# 4 Basic Concepts Associated with Force

## 4.1 Force

Let us consider situations like lifting an object, pushing a table, opening or closing a door or hitting a ball (figure 4.1).

**Figure 4.1**

In such instances what we do is, pulling or pushing the object. Such a pulling or pushing is called a force, simply a **force means a pull or a push**.

When we push a book on the table, it moves. A ball moves faster if we kick it. But, you can not push and move a wall. A single person cannot push and move a bus or a lorry. Thus, it is clear that, sometimes we can move an object by applying a force or sometimes a force cannot result any motion.

When you catch a ball that comes towards you, a force is applied to stop it. When you hit a ball with a bat, you apply a force to change the direction and the speed of the ball.

You can press a ball by keeping it on the ground and tread on it. Here, you change the shape of the ball by applying a force.

Accordingly, by applying a force;

- object at rest can be moved.
- object in motion can be stopped.
- the speed of motion can be changed.
- the direction of motion can be changed.
- the shape of object can be changed.

## 4.2 Magnitude of force

A ball can be moved slowly by hitting slightly. If you hit it harder it moves fast. When hitting slowly, applies a small force. Hitting fast, applies a large force. Thus, it is clear that a force has a magnitude.

There are several equipment that can be used to measure the magnitude of a force. Spring balance is a simple equipment, used for this purpose. What is inside of a spring balance is a spring, that changes its length according to the force applied. It is calibrated according to the stretched length of the spring.

There are several units to measure the magnitude of a force. According to the international system (SI) of units, magnitude of force is measured in Newtons (N). There are spring balances in school laboratories, which are calibrated in Newtons. But, spring balances which are used for commercial purposes are usually calibrated in grams (g) or kilograms (kg).

Do the activity 4.1 to understand how a spring balance can be used to measure a force.

### Activity 4.1

**You will need :-** A Newton spring balance, a piece of stone, a wooden block, a helical spring, a piece of thread, a metal hook, a G-Clamp

**Method :-**

- Tie the stone by a piece of thread.
- Hang the stone on the spring balance, as shown in figure 4.2, and take the reading.
- This reading gives the magnitude of the gravitational force exerted by the Earth on the piece of stone. This is known as the weight of the stone.

Figure 4.2

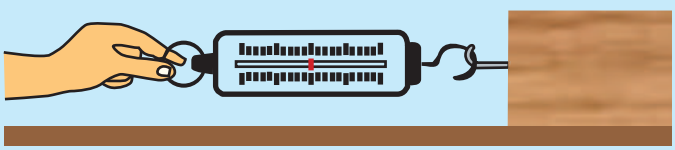


Figure 4.3

- Fix the metal hook to the wooden block.
- Connect the spring balance to the hook as shown in figure 4.3. Pull the spring balance, while keeping it horizontally, till the block just starts to move. Take the reading of the spring balance. It is the magnitude of the force exerted by your hand on the wooden block.

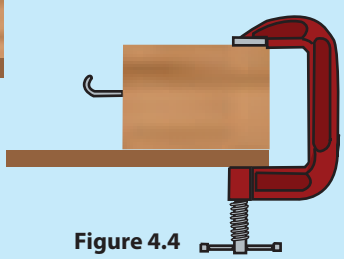


Figure 4.4

- Fix firmly, the wooden block with metal hook, to the table-top using the G-clamp (figure 4.4).
- Connect the helical spring as shown in figure 4.5.
- Join the other end of the helical spring to the spring balance as shown in figure 4.5. Pull the spring balance till the length of the helical spring is increased by 10 cm. Then, take the reading of the balance.

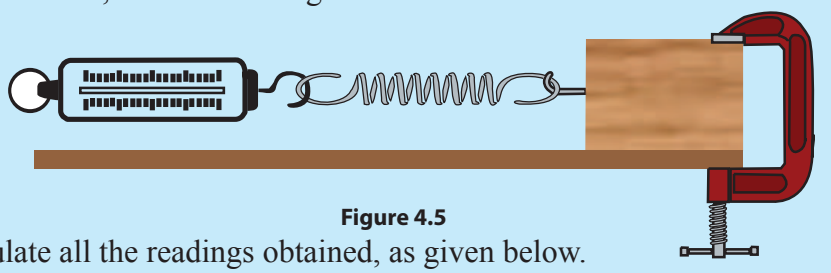


**Figure 4.5**

- Tabulate all the readings obtained, as given below.

**Table 4.1**

| Instance | Quantity | Magnitude of force (N) |
|---|---|---|
| 1 | Weight of the piece of stone | |
| 2 | Force applied to pull the wooden block | |
| 3 | Force applied on helical spring | |

According to the activity 4.1, it is clear that a force has a magnitude.

## 4.3 Direction of force and point of application

When a ball is being hit, the direction of the ball decides the direction of its motion. When a drawer is being opened, it should be pulled towards us. When it is to be closed, it should be pushed to the opposite direction. Thus, it is clear that not only the magnitude, but also the direction of application of force is important.

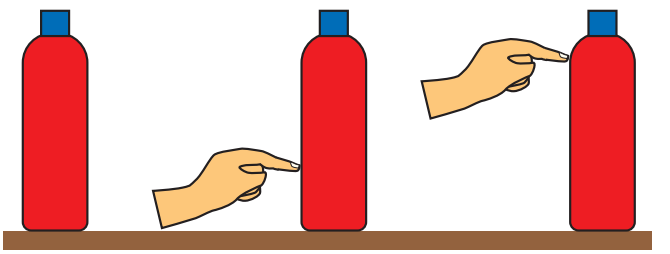


**Figure 4.6**

Apart from this, the result of a force changes according to the point on which it is applied. For an example consider a bottle placed on a table. If it is pushed with the finger, kept closed to the bottom, it will move away along the table top. But if it is pushed at the top, it may topple. **The point of an object, on which the force is exerted is known as the point of application of force**.

Let us do activity 4.2 and activity 4.3 to furthermore study about the direction of force.

## Activity 4.2

**You will need:-** A wooden block, few tintex nails, some thread

**Method :-**

- Fix a nails at the mid point on one side of the wooden block. Tie a piece of thread to the nail (figure 4.7). So that the thread is learning on the block.

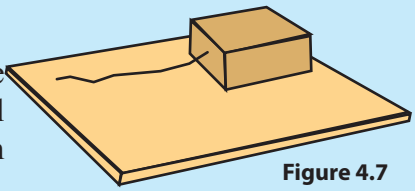


**Figure 4.7**

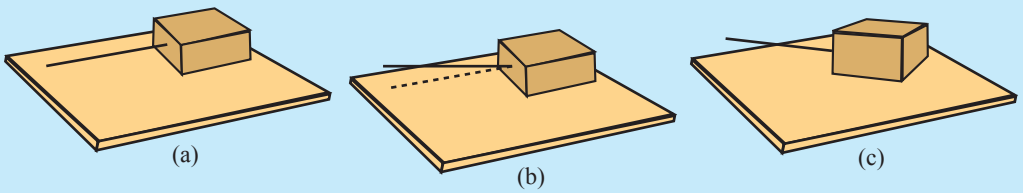



**Figure 4.8 - The wooden block on the table viewed from the top**

- Place the wooden block on the table as in figure 4.8 (a), and pull it to a side by the thread, keeping the tread, keeping the tread horizontally. Observe the direction of motion of the wooden block.
- Then, change the direction with keeping the thread horizontally of thread as in figure 4.8(b) and draw. Observe the direction of motion of the wooden block.

You can observe that the wooden block moves in the direction of pull as in the figure 4.8(a) of the above activity. When the direction of pulling is changed as in figure 4.8(b), the direction of motion of the wooden block changes as shown in figure 4.8(c).

Thus, it can be concluded as follows.

- The force acts to the direction of pulling, along the thread.
- The object moves along the direction of force exerted.

## Activity 4.3

**You will need:-** A wooden block, a circular wooden disc, few tintex nails, some thread

**Method :-**

- Fix tintex nails to the points A, B and C of the upper surface of the wooden block as shown in figure 4.9.
- Fix a nail to the center of the wooden disc as shown in figure 4.10.

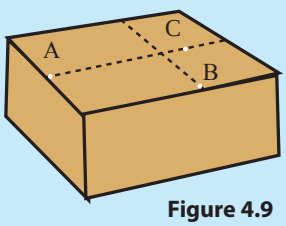



**Figure 4.9**

- Now tie a piece of thread to the nail A of the wooden block and pull the thread, keeping it horizontally. Observe the direction of motion of the wooden block .

- In the same way, tie pieces of thread to points B and C of the block and pull separately. Observe the direction of motion of the wooden block.
- Then, tie a piece of thread to the nail fixed to the centre of the disc. Pull the thread to the directions 1, 2 and 3 keeping it horizontally as shown in the figure. Observe the motion of the disc.

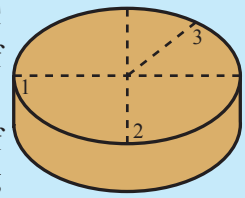


**Figure 4.10**

In the above activity, it is observed that the objects move to the direction of force, irrespective of the shape and the change of direction. Moreover, the thread is directed to the direction of force applied through the point of tieing it to the object.

Here, the point that the thread is tied is point on which the force is acting on the object. That point is known as the **point of application of the force**.

The quantities that have a magnitude as well as a direction are known as **vector quantities**. In the above activities, it is confirmed that the force has a **magnitude** and a **direction.** Therefore, **force is a vector quantity**.

## 4.4 Graphical representation of force

The magnitude, direction and the point of application of a force can be graphically represented by a segment of straight line. Here;

- The **magnitude** is represented by the **length**,
- The **direction** is represented by the **arrow head**,
- The **point of application** is represented by the **dot** at the starting point of the segment of straight line.

For example let us consider a force of 10 N acting on the wooden block X, and a force of 5 N acting on the wooden block Y.

The magnitude of the force of 10 N acting on the object X is denoted by the length of the horizontal line, the direction by the arrow head and the point of application by point P in figure 4.11.

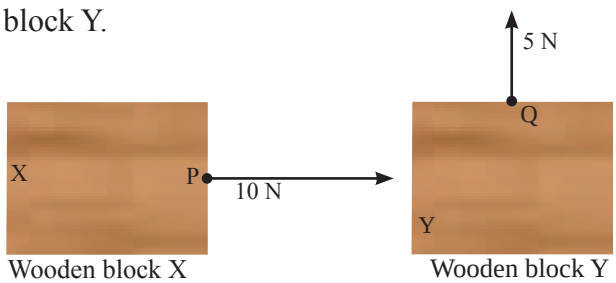


**Figure 4.11**

The magnitude of the force of 5 N acting on the object Y is denoted by the length of the vertical line, the direction by the arrow head and the point of application by point Q, in figure 4.11.

Moreover the length of the straight line drawn to denote the force of 10 N on X should be twice as long as the one drawn to denote the force of 5 N on Y.

In our day-to-day life, we apply forces on various objects. When we write with a pen, we have to apply forces to move the pen on the sheet of paper. When walking, forces are applied on the floor by our feet. When playing cricket, forces are applied on the ball by hitting the bat. To move the bat, the player has to apply force on the bat.


**Figure 4.12**

We have to make an effort to do these types of work. Most of the time, we apply forces in the easiest way to reduce effort. For example, let us consider the figure 4.12(a). A person drawing a loaded cart is shown there. He applies a horizontal force, because the cart should be moved horizontally. But, the person has to bend and pull with a difficulty to maintain the horizontal force. This difficulty can easily be overcome by drawing the cart to a direction shown in figure 4.12(b). Although the force is not applied horizontally, the cart moves to the direction we want. What we do here is change the direction of force to make the work easy.

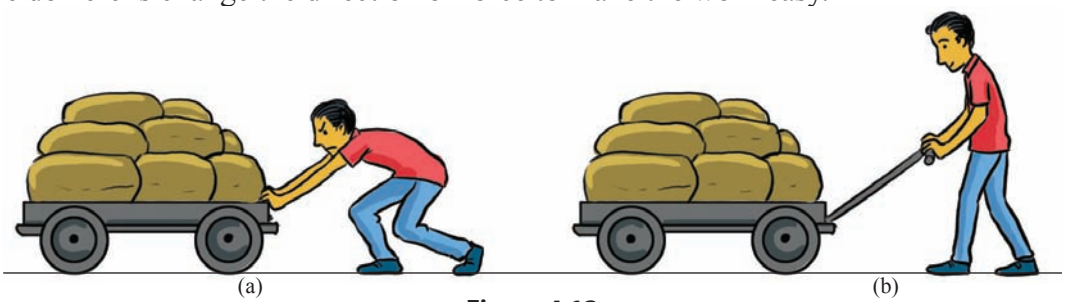



**Figure 4.13**

A person pushing a loaded cart is shown in the figure 4.13(a). The person has to bend and push it with difficulty. To ease the work, a wooden or metal handle can be fitted to the cart and the point where the force is applied (point of application) can be changed (figure 4.13 (b)).

In our day-to-day life, we select the way of applying forces in such a way, that the work is handled easier. What is applied here is not merely the scientific knowledge, but our practical experiences also contribute a lot. But, if there is some knowledge about forces, our tasks can be fulfilled easier.

## Summary

- Force is a pull or a push.
- When a force is applied,
  - an object at rest can be moved.
  - an object in motion can be stopped.
  - the speed of motion can be changed.
  - the direction of motion can be changed.
  - the shape of an object can be changed.
- Standard unit of measuring force is Newton (N).
- Newton spring balance is used to measure the magnitude of a force.
- Force has a direction and a magnitude. Therefore, force is a vector quantity.
- The point on which the force is acting on the object is known as the point of application of the force.
- Day-to-day life activities can be done easily by changing the direction and the point of application of a force.

## Exercise

**01) Select the correct or most suitable answer.**

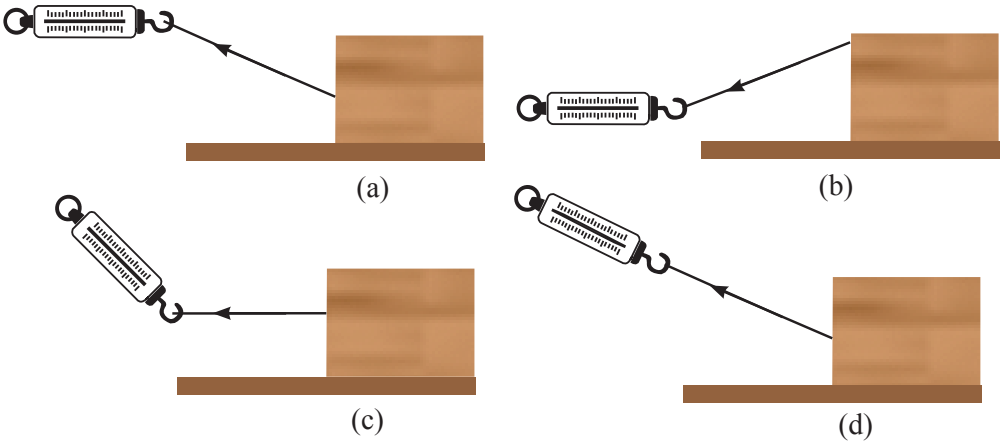
1. The weight of an object is a force. What is the unit of measuring weight?
   (1) kg (2) kg s (3) N (4) N s

2. Force is considered as a vector quantity, because it has
   (1) a magnitude. (2) a point of application.
   (3) direction. (4) magnitude and a direction.

3. A force can be graphically represented by a straight line. Consider the following statements in this regard.
   a. The magnitude of force is denoted by the length of the straight line.
   b. The direction of force is denoted by the arrow head on the line.
   c. The point of application of the force is indicated by the mid point of the straight line.

   The true statements are;
   (1) a and b only (2) a and c only
   (3) b and c only (4) a, b, and c

4. Figures given below show, how a newton spring balance is used to measure the magnitude of a force applied on an object.




Which figure above, shows the correct way of using the spring balance?

1) a 2) b 3) c 4) d

5. Consider the statements given below, about a force.
Because of a force applied on an object,

a. Object at rest can be moved.
b. Object in motion can be stopped.
c. The direction of motion can be changed.

What are the true statements above?

(1) a and b only (2) a and c only
(3) b and c only (4) a, b and c

## Technical Terms

| | | |
|---|---|---|
| Force | - බලය | - விசை |
| Vector | - දෛශිකය | - காவிக் கணியம் |
| Point of application of force | - බලයේ උපයෝගී ලක්ෂ්‍යය | - விசையின் பிரயோகப் புள்ளி |
| Magnitude of force | - බලයේ විශාලත්වය | - விசையின் பருமன் |
| Direction of force | - බලයේ දිශාව | - விசையின் திசை |
| Graphical representation | - රූපික නිරූපණය | - வரிப்பட வகைகுறிப்பு |
| Spring balance | - දුනු තරාදිය | - விற்றராசு |
| Newton | - නිව්ටනය | - நியுற்றன் |