Motion; Speed; Velocity; Acceleration

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?**

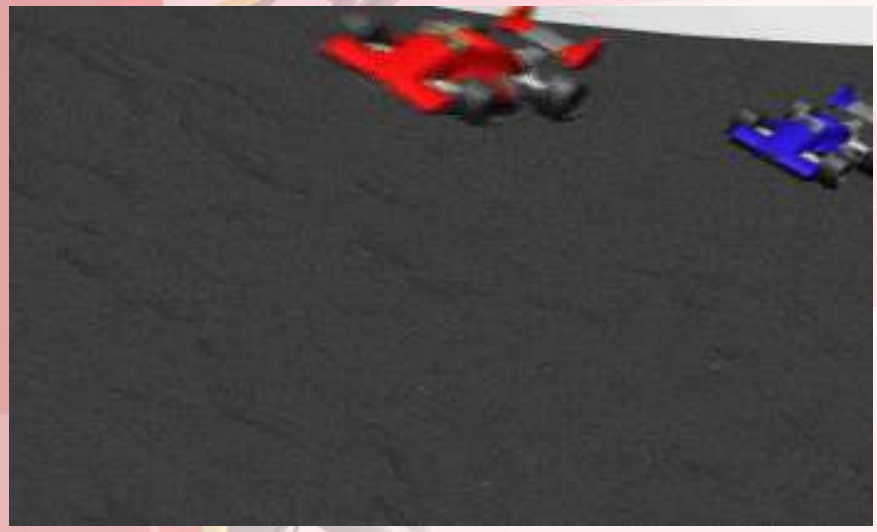
What Is Speed?

Speed is the distance an object travels in a certain amount of time.

To calculate speed, you use the following formula:

$$\text{Speed (s)} = \frac{\text{Distance (d)}}{\text{Time (t)}}$$

Speed Math Problem



Suppose you ran 2 km in 10 min. What is your speed?

$$S = \frac{2\ \text{km}}{10\ \text{min}} = 0.2\ \text{km/min}$$

Another Problem

What is the speed of a car traveling 144 km in 90 minutes per hour?

_____ km/h

In miles per hour? _____ mph

Solution

Km/hour:

How many hours are in 90 minutes? There are 60 minutes in 1 hour; therefore 90 minutes equals 1.5 hours

$$\frac{144 \text{ km}}{1.5 \text{ hours}} = 96 \text{ km/h}$$

Miles per hour:

How many km are in a mile? 1 km = 0.621 miles; therefore 144 km = 89.424 miles

$$\frac{89.424 \text{ miles}}{1.5 \text{ hours}} = 59.616 \text{ mpg or } 59.6 \text{ mpg}$$

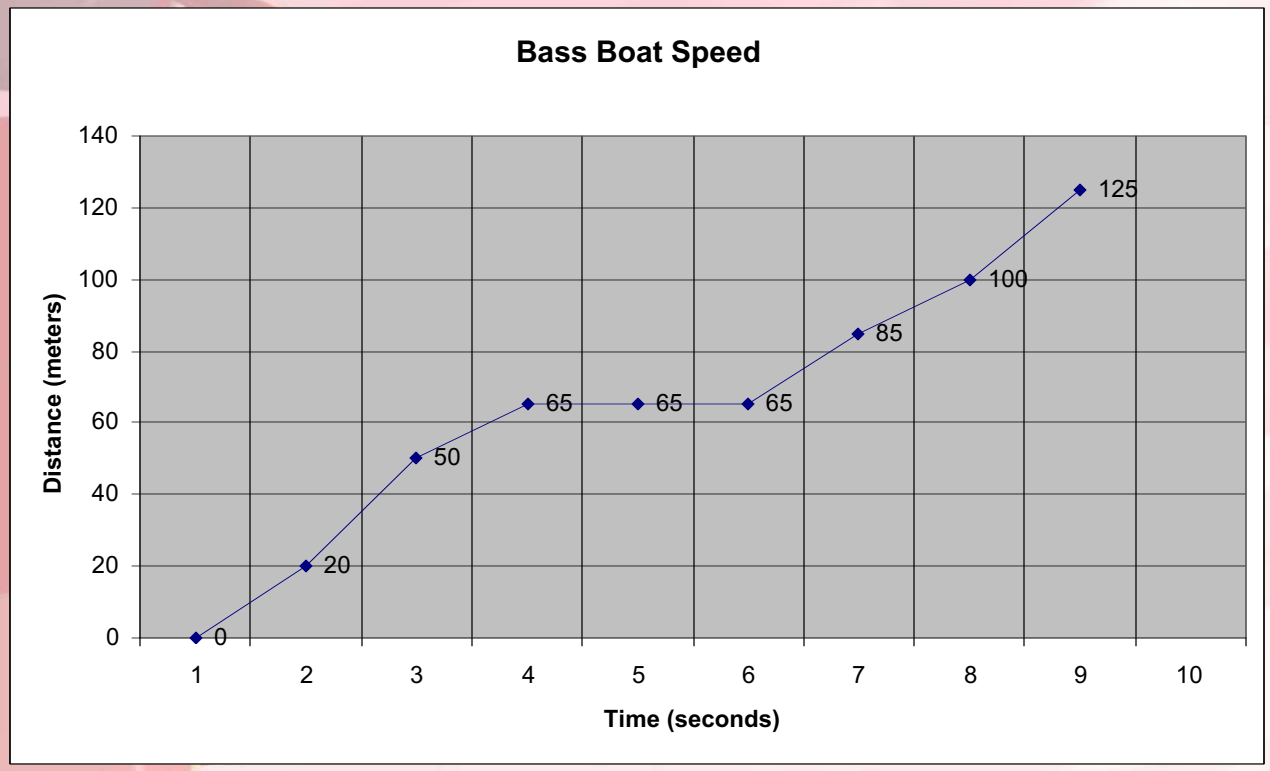
Ways To Calculate Speed

Constant speed is when you are traveling at the same rate of speed, such as 55 mph constantly on a highway.

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

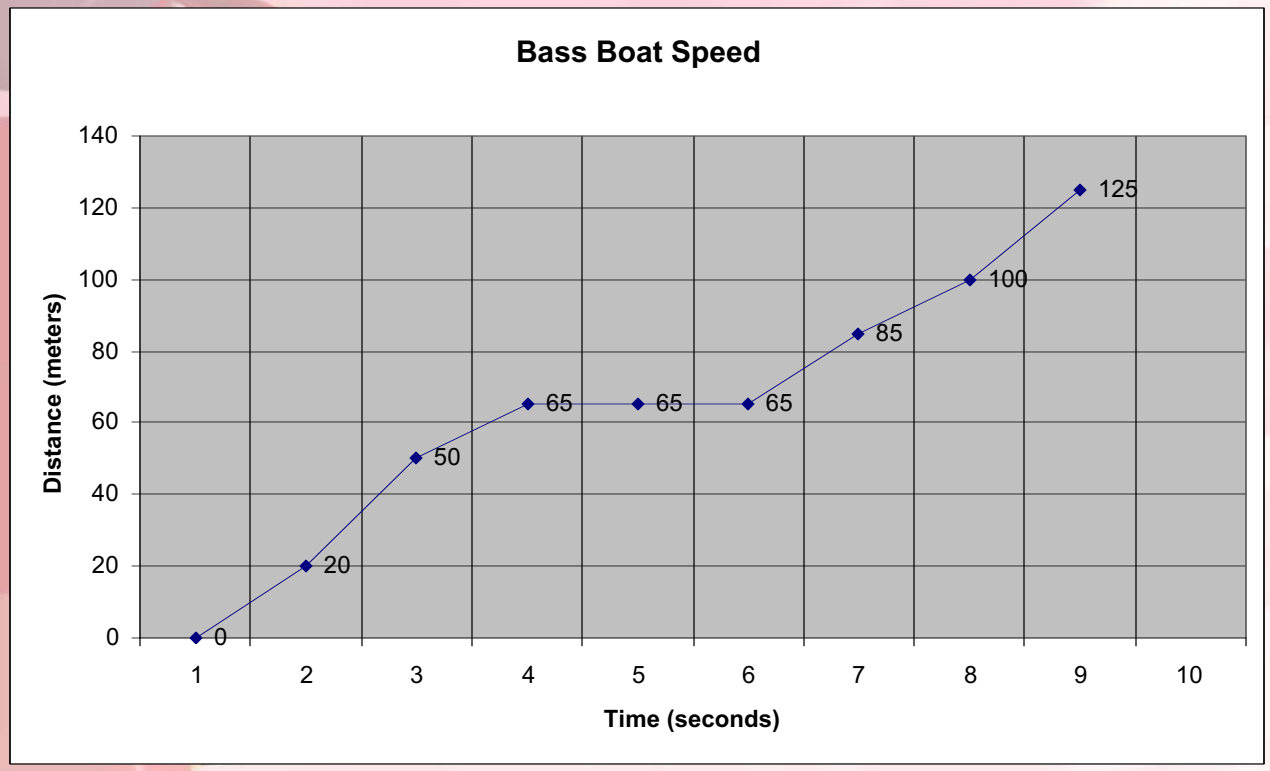
Instantaneous speed is the speed at any one given point in time.

Average Speed



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

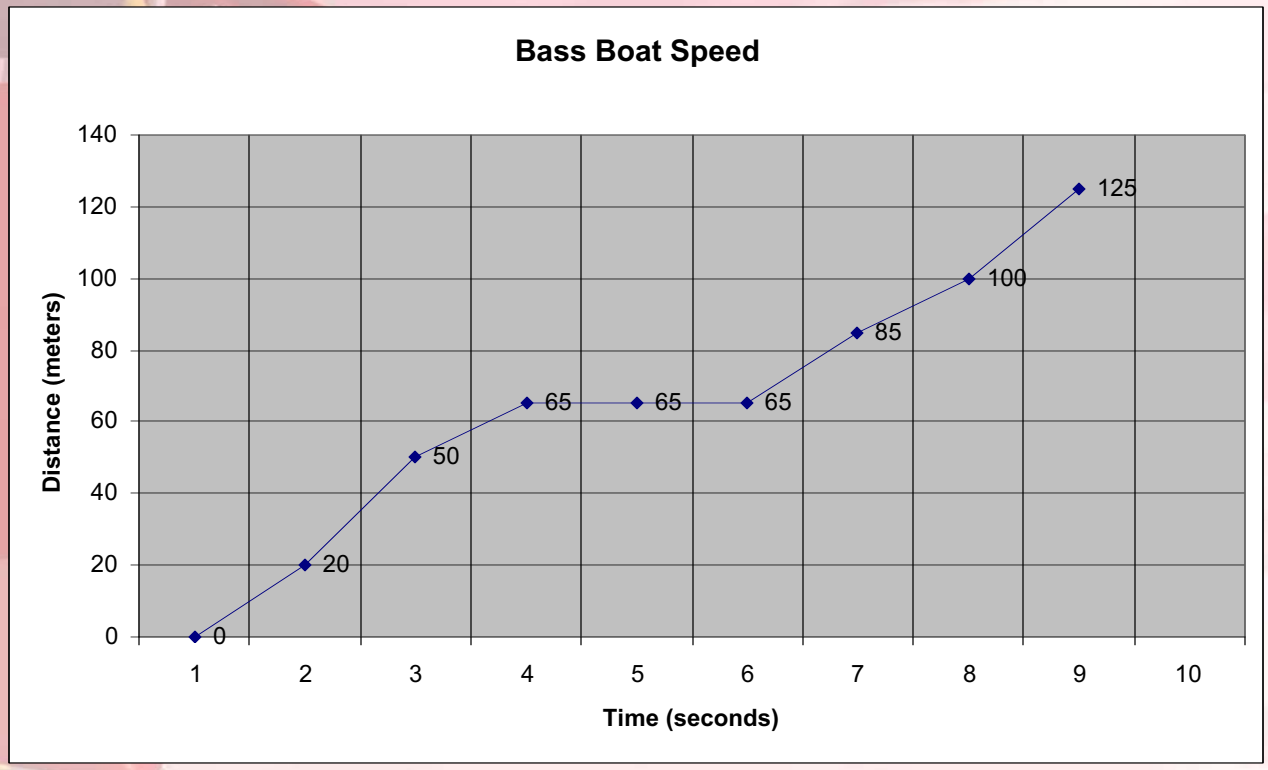
Average Speed



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

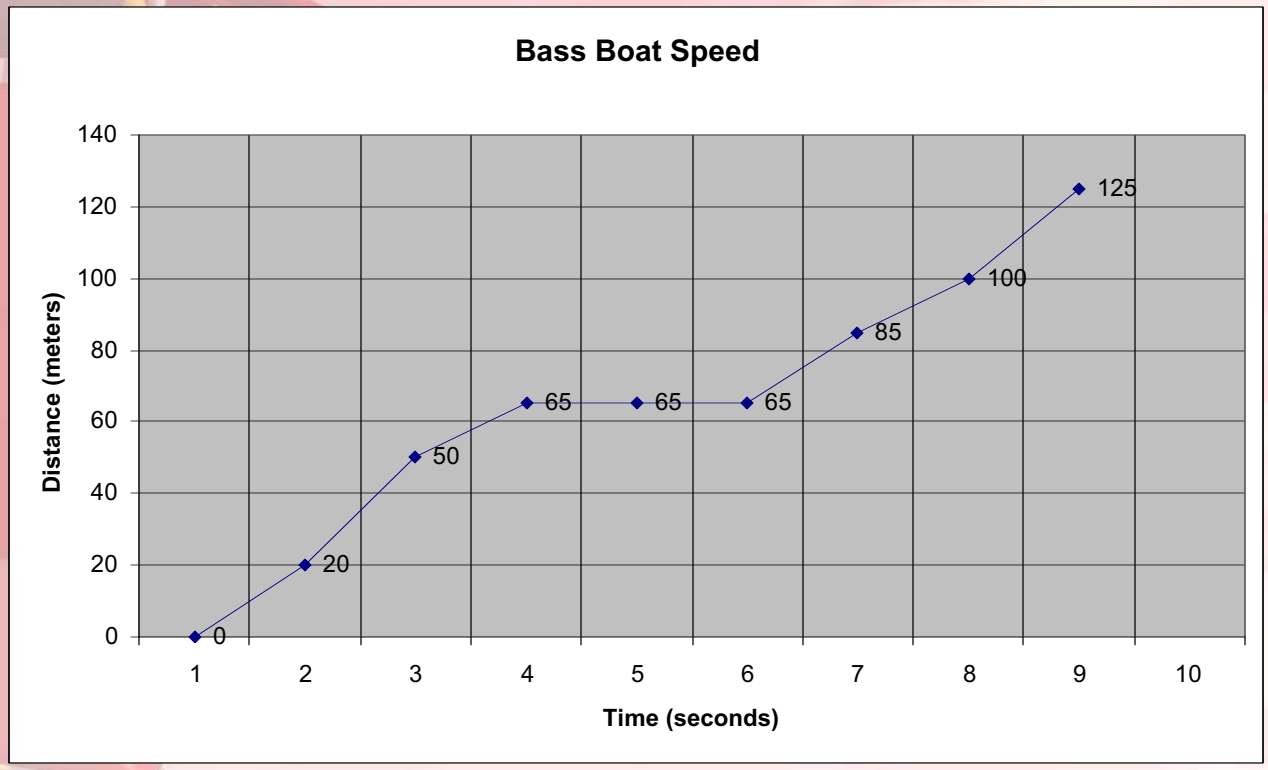
Average speed is taking the total distance traveled (0 to 125 meters), and dividing by the total time (1 to 9 seconds) it takes.

Instantaneous Speed



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

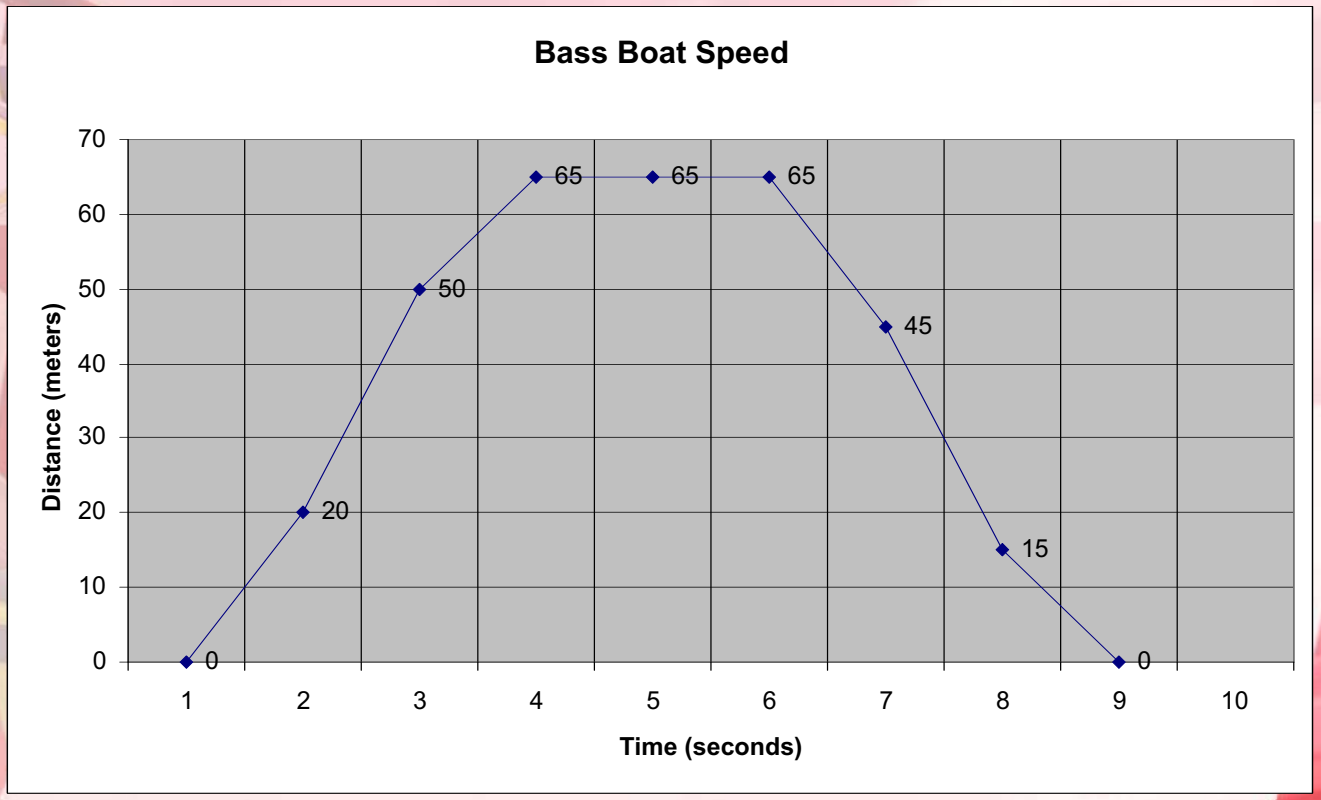
Instantaneous Speed



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

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

Speed Graphs

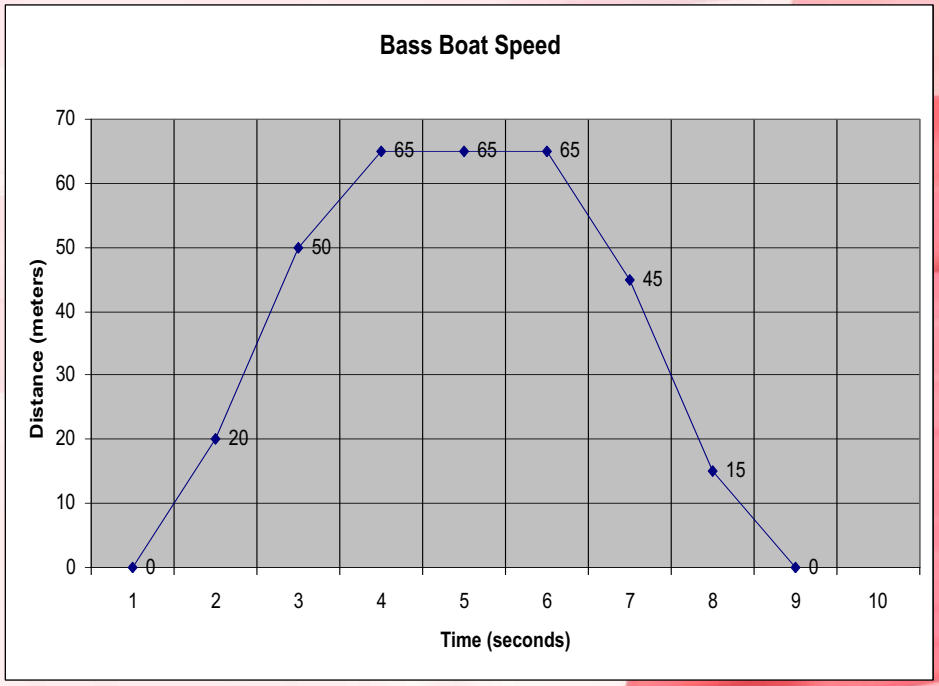


- In what time period is the bass boat speeding up?
- In what time period is the bass boat slowing down?
- When is the speed NOT changing?

Graphing Speed

Speed is usually graphed using a line graph, and it depicts the distance and time.

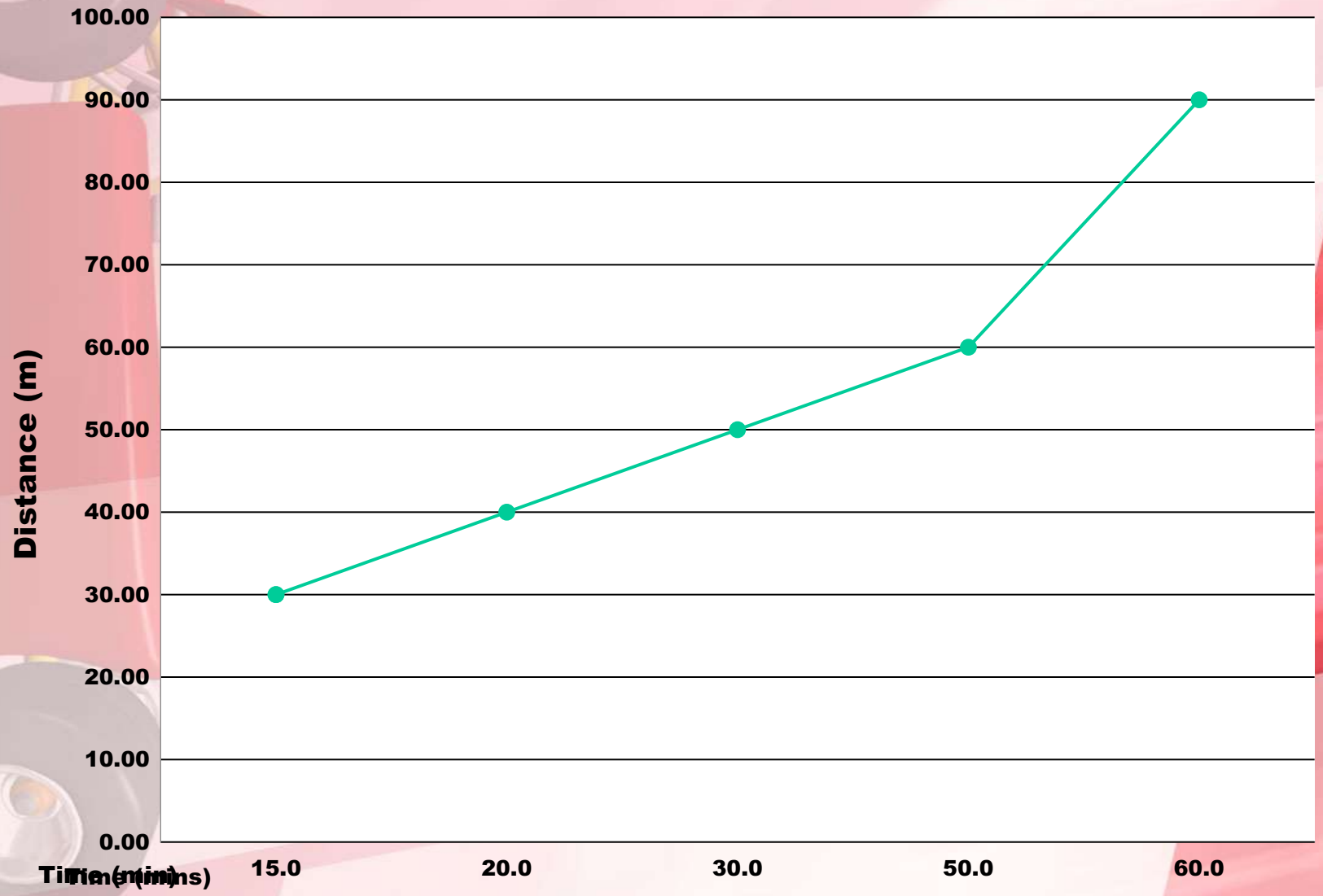
- **Time is the independent variable, and thus is ALWAYS on the x-axis.**
- **Distance is the dependent variable, and is ALWAYS on the y-axis.**



Graph the following data

Distance	Time
30	15
40	20
50	30
60	50
90	60

Distance over Time



Velocity

Velocity is the speed of an object, but the direction is also included. It is calculated the same as speed, but you must include a direction in your answer.

Example: the bass boat was moving 12 mph toward the north.

Velocity Problem

Indicate which of the following are velocities:

a. 125 cm/sec
b. 30 km/h northwest
c. 350m/sec north
d. 520 km/h

Velocity Problem

Indicate which of the following are velocities:

a. 125 cm/sec	**no**
b. 30 km/h northwest	**yes**
c. 350m/sec north	**yes**
d. 520 km/h	**no**

Acceleration

Acceleration is the rate of change of velocity. A change in velocity can be either a change in speed, or direction, or both.

Deceleration is when acceleration has a negative value.

Acceleration

The formula for calculating acceleration is:

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

The unit for velocity, in this case, is

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?

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

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

Acceleration Math Problem

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?

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

Homework Assignment

- Handout on calculating speed and velocity
- Handout on average speed
- Handout on acceleration

Speed / Velocity / Acceleration

Speed=Distance/Time

Time=Distance/Speed

Distance=time X Velocity

Time= Distance/Velocity

Velocity=Distance/Time

Velocity=Time X Acceleration

Time= Velocity/Acceleration

Acceleration=Velocity/Time


The End!