

16

Force and Motion

16.1 Distance and displacement

Imagine that you have a chance of going on a trip during your school vacation. Can you suggest a method to find the distance to the places, that you expect to visit during that trip? Let us pay attention to Activity 16.1.



Activity 16.1

- Find a road map of Sri Lanka, drawn to scale and identify the scale.
- Place a thin thread along the main road and measure the length between two cities.
- Calculate the distance to travel from Colombo to Kandy, Galle, Matara, Kurunegala, Puttalam, Trincomalee and Jaffna.
- Measure the straight length from Colombo to each city mentioned, and calculate the straight distance.
- Tabulate the findings as below.

Table 16.1 ▼

Two cities	Distance to travel between the two cities	Straight distance between the two cities
Colombo to Kandy		
Colombo to Galle		
Colombo to Matara		
Colombo to Kurunegala		
Colombo to Puttalam		
Colombo to Trincomalee		
Colombo to Jaffna		

It will be clear to you that the straight distance between the two cities is always less than the distance to travel between them.

Recall an instance where there is a staircase and an escalator go to the

top floor of a multi-storeyed building. It may be clear to you that the path of the escalator is linear and is shorter than the path of the staircase. You may travel from one place to another when you go on a trip. A person may go from one floor to another in a multi-storeyed building. An escalator goes up and down in a straight path. The change of position, with time, of living or non living objects is known as motion.

Distance is the total length of the path of a motion. Here, the direction of motion may or may not change from time to time. Therefore, distance has not a definite direction.

Displacement is the linear length between the starting and ending positions of a motion. When mentioning displacement, the direction of motion should always be indicated.

Recall Activity 16.1 you did above. You may have understood that the length of the road between two cities is known as the distance and the straight distance is known as the displacement. Geographical directions or the direction from one city towards the other can be used to mention the direction between the two cities. The same way, motion along a staircase is the distance and motion of an escalator is the displacement. The direction of the displacement is the direction of the motion of the lift.

To find out more about distance and displacement, let us consider the following facts. Recall the 100 metre and 400 metre running events of a sportsmeet.



100 metres



400 metres

Figure 16.1a ▲

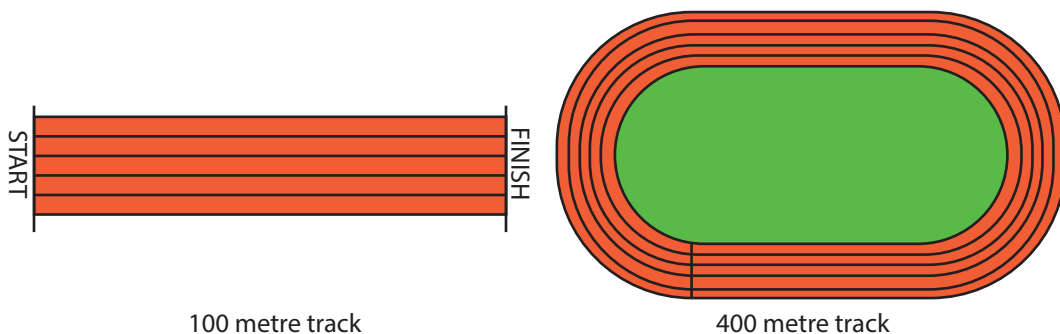


Figure 16.1b ▲

Both events are short distance races. But, there are some clear differences between them.

Table 16.2 ▼

Differences	100 metres	400 metres
01. Direction of motion	Direction does not change	Direction changes from time to time
02. Total length of the path	100 metres	400 metres
03. Linear length between the points of start and end	100 metres	0 metre (zero)

Thus the distance (distance of the motion) of the runner in the 100 metre event is 100 metres, and the distance (distance of the motion) of the runner in the 400 metre event is 400 metres. The distance between start and end points of the 100 metre runner is 100 metres. Therefore, his displacement is 100 metres. The 400 metre runner ends his event at the same point where he started. So, his displacement is zero.

As both the distance and displacement are lengths, the unit of measuring distance and displacement are the units of measuring length.

You already know that millimetre, centimetre, metre and kilometre are used to measure length. Out of those, the international unit of measuring length is metre. Therefore, the international unit of measuring both distance and displacement is metre (m). Displacement has a definite direction, therefore it has to be mentioned.

Let us solve a simple problem to clarify distance and displacement further.

The route of the motion of an object from A to B is shown in Figure 16.2.

The distance travelled from A to B or the total length of the route passed is 120 m.

The displacement from A to B or the linear length between the initial and final points of motion is 40 m towards the direction AB (South-east)

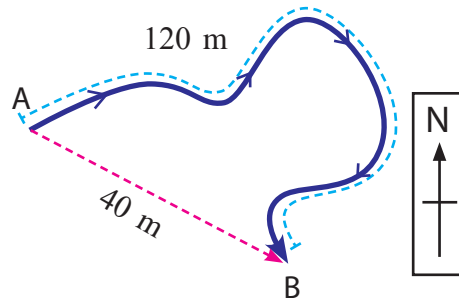


Figure 16.2 ▲

Self assessment -1

A route for a child to travel from his home to a tank is shown in Figure 16.3.

- What is the distance travelled by the child?
- What is the displacement of the child?

Answer

- 400 m
- 100 m towards north-east

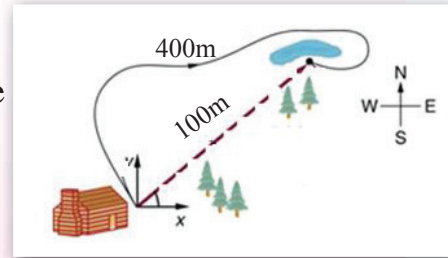


Figure 16.3 ▲

02. Let us consider a man travelling from P to R via Q by a motor vehicle as shown in Figure 16.4.

- What is the total distance travelled during this motion?
- What is the displacement of the vehicle during this motion?

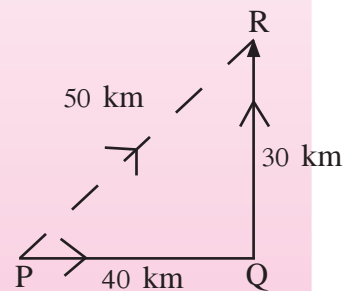


Figure 16.4 ▲

Answer

- 70 km
- 50 km towards north-east

Now, it is clear to you that distance is a quantity with a magnitude, and displacement is a quantity with both magnitude and definite direction.

16.2 Force

We engage in various actions in our day-to-day life. Some of them are given below.

- Pushing a table
- Riding a bicycle
- Drawing water from a well
- Hitting a ball
- Erasing pencil lines drawn in a book
- Writing with a pen
- Pulling a table
- Applying brakes of a bicycle
- Turning a tap
- Brushing teeth
- Lifting a bag

What do we do during these actions? You may have understood that a pull or a push is applied during all these actions.



Figure 16.5 ▲

Lifting a bag is an upward pulling. When drawing water from a well, a pull is applied. When riding a bicycle, push is applied by the feet on the paddle.

Let us do Activity 16.2 to find out more about pulls and pushes.



Activity 16.2

Engage in the following activities. Copy table 16.3 in your notebook and mention whether the action done is a pull or a push.

Table 16.3 ▼

Action done	Is it a pull or a push
Pushing a table	Push
Drawing water from a well	Pull
Lifting a bag	
Riding a bicycle	
Turning a tap	
Hitting a ball	
Writing with a pen	
Brushing teeth with a tooth brush	
Erasing pencil lines drawn in a book	
Applying brakes of a bicycle	

Pulling or pushing is known as applying a force.



Figure 16.6 ▲

When pulling a car, the rope attached is pulled and a force is applied on the car. What is done by the child when pushing the trolley, is the forward application of a force. A large force should be applied to push a heavier table than to push a lighter one.

Let us do Activity 16.3 to find out about the amount of force applied on an object.



Activity 16.3

You will need :- Two similar size wooden blocks, a rubber band, a Newton spring balance

Method :-

- Place a wooden block on a table and pull it using a rubber band attached.
- Place the other wooden block on the first block and pull again using the same rubber band.
- When the motion starts the rubber band will stretch longer. That means the force applied later is larger.
- Repeat the activity using a Newton spring balance instead of the rubber band.
- Record the readings of the Newton balance in both occasions. The amount of force applied can be obtained numerically.

The rubber band is stretched less when there is one wooden block and it is stretched more when there are two wooden blocks. That means, more force is applied at the second occasion. When you compare the readings in the spring balance, it can be understood properly.



Figure 16.7 ▲
Newton spring balance

International unit of measuring force is newton. Symbol of newton is N. The equipment used to measure force is newton spring balance.



Activity 16.4

Take a balance calibrated in grams or kilograms and a spring balance calibrated in newton. Weigh the same object using both balances and record the readings in a table as given below. Develop a relationship between weight and mass with the help of your teacher

Table 16.4 ▼

Object weighted	Mass (kg)	Weight (N)



Activity 16.5

You will need :- A spring balance, a piece of thread, a wooden block

Method :-

- Attach a newton spring balance using a piece of thread, to a wooden block kept on a polished table. Pull the block using the newton balance.

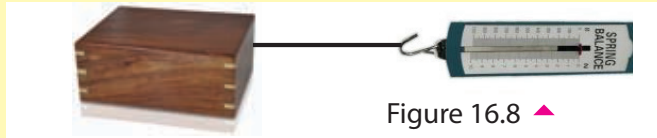


Figure 16.8 ▲

- Observe the direction of the motion of the wooden block and the direction of pulling the thread.
- Push the wooden block, while it is on the table. The direction of pushing is the direction of applying the force.



Figure 16.9 ▲

- Observe the direction of pushing the wooden block and the direction of the motion of it.

The thread in Figure 16.8 shows the direction of the pull. Newton spring balance shows the magnitude of the force. The wooden block has moved to the direction of the force applied in the above pulling and pushing. Thus, it is clear that a **force has a magnitude (amount) and a definite direction.**

There are various effect of a force. Let us find out some of them.

- **An object can be moved by applying a force. At the same time moving object can be stopped by applying a force.**



Figure 16.10 ▲

An arrow at rest can be moved by applying a force to a bow. Vehicle at rest can be moved by applying a force by its engine. Ball at rest can be moved by hitting it with a bat. Thus, living as well as non living objects, at rest, can be moved by applying a force.

- **The speed of an object can be changed by applying a force.**



Figure 16.11 ▲

The speed of motion of a bicycle can be increased by increasing the force applied on its pedal. The speed of it can be decreased by applying brakes. An animal can change its speed of moving by changing the force applied on its limbs. Speed of a vehicle can be increased by treading on the accelerator and it can be decreased by applying brakes.

- **Direction of motion can be changed by applying a force.**



Figure 16.12 ▲

In Figure 16.12 a cricketer can change the direction of the ball by hitting it. In the event of pulling rope, each team tries to change the direction of motion of the rope. Two puppies are applying force to drag the bone towards itself.

- **Rotation or a turning effect can be resulted by applying a force**



Figure 16.13 ▲

When a force is applied to a tap, it turns. A steering wheel also turns when a force is applied. How do you turn a bicycle when you are riding? It is done by applying a force on the bicycle.

- **The shape of an object can be changed by applying a force.**

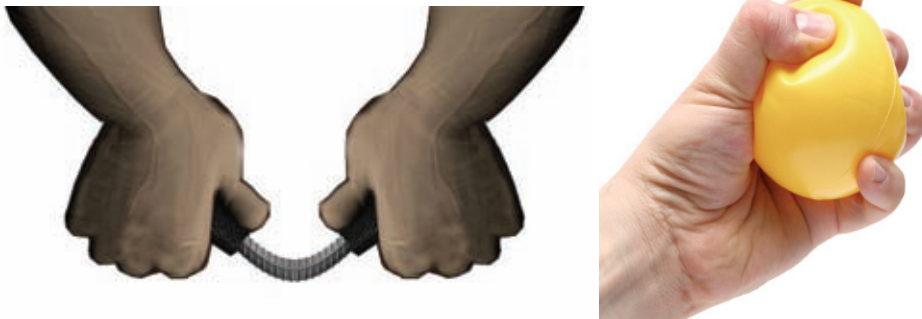


Figure 16.14 ▲

Bending iron bars is done in various displays. Then the shape of the iron bar changes.

Various goods are shaped with clay by applying force. The shape of plastic goods can be temporarily changed by pressing them.

Changing the shape due to the force applied on it is occurred in such occasions.



Assignment 16.1

Recall instances of applying forces by you today. Prepare a list of uses that you get by applying those forces.



For extra knowledge

A force is exerted by the centre of the earth on all the objects on the earth. This force is known as gravitational force.

The weight of an object is the gravitational force exerted on the mass of the object. Though the mass of an object is always constant, its weight may slightly change from place to place because of the change of gravitational force.

The gravitational force of the moon is about one sixth of that of the earth. Therefore, the weight of an object on moon is one sixth of the weight of that object on the earth.

e.g.:- The weight of a man whose mass is 60 kg, is 600 N on the earth. The weight of the same man on the moon will be 100 N. But, his mass will remain unchanged as 60 kg on the moon.



Assignment 16.2

Collect pictures, photographs and diagrams of the instances of applying forces in day-to-day life and make a collection of information on forces.



Summary

- The total length of an object in motion is the distance.
- The straight length between the starting and end points of the motion of an object is the displacement. Displacement has a definite direction.
- A pull or a push is known as a force. Force has a magnitude and a definite direction.
- The standard unit of measuring force is newton.
- An object at rest can be moved by applying a force on it.
- The speed of a moving object can be changed by applying a force.
- The direction of motion of an object can be changed by applying a force.
- Rotation or a turning effect can be done by applying a force.
- The shape of an object can be changed by applying a force.

Exercise

- Select the correct or the most suitable answer, for the questions below.

01. What is the international unit of measuring distance?

1. Millimetre 2. Centimetre 3. Metre 4. Kilometre

02. A moving bicycle is pushed from behind by a child. What will be the change of motion?

1. Speed increases 2. Speed decreases
3. It will rotate 4. Direction changes

03. What is the instrument used to measure force?

1. Pan balance 2. Table balance
3. Newton balance 4. Electronic balance

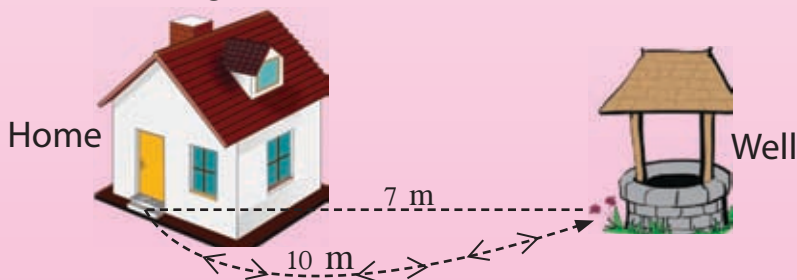
04. Which measurements, have a magnitude and a definite direction?

1. Distance and displacement 2. Displacement and force
3. Force and distance 4. Force only

05. Which is the correct statement about force?

1. Force has a magnitude only
2. Pulling only can be resulted by applying a force
3. Pushing only can be resulted by applying a force
4. Pulling and pushing can be done by applying a force

- A child goes to the well, which is in the east from his home and returns back along the same route.



01. Write down in the table, the distance travelled and the displacement for each instance given below.

Table 16.5 ▼

Motion	Distance travelled (m)	Displacement (m)
Going from home to the well		
Going from well to the home		
Going from home to the well and returning back		

02. There are some instances given below, where a force is applied. Mention whether it is a pull or a push for each instance.



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Technical Terms

Force	- விசை	- விசை
Motion	- இயக்கம்	- அசைவு
Distance	- தூரம்	- தூரம்
Displacement	- இடப்பெயர்ச்சி	- இடப்பெயர்ச்சி