What is Motion?

If an object keeps on changing its position with time, it is said to be moving or in **motion**. Motion can be of different types:

- **Linear or straight** in which the object travels in a straight line.
- **Circular** in which the object travels along a circular path.
- **Curvilinear** in which the object moves along a curve.

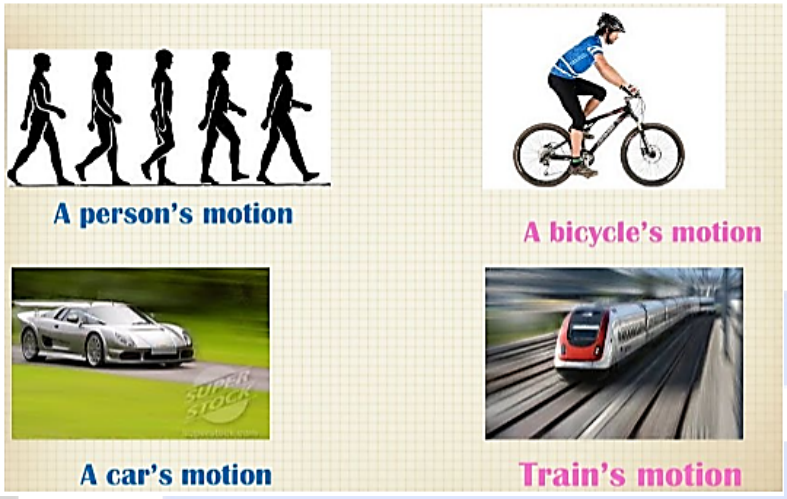


Figure 1: Examples of Motion

Slow and Fast Motion

If one object covers a particular distance in less time and another object covers the same distance in more time then the first object is said to be moving slowly while the second object is said to be moving faster.

The Speed of an object

The distance travelled by an object in unit time is called its **Speed**.

Types of Speed:

- **Uniform Speed** - When the object travels a fixed distance same time gaps, it is said to have a uniform speed.
- **Non-uniform speed** - When an object covers different distances in different time gaps, it is said to have a non-uniform speed.
- **Average speed** - The total distance travelled by an object divided by the total time taken by the object is called its average speed

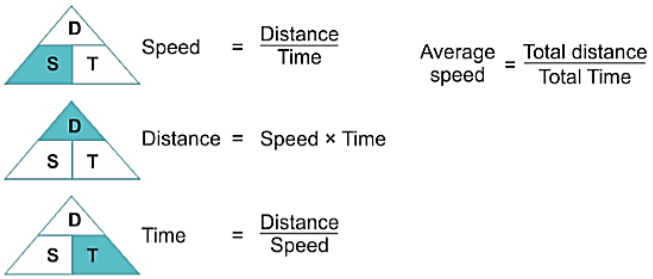


Figure 2: Finding Speed, Time and Distance

Measuring Time

There are many events in nature that repeat after a time interval:

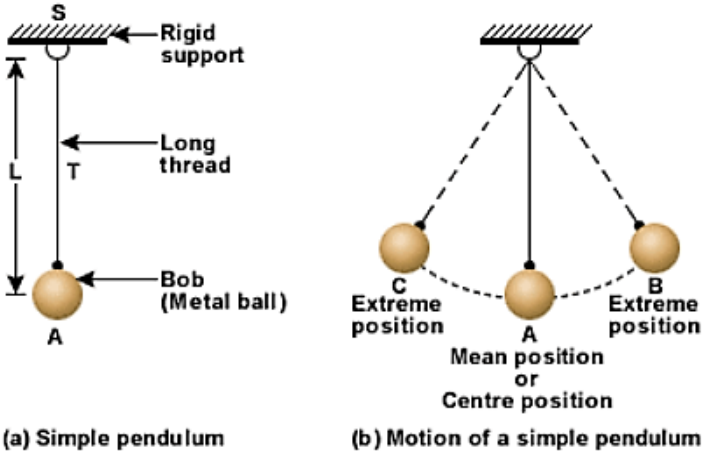
- Morning – The rising of the sun
- Day and Night – The time between the sunrise and sunset
- Month – The time between two new moons
- Year – The time the earth takes to complete its one revolution around the sun

Time measuring devices or clocks - **Clocks** use the concept of **periodic motion** to measure time. It means that it uses motion that repeats itself in equal amounts of time. There are different types of time measuring devices.

Sundial – It uses the position of the sun to depict time	
Sand Clock (hourglass) – It uses sand to measure time	

Water Clock – It uses water to measure time	
Pendulum Clock – It uses a pendulum to measure time	
Quartz Clocks – They have an electric circuit that works with the help of cells. They provide accurate time.	

Periodic Motion of a Simple Pendulum



(a) Simple pendulum (b) Motion of a simple pendulum

Figure 8: Simple Pendulum

- A simple pendulum contains a **Bob**. It is a metallic ball or a stone which is suspended from a rigid stand with the help of a thread.
- **Oscillatory motion** - The to and fro motion of the pendulum is called as **Oscillatory Motion**. The bob of the pendulum does move from the centre (mean position) of the pendulum to its extreme positions on the other side.
- **Oscillation** - When the bob moves from its centre (mean position) to its extreme ends it is said to complete one oscillation.
- **Time Period of a pendulum** - The time taken by the pendulum bob to complete one oscillation is called its **Time Period**.

Units to Measure Time Speed

Time	Second (s) Minutes (min) Hours (h)
Speed = Distance/time	Meter/Second (m/s) Meter/minute (m/min) Kilometer/hour (km/h)

Conversion between km/hr and m/s

To convert between m/s and km/h:

$$\frac{1\text{ km}}{1\text{ h}} = \frac{1000\text{ m}}{1\text{ h}} = \frac{1000\text{ m}}{60\text{ min}} = \frac{1000\text{ m}}{3600\text{ s}} = \frac{1}{3.6}$$

Km/h → (Divide by 3.6) m/s

m/s → (Multiply by 3.6) Km/h

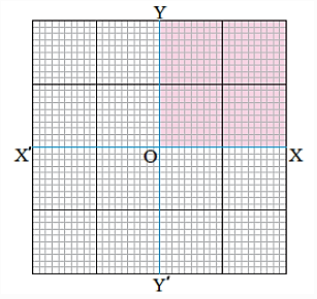
- **Speedometer** - It is a device which is used in vehicles such as cars and trucks which measures the speed in kilometer per hour.
- **Odometer** - It is a device which measures the distance travelled by a vehicle in meters or kilometers.

The dashboard of a car

Figure 9: Measure of Distance and Speed of a car

Distance-time Graph

A graph which represents the distance travelled by an object with respect to time is called a distance-time graph.

Making a distance-time graph:	
1. Mark the x-axis and y-axis and divide them in equal quantities.	 **Figure 11: Take the first quadrant**

2. Choose one scale to represent distance (for example, x-axis to represent distance where 1 km = 1 cm) and the other to represent time (for example, y-axis to represent the time where 1 min = 1 cm).

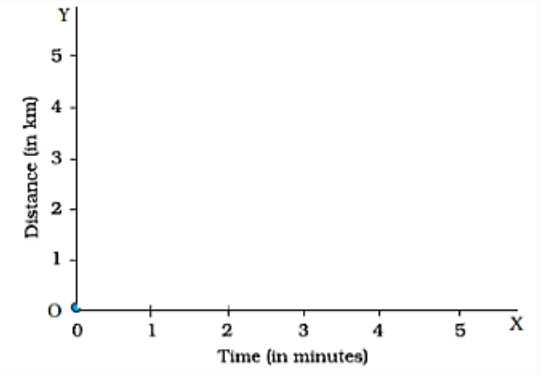


Figure 12: Choosing the scale

3. Mark the values of time and distance in the graph.

4. Mark the set of values of time taken and distance covered in that time by the object in the graph. For example, if 1 km is covered in 1 minute then mark 1 unit on both the x-axis and y-axis.

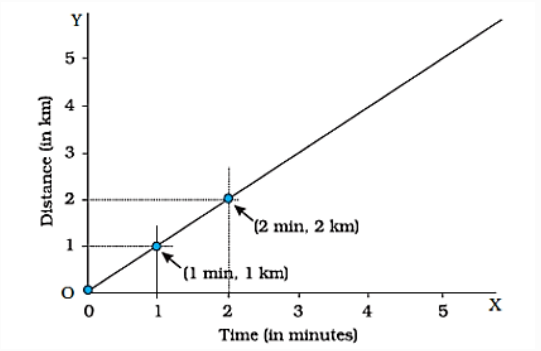


Figure 13: Marking the values for time and distance

5. Now draw lines parallel to x-axis and y-axis at the points that you have marked.
6. Mark the points where these lines intersect on the graph. These points show the position of the moving object.
7. Now join all the points of intersection and obtain a straight-line graph.
8. This is the distance-time graph of a moving object.

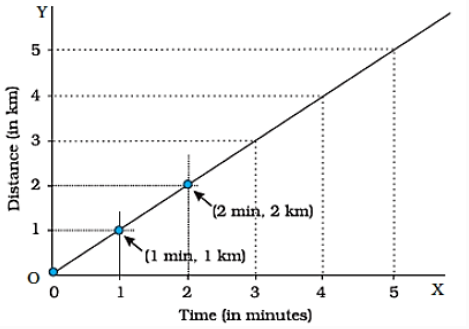


Figure 14: Obtaining a straight line graph

The shape of the distance-time graph can be the following:

Shape of Graph	Interpretation
Straight line	The object has a uniform or constant speed
Parallel to time-axis	It is a stationary object
Curve shape	The object has a non-uniform speed

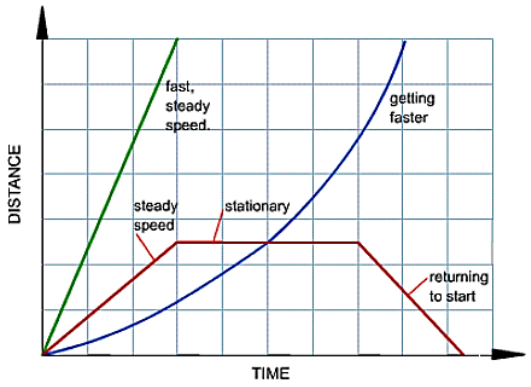


Figure 15 Distance-time Graphs

To find the speed of the distance-time graph

- Speed = distance/time = (final position of object – initial position of object)/time taken by object
- Also, the speed of the distance-time graph can be calculated by the **Slope** of a graph. The steeper the slope of the graph, the more is the speed of the object. For example, in the graph given below object A has a steeper slope. This means that object A is moving at a higher speed than object B.

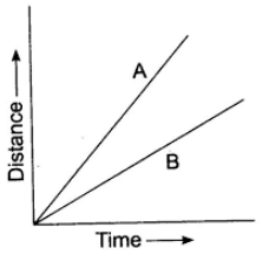


Figure 16 Distance-time graph of two objects