14. Elements, Compounds and Mixtures

Let's recall.

1. How many different states of matter are there? Name them.
2. What brings about a change of state of matter?
3. What are the properties of matter?
4. Do all substances have the same properties?

Classify the following substances according to their properties.

Water, thermocol, soil, iron, coal, paper, rubber, copper, coir, plastic.

Can you tell ?

1. What are objects made of?
2. What are these articles of everyday use made of – electric wire, kitchen utensils, nails, tables and chairs, window panes, soil, salt, sugar ?

Matter

We say that an object is made of a certain substance. The term matter is also used as a synonym of substance. In scientific language, however, a single term is used for a single concept, and that which an object is made of is called **matter.**

The particulate nature of matter and properties of matter

Try this.

1. Take a piece of chalk and keep on dividing it into smaller pieces. What will happen?
2. Wipe a drop of ink with a handkerchief. What effect does it have on the cloth of the handkerchief?
3. What happens when the lid of a bottle of perfume is opened?

It is the matter present in various things in solid, liquid or gaseous states that is responsible for their properties. Even though they are divided into small particles their properties due to the matter present in them, remain the same. The properties such as the white colour of a chalk, the blue colour of ink, the fragrance of a perfume are the properties of the matter of which each of them is made.

Use your brain power!

1. In day-to-day life, we come across many things in our surroundings. We touch them, we study their properties. Are all these things made from only one kind of matter or from more than one kind of matter?
2. Classify the following according to the nature of matter in them – whether it is made from one kind of matter or from more than one kind of matter; and whether it is in solid, liquid or gaseous state : an engraved idol, gold, milk, water, a plank, concrete, salt, soil, coal, smoke, sherbet, cooked *khichadi*, steam.

Try this.

1. Fill a glass of water upto the brim. Drop a small stone in it. What happens ?
2. Take a balance. Place a small stone in one pan and a big stone in the other. Which pan goes down? Why?

Which properties of matter can you tell from the above activities?

Objects have mass and mass can be measured with the help of devices like the common balance. Also, they occupy space. They acquire both these properties from the matter that they are made of. In other words, mass and volume are two important properties of matter.

Many kinds of matter found in nature are in pure form, that is, they contain only one constituent. In scientific language, matter made of only one constituent is called '**substance**', for example, gold, diamond, water, chalk. Other kinds of matter are made of two or more substances. They are called '**mixtures**'.

Use your brain power!

Which of the following are mixtures – water, sherbet, iron, steel, coal, air, salt, copper, brass, soil.

Elements

Try this.

1. Take water in a teapot and cover it. Heat the water to a boil. What do you see on the inside of the lid?
2. Fill water in a spray pump, spray the water and observe the spray.

14.1 Spray-pump

The water droplets collected on the inside of the lid of the teapot are formed by condensation of the vapour from the boiling water. Water in the form of vapour is composed of extremely tiny particles and, therefore, we cannot even see them. You will see that the spray is also composed of small particles of water. Similarly, all substances are made of extremely tiny particles. The smallest particles of substances are molecules. A substance whose molecules are made of one or more atoms which are exactly alike, is called an **element**.

We do not get different substances by the decomposition of an element. The smallest particles of elements are made of only one type of atoms. We cannot see atoms with the naked eye, but when crores of atoms come together, their total volume is large enough to be visible to our eyes. The mass and volume of atoms of different elements are different.

Do you know?

To date, scientists have discovered 118 elements. Of these, 92 elements occur in nature, while the remaining are man-made. Hydrogen, oxygen, nitrogen, carbon, iron, mercury, copper are a few of the important natural elements. More new elements are being discovered through research work.

Great Scientists

Democritus named the small particles of elements 'atom' because in the Greek language *atomos* means indivisible.

In 1803, John Dalton proposed his theory stating that atoms cannot be created or divided into smaller particles or destroyed.

He used certain symbols to represent elements.

For example : © Copper, ⊕ Sulphur, ⊙ Hydrogen.

Oxygen occurs in nature in the gaseous state. Two atoms of oxygen are joined to form a molecule of oxygen, which has an independent existence. Oxygen in air is always in molecular state. Just like atoms, molecules also cannot be seen with naked eyes.

Use your brain power !

1. Which elements are present in air?
2. Is carbon dioxide an element?
3. What are the properties of elements due to?
4. Are the atoms of different elements similar or dissimilar?

Can you tell ?

What do the short forms Dr, H.M., AC, Adv., C.M., DC stand for?

In day-to-day life, we use short forms in many places. A similar method is used to indicate elements.

The scientist, Berzelius, was the first to use the present method of using symbols for elements. The symbol of an element is written in the English script and is the short form of its name.

Some elements and their symbols are listed in the table alongside. When the initial letter in the names of two or more elements is the same, a pair of letters is used to write the symbol. For example, we write C for carbon and Cl for chlorine.

Element	Symbol	Element	Symbol
Hydrogen	H	Sodium	Na
Helium	He	Magnesium	Mg
Lithium	Li	Aluminium	Al
Beryllium	Be	Silicon	Si
Boron	B	Phosphorus	P
Carbon	C	Sulphur	S
Nitrogen	N	Chlorine	Cl
Oxygen	O	Argon	Ar
Fluorine	F	Potassium	K
Neon	Ne	Calcium	Ca

From the Internet or reference books, obtain information about elements and prepare a table according to the format given below.

Name of the element	Symbol	Discovery of the element	State	Information and uses

Can you tell ?

1. Which metals do we use in day-to-day life ?

2. Are metals elements ?

Elements are generally classified into two groups: metals and non-metals. We have studied the properties of metals such as malleability, ductility, conductivity of heat and electricity, density, lustre and sonority. The elements that do not show these properties are called non-metals, for example, phosphorus, sulphur, chlorine. The elements that show some properties of metals and some properties of non-metals are called metalloids. This is the third group of elements. Arsenic, silicon, selenium are examples of metalloids.

Do you know ?

The wire that we see in the electric bulb in our house is made of the element tungsten. Its symbol 'W' is derived from its German name 'Wolfram'. Similarly the symbols of silver (Ag) and gold (Au) are derived from their Latin names Argentum and Aurum respectively. Elements occur in solid, liquid or gaseous state.

Some metals are difficult to use in pure form. For example, pure iron rusts in air, pure gold is very soft and bends easily. The properties of the original metal can be modified by mixing one or more elements in it. Such a mixture of metals is called an alloy. Brass, steel, twenty-two carat gold are a few examples of alloys.

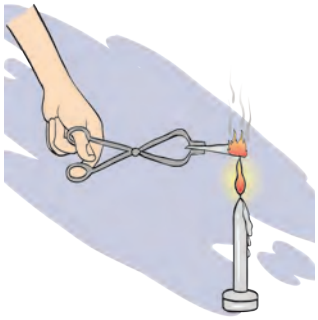
Find out.

Which of the elements are metals, which are non-metals and which are metalloids ?

Compounds

Try this.

1. Take sugar in a test tube and heat the test tube. Observe what happens. What remains behind ?
2. Using tongs, hold a magnesium ribbon in a flame and observe. What changes took place in the above two experiments ?



14.2 Burning of magnesium

In the first case, the sugar melts and then it loses water leaving behind a black substance. This black substance is carbon. What does this imply ? How many elements is sugar made of ?

What does the name carbon dioxide imply – how many and which elements is this substance made of ?

The substance formed by a chemical combination of two or more elements is a compound.

1. Which of these are compounds, which are elements – water, oxygen, carbon dioxide ?

2. What is the smallest particle of a compound called ?

Always remember –

A substance is a compound only if its molecules are made up of atoms of different types. Water is a compound. One molecule of water is made of two atoms of hydrogen and one atom of oxygen.

Can you tell ?

1. Which element helps combustion ?
2. Does water help combustion ?

Hydrogen is a combustible substance, that is, it burns. Oxygen helps combustion. But water, which is formed by a combination of hydrogen and oxygen is used to extinguish a fire. In other words, the properties of a compound are different from those of the constituent elements.

Like an element, a compound is also written in an abridged form. A molecule of a compound is formed by a chemical combination of atoms of two or more elements. Therefore, a molecular formula is used to represent a compound. A **molecular formula** of a compound is a short form of its name written with the help of the symbols of the constituent elements and the number of their respective atoms.

Collect information and prepare a table.

Constituent elements and molecular formulae of various compounds such as salt, alum, blue vitriol, ammonium chloride, baking soda, chalk, washing soda.

Compound	Constituent elements	Symbol and number of atoms	Molecular formula	Characteristics
Water			H_2O	

Mixtures

Try this.

1. Prepare a sherbet.
2. Prepare a *bhel*.

Did the taste of the original ingredients change due to the above processes ?

A mixture is formed by mixing different elements or compounds. The proportion of various components in a mixture is not fixed. No chemical change takes place during the formation of mixtures and no new substance is formed.

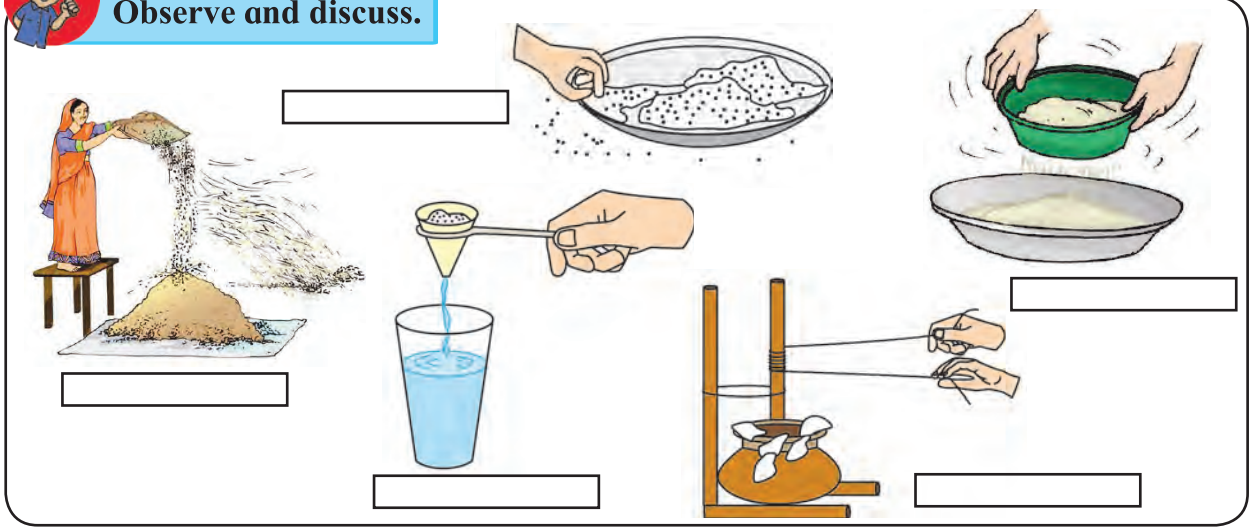
Can you tell ?

1. What are the mixtures used in everyday life ?
2. Are all mixtures useful to us ?
3. How will you separate each component from a mixture of semolina, salt and iron filings ?

You might remember that mixing unwanted substances in any foodstuff is called adulteration. In other words, an adulterated foodstuff is also a kind of mixture.

When an unwanted and harmful substance is mixed with another substance the resulting mixture no longer remains useful. In such cases, we separate the unwanted ingredients from the mixture. For this purpose, simple and easy methods such as straining (filtering), sifting, picking, sorting, winnowing, combing with a magnet and sublimation are used. Which ingredients, from which mixtures could be separated by using these methods ? We have learnt about the properties of matter and the effects of heat. These properties are also used for separating the components of a mixture.

Observe and discuss.

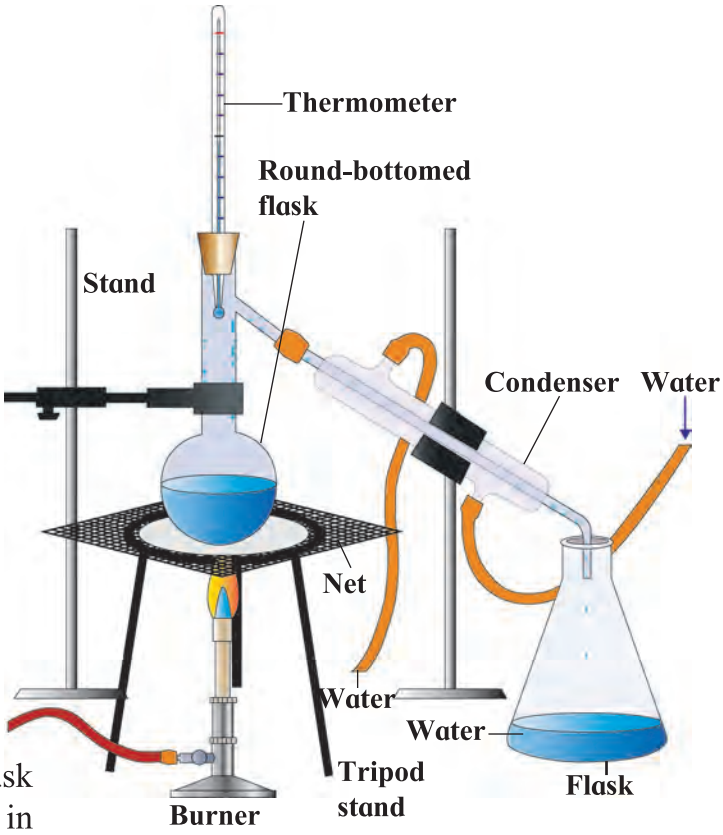


14.3 Some methods of separating the components of a mixture.

Method of distillation

Take some salt water in a round-bottom flask. Arrange the apparatus as shown in the figure. Start heating the liquid in the flask placed on the wire gauze. Observe the conical flask. Slowly droplets of water start falling into it. Where did these drops come from?

The salt water in the round-bottom flask boils on heating. The water in it vapourizes. When the vapour passes through the inclined tube, it gets cooled due to the surrounding cold water and condenses to form water. Thus, the drops falling into the conical flask are of the water from the salt solution in the round-bottom flask. Salt remains behind at the bottom of the round-bottom flask when all the water has collected in the conical flask. This method is called distillation. Distillation is also used for purification of impure liquids.



14.4 Distillation method

Use your brain power!

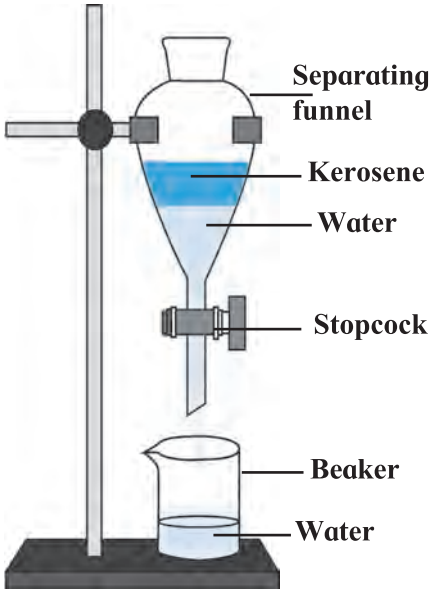
1. Is the water that falls from clouds naturally pure?
2. Which properties of a liquid are seen in the distillation method?
3. For what purposes is distilled water used?

Method of separation using separating funnel

When a mixture of two immiscible liquids is left undisturbed two layers are clearly seen to have formed. The heavier of the liquids remains below and the lighter liquid floats on it. Two liquids in a mixture can be separated by making use of this property.

Procedure : Pour a mixture of kerosene and water into a separating funnel with its stopcock closed. Close the stopper. Fix the separating funnel firmly on a stand. Leave the mixture in the funnel undisturbed for a while. Water will remain below and kerosene will float on it.

Now, without shaking the funnel remove the stopper. Open the stopcock to collect the water at the bottom of the funnel, in a beaker. Close the stopcock when all the water is collected in the beaker. Now, kerosene and water are separated.



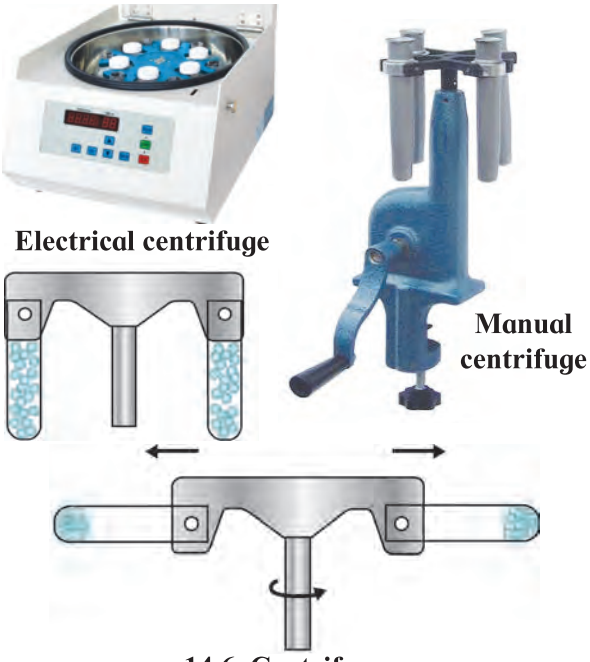
14.5 Separation method

Method of centrifugation

Turbid water, ink, milk, buttermilk, blood are mixtures of liquids and insoluble solids. When turbid water is kept undisturbed for a while, the soil particles in it slowly settle to the bottom. The particles of milk or ink, however, do not settle even on being left undisturbed. This is because the particles of the solids in such mixtures, being very tiny and light, remain evenly distributed in the liquid. These particles cannot be separated from the liquid even by methods like filtration or settling.

How will you separate such solid particles from the liquid ? In the laboratory, a centrifuge machine is used to separate solids from a mixture of a liquid and solid. In consists of a disc, which rotates like a fan at great speed. There is a provision to attach test tubes at the rim of this disc.

When the tubes attached to the disc rotate at high speed, a force is generated which pushes the particles away from the centre. As a result, the solid particles in the mixture in the test tubes collect at the bottom of the tubes and are thereby separated from the liquid.



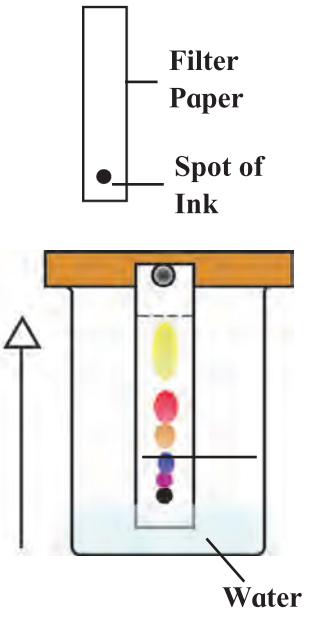
14.6 Centrifuge

Method of chromatography

If two or more substances are dissolved in small proportions in the same solution, these substances are separated from each other by means of chromatography. This method is used in pharmaceutical science, factories and scientific laboratories for detecting new ingredients and for identifying and separating components of a mixture.

Procedure : Take some water in a beaker. Take a rectangular piece of a filter paper. Put one spot of blue ink on it about 2 cm away from one edge. Keep this paper upright in the water in the beaker. Place a lid on the beaker. After some time, the spot of the ink is seen to have risen and collected at a particular height on the filter paper. If there are two or more constituents of different colours in the ink, they will be seen to have risen to different heights due to their different colours and thus appear distinct from each other. This experiment can be done using a chalkstick instead of the filter paper.

In this method of separation called chromatography, two properties of substances are used. These are the solubility of the substance in the solvent that moves up and the ability of the substance to stick to the stationary filter paper. These properties are mutually opposite and are different for different substances. As a result, all the components of the mixture do not rise all the way to the upper end of the filter paper, but remain behind at different heights.



14.7 Chromatography

Exercise

1. Who are my companions?

Group 'A'	Group 'B'
1. Stainless steel	(a) Non-metal
2. Silver	(b) Compound
3. *Bhajani* mixture for milling	(c) Mixture
4. Salt	(d) Element
5. Coal	(e) Alloy
6. Hydrogen	(f) Metal

2. Write the names of elements from the following symbols : Zn, Cd, Xe, Br, Ti, Cu, Fe, Si, Ir, Pt.

3. What are the molecular formulae of the following compounds?

Hydrochloric acid, sulphuric acid, sodium chloride, glucose, methane.

4. Give scientific reasons.

(a) Buttermilk is churned to get butter.

(b) In chromatography, the ingredients of a mixture rise up to a limited height when water rises up to the upper end of the paper.

(c) A wet cloth is wrapped around a water storage container in summer.

5. Explain the difference.

(a) Metals and non-metals

(b) Mixtures and compounds

(c) Atoms and molecules

(d) Separation by distillation and by separating funnel

6. Write answers to the following questions in your own words.

(a) How are the components of mixtures separated by simple methods?

(b) Which elements (metals and non-metals), compounds and mixtures do we use in our day-to-day life?

(c) In everyday life, where and for what purpose do we use centrifugation?

(d) Where are the methods of separation by distillation and by separating funnel used? Why?

(e) Which precaution will you take while using the methods of distillation and separation by separating funnel?

Project : Visit a jaggery or a sugar factory. Obtain information about the methods that are used to separate the components of the mixture while making jaggery or sugar. Present it in the class.

15. Materials we Use

Let's recall.

1. What is meant by natural and man-made materials?
2. Make a list of natural and man-made substances you see around you.

We have learnt that, a new substance produced by the chemical processing of natural substances is called a man-made substance. In this lesson, we will learn about some substances of daily use.

Can you tell ?

1. Which substances were used earlier, for cleaning teeth?
2. What do we use today to clean our teeth?

We have seen that in olden times in India, acacia bark, neem twigs, coal powder, ash, tooth powder, salt, pomegranate rind were used for cleaning teeth. Today, however, a variety of toothpastes and tooth powders are used for this purpose.

Do you know?

In the period prior to 500 BC, in countries such as China, Greece, Rome, toothpaste was made by mixing the powder of bones and shells. Toothpaste, of which soap was the ingredient, came into use in the 19th century. Later, toothpaste was made using a chalk-like material. The first commercial toothpaste was made by the Colgate company in New York city in 1873.

Toothpaste

The principal ingredients of a toothpaste, calcium carbonate and calcium hydrogen phosphate, remove the dirt on teeth. These ingredients also polish the teeth. A certain proportion of flouride in the toothpaste helps prevent tooth decay. Fluoride is essential for the strengthening of bones and the enamel covering of teeth.

Find out.

1. What is the source of the fluoride in a toothpaste or tooth powder ?
2. Note down all the information given on a tooth powder/ toothpaste container or carton and discuss.

Detergents

The word 'detergent' is derived from the Latin word '*detergere*' which means 'to wipe away'. A detergent is 'a substance that cleans or wipes away dirt.' Soap nut (*ritha*), soap pod (*shikekai*), soap, washing soda, washing powder, liquid soap, shampoo are all detergents.

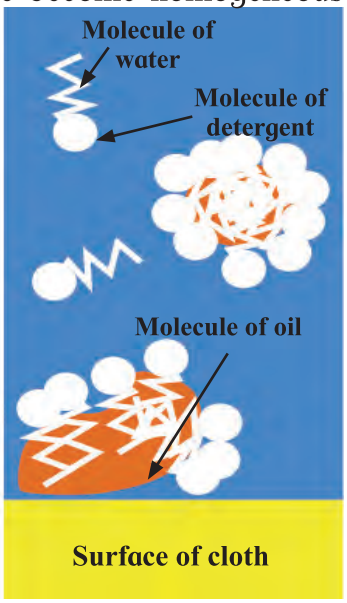
Can you tell ?

1. What do we use for cleaning our body ?

Apparatus : A clean glass bottle, water, oil, detergent, etc.

Procedure : Take some water in a clean glass bottle. Add some oil to it. The layer of oil will float on the water. Shake the bottle vigorously. After some time, when the liquid in the bottle settles, the oil will again be seen floating on the water.

Now add a few drops of the solution of a detergent to the above mixture. Shake the bottle vigorously. You will see that the water and oil have become homogeneous and the colour of the mixture appears milky.



15.1 Action of detergents

Why does this happen ?

The molecules of a detergent are long and the properties of its two ends are different. A molecule of a detergent holds on to a water molecule at one end and an oil molecule at the other. As a result, the molecules of oil mix with the water. This is how soap acts when we wash ourselves or our soiled clothes. Our body and clothes become oily for various reasons such as applying gels or creams, oiling our hair, etc. The oily layer sticks fast to the criss-crossing threads of the material of our clothes. Soap is used for removing it. Due to the property of holding on to both oil and water, soap water spreads easily on many types of surfaces. The property of a substance of spreading on a surface is called **surface activity** and the substance is said to be a **surfactant**. Detergents are surface active. One effect of surface activity is lather formation.

Natural detergent

Soap nut (*ritha*) and soap pod (*shikekai*) are the natural detergents in common use. They contain a chemical named saponin. Soap nut and soap pod do not have any harmful effect on human skin or on silk and woolen threads and cloth.

15.2 Natural detergents

Man-made detergent

Soap : Soap is a man-made detergent which has been in use since ancient times. It is believed that soap was invented in the west about 2000 years ago. In those days, soap was prepared using animal fat and wood ash. Today we come across a variety of soaps.

Types of soaps : Hard soap is used for washing clothes. It is a sodium salt of fatty acids. Soft soap is used for bathing. It is a potassium salt of fatty acids. It does not cause irritation of the skin.

In the hard water of a well or a tube-well, soap does not give lather but forms a scum. As a result, soap loses its cleansing property.

Synthetic detergent

Now synthetic detergents have taken the place of soap. There are several methods of producing these detergents. The long structural units in the synthetic detergents are obtained from raw materials which are mainly fats or kerosene. Detergents are obtained by subjecting these raw materials to a variety of chemical processes. Synthetic detergents are used in many types of cosmetics. Synthetic detergents can be used in hard water as well.

As per the use of the detergent, supporting additives such as perfumes dyes, germicides, alcohol, anti-foaming agents, moisturizers, fine sand, etc. are mixed with different detergents to give them certain useful properties.

Try this.

15.3 Making soap

Preparation of soap

Material : 15g sodium hydroxide, 60 ml coconut oil, 15g salt, perfume, a glass rod, beaker, tripod, wire gauze, burner, water, mould, etc.

Procedure : Take 60 ml coconut oil in a beaker. Dissolve 15g sodium hydroxide in 50 ml water. Mix the sodium hydroxide solution in the oil slowly while stirring it with a glass rod. Heat the mixture, and boil it for 10-12 minutes, stirring it all the while. Take care that the mixture does not boil over while heating. Dissolve 15 g salt in 200 ml water. Pour this solution into the above mixture and stir. The soap formed by the chemical reaction now floats on the water. After some time, it becomes thick. Now, separate the thick soap and add the perfume to it. Shape the bar of soap using the mould.

In the above process, fat and alkali combine to form salts of fatty acids. Chemically, soap is a sodium or potassium salt of fatty acids.

Cement

Can you tell ?

1. What are the materials used for construction?
2. Which of the houses seen in the pictures here have a strong structure? Why?

15.4 Houses

15.5 Cement

Cement production

Cement is an important material in construction. Sheets, blocks, pillars and pipes are made from concrete produced from cement. Cement is a dry, greenish grey powder with fine particles. It is made from silica (sand), alumina (aluminium oxide), lime, iron oxide and magnesia (magnesium oxide).

Portland cement is the most commonly used cement for construction work. It is made from raw material which consists of 60% lime (calcium oxide), 25% silica (silicon dioxide), 5% alumina. The rest is iron oxide and gypsum (calcium sulphate). Portland cement gets its name from the stone quarried from the Isle of Portland in England, which has a similar texture.

In ancient times, the Romans had made cement as well as concrete. They used to make aqueous cement by mixing volcanic ash in moistened lime. It was a very durable cement. With the decline of the Roman empire, this art of making cement was also forgotten. In 1756, the British engineer, John Smeaton developed the method of making aqueous cement.

Concrete

Concrete is prepared by mixing cement, water, sand and gravel. For making a strong and leak proof slab certain substances are mixed in concrete.

Find out.

1. Nowadays, why are the roads made of concrete?
2. What causes the hardness of water?

Exercise

1. Fill appropriate terms in the blanks. (white cement, soap, detergent, wearing of bones, tooth decay, hard, soft, Portland, fatty acid)

(a) The substance that helps water to remove dirt from the surface of materials is called …….. .

(b) Fluoride is used in toothpaste to prevent ……. .

(c) Soap is a salt of …….. and sodium hydroxide.

(d) Synthetic detergents can be used in …….. water as well.

(e) For construction purposes …….. cement is the most commonly used cement.

2. Write answers to the following questions.

(a) How does the use of a detergent help to clean soiled clothes?

(b) How will you check with the help of soap powder whether water is hard?

(c) What are the important ingredients of a toothpaste, and what is the function of each?

(d) What are the ingredients of cement?

(e) What will happen if cement is not used in making concrete?

(f) Make a list of detergents that you use.

(g) What should be expected from a detergent for delicate garments?

(h) What is meant by 'surface activity'? Name three chemicals responsible for the surface activity of various detergents.

3. What are the similarities and differences between -

(a) Natural detergents and man-made detergents

(b) Soap and synthetic detergent

(c) Bath soap and soap for washing clothes

(d) Modern cement and ancient cement

4. Explain why -

(a) Soap cannot be used in hard water.

(b) Oil does not mix in water. However, oil and water become homogeneous if a sufficient quantity of detergent is added.

(c) Synthetic detergents are superior to soap.

(d) Often coloured spots are formed on clothes during washing.

(e) Tobacco *masheri* should not be used for cleaning teeth.

Project :

1. Visit a cement factory. See how cement is prepared and discuss the process.
2. Write a conversation based on cement houses, mud-houses and wattle-and-daub houses.

♦ ♦ ♦

16. Natural Resources

Let's recall.

1. What is meant by natural resources?
2. Give some examples of natural resources.

We get many substances from nature. They satisfy a variety of our daily needs. Soil, stones, minerals, air, water, plants and animals on the earth are all various kinds of natural resources.

Let's recall. What is meant by lithosphere?

Natural resources in the earth's crust

The earth's lithosphere is made up of land and the hard crust beneath it. The lithosphere is not homogeneous but is made up of many types of rocks. Resources in the earth's crust include minerals, ores, mineral oil and other fuels, rocks, water, elements, etc.

Minerals and ores

Mineral wealth has an important place among natural resources. Minerals are formed by various processes taking place in the environment.

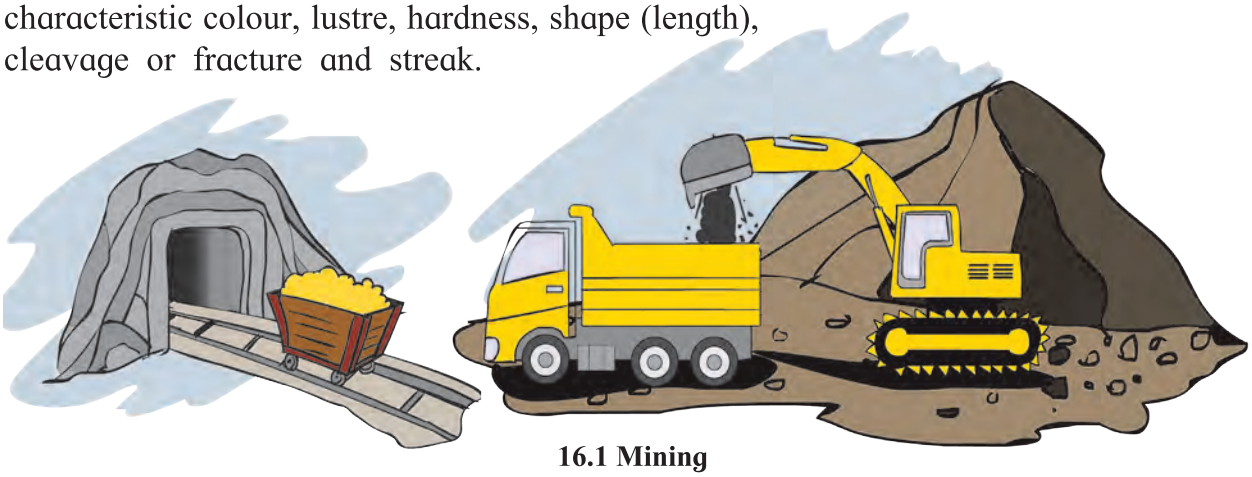
The rocks on the earth are mainly made of minerals. These minerals can be obtained by mining.

Only a few metals like, for example, gold, silver, copper, platinum and bismuth occur in the free state in nature. A majority of the metals occur in the form of compounds. Minerals that contain a high proportion of metal are called ores. It is economical to obtain metals from ores. The properties of minerals become clear from their characteristic colour, lustre, hardness, shape (length), cleavage or fracture and streak.

Metals are obtained from their ore by extraction and purification. Impurities of sand and soil in an ore are called 'gangue'.

Use your brain power!

1. Why are all minerals not ores?
2. What is meant by 'metal mineral' and 'non-metal mineral'?



16.1 Mining

How are minerals formed?

Minerals are formed from the magma in the earth's crust and the lava from the eruption of volcanoes, when they cool and get transformed into crystals.

Magnetite

Mica

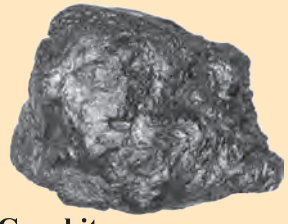
Minerals are formed when solid crystals remain behind after the process of evaporation.

Halite

Gypsum

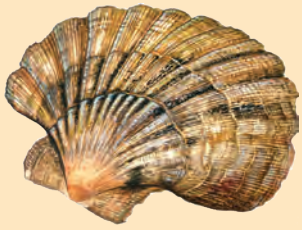
Minerals get transformed from one form into another due to large changes in temperature and pressure.

Diamond



Graphite

Some living organisms produce inorganic minerals. e.g., conches, shells, etc. formed for the protection of the body.



Shell

Classification of minerals according to their properties.

Non-metal minerals	Metal minerals	Energy minerals
Mica, sulphur, gypsum, potash, graphite, diamond, feldspar.	Iron, gold, silver, tin, bauxite, manganese, platinum, tungsten.	Coal, mineral oil, natural gas.

Gems and gemlike minerals

Some important minerals like diamond, ruby, sapphire, emerald, jade, zircon are used as gems. Gems are in great demand.

Do you know?

Deposits of common salt are also found in the earth. This salt is called rock salt. It is used in food and in some medicines.

National Institutions

The Indian School of Mines, Dhanbad, was founded in 1926 to impart education in mining. This institute has now been converted into an **Indian Institute of Technology**.

My friend, the internet!

Pictures of various minerals. www.rocksandminerals4u.com/mineral

Obtain videos related to mining from YouTube and present them in the class.

Some important minerals and ores

1. Iron ore : Iron occurring in the impure state is called iron ore. Iron ore is used to make a variety of articles from pins to heavy machinery. For example, farming implements, rails of railway tracks, etc.

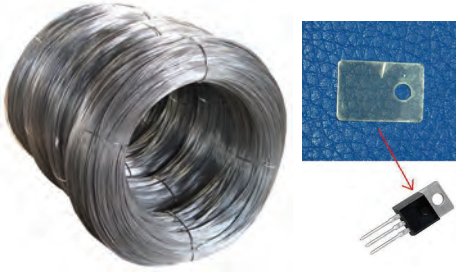
The four main ores of iron are magnetite, haematite, limonite and siderite.

2. Manganese : Manganese occurs in the form of its carbonate, silicate and oxide. Compounds of manganese are used in the preparation of medicines and for giving a pink tinge to glass. Manganese is also used in electrical appliances.

3. Bauxite : Bauxite is the most important ore of aluminium. It contains 55% aluminium. Bauxite consists mainly of aluminium oxide. Aluminium is a very good conductor of electricity and heat. Its density is low. Therefore, it is used mainly in aeroplanes, transport vehicles and to make electric wires.

4. Copper : Copper is found in the impure state in the vicinity of iron and other minerals. Copper is a very good conductor of electricity. Therefore, it is used to make electric wires as well as in radios, telephones, vehicles, and for making kitchen utensils and statues.

5. Mica : Mica is a bad conductor of electricity. Its value depends on the thickness of its layers. Mica has many uses such as in ayurvedic medicines, dyes, electric machines and equipment, wireless communication equipment, etc.



16.2 Uses of minerals

Find out.

How did the various ages of the prehistoric period get their names on the basis of the use of metals?

Fuel

Can you tell ?

1. What is meant by fuels?
2. Which natural resources do we use as fuels?

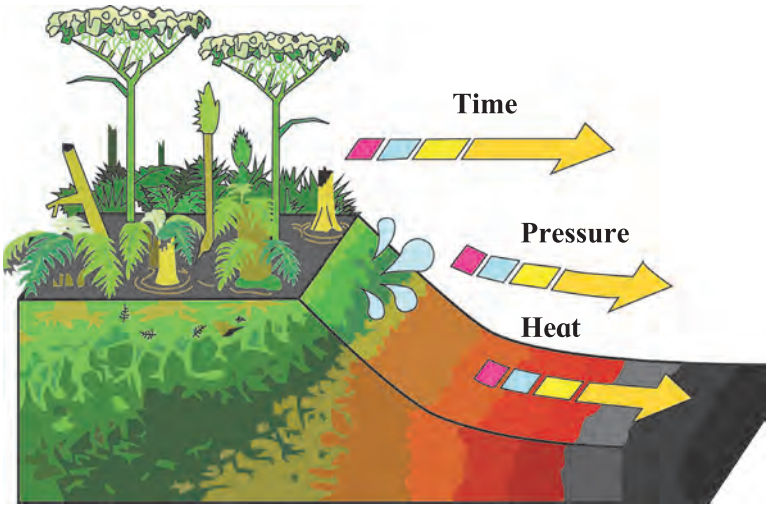
Various substances are used in day-to-day life for generating energy. These substances are called fuels. Fuels are found in the solid, liquid or gaseous state.

Coal

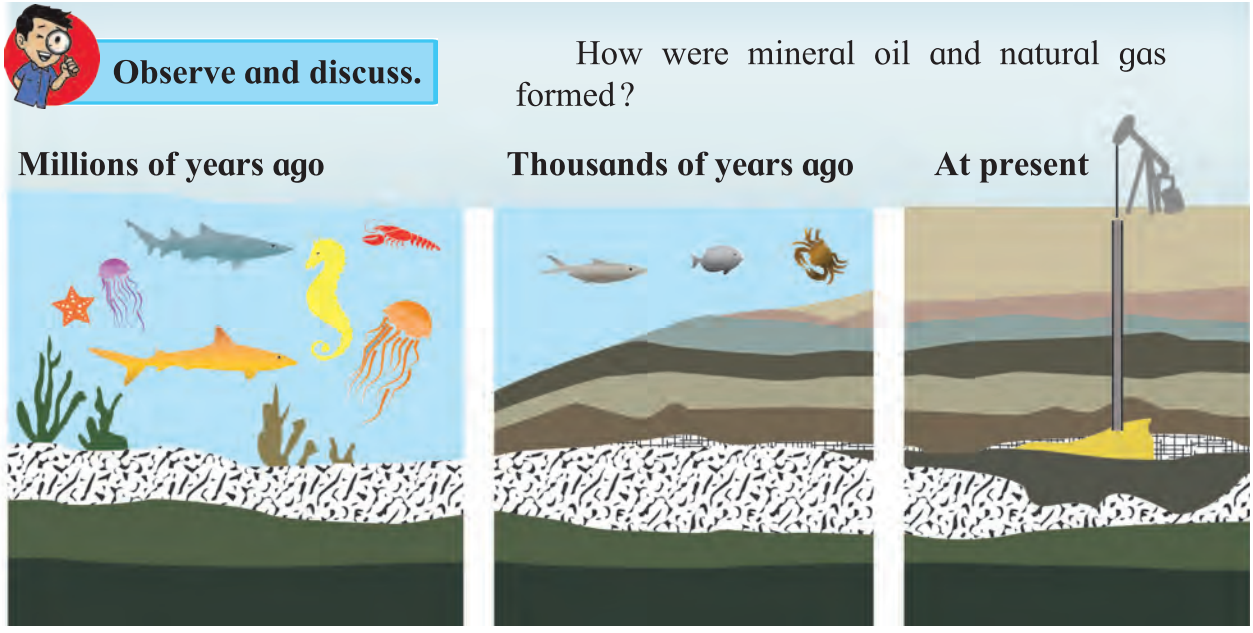
Millions of years ago, forests got buried underground as a result of certain natural events. Layers of soil kept getting deposited over them. The very high pressure from above and the heat from the earth's interior, slowly transformed the buried plants into fuel. Coal was thus formed from the remains of those plants. That is why coal is said to be a fossil fuel.

Coal is found in mines. Peat, lignite (brown coal), bituminous coal and anthracite are the various types of coal. Anthracite is the coal of the highest grade.

Coal is, in a way, a storehouse of carbon. It is burnt to obtain heat energy. Coal is used as fuel. It is used as a fuel in thermal power plants as well as to run boilers and railway engines. Coal is also used as a fuel for cooking and for baking bricks in kilns on a large scale. The gaseous fuels, producer gas and water gas, are obtained from coal. Coal, as an energy resource, contributes greatly to industrial development.



16.3 Formation of coal



16.4 Formation of mineral oil and natural gas

National Institutions

The Oil and Natural Gas Corporation (ONGC) was established on 14th August 1956. It functions under the ministry of Petroleum and Natural Gas of the Government of India. ONGC is the largest oil and gas research and production company in India. Its head office is at Dehradun, Uttarakhand. ONGC produces about 77% of the crude oil and about 62% of the natural gas produced in India. Of the seven commercially important underground oil reserves in India, ONGC has successfully explored six.

Mineral oil

Mineral oil is the liquid fuel formed by the decomposition of organic substances buried underground. Millions of years ago, bodies of dead sea organisms sank to the bottom of the sea. Layers of soil and sand collected on them. Due to high pressure and temperature the remains of the dead organisms were transformed into mineral oil.

The underground mineral oil is extracted through oil wells. Mineral oil is found mainly in oil sands, shale, sandstone and limestone at a depth of about 1000 to 3000 metres.

Mineral oil is also known as petroleum or crude oil. It is greenish brown in colour. Petroleum is a mixture of many compounds mainly of the hydrocarbon type. It also contains compounds of oxygen, nitrogen and sulphur. Petroleum is extracted through oil wells and refined by fractional distillation to separate other components. Aviation petrol, gasoline, diesel, kerosene, naphtha, lubricating oil, tar are all obtained from petroleum. They are used as fuel and for production of dyes, pesticides, perfumes and artificial fibres.

Natural gas

Natural gas is an important fossil fuel. It is found associated with petroleum in underground oil wells and in some places as natural gas alone. The main component of natural gas is methane (CH_4) while ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) are present in small proportions.

Natural gas is formed from the remains of organisms buried deep underground and subjected to high pressure. This fuel can be carried over long distances by means of a gas pipe line. But in the absence of a network of pipelines, it is transformed under high pressure into compressed natural gas (CNG) and liquefied natural gas (LNG). This makes it possible to transport the gas.

Characteristics of CNG:

1. Catches fire easily.
2. No solid waste remains after combustion.
3. Carbon dioxide and water are formed in small quantities.
4. Other pollutants are not produced.
5. Can be transported easily.
6. Combustion can be controlled easily.

Do you know?

Fossils are the preserved remains of dead organisms in rock. Fossils are the signs of their existence left behind by organisms that got buried billions of years ago. Sometimes impressions of the organisms are seen on the surfaces of coal and stones.

Use your brain power!

1. Why is mineral oil called 'liquid gold'?
2. Why is coal called 'black gold'?
3. What would happen if underground mineral resources are exhausted?

Do you know?

Liquified Petroleum Gas (LPG)

Petroleum gas is obtained during refining of crude petroleum. Petroleum gas is transformed into a liquid by subjecting it to high pressure and reducing its volume to 1/240 of the original. It is stored in thick-walled steel cylinders so that under pressure it remains in the liquid state. As it comes out from the storage cylinder it is transformed back into a gas. This gas contains mainly two components, propane and butane, in the ratio 30:70. It is an odourless gas; but a small amount of a chemical called 'ethyl mercaptan' which has a strong characteristic odour is added to it. This helps to detect any leakage of LPG gas immediately and thus, avoid any accident.

Use your brain power! Why is natural gas an eco-friendly fuel?

The demand for fuels has increased greatly due to the rapidly growing population but the reserves of fossil fuel are limited. It is becoming difficult to meet the increased demand. The likelihood of these reserves getting exhausted is known as the energy crisis.

As the reserves of fossil fuels, namely, mineral oil and coal are limited and the demand is increasing, alternative fuels are coming into use. Hydrogen, biofuels, methanol or wood alcohol, ethanol or green alcohol are some of the alternative fuels.

Forest resources

Can you tell ?

1. What is meant by forests?
2. What are their uses?

An extensive area of land covered by a variety of plants is called a forest. A forest is a natural habitat of plants, animals and microbes. About 30% of the total land of the world is covered by forests. Forests perform certain specific protective and productive functions.

Protective functions of forests

1. To reduce the velocity of water flowing over the land.
2. To prevent soil-erosion.
3. To help percolation of water into the ground.
4. To control floods.
5. To reduce the rate of evaporation.
6. To protect wildlife.
7. To maintain the balance of atmospheric gases.

Thus, forests help improve and maintain the quality of the environment.

Books, my friends! From your Geography textbook and other reference books, collect information about the various forests in India and the extent of land covered by them.

Productive functions

Medicinal plants

Plant	Medicinal use : for treatment of
Adulsa	Cough and cold
Bel	Diarrhoea
Neem	Fever and cold
Periwinkle	Cancer
Cinnamon	Diarrhea, nausea
Cinchona	Malaria

Prepare a list of medicinal plants like *ashwagandha, shatavari, amla, hirda, behda, tulsi* and their uses. Take the help of your grandparents or people in your neighbourhood who have knowledge of plants to obtain this information.

Wood : We get strong and durable wood as also firewood from trees like teak, mahogany, neem, acacia, *subabhul*. Wood is used for making furniture, farming implements and various other articles as well as in construction work.

Forest wealth includes fibres, paper, rubber, gum and aromatic substances. We get fragrant essential oils from lemon grass, vanilla, *kewada*, vetiver (*Khus*), and eucalyptus. Sandalwood and oil of eucalyptus are used for making soaps, cosmetics and incense sticks. In addition, we get various fruits, bulbs and roots, honey, sealing wax, catechu, dyes, etc. from forests.

Use your brain power!

1. What useful things will we have to do without if rubber is no longer available?
2. What are the adverse effects of clearing of forests or cutting down trees?

How to conserve forests?

1. Young trees should not be cut.
2. Many more trees, than are cut down, should be planted and looked after.
3. The stringent restrictions/laws/regulations regarding use of forests should be strictly followed.

Ocean resources

Let's recall.

1. Name the oceans of the earth.
2. How is seawater useful to us, even though it is salty?

We have learnt that oceans occupy a greater part of the earth's surface than land does.

Energy can be obtained on a large scale from oceans. Sea waves at high and low tide and ocean currents are being used for generation of power. Last year, we have learnt something about this in Geography. There are reserves of a variety of natural resources in seawater, at the bottom of the sea and beneath the seabed, too. These resources available from seas and oceans are called marine resources.

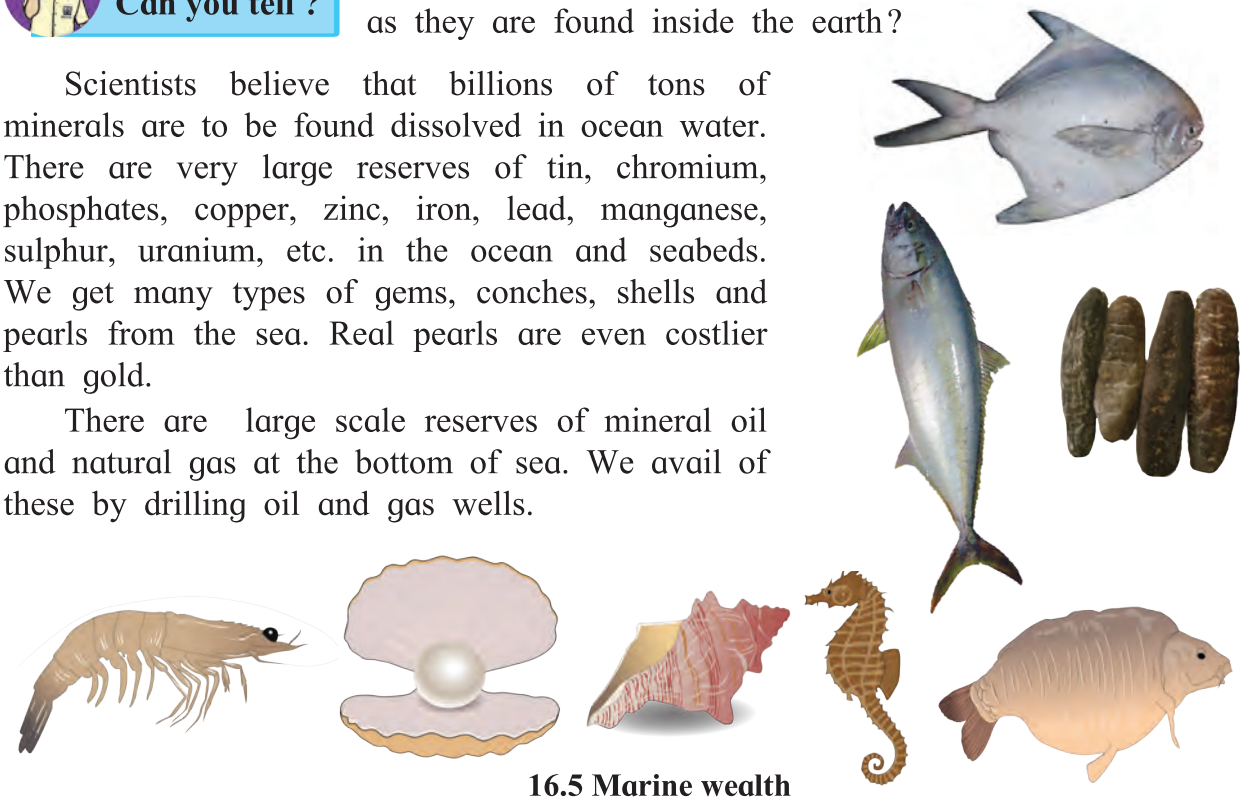
Mineral and bio-resources from oceans

Can you tell ?

Are minerals to be found in seas and on the seabed as they are found inside the earth?

Scientists believe that billions of tons of minerals are to be found dissolved in ocean water. There are very large reserves of tin, chromium, phosphates, copper, zinc, iron, lead, manganese, sulphur, uranium, etc. in the ocean and seabeds. We get many types of gems, conches, shells and pearls from the sea. Real pearls are even costlier than gold.

There are large scale reserves of mineral oil and natural gas at the bottom of sea. We avail of these by drilling oil and gas wells.



16.5 Marine wealth

In India, the first mineral oil well, 'Sagar Samrat', was drilled in 1974 at the oilfield called Bombay High for obtaining mineral oil and natural gas from the bottom of the sea. The natural gas from this well is carried via a pipeline to a place called Uran.

Mineral resources from oceans	Bio-resources in ocean
Thorium – used in the production of atomic energy. **Magnesium –** used in the flash bulb of a camera. **Potassium –** the main ingredient in production of soap, glass, fertilizer. **Sodium –** used in the production of cloth and paper. **Sulphate –** used in making artificial silk.	**Fishes** like pomfret, seer fish as also shrimps and prawns – they are sources of proteins and vitamins, therefore, mainly used as sea food. **Dried shrimp, Bombay duck powder –** used as poultry feed and is a good manure. **Shells –** used for preparation of medicines, ornaments and decorative articles. **Fungi –** used for the production of antibiotics. **Shark and cod fish –** used for producing edible oil rich in Vitamins A, D and E. **Sea cucumbers –** used as medicine for treating cancer and tumours.

Marine occupations

1. Fishing – main occupation
2. Salt farming – a big industry
3. Transport business – transport by sea
4. Sea tourism – means of financial income
5. Manufacturing decorative articles

Always remember –

Natural resources are important for meeting our needs. Reserves of some resources are limited. There is a danger that excessive use will lead to their early depletion. We must keep a control on the use of natural resources to maintain the balance in nature.

Exercise

1. Describe natural resources with reference to the following three types.

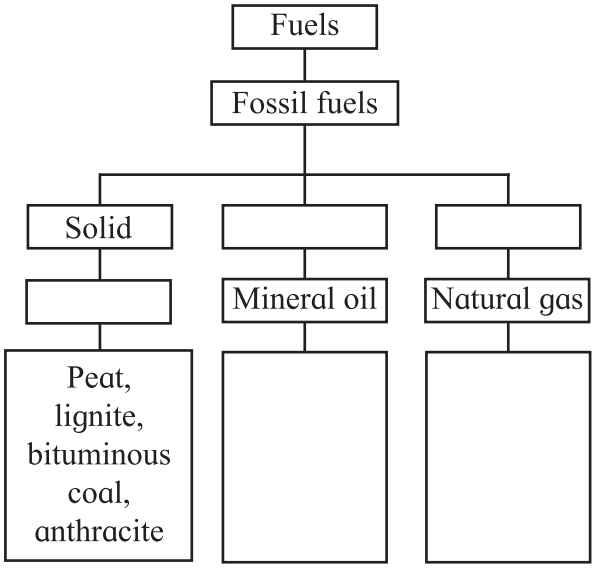
(a) Mineral resources
(b) Forest resources
(c) Ocean resources

2. Write answers to the following questions in your own words.

(a) What is meant by fossil fuel? What are their types?
(b) Make a list of the components we obtain from mineral oil.
(c) What do we get from forests?
(d) What are the items included in ocean resources? What are their uses ?
(e) Why should we prevent the wastage of fuel used for vehicles?
(f) Why is the diversity of plants and animals in the forests declining?
(g) Write the names of five minerals and the useful substances obtained from them.
(h) Name the two important stages in the process of obtaining metals from ores?

3. What steps are taken for protection and conservation of natural resources ?

4. Complete the flow chart.



5. How does the economic condition of a nation depend on its natural resources?

6. Which medicinal pants will you grow on your school premises and near your house? Why?

Project :

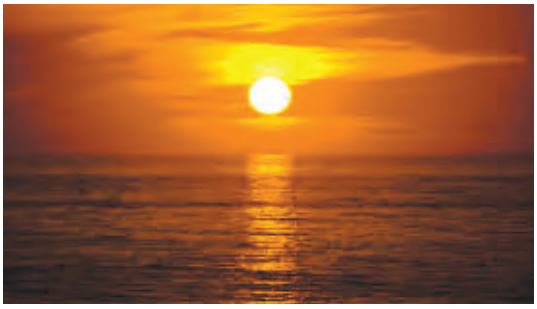
1. Collect conches and shells of various shapes and colours and make a decorative article.
2. Collect information about the mines of various minerals.

♦ ♦ ♦

17. Effects of Light

Let's recall. When sunrays pass through a glass prism, what are the colours in the band of light seen on the other side of the prism?

You have learnt that light is composed of several colours. You must have also seen the dust particles in a beam of sunlight entering the house through a small window. We switch on the head lamps of a car when we drive through a thick fog. You might have seen the beams of those lamps. What do we really see, when we see a beam of light? We see tiny dust particles floating in the beam. That is why we are able to see the beam of light. We see a variety of shades of colour in the early morning and evening sky. In the photographs taken from space by satellites the earth appears to be bluish. What is the cause of all these effects?



Scattering of light

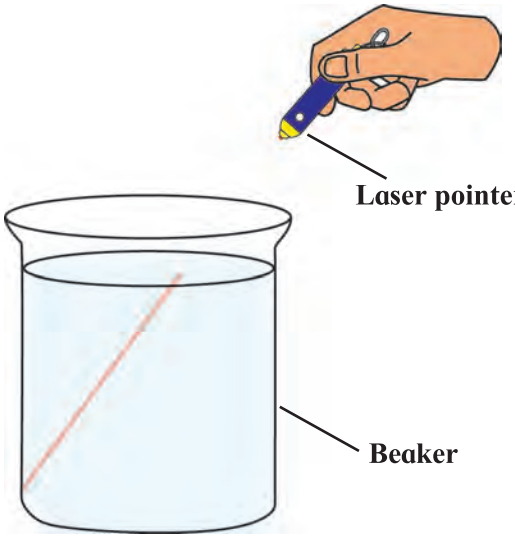
Try this. (All the experiments using laser rays should be done under the supervision of the teacher)

Apparatus : Glass beaker, diode laser (laser pointer), water, milk or milk powder, spoon, dropper, etc.

Procedure : Take clear water in a glass beaker. Pass a beam of laser rays through it. Check whether the beam is seen in the water.

Now use the dropper to add a few drops of milk to the water and stir. The water will be seen to have become slightly turbid. Now, pass the laser beam into it again. A light beam will show the existence of light rays.

A light beam is not seen in plain water, but is clearly seen in slightly turbid water. The light rays hit the tiny particles of milk and get scattered. If these scattered rays enter our eyes, we perceive the light.



17.1 A beam of laser light

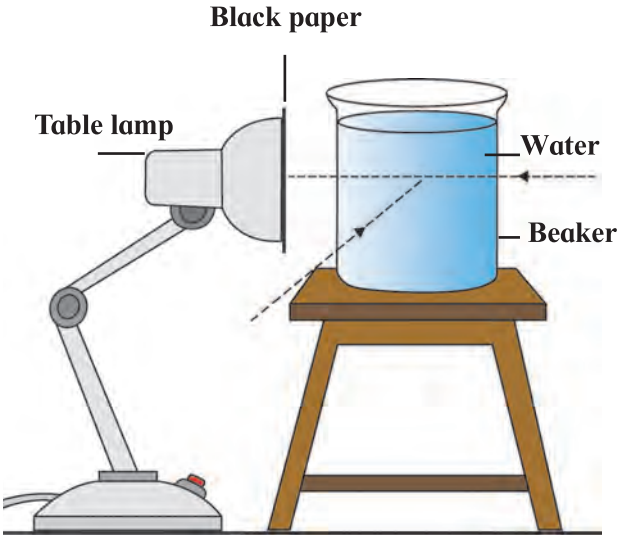
Try this.

1. Instead of using milk, mix salt, sugar and detergent powder in separate beakers of water and observe whether a laser beam is seen in them.

When the sun rises our surroundings appear illuminated. The entire sky appears bright. This happens because of the dust and other tiny particles in the air. This is the scattering of sunlight by the tiny particles of the various constituents of air. Had there been no atmosphere, the sky would have appeared dark during the day and of course, the sun would be directly seen. This has been verified by observations from the rockets and satellites which go out of the earth's atmosphere.

Apparatus : A table lamp with a 60 or 100 W milky bulb (LED will not do), thick black paper, sticking tape, a packing needle, 100/200 ml glass beaker, milk or milk powder, dropper, spoon, etc.

Procedure : Cover the mouth of the lampshade properly with black paper, using sticking tape. Prick a hole of 1 to 2 mm diameter in the center of the paper with the help of the packing needle. Take clear water in the beaker. Light the bulb and place the beaker in contact with the hole. Observe from the front and at an angle of 90°. Now add 2-3 drops of milk to the water and stir. Observe again.



17.2 Scattering of light

A few more drops of milk may have to be added to make the water turbid. A blue tinge is seen when observed along the 90° angle. This is the scattered blue light. Because the blue light is scattered, a red-yellow light is seen from the front, and the hole appears reddish.

(**Important :** This experiment should be done in a dark room and by small groups of students.)

Use your brain power!

If a few more drops of milk are added, the reddish colour seen from the front becomes an intense red. However, if many more drops are added, the reddish colour is not seen. Why is this so?

Sunlight is scattered by the molecules of gases like nitrogen, oxygen in the atmosphere. The blue colour in the sunlight is scattered the most, and, therefore, the sky appears blue.

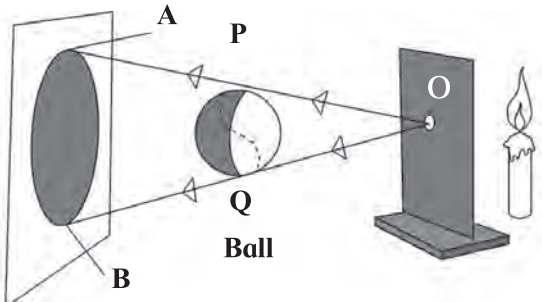
Sunlight reaches us through the layer of the atmosphere. At sunset, the light reaching us travels a greater distance through the atmosphere. Due to the greater distance, there is more scattering of the blue colour. As a result the red-yellow light reaches us directly and the sun appears red. Red light is scattered less than blue light.

Let's recall. What is a shadow? How is a shadow formed?

The shadow obtained from a point source and extended source.

Try this. **Apparatus :** Candle/torch, cardboard, screen, small ball, big ball, etc.

Take either a candle or torch as a light source. In front of it, set up a cardboard with a tiny hole (O) as shown in the figure. Now the light is seen to emerge from the hole on the cardboard. Such a light source is called **point source.** Place a screen vertically at a distance of one metre beyond the cardboard. Hang the big ball between the screen and the cardboard. Observe the shadow AB of the ball.

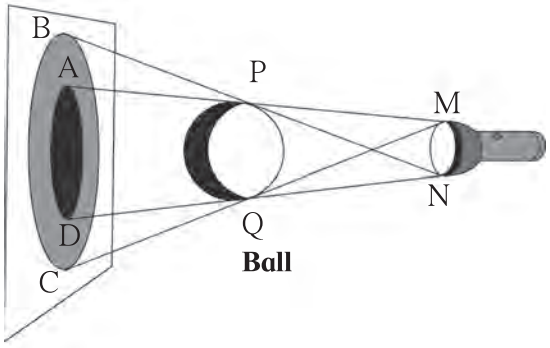


17.3 Shadow formed by a point source

The rays OP and OQ starting from the point source just pass by the ball and fall on the points A and B on the screen, respectively. However, since no rays reach the screen between the points A and B, that part remains unlit. This is the dark shadow or the umbra.

What happens if the cardboard with the pinhole is removed? Now, we do not have a point source. This source is called an **extended source**. What is the nature of the shadow formed by an extended source?

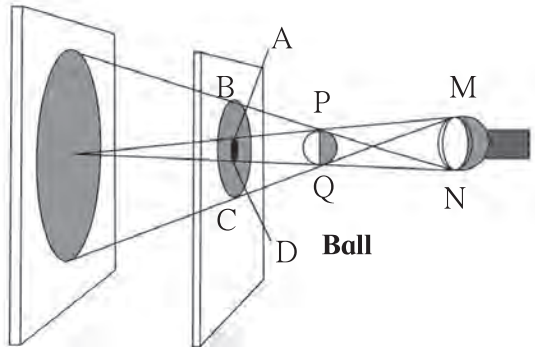
Due to the extended source, we see two parts in the shadow of the ball on the screen – one faint and one dark. The faint part BC is called the **penumbra** and the dark part AD, is called the **umbra**.



17.4 Shadow formed by an extended source

Let us see what happens in the following activity when the ball is bigger than the extended source. Keeping the distance between the extended source and the ball constant, move the screen further and further away and observe the shadow. As the screen moves further, the umbra and the penumbra in the shadow of the ball are seen to become bigger and bigger.

Now replace the big ball with one that is smaller in size than the light source. Observe its shadow on the screen. We see the umbra and penumbra of the ball on it. Now, without moving the light source and the ball, move the screen further away from the ball and observe its shadow. As the screen moves further, the umbra becomes smaller and smaller and at a certain point it disapperars.



17.5 Shadow of a small object formed by an extended source

Eclipses

What is an eclipse?

The moon revolves about the earth, and the earth along with the moon, revolves around the sun. Their orbits of revolution are all different. When the sun, the moon and the earth come in a straight line an eclipse is said to have taken place.

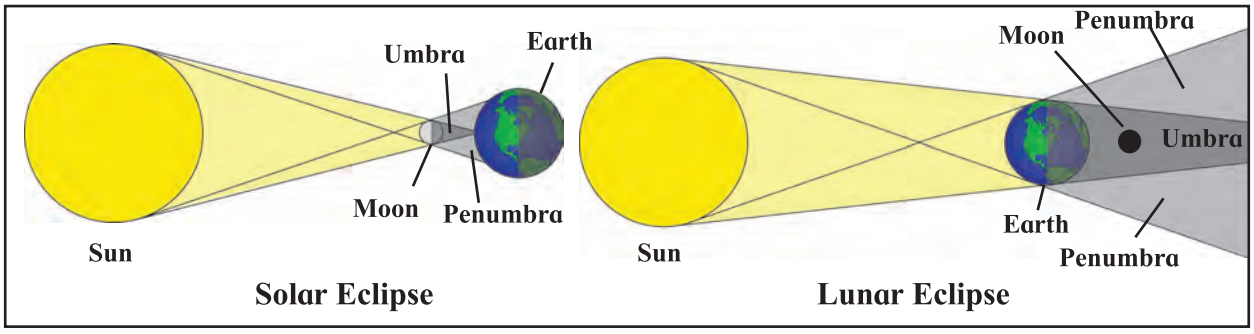
Solar eclipse

During its revolution, when the moon comes between the sun and the earth, a shadow of the moon is cast on the earth and the sun cannot be seen from the part in the shadow. This is called a solar eclipse. A solar eclipse is seen only on a new moon day. The solar eclipse may be either partial or total. Sometimes the solar disc is completely covered by the moon. This is the total solar eclipse. When the solar disc is not covered fully by the moon, we have a partial solar eclipse. During a solar eclipse, ultra-violet rays which are harmful to us reach the earth. A solar eclipse should never be watched with the naked eye. A special type of goggles should be used for this purpose.

Lunar eclipse

When the earth comes between the sun and the moon a shadow of the earth is cast on the moon and a part of the moon is covered. This is called the lunar eclipse. A lunar eclipse is seen only on a full moon night. If the whole moon comes in the shadow of the earth, it is a total lunar eclipse. When the shadow of the earth is cast only on a part of the moon, it is a partial lunar eclipse. You can watch a lunar eclipse with the naked eye. A lunar eclipse can be seen over a period of a few hours.

Note : For more information refer to the lesson 'The Sun, the Moon and the Earth' in the Geography textbook.



17.6 Eclipse

Do you know?

Eclipses often occur in the solar system. As seen from the earth, when a planet or a star passes behind the moon, that state is called a '**occultation**'. It is a common phenomenon that occurrs with the sun, the moon or other stars. For example, in 2016 the star called 'Rohini' was hidden behind the moon. After some time it came appeared on the other side of the moon. Did you see this occultation?

Find out.

1. Time periods of lunar and solar eclipse.
2. Various eclipses in the past and relevant interesting information about them.
3. Eclipses and transits which will occur in the near future.

Zero shadow day

The day on which the sun reaches exactly overhead is called the **zero shadow day**. On that day, at noon shadows completely disappear. This event can only be seen in the region between the Tropic of Cancer (23.5^0N) and the Tropic of Capricorn (23.5^0S). This event occurs in summer on different days in different places in this region.

Always remember –

An eclipse is a natural phenomenon. Many superstitions connected to eclipses are prevalent in the society. It is necessary that everyone makes efforts to rid the society of superstitious beliefs.

Think and discuss.

1. Discuss why it is not right to tie lemon-chilli to our car?
2. In our surroundings and in day-to-day life, we unknowingly believe in many such things. Is that right?

1. Fill in the blanks.

(a) When the beams from the headlights of a car fall on an object in the night, the shadows called ..... and ..... can be seen.

(b) During a lunar eclipse the shadow of the ..... falls on the ..... .

(c) During a solar eclipse the shadow of the ..... falls on the ..... .

(d) Various shades of colour are seen in the sky at sunrise and sunset due to ..... .

2. Give reasons.

(a) Space beyond the earth's atmosphere appears dark.

(b) We are able to read while sitting in the shade.

(c) We should not observe the solar eclipse with naked eyes.

3. Give some example of scattering of light that we come across in day-to-day life.

4. Why is the shadow of a bird flying high not seen on the earth?

5. Why is a penumbra not obtained from a point source?

6. Answer the following questions in your own words.

(a) What is meant by scattering of light?

(b) Does the shadow really vanish in the zero shadow condition?

(c) Will the laser beam be seen if it passes through a glass box which contains a lighted incense stick?

7. Discuss and write.

(a) Write a science based paragraph on 'What if the sun did not rise?'

(b) What efforts will you make to remove the misconceptions about eclipses?

(c) Various eclipses and the conditions during that period.

8. Explain the difference :

(a) Point sources and extended sources of light.

(b) Umbra and penumbra.

Project :

Obtain information about the special goggles used to watch a solar eclipse.

♦ ♦ ♦

18. Sound : Production of Sound

Let's recall.

Some events are given below. Put a tick mark '✓' in the box if you have experienced the event. If not, put a cross '✗' in the box.

1. Clapped your hands together. ☐
2. Played a musical instrument. ☐
3. Burst a fire cracker. ☐
4. Knocked on a closed door. ☐
5. Whistled using the cap of a pen. ☐
6. Placed your palm on a mobile that is ringing. ☐
7. Swung the clapper of the bell and the bell rang. ☐
8. A metal utensil fell down with a clatter. ☐
9. There was a thunderclap in the sky. ☐
10. Put your hand on a speaker which is producing sound. ☐

It is seen from the above examples that sound is generated due to a variety of events. In some examples, sound was generated due to the vibration of an object, for example, the bell, or the strings or diaphragm of a musical instrument; while in some examples like bursting a cracker, clapping, a lightning strike, vibrations are not actually felt. However, vibrations are produced in those cases as well. All these vibrations are imparted to the molecules in the air and sound is produced. You might have seen that, when a stone is thrown into the calm water of a lake, waves are generated and they reach up to the banks of the lake. Vibrations reach our ears through the air in a similar way and the sound is heard.

Use your brain power!

When a singer tunes the musical instruments before he starts singing, what exactly does he do? He ensures that the *tanpura* will produce the required notes, by adjusting the tension in its strings i.e. he 'tunes' the *tanpura*. A ***tabla*** player tunes the ***tabla*** by hammering the pegs to adjust the tension in the diaphragm of the ***tabla***. The harmonium accompanist finds out beforehand the key in which the singer will sing. To tune an instrument is to adjust how high or low the pitch of the notes produced will be. The pitch of a sound depends upon its frequency. In Indian music, the musical notes, ***Sa, Re, Ga, Ma, Pa, Dha, Ni,*** are of increasingly higher pitch. In scientific terms frequency is a measure of pitch.

You have learnt how sound is generated, how it reaches us on travelling through some medium and is heard by us. You have also seen that vibration of an object is necessary for generation of sound.

In the present lesson we will learn more about vibration, pitch, intensity and level of sound.

When the string of a musical instrument such as a *tanpura* is plucked, the string can be seen to vibrate but the two ends of the vibrating string are still. As it vibrates, the string moves to one side of the central position and comes back to the central position. This motion of the string is repeated again and again at fixed intervals of time. Such motion is called periodic motion.

18.1 Tuning the instruments

Always remember –

Sound is generated by the rhythmic vibration of an object. We can hear the sound as long as the object vibrates. But, when we touch the vibrating object with our hand, the vibrations stop and we no longer hear the sound. Sometimes we can see the vibrations, but sometimes, the vibrations are so minute that we cannot see them with our eyes.

Try this.

Make a list of musical instruments you are familiar with. Find out which part of the instrument vibrates and produces the sound.

Such vibrations, that produce sound, can be studied with the help of a simple 'oscillator'.

Oscillator, oscillation and oscillatory motion

You must have seen children playing on a swing in a garden. Observe carefully the motion of the swing. Go to a swing at rest in a garden and mark its position on the ground below it. You can call this mark the central position of the swing. Now pull the swing to one side and let it go. Observe how it swings.

The swing will be seen to cross the central position again and again as it moves from one end to the other of its swing.

A swing that moves back and forth like this, is an **oscillator**. When the swing moves from one end to the other and returns to its starting point, it is said to have completed one **oscillation**. The back and forth motion of an oscillator on either side of a central position is called oscillatory motion.

Take an empty porcelain bowl or an empty steel glass. Stretch a rubber band and fix it on the bowl or glass as shown in the picture. Now give a jerk to the rubber band. Repeat this action applying a smaller or greater force. While doing this, observe the farthest distance to which the rubber band is stretched. Take note of the sound generated.

When the rubber band is stretched and released it vibrates. Compare the vibrations with the figure alongside. When the rubber is stretched from the original position A and comes to position B, it is seen to be curved. The maximum distance between the original position A and the position B on stretching the rubber, is called the **amplitude** of vibration.

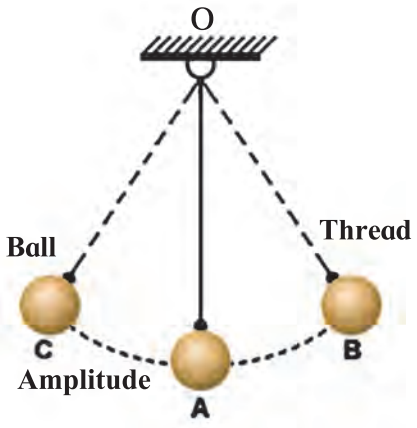
When a greater force is applied to the rubber, it is stretched further, meaning that the amplitude increases. On releasing it, a louder sound is generated. When a smaller force is applied, the rubber is stretched less. Then the amplitude is smaller and the sound is softer, too.

Take a strong thread, about half a meter long. Tie a small iron or wooden ball to it and suspend it from a support as shown in the figure. Such an oscillator is called a pendulum.

Give an oscillatory motion to the pendulum. The maximum distance between the original positions A of the pendulum and the extreme position B or C is called the amplitude of oscillation. In the figure, AB or AC is the amplitude of oscillation.

18.1 Oscillation of a swing

A rubber band stretched over a porcelain bowl



18.2 Oscillatory motion and amplitude

Do you know?

1. A stretched rubber returns to its original state when it is released. This property is called elasticity.
2. When a stretched rubber band vibrates, elasticity is at work.
3. All the while that the pendulum oscillates, earth's gravitation is at work.

Time period of oscillation and frequency

The time required by an oscillator to complete one oscillation is called the time period of the oscillator. In the previous activity, the oscillator traverses the distance from the extreme position B to central position A and from there to the position C, then back again to A and from A to B. The time required by the oscillator to traverse this distance B-A-C-A-B, is the time period of oscillation (T) of the oscillator. The number of oscillations completed by an oscillator in one second is called the frequency of oscillation.

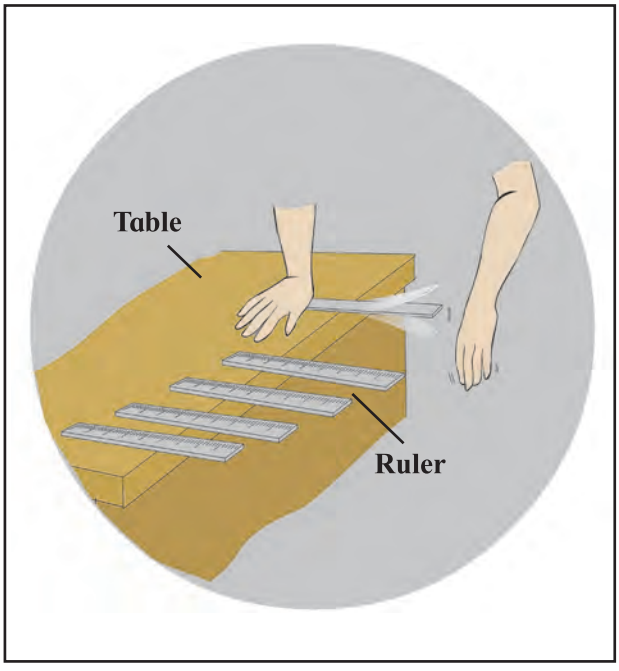
The total motion B-A-C-A-B in the previous activity is one oscillation.

$$\text{Frequency (n)} = \frac{1}{\text{time period of oscillation (T)}} = \frac{1}{T}$$

Frequency is the number of oscillations occurring in one second. The unit of frequency is Hertz (Hz). 1 Hz means there is one oscillation in one second; 100 Hz means hundred oscillations in one second.

Try this.

Take a plastic ruler and hold one of its ends pressed down on the table, as shown in the picture, so that a large portion of the ruler is off the table. Now ask your friend to press the free end of the ruler down and release it. Observe what happens. Now press the ruler with your finger at such a point that it stops making any sound. Now pull in 10 cm more of the ruler onto the table and repeat the action. Listen to the difference in the first and the second sound. Take note of the difference in the frequency and pitch of the sounds. Also, take note of what happens by further decreasing the length of the free part of the ruler little by little.



18.3 Vibration of the ruler and the sound produced

Use your brain power!

1. Will a sound be generated no matter how the ruler is kept on the table?
2. Is there any correlation between the length of the free part of the ruler and the sound generated?
3. If the ruler is plucked while it is held with 25 cm of it off the table, does it make any sound? If there is no sound, look for the reason why it is so.

Try this.

Take a strong thread of sufficient length. Tie a wooden or metal bob to one of its ends to make a pendulum. Measure the length of the thread in centimetres and make a note of it. Suspend the pendulum freely from a support. Now swing the pendulum and with the help of a stop-watch record how many seconds are required for 20 oscillations. Repeat this procedure 4 or 5 times, decreasing the length of the pendulum by 10 cm every time. Record your observations in the following table. Deduce the time period of oscillation and the frequency of the pendulum by making use of the given formula.

S.No.	Length of the oscillator (in cm)	Time required for 20 oscillations, t (in seconds)	Time period of oscillation T = t/20 sec	Frequency n(Hz) =1/T (Hz)
1. 2. 3. 4. 5. 6.				

1. What can we infer from these observations?
2. What is the relationship between the frequency and the length of the pendulum?
3. Explain what is meant by low frequency and high frequency?

Now keep the length of the pendulum fixed at 30 cm but, varying the amplitude, measure the time required for 20 oscillations, in each instance. Deduce the time period of oscillation and frequency of the pendulum in each case. Use the following table for this purpose.

S. No.	Length of the pendulum in cm	Amplitude	Time required for 20 oscillations, t (in seconds)	Time period of oscillation T (s)	Frequency n (Hz)
1.	30	small			
2.	30	a little larger			
3.	30	larger			
4.	30	even larger			
5.	30	very large			

The time period of oscillation (T) depends on the length of the pendulum. The time period of oscillation increases if the length of the pendulum is increased.

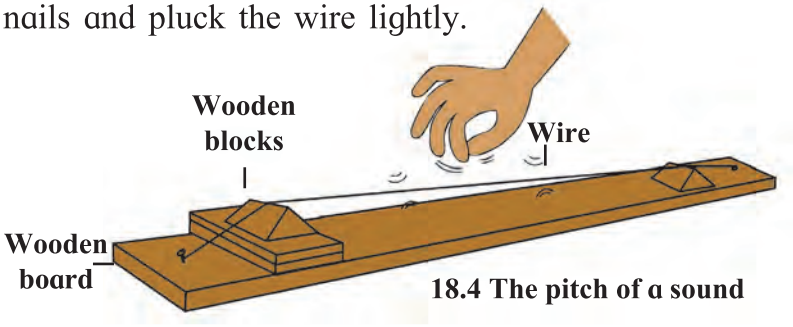
The frequency remains the same even if the amplitude decreases or increases.

High and low pitch of sound

Try this.

Take a wooden board, 80 to 90 cm long and 5 cm wide. Hammer two nails into it, each a few centimeters away from its two ends. Tie the ends of a thin metal wire to the nails so that the wire is stretched tightly between them. Insert a wedge-shaped wooden or plastic block under the wire near each of the nails and pluck the wire lightly.

Did you hear any sound? Observe whether the wire vibrates. Now insert two or three small rectangular blocks below the wedge-shaped block on one side in such a way that the length of the wire does not change. Observe whether there is any change in the tension in the wire. Now pluck the wire with your finger and listen to the sound. Also watch its vibration. Note the difference you perceive in its frequency. What can you infer from this? When tension in the wire is increased, the frequency is seen to increase and when it is reduced, frequency is also seen to decrease. We also perceive a difference in the sounds generated. When the tension is increased the resulting sound is shriller. When the tension is reduced the sound is also less shrill. This is what is called the high and low pitch of sound.



18.4 The pitch of a sound

1. Which of the sounds, the roar of a lion or the hum of a mosquito has the higher pitch?
2. What structures in the sitar help to produce higher or lower pitched sounds?

Intensity of sound – sound level

Loudness or softness of sound is indicated by two terms, namely, intensity of sound and sound level. Sound level is the intensity of sound as perceived by our ears. The intensity of sound is proportional to the square of the amplitude of vibration. For example, if the amplitude is doubled the intensity of sound becomes four times as much.

The **decibel** (dB) is the unit for measuring sound level. It was named decibel in honour of the work of the scientist Alexander Graham Bell. The magnitude of sound level, 'decibels' can be deduced from the intensity of the sound using a mathematical formula. When intensity of sound becomes ten times the original, the sound level increases by 10dB.

Do you know?

Decibel levels of some common sounds

1. Begining of audible sound – 0 dB
2. Normal breathing – 10 dB
3. Murmuring from 5 metres away – 30 dB
4. Normal conversation (between two persons) – 60 dB
5. Heavy traffic – 70 dB
6. Ordinary factories – 80 dB
7. Jet engine – 130 dB
8. Start of ear-splitting sound – 120 dB

Hearing is temporarily affected by sounds of frequency greater than 1000 Hz and levels higher than 100 dB. This can result in temporary deafness. Workers who work near aeroplane engines experience this.

Use your brain power!

What would be the difference perceived between hearing only two pupils in the class talking to each other and all the children talking to one another at the same time?

Audible sound

The frequency of the sound audible to human beings is between 20Hz and 20,000 Hz. We can only hear sounds in this frequency range.

Infrasonic sound

Have you ever heard the sound of the movement of our hands or of the movement of leaves falling from a tree?

Try this.

Swing an oscillator which makes 3-4 oscillations in a second, and listen carefully for any sound it makes.

That the oscillator makes 3 to 4 oscillations in one second means that the frequency of the sound is 3 to 4 Hz. Humans cannot hear sounds of frequency less than 20 Hz.

In all the above examples, oscillations did take place, but no sound was heard. It means that this sound is of a frequency less than 20 Hz. A sound with a frequency less than 20 Hz is called infrasonic sound. Sounds with a frequency less than 20 Hz are produced by some animals, namely, whales, elephants and rhinoceros.

Ultrasonic sound

A sound with a frequency higher than 20,000 Hz is called ultrasonic sound. Human beings cannot hear such sounds. However, some animals, for example, a dog, can hear such sounds.

Find out.

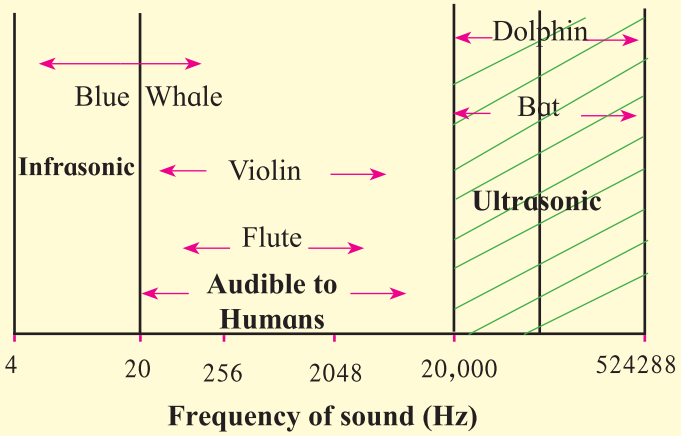
There is evidence that elephants communicate with each other over distances of up to 10 km using infrasonic sound inaudible to us. It is also believed that dogs and other animals can receive ultrasonic sound signals in advance of an impending earthquake. Find out more about this from the internet.

Uses of ultrasonic sound

1. To clean delicate ornaments and the tiny parts of a watch.
2. To observe internal organs of the body.
3. To detect tumours in the brain.
4. To detect faults in a metal.
5. In RADAR systems.
6. To kill certain microbes and insects.
7. SONAR (Sound Navigation And Ranging) is used to locate the seabed or the position of a ship.

Do you know?

The pitch of sound is directly related to the frequency of sound. From the graph alongside we get further information about the frequency of sound and infrasonic, audible and ultrasonic sound.



Exercise

1. Fill in the blanks.

(a) Sound is generated by the rhythmic …….. of any object.

(b) The frequency of sound is measured in …… .

(c) If …… of sound is decreased, its loudness also decreases.

(d) A medium is necessary for …… of sound.

2. Match the pairs.

Group 'A'	Group 'B'
(a) Flute	(1) Frequency less than 20 Hz
(b) Frequency	(2) Frequency more than 20000 Hz
(c) Sound level	(3) Vibrations in the air
(d) Ultrasonic sound	(4) Measured in Hz
(e) Infrasonic sound	(5) Decibel

3. Give scientific reasons.

(a) In earlier times, people used to listen for the arrival of a distant train by putting their ear to the rail.

(b) The sounds generated by a *tabla* and a *sitar* are different.

(c) If you were both on the moon, your friend will not be able to hear you call.

(d) We can hear the movement of a mosquito's wings but we cannot hear the movement of our hands.

4. Write answers to the following questions.

(a) How is sound produced?

(b) What does the intensity of sound depend upon?

(c) Explain how the frequency of oscillation is related to the length of a pendulum and the amplitude of its oscillation.

(d) Explain the two ways by which the pitch of the sound generated by a stretched string can be changed.

Project :

The bat, a mammal, flies during the night manoeuvering with the help of the ultrasonic sounds it produces. Find out more about this.

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