4 MOTION & TIME

Y8V3L2

Motion is a common experience in our life. We observe birds flying in air, buses, autos, cars, bullock carts, moving on roads , trains on railway tracks and many other objects around us in motion. Apart from observing motion of objects around us, we ourselves experience motion while we are walking, running, playing, riding a bicycle etc., Similarly we observe many objects like trees, buildings, display boards, electric poles etc., at rest while we walk to school.

Other than running, playing and walking when do you experience motion? Prepare a list.

When we sit inside a moving bus or train we observe that the objects like trees, buildings, electric poles etc., appear to be moving.

Are these trees, buildings, electric poles etc., really in motion or at rest?

To understand this we should understand the meaning of motion and rest.

Motion and Rest:

Observe the following pictures


Fig. 1


Fig.2 (2 sec later)

- What difference do you notice in the position of the car?
- What difference do you notice in the position of the tree?
- Why has this difference occurred?
- Is it because the tree moved to the right of the car or the car moved to the left of the tree?

We know that the position of the car has changed with respect to the tree in '2' seconds. But there is no change in the position of the tree with respect to its surroundings.

An object is said to be in motion if it changes its position with respect to its surroundings in a given time.

An object is said to be at rest if there is no change in its position with respect to its surroundings in a given time.

Thus, we can say that the tree is at rest and the car is in motion while we observe them over a period of time (2 seconds in this case).

Can you give some more examples of objects which are at rest or in motion?

Let us do - 1:
Observing motion of the car.


Fig .3


Fig.4

Look at the pictures. State which of the following statements are true.

i. The distance between the driver and the car changes. (   )

ii. The distance between the car and gate of the house is changed (   )

iii. There is no change in the position of gate of the house with respect to its surroundings (   )

iv. There is no change in the position of the car with respect to its surroundings (   )

Imagine that you sat in the above moving car beside the driver. Would you observe any change in the driver's position? Is there any change in the scene you view through the window (buildings, trees etc.)?

As the car moves, the distance between you and the landmarks like buildings, trees, poles etc., outside the car changes. This change in the scene you view through the window indicates that the car is moving. However your position with respect to the driver of the car remains the same.

That is, you and the driver of the car are at rest with respect to each other, but both of you are in motion with respect to the surroundings outside the car.

A body may be at rest with respect to one set of surroundings and at the same time be in motion with respect to another set of surroundings.

Thus motion is relative to the observer.

Let us do - 2:

Observing certain motions.

Observe the following pictures. Read the statement below the first picture and write similar statements about other pictures. Talk about them with your friends.

Fig. 5

The man in the boat is moving with respect to the bank of river. He is at rest with respect to the boat.

Fig. 6

The girl on the swing is .... with respect to the seat of the swing.

She is .... with respect to the garden.

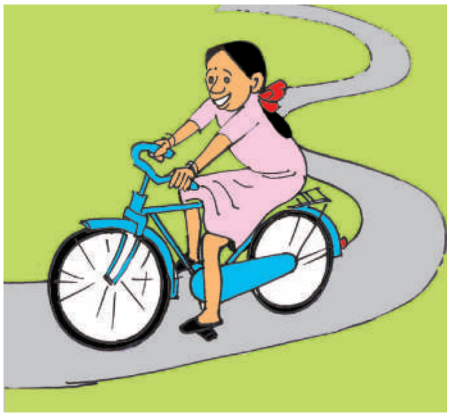


Fig. 7

The girl on the bicycle is ....with respect to the road.

She is .... with respect to the bicycle.

Uniform and non uniform motion

A body is said to be in motion if its position keeps on changing with time (with respect to the observer). But in our daily life we experience certain motion in which, the change in position of objects remains the same for a time interval. In some other motion, the change in position of an object will not be the same for a given time interval.

Imagine the movement of hands in a wall clock and the movement of a butterfly in a garden. In these two cases; hands of wall clock and the butterfly are in motion. They change their positions with time.

Fig. 8


Fig. 9

What difference do you find in the movement of the hands of a clock and the body of a butterfly?

In which case is the change of position with time constant?

We observe that in case of the wall clock, change in position of minute hand is the same for every minute. How do we know this? Measuring the angle between two positions of the minute hand is the way. But in the case of the butterfly, the change in its position is not constant while it is flying from one flower to another in the garden.

Let us do - 3:

Observing time and distance values.

Observe the following tables, showing distances travelled by two different cars for different intervals of time.

Time in Seconds	Distance Traveled
0	0 m
10	150 m
20	300 m
30	450 m
40	600 m

Car A

Time in Seconds	Distance Traveled
0	0 m
10	50 m
20	90 m
30	180 m
40	230 m

Car B

1. Which car has travelled equal distances in equal intervals of time ?
2. Which car has travelled unequal distances in equal intervals of time?

Obviously we notice that for car - A, the change in position in every 10 seconds is 150m but for car-B, the change in position is not constant. For 1^{st} 10 seconds, it is 50m, for 2^{nd} 10 seconds, it is 40m, for 3^{rd} 10 seconds it is 90m, and for 4^{th} 10 seconds it is 50m.

Thus motion of car - A is uniform and motion of car - B is non-uniform.

If a body covers equal distances in equal intervals of time, it is said to be in uniform motion.

If a body covers unequal distances in equal intervals of time, it is said to be in non-uniform motion.

Let us do - 4

Identifying Uniform and Non-Uniform motion.

Identify uniform and non-uniform motion among the following examples and mark Uniform as (U) and non uniform as (NU).

1. Movement of hands of a clock. (   )
2. A boy cycling in a crowded place. (   )
3. Movement of a housefly. (   )
4. The fan in an air cooler running at fixed speed. (   )
5. A train entering into a railway station. (   )
6. Kite in the air. (   )
7. Rotation of Earth. (   )

Types of Motion

When we discuss about motion, it is important to be aware that there exist different types of motion and each type is dependent on a particular situation.

Let us consider the following examples.

A car travelling along a straight road.

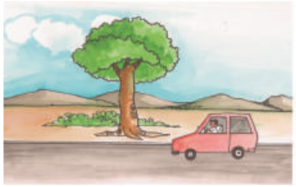
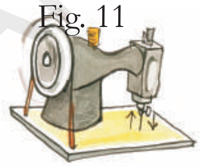


Fig. 10

Motion of blades of a ceiling fan

Fig. 11

Motion of needle in a running sewing machine



Motion of pendulum in an old wall clock

Fig. 12

Considering the direction of motion what differences do you notice in the above examples?

The motion in the above examples are different in terms of direction of motion.

- Car is moving in same direction along a straight line.
- Blades of ceiling fan rotate about a fixed line in a circular path.
- Needle of sewing machine moves up and down about a fixed point.

- Pendulum of the wall clock oscillates 'to' and 'fro' about a fixed point.

Based on the path taken by the bodies in motion we classify motion of bodies as,

1. Translatory motion 2. Rotatory motion 3. Oscillatory motion

Translatory motion

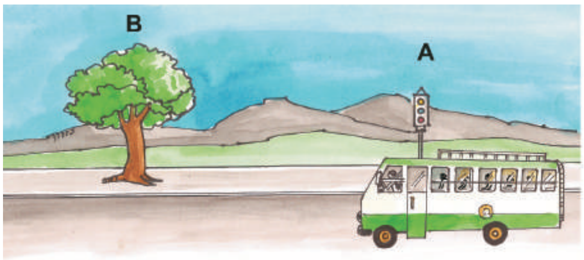


Fig. 13

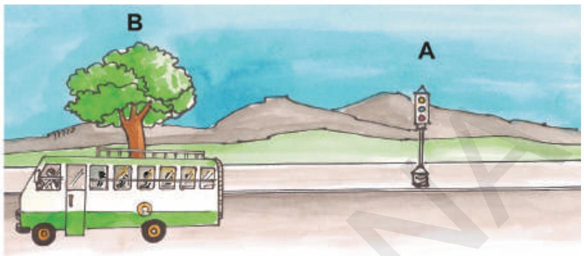


Fig. 14

The bus moved from point 'A' to 'B', in a certain interval of time.

Think and answer the following questions:

1. Do all the parts of bus (like wheels, head lights, windows etc.,move along from point 'A' to 'B'?
2. Is the direction of motion of bus along a straight line or a curved line?

Can you give some more examples of motion in which all points of moving body move in the same direction as that of the body?

Let us do - 5: Observing the path of the motion.

Observe the following table, and state the paths of motion for each case by putting (✓) mark in the relevant column .

Sl. No.	Movement of body	Path of motion	
		Straight line	Curved line
1	Soldiers marching in a parade		
2	Car taking a turn on road		
3	Stone dropped from a height		
4	Running race along a road		
5	Running race along a track on a ground		
6	Movement of bicycle on a road		

In all the above cases of motions, do all the points of moving objects move in same direction of motion?

> If all parts of a moving body move in the direction of motion then the motion is said to translatory motion.

If a body in translatory motion moves along a straight line then motion is called rectilinear motion.

If a body in translatory motion moves along a curved path then motion is called curvilinear motion.

Let us do - 6: Identifying types of motion.

We notice everyday some motion which are rectilinear and curvilinear at a time. Some examples of motions are given below: Label them as rectilinear (R) or curvilinear (C) or Rectilinear and curvilinear (RC) motion.

1. Seconds hand of a watch. ( )
2. Movement of a train on tracks. ( )
3. Movement of a tape in a tape recorder. ( )
4. Movement of a needle in a speedometer of car. ( )
5. Movement of a bus on hill station road. ( )
6. Motion of coins on a carrom board. ( )
7. Motion of the ball in pin board. ( )
8. Motion of a mango falling from tree. ( )

Rotatory motion:

Let us do - 7:

Observe the following diagrams

Fig. 15

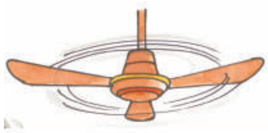


Fig. 16

Fig. 17

Fig. 18

Fig. 19

Fig. 20

1. What similarity do you find in all the motion?
2. What is the path of motion of each particle of the body that moves?
3. Is there any change in the position of a body while it is in motion?

Let us examine motion of blades of ceiling fan. Consider one blade of the rotating ceiling fan drawn below.

While the blade of a fan is moving, the points A, B, and C on the blade move to A_1, B_1, C_1 first and then move to A_2, B_2 and C_2 position. Thus when a fan is in motion, each point on the blade moves in a circular path around the centre of the fan which is fixed.

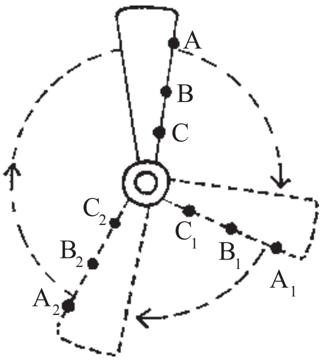


Fig. 21

Here, we observe that the position of a fan is not changing. Only the blades of fan are changing their position continuously and moving in circular path around a fixed point. The imaginary line passing through this fixed point is called axis of rotation. This type of motion is called Rotatory Motion.

Rotatory motion means that, motion of all particles of a moving body follow a circular path with respect to a fixed centre or axis of rotation.

1. Are all the objects shown in activity - 7 in rotatory motion?
2. Can you give some more examples of rotatory motion?

Let us do - 8:

Observe the following motion of objects, State whether they are in rotatory motion? Draw a line showing axis of rotation by using a pencil.

1.  ....

Fig. 22

2.  ....

Fig. 23

3  ....

Fig. 24

 ....

Fig. 25

Let us do - 9:

Take a table tennis ball, and keep it on the surface of a table. Push the ball with your finger and observe its motion.

Fig. 26

Is it in Rotatory motion or in Translatory motion?

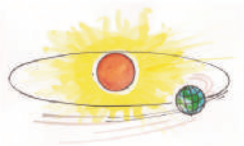
When you push the ball on the surface of a table, it moves from one end to the other end and all the particles of the ball also move along the direction of motion of the ball. Hence the ball is in translatory motion. Similarly, each particle of the ball moves in a circular path about a particular line, when the ball rolls on the surface. Therefore it is in rotatory motion.

Thus in the above example the ball possesses both translatory and rotatory motion.

Can you give some more examples of objects having both translatory and rotatory motion?

Let us do - 10:

Observe following motion of bodies and label them as Rotatory (R), Translatory (T), Translatory and Rotatory (TR)

1		Motion of blades of a ceiling fan	
2		Motion of an arrow from a bow	
3		Motion of the earth around the sun	
4		Motion of a drill bit	
5		Motion of wheels of an object	

Oscillatory motion:

Observe the following pictures and answer the following questions.


Fig. 27


Fig 28


Fig. 29


Fig. 30

- What similarity do you find in the motions of the above given situations?
- Are the objects in motion following the same path again and again?
- Is the direction of motion constant?

If we critically examine the above mentioned motion, we understand that in each case the objects move backwards and forwards or upward and downward, on the either side of a fixed point or a line. For example, the girl on a swing moves backwards and forwards, on either side of the rest position of the swing.

Similarly in other cases also the body is in 'to' and 'fro' motion along the same path of motion. This type of motion is called oscillatory motion.

The 'to' and 'fro' motion of an object about a fixed point always following the same paths is called oscillatory motion.

Can you give some more examples of such type of motions?

Let us do - 11

Identify oscillatory motion among the following and put (✓) mark in the brackets given.

1. A spinning top ( )
2. Bullet fired from a gun ( )
3. Typewriter key ( )
4. Motion of a potter's wheel ( )
5. Motion of a vibrating sitar string ( )
6. Motion of a car taking a turn while moving ( )
7. Ringing of a bell ( )
8. A bouncing ball ( )

4.1 Slow and Fast Motion:

We observe many objects in motion in our daily life. In some cases objects move slowly and in other cases they move fast. How do we know whether the motion is slow or fast?

Let us assume that you started to school on a bicycle and your friend started in a bus at the same time from a place.

- Who reaches the school first? Why?
- Do you find any difference in the time taken by bicycle and bus to reach the school?

Let us do - 12: Comparing the motion of objects.

Observe following pairs of objects that are in motion. Compare their motions and decide which moves slower and which move faster. Mark (✓) in relevant box.

S.No.	Pairs of Objects in Motion	Slow	Fast
1	a. Aeroplane		
	b. Train		
2	a. Bus / Auto Rikshaw		
	b. Rikshaw		
3	a. Bicycle		
	b. Scooter		
4	a. Elephant		
	b. Cheetah		
5	a. Dog		
	b. Buffalo		
6	a. Man		
	b. Horse		

- How can you decide whether the motion of a body is slow or fast?

- Do we need to know about distance covered, time taken by the body in motion to decide whether the motion is slow or fast?

Let us look at details of a running race.

Priya, Karthik, Divya and Kiran participated in a 100 m. running race. They took 20 s, 22s, 25s and 28s respectively to reach the finishing line.

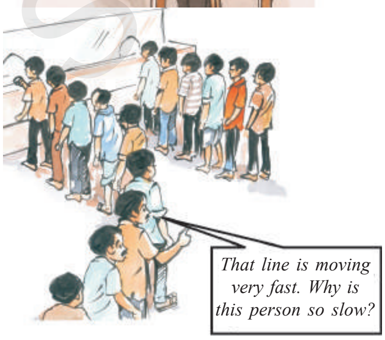
Who do you think ran the fastest and whose running is slowest? Why?

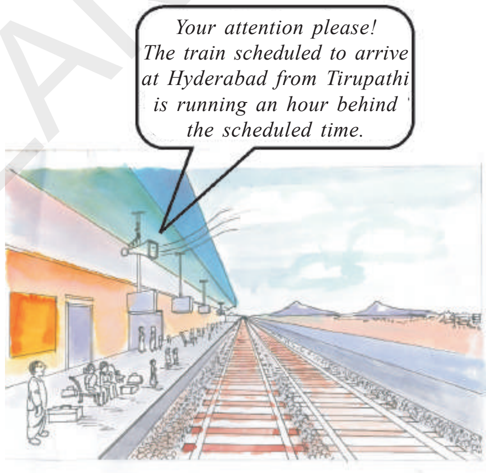
Obviously we can see that all of them ran the same distance of 100 m but time taken to cover the distance was different. Priya took the shortest time of 20 seconds which shows that she was the fastest.

Thus we understand that the distance travelled by an object in a given interval of time can help us decide which one is faster and which one is slower.

Time:

We use the word time very often in our daily life. Look at the following examples.





If we observe the above examples, we use the word 'time' for different purposes. In some situations, without using the word 'time', we express the duration of time like 'so late', 'so early' etc.

How do we measure or estimate time?

Let us do - 13: Estimating time.

Ravi and Sathish started for school at 8.00 a.m. from their houses which are side by side. Ravi started on a bicycle and Sathish by walk.

- Who will reach the school first? How much earlier will he be compared to the other?
- How do you measure 'early' or 'late' arrival at school?

You can easily estimate that Ravi reaches the school earlier than Sathish. But to answer the question of how early Ravi reached, we need to measure the times taken by both Ravi and Sathish and find the difference of time between both the cases.

For this we need time measuring instruments like watches, clocks etc.

Try to give some more examples of how to measure time in addition to watches

Now-a-days, we use different instruments like electronic clocks, digital clocks, quartz clocks etc to measure time. A few decades ago people used pendulum clocks that have now become rare.

Fig. 31

Fig. 32

Do you know:

Like minutes and hours, week, fortnight, month, season, ayanam are also units for measuring time. Sand clock, water clock, sun dial etc. were used earlier instruments for estimating time.

Measurement of time using stop clock

Stop clocks are used to measure time interval between occurrence of events accurately. You might have seen stop clocks in the laboratory. We use stop clocks in the laboratory to measure short intervals of time like time taken for completion of chemical reaction, time taken by the pendulum for one oscillation etc.

Fig. 33

Fig. 34

Now-a-days we find stop clocks almost in all cell phones. In our daily life stop clocks help measure pulse rate etc. Apart from this, they also help us to accurately measure the times in running races , swimming races etc.

Let us try to measure time using a stop clock.

Let us do - 14:

Take a cell phone . Go to 'setting' and open 'stop clock' option. If you are not able to do this take help from your friend or teacher. Measure the time taken for the events mentioned in the table.

Event	Duration of Time
Ringing of long bell in the school.	
Completion of prayer song	
Running 200m by your friend in the school ground.	
Completion of pledge during school assembly	

Which event has taken more time to complete? Let us know, how much time does it take to sing the national anthem?

Units of time:

Depending on the context, we express time in seconds or minutes or hours to specify the occurrence of and time taken by an event.

The basic unit of time is a second (s). Larger units of time are minutes (min) and hours (h).

Table: Units of time

60 seconds	1 minute
60 minutes	1 hour
24 hours	1 day
365 days	1 year
10 years	1 decade
10 decades	1 century
10 centuries	1 millennium

Speed:

Many objects in the world around us are moving. To compare how fast they are moving, we need to know their speed.

You may have observed the speedometer in motor cars which tells us how fast the car is travelling.

Usually, the Odometer in a vehicle shows the distance travelled in kilometers and the Speedometer the speed of the journey in kilometres per hour.

Look at the speedometers of two vehicles shown here and decide which vehicle is slower.


Car - 1


Car - 2.

Have you seen any other vehicles having speedometers? Write their names?

Have you seen a bicycle with a speedometer?

Do the following activity:

Travel on a motor vehicle with your father to market or any other place and observe the changes in speedometer reading.

Note the exact time when you started from home and observe speedometer reading carefully and note it and the corresponding

Speedo Meter Reading (Speed)	Corresponding Time (Time)
0	Started at home 9-10 a.m.
20	9.15 a.m.
30	9.20 a.m.

time in the table. Some examples are given in the table.

- Does the speed of the vehicle remain the same throughout the journey?
- If not, what can you say about the speed of the vehicle during the journey?

We experience in our everyday life that most of the objects in motion do not have the same speed throughout the journey. To express the speed of the object, we consider its average speed.

How to calculate the average speed?

Average speed = Total distance travelled / Total time taken to travel the distance

Thus we can define speed of an object as the distance travelled by it in a unit of time.

Units of speed

Depending on the need and context, speed is measured in different units.

Unit of speed in S.I. system is meter per second (m/s)

Another unit commonly used for speed is kilometer per hour (Km/h)

$$1 \text{ Km / h} = 5/18 \text{ m/s}$$

Do you know how we got this?

$$1 \text{ km} = 1000 \text{ m}$$

$$1 \text{ h} = 3600\text{s}$$

$$1 \text{ km / h} = 1000 \text{ m / } 3600\text{s}$$

$$= 5/18 \text{ m/s}$$

If we travel 1km in 1 hour it means we travelled 5 meters in 18 seconds.

Consider a car driven on a road. A person seated beside the driver recorded the distance travelled after every 10 minutes by noting the distance reading in the Odometer. The distance travelled by the car at different instances of time is as follow.

Time	Reading of Distance Covered
0 minute	0 km
10 minute	15 km
20 minute	25 km
30 minute	38 km
40 minute	60 km

- What is the total distance travelled by the car?
- What is the time taken to travel the distance?
- How do you find the speed of the car?
- Is the speed of the car uniform throughout the journey?

From the table, we notice that the car has covered unequal distances in equal intervals of time (10 min), which shows the speed of the car is not uniform. To find the speed of the car in the journey we should calculate total distance travelled by the car and the total time taken to cover that distance.

Total distance travelled by the car = 60 km

Time taken = 40 min.

The distance must be either in meters or kilometers and time in seconds or hours. We express the speed either in m/s or in km/h. In this example distance is 60 km and time is 40 min.

$$1 \text{ hour} = 60 \text{ min}$$

$$40 \text{ min} = \frac{40}{60} hour = \frac{2}{3} h$$

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$= \frac{60 \text{ km}}{\frac{2}{3} h} = 60 \times \frac{3}{2} km/h = 90 \text{ km/ h}$$

Thus, the car travelled with an average speed of 90 km/h.

Solve the following problem

The speed of a bus is 72 km/h, whereas the speed of a car is 12.5 m/s. Which vehicle moves faster?

To compare two speeds. They must be expressed in the same units. In the above example, speed of a bus is expressed in km/h and the speed of a car in m/s, to compare these speeds, one of them must be converted to other.

Speed of a bus = 72 km/h

Speed of a car = 12.5 m/s

1 km/h = 5/18 m/s

1 m/s =18/5 km/s

Thus the speed of car is

12.5 x 18/5 km/h = 45 km/h

Hence, the bus moves faster than the car

Key words:-

Motion, Rest, Translatory motion, Rotatory Motion, Axis of Rotation, Oscillatory Motion, Speed, Average Speed.

What we have learnt?

- Motion is a common experience in our life.
- An object is said to be in motion if it changes it's position. And it is said to be in rest if it does not changes it's position with respect to time.
- There are three types of motion namely translatory motion, rotatory motion and oscillatory motion.
- We measure time by using diffrent instruments like electronic clocks, digital clocks, etc.
- Speedometer helps us know the speed of a vehicle.
- Units of speed in SI system is meters per second. In another system it is kilo meter per hour

Improve your learning

A5B6X9

1. State whether the following statements are True or False. Rewrite the wrong statements correctly.

   a) A body can be at rest and in motion at the same time in relation to the same set of surroundings.

   b) A passenger flying in an airplane is at rest with respect to the airport and moving with respect to other passengers.

   c) The wheels of a train are in rotatory motion as well as in translatory motion, when it moves.

2. John tied a stone to a string and whirled it around. What type of motion do you find there?

3. What is common to the following? Motion of the propeller of a flying helicopter, the minute hand of a watch, the tape of a cassette recorder.

   a) All are examples of translatory motion

   b) All are examples of oscillatory motion

   c) All are examples of rotatory motion

   d) All are examples of periodic motion

4. Which of the following is not an oscillatory motion?

   a) Motion of the hammer of an electric bell.

   b) Motion of your hands while running.

   c) Motion of a child on a see - saw.

   d) Motion of a horse pulling a cart.

5. Arun completed a 100 meter race in 16s., while Karthik finished it in 13s. Who ran faster ?

6. **I.** A train runs from New Delhi to Hyderabad. It covers first distance of 420 km in 7 hrs. and next distance of 360 km in 6 hrs.

   II. Gopi takes part in a car race. He drives a distance of 70 km each in the first, second and third hours.

   Which of the following statements is true.

   a) I, is an example uniform motion and II is an example of non-uniform motion.
   b) I is an example of non-uniform motion and II is an example of uniform motion.
   c) I and II are examples of uniform motion.
   d) I and II are examples of non-uniform motion.

7. Write the motion of different parts of a bicycle while it is in motion.

   a) the wheel
   b) the cycle chain
   c) the pedal with its arm
   d) the movement of the feet pedaling
   e) the movement of the rider along with the bicycle.

8. Which of the following statements is correct?

   a) The basic unit of time is second.
   b) Every object's motion is uniform.
   c) Two cars move for 5 minutes and 2 minutes respectively. The second car is faster because it takes less time.
   d) The speed of a car is expressed in km/h.

9. The basic unit of speed in SI system is

   a) km / min b) m/min.
   c) km/h d) m/s

10. The correct relation between speed, distance and time is.

    a) Speed = distance x time
    b) Speed = time / distance
    c) Speed = distance / time
    d) distance = speed / time

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

12. A train travels at a speed of 180 km/h. How far will it travel in 4 hours?

13. When do you say an object is in rotatory motion?

14. Can an object possess translatory and rotatory motion at the same time? Give an example.

15. Make a collection of action pictures showing living and non-living things in motion. Paste them neatly in a scrap book. Under each picture write the type of motion the picture shows.

16. In a sewing machine used by tailors, mention the type of motion of sewing machines parts when it runs.

    a) the wheel
    b) the needle
    c) the cloth