MOTION AND TIME Chapter 13 Class VII

Learning Objectives-

1. To understand motion and its types
2. To define speed
3. To understand uniform and non-uniform motions
4. To know the concept of time
5. To know units of time and speed
6. To know common modern and ancient time-measuring devices
7. To know state of rest and motion
8. To plot different distance-time relationships on graph

Introduction- In this chapter we will learn about motion, its types, fast and slow motion, speed, uniform and non-uniform motions, time and its measurement, simple pendulum, ancient time measuring devices, unit of time and speed, measuring speed and distance time graphs.

Motion and its types- The change of place with respect to time is called motion. The main types of motion are-

(a) Linear/Rectilinear/Straight line motion- The motion which occurs on a straight pathway is called rectilinear motion. In it position changes but not the direction. e. g- Motion of a car on a straight road, an apple falling from tree etc.

(b) Circular motion- The motion which occurs on circular pathway is called circular motion. In it position as well as direction change. e.g.- Motion of a fan , Motion of a child in a merry –go-round etc.

(c) Periodic motion- The motion which repeats itself after a fixed interval of time is called periodic motion. E.g.- Motion of arms of a clock, motion of the Earth around the Sun etc.

(d) Oscillatory motion- The to and fro motion along the same pathway is called oscillatory motion. E.g.- Motion of pendulum of clock, Motion of a child on a swing etc.


Wall Clock with Pendulum

Slow and Fast motion-

The slow and fast motions are relative terms to each other. When an object covers more distance in less time than the other object, it is called fast and other object will be called slow. If time duration is kept fixed, the slower object will be behind the faster object.

Let us take an example

Car 1……**Car 1** (after 10 Minutes)

Car2……**Car2** (after 10 Minutes)

At Rest In Motion

Obviously **Car2** is moving faster than **Car1.**

Speed- The slow or fast moving object can be described easily by its speed. The speed of slow moving object will be less as compared to the faster one.

The ratio of distance covered by an object and time taken in it is called speed of an object. Simply, distance by time is called speed.

Speed=Total distance covered/Total time taken

Or, **s=d/t**

Basic or S.I. Unit of Speed is meter per second (m/s). The higher unit is Kilometer per hour (Km/h).

Uniform and Non-uniform motions-

When an object moves along a straight pathway with constant speed is said to be in uniform motion. In uniform motion, the actual speed and average speed will be same.

In daily life hardly any object moving with uniform motion for long duration. The motion which changes its speed on a straight pathway is said to be in non-uniform motion. In non-uniform motion, the actual speed and average speed are different.

Average speed- When speed is different in different time of travel average speed is calculated. It is calculated by total distance travelled divided by total time taken.

Measurement of Time-

The interval between two instances is called time. E.g.- The interval between one sunrise to the next sunrise is a time called **a day**. The interval between one rotation to the next by the Earth on its axis is a time called **a solar day**. The interval between one new moon to the next is a time called **a month**. The interval between one revolution to the next by the earth is a time called **a year**. So, a day, a solar day, a month, a year denotes time. For measuring shorter time intervals **second**, **minute** and **hour** are used.

Time is measured by devices like watch and wall clock. Both these use periodic motion to measure the time. In a wall clock the pendulum shows periodic motion to measure time. Let's understand the motion of a simple pendulum.


Table clock Digital Clocks


Wrist Watch Wall Clock with Pendulum

In ancient time the Sun dial, The Sand Clock and water clock were used to know the time.

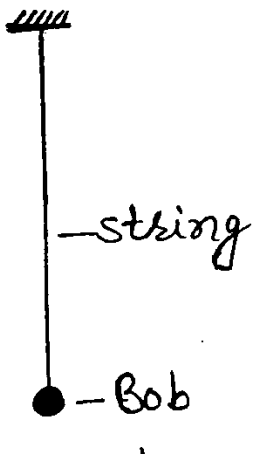

Water Clock

Jantar Mantar: Delhi (Photographs Courtesy, NCERT)

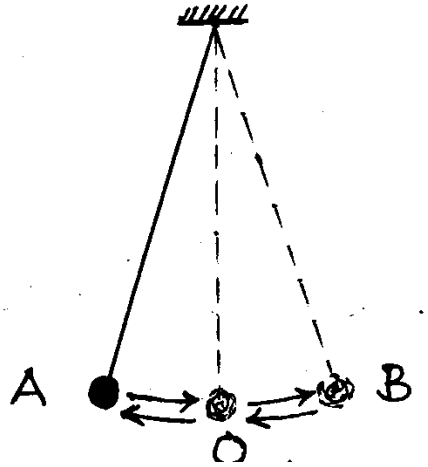
Simple Pendulum-

First of all Galileo Galilei (A.D. 1564-1642) did experiments on simple pendulum. A simple pendulum is a small metallic ball suspended by a thread from a rigid point. The small metallic ball is called **bob** of the pendulum.

When the bob is released from after pulling it slightly to one side, it starts moving to one side. The to and fro motion of the simple pendulum which repeats itself after a fixed interval of time is called **periodic or oscillatory motion**. The pendulum completes one oscillation when it moves from A--> O-->B-->O-->A. **or** O-->A-->O-->B-->O **or** O-->B-->O-->A-->O **or** B--> O-->A-->O-->B. The time taken by simple pendulum to complete one oscillation is called '**time period**'.



A Simple Pendulum



Different Positions of the bob of an oscillating simple pendulum

Activity 13.2 To Calculate the time period of a simple pendulum

Length of string = 100 cm or 1m

S. No.	Time taken for 20 oscillations	Time period
1	28 s	1.4 s
2	42 s	2.1 s
3	38 s	1.9 s

Units of Time and Speed

The basic unit of time is called second. It symbol is **'s' or 'sec'**. Minute (m) and hour (hr) are larger units of time. To measure time smaller than second 'atomic clocks' are used. Atomic clock measures 10 millionth of a second. There are clocks which measures time in microseconds (one millionth of a second) and nanoseconds (one billionth of a second). Centuries, millenniums, millions and billions of years are also used to express historical and evolutionary events.

Speed is the ration of distance and time. Therefore, the basic unit of speed is **m/s**. It can also be written in **m/min or km/hr**. **The symbol of any unit is always written in singular**. e.g- 21 km and not 21 kms.

Measuring speed

If the value of distance covered by an object and time taken is known to us, the value of speed can be deduced by the formula-

Speed = Distance/Time

We can find distance if the value of speed and time is known to us.

Distance= speed X Time

Similarly we can find time if the value of speed and distance is known to us.

Time= Distance/Speed

S.N.	Name of Animal	Speed in km/h	Speed in m/s	
1	Falcon	320	$\frac{320 \times 1000}{60 \times 60}$	88.8
2	Cheetah	112	-	31.1
3	Rabbit	56	-	15.5
4	Squirrel	19	-	5.2
5	Human	40	-	11.1
6	Giant Tortoise	0.27	-	0.075
7	Snail	0.05	-	0.013

On the dashboard of vehicles like car, bus two meter dials in front of driver remain fitted. One of them is a **speedometer** and another one is an odometer. Speedometer records the speed in km/h and **odometer** records the distance travelled in km.

Speedometer Odometer

Distance-Time Graph

We use different types of graphs to represent data or values in an organized way. The graph shows relationship between two groups of measurements or quantities.

In a cricket match the runs scored by a team in each over in an innings can be easily shown by a **bar graph**.

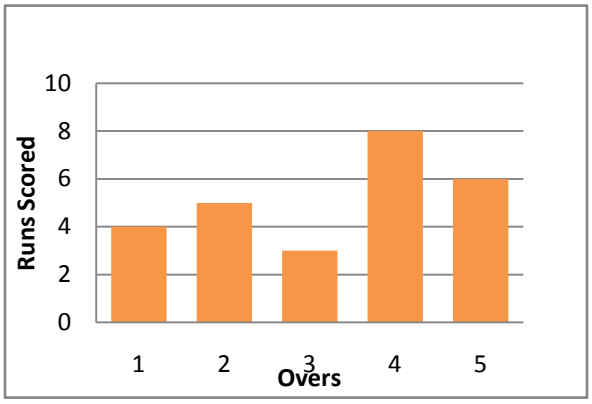
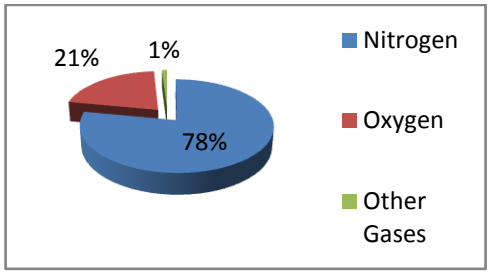
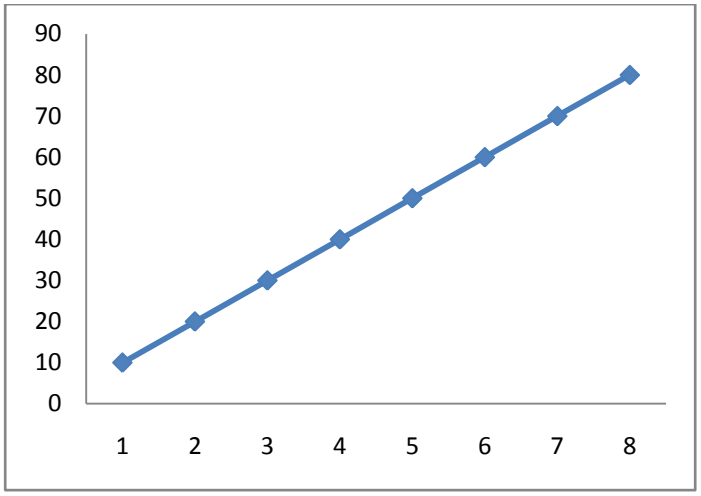


Fig. A Bar Graph showing runs scored by a team in each five over

A **Pie chart** is a graphical representation in form of divisions or different percentages. What is the percentage of anything out of 100 %. So, pie chart is a division of whole.

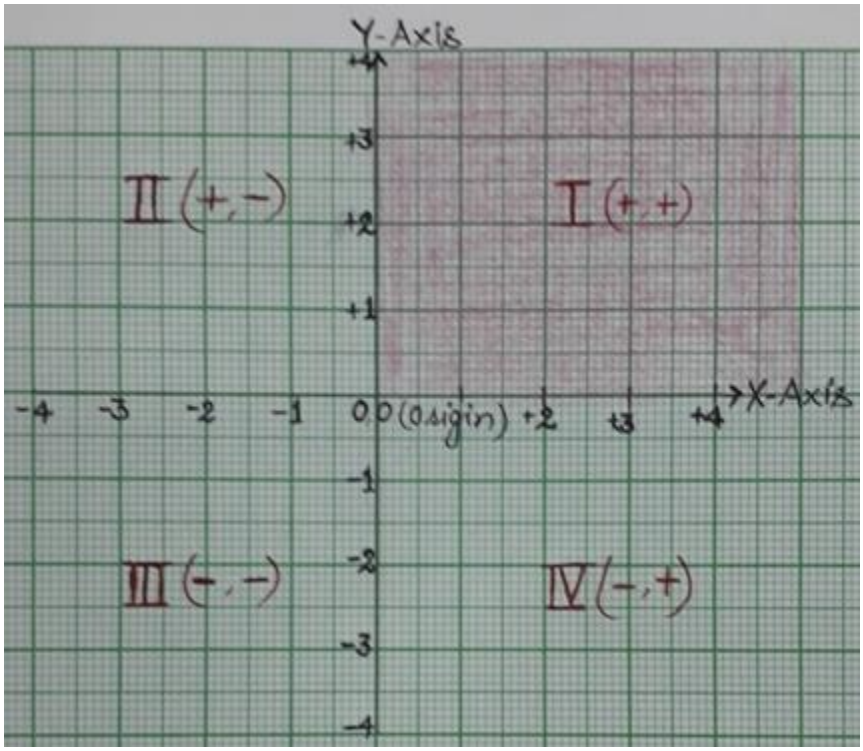


The **line graphs** show relationships in form of a line. The distance-time graphs are line graphs. When the speed of vehicle is constant then the distance time graph will be a straight line. When the speed of vehicle keeps on changing then the distance time graphs can be of various shapes.



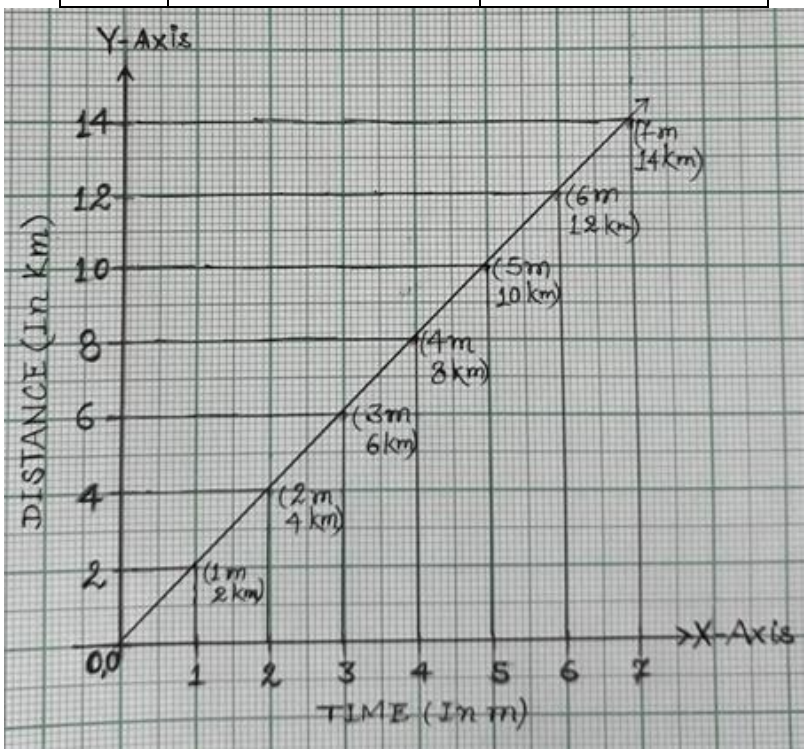
How to Draw Line graph-The X-axis (horizontal) and Y-Axis (vertical) of a graph paper are used to put the data. The first coordinates have all the positive values; so, it is taken to plot the

graph. On X-Axis the first kind of measurement data is kept and on Y-Axis second kind of measurement data is kept. On matching the values on X-axis and Y-axis, a relationship in form of line is obtained.



Example 1- A vehicle is running 2 Km in each minute. The graph will show a constant speed as like the data.

S.N.	Time (In Minute)	Distance (In Km)
1	0	00
2	1	02
2	2	04
3	3	06
4	4	08
5	5	10
6	6	12
7	7	14



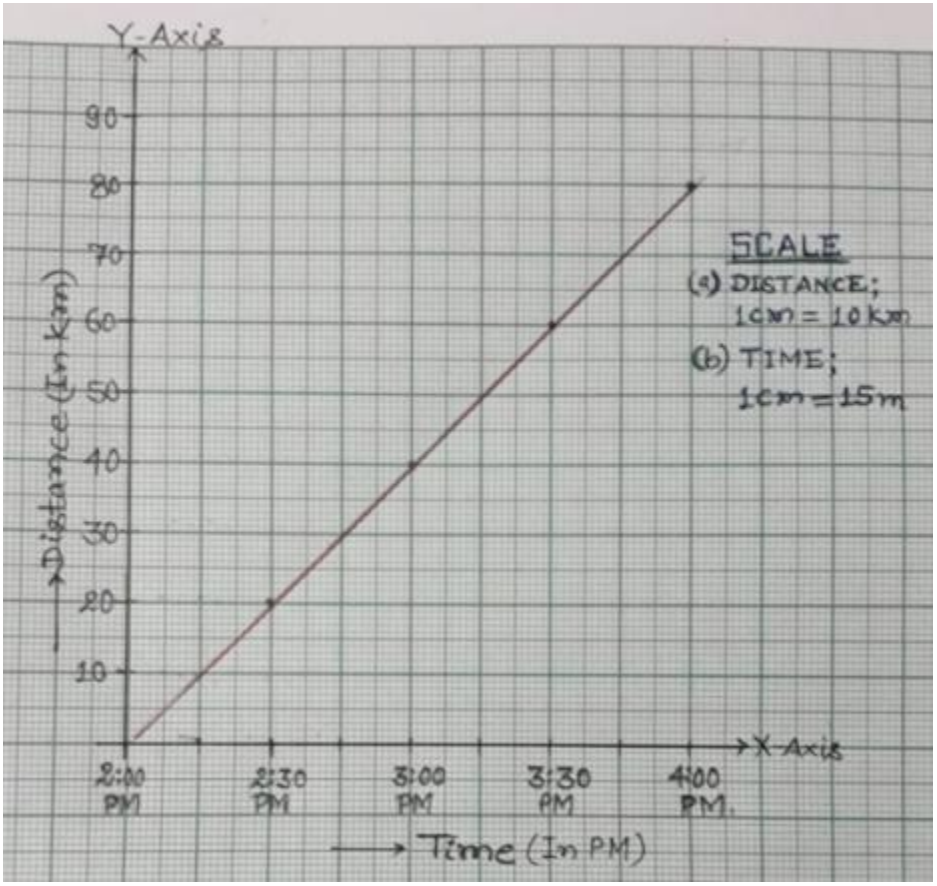
The scales used for representing motion of a car can be-

Time: 1min= 1cm on X-Axis

Distance: 2km= 1cm on Y-Axis

Example 2 –A bus starts journey at 2 P.M. and covers a distance of 80 Km in 2 Hours at constant speed.

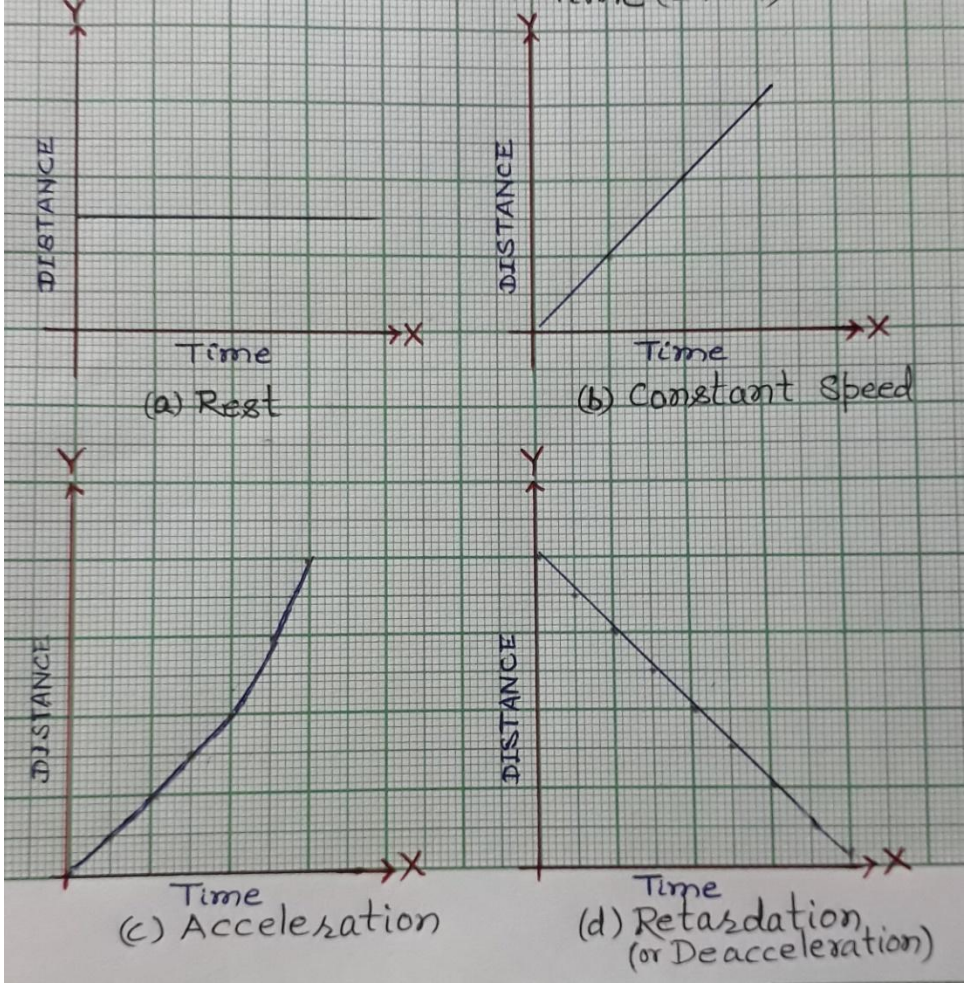
S.N.	Time (In Per Half hour)	Distance (In Km)
1	2:00 PM	00 Km
2	2:30 PM	20 Km
3	3:00 PM	40 Km
4	3:30 PM	60 Km
5	4:00 PM	80 Km



There are basic types of line graphs in four situations-

(a) At rest (b) Constant speed

(c) Acceleration (d) Retardation (De-acceleration)



Points to Remember-

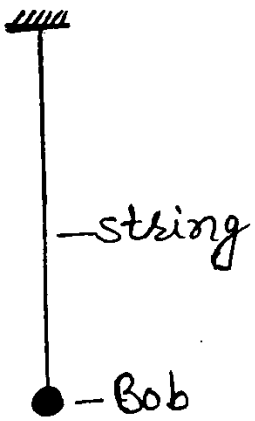
1. **Motion is change of place with respect to time. Linear, Circular, Periodic and oscillatory are main examples of motion.**
2. **The distance moved by an object per unit time is called speed.**
3. **Speed = Distance/ Time Unit= m/s**
4. **By comparing the speed of two moving objects we can say which is faster than other.**
5. **Measurement of time occurs by modern devices like watches and clocks. They are based on oscillatory motion of simple pendulum.**
6. **Ancient devices to measure time are sundial and water clock.**
7. **The time taken to complete one oscillation is called its time period.**
8. **Speedometer measures speed in Km/h and Odometer measures distance covered by the vehicle.**
9. **Distance time graphs show the motion of object. For an object moving with constant speed the distance time graph will be a straight line.**

NAME OF ACTIVITY- To Know the Time Period of a Simple Pendulum

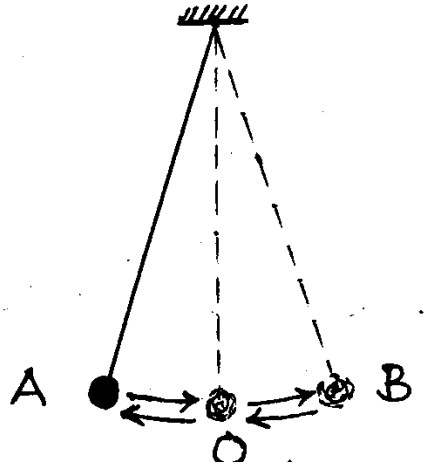
REQUIREMENTS- Metallic bob or Small stone, String or thread, Stop watch or Wrist watch

THEORY- A simple pendulum has a string and a bob suspended from any rigid point. It is used to calculate the time period.

PROCEDURE- A simple pendulum of length **1m (100 cm)** was firmly suspended from a rigid point. The bob is taken at one of extreme position away from the mean position of simple pendulum and released carefully without pushing. The number of oscillations completed in 20 seconds was recorded.



A simple pendulum



Different Positions of the bob of an oscillating simple pendulum

Where, A= Extreme Point A
B= Extreme Point B
O= Mean Position

The experiment is repeated 3 times. The time period of each oscillation can be calculated by dividing the total time with 20 i.e. number of oscillations we have assumed to be completed in each case.

S.N. of Experiment	Time taken to complete 20 Oscillations (in s)	Calculation	Time Period (in s)
1.	44 s	44 s/ 20	2.2 s
2.	56 s	56 s/ 20	2.8 s
3.	68 s	68 s/ 20	3.4 s
4.			

Fourth experiment is for you.

CONCLUSION- The measurement of time period of an oscillation can be done by dividing total time taken in completing 20 oscillations (supposed).

Note- Number of oscillations per second is called frequency. On increasing the length of string/ thread the time period increases and frequency reduces. But, on reducing the length of string the time period decreases and frequency increases.

NAME OF ACTIVITY- To measure the speed

REQUIREMENTS – A ball, Measuring tape and Stop watch or Wrist watch

THEORY- Speed is the ratio of distance to the time. Speed =Distance/ Time. It's unit is m/s.

PROCEDURE- The ball was moved on a flat surface having marking of the length. In each case the distance covered before stoppage and time taken was noted. By the formula of speed, the speed was calculated.

S.N. of Activity	Distance covered by the ball (in m)	Time taken (in s)	Speed=distance/Time taken = m/s
1.	4.2 m	8 s	4.2m/8s =0.52 m/s
2.	3.8 m	6 s	3.8 m/6s=0.63 m/s
3.			

Third activity is for you.

EXERCISE QUESTIONS SOLVED

Q.1 Classify the following as motion along a straight line, circular or oscillatory motion:

(i) Motion of your hands while running.

(ii) Motion of a horse pulling a cart on a straight road.

(iii) Motion of a child in a merry-go-round.

(iv) Motion of a child in see saw

(v) Motion of the hammer of an electric bell

Ans- (i) Oscillatory motion (ii) Straight line motion

(iii) Circular motion (iv) Oscillatory motion

(v) Oscillatory motion (vi) Straight line motion

Q.2 Which of the following are not correct?

(i) The basic unit of time is second.

(ii) Every object moves with a constant speed.

(iii) Distances between two cities are measured in kilometers.

(iv) The time period of a given pendulum is not constant.

(v) The speed of a train is expressed in m/h.

Ans- (ii), (iv) and (v) are not correct.

Q.3 A simple pendulum takes 32 s to complete 20 oscillations. What is the time period of the pendulum?

Ans- Given that, Number of oscillations = 20

Time taken = 32 s

So, Time period = Time taken/Number of oscillations

= 32/20 =1.6 s

Q.4 The distance between two stations is 240 km. A train takes 4 hours to cover this distance. Calculate the speed of the train.

Ans-Given that, the distance covered = 240 km.

Time taken = 4 h

So, Speed = Total distance covered/Total time taken

= 240/4 =60 km/h

Q.5 The odometer of a car reads 57321.0 km when the clock shows the time 08:30 AM. What is the distance moved by the car, if at 8:50 AM, the odometer reading has changed to 57336.0

km? Calculate the speed of the car in km/min during this time. Express the speed in km/h also.

Ans- Given that, reading of odometer at 08:30 AM = 57321.0 km

reading of odometer at 08:30 AM = 57336.0 km

So, Total distance covered by the car= 57336.0-57321.0 km

= 15 km

Total time taken = 08:50 AM – 08:30 AM= 20 min

= 1/60 x 20 h

=1/3 h

So, Speed of the Car =15 km/20 min = 0.75 km/min

Or, speed of the car in km/h = 15 km**/**(1/3h) = 15 x 3 km/h

= 45km/h

Q.6 Salma takes 15 minutes from her house to reach her school on a bicycle. If the bicycle has a speed of 2 m/s, calculate the distance between her house and the school.

Ans- Given that, Time taken = 15 min = 15 x 60 =900 s

Speed of bicycle = 2 m/s

˚˳˚ Speed =Total distance covered/ Total time taken

Or, Total distance covered = Speed x total time taken

= 2 m/s x 900 s

=1800 m = 1.8 km

Q.7 Show the shape of the distance-time graph for the motion in the following cases: (i) A car moving with a constant speed.

(ii) A car parked on a side road.

Ans- (i) A car moving with a constant speed covers equal distance in equal interval of time. So, the distance-time graph for such motion looks like as this.

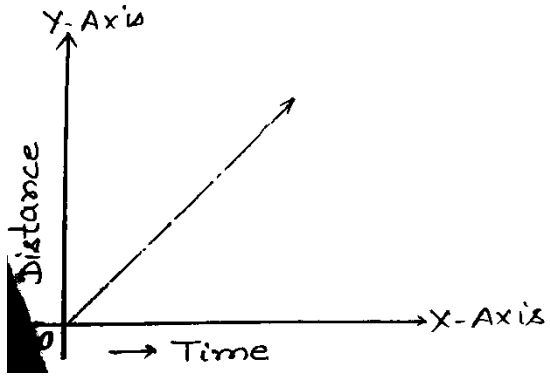


Figure 1Uniform /Constant Speed

(ii) A car parked on a side road will not change its position with change in time. So, the distance-time graph for a parked non-moving car looks like as this.

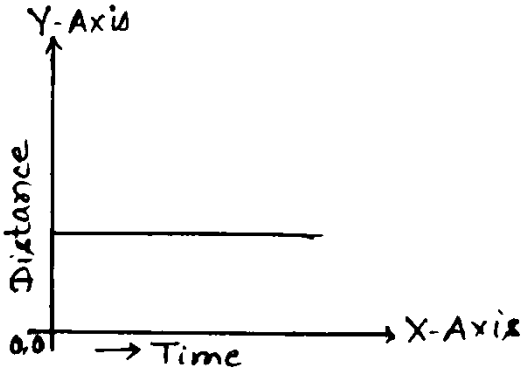


Figure 2 Object at rest

Q.8 Which of the following relations is correct?

(i) Speed = Distance x Time (ii) Speed = Distance / Time
(iii) Speed = Time / Distance (iv) Speed = 1/Distance x Time

Ans- (ii) Speed = Distance/ Time

Q.9 The basic unit of speed is:

(i) km / min (ii) m /min
(iii) Km / h (iv) m /s

Ans-(iv) m /s

Q.10 A car moves with a speed of 40 km/h for 15 minutes and then with a speed of 60 km/h for the next 15 minutes. The total distance covered by the car is:

(i) 100 km (ii) 25 km
(iii) 15 km (iv) 10 km

Ans

Total time =15 min + 15 minutes =30 minutes or ½ hr.

$$\text{Average Speed} = \frac{40 + 60 \text{ km/h}}{2} = 50 \text{ km/h}$$

Total distance= 50km/h X 1/2h = 25 km.

Q.11 Suppose the two photographs, shown in fig. 13.1 and 13.2, had been taken at an interval of 10 seconds. If a distance of 100 meters is shown by 1 cm in these photographs, calculate the speed of the faster car.

Fig 13.1

Fig 13.2

(Photographs Courtesy, NCERT)

Ans- Here green car and blue car are moving faster than white car. The distance covered by the blue car from one white strip to the next is 1.3 cm approximately.

Given that, 1 cm = 100 m So, 1.3 cm = 1.3 x 100 m = 130 m

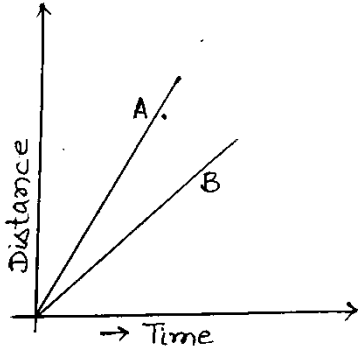
Also, the time interval between two photographs= 10 s

So, Speed = total distance covered/ Total time taken

= 130 m/ 10 s

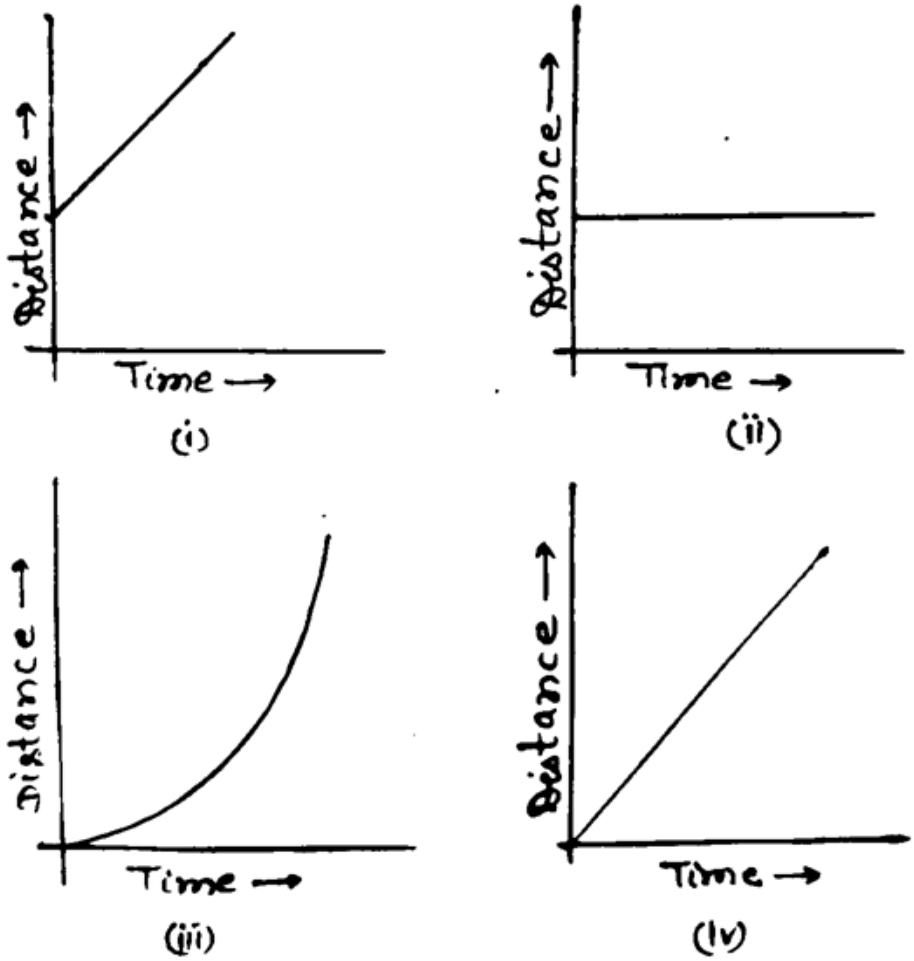
= 13 m/ s

Q.12 Fig.13.15 shows the distance- time graph for the motion of two vehicles A and B. Which one of them is moving faster?



Ans- On comparing the distance covered by car A with car B for given points of time, it can be concluded that car A is moving faster.

Q.13 Which of the following distance-time graphs shows a truck moving with speed which is not constant?



Ans- (iii) is not a constant motion. It is increasing (or ascending).

Useful links for reference-

1. https://www.youtube.com/watch?v=NM6Q958lpJc
2. https://www.youtube.com/watch?v=OrOKEVND7_w
3. https://byjus.com/physics/distance-time-graph/
4. https://www.toppr.com/guides/science/motion-and-time/