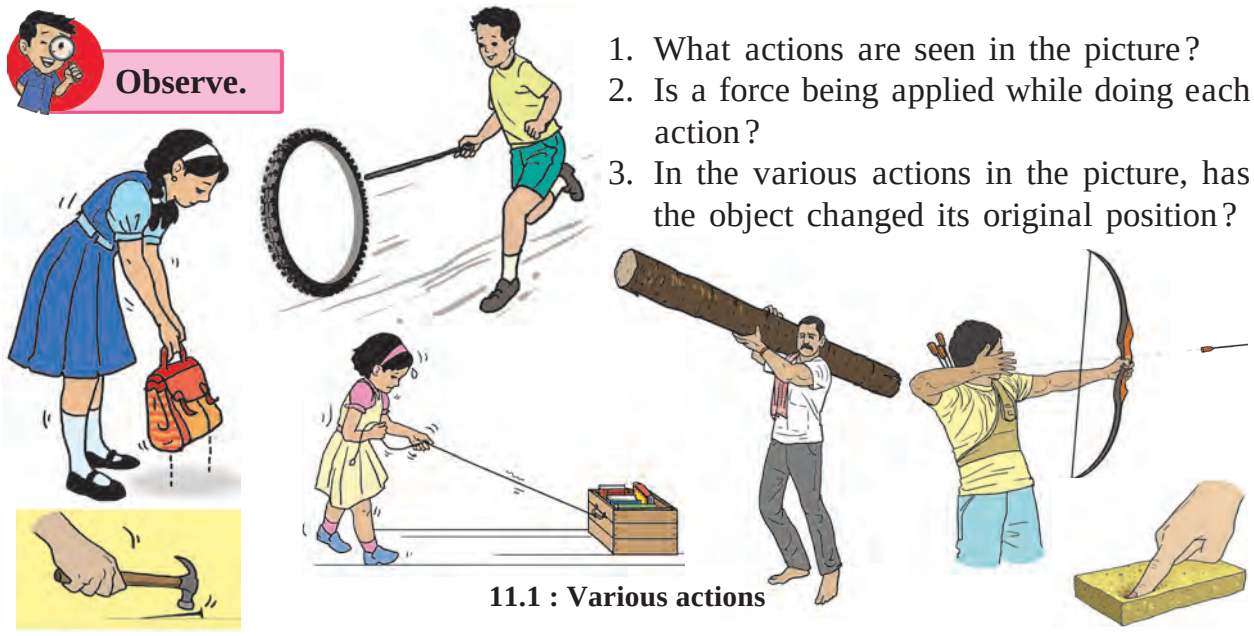
11. Work and Energy

Observe.



1. What actions are seen in the picture?
2. Is a force being applied while doing each action?
3. In the various actions in the picture, has the object changed its original position?

11.1 : Various actions

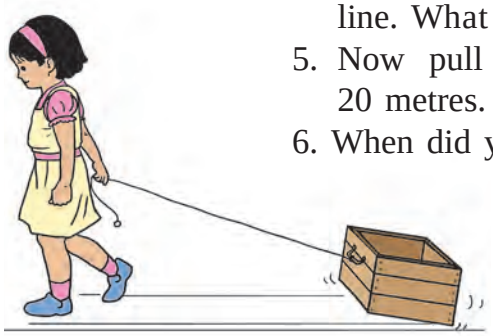
In the above picture, we see that the position of some of the objects has changed. That is, these objects are displaced.

When an object is displaced by applying a force on it, work is said to be done.

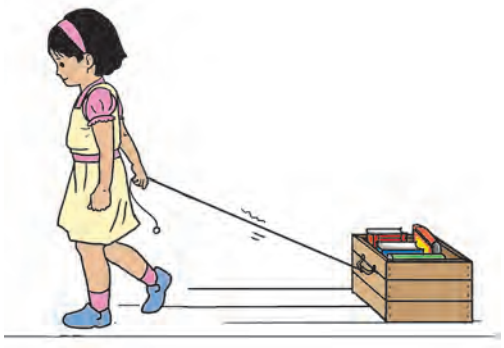
Work

Try this.

1. Tie a string to an empty box, as shown in the picture.
2. Pull the box through a distance of 10 metres along a straight line.
3. Now fill the same box with 20 books.
4. Pull the box again through a distance of 10 metres in a straight line. What was your experience this time?
5. Now pull this loaded box through a straight distance of 20 metres.
6. When did you feel that more work was done?



More work is done for the same displacement, when more force is applied to do the work. If the same force is applied for more displacement, more work is done by the force.



11.2 : Pulling a box

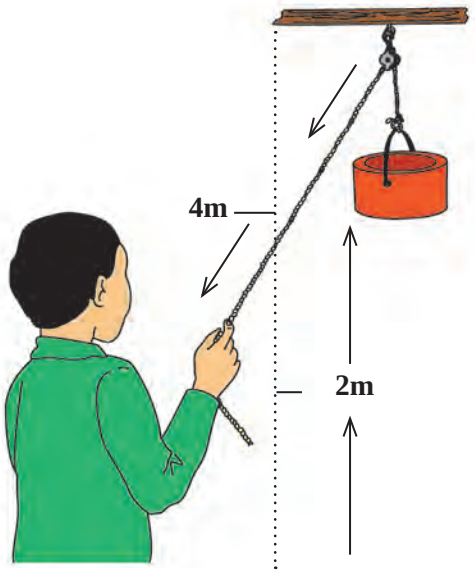
Use your brain power!

1. In the above activity, which are the different forces acting on the box?
2. Is a displacement possible without a force?
3. If a force is applied with both the hands on a wall, will there be a displacement?
4. If no displacement occurs on applying a force, what does it indicate?

Let's try this.

Take a pulley. Fix it at a height. Draw a string over the pulley. Tie a load of two kilograms at one end. Hold the other end of the string and pull it downwards to lift the load, first up to a height of one metre, and then up to a height of four metres. When is more work done?

When the applied force is the same, more work is done when there is greater displacement. In other words, for measuring the work, both the force and the displacement must be considered.



11.3 : Using a pulley

The relationship between work and energy

The boy in the picture has applied a force to the toy car. Work has been done because the force applied to the car has caused displacement. In other words, transformation of the boy's energy into work has taken place through the applied force.

11.4 : A boy pushing a car

Run around the ground with your friends. Can your friends run as many rounds as you can?

Do all the friends have the same capacity for running?

Your friends will complete either more or less rounds than the number of rounds you complete. The number of rounds will not be the same. Some will get tired on completing two rounds, while others will get tired on completing three or four rounds. That is to say, each one's capacity to complete rounds is not the same. You can complete only as many rounds as you have the capacity for. The capacity to do work is called energy.

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Use your brain power!

1. Why do you get hungry after physical exercise?
2. From where does our body get energy?
3. Why do we get tired?

Do you know?

The units of work and energy are the same. Work and energy are both measured in the unit named Joule in S.I. (System International) units.

Forms of energy

A. Mechanical energy

Can you tell?

What will happen as a result of the action in the picture?

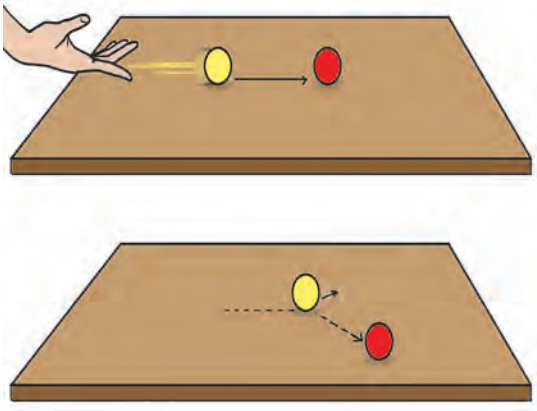
1. The rubber band is released after stretching it.
2. A stone is held in the rubber of a catapult, the rubber is stretched and released.

In the above examples we see that when the rubber of a catapult is stretched and released, it comes back to the original state and the stone flies off. Similarly, when the spring of a toy is wound and then released, the toy starts playing. When water stored at a height is made to fall on a wheel, the wheel starts rotating. In each of these actions, displacement takes place, which means that work is done. From where is the energy obtained to do this work? The energy which is stored in an object due to a specific state or position of that object is called **potential energy**.

11.5 : Potential energy

Let's try this.

1. Take two balls. Let one of them stand stable at the centre of a table.
2. Place the second ball on the table and push it so that it hits the first ball.
3. What happens when the second ball hits the first one?
4. From where did the second ball get the energy to set the first ball in motion?



11.6 : Kinetic energy

Can you tell?

1. In the game of marbles, from where does one marble get energy to set another marble in motion?
2. While playing carrom, from where does the striker get the energy to make the pieces move?

We give energy to the marble or the striker and set them in motion. The energy obtained from motion is called **kinetic energy**.

The energy used for doing mechanical work is called mechanical energy. There are two types of mechanical energy, namely, potential energy and kinetic energy. Potential energy is obtained due to position and kinetic energy, by motion.

B. Heat energy

The earth receives heat in proper quantities from the sun. That is how an atmospheric temperature favourable to the living world is maintained. Heat is a form of energy. Sunlight contains heat energy.

Heat is produced by burning of fuel. Heat energy is used in the kitchen all the time. Heat is measured in the unit 'Calorie'.

11.7 : Heat energy

Let's try this.

1. Take a convex lens and hold it over a sheet of paper in sunlight.
2. Now, move the lens in such a way that there is a tiny spot of light on the paper.
3. Hold the lens in this position for a while. What happens?

C. Light energy

We have learnt that plants make their own food with the help of sunlight. It means that light energy is transformed into the energy in food. Plants and animals use this food for doing their work. It means that light is a form of energy.

Collect information.

1. Generally, grapes which appear in the market during December and January are sour. However, in March-April the grapes are sweet. Why is this so?
2. How does a picture appear on the screen of a TV, mobile, laptop and a cinema theatre?

D. Sound energy

You might have seen the glass panes of windows crack due to a loud noise. Similarly, sound is used to control the movements of some toy cars. This means that some work is done by sound. It tells us that **sound is a form of energy**.

E. Chemical energy

When wood burns, we get heat and light. Sometimes, we hear a crackling sound as well. What makes this happen? The energy stored in wood is emitted in various forms through chemical action. Also, it is due to the chemical action in the lead acid battery that electrical energy is produced.

11. 8 : Chemical energy

The energy obtained through chemical action is called chemical energy.

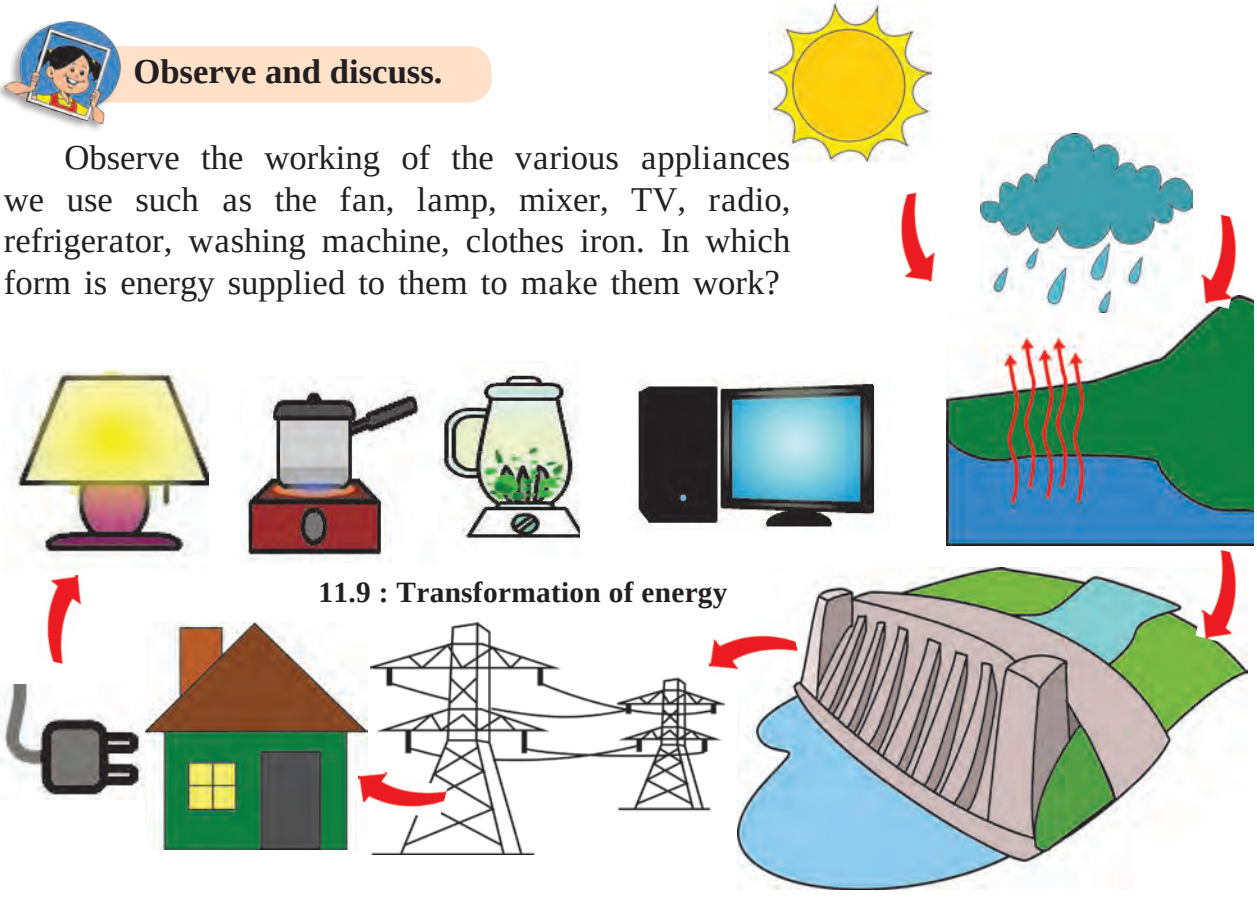
Use your brain power!

1. In which form is energy stored in plant food?
2. How is energy obtained from cooking gas?

Mechanical energy, heat, light, sound, chemical and electrical energy are the various forms of energy.

Observe and discuss.

Observe the working of the various appliances we use such as the fan, lamp, mixer, TV, radio, refrigerator, washing machine, clothes iron. In which form is energy supplied to them to make them work?



11.9 : Transformation of energy

Transformation of energy

Transformation of energy takes place when work is done. Let us consider one chain of transformation of energy.

In the course of the water cycle, water evaporates due to the heat of the sun. This water vapour forms clouds that give rain. Rainwater flows into rivers and is stored in reservoirs on dams. These are at a height and therefore their water has potential energy, which is transformed into kinetic energy as the water falls downwards. When the water falls on the blades of turbine, its kinetic energy is transferred to the turbine. The turbine rotates producing electrical energy. This electricity gets transformed into various other forms of energy.

Electrical energy is used in our houses for various purposes. It is transformed into light energy on lighting a bulb, into kinetic energy on starting a fan, into sound energy while playing a music system, and into heat energy in an oven.

Thus we see that we are indirectly utilizing nothing but solar energy in all these transformations of energy. **In other words, the sun is the most important source of all energy**.

Energy resources

The resources used for getting energy can be classified into two types.

1. Conventional energy resources or non-renewable energy resources.

The energy resources which man has been using for centuries are called **conventional energy sources.**

Conventional energy resources include coal and fossil fuels such as petrol, diesel and natural gas. We cannot replenish these resources. Wood also cannot be replenished easily.

2. Non-conventional energy resources or renewable energy resources

These resources have not been used traditionally. They are inexhaustible and continuous and can be used in various forms again and again.

Due to the increasing population and increasing usage of energy resources, there is a danger that the limited reserves of coal, petrol, diesel, crude oil and natural gas will get exhausted. Therefore, it will be better to use alternative and supplementary resources instead of the conventional ones.

A. Solar energy : The energy obtained from the sun is continuous and enormous. Solar energy is at the root of all energy available on the earth. A variety of devices have been developed for making use of solar energy. For example, the solar cooker, solar water heater, solar drier, solar cell, etc.

In the first three devices mentioned above, heat energy obtained from the sun is utilized to cook food, heat water and to dry grain. In a solar cell, electrical energy can be obtained from solar energy. Solar electric plants have the capacity to produce electricity on a large scale. A solar plant consists of many solar cells.

11.10 : Solar energy

B. Wind energy : Electricity is generated by means of windmills using strong winds. A windmill is also used for drawing water from a well.

11.11 : Wind energy

C. Tidal energy : A wall is constructed at a narrow region of a creek. Due to waves generated by high and low tides, the turbine of the generator fitted in the wall starts rotating and electricity is generated.

D. Hydroelectric or hydel power : The water stored in a dam at a height is brought down through a tunnel and the turbines of the generator are rotated. The place where electricity is generated in this way is called a 'hydroelectric or hydel power' plant. The Koyna project in Maharashtra is a well-known hydel project. There are also other smaller hydroelectric plants located at other dam sites.

11.12 : Hydel power

E. Energy obtained from oceanic waves : While sea waves move forward in a certain direction, the water moves up and down regularly at a position. This, too, can be used to generate electricity.

F. Atomic energy : The serious crisis of electricity shortage can be eased by generating electricity by means of atomic energy. The heat liberated during the fission of atoms of heavy elements such as uranium, thorium is used to generate electricity.

Use your brain power!

There is energy in every substance in the universe. It is present in non-living things as well as in living things. Why, then is energy not visible to us?

Think over it!

Note the amounts of your electricity bills of the last eight months and think about the consumption of electricity during each month.

Energy saving and green energy

In a way, saving energy is as good as generating energy. There are several ways of saving energy such as putting off lamps when not needed, making maximum use of sunlight, etc. Saving energy and energy resources is very necessary. Otherwise, we will have to face a serious calamity like global warming.

The energy resources which do not produce smoke and carbon gases such as carbon dioxide or carbon monoxide are called 'Green energy resources'. Greater use of such resources is the need of the hour.

What we have learnt–

- Work is done when an object undergoes displacement on application of a force.
- Energy is the capacity to do work.
- The various forms of energy are mechanical energy, heat energy, light energy, sound energy, chemical energy and electrical energy.
- Something that can be used to obtain energy is called an energy resource.
- Energy resources are of two kinds: conventional (non-renewable) and non-conventional (renewable) energy resources.

Exercise

1. Fill in each blank with the appropriate term from the brackets.

(a) A bucketful of water is to be drawn from a well. ……. will be done when a …… is applied to do this, because there will be a …….. of water. (displacement, work, force)

(b) If a ball is dropped on the sloping roof of a house, it acquires …… and falls on the ground. That is, transformation of …….. energy into ……. energy takes place. (kinetic, potential, motion)

(c) You might have seen some beautiful fireworks during Diwali. It is an example of transformation of ……. energy into……. energy. (light, atom, chemical, solar)

(d) The solar cooker is an application of the …… energy of the sun, while solar cells, solar lamps are applications of the …… energy of the sun. (light, chemical, heat)

(e) One labourer carried four pans of road metal through a distance of 100 metres. If he carries two pans of road metal through a 200 metre distance ..... work will be done. (equal, more, less)

(f) The capacity that an object has for doing work is called ……. . (energy, displacement, force)

2. Match the pairs.

Group 'A'	Group 'B'
(1) Rolling object	(a) Heat energy
(2) Food	(b) Atomic energy
(3) Stretched bow	(c) Kinetic energy
(4) Sunlight	(d) Potential energy
(5) Uranium	(e) Chemical energy

3. Can you tell?

(a) When can we say that displacement has taken place?

(b) What should be taken into account for measuring work?

(c) What are the various forms of energy?

(d) Describe one natural chain of transformation of energy.

(e) Why should we save energy?

(f) What is 'green energy'?

(g) What are the non-conventional energy resources?

(h) Which forms of energy from the sun are used in solar energy devices?

(i) Why should we maximise the use of non-conventional energy resources?

4. Who is the odd-one-out?

(1) Diesel, crude oil, natural gas, wind

(2) A running car, hauling a log, a book kept on a table, picking up the school bag.

(3) Sunlight, wind, waves, petrol

(4) Leaving the fan on in a vacant room, leaving the TV on while working, using AC during winter, putting off the light when going out.

5. Find out the types of energy from the following puzzle.

z	s	q	p	y	m	w	n	e
p	o	t	e	n	t	i	a	l
l	l	s	u	h	v	n	x	i
t	a	o	j	e	v	d	z	g
q	r	u	l	a	b	a	d	h
k	i	n	e	t	i	c	q	t
r	w	d	h	k	l	w	y	f

Activity :

- How can you save energy at home and in school? Discuss this with your friends and list all such measures. Put them into practice.
- Find out about energy saving devices available in the market.