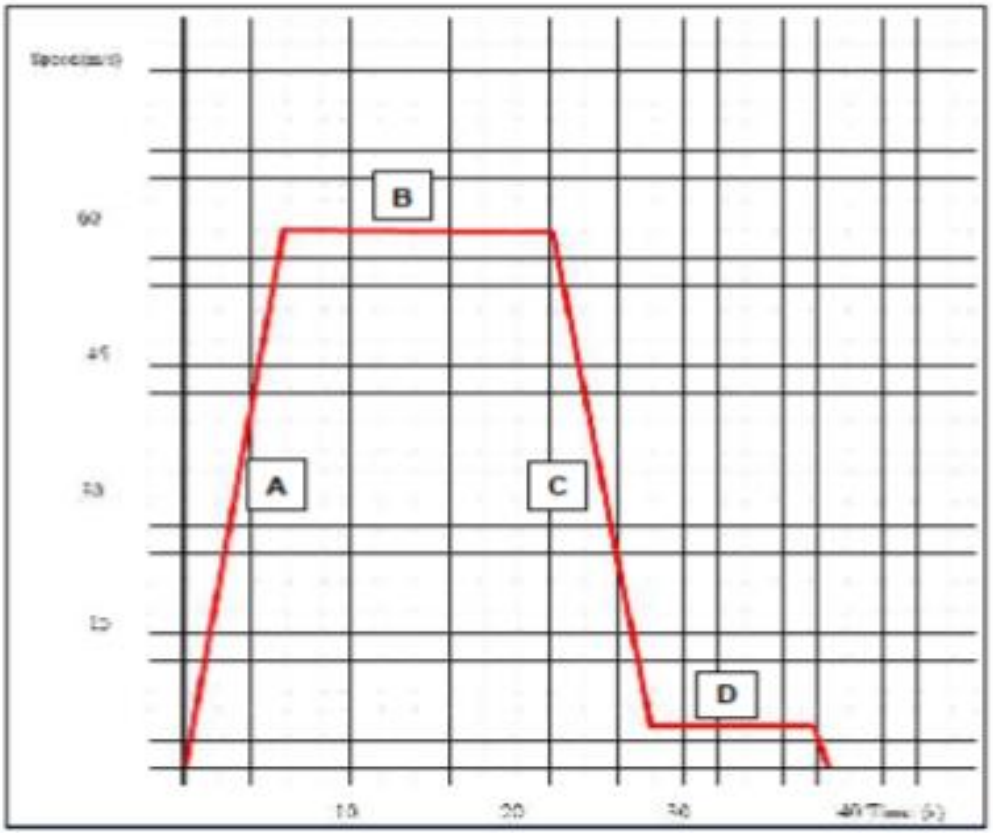
Momentum can be transferred from one object to another.
Ex: car crash or two pool balls

Units will be $\frac{kg \times m}{s}$ with direction

Velocity and Acceleration Lab Activity



Velocity and Acceleration Summarizer Name _____ Date _____



1. Identify the point(s) where velocity is changing.

2. Identify the point(s) of acceleration.

3. Identify the point(s) of positive acceleration.

4. Identify the point(s) of negative acceleration (deceleration).

5. Identify the point(s) of zero acceleration.

6. Write a short situation that the graph above could represent. For example, a bike, car, boat, plane, etc. traveling…