13 Motion and Time

Lesson at a Glance

- **Motion:** The act or process of moving or of changing position or change of posture or a gesture is called *motion.*
- **Types of Motion**
  - (*i*) **Linear motion:** The movement of an object along a straight path is known as *linear motion.* For example, movement of a ball on a plane ground, moving vehicles on a straight road. The motion of a carrom-board coin hit by a striker is also linear.
  - (*ii*) **Circular Motion:** Some objects like a merry-go-round, wheel of a sewing machine, an electric fan and a potter's wheel move in a circle. Their motion is called *circular motion.*

    Circular motion in some cases is also known as *spinning motion.* A top spinning around its nail and our earth spinning around its axis are other examples of spinning motion.
  - (*iii*) **Vibrational Motion:** You might have observed a *Sitar* or *tabla* player playing these instruments. How do the strings of the *Sitar* or skin of the *Tabla* move?

    The motion of the string is called vibrational motion. In *vibrational motion,* an object moves repetitively and changes its shape and size. For example, when we pluck the strings of a *Sitar,* the strings have vibrational motion.
  - (*iv*) **Oscillatory Motion:** Some objects like a swing, a pendulum of a clock move to and fro. The motion of these objects is repetitive, one complete to and fro motion of such objects is known as one oscillation. Such a motion is called *oscillatory motion.*
  - (*v*) **Periodic Motion:** Oscillation of a Pendulum may be big or small but it takes some time to complete one oscillation. Such a motion is known as *periodic motion.* Periodic motion is repetitive and takes place after a regular interval of time. The motion of a clock pendulum, the motion of hands of a clock and the beating of heart are examples of periodic motion.
  - (*vi*) **Random Motion:** You might have observed the motion of hockey or football players while playing in the playground. Their motion is not along a definite path but they keep on changing direction of motion. A mosquito also moves in zigzag path. When the objects do not move along a definite path but their directions keep on changing then they are said to have *random motion.*

    It is interesting to note that an object can have more than one type of motion at the same time, for example, in a cricket match, the ball delivered by a spin bowler has linear and spinning motion simultaneously. When we spin a top or a phirki on a plane ground, it also possesses oscillatory and linear motion.

    When the moving body covers small distance in certain interval of time, its motion is said to be *slow.* For example, movements of an ant and a snail are slow.

    When a body covers large distance in small interval of time, its motion is said to be *fast.* For example, a person moving in a car or aeroplane.
- **Uniform and non-uniform (Variable) movements.**
  - (*i*) When a body covers same distances in same intervals of time (however small the interval may be), its motion is said to be *uniform motion.*
  - (*ii*) If a body covers different distances in same intervals of time, its motion is said to be *non-uniform* (*variable*) *motion.*
- **Speed:** It can be observed that the rate of change of position, i.e., change of position in unit time of two objects may vary. For example, the rate of change of position of an aeroplane is much greater than the rate of change of position of a bus. In the language of physics we say that speed of an aeroplane is greater than the speed of a bus.

  The rate of change of position of an object is its *speed.* When an object covers a distance S, in time T, speed is given by relation,

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{S}{T}$$

The unit of speed is metre per second, i.e., m/s. When a man moves 3 metre in one second, then his speed is said to be 3 metre per second, i.e., 3 m/s.

Sometimes, speed is also expressed as kilometre per hour (km/h). A truck moving a distance of 60 kilometre in an hour is said to possess speed of 60 km/h.

- **Units of Time and Speed:**

(*i*) Since the speed is distance/time, the basic unit of speed is m/s. Of course, it could also be expressed in other units such as m/min or km/h.

You must remember that the symbols of all units are written in singular. For example, we write 50 km and not 50 kms, or 8 cm and not 8 cms.

Minute	1 minute has 60 seconds in it
Hour	1 hour has 60 minutes in it.
Day	1 day has 24 hours in it.
Month	1 month has 30 or 31 days in it (However, February has 28 or 29 days)
Year	1 year has 365 days in it (366 days during a leap year)

(*i*) How many seconds there are in a day?

Number of seconds in a day = 60 × 60 × 24 = 86400 s

(*ii*) How many hours in a year?

Number of hours in a year = 24 × 365 = 8760 hours

- **Graph:** A *graph* is used to study the relation between two inter-dependent physical quantities. The graph shows how one quantity varies with the other. The quantity that is made to alter at will is called *Independent variable* and the other quantity which varies as a result of this change is known as *Dependent variable.* The graph may be a straight or curved line.
- **Speedometer:** It records the speed of vehicle directly in km/h.
- **Odometer:** This meter measures the distance moved by the vehicle.

TEXTBOOK 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 on a see-saw.*

(*v*) *Motion of the hammer of an electric bell.*

(*vi*) *Motion of a train on a straight bridge.*

Ans. (*i*) Oscillatory motion

(*ii*) Linear motion

(*iii*) Circular motion

(*iv*) Oscillatory motion

(*v*) Oscillatory motion

(*vi*) Linear 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*), (*v*)

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

Ans. Time taken to complete 20 oscillations = 32 s

Time taken to complete 1 oscillation = 32/20 s = 1.6 s

Time period of a pendulum is time taken by it to complete 1 oscillation.

∴ Time period of pendulum is **1.6 seconds.**

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. Distance = 240 km

Time taken = 4 hours

$$\text{Speed} = \frac{\text{Distance covered}}{\text{Time taken}} = \frac{240 \text{ km}}{4 \text{ h}}$$

= 60 km/h

Speed of train = **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 08:50 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. Distance = 57336.0 km – 57321 km = 15 km

Speed in km/min $= \frac{15 \text{ km}}{20 \text{ min}} = \frac{3}{4}$ km/min

Speed in km/hr $= \frac{15 \text{ km}}{\frac{1}{3}\text{hr}}$

= (15 × 3) km/hr

= **45 km/hr.**

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/min, calculate the distance between her house and the school.*

Ans. Time taken = 15 min

Speed = 2 m/min

Distance = speed × time

= 2 × 15 = 30 m

Distance between Salma's school and her house is **30 m.**

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.

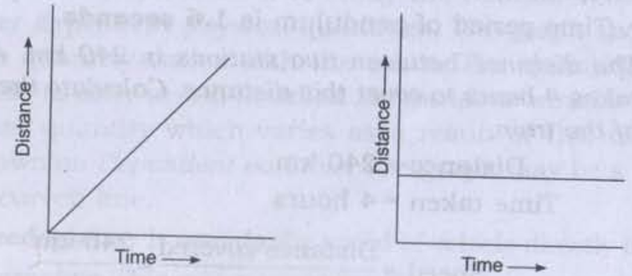

Fig. 13.1

Q.8. *Which of the following relations is correct?*

(i) *Speed = Distance × Time*

(ii) *Speed = Distance/Time*

(iii) *Speed = Time/Distance*

(iv) *Speed = 1/Distance Time*

Ans. (ii) Speed = Distance/Time is correct.

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. (ii) 25 km

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

Ans. 0.1 cm/s or 10 m/s

Q.12. *Fig 13.2 shows the distance-time graph for the motion of two vehicles A and B. Which one of them is moving faster?*

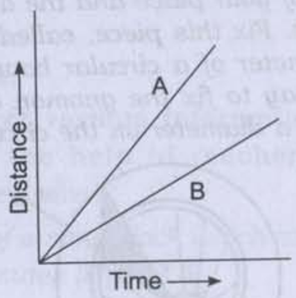

Fig. 13.2

Ans. 'A' is moving faster.

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

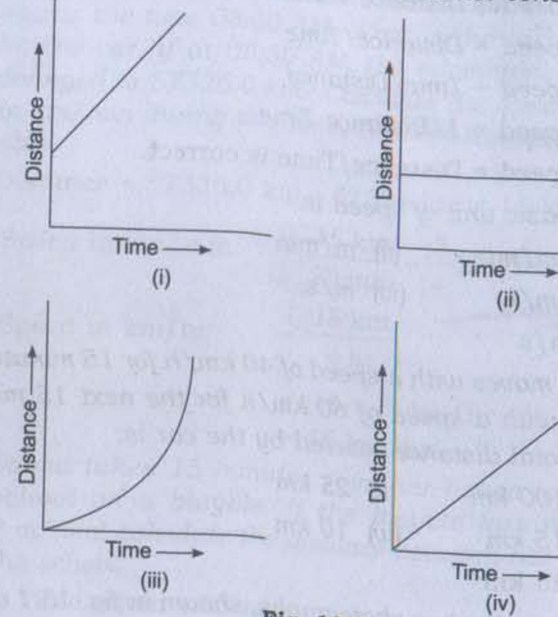

Fig. 13.3

Ans. *(iii)*

EXTENDED LEARNING — ACTIVITIES AND PROJECTS

Q.1. *You can make your own sundial and use it to mark the time of the day at your place. First of all find the latitude of your city with the help of an atlas. Cut out a triangular piece of a cardboard such that its one angle is equal to the latitude of your place and the angle opposite to it is a right angle. Fix this piece, called* ***gnomon****, vertically along a diameter of a circular board as shown in Fig. 13.4. One way to fix the gnomon could be to make a groove along a diameter on the circular board.*

Fig. 13.4

Next, select an open space which receives sunlight for most of the day. Mark a line on the ground along the North-South direction. Place the sundial in the sun as shown in Fig. 13.4. Mark the position of the tip of the shadow of the gnomon on the circular board as early in the day as possible, say 8:00 AM. Mark the position of the tip of the shadow every hour throughout the day. Draw lines to connect each point marked by you with the centre of the base of the gnomon as shown in Fig. 13.4. Extend the lines on the circular board up to its periphery. You can use this sundial to read the time of the day at your place. Remember that the gnomon should always be placed in the North-South direction as shown in Fig. 13.4.

Ans. The students prepare gnomon and find out the time at any place with the help of gnomon themselves or with the help of their friends.

Q.2. *Collect information about time-measuring devices that were used in the ancient times in different parts of the world. Prepare a brief write up on each one of them. The write up may include the name of the device, the place of its origin, the period when it was used, the unit in which the time was measured by it and a drawing or a photograph of the device, if available.*

Ans. The time measuring devices used in ancient days are:

(*i*) Sundial: It is situated at Jantar Mantar in Delhi.

(*ii*) Sand clock.

(*iii*) Water clock.

Students collect various information from various sources with the help of teachers, parents and newspapers themselves.

Q.3. *Make a model of a sand clock which can measure a time interval of 2 minutes (Fig. 13.5).*

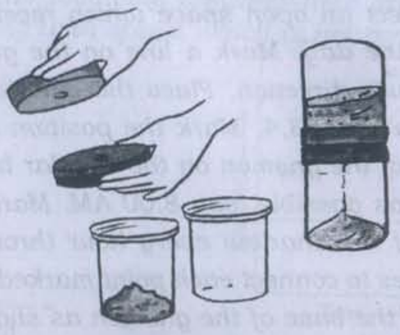

Fig. 13.5

Ans. Do it yourself.

Q.4. *You can perform an interesting activity when you visit a park to ride a swing. You will require a watch. Make the swing oscillate without anyone sitting on it. Find its time period in the same way as you did for the pendulum. Make sure that there are no jerks in the motion of the swing. Ask one of your friends to sit on the swing. Push it once and let it swing naturally. Again measure its time period. Repeat the activity with different persons sitting on the swing. Compare the time period of the swing measured in different cases. What conclusions do you draw from this activity?*

Ans. Compare the time period of swing oscillation without anyone sitting on it again with you are sitting, then two students are sitting then 3, 4 and so on. Measure the time period of swing in each case. We conclude that as the mass on swing increases the time period decreases.