5

MOTION AND FORCE

Look around yourself. Birds flying in the sky, children running in the park, the water flowing in the canal, the moving pendulum of the clock, the fan rotating on the roof - there are many other things that we say are moving. What is this 'moving' called?

Talking about the trees standing on the side of the road, the stones lying in the park and the school building, we say that they are stable, that is, they are not moving. Why do we say this?

Moving means 'motion' which is very important for life. Just think, if all the movement stops in your school, if we stop, what will happen?

The question is that what is the main cause of motion? How does the speed of an object change? Regulation of speed is according to which principles.

Come, in this lesson we will read about speed, its type and its cause. Apart from this, we will also study the effect of force on motion and the stopping force i.e. friction.

OBJECTIVES

After reading this lesson you will be able to:

- Being able to differentiate the different kinds of movements happening around you;
- Understand the movement and motion;
- Understand mass and weight; and
- Understand the force of friction.

5.1 REST AND MOTION

When you walk from home to the other place, your position changes with the time. The change in the position of the object with time is called motion.

Fig. 5.1 Some moving objects

Now think about the tree standing on the side of the road. Where it was yesterday, it is still there today. Its position does not change with time, so it is in a state of rest.

So objects that do not change their position over time are said to be at rest.

Types of motion

Think about the motions shown in the following picture. Are all these movements of the same type?

(1) Butterfly flying

(2) Ball falling from a height

(3) Children slipping on the plane strip

(4) Spinning top

(5) Swinging children in mary go-round

(6) Children swinging in a swing

Let us analyze these motions and classify them on that basis:

Butterfly flying goes on an irregular path, moving even when the direction of its movement changes. This type of motion is called random motion.

Ball falling from a height moves in a straight line, at any moment all its particles are found moving in the same direction. This type of motion is called linear motion. Similarly, the motion of a child sliding on a plane bar is also an example of linear motion.

The motion of the spinning top is rotary motion, in which the spinning top rotates in a circular form around its own orbit.

Children in the mary go-round, move around an axis on a circular path. This type of motion is called circular motion.

The swinging child repeatedly moves around a midpoint. Such motion is called oscillation motion.

Many times there is also motion of some objects, which have more than one type of movement simultaneously. For example, the wheel of a car rotates on its axis and also moves forward, which means its speed is linear motion and rotary motion too.

ACTIVITY 5.1

What you need to do: to study different types of motions

What you need: a small stone, thread, copy and pan

(i) First, watch the stone three to four times, throwing from different heights.

(ii) Then tie the stone with a thread and spin it round.

(iii) Now tie the stone with a thread and hang it with a nail and remove one side and leave it. Then pay attention to its speed.

(iv) Similarly, observe the speed of the nib of a pen while writing the observation note in the copy.

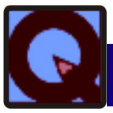
What did you see:

(i) The motion of the stone in the first position is linear motion.

(ii) In the second case, the stone is moving on the circular path.

(iii) The motion of the stone in the third position is the oscillation motion.

(iv) While the direction of the pen's nib changes randomly.



INTEXT QUESTIONS 5.1

1. Which of the following objects are moving and which are at rest?
   (a) Football immediately after kicking.
   (b) Needles of a running clock.
   (c) Blackboard in your class.
   (d) Planets of the solar-system.
2. The following motions are examples of what type of motion?
   (a) The movement of the player playing hockey in the playground. _____
   (b) The movement of the swinging child. _____
   (c) The movement of a man climbing stairs. _____
   (d) The movement of the Earth revolving around the Sun._____

Special terms used to describe motion.

Distance, displacement, speed, velocity and acceleration.

(A) Distance: When we talk of moving objects, we say that it changes its position over time. The length of the path that a

body moves from one place to another is called the distance traveled by that body. For example, assuming you walk in a straight line to a tree standing 100 meters away from your orbit and return 20 meters on the same path, the total distance you walked is 120 meters.

(B) Displacement: We have just given the definition of distance. By merely giving a description of the distance of an object from a reference point, the actual position of that object is not known.

Let us understand this with an example. Suppose you tell your friend that if he walks to your house exactly 2 km from here, can he really reach your house? No, because it is 2 km Distance can be in any direction.

But if you tell your friend that he can reach your house by walking 2 km west, then he will definitely reach the right place. Reflecting on the example given in terms of distance, you will find that because you have returned 20 meters towards the 100 meter circle, your displacement from the starting point is 80 meters. Because you have also described the right direction in which direction it is with distance.

ACTIVITY 5.2

What you need to do: Understand the difference between moving distance and displacement.

What you need: Meter Scale, graph paper, pea or gram, scale, pencil.

How to do you:

1. Put a mark (A) on the paper. Put gram seed on A.
2. Stop the grain A from sliding to the point B at a distance of 12cm towards the east.
3. Mix A and B.
4. Stop the grain by sliding it 5 cm from point B to point B in the north direction.
5. Now find the displacement of the grain and the distance traveled by it.

What did you see:

1. Distance = AB + BC = 12cm + 5cm = 17 cm
2. Expansion = AC = 13cm in North-East direction.

(C) Speed: We sometimes need to compare the speed of moving objects. Comparing the movements of the objects given in the picture, we find that the snail moves very slowly and the

Fig. 5.2 Different speeds

airplane is very fast. In an hour, the snail barely covers a distance of 0.05 km while the airplane goes more than 200 km. This distance traveled by the object in a single time is called its speed and helps us to compare the speed of the objects.

If the distance is measured in meters (m) and the time in seconds (s), the unit of speed is meter / second (m / s) i.e. meter per second.

(D) Velocity: By the speed of an object it is known how fast the object is moving. But to know where she will reach after a certain time, it is also necessary to know the direction of her walking. The amount that tells how fast an object moves in a given direction is called the velocity of that object.

The unit of displacement is the meter and the second of time. Therefore the unit of velocity is meters per second (m / s).

(E) Acceleration: When we travel by bus does the movement of the bus remain the same throughout the duration of motion? You know that it is not so. It starts moving at rest and then gradually increases its speed. When the path is obstructed, its speed is reduced and when the next bus stand comes, the bus slowly slows down and stops. If the speed remains the same, even if the direction of motion changes, the velocity changes. The change in velocity of an object in unit time is called acceleration.

The unit of velocity is meter per second (ms^1) and the second (s) of time. Hence the unit of acceleration is (ms^2).

INTEXT QUESTIONS 5.2

1. Fill in the blanks:
   (i) The distance traveled by an object is _____ of its travel path.
   (ii) To tell the displacement of the object it is necessary to tell both the _____ of the movement moved by it.
   (iii) If the speed of the object is 30 km If hourly, it covers a distance of _____ km in an hour.
   (iv) If the velocity of the object is changing, then _____ is happening in it.
2. What is the normal unit of speed?
3. What is the normal unit of acceleration?

5.2 REASON FOR MOTION-CHANGE : FORCE

You may have noticed that a stone lying on the side of the road does not change its place until someone pushes or drags it away. Similarly, the motion or the direction of movement of a moving object also cannot change by itself. To change the speed or velocity of an object, it has to be pushed or dragged . This stretch, which is applied on an object, is called force.

The laws of motion

People knew for a long time about the effect of force on motion. But the effect of force in motion was studied in detail by the great English scientist Isaac Newton (1642-1727) and in his study presented the result in three rules.

(1) Newton's first law of motion

Let's begin by understanding the rules with some activities:

ACTIVITY 5.3

What you need to do: Observe that the stationary object has a tendency to remain stable.

What you need: A thick smooth card, a glass of glass, a coin.

How to do this:

1. Put the glass on the table, cover its mouth with the card and place the coin in the middle over the card.
2. Flick the card.

You will see that: The coin falls into the glass. Have you wondered why this happened? The coin was held steady above the card. Because no force was applied on it, it remained fixed in its place and fell into the glass due to the card being removed from the bottom.

ACTIVITY 5.4

What you have to do: It is to see that the moving object has a tendency to move.

What you need: shoe case, ball,

How to do it:

1. Remove the lid of the shoe box. Also remove another

cardboard from the width side. Place the ball along the wall on the other side of the box.

2. Push the box at one end of the table, so that the ball remains adjacent to the wall opposite the motion.
3. Stop the box from moving instantly.

What did you see: As soon as the cardboard box stops, the ball starts moving and comes out from the open side.

Did you wonder why this happened?

When the box was moving, the ball inside it was moving at the same speed. Even after stopping the box, the ball kept inside it keeps moving at its earlier velocity, because no force has been applied on it to stop it from moving.

The conclusion of the above mentioned activities can be understood as Newton's first law. According to this rule, "If an object is stationary, it will remain stationary and if an object is moving, it will move until an external unbalanced force is applied on it".

To understand the meaning of unbalanced force, let us consider the condition of the towing of the tug of war competition. If both the teams are pulling it in exert equal force, the total force applied on the rope will be zero and the rope will remain in balance. But if the force of one team is more than the other, then this additional force will be called unbalanced force and due to this the towing will be pulled towards that team.

(2) Newton's second law of motion

Two activities will also help in understanding this rule. If equal force is applied to two objects of different mass, then why is there a difference in the acceleration produced in them?

ACTIVITY 5.5

What you need to do: Study Newton's second law of motion.

What you need: For this, take a cricket ball (heavy) and a tennis ball (light).

How do you do: Place both balls on the ground nearby and with the help of a wiper or a stick, push them together and see which ball runs fast and keeps going for long.

You will see that: The tennis ball runs faster and lasts longer. This leads to the conclusion that if equal force is applied to two objects, the acceleration produced in them is inversely proportional to their mass.

ACTIVITY 5.6

What you have to do: What will be the effect on the acceleration of an object when it changes the magnitude of the force applied on it?

What you need: Any ball, viper

How you have to do :

1. Place the ball on the floor.

2. Push him lightly by the wiper and see how far the ball stops.
3. Again push the ball in the same place and see how far the ball stops.

You will see that: The ball stops further when pushed harder, because it has more acceleration. From this we can conclude that the acceleration of an object is proportional to the force exerted on it.

The conclusions of the above activities can only be called Newton's second law of motion. Hence one can conclude from this rule that the force exerted on the body is equal to the mass of the body and the product of the acceleration generated in the body by the force. That is:

force mass acceleration

the unit of force is Newton (N). 1 Newton force is the force which, when applied to a body of 1kg mass, produces an acceleration of 1ms-2. To experience the magnitude of the IN force, put a weight of 100b on your palm and experience the force due to it. This is approximately equal to 1N force.

(3) Newton's third law of motion

Consider the situation shown in Figure 5.3. If you jump from the boat standing in the river, then in which direction is the boat getting pushed? Is it on the opposite side of the coast? Have you wondered why this happens? They can be interpreted according to Newton's third law of motion. According to this law, "For

Fig. 5.3 Newton's Third Law of Motion

every action there is an equal and opposite reaction ". If you force the boat into the water and push it into the water, the boat forces you with the same force.

ACTIVITY 5.7

What you need to do: Study the third law of motion by balloon rocket.

What you need: a balloon, thread, two nails, cello tape, paper tube.

How to do you:

1. Push the nails on opposite walls of the room.
2. Tie one end of the thread to a nail.
3. Remove the thread from the tube and tie its other end on the second funnel.
4. After inflating the balloon, close its mouth and hold it firmly with the help of paper tape and stick it firmly with a paper tube.
5. Now release the balloon so that air comes out from its mouth slowly.

What did you see: The balloon on the thread starts moving in the opposite direction in the direction in which the air comes out of the balloon. From this you can naturally conclude that every action has the same reaction in the opposite direction.

Freely falling objects

If an object is lifted off the floor and left, it always falls downwards. Have you thought about why this happens? Seeing the apple falling from the tree, when Newton wondered why the apple fell from the tree, he came to the conclusion that it is because the earth pulls it towards him. This force of the earth is called the force of gravity.

When an object exerts force, acceleration is produced in it. This acceleration in a falling object due to the gravitational force of the Earth is called gravitational acceleration. It is denoted by 'g' and its value is 9.8ms-2. That is, the velocity of an object freely falling towards the Earth increases to 9.8 meters per second in 1 second. You might be surprised to know that this value of 'g' does not depend on the mass of air. A heavy object also falls below the same acceleration as an object lighter than the acceleration. This is the reason that if you drop an iron ball and a wooden ball from any height together, they will come together and hit the earth.

Mass and Weight

The mass and weight of an object are two different quantities. The mass of the object means the amount of material from which that object is made. The mass of one pot of brass is 2kg, which means that the pot has 2kg brass.

The weight of an object is the force with which the earth pulls the object towards it. One unit of weight is Newton and the other is kilogram weight (kg wt).

1kg wt = 9.8 newtons.

We can say that the weight of pot is 2 kg wt or 4.9 newtons.

Weights and mass have the following relationship:

mass gravitation acceleration

We measure the weight with the spring balance and the mass with the physical balance. The mass of an object does not change by moving it from one place to another, but its weight can change. This is because the value of 'g' varies at different places. The weight of an object on the moon that is 60kg on Earth will only be 10kg because the value of gravitational acceleration on the moon is 1/6 of that of the Earth.

5.4 FRICTION FORCE

Let us do an activity to understand friction.

ACTIVITY 5.8

What you have to do: See that the force of friction depends on the nature of the surface.

What you need: 30 () long scale of wood, two thick books, used torch battery or glass, a half of thick cloth, a half Meter long ten centimeter wide piece.

How do you do:

1. Put one end of the scale on the books and make a flat plane.
2. Make a mark on the inner plane at a distance of about 20 () from the lower end.
3. Now leave the battery (or marbles) on the trail so that it comes down rolling on the floor.
4. See how far it drops and stops on the table. Put a mark there.
5. Now, spread the cloth on the table, and roll the battery again with the same mark. Now it rolls over the fabric Wherever it stops, mark it again.

What you noticed: The battery on the cloth goes a short distance and on the empty table goes a long distance.

From this we can conclude that the friction force values are different for different surfaces.

Friction has its benefits as well as disadvantages. Let us know in more detail the benefits and disadvantages of friction.

Benefits of friction

1. If there was no friction, it would be difficult for us to walk. Can you walk easily on smooth floors or on moss stones?
2. In the absence of friction, it becomes difficult to stop a moving object, because the force of friction only stops it by opposing the motion of the moving object.

3. It is difficult to hold an object without friction. The force between the object and fingers is helpful in holding that object.
4. Would you burn matchsticks without friction? The primitive man also lit the fire by friction between the two flint stones.
5. Due to friction between the rim and brake pads of the cycle wheel, your cycle stops.

Disadvantages of friction

1. Many parts of the machines move by rubbing against each other. Due to friction they are worn out and the lifespan of the machine decreases.
2. Objects become hot due to friction and due to this, a lot of energy is lost. As a result the efficiency of the machines decreases.

Machines need to reduce friction to avoid these losses. Oil is used for this in machines like sewing machines and in machines like bicycles, hair bearings or roller bearings are used.

INTEXT QUESTIONS 5.3

1. Which law of motion applies in the following situations?
   (a) The coin lying on the road remains there until someone removes it.
   (b) A woman carrying a pitcher filled with water puts the same amount of force on the pitcher as the pitcher puts on her head.

(c) When a toy car and a real car are pushed with equal force, the toy car has more acceleration.

2. Fill in the blanks by choosing the appropriate word from the given words:

(a) Your mass on the moon _____ will be(equal to, greater than, Less)

(b) Your weight on the moon compared to your weight on earth _____ will be. (Equal, more or less)

(c) The gravitational acceleration value of the Earth is _____ . ()

(d) Oil is added to the machine _____ to reduce. (Friction, force, gravitational force)

WHAT HAVE YOU LEARNT

The object whose position changes with time, this object moving and whose position does not change with time is called static.

- The motion of an object moving along a linear path is called linear motion.
- If the object keeps changing direction of motion with time, its speed is called random motion.
- Like spinning top, the object rotates round and round, its motion is called rotational motion.
- If the object moves around a midpoint like a swing, its motion is called oscillating motion.

- The distance traveled by an object is the length of the path on which it moves from the initial position to the final position. The unit of distance is a meter.
- Displacement is the minimum distance between the initial and final positions of the object. Its unit is also a meter.
- The distance traveled in unit time is called speed. The displacement occurring in unit time is called velocity. The units of both are meters per second or ms-2.
- The change in velocity of an object in unit time is called acceleration. Its unit is ms-2.
- The push or pull force on the object is called force.
- Newton's first law of motion states that the state of motion or stop of an object cannot change unless an unbalanced force is applied to it.
- Force mass acceleration according to Newton's second law
- Newton's third law of motion states that every action has the same reaction in the opposite direction.
- Each freely falling object comes down due to the gravitational force of the earth and produces an acceleration of 9.8ms-2.
- As long as one surface slips on the other surface, the force of friction between them to resist their motion becomes dominant.
- Friction has its benefits as well as disadvantages.

TERMINAL QUESTIONS

1. Give two examples of moving and stationary objects.
2. What are the different types of motion? Give an example of each.
3. You take a full circle of circle with circle 105m. What is your displacement and the distance you run?
4. A boy runs 50m in 10s. Explain its trick.
5. Give the definition of acceleration. Also tell its unit.
6. What is force? explain.
7. Name the force with which the earth pulls every object towards its center.
8. Name of the device used to measure the mass of an object.
9. Name the device used to measure the weight of the object.
10. Why does ___ have difficulty in cycling on clay soil immediately after rain?
11. Explain the three advantages and disadvantages of friction.
12. Write two practices to reduce friction.
13. Why is the speed of a child playing soccer called random motion?
14. Write Newton's law of motion.
15. Give the definition of unit of force (Newton).

16. Explain the difference in the following:

    (i) distance and displacement (ii) speed and velocity (iii) mass and weight

17. Match the quantities in column 'A' with the units taken in column 'B'.

(A)	(B)
1. Velocity	(a) N
2. Acceleration	(b) -1
3. Force	(c) Ms-2
4. Mass	(d) m
5. Distance	(e) kg

18. Mark the correct answer against the correct answer in the following:

    (a) What is the speed of the pendulum of the hour clock?

    (i) linear motion (ii) random motion (iii) oscillating speed (iv) Rotational speed

    (b) If you roam in the Marie-Go-Round, where you had gone, then you have to go to the same place and take the round, then what will be your displacement?

    (i) equal to the circumference of Marie-go-round (ii) zero (iii) equal to the diameter of Marie-go-round (iv) equal to ten times the circumference of Marie-go-round

(c) Which of the following principles are Diwali rockets based on ?

(i) Newton's first law of motion (ii) Newton's second law of motion (iii) Newton's third law of motion (iv) None of the above.

(d) By what force do you stop the moving bicycle by applying a brake.

(i) gravitational force (ii) reaction force (iii) frictional force (iv) magnetic force

(e) If someone walks 20 km in half an hour, How much will his speed be?

(i) 10 km per hour (ii) 20 km per hour

(iii) 40 km per Hour (iv) 80 km per hour

(f) Which scientist who invented the laws of motion.

(i) Aristotle (ii) Galileo (iii) Faraday (iv) Newton

ANSWERS TO INTEXT QUESTIONS

5.1

1. Dynamic: - (a), (b), (c) pause - (c)
2. (a) random motion (b) oscillation speed (c) linear motion (d) circular motion

5.2

1. (1) Length, (2) distance, direction, (3) 30, (4) acceleration
2. m / s
3. Meter / second

5.3

1. (a) First rule, (b) Third rule, (c) Second rule
2. Equivalent to (a), (b) Less, (c) () (d) Friction