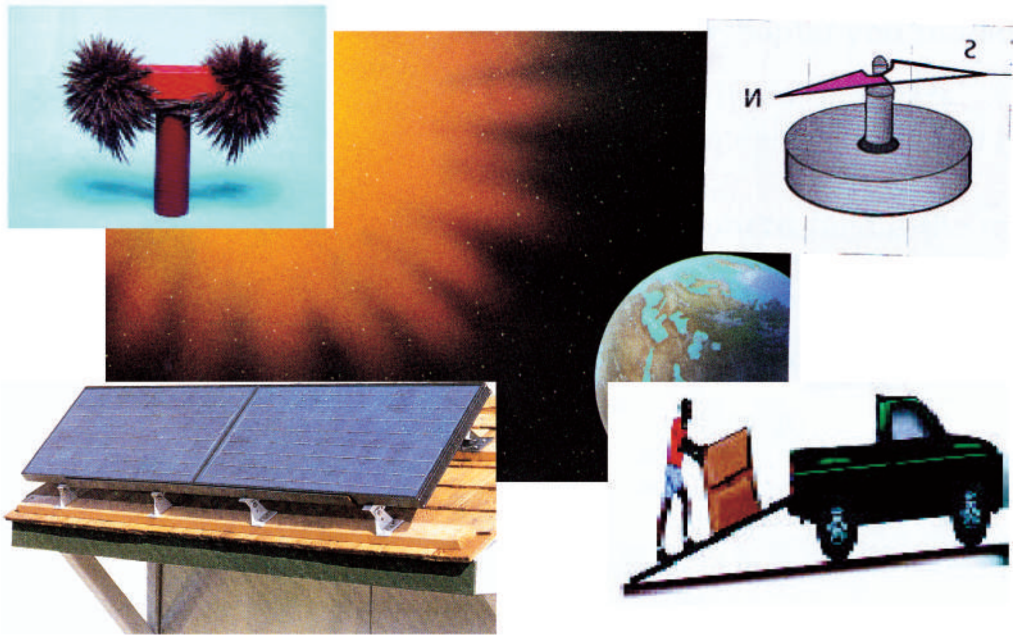
06 Using force, energy, and work Productively



By the end of this chapter, you will be competent to...

- use the knowledge of forces productively.
- investigate about the different types of forces and their applications.
- investigate the different types of motion and their applications.
- use simple machines accurately.
- use machines to produce energy from different sources.
- apply different strategies for the transmission of mechanical energy.
- use energy productively.

6.1 Using force productively

We do apply forces in various ways in our day to day activities. Applying force productively will help us to do our work easily. Let us consider some such instances in this chapter.

Table 6.1 shows some tasks where forces are applied and the nature of the force.

Task	Nature of the force
Opening a gate	Push or pull
Getting a stalled vehicle off the road	Push or pulling the vehicle
Taking patients on a stretcher	Push the stretcher

Table 6.1

You will understand that in all of the above instances,a force had to be applied and that force was a push or a pull.

Therefore, in simple means we can say that force is a push or a pull.

At the same time, we can apply a force and;

- move an object, at rest
- Stop a moving object.
- Increase or decrease the speed of a moving object.
- Change the direction of motion of an object.

Assignment - 6.1

Draw a sketch of the different ways of applying force on the ball in a game of football or volleyball.

6.1.1 Force as a vector quantity

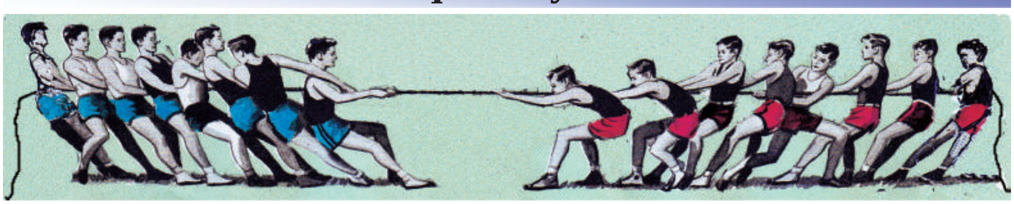


Fig. 6.1- Tug of war

Tug of war is a popular sports event between two groups. The rope moves towards the direction of the higher force. The winning side applies more force and pulls rope towards their side.

In this sport event, the force applied by the winning side has a higher magnitude and a direction. The rope has moved towards the side with the higher force. This shows that force has a magnitude and a direction. Such quantities are known as **vector quantities**. The quantities such as time, length, mass, volume and speed have only a magnitude and they do not have a direction. Such quantities are known as **scalar quantities**.

6.1.2 Measuring force and units of force

The International unit used to measure the force quantitively is **Newton**. It is denoted by the symbol N. The instrument used to measure force is the Newton balance (spring balance) (Fig 6.2).

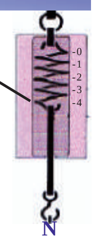


Fig 6.2 Newton balance

Activity 6.1

Arrange the apparatus as in Figure 6.3.

- Mark the position of the pin point on the strip of wood. Label it as 'O'.
- Use a Newton balance and prepare a number of sand bags of 1N weight.
- Place each bag on the pan at a time.
- Mark the position of the pin point.

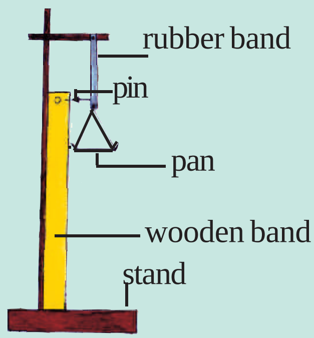


Fig. 6.3 - A model of a Newton balance

The Activity 6.1 shows that when the force is increased by adding sand bags one by one, the rubber band stretches proportionately. Therefore you must understand that a force has a magnitude and we can use a similar instrument to measure it.

6.1.3 Representing forces

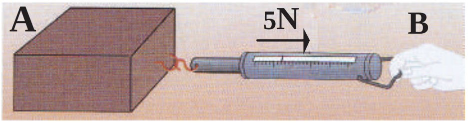


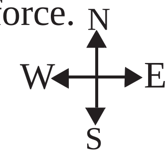
Fig 6.4- Changing the position of an object by a pull

As in Figure 6.4, the object at the position A has to be shifted, to position B. If its position is changed by applying a force of 5N along the direction of motion we can represent this force as $\underrightarrow{\text{5N.}}$

The number shows the magnitude of the force and the arrow head shows the direction.

Representing force by a line drawn to scale

The magnitude and direction of a force can be indicated by a line drawn to scale. Using this we can solve problems about force.



Solved examples

(1) Scale :- 1cm =10N

Find the force represented by this line (5cm). 5cm are marked on this line. 1cm represents 10N. 5cm represents 5x10 = 50N. The arrow head points towards East. The line show a force of 50N along East.That is $\underrightarrow{\text{50N.}}$

6.1.4 Factors to be considered when applying forces

i) Magnitude of the force

In order to move an object, the force applied should be sufficient to move the object.

Suppose we have to move the object of 60 kg kept on a table. (60kg=600N) (6.5 and 6.6) Two forces 500N and 700N are applied separately on the object.

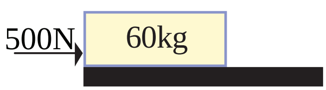


Fig 6.5.
No change in position

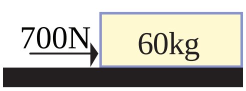


Fig 6.6
There is a change in position

In the first instance, the 500N force was not sufficient to move the object.When we gradually increased the force applied,at the point of 700N the object begins to move. Therefore we understand the force that should be applied to do a certain work, should has a certain magnitude.

ii) Direction of the force

We can apply force in various directions. It is important to apply force in the direction of motion. Let us investigate the result of applying similar forces in various directions.

Activity 6.2

Apply similar forces on the object in various directions as in Fig 6.7 using a Newton balance

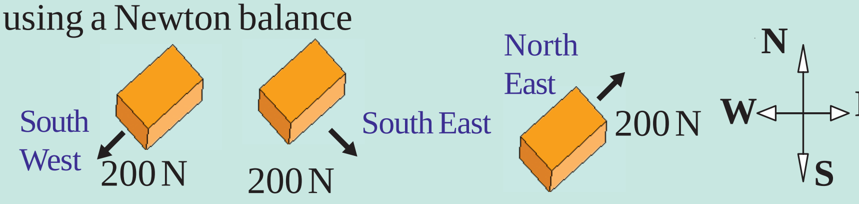


Fig 6.7

The figure 6.7 shows that the object has moved towards the direction of the force applied. It shows that the movement takes place towards the direction of the force. Hence we must apply force in the direction where we need motion.

iii) Point of application of force

Now you know that a force has a magnitude and a direction. There is a point of application of force also. Let us investigate what happens when equal forces are applied on the same object at different points.

The figure 6.8 shows what happens when a force of 100N is applied on an object at three different places, A, B and C.

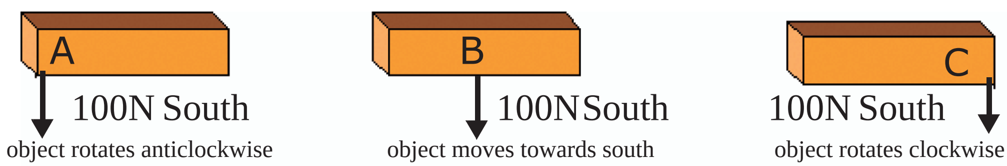


Fig 6.8

The above picture shows that when forces of equal magnitude and direction are applied at different points the direction of movements is not the same. When we apply a force,we have to consider about the **point of application** as well as the **magnitude** and **direction**.

6.2 Types of forces and their applications

Forces are divided into two main groups, to facilitate learning. They are; **Contact forces** and **non Contact forces.**

6.2.1 Contact forces and their applications

When two objects contact each other physically, the force excerted by one object towards the other is defined as **contact forces**. Some examples for Contact forces are **impact force**, **frictional force**, **tension** and **thrust** etc.

Impact forces

A contact force which acts on an object for a very short period of time is called an impact force. Impact forces are sometimes useful but at times they may cause harmful effects too. (Fig 6.9 and 6.10);

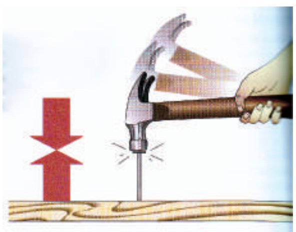


Fig 6.9- Striking with a hammer
A useful impact force

Fig 6.10 - Two vehicles colliding with each other. A harmful impact force

Instance	Impact force used	Result
Breaking up of a rock	Hitting the rock with a hammer	Rock crushes into pieces
Pressing of soil	Pressing the soil with a compressor	Soil layers get harden

Table 6.2 - Some examples of impact forces

Activity 6.3

- Drop two objects of similar shape and size but with different masses on a tray containing wet clay, from a similar height.
- Drop the heavier object faster from the same height on the tray.
- Note the amounts to which the object has sunk in each case.

The activity 6.3 shows that the object with a greater mass sinks more in the clay. When the dropping speed is more, sinking is more deeper. From this activity we can see that, by increasing the mass and speed of a moving object, contact force could be increased.

Frictional forces

If a force parallel to the surface is applied on an object which is resting on a surface, the surface creates an opposing force against the direction of the force. This opposing force is called **frictional force**. If you want to move the object the force applied should be able to exceed the frictional force.The minimum force necessary to start motion is equal and opposite to the frictional force.

Activity 6.4

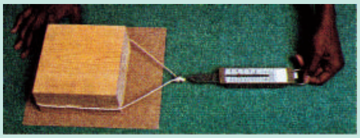


Fig 6.11
On sanpaper

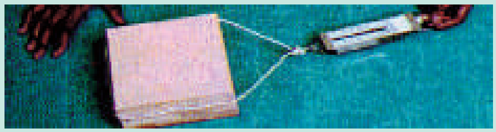


Fig 6.12
On a sheet of glass

- According to figure 6.12, keep a block of wood on a sandpaper and note the minimum force needed to move it, by using a Newton balance.
- Keep the block of wood on a sheet of glass (Fig 6.13) and note the minimum force needed to move the block of wood.

The values we get in the Newton balance are equal and opposite to the frictional force. You will see that it is easier to move the block of wood on glass than on sandpaper.

Rough surfaces have more friction and it is difficult to move on such surfaces. Smooth surfaces have lesser friction therefore it is easier to move on such surfaces.

In our day to day life activities, we come across instances where frictional forces are high and certain others are less frictional forces. It may be advantageous or disadvantageous.

To decrease friction, we put powder on carrom boards, and used ball bearings and roller bearings in vehicles. Apply grease or engine oil in the moving parts of the machines to make the surfaces smooth.

To increase frictional forces we use carpets on the floor, cut grooves on tyres, soles of shoes and put rough covers and make the surfaces rough.

instance	Frictional force has to decrease / increase
Prevent skidding of vehicles on the road.	Friction between road and tyre must be high.
Prevent wasting between two moving parts of machines.	Friction between the parts must be low.

Table 6.3 - Some examples for advantages and disadvantages of friction

So, we can see that frictional forces are sometimes useful but sometimes not We can make our work easier by increasing or decreasing friction, in appropriate instances .

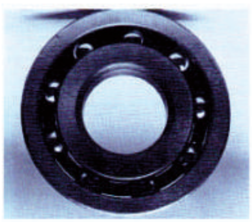


Fig 6.13 - Bearings reduce friction between the surfaces

Fig. 6.14 - Grooves on tyres increases friction between the two surfaces

Tension

If a rubberband, a string or a spring is stretched, a force opposite to the pulling force is created in them. Because of this opposite force, the object tries to come to its original position. The opposite force created against the pulling force in a stretched string, rod or a spring is called "tension". The tension of the wires is an important factor to be considered.

Activity 6.5

Stretch a rubberband or a spiral spring apart and note what you feel in your hands. Stretch it harder and observe the results.

In this activity you will feel that, the rubberband or the spring is trying to bring your hands together. This equal and opposite force created by a rubberband,is known as **tension**.

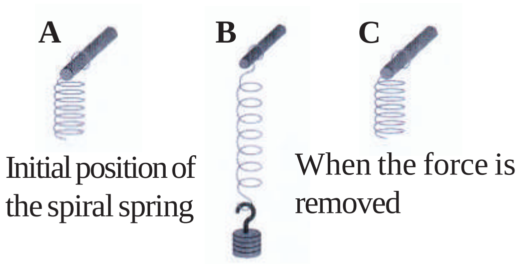


Fig. 6.15 - Tension in a spiral spring

The spiral spring stretches when a force is applied and when the force is released comes back to its initial position. This happens because of the tension in the spiral spring. Fig 6.16 shows how tension acts when an object is hung by a string.

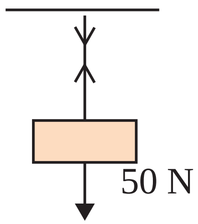
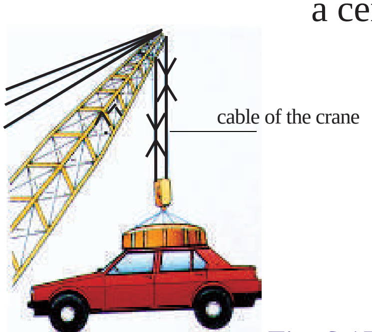


Fig. 6.16 Tension in a string

The weight of the object is 50N and it acts downwards. (Fig 6.16). Tension acts upwards which is equal and opposite. Tension is 50N and it acts upwards. Tension is useful to us very often. Tension helps to hang an object. Cable of a crane also shows a certain tension (Fig.6.17).



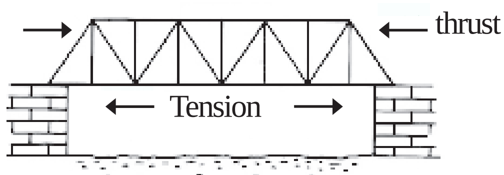


Fig.6.18-The tension on bridge walls and how it is controlled by thrust

Fig. 6.17- How the tension of the belt of a crane occurs

In building construction, when constructing concrete slabs, columns and beams, the tension of the wires is an important factor to be considered.

Thrust

When an object applies a force on another object, the second object creates a force in the opposite direction. This is called **thrust.** An object which is kept still on a table creates a **force** downwards on the table. This force is equal to the weight of the object. To keep the object at equilibrium on the table, the table has to create an equal and opposite force on the object. Until these two forces are equal and opposite, the object remains still on the table.

Thrust created by liquids

When you push down a block of Styrofoam which is floating on water you will feel that it pushes your hands up. This is due to the thrust created by water (Fig 6.19).

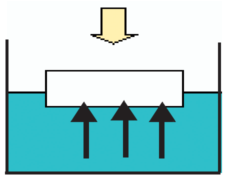


Fig 6.19 - Thrust acts upwards on a floating object

Keep a tin with a small hole at the bottom of water and push it down. Because of the upward thrust created by water, the water flows into the tin as a fountain.

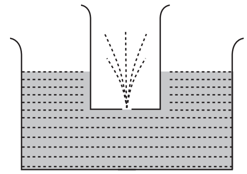


Fig 6.20 - Water flows into the tin as a fountain

Thrust created by air

Pour a little water into an open tin and heat it well. When heated the air in it escapes with the water vapour. Close the tin and let it cool. When cooling the thrust created by air inside the tin decreases because the air has escaped from the tin. The thrust created by the outside air is more and it pushes the tin inwards causing to collapse the tin. (Fig 6.21)

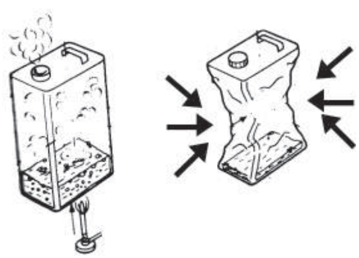


Fig 6-21 Collapsing of the tin due to pressure of air

Forces created by thrust are useful to us in various ways. You will learn about them in detail later.

6.2.2 Non contact forces and their applications

The force acting on one object by another object, when they are apart and are not in contact physically are known as **non-contact forces**. Gravitational force, magnetic force and electrostatic force are some examples of non contact forces.

Gravitational force

The force of attraction of one object towards another object is known as the gravitational force. This force depends on the mass and the distance between the two objects. When the mass increases the gravitational force too increases and when the distance increases it decreases. Because of this force the objects on earth stay without falling, and objects thrown upwards fall back to earth. When we compare the masses of objects on earth with the mass of the earth, the earth has a much greater value. Therefore gravitational force of earth is very high and this force acts on a large area around the earth. Very large forces have to be used to escape from the earths gravitational force.

Earths gravitational force is about 10 Newtons per 1kg, approximately. (10N/kg). That is the earth exerts a force of 10N on an object of 1 kg. The gravitational force of earth is very small beyond 25000 km around the earth. The gravitational force of moon is 1/6 of that of the earth and this value is zero in space. Similarly the gravitational force of Jupitor is many times that of the earth. This is because Jupitor has a bigger mass than earth.

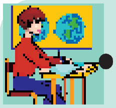
The amount of matter present in a body is its mass. This value does not change in a given body. The weight of an object is the gravitational force acting on the mass of the object. The Newton balance could be used to measure the weight of an object. The table 6.4 shows some examples.

Weight (W) N force	Mass kg
10	1
100	10

Table 6.4 - The relationship between mass and weight

Magnetic forces

A magnet can attract another magnet as well as metals such as iron, nickel, cobalt or their alloys . This non contact attracting force is called magnetic force.



Activity 6.6

- Spread iron powder at the two ends of a bar - magnet and observe the manner in which iron powder is attracted to the magnet.
- Keep a piece of bristolboard on a magnet (25cm x 25cm)
- Spread iron powder slowly over it and tap on the cardboard lightly.
- Note the pattern of iron powder on the bristolboard

You will notice that the iron powder is arranged in a certain Pattern around the magnet, and that the iron powder is attracted to the magnet.

Fig. 6.22 - Poles of a magnet showing the attraction of iron powder

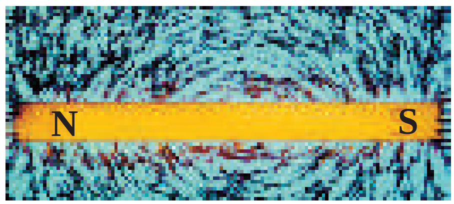


Fig. 6.23 - Arrangement of iron powder around a magnet

According to the Fig 6.22, the two ends of the magnet where iron powder is attracted most are called North (N) and South (S) poles of the magnet. The area around a magnet where magnetic forces act is known as a **magnetic field.**

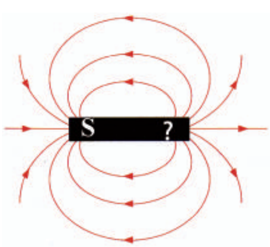


Fig 6.24 - Magnetic lines of force

Magnetic field is activated towards a particular direction. Magnetic lines are used to show this direction. Magnetic lines always activated between the north and south poles of a magnet (Fig .6.24).

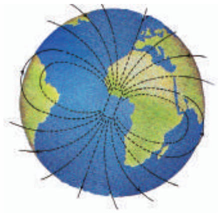


Fig 6.25- Earth's magnetic field

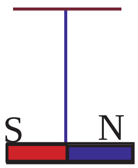


Fig 6.26 - Magnet hanging freely

The earth we live acts as a very large magnet. The area where magnetic forces act is known as earth’s magnetic field. From Fig 6.25 you can see how the earth’s magnetic field is arranged in space.

When a light magnet is hung freely it turns towards North-South direction. The end which points the north of the earth is the Northpole (N) and the end which points south is the Southpole (S) (Fig 6.26)

Magnetic Compass

6.27 Magnetic compass

The compass is used to find the North and South directions and to identify magnetic fields. It has light magnet which is pivoted on a pin point. The compass needle always stays still along the North South direction of the earth.

Some appliances using magnetic force are telephone receiver, dynamo and speaker.

Forces between magnetic poles

If we bring two unlike magnetic poles together they attract, and like poles together they repel (Fig 6.28).

Like magnetic poles have repulsive forces, while unlike magnetic poles have attractive forces (Fig 6.29).

- Like poles repel each other.
- Unlike poles attract each other.

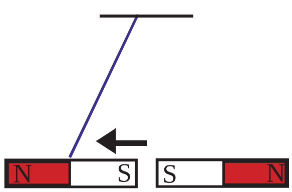


Fig 6.28 - Repulsion of like poles

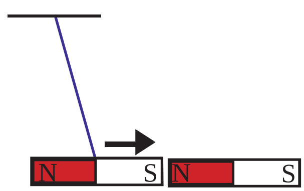
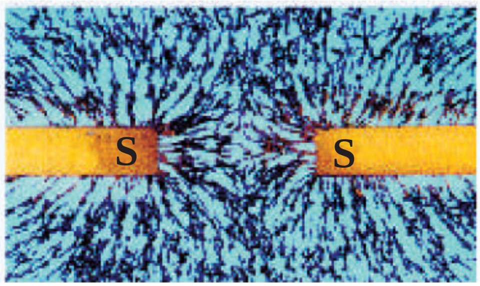
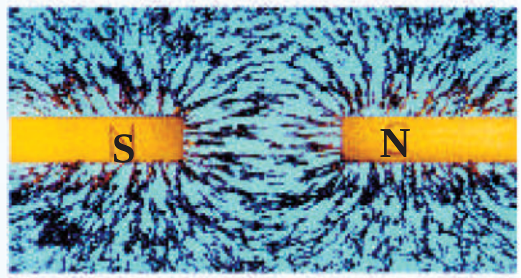
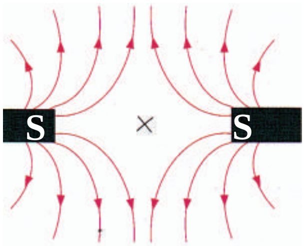


Fig 6.29 - Attraction of unlike poles

You can observe how the magnetic field and magnetic lines are arranged in above instances (Fig - 6.30 and 6.31)







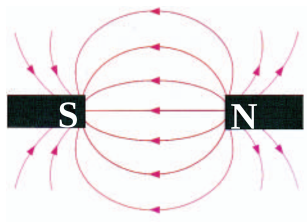


Fig 6.30 - Magnetic field and lines of force between two like poles.

Fig 6.31 - Magnetic field and lines of force between two unlike poles.

When an electric current flows through a conductor, magnetic field is formed around the conductor.

Let us try the activity 6.7.

Activity 6.7

- Arrange the apparatus as shown in the figure 6.32
- Keep the compass on the conductor.
- Close the switch (On) and observe the bulb and the compass.

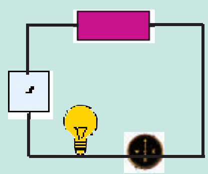


Fig 6.32

When you close the switch, the bulb lights up and the compass needle shows a deflection. Because when the current of electricity flows through the conductor, a magnetic field is created around the conductor.

Some appliances based on this principle are electrical crane and electric bell.

Electrostatic forces

You know that certain materials when rubbed against each other electro static charges are produced. When rubbing the objects become changed and they, show attraction or repulsion. Non-contact forces produced by charged objects are called electrostatic forces, and these forces occur as attractions or repulsions. There are two types of charges produced by rubbed objects. They are positive electric charges and negative electric charges. Here again like charges repel each other and unlike charges attract each other.

Instances where we come across electrostatic forces

- When you bring an ironed (pressed) dress close to your hair or skin the hair is attracted towards the dress.
- If you shake fast some styrofoam balls in a polythene bag the balls stick to the wall of the polythene bag.
- After combing your dry hair with a plastic comb if the comb is brought closer to bits of light paper they get attracted towards the comb.
- Baloons, if rubbed against your dress will stick to the roof or wall.

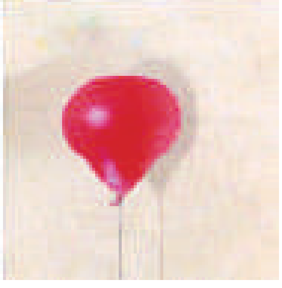


Fig 6.33
Charged balloon attracted towards the wall

Fig 6.34
Attraction of light piece of paper towards the comb

6.3 Types of motions and their applications

You know that when force is applied;

- An object at rest tends to move .
- A moving object can change its direction.
- Rate of motion of a moving object changes.
- A moving object comes to rest.

We can move an object in various ways by applying force. Let us investigate about some of these motions.

1. Linear motion
2. Circular motion
3. Rotational motion
4. Oscillations and vibrations

Linear motion

The motion between two points along a straight line is **linear motion**.

The Table 6.5 shows some linear motions.

Motion	Direction
• Falling of a fruit from a tree	Towards earth
• Movement of a carrom disc	Along the aimed direction

Table 6.5- Some linear motions

The short arrows use show the direction of the linear motions. We call them linear motions because they move along a definite direction along a straight line.As you learnt earlier, the speed of an object can be calculated as the distance travelled in unit time.

Circular motion

Motion along a circular path with a force directed towards the centre is called **circular motion**. The speed of circular motion is measured by the number of rotations made in unit time. The units are rotations per second. Let us do activity 6.8 to understand about circular motion.

Activity 6.8

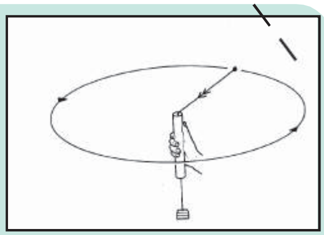


Fig 6.35

- Tie a rubber stopper to one end of a string.
- Hold the string by the other end and rotate it fast as in the figure.
- Observe the following while you rotate the string.

1. What is the path of the stopper when it rotates?
2. Do you feel that the string is stretched while you rotate it?
3. What happens to the direction of the stopper while rotating?
4. What happens if you release the string while rotating?

The stopper moves in a circular path while rotating and there is a pulling force towards the centre in the string. The direction of motion of the stopper changes every moment. If you cut the string that pulling force is lost and the stopper flies away from the circular path.

Applications of circular motion

In a road the bends are made slanting inwards. This stops the throwing of vehicles away from the bend. The riders of motorcycles bend inwards when they take a bend.(Fig 6.36). The earth moves in an elliptical path around the sun, under the gravitational force of the sun. Now you can imagine what would happen, if the earth gets released from the sun's gravitational force. Circularmotion helps the weather satellites to revolve round the earth.

Fig 6.36

Assignment 6.2

1. State a circular motion you are familiar with
2. Discuss reasons for identifing it as a circular mortion

Rotational Motion

Moving an object around its axis is called **rotational motion**. This motion can take place clockwise or anti-clockwise. Units are taken by calculating the number of rotations made in unit time (Figure 6.37).

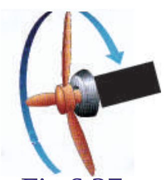


Fig 6.37

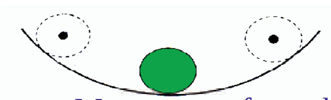
Table 6.6 shows some rotational movements.

Motions	How it makes
Rotating of vehicle wheels	Around the axis of the wheels
Rotating of arms of a clock	Around the axis of the arms of the clock.
Rotating a turbine	Around the axis of the turbine
Rotating of fan	Around the axis of fan blades

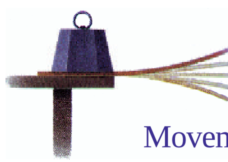
Table - 6.6

Oscillations and vibrations

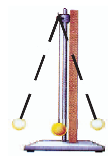
Let us consider a different type of motion now. Movements occuring rhythmically in equal displacements to either sides from a fixed point are known as **oscillations** or **vibrations**. It is measured by counting the number of oscillations or vibrations made in unit time. Movements of a swing, movements of a marble in a circular vessel and the movements of a pendulum of a clock are some examples for oscillations. Movements of a hacksaw blade fixed to a bench, movements of a tuning fork are examples for vibrations.



Movements of a marble



Movement of a hacksaw blade



Movement of a pendulum

Fig 6.39 - some oscillations and vibrations

Instances where oscillations and vibrations are used.

- Vibrations of a string or a membrane make sounds. This is used to make various musical instruments e.g. Violin, Guitar, Drum, Rabana
- Defects in the human ear could be detected by using tuning forks
- Pendulum clocks are made using the oscillations of a simple pendulum

6.4 Simple machines to make our tasks easier

Simple machines

We use various devices to make our daily work easier. Simple devices which do not use outside sources of energy to make our work easy are known as simple machines.

In these instances we can do our work with much less effort. Let us consider some instances where we use simple machines. Ladder which is used to climb, axe and wedge used to cut firewood, rowing of a boat using a screw jack, using a pulley to draw water from a well and the broom for sweeping are some simple machines which we use in our daily life.

There are four types of simple machines

1. lever
2. pulleys
3. inclined planes
4. wheel and axle

Levers

Lever is a very simple device used to carryout our work easily. Lever is a rod which is pivoted at one point and, it can rotate around that point . Force is applied at one place of the lever and the movement takes place at another place of the lever. Heavy tasks can be done with a small force by using a lever.

The Figure 6.39 shows how a load is lifted using a lever.

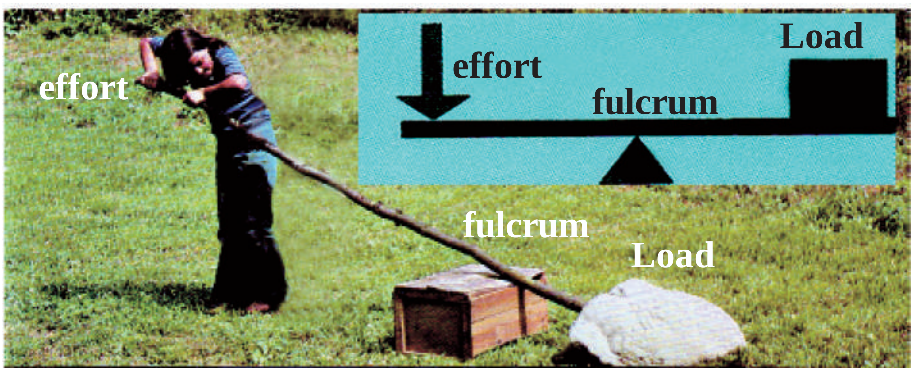


Fig 6.39 Method of lifting a load using an effort

The force applied is known as the **effort**. Lifted or moved object is known as the **load**. the pivoted place of the lever is called **fulcrum.**

There are three types of levers according to the position of load, effort and fulcrum

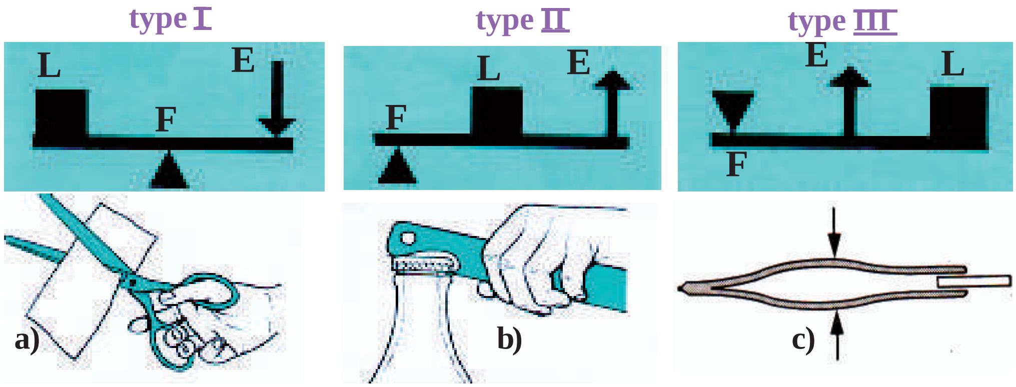


Fig 6.40 - Examples for different types of levers

Figure 6.41
Pulley

Pulleys

This simple machine is used to change the direction of the effort and to carryout our work easily. A pulley is a wheel which can be rotate freely around an axis. Around the circumference of the wheel there is an alley or groove for the string. The pulley is fixed from its axis and the load can be tied to one end of the string. Force is applied from the other end of the string.

When we lift an object from a lower position to a higher position we have to apply a force upwards perpendicular to the earth. A pully can change the direction of the force. In a pully the effort (force) is applied downwards which makes our work easier.

Inclined planes

Inclined plane is a device used to lift an object with a little effort. It is easier to pull or push an object along an inclined plane than lifting it up vertically. When the inclination is less and the length of the inclined plane is more,the effort we should exert, decreases still further.

Fig 6.42 -a and b. How the work is made easier when the length of the inclined plane is more

Activity 6.9

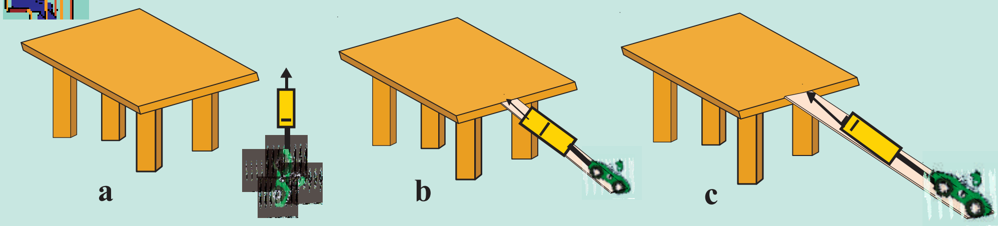


Fig 6.43 - Lifting a trolley on to a table with a less effort

a. Read the force which is needed to lift the trolley up to a table of 1 meter in height using a Newton balance.

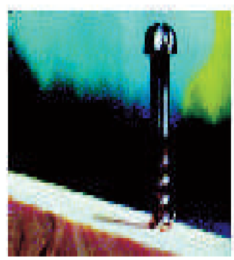
b. Read the force needed to pull the trolley along the inclined plane.

c. Increase the length of the plane and note the force needed to pull the trolley along the plane.

From Activity 6.9 we can see that the force needed to pull the object along the inclined plane is less than the force needed to lift it vertically. Inclined planes are used to load huge logs, barrels of tar and oil into vehicles. There are other forms of inclined planes. (Figure 6.44)

Axe/knife

wedge



screw

Fig 6.44 - Different forms of inclined planes

The grooves on a screw is an inclined plane. Let us do activity 6.10 to understand this.

Activity 6.10

Take a right triangular shaped piece of paper and wrap it around a nail as shown in Figure 6-45. We get a model of a screw, around the nail. Screw nail is an inclined plane built around a cylinder.

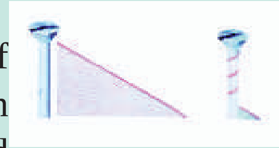
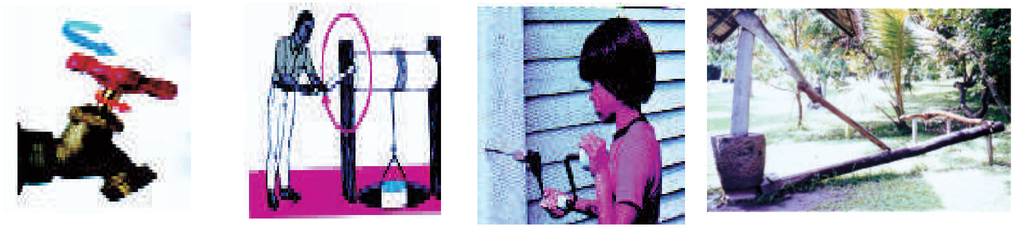


Fig 6.45

Wheel and axle

This simple machine consists of an axle which is tightly connected to a wheel. The radius of the wheel is several times larger than the radius of the axle. Work can be done easily by giving a small effort to move a larger load.



Water tap   windlass (Dabaraya)   Hand drill   Sekkuwa

Figure 6.46- Some applications of wheel and axle

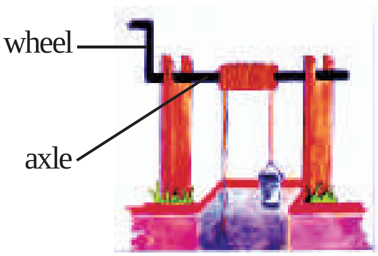


Fig6.47 - windlass (Dabaraya)

Arrange the apparatus as shown in Fig 6.47 to understand the working of a wheel and axle.

The work becomes easier as the radius of the wheel increases compared to the radius of the axle.

The 'sekkuwa' which was used to get coconut oil from copra was constructed on the principle of this simple machine.

The complex machines we use in our daily life such as bicycle and sewing machine consists of many simple machines.

Assignment 6.3

Identify the complex machines you com across in your daily life. List the types of simple machines that are included in complex machines mentioned above.

6.5 Energy from various energy sources

6.5.1 Sun as the primary source of energy

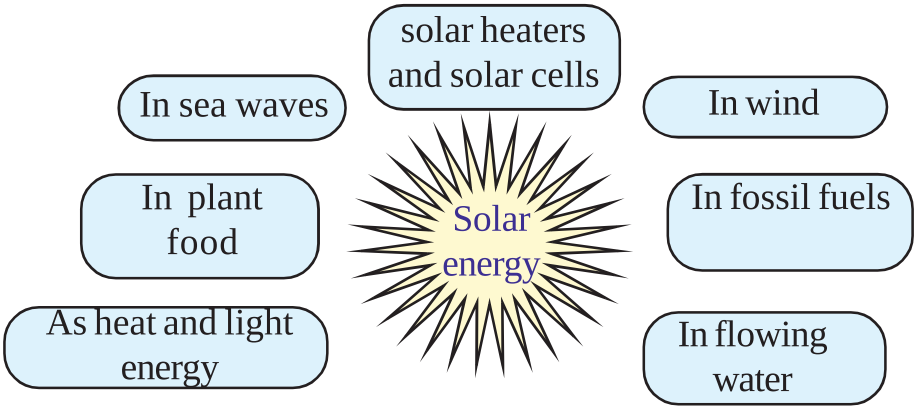


Figure 6-48 Different ways in which solar energy is stored

Plants produce food using the energy of the sun. This energy is taken by animals when they eat plants. Plant and animal matter get deposited under the earth crust for millions of years and become fossil fuels. These fossil fuels, on burning will liberate the energy in them. Sun's energy is responsible for producing rain and wind too. This shows that the primary source of energy for the earth is the sun (figure 6.48 and 6.49).

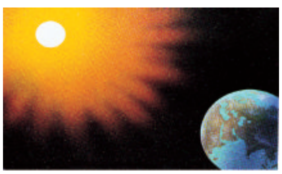


Fig 6.49 - The sun and the earth

6.5.2 Ways in which solar energy is stored

Energy stored in food

Early in the morning, you get ready for school and have your breakfast before you run to catch your school bus. This food taken as your breakfast will supply you energy till your next meal during the school interval. All living organisms depend on energy of the sun directly or indirectly. Green plants have the ability of using energy of the sun to manufacture food. This process is called **photosynthesis**. The prepared food is stored in various parts of the plant. Seeds of rice, fruits of mango, roots of sweet potato, stem of sugarcane, underground stem of potato are some examples of such stored food.

Assignment 6.4

Make a list of food obtained from plants and animals

The energy in the food is stored as chemical energy. You get this energy from food you eat. Sometimes when you play or do other activities you will feel very tired.It is because some of the stored energy in your body has been used. When athletes need instant energy they take glucose because it is a simple food, which can be absorbed quickly to liberate energy.

Fig 6.50 An athlete takes glucose

Assignment 6.5

Paste pictures of energy giving food or draw them in your note book.

Energy stored in fuels

When you need to prepare a cup of tea, you will boil water by using a gas cooker or a firewood hearth. In both these instances you have burnt some fuel. Fuels are substances that can be burnt to get enegy. Energy is stored as chemical energy in fuels and it is released during the burning process of fuels.


Figure 6.51
Burning firewood


Figure 6.52
Burning L P gas

The energy stored in fuels can be used to produce electric energy. Electric generator is one of the examples.

Fuels can be divided into three groups. They are solid, liquid and gaseous fuels.

Solid fuels	liquid fuels	Gaseous fuels
Firewood Charcoal Coal Dung of animals (cowdung) Plant parts	Petrol Diesel Kerosene oil Alcohol	L.P gas (Liquid Petroleum gas) Hydrogen Water gas Natural gas Bio gas

Table 6-8 Different types of fuel

Energy stored in wind

Fig 6.53- Windmill

On a warm day you would like to go outside the classroom and feel the cool breeze for a while. What is cool breeze? It is circulating air or wind. Air on land gets heated by the sun and rises up. The cool air around rushes to fill the gap. Circulation of cool air is known as wind. Wind has a large amount of energy. The energy that can be obtained from wind depends on the speed of the wind.

Do you know?

- From time to time natural wind energy becomes focused to a spiral, forming cyclones. These move very fast and cause serious damage.
- A cyclone has a large amount of energy and they reach a speed of hundreds of kilometres per hour.

Energy stored in oceanic waves

It is enjoyable to watch the sea waves. Have you ever thought of the immense amount of energy contained in sea waves? Can you remember the tsunami disaster which occurred a few years back.

Sea waves have a large amount of stored energy. In some countries the energy of sea waves is transferred into electrical energy with the help of mechanical devices.

Energy stored in flowing water

On a rainy day, you would love to sail paper boats on the flowing water. What makes paper boats to move on the surface of water? The stored energy in flowing water moves the paper boats. Flowing water has a large amount of energy. Damage caused by floods give us evidences of this. The energy in flowing water can be demonstrated by the following activity.

Activity 6.11

Make a small water wheel as in figure 6.54. You can use yoghurt spoons for this. Keep the water wheel under a water tap and open the tap. Observe what happens when you move the water wheel up and down.

Fig 6.54- Water wheel

The energy in flowing water can be used to transport logs down rivers to saw mills (Figure 6.55). In the past, large water wheels were built on river banks and the energy of flowing water was used to rotate them. This energy was used to grind grain by connecting to mills. (Figure 6.56)

Fig 6.55 - Transporting logs down rivers

Fig 6.56 - Using water wheels

The energy in flowing water can be used to generate electricity.This is known as hydro-electric power. Hydro-electric power stations take water from a waterfall or from a reservoir and direct it through large tunnels or pipes to rotate huge turbines. Turbines are connected to generators which generate electricity. (Fig 6.57)

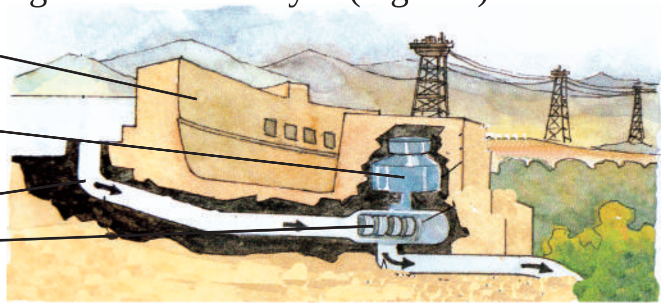


Fig 6.57- Hydro-electric power station

Here the mechanical energy of flowing water is converted to electrical energy.

6.5.3 Energy stored artificially

Electrochemical cells

If you have to go outside on a dark night, you have to use an electric torch. the batteries which are used in a torch are electro-chemical cells. Energy is stored in chemicals present in these cells.

Activity 6.12

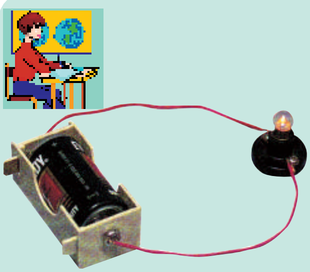


Fig 6.58 - Lighting up a bulb using a battery

Connect the circuit as shown in the picture 6.58You will see the bulb lighting up.The energy stored in electro chemical cells first turns into electrical energy. If you touch the bulb, you will feel that it gives heat energy also.

Fig 6.59 - different types of electro-chemical cells

Energy stored due to the position of an object


Fig 6.60


Fig 6.61

Look at the child sitting on the top of the slide. (Fig 6.60) He has more energy stored in his body, when he is at a higher position. This energy is used to slide down. Look at the heavy hammer on top of the machine. (Fig 6.61) When the hammer is at a higher position it has more energy. When the hammer comes down, the energy in it decreases gradually and that energy pushes the piles into the ground.

Assignment 6.6

Draw a picture of a woman who pounds rice by using a motar and pestle. Discuss how they get energy for pounding rice.

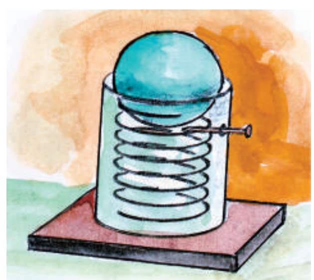
Energy can be stored by changing the form of an object

Keep a small stone on the rubberband of a catapult and hold it in place. Pull the rubberband and release. See what happens to the stone. Energy is stored in the stretched rubberband. When you release it comes to the initial position and liberates energy. This energy throws the stone to some distance. (Fig 6.62)

A stretched bow and a spiral spring bolt contain stored energy.


Fig. 6.62-Catapult


6.63-Stretched bow


6.64-Spiral spring

A compressed spiral spirng can be used to throw a ball. Fig (6-64)

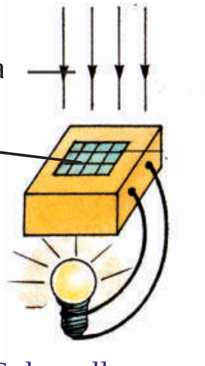
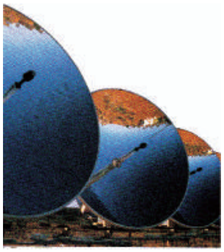


Fig 6.65 - Solar cell

Energy can be stored in solar cells

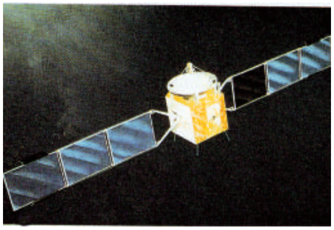
Sun is our main source of energy. The energy falling on earth within 15 minutes can supply all the energy needed by earth for a whole year. Most of this energy is wasted because we are still in the early stages of technology of using solar energy for our purposes. Solar cells are used to transfer solar energy to electrical energy. They do not store solar energy but directly convert solar energy to electrical energy. A number of solar cells are known as a solar panel. Solar cells are not very popular because they are expensive and only 1/10th of solar energy falling on the panel is used.

However, the process of harnessing solar energy is very difficult. Experiments are being conducted to make modern solar cells.



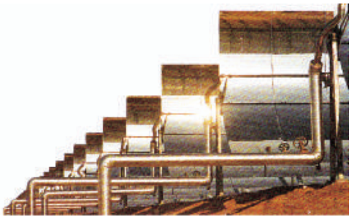
a

solar energy is collected by concave surfaces



b

solar cells providing energy to satellites



c

solar energy is focussed on shining surfaces and water is boiled. The vapour is used to turn turbines to generate electricity

Fig 6.66 - Modern solar cells

6.6 Transmission of mechanical energy

6.6.1 Need for transmission of energy

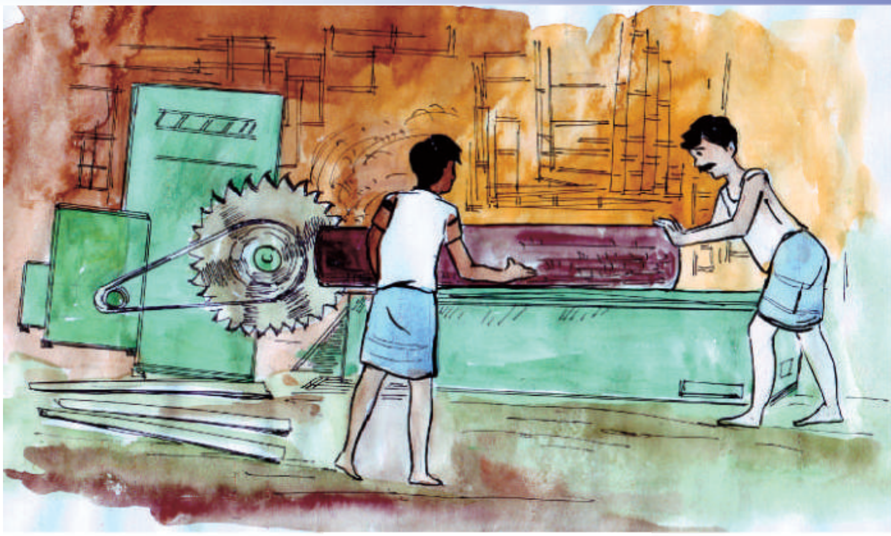


Fig 6.67 - A sawmill

Above picture shows a sawmill. It is difficult to supply energy directly for cutting saw and the belt transmits energy to it. The belt used in this mill transmits the energy produced in the engine to the other parts. Transmission methods are used when the energy cannot be supplied directly to the necessary place.

6.6.2 Methods of transmission of energy

- Endless belts
- Endless chains
- Cog wheels
- Shafts
- Fluids/hydraulic
- Air / pneumatic

Transmission of energy through endless belts

Have you seen a sewing machine working? When we move the pedal the energy is applied on the big wheel. It is transmitted to the small wheel through the belt. Then the needle moves up and down . It is difficult to supply energy directly to the needle. Because of this we have to use a method of transmitting energy and in the sewing machine it is done by an endless belt. Endless belt is a belt in which the two ends are joined together. This belt goes round the two wheels. When we rotate one wheel, the other wheel also rotates in the same direction.

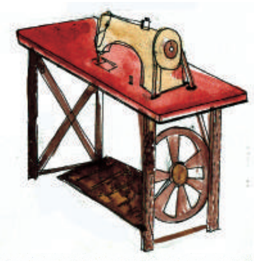


Fig 6.68 - Endless belt of a sewing machine

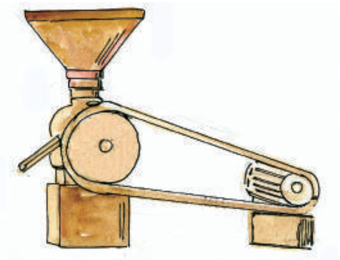


Fig 6.69 - Endless belt of a paddymill

Transmission of energy through chains

The energy produce at one place is transmitted to another place through chains. Foot bicycle is a good example for this. (Fig 6.70)

Fig 6.70- A bicycle

The two cog wheels of the bicycle are connected together by a chain. The teeth of the cog wheel fit into the links of the chain. When we tread the pedal of the bicycle the bigger cog wheel turns and moves the smaller cog wheel, pushing the bicycle forwards.

Transmission of energy through cog wheels

Have you examined the inside of a clock? You will see a number of cog wheels inside it. These cog wheels are connected together. The teeth of one cog wheel fit into the notches of the other cog wheel. These cog wheels can change the direction of a force. When one cog wheel turns in the clock wise direction the other cogwheel turns in the anti-clock wise direction. If the two cog wheels are connected by a chain, they turn in the same direction.

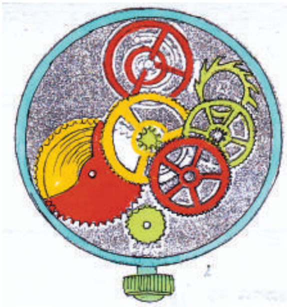


Fig 6.71 -Cog wheels of a clock

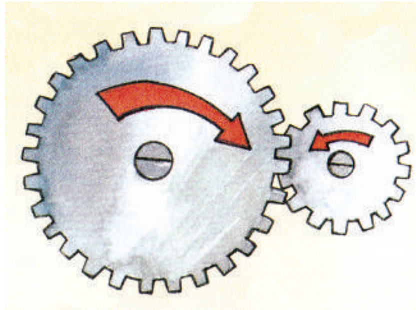


Fig 6.72 -Two connected cog wheels

Transmission of energy through shafts

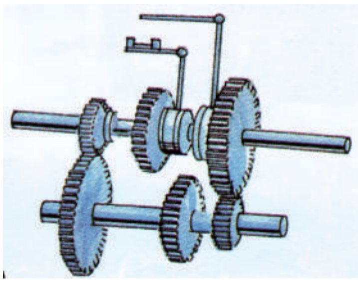
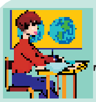


Fig 6.73- Arrangement of shafts in a gear box

When a motor vehicle is moving how is the energy transmitted?

Energy is liberated in the engine by the burning of diesel or petrol. This energy is transmitted to the wheels through a system of cog wheels and shafts. These shafts are of various sizes and they transmit energy to various parts of the vehicle. There are similar systems of shafts to transmit energy to the gear box and the brakes.

Transmission of energy through fluids



Activity 6.13

Take two syringes and fix one (B) to the table as shown. Fix this to the other syringe by means of a plastic tube filled with water (A).

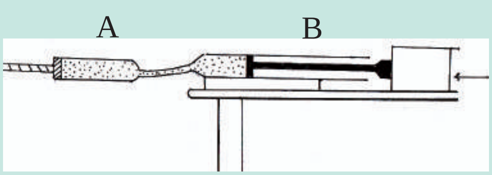


Fig 6.74

- What can you observe when you push the piston of syringe A forward?

You will see that the block of wood on the table gets pushed forward. This shows that energy has been transmitted through fluids as well. The brake system of motor vehicles and the hydraulic jack used in lifting vehicles, both are based on transmitting energy through fluids (oil).

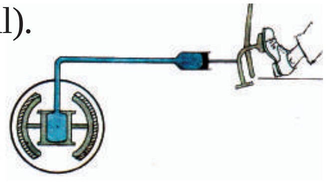


Fig 6.75 -The brake system of motor vehicles

Transmission of energy through air

Have you seen a drill machine working with the transmission of energy through air? It can easily drill hard stones and metals.

In many modern factory energy is transmitted through compressed air. In this way energy can be transmitted easily without an energy loss.Following are some examples for such instruments. They are called Pneumatic instruments.

Some examples of pneumatic instruments are

- Pneumatic drills
- Pneumatic switches
- Air compression machines
- Vacuum pumps

Pneumatic instruments can be used in places where electric motors cannot be used. To remove combustible gases or powders in deep places of mines Pneumatic machines are used. It is dangerous to work with electric motors in such places.

6.7 Utilization of energy and its economical usage

6.7.1. Economical consumption of energy

Domestic usage

To fulfil domestic energy needs we use energy sources like fire wood, gas, kerosene oil and electricity. These energy sources will be over in the near future. Therefore it is important that we consume these energies economically. Saving energy is saving money. As a good citizen of Sri Lanka you can use energy economically and help the progress of our country. Are you conscious of the following when you are at home?

- Switching off unnecessary electric lamps
- Using fluorescent lamps
- Ironing all your clothes at one time
- Switching off the engine when you stop a vehicle
- After using the firewood hearth removing ashes and charcoal
- Using vessels which get heated quickly for the gas cooker.

Assignment 6.7

Write down five instances where you could contribute to saving energy at school.

Using energy economically in institutions and in factories

Most of our work places use electrical energy as the main energy source. In factories electricity, gas, liquid fuels and coal may be used as energy sources. As responsible citizens of a country we can contribute to save energy in our work places.

- Construct the buildings to get the maximum amount of light and air. Then we can save the cost of having electric lamps during day time and the cost of air conditioning .
- Switch off the fans and lamps before you leave a place.

- Use the stairs instead of using the lift
- Use water economically
- Use alternate sources to obtain electricity in factories
  e.g.: Glyrecidia wood is used to generate electricity in some factories
- Constructing small scale hydro-electric power stations near rivers or other waterways.

Utilization of energy economically in transport and in public places

More than 25% of the total energy of a country is used for transport. More fuel energy is used by private consumers than by public vehicles. The amount of people who use private vehicles are increasing daily. About 20 million barrels of petrol and diesel are used each day in the world. However this is a growing problem to a country. Following are some suggestions that could be carried out to over -come the power crisis.

- Automobile engineers to construct new engines with high fuel efficiency.
- Construct engines to use alternate energy sources.
- Usage of vehicles using electricity.
- Using public vehicles instead of using private vehicles.
- Using bicycles instead of using fuel vehicles whenever possible.
- Using solar energy to run vehicles.
- Tuning the engines.

6.7.2 Problems encountered in utilization of energy

Main problem arising in utilizing energy is environmental pollution.Burning of fossil fuels such as petrol and diesel release carbondioxide, carbonmonoxide, carbon particles, lead and iron to the air. Most of these are harmful to the body.

Burning of firewood and coal in factories and for domestic purposes may produce carbondioxide, particles of carbon, carbon soot, sulphurdioxide and nitrogendioxide. These are all liberated in to the air.

Another problem arising is the high cost of these fuels. For a country like Sri Lanka the high cost of petrol and diesel is not affordable.

In addition to all these problems these fuel resources will be over in the near future.If this happens we will not be able to run our vehicles with petrol nor use L.P gas for cooking.

What is the solution for this problem ?

To overcome this problem we have to look forward for alternate energy sources.

6.7.3 Alternate energy sources

Solar energy is a cheap source of alternate energy. Using solar energy we can

- boil water
- cook food
- drive vehicles
- dry substances
- generate electricity

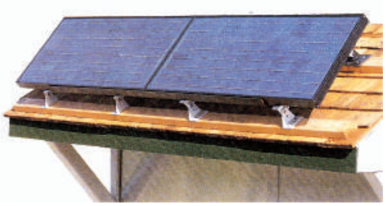


Fig 6.76 - Solar heater

Activity 6.14

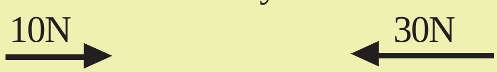
- Design a model of a suitable drier to dry sliced vegetables.
- You may use a sheet of glass, a sheet of darkened aluminium and cardboard or rigiform to make the box.

Exercises

1. Use the words listed below to fill in the blanks
   (Newton, point of application, N, direction, magnitude, push, pull)

Force can be described as a .... or a.................. Because force has a .... and a .... ,it is known as vector quantity. The international unit of measuring force is a .... , and it's symbol is .... A Newton balance is used to measure force. To move an object the magnitude, direction and it's .... are very important.

2. Show these forces by lines drawn to scale.



3. State three advantages and three disadvantages of friction.
4. To what class of simple machines do the following belong ?

1. Nut cracker	2. Screw
3. See-saw	4. Axe
5. Wheel barrow	6. Driving wheel
7. Ladder	8. Pair of scissors

5. An object of 60 kg when weighed using a Newton balance showed 600 N. The same object showed 100 N when weighed on the moon. Explain the reason for this.

6. 1) Mention three sources of energy which can be used without polluting the environment.
   2) Write down three methods of transmitting energy.
   3) Write five instances where energy is wasted at your home. What are the steps to be taken to minimize the energy loss ?
   4) Write three alternative energy sources used in transport, instead of fossil fuels.