
SANTA CLAUS
1836 - 2000

Chapter 1

Motion and Momentum

1 – 1 What is Motion ?

- All matter in the universe is constantly in motion.
  - Electrons moving around the nucleus of an atom.
  - The particles in solid objects are still moving.

Changing Position

- Something is in motion if it is changing Position.
- When an object moves from one location to another, it is changing position.

Example :

- Runners sprint from the start line to the finish line.
- Their positions change, so they are in motion.

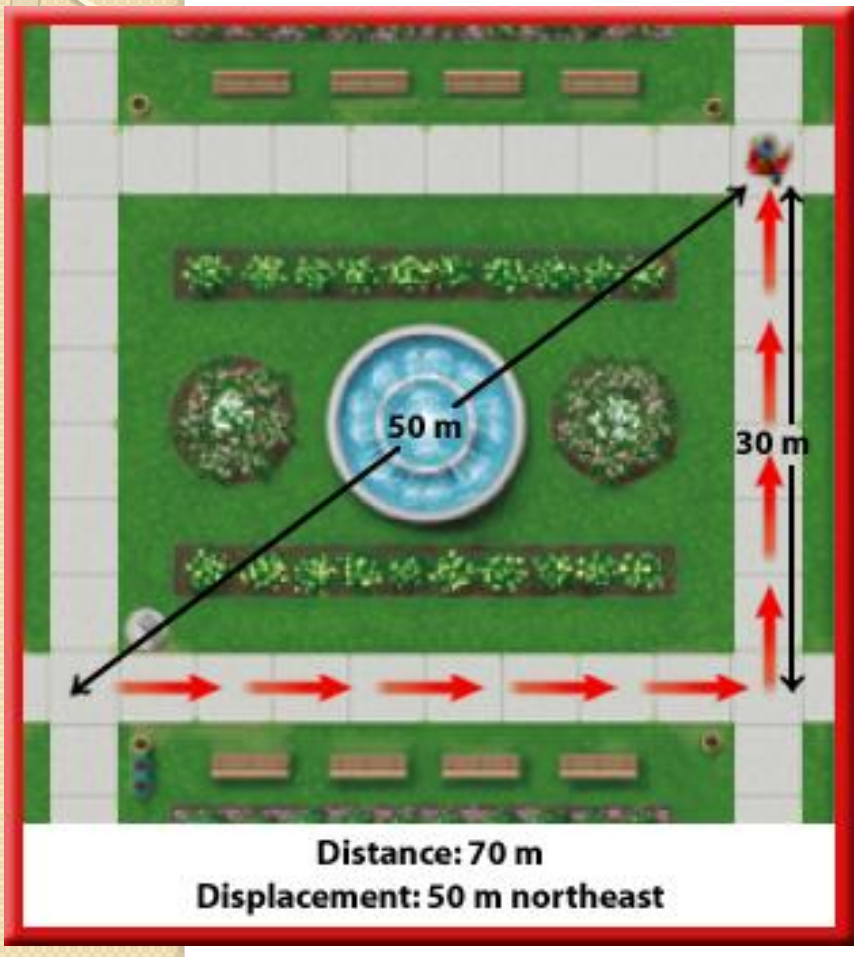
Relative Motion

- An object changes position if it moves relative to a Reference Point.

Example :

- Picture yourself competing in the 100m dash.
- You begin just behind the start line.
- When you finish, you are just past the start line.
  - The start line is the Reference Point.
  - Your position has changed 100m relative to the start line.
  - Motion has occurred.

Distance and Displacement



- Displacement Includes :

1. The distance between the start and end points.
2. The direction in which you travel.

Speed

- Speed – The distance traveled divided by the time taken to travel that distance.

$\frac{m}{s}$ $\frac{km}{h}$

$$\text{Speed (in meters per second)} = \frac{\text{Distance (in meters)}}{\text{Time (in seconds)}}$$

m km

s h

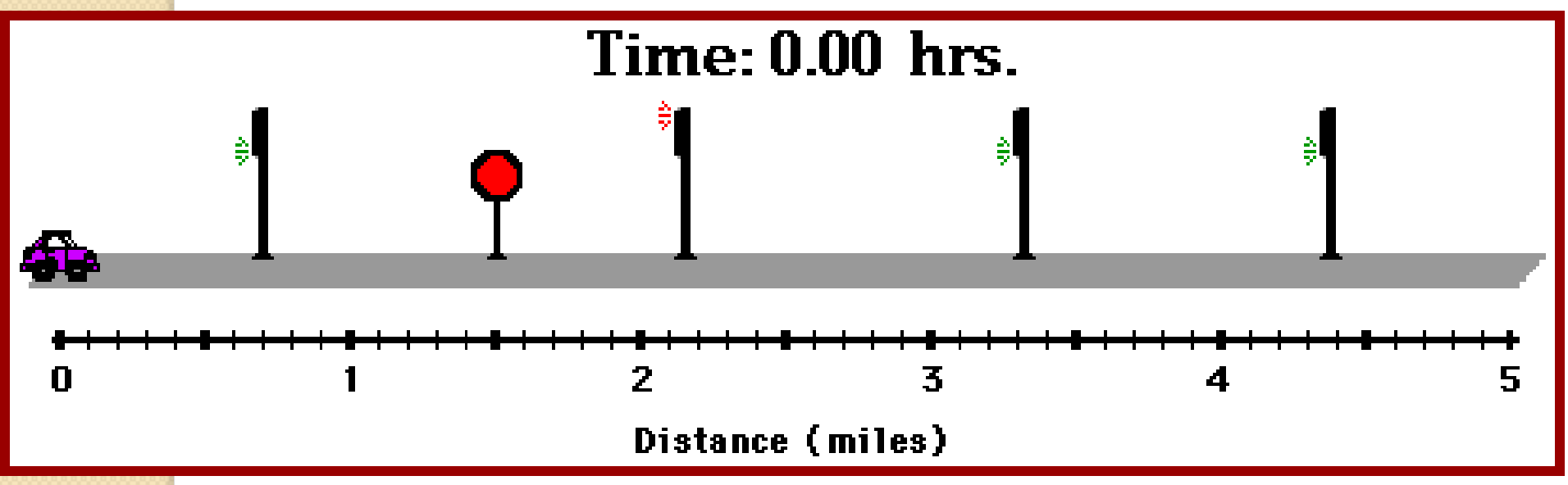
$$s = \frac{d}{t}$$

Average Speed

- Average Speed – The total distance traveled divided by the total time traveled.

• An object in motion can change speeds many times as it speeds up or slows down.

- Calculate the average speed.



Example

- Calculate your average speed if it takes 0.5 hours to walk 2 km to the library.

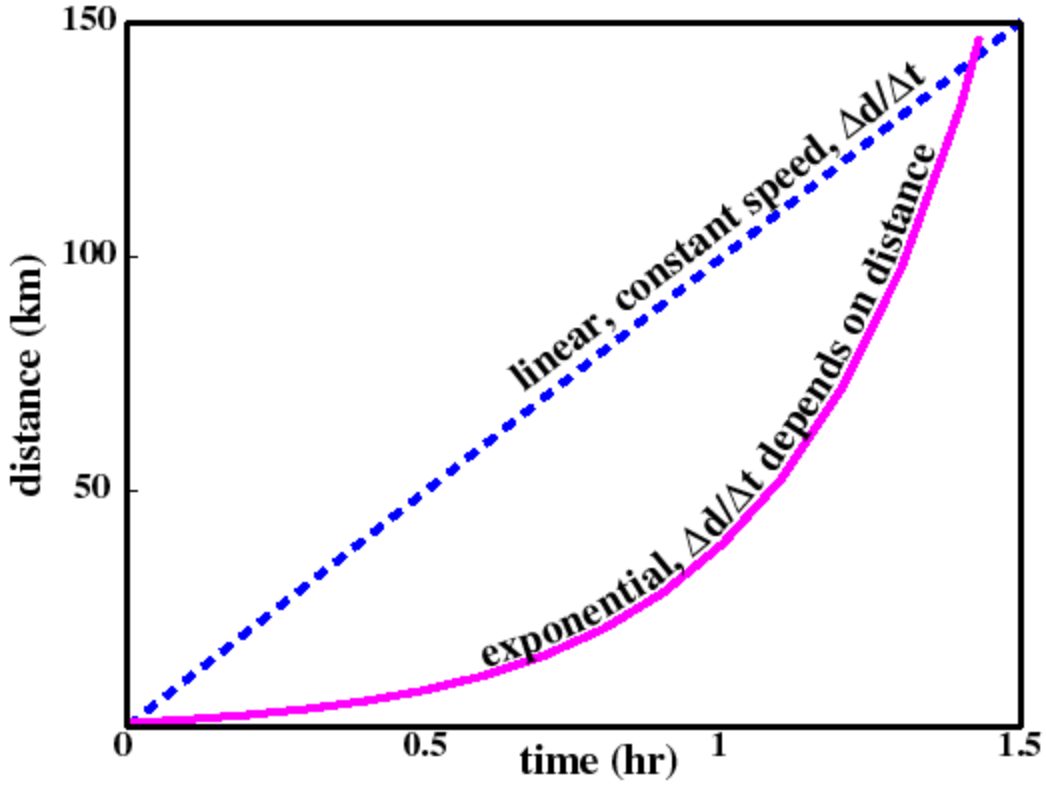
- Florence Griffith Joyner set a world record by running 200m in 21.34s. What was her average speed ?

Instantaneous Speed

- Instantaneous Speed – The speed of an object at one instant of time.

Constant Speed

- Constant Speed – Speed that does not vary.



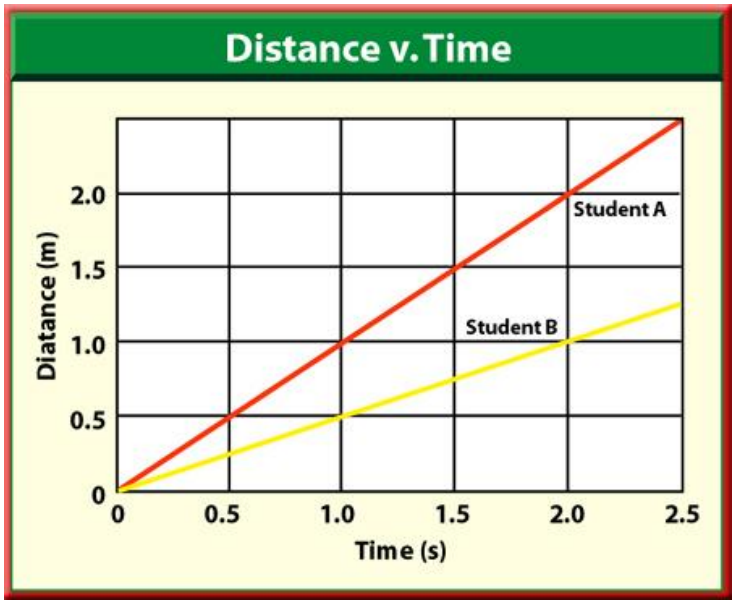
Graphing Motion

- You can represent the motion of an object with a distance-time graph.

- Time is plotted on the x-axis.
- Distance is plotted on the y-axis.

Distance-Time Graphs and Speed

- Which students traveled faster ?
- Steepness of the line shows us speed.
- What would a horizontal line represent ?



Velocity

- If you are hiking in the woods, you want to know not only your speed, but also the direction in which you are moving.
- Velocity includes :
  1. Speed of an object.
  2. Direction of its motion.

Changing Velocity

- Velocity can change if :
  1. The object's speed changes.
  2. The object's direction of motion changes.
  3. Both the speed and direction of motion change.

1 – 2 Acceleration

- Acceleration – The rate of change in velocity.
- Units : $\frac{m}{s^2}$ $\frac{km}{h^2}$

- 3 ways to accelerate :
  1. Change speed
  2. Change direction
  3. Change both speed and direction

Velocity and Acceleration

- Positive acceleration :
  - Velocity and acceleration are acting in the same direction.
  - You speed up.

- Negative acceleration :
  - Velocity and acceleration are acting in opposite directions.
  - You slow down

Calculating Acceleration

- Acceleration = Change in velocity divided by time.

$$a = \frac{\triangle s}{t} = \frac{s_f - s_i}{t}$$

△- " delta " means : change in

Things that affect acceleration

1. Change in velocity
2. Time interval

$$\frac{\triangle s}{t}$$

- A roller coaster starts down a hill going 10 m/s. Three seconds later it is going 32 m/s at the bottom of the hill. What is the acceleration of the roller coaster ?

- A car goes from 20 km/h to 70 km/h in 4 seconds. What is the acceleration of the car ?

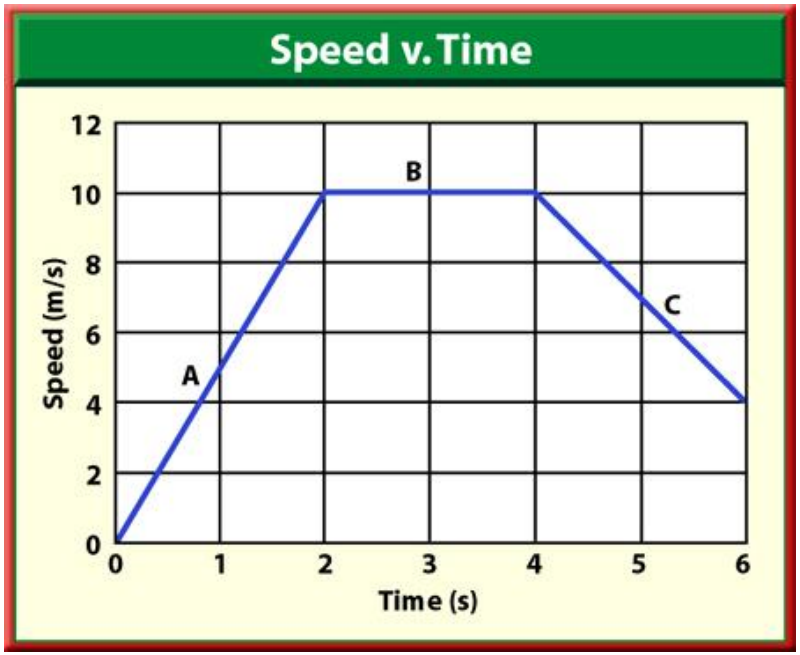
- A truck slows from 60 km/h to 0 km/h in 10 seconds. What is the acceleration of the truck ?

- Motion is not always along a straight line.
- If the acceleration is at an angle to the direction of motion, the object will turn.
- At the same time, it might speed up, slow down, or not change speed at all.

Graphing Accelerated Motion

- The motion of an object that is accelerating can be shown with a graph.

- For this type of graph, speed is plotted on the vertical axis and time on the horizontal axis.



- An object that is speeding up will have a line on a speed-time graph that slopes upward.
- An object that is slowing down will have a line on a speed-time graph that slopes downward.
- A horizontal line on the speed-time graph represents an acceleration of zero or constant speed.

1 – 3 Momentum

- Mass – the amount of matter in an object
- Units : kg (kilogram)
- Mass is NOT weight.
  - Objects with more mass weigh more than objects with less mass.
  - However, the size of an object is not the same as the mass of the object.

- The more mass an object has, the harder it is to start it moving, slow it down, speed it up, or turn it.
- Inertia – The tendency of an object to resist a change in its motion.
  - Objects with more mass have more inertia.

Momentum

- Momentum – The measure of how hard it is to stop the object.

  Momentum = Mass * Velocity

  $p = mv$

- Momentum depends upon :
  1. The object's mass.
  2. The object's velocity.
- Momentum has a direction that is the same as the direction of the velocity.

Conservation of Momentum

- Law of Conservation of Momentum - The total momentum of objects that collide is the same before and after the collision.

Using Momentum Conservation

- There are many ways that collisions can occur.
- Sometimes, the objects that collide will bounce off of each other.
- In other collisions, objects will stick to each other after the collisions.
- In both of these types of collisions, the law of conservation of momentum enables the speeds of the objects after the collisions to be calculated.