

You might have seen a driver of a car, truck slowing down the vehicle at a traffic signal. You, too slow down your bicycle whenever needed by applying brakes. Have you ever thought why a vehicle slows down when brakes are applied? Not only vehicles, any object, moving over the surface of another object slows down when no external force is applied on it. Finally it stops. Similarly a moving ball stops on the ground slopping after some time. Why is it difficult to walk on a smooth and wet floor? Why do we slip when we step on a banana peel?

Let us find out the reason behind all these incidents?

14.1 Force of Friction



Activity 1

Materials required -A table, a book.

Gently push a book on a table. You observe that it stops after moving for some distance(fig 14.1a). Now push the book from the opposite direction (fig 14.1b). Does the book stop this time, too? Is there any force acting on the book opposing its motion? The force which opposes the motion of an object is called the force of friction.

Thus, we saw that if we apply the force along the left, friction acts along the right and if we apply the force along the right the friction acts along the left direction. In both cases the force opposes the motion of the book. The force of friction always opposes the applied force. In the above activity, the force of friction acts between the surface of the book and the surface of the table.

Think, is the force of friction the same for smooth and rough surfaces or does it differ?

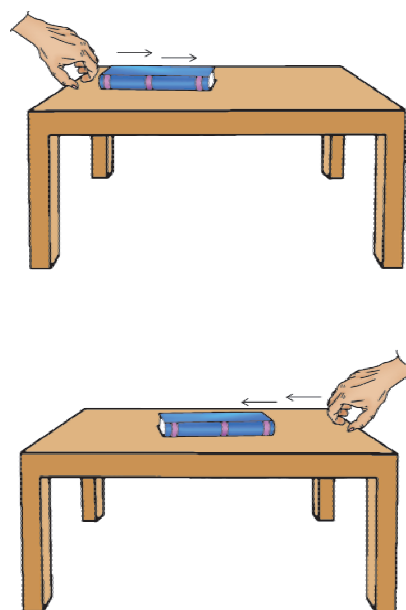


Fig 14.1(a and b): Friction opposes relative motion between the surfaces of the book and the table.

14.1.1 Is Frictional Force a Contact Force?

In activity 1, when we push a book we use the force of muscles, this force is called muscular force. Muscular force is only applicable when our muscles are in contact with any object. So, it is also called contact force. Similarly the frictional force exists in between the surfaces of book and table is contact force.

Some forces are non-contact forces e.g. magnetic force exerted by magnet on the pieces of iron, electrostatic force exerted by a charged body on another charged or uncharged body and the gravitational force exerted by the earth on the bodies lying on it. All these forces are non-contact forces because here the force is exerted between bodies without being in contact.

14.2 Factors Affecting Friction

Let us do an activity to understand what are the factors affecting friction.



Activity 2

Materials required - Wooden board, brick, pencil cell, cloth, sand etc.

Make an inclined plane on a smooth floor or on a table. You may use a wooden board supported by bricks or books. Put a mark with a pen at any point A on the inclined plane. Now, let a pencil cell move down from this point. How far does it move on the table before coming to rest (fig 14.2 a)? Note down the distance. Now spread a piece of cloth over the table. Make sure that there are no wrinkles in the cloth. Again let the pencil cell move from the point A (fig. 14.2 b).

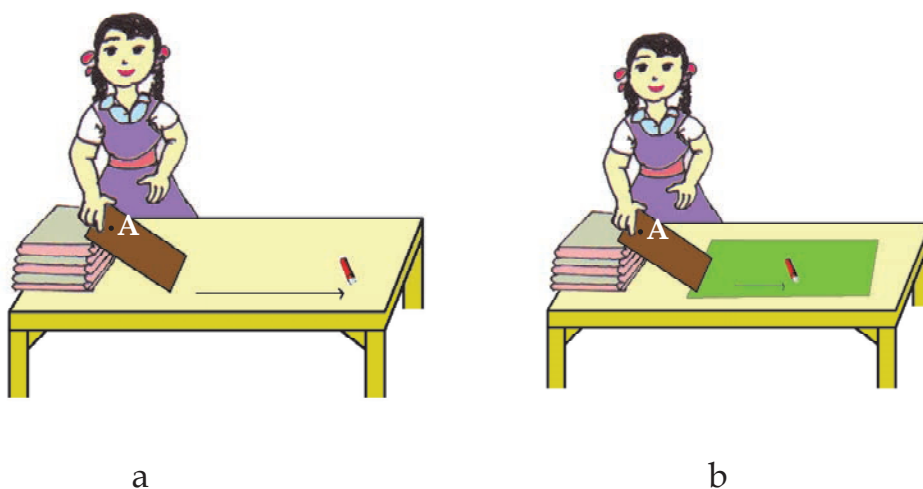


Fig 14.2 (a) and (b) the pencil cell covers different distances on different surface

Now, repeat this activity by spreading a thin layer of sand over the table. Maintain the same slope throughout the activity.

Is the distance covered by the pencil cell in each case the same? In which case the distance covered by pencil cell is least? Why the distance covered by the pencil cell different in every case?

The distance covered by pencil cell, depends on the nature of the surface on which the cell moves. The smoothness of the surface of the pencil cell also affects the distance travelled by it. For this you shall try the activity by wrapping a piece of sand paper around the pencil cell.

Friction is caused by the irregularities on the two surfaces in contact. Irregularities on the two surfaces lock into one another. When we attempt to move any surface, we have to apply a force to overcome interlocking. There are minute irregularities in both the smooth and rough surfaces. Even those surfaces which appear very smooth have a large number of minute irregularities on them (fig.14.3) but on rough surfaces the irregularities are more. Now you understand that why the pencil cell covers a short distance on sand and longest distance on smooth surface of table.

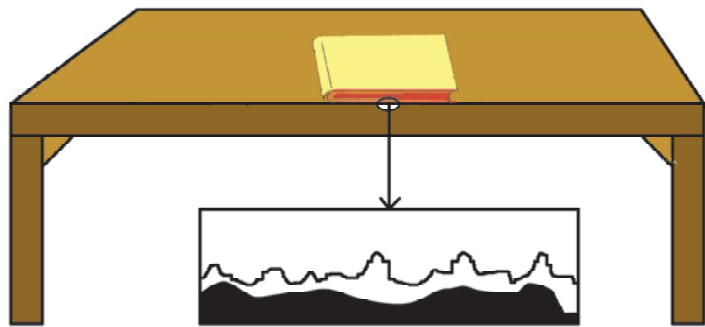


Fig 14.3 Surface Irregularities

We understand that the friction is caused by the interlocking of irregularities in the two surfaces. The force of friction will increase if the two surfaces are pressed harder. This can be experienced by dragging a mat when nobody is sitting on it, and when a person is sitting on it.

Think what is easier, to move the heavy box from rest or to move it, when it is already in motion?

The force required to overcome friction at the instant when an object starts moving from rest is a measure of static friction. On the other hand, the force required to keep the object moving with the same speed is a measure of sliding friction.

When the box starts sliding, the contact points on its surface do not get enough time to lock into the contact points on the floor. So, the sliding friction is slightly smaller than the static friction. So it is easier to move the heavy box already in motion than to get it started.



NOW ANSWER THESE

1. Why we slip down on stepping over the banana peel?
2. Explain why sportsmen wear shoes with spikes?
3. Abdul has to push a lighter box and Rama has to push a heavier box on the same surface. Who will experience more frictional force and why?
4. Explain contact and non-contact force with examples.

14.3 Friction a Necessary Evil

Recall your experience; is it easier to hold a kulhar (earthen pot) or a glass tumbler? It is clear that the surface of a glass tumbler is smooth while kulhar is rough, that's why glass tumbler slips but a kulhar does not. So, holding a glass tumbler is difficult than to hold a kulhar. Suppose the outer surface of the tumbler is greasy, or has a film of cooking oil on it, would it become easier or more difficult to hold it?

Imagine, what would happen if there were no friction at all? Could vehicles move on the road? If there had been no friction between the tyres of the automobiles and the road, they could not be started or stopped or turned to change the direction of motion.

You could not write with pen or pencil if there was no friction. It is due to only friction that we can write with chalk on blackboard. When something is written with chalk on the blackboard, its rough surface rubs off some chalk particles which stick to the blackboard. If an object started moving, it would never stop if there were no friction. We could not fix a nail on the wall, tie a knot or construct a building without friction.

On the other hand, friction is an evil, too. It wears out the materials whether they are screws, ball bearings or soles of shoes.

Can friction also produce heat? To understand this, vigorously rub your palms together for a few minutes. Do they become warm? Now you learn that friction produces heat. When you strike a matchstick against the rough surface, it catches fire due to generation of heat by friction.

There are so many other examples in which friction generates heat. In fact, when we operate a machine the generated heat causes much wastage of energy.

14.4 Methods of Increasing and Reducing friction

Have you ever thought why the sole of your shoe is grooved? Due to these grooves, shoes provide better grip on the floor, so that we can move safely. Similarly, the treaded tyres of cars, trucks and bulldozers provide better grip with the ground.

We deliberately increase friction by using brake pads in the brake system of bicycles and automobiles. When we are riding a bicycle, the brake pads do not touch the wheels. But when we press the brake lever, these pads arrest the motion of the rim due to friction.

You might have seen that kabaddi players rub their hands with soil for a better grip of their opponents. Gymnasts for better gripping apply some coarse substances on their hands to increase friction.

Is friction necessary in every situation? In some situations, however, friction is undesirable; so that in this situation we minimize it e.g. we sprinkle fine powder on the carrom board to reduce friction. You might have noticed that when a few drops of oil are poured on the hinges of a door, the door moves smoothly. A bicycle and a motor mechanic use grease between the moving parts of these machines. In the above cases, we want to reduce friction in order to increase efficiency. When oil, grease or graphite is applied between the moving parts of a machine a thin layer is formed there and moving surfaces do not directly rub against each other. Interlocking of irregularities is avoided to a great extent so that movement becomes smooth. The substances which reduce friction are called lubricants. In some machines, it may not be advisable to use oil as lubricant. An air cushion between the moving parts is used to reduce friction.

Friction can never be entirely eliminated because no surface is perfectly smooth. Some irregularities are always there.

14.5 Wheels Reduce Friction

You must have known that attaches and other pieces of luggage fitted with wheels or rollers. On pulling attaches, rollers roll over, here the motion of the roller is called rolling motion. When one body rolls over the surface of another body, the resistance to its motion is called rolling friction. Rolling reduces friction. It is always easier to roll than to slide a body over another. That is the reason it is convenient to pull attaches fitted with rollers in comparison to the attaches without rollers.

Since the rolling friction is smaller than the sliding friction, so sliding is replaced in most machines by the use of ball bearings. Common examples are the use of ball bearings between hubs and the axis of ceiling fans and bicycles.

14.6 Fluid friction

You know that in science, the common name of gases and liquids is fluids. Air, Water and other liquids exert force of friction when objects move through them. The frictional force exerted by fluids is also called drag. The frictional force on an object

in a fluid depends on its speed with respect to the fluid. The frictional force also depends on the shape of the object and the nature of the fluid.

When objects move through fluids, they have to overcome friction acting on them. In this process they lose energy. Efforts are, therefore, made to minimize friction. So, objects are given special shapes. In fact, all vehicles are designed to have shapes which reduce fluid friction like the shapes of ships and boats.

14.7 Earthquake: A Natural Phenomenon

You know that there are certain natural phenomena occurring on earth, to which it is very difficult to protect ourselves from them, so they are called natural disaster. Some natural phenomena are flood or drought, lightning or thunderstorm earthquake, getting fire, wind or cyclone etc. These natural phenomena can cause large scale destruction of human life and property. Due to protective steps taken by Science and Technology, these phenomena can be predicted to some extent.

Let's learn about the major steps to be taken for our protection by reducing the loss due to the natural phenomenon earthquake.

Earthquakes occur all the time all over the earth. They are not even noticed. Major earthquakes are much less frequent. They can cause immense damage to buildings bridges, dams and people. They can also cause floods landslides and tsunamis.

An earthquake is a sudden shaking or trembling of the earth which is caused by a disturbance deep inside the earth's crust. We know that the outer most layer of the earth is not in one piece. It is fragmented. Each fragment is called a plate. These plates are in continuous motion. When they brush past one another or a plate goes under another due to collision, they cause disturbance in the earth's crust which is shown up as an earthquake on the surface of the earth (fig 14.4)

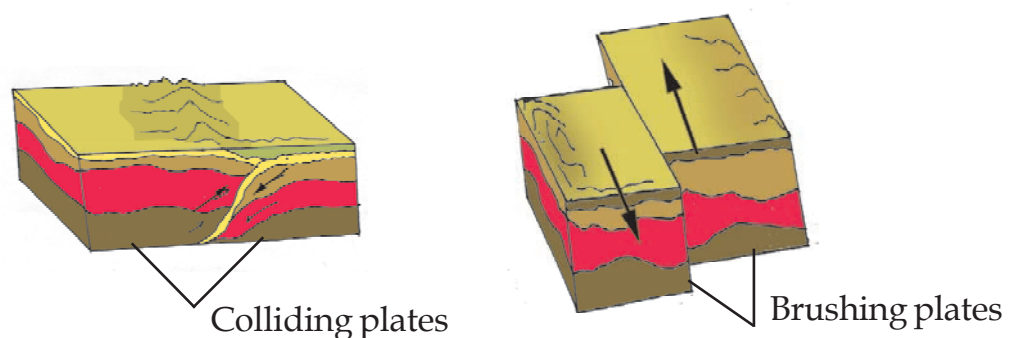


Fig. 14.4 Movements of Earth's plates

Tremors on the earth can also be caused when a volcano erupts, or a meteor hits the earth or an underground nuclear explosion is carried out. However, most earthquakes are caused by the movement of earth's plates.

The power of an earthquake is expressed in terms of a magnitude on a scale called the Richter scale. Destructive earthquakes have magnitudes higher, than 7 on the Richter scale. It is advisable to make the structure of building simple and 'Quake safe'.

Protection against earthquakes

- If you are at home, take shelter under a table and stay there till the shaking stops.
- Stay away from tall and heavy objects that may fall on you.
- If you are in bed, do not get up; protect your head with a pillow.
- If you are outdoors, find a clear spot, away from buildings, trees and overhead power lines; drop to the ground.
- If you are in a car or a bus, do not come out. Ask the driver to drive slowly to a clear spot.



NOW ANSWER THESE

1. Explain how the shape of an aeroplane reduces friction.
2. By continuous movement, why does a machine get heated up?
3. Can friction be less or become nil by using lubricants?



WE HAVE LEARNT

- Friction opposes the relative motion between two surfaces in contact; it acts on both the surfaces.
- Friction is caused by the irregularities on the two surfaces in contact.
- For a given pair of surfaces, friction depends on the nature of surface and the state of smoothness.
- Friction also depends on how hard the two surfaces press together.
- Sliding friction comes into play when an object is sliding over another.
- Friction can be increased by making a surface rough.
- Friction can be reduced by using lubricants (oil, grease or graphite).
- When one body rolls over another body, rolling friction comes into play. Rolling friction is smaller than sliding friction.

- In many machines, friction is reduced by using ball bearings.
- An earthquake is a sudden shaking or trembling of the earth which is caused by a disturbance deep inside the earth's crust.



QUESTION FOR PRACTICE

1. **Fill in the blanks -**
 - (a) Friction opposes the _____ between the surfaces in contact with each other.
 - (b) Friction depends on the _____ of surfaces.
 - (c) Friction produces _____.
 - (d) Sprinkling of powder on the carrom board _____ friction.
 - (e) Sliding friction is _____ than the static friction.
2. Aabida runs her toy car on dry marble floor, wet marble floor, newspaper and towel spread on the floor. The force of friction acting on the car on different surfaces, in increasing order will be -
 - (a) Wet marble floor, dry marble floor, newspaper and towel.
 - (b) Newspaper, towel, dry marble floor, wet marble floor.
 - (c) Towel, newspaper, dry marble floor, wet marble floor.
 - (d) Wet marble floor, dry marble floor, towel, newspaper.
3. Suppose your writing desk is tilted a little. A book kept on it starts sliding down. Show the direction of frictional force acting on it.
4. Would it be easier or more difficult for you to walk on the floor of soapy water? Give reason in support of your answer.
5. Give example to show that friction is both a friend and a foe.
6. Explain why the objects moving in fluids must have special shapes.
7. Suppose you are outside your home and an earthquake strikes. What precautions would you take to protect yourself?



TRY TO DO THIS ALSO

1. Ask your parents about the huge damage to life and property caused by these earthquakes; collect a few pictures showing the damage caused by the earthquakes from newspapers and magazines. Prepare a short report on the suffering of the people during and after the earthquakes.

