MOTION AND TIME

2

CHAPTER

CONTENTS

➢ UNIT

Measurement of any physical quantity is expressed in terms of an internationally accepted certain basic standard called unit.

Length, time & mass are measured in metre, sec, and kilogram

➢ PHYSICAL QUANTITIES

The quantities which can be measured by an instrument and by means of which we can describe the laws of physics are called physical quantities.

Eg. length, velocity, acceleration, force, time, pressure, mass, density etc.

➢ REST & MOTION

An object is said to be at **rest** if it does not change its position with respect to its surrounding with the passage of time.

A body is said to be in **motion** if its position changes continuously with respect to the surroundings (or with respect to an observer) with the passage of time.

➢ TYPES OF MOTION

(a) Linear motion : The motion of a moving car, a person running, a stone being dropped.

(b) Rotational motion : The motion of an electric fan, motion of earth about its own axis.

(c) Oscillatory motion (to and fro motion) : The motion of a simple pendulum, a body suspended from a spring etc are the examples of oscillatory motion.

➢ UNIFORM & NON UNIFORM MOTION

(a) Uniform Motion :

A body has a uniform motion if it travels equal distances in equal intervals of time, no matter how small these time intervals may be.

For example, a car running at a constant speed of say, 10 m/s, will cover equal distances of 10

metres, in every second, so its motion will be uniform.

(b) Non-Uniform motion :

A body has a non-uniform motion if it travels unequal distance in equal intervals of time.

For example, if we drop a ball from the roof of a building, we will find that it covers unequal distances in equal intervals of time.

It covers :

4.9 meters in the 1st second

14.7 metres in the 2nd second

24.5 metres in the 3rd second and so on.

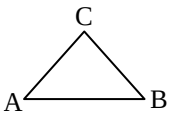
TERMS USED TO DEFINE MOTION

(a) DISTANCE & DISPLACEMENT :

(i) Distance : Distance is the actual path travelled by a body in a given time.

Consider a body travelling from A to B along any path between A and B. The actual length of the path that a body travels between A and B is known as the distance. Here if the body goes from A to B via C, the distance travel will be ACB.

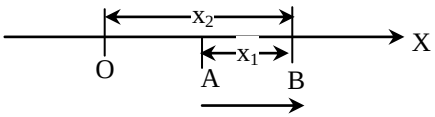
The distance travelled will be different for different paths between A and B. It is a scalar quantity.



(ii) Displacement : The distance travelled in a given direction is the displacement. Thus displacement is the shortest distance between the given points.

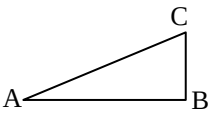
S.I. unit of distance and displacement is metre.

Ex. When an object moves from O to B and then from B to A. Then displacement = $x_2 - x_1$.



$x_2 - x_1$ =positive

Ex. Suresh walks from point A to B and then again from B to C.



Distance he has travelled is A to B + B to C.

Displacement he has travelled is line A to C

Note : If a body travels in such a way that it comes back to its starting position, then the displacement is zero. However distance travelled never zero.

(b) SPEED :

(i) Speed : Speed of a body is the distance travelled by the body in one second

$$\text{speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

Distance travelled is measured in metre and time in second.

Therefore, the unit of speed is metre/second.[(m/s)].

It can also be expressed in kilometer/hour [km/h]

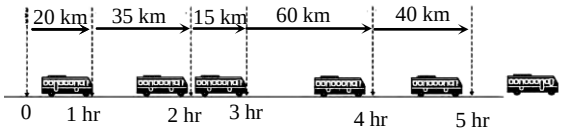
If we know the speed of an object we can find out the distance covered by it in a given time.

Distance covered= speed × time.

(ii) Average speed :

The speed of a bus during a journey may vary. When the bus is nearing a bus stop, its speed decreases. On the highways the bus travels with greater speed but in a city or town it travels with less speed due to heavy traffic.

The bus has different speeds at different times. So we say that it has **variable speed.**

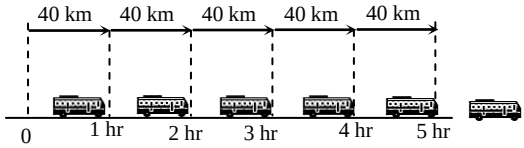


Variable speed

for such bodies, we can calculate the average speed.

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

If a body moves with the same speed at all times we say that it has **uniform speed.**

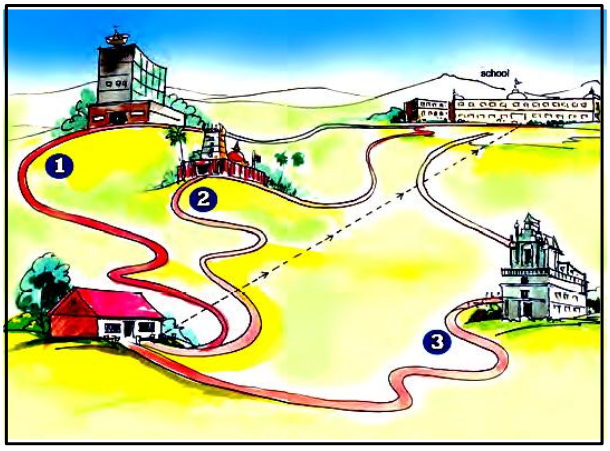


Uniform speed

(c) VELOCITY :

Every day when you go to school from your house, you could take path 1 or path 2 or path 3. Do these paths have the same distance? No, the distance is not the same; it varies with the path taken. Imagine that you travel from your house to school in a straight line. This will be the shortest distance between them, called **displacement**. In the picture, it is represented by a dotted line. **Displacement is the shortest distance between two points.**

Velocity is the displacement of a body in one second.



$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$$

its unit is **m/s**

Velocity is nothing but speed in a definite direction.

(d) ACCELERATION :

Do you ride a bicycle to school? If you are late, what would you do? you would increase your velocity or accelerate.

Acceleration is the change of velocity in one second

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

Its unit is **m/s^2 .**

If car has an acceleration of 5 m/s^2 every second its velocity increases by 5 m/s. If the velocity of a moving body decreases, we say that it has negative acceleration or retarding or deceleration.

ACCELERATION DUE TO GRAVITY :

Let us see what happens when a ball is thrown up vertically? As it rises, its velocity gradually decreases till it becomes zero i.e., the ball is retarded. As the ball falls down its velocity gradually increases i.e., it is accelerated. The

retardation or acceleration is due to the earth's gravitational force. *It is known as acceleration due to gravity.* This means that the velocity of a body decreases by 9.8 m/s every second when it is thrown up and the velocity increases by 9.8 m/s every second when it falls down.

➢ MEASUREMENTS

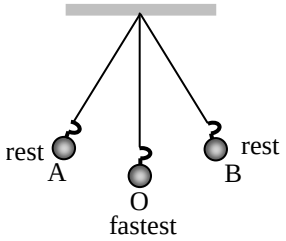
(a) Measurement of time :

Many events in nature repeat themselves after definite intervals of time. For example, we can find that the sun rises everyday in the morning. The time between one sunrise and the next was called a day. Similarly, a month was measured from one new moon to the next. A year was fixed as the time taken by the earth to complete one revolution of the sun clocks or watches are perhaps the most common time measuring devices.

All of them make use of some periodic motion. One of the most well-known periodic motions is that of a **simple pendulum** .

A simple pendulum consists of a small metallic ball or a piece of stone suspended from a rigid stand by a thread. The metallic ball is called the **bob** of the pendulum.

Initially the pendulum at rest in its mean position. When the bob of the pendulum is released after taking it slightly to one side, it begins to move to and fro. The to and fro motion of a simple pendulum is an example of a periodic or an oscillatory motion.



The pendulum is said to have completed one **oscillation** when its bob, starting from its mean position O, moves to A, to B and back to O. *The time taken by the pendulum to complete one oscillation is called its time period.*

To set the pendulum in motion, gently hold the bob and move it slightly to one side. Now release the bob from its displaced position. Measure the time the pendulum takes to complete 20 oscillations. Repeat this activity a few times and record your observations. You will note that a slightly change in the initial displacement not affect the time period of your pendulum.

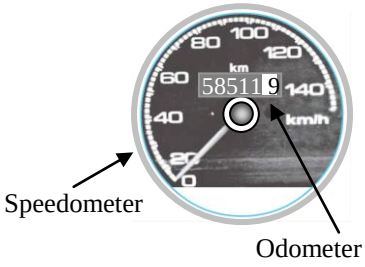
◆ **Unit of time :**

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

Many time measuring devices were used in different parts of the world before the pendulum clocks became popular. Sundials, water clocks and sand clocks are some examples of such devices.

(b) Measurement of speed : By calculating the distance travelled in the given time, we can calculate speed. Speed generally measured in **m/s**. In vehicles speed is measured in km/h by the instrument *speedometer*.

(c) Odometer : It measure the distance moved by vehicles directly.



DISTANCE- TIME GRAPH

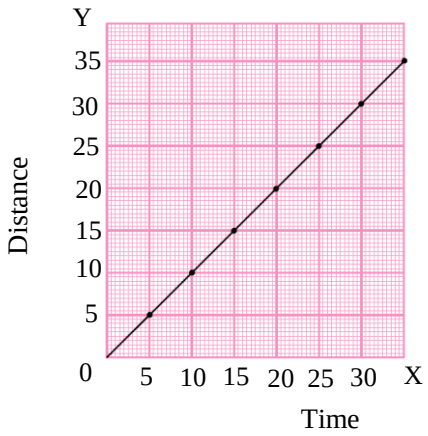
Consider the example : Rajesh was travelling with his father in their car from Kota to Bundi. He kept himself busy by noting the distance travelled by the car every 5 minutes. This is what he noted in the first 30 minutes.

S. NO.	Time in minutes	Distance in km
1	0	0
2	5	5
3	10	10
4	15	15
5	20	20
6	25	25
7	30	30

You can make a graphical representation of his observations follow these simple steps.

Taking axes and scale : Take a graph sheet an draw two lines perpendicular to each other.

Mark the horizontal line as OX (x-axis) and the vertical line as OY(y-axis). Time is taken on the X-axis and distance on the Y-axis.



Choose scales to represent distance and time.

For example, the scales could be

X-axis : 1 cm = 5 minutes

Y-axis : 1 cm = 5 km

Plotting the graph: Mark the value on the axes for time and distance according to the scales you have chosen. According to the values noted, mark the points on the graph sheet. Join the points

For uniform speed, the distance time graph is always a straight line.

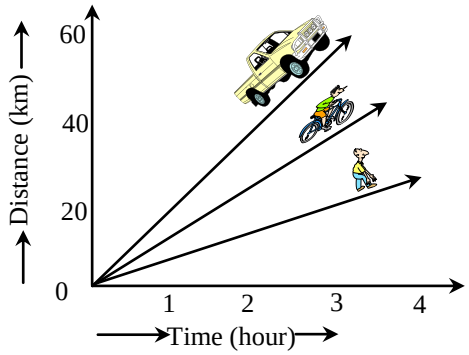
For variable speed, it could be of any shape.

Ex. Three cars A, B and C travel from Delhi to Agra. The time taken and the distance covered are given in the table below.

S. NO.	Time taken in hours	Distance travelled in km		
		Car A	Car B	Car C
1	1	20	50	40
2	2	40	100	80
3	3	60	150	120
4	4	80	200	160
5	5	100	250	200

Plot the distance time graph of the three cars in the same graph sheet.

Sol.



Greater the speed, steeper will be the graph

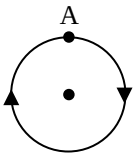
EXERCISE # 1

Theoretical Questions

Q.1 Selvi goes for a morning walk in the park near her house. She starts from point 'A' walks a circular path or radius 7 meter and returns to same point 'A'.

(i) What is her displacement

(ii) Find the distance she has walked



Q.2 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.

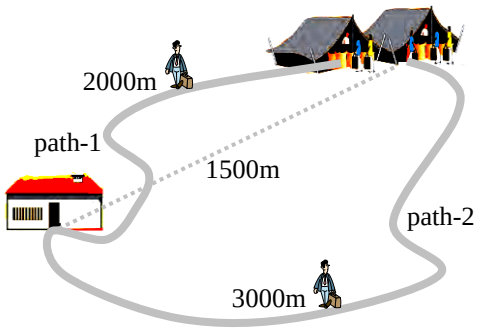
Q.3 A simple pendulum takes 32 s to complete 20 oscillations. What is the time period of the pendulum?

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.

Q.5 Mani and Shankar walk from their home to the market in 20 minutes, Mani takes path 1 while Shankar takes path 2.

(i) What do you infer about their speeds ?

(ii) Who has the greater velocity? Why ?



Q.6 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.

Q.7 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.

Q.8 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.

Q.9 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.

Q.10 Which of the following relations is correct?

(i) Speed = Distance × Time

(ii) $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

(iii) $\text{Speed} = \frac{\text{Time}}{\text{Distance}}$

(iv) $\text{Speed} = \frac{1}{\text{Distance} \times \text{Time}}$

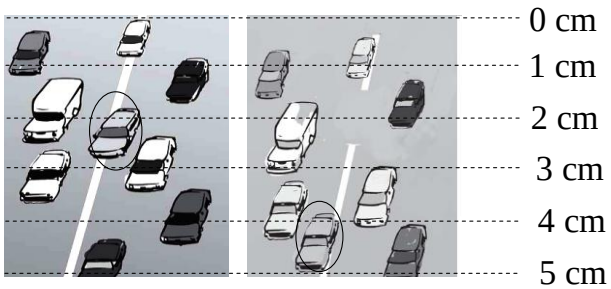
Q.11 A car moves with a speed of 40 km/h for 15 minutes and then with a speed of 60 km/h for the next 15 minutes. The total distance covered by the car is:

(i) 100 km (ii) 25 km

(iii) 15 km (iv) 10 km

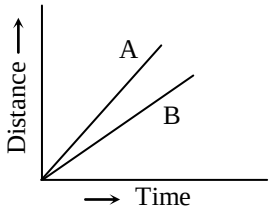
Q.12 Raju is travelling in a train moving at a speed of 72 km/h. In order to stop the train, the driver decreases the speed. The rate of decrease in speed of the moving body is known as deceleration. If the declaration of the train is $10 m/s^2$, how much time will it take to come to a stop?

Q.13 Suppose the two photographs, shown in figure 1 and figure 2 had been taken at an interval of 50 seconds. If a distance of 100 metres is shown by 1 cm in these photographs, calculate the speed of the blue car.



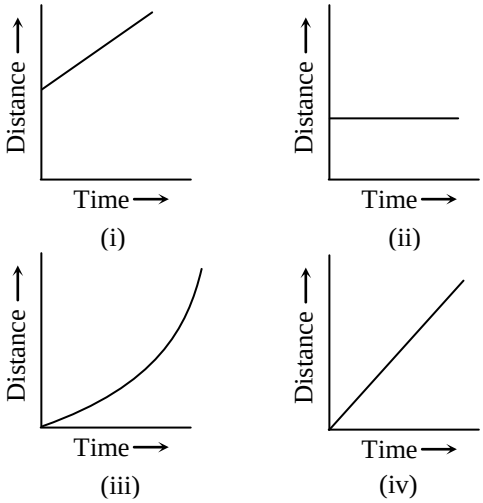
figur 1 figrue 2

Q.14 Figure shows the distance-time graph for the motion of two vehicles A and B. Which one of them is moving faster?



Distance time graph for the motion of two cars

Q.15 Which of the following distance-time graphs shows a truck moving with speed which is not constant?

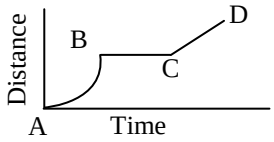


Q.16 The given graph depicts the motion of a bus. Interpret the motion of the bus.

(a) AB represents .....

(b) BC represents .....

(c) CD represents .....



EXERCISE # 2

Single Correct Answer type Questions

Q.1 A boy whose position with respect to surrounding does not change, is said to be in a state of -

(A) Rest (B) Motion

(C) Vibration (D) Oscillation

Q.2 In case of a moving body-

(A) Displacement > Distance

(B) Displacement < Distance

(C) Displacement ≥ Distance

(D) Displacement ≤ Distance

Q.3 A distance is always -

(A) Shortest length between two points

(B) path covered by and object between two points

(C) product of length and time

(D) none of these

Q.4 Which of the following is not characteristic of displacement ?

(A) It is always positive

(B) It has both magnitude and direction

(C) It can be zero

(D) Its magnitude is less than or equal to the actual path length of the object

Q.5 In five minutes distance between a pole and a car changes progressively. What is true about the car ?

(A) Car is at rest

(B) Car is in motion

(C) Nothing can be said with this information

(D) None of the above

Q.6 A distance-

(A) Is always positive

(B) Is always negative
(C) May be positive as well as negative
(D) Is neither positive nor negative

Q.7 A particle is travelling with a constant speed. This means-
(A) Its position remains constant as time passes
(B) It covers equal distance in equal interval of time
(C) Its acceleration is zero
(D) It does not change its direction of motion

Q.8 In 10 minutes, a car with speed of 60 kmh^{-1} travels a distance of
(A) 6 km (B) 600 km
(C) 10 km (D) 7km

Q.9 A car acceleration uniformaly from 18 km/h to 36 km/h in 5s. The acceleration in ms^{-2} is-
(A) 1 (B) 2
(C) 3 (D) 4

Q.10 The brakes applied to a car produce a negative acceleration of $6ms^{-2}$. If the car stops after 2 seconds, the initial velocity of the car is-
(A) $6ms^{-1}$ (B) 12 ms^{-1}
(C) 24 ms^{-1} (D) Zero

Q.11 A body is moving with uniform velocity of 10 ms^{-1}. The velocity of the body after 10 s is-
(A) 100 ms^{-1} (B) 50 ms^{-1}
(C) 10 ms^{-1} (D) 5 ms^{-1}

Q.12 In 12 minutes a car whose speed is 35 kmh^{-1} travels a distance of-
(A) 7 km (B) 3.5 km
(C) 14 km (D) 28 km

Q.13 A body is moving along a straight line at 20 ms^{-1} undergoes an acceleration of $4ms^{-2}$. After 2 s. its speed will be-
(A) 8 ms^{-1} (B) 12 ms^{-1}
(C) 16 ms^{-1} (D) 28 ms^{-1}

Q.14 A car increases its speed from 36 km/h to 54 km/h in 10s. Its acceleration is-
(A) 30 ms^{-2} (B) 3 ms^{-2}
(C) 18 ms^{-2} (D) 0.5 ms^{-2}

Q.15 The device used to measure speed of a vehicle is -
(A) Odometer (B) Speedometer
(C) Thermometer (D) Voltmeter

Q.16 The duration of the day from the moment the sun is over head today to the moment the Sun is overhead tomorrow is determined by-
(A) the rotation of Earth around the sun
(B) the revolution of Earth on its axis
(C) the inclination of the axis of rotation of the Earth from its plane of revolution
(D) The rotation and revolution of Earth around the sun.

Q.17 The increase in the speed of a car is proportional to the additional petrol put into the engine. Is it possible to accelerate a car without putting more petrol or less petrol into the engine ?
(A) Yet it is possible, if we add additional peterol
(B) Not possible, the statement is wrong
(C) May be possible if there is a leakage in the car

(D) Yes it is possible provided the car moves in circular path.

ANSWER KEY

EXERCISE-2

Ques	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans	A	D	B	A	B	A	B	C	A	B	C	A	D	D	B
Ques	**16**	**17**													
Ans	B	D													