Chapter 11

Time and Speed

Points to be studied:

11.1 Concept of Time
11.2 Simple pendulum and its time-period
11.3 Unit of Time
11.4 Concept of speed
11.5 Speed and time graph

Whatever we do time passes on continuously. So, it becomes extremely important for us to have knowledge about time. If you do not have a watch then how will you decide what is the time right now? Are you not eager to know that how our ancestors could tell the approximate time of the day by just looking at shadow? At capital city Jaipur of Rajasthan, we have a **"Large Samrat clock"** sun clock at Jantar - Manter which measures even 2 secs with accuracy. It was built in 1735 AD by Maharaja Swai Jai Singh. In the same manner, sand clock and water clock, were used to measure time during ancient times.

Fig. 11.1 Jantar Mantar

11.1 Concept of Time

Fig. 11.2 Sand clock

Our ancestors saw that many periodic events occurred in nature which happens repeatedly after specific time intervals by which we come to know about time and time intervals. These are -

1. **Solar Day :** Sun rises in morning every day. Time interval between one sun rise and the next sun rise is known as one "Solar-day"
2. **Moon Month :** Period between new moon to next new moon is called as one "Moon-Month".
3. **Year :** The time at which earth completes one revolution around the sun has been fixed as one year time period.

If mean solar day is assumed as standard time and it is divided into 24 equal parts then 1 day = 24 hours.

Similarly, if one hour is divided into 60 equal minutes and one minute is divided into 60 eqaul seconds, then

1 hour = 60 minutes

1 minute = 60 seconds

Similarly, you will find that 1 hour has 3600 seconds and 1 day has 86400 seconds.

Now find out how many hours and seconds are there in 1 year?

Now, you may have come to know that how we measure the time-interval for one day or one month or one year. Our ancestors had made periodic motion as base for measuring time. To measure time, a normal device is clock. The working principle of clock is very complicated. However, all watches work on the basis of periodic motion. The well known example for periodic motion is simple pendulum.

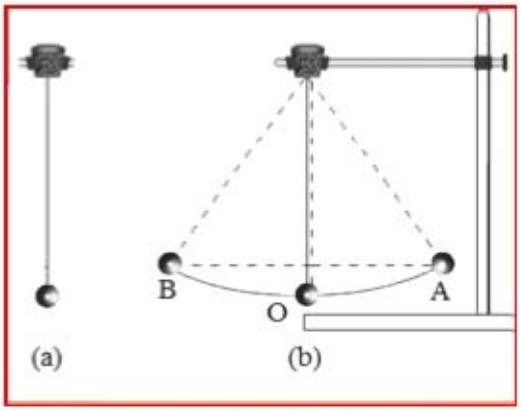


Figure 11.3 Simple Pendulum

11.2 Simple pendulum and its predict time :

The oscillation that is produced by a small metallic ball or a piece of stone suspended from rigid support by a thread is called a simple pendulum (figure 11.3). The small metal sphere is known as ball for simple pendulum.

In Figure 11.3(a), a simple pendulum is shown at rest position. It is the mean position of pendulum. When the bob of pendulum is to either side from rest position and released slowly, it begins to move to-and-fro. This motion is called Oscillatory motion. As shown in fig 11.3 (b), as the pendulum, starting from its mean position O, moves to A, from A to B and back from B to A is said to have completed one oscillation. Similarly, a ball starts to move form extreme position A to another extreme position B and again from B to A, it is also known to complete one oscillation.

> Time taken by the pendulum to complete one oscillation is called periodic time of simple pendulum.

Activity 1

Calculation of periodic time:

Take more than one meter long thread or rope and make a simple pendulum as shown in figure 11.3 by hanging the thread on a nail or a stand and ensuring that length of simple pendulum is one meter (100 cm.). Switch off any

fans nearby. Wait till the bob of pendulum comes at rest. Mark the mean position of bob on wall behind it or on the floor below it. To measure time-period of pendulum, we need a stop-watch. If stop-watch is not available then table-watch or wrist watch can be used.

To set the pendulum in motion, gently hold the bob and move it slightly on one side and make sure that the string attached to the bob is taut as you displace it. Now release the bob from displaced position, making sure that there is no jerk on bob during release. Note down the time from a clock when bob passes through the mean position. You can also note the time when the bob is in either extreme position. Measure the time taken by a pendulum for 20 oscillations. Table 1.1 has sample observations. Your observation may be different from it. Repeat the activity for three to four times and note it down in the table. Now, to get periodic time for one oscillation, divide the time taken in 20 oscillations by 20 i.e. Calculate the periodic time for pendulum.

Table 11.1 The periodic time for simple pendulum (rope length =100 cm.).

Sr. No.	Number of Oscillations (N)	Time taken for Oscillations (t)	Time-period = t/N
1	20	40 second	40/20=2.0 second
2	20	.....second	.....
3	20	.....second	.....
4	20	.....second	.....
5	20	.....second	.....

Is the periodic time for the pendulum approximately equal each time?

Note that slight variation in initial displacement does not affect the periodic time of a pendulum.

11.3 Unit of time:

International unit of time is seconds. It is a small unit of time. The time interval of one second is how much short or long? The pronunciation of two or three words loudly likes **"Jai Rajasthan"** takes approximately one second by us. At rest, the pulse rate of a normal healthy man 72 times in one minute. i.e., 12 times in 10 second. In children, it can be slightly increased.

What are the other big units of time? Show by writing in Table 11.2.what is the relation between different units of time like minute, hour, day, year, etc. with

smaller time units?

Table 11.2 Time units and their relations

Sr. No.	Unit name	Relation with small unit
1	Minute	1 Minute = ...Second
2	Hour	1 Hour = ... Minute = ...Second
3	Day	1 Day = ...hours = ...Minutes
4	Year	1 Year = ...Day = ...Hours

According to necessity, the different units of time can be used. For example, age of person is easy to express in unit of years compared to days or hours. Similarly, it is not wise to express the time taken to travel from home to school in one year.

Now a days, most of clocks have electronic circuits of one or two cells. These clocks are called quartz clocks. The time measured by these watches is more accurate as compared to earlier watches. In addition, today the electronics or digital clocks are also available in which time is expressed in digits.

Fig. 11.4 Digital watch

Today specific clocks are available for use in scientific research. Among them few are able to measure ten millionth fraction of one second (micro second) and also one trillionth part of a second (nano second).

India's National Physical Laboratory, New Delhi provides time maintenance service. The clocks are available here can measure of ten millionth of one second with accuracy.

11.4. Concept of speed.

We know that any change in the position of an object with respect to time is said as motion of the object. In our surroundings, we see many objects in motion. Among them few objects move fast and few objects move slowly.

Let us assume that a bullock cart and motorcycle both are moving simultaneously along a straight line path, tell which moves fast or slow?

Similarly, take the objects which move on straight line motion and pair them and then classify their speed as slow or fast in table 11.3 in two separate columns.

Table 11.3 Slow and fast motion.

Sr. No.	Pair of objects	Slow motion	Fast motion
1	Car and Motorcycle		
2			
3			
4			
5			
6			
7			
8			

How have you ensured which object is moving slowly and which is moving fast?

"In a fixed time if an object 'A' travels more distance as compared to other object 'B', then we say that Object 'A' is moving faster than object 'B'."

When the object moves fast, then we say that the speed of the object is more and when object moves slowly then we say that the speed is less.

To know, which object is moving faster among two or more objects, the simplest method is to calculate the distance covered by an object in unit time. Let us assume that two cars are moving. First car travels 50 km in an hour and second car travels 65 km in an hour. It is clear that the second car is moving fast.

Distance covered by an object in a unit time is called speed.

Similarly, if we know the distance travelled by two objects in an hour then we may say which has more speed and which has less speed. When a car or bus starts to move, initial speed is slow then it raises its speed. Its speed doesn't remain constant during the motion, sometimes it's speed is more and sometimes it is less due to turn or any other obstruction that comes across on the road. So, no vehicle moves with a constant speed (constant speed) in an hour. If the speed of an object along a straight line path keeps on changing

then it is called non-uniform speed of that object. When we say that a car has speed of 50 km per hour, usually we only consider the distance travelled by a car in one hour. We do not bother about the speed of car as uniform or non-uniform in one hour. In reality, the calculated speed is the average speed of a car. In this chapter, the word speed has been used for average speed.

When an object moves along on straight line path with constant speed then it is known constant speed or uniform speed. In the condition of uniform speed, the average speed is equal to its actual speed.

The calculation of speed is done by dividing the total distance covered by the object by total time taken.

$$\text{Speed} = \frac{\text{Total distance covered}}{\text{time taken in covered distance}}$$

So, if we measure the total distance covered by an object and time taken to cover it then we can calculate the speed of an object.

If we know the speed of an object. you can calculate the distance covered by in it given time. For that you have to multiply the speed of the object with time.

$$\text{Distance travelled} = \text{Speed} \times \text{Total time taken}$$

$$\text{Time taken} = \frac{\text{Total distance covered}}{\text{Speed}}$$

You can also calculate how much distance can be covered by on object in given time for a given speed.

Activity 2

Measurement the speed of an object

Draw a straight line on the floor and tell your friend to stand about 2 meters away from this line. Ask your friend to roll a ball slowly perpendicular to the straight line along the floor. Now, take a stop-watch and start it when the ball crosses the straight line and stop the watch the moment the ball becomes still. In this way you can find out how much time the ball takes to come to rest. Measure the distance between straight line and stop point of the ball by a tape or a scale. Write down the time and distance measurements in table 11.4 and also repeat the activity 4-5 times. Calculate the speed of ball from these measurements.

Table 11.4 Measurement of speed

Sr. No.	Distance travelled by the ball (S) in meter	Time taken (t) in seconds	Speed = $\frac{\text{total distance travelled}}{\text{time taken}}$ (meter per second)
1			
2			
3			
4			
5			

Unit of speed

In above activity, you have calculated the speed in units of Meter per second. The international unit (SI) of speed is meter per second. The other units of speed are centimetre per second (cm/s), kilometre per second (km/s), kilometre per hour (km/h), etc. You must remember that all the symbols of units are written in singular person. For example, for distance we write 50 km, but not 50kms or 8cm but not 8cms.

Fig. 11.5 Speedometer and odometer

You may have seen a meter in motorcycle, car, bus, or other vehicle as shown in figure 11.5. Observe the meter of any vehicle. Km/h is written on the meter. It is known as **"Speedometer"**. By this, speed can be measured directly in km/h. There is another meter in vehicles which measures the distance travelled by a vehicle. It is called **Odometer.**

Activity 3

Distance - time graph

Take a graph paper. Draw two perpendicular straight lines on it as shown in figure 11.6. Mark X'OX on the horizontal line. It is called X-axis. Similarly, mark YOY' on the vertical line. It is called Y-axis. The intersection of X-axis and Y-axis is referred to as origin point 'O'. A graph is plotted between two quantities mentioned across these two axes. We assign positive values along OX-axis.

Similarly, we assign positive values along OY-axis. In this chapter we will consider only positive values of quantities.

Table 11.5

Sr. No.	Time	Distance
1	0 minute	0
2	10 minute	5 km
3	20 minute	10 km
4	30 minute	15 km
5	40 minute	20 km
6	50 minute	25 km

The distance and time values for a vehicle have been shown in table 11.5.

Steps for making a graph -

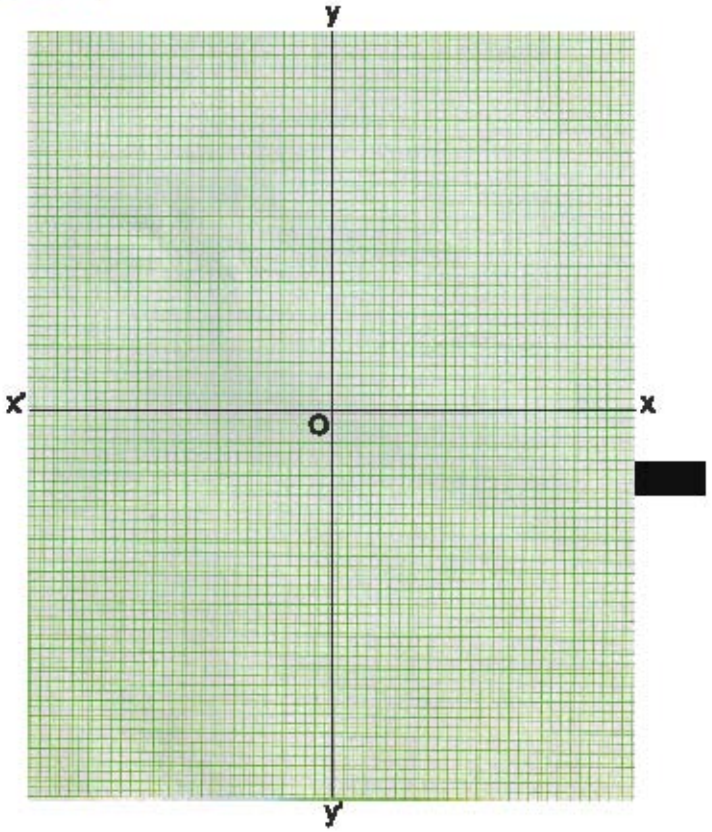


Figure 11.6: Graph paper

1. To represent two axes, draw two perpendicular lines and mark OX and OY on it as shown in figure 11.6.
2. First ascertain which quantity is to be represented along X-axis and which quantity is to be represented along Y-axis. Represent time on X-axis and distance on Y-axis.
3. Choose an appropriate scale to represent the distance along Y-axis, Similarly choose another scale to represent time on X-axis. For vehicle speed, the scales can be as follows -

On X-axis	Time 10 min.	= 1 cm.
On Y-axis	Speed 5 km	= 1 cm.

4. As per scale selection, mark values for time and distance on X-axis and Y-axis respectively. For car speed, represent time on X-axis by mark time as 10 min., 20 min., 30 min., 40 min., 50 min. on X-axis from origin point 'O'. Similarly, represent distance on Y-axis from origin point 'O' by marking 5km, 10km, 15km, 20km and 25km.
5. In table 11.5, in the first observation the distance travelled for time o min is zero. This set of value is positioned at origin point 'O'. After 10 min, the car travels 5 km. To represent, this set of value (10, 5), draw a parallel line to the Y -axis through 10min on X-axis and similarly draw a parallel line to the X-axis through 5km on Y-axis. Identify the point at which both the lines intersect each other, it represents the set (10, 5). By adopting the above method, mark other points of different sets values on the graph paper.
6. All the different sets of time and distance covered by the car have been marked in figure 11.7.
7. Join all these points on the graph. You will find a straight-line after joining the points. This is the time-distance graph for speed of car.

If the distance-time graph is a straight-line, it indicates that

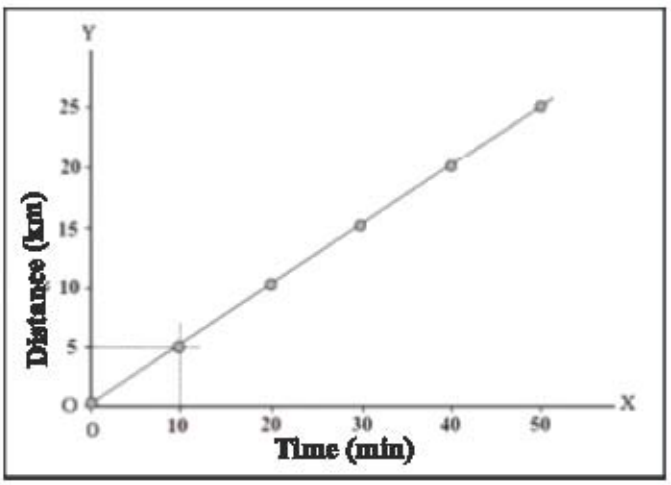


Figure 11.7 Distance -time graph.

the object is moving with a constant speed. If speed of an object keeps on changing, the nature of graph will be different.

Activity-4

We may easily know how much distance an object has covered in a given time from the points on distance-time graph. A vehicle starts to move at 1:00 clock from some location. The distance travelled and time values are given in table 11.6 whose graph has been shown in figure 11.8. From the graph, find out how much distance has been travelled by a vehicle at 2.15 pm?

Table 11.6

Sr. No.	Time	Distance
1	1:00 PM	0
2	1:30 PM	30km
3	2:00 PM	60 km
4	2:30 PM	90 km
5	3:00 PM	120 km
6	3:30 PM	150 km

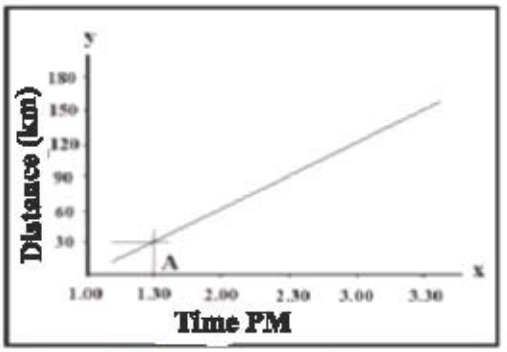


Figure 11.8 Distance-time graph

What have you learnt

- Periodic events are used to measure time.
- Time taken to complete one oscillation is called periodic time of a simple pendulum.
- The fundamental unit of time is second. Minute, hour, day, years, etc are other units of time.
- By motion of objects one can compare their low and high speeds.
- The distance covered by an object in unit time is called its speed.
- The speed of an object is the distance travelled divided by the time taken to cover that distance. Its fundamental unit of motion is meter per second (m/s). The other units of speed are centimetre per second (cm/s), kilometer per second (km/s), kilometer per hour (km/h), etc.
- Distance-time graph of an object which travels with a uniform speed is a straight-line.

Exercises

Choose the correct answer

1. If Bharti's brother is 10 days old than his age in hours will be:
   (A) 120 hours (B) 100 hours
   (C) 240 hours (D) 80 hours ( )
2. The working principle of watches is based on which type of motion:
   (A) Linear motion (B) Periodic motion
   (C) Curvilinear motion (D) Rotational motion ( )
3. Meter per second is International units of:
   (A) Time (B) Weight
   (C) Speed (D) Distance ( )

Fill in the blanks with suitable words.

1. The international unit of time is.....
2. The distance travelled in unit time by an object is called it's.....
3. An object is moving with uniform speed along a straight-line. The speed of an object is called.....

In the following statements, tick T against those which are true, and F against those which are false:

1. Each object is moves in straight-line. (T/F)
2. The motion of a bus is represented in meter. (T/F)
3. The distance between two cities is measured in kilometer. (T/F)
4. The time period for a given pendulum is not constant. (T/F)
5. An object, moving with a uniform speed, has straight-line on distance - time graph. (T/F)

Short answer type questions

1. A simple pendulum takes 80 second to complete 40 oscillations. What is the time period of the pendulum?
2. The distance between two stations is 100 km. A bus takes 2 hours to cover this distance. Calculate the speed of the bus.
3. A motorcycle rider moves with a speed of 40 km/h for 1.5 hour and reaches the destination. What is the total distance covered by him?
4. Define a solar day?

Long answer type questions:

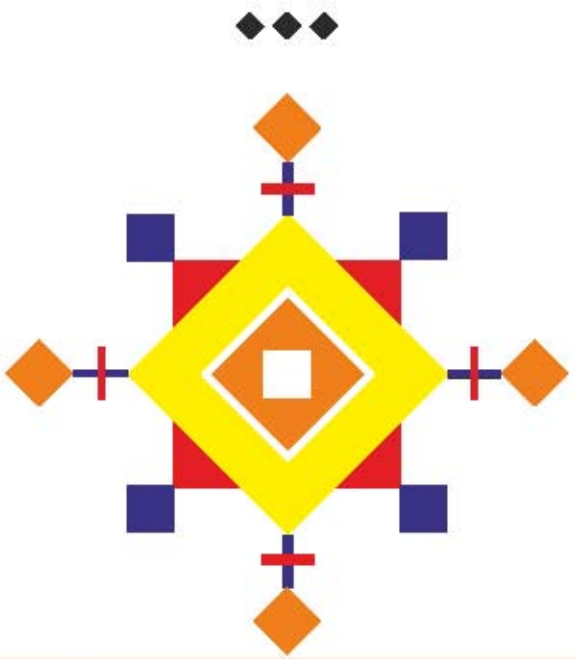
1. For speed of any vehicle the distance travelled by it and the time taken is given in the table below. Draw the time-distance graph.

S. No.	Time	Distance
1	2 seconds	10 m
2	4 seconds	20 m
3	6 seconds	30 m
4	8 seconds	40 m
5	10 seconds	50 m

2. What do you mean by simple pendulum? Explain its time-period.

Activity based work:

1. Observe the speed of your nearby objects- on earth, in air, and water. By observing the distance travelled and time taken, find out the speed of these objects.
2. Take two plastic bottles. Fill sand in one bottle, cap the bottle and make a hole into the cap. Fit another plastic bottle on it without cap and make a model of sand watch.



Time calculation in ancient times

In India, there has been a tradition to measure smallest time unit (time) since ancient times. It is evidenced in many books which explain in detail about time calculation. There is no evidence for this time calculation in any other civilization of the world. As described in "Sun-Theory" book time has two forms.

Abstract Time - "It is time which can neither be seen nor calculated by the simple methods. This type of time cannot be perceived by ordinary sense organs."

Real Time - "This time can be calculated and can be visualized and felt."

Truti : Fundamental unit of time calculation is **Truti** which is equal to 0.32400000 second i.e. an error is equal to three crorth part of a second. Time from Truti to 'Pran' is abstract and after that real.

Time table of Sun-Theory

fundamental unit is Truti.

60 Truti = 1 Renu

60 Renu = 1 Love

60 Lav = 1 Leshak

60 Leshak = 1 Pran

60 Pran = 1 Vinadi

60 Vinadi = 1 Nadi

60 Nadi = 1 Ahoratra (Day-Night)

7 Ahoratra + 1 Week

2 Weeks = 1 Paksh

2 Paksh = 1 month

2 months = 1 season

6 months = 1 Ayan

12 months = 1 Year

432,000 years = Kali Yuga

864,000 years = Dwapara Yuga

1296,000 years = Treta Yuga

1728, 000 years = Satya yuga

4320, 000 years = Chatur Yuga

71 Chatur Yuga = Manvantar (Block Pralay) (32258,000 years)

14 Manvantar = 1 Brahm day (432,00,00, 000)

864,00,00,000 year = 1 ahrotra of Brahma = 1 Sristi cycle.