- Place the funnel in the beaker. Slowly pour the soaked seeds and water into the funnel. The water will pass through the tissue paper and drip into the beaker, leaving the seeds on the tissue paper.

Fig. 1.9 Cut a bottle to make a funnel and a beaker. Cut a circle shape from the tissue papers. Fold them in half twice. Then open out the shape to form a cone. This cone placed in a funnel will filter out solids from liquids.

DO & DISCOVER

- Let us make a simple circuit. A circuit is a path through which electricity flows. Remove the covering from the ends of a wire to expose the metal wire inside. If you have a torch bulb, wrap the metal wire tightly around its metallic part. Then, stand the bulb on the cell's positive terminal. Hold the wire and the bulb in place with the help of a rubber band, as shown. Put the other end of the wire under a cell's lower terminal. This completes the circuit with the bulb, cell and wire, which makes the bulb glow. Do this with an LED, keeping the polarity right.
- Now let us see how switches work. Tape the shorter leg of an LED to the negative terminal of a button cell. Slightly bend the longer leg of the LED so that it does not touch the positive terminal. The LED will glow each time you press this leg to the terminal. This works like a bell push switch. A switch works by completing a path for electricity to flow. We will use this simple method later in an activity.

Fig. 1.10 On the left: Simple circuits. On the right: A button cell standing on a magnet, with the shorter leg of an LED taped to the negative terminal. The LED lights up when the bent leg touches the positive terminal.

We will learn about all this and more in our science course. Have fun while you learn!

Compounds

A compound is formed when two or more elements combine chemically.

The properties of a compound are very different from the elements that make it. For example, water is a compound made of hydrogen and oxygen. Both hydrogen and oxygen are gases, but water is a liquid.

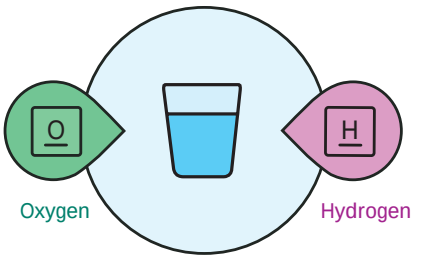


Fig. 2.4 Oxygen and hydrogen combine to form water.

Impure substances

An impure substance, or mixture, contains two or more substances mixed together in any amount. Mixtures can be of elements, compounds or both. The pure substances that make up the mixture are called the components of the mixture.

A mixture can be of two types—homogeneous and heterogeneous. We will learn more about these in a later chapter.

Info Flash

Building Blocks of Matter

All matter is made up of tiny particles that can exist on their own. These can be molecules or even smaller particles called atoms.

Some pure substances, like gold and silver, are made up of atoms and do not form molecules.

An atom is the smallest part of an element that keeps all its properties. Atoms usually do not exist on their own. Imagine breaking a piece of gold into smaller and smaller pieces. The smallest piece of gold you can get, which cannot be divided further without losing its properties, is a single atom of gold. Atoms of one element are different from atoms of other elements.

Fig. 2.5 Atoms are so small that millions of them fit into a tiny speck of matter such as the tip of the pencil.

A molecule is the smallest part of an element or a compound that can exist independently.

When atoms join together, they form molecules. A molecule can have atoms of the same kind or different kinds.

For example, a molecule of oxygen is made of two oxygen atoms. But a molecule of water is made of two hydrogen atoms and one oxygen atom. Similarly, one carbon atom can combine with two oxygen atoms to form a molecule of carbon dioxide.

What is inside an atom?

An atom is made up of even smaller particles called electrons, protons and neutrons. These are known as subatomic particles.

Some of these particles have a property called electric charge. There are two types of charges—positive and negative. Particles with the same charge push each other away, while particles with opposite charges pull each other closer.

Electrons have a negative charge, protons have a positive charge and neutrons have no charge. The negative charge of the electrons balances the positive charge of the protons, making the atom neutral.

For example, a carbon atom has six protons and six electrons. The positive and negative charges cancel each other out, so the atom has no overall charge.

Common SI prefixes and examples

Prefix and symbol	Meaning	Examples
kilo (k)	1000 times bigger (× 1000)	1 km = 1 m × 1000 = 1000 m 1 kg = 1000 g We measure distances between towns in km and length of cloth in metres.
milli (m)	1000 times smaller (÷ 1000)	1 mm = 1 m ÷ 1000 = 0.001 m 1 g = 1000 mg Width of 10–15 sheets of paper = 1 mm. The thickness of a coin can be about 1–2 mm.
centi (c)	100 times smaller (÷ 100)	1 cm = 1 m ÷ 100 = 0.01 m Shirt buttons measure around 1 cm.

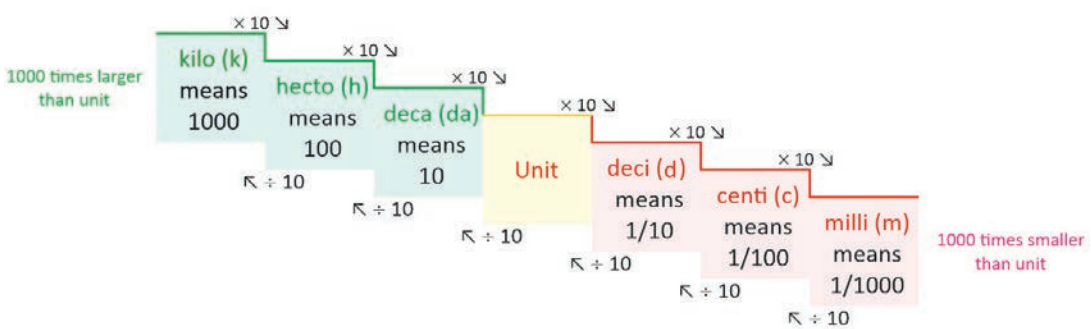


Fig. 3.5 From milli to kilo, each prefix means 10 times more than the previous one. From kilo to milli, each prefix means 10 times less (1/10). The mnemonic above will help you remember the prefixes in order.

Expressing measurements correctly

There are simple rules for writing unit names and symbols correctly.

- Unit names and symbols are usually in lowercase. Examples: metre, m; gram, g. The symbol for the litre can be L or l. We prefer L, as l can be mistaken for the number one or capital 'I'.
- Put a space between the number and the unit's name or symbol.
- Do not put a space between the prefix and the base unit. For example, write cm and mL instead of c m and m L.
- Do not add anything, including s for plural after the symbols of units. For example, 3 kg and 2 grams, 12 m or 12 metres, but not 5 kgs or 2 gms or 2 g or 12 ms.

  ★'ms' stands for milliseconds, not metres.

SCIENCE SUPERHEROES

Sir Isaac Newton loved finding out how things worked. He described gravitation, the laws of motion and the forces we discussed earlier. A popular story says an apple fell on his head and taught him about gravity. He would have been amused because it is not true. He also studied light and showed that white light splits into a rainbow of colours. His ideas help us understand the universe. They are still very important in science.

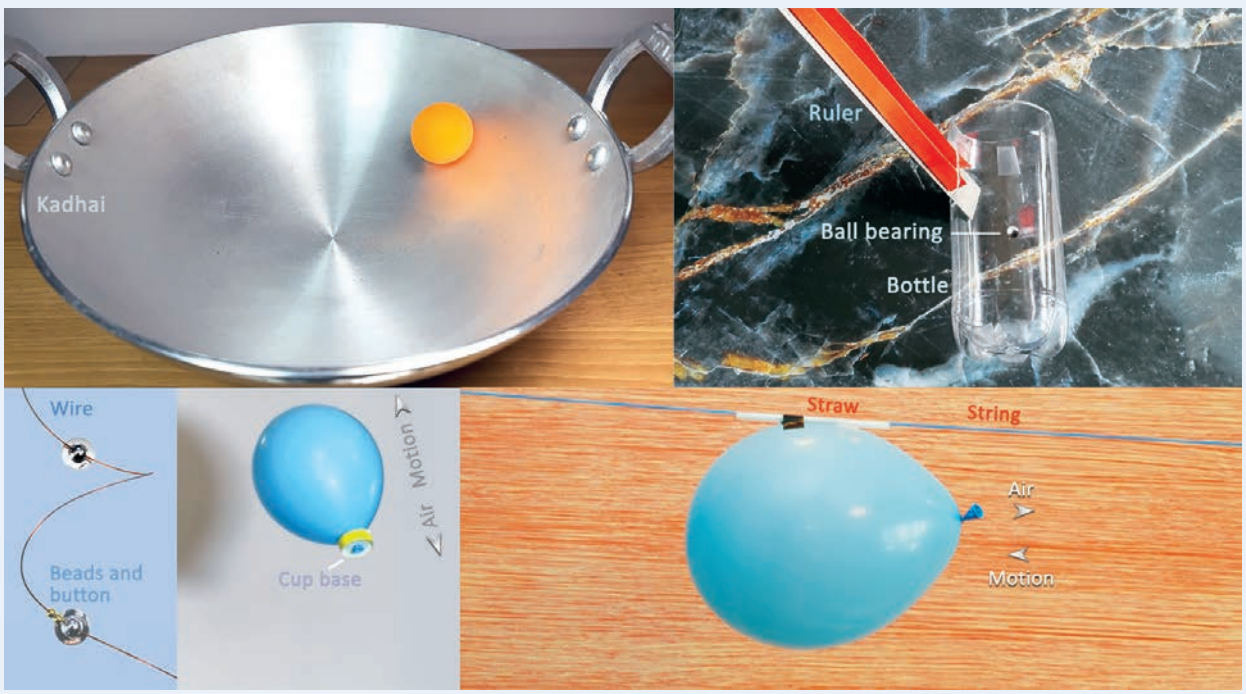
Galileo Galilei was born in 1564 in Pisa, Italy. He built his own telescope and saw four of Jupiter's moons. He watched a swinging lamp in a cathedral. He found each swing took the same time by timing it against his pulse. His work led to the pendulum clock.

SCIENCE ACTION!

Let us do some more fun activities to understand different kinds of motion. Record them in slow motion on a phone to watch later. We will also learn some fun things about forces.

- Twist a wire around a cylindrical bottle to form a spiral. Let beads, rings, or buttons spiral down the wire held vertically. Their motion is curvilinear.
- Roll a small ball inside a gently sloping bowl or *kadhai*. Its motion will be curvilinear.
- Build a loop track using the wall of a plastic bottle. Cut a window wide enough for a ruler and a small bead. Set the ruler on the inner surface of the bottle at a slight angle. Lift its other end to form a slope. Let a bead or ball bearing roll down the ruler. It will loop around several times. (Linear and curvilinear motions).
- Blow up a balloon and let it go. It moves wildly as air escapes. To direct the air, attach the balloon's mouth to a straw. Or pass it through a hole in a paper cup. If you let go with the mouth downwards, it rises like a rocket. On the floor, it moves opposite to the mouth.

  Tape an inflated balloon to a straw on a string stretched across the room. The balloon will zoom along the string like a jet. In each case, the escaping air pushes back the balloon, moving it.



Some animals are very small. For example, ants are tiny insects. They are so small that we can hardly see them. Bees are small too. They fly from flower to flower.

A line of black ants

Animals have different shapes. Hedgehogs are round and spiky, whereas snakes are long and slim. Giraffes have long necks, helping them reach high leaves, while turtles stay close to the ground. Fish have a smooth, slim body. This helps them swim in water. Snails and turtles have a shell on their back. The shell keeps them safe.

Snake

Snail

Hedgehog

Limbs and movement

Animals have different kinds of limbs like legs, arms and wings for movement.

Many animals have four legs. Dogs, cats, cows and lions have four legs. They use their legs to walk and run.

Birds also have two legs and two wings. They use their wings to fly. Some birds, like penguins, ostriches and emus, cannot fly. Penguins use their wings, called flippers, to swim. Ostriches and emus can run very fast on their strong legs. They use their wings for balance while running. Some birds, like ducks and swans, swim and fly as well.

Some animals like centipedes and millipedes have many legs. Insects have six legs, while spiders have eight legs. Some insects have wings and can fly.

Some animals have no legs, such as snakes and earthworms. They slither and crawl on the ground. Fish have fins that help them swim.

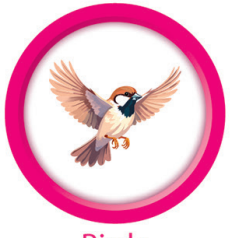
Fig. 7.1 Ostriches are the tallest birds in the world.

Fig. 7.2 Humboldt penguins live in South America.

Animals

VERTEBRATES (WITH BACKBONE)

WARM-BLOODED



Birds

Mammals

COLD-BLOODED

Fish

Amphibians

Reptiles

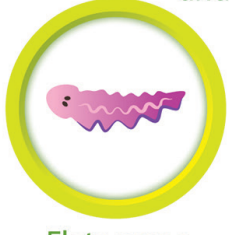
INVERTEBRATES (NO BACKBONE)

Sponges

Jellyfish, sea anemones and corals

Segmented worms

Molluscs

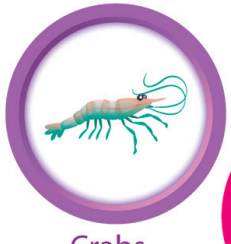


Flatworms

Roundworms

Starfish, sea urchins and sea cucumbers

Arthropods



Crabs, shrimps and lobsters

Spiders and scorpions

Insects

Millipedes and centipedes

Vertebrate Comes from a Latin word meaning ‘joint’ or ‘spinal joint’.

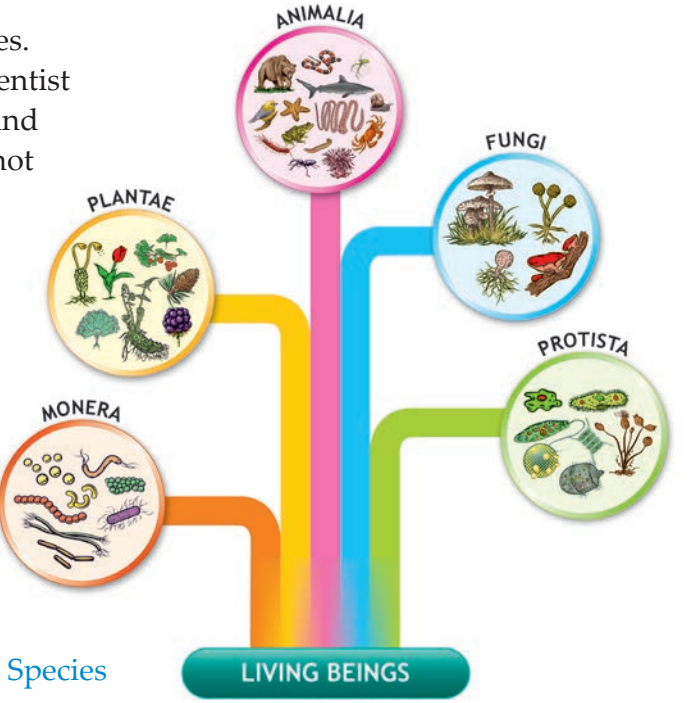
Pod From Greek *pous*, meaning ‘foot’. Arthropod (*arthro* in Greek means ‘joint’) means ‘jointed foot’.

Pede From Latin *pes* (plural *pedes*), also meaning ‘foot’. Millipede means ‘thousand feet’ (*mille* in Latin means ‘thousand’). Centipede means ‘hundred feet’ (*centum* in Latin means ‘hundred’). But millipedes and centipedes do not have that many feet.

More on Classification

Scientists group living beings by their common features. The largest groups are called kingdoms. Long ago, scientist grouped creatures under just two kingdoms—plants and animals. But scientists found tiny organisms that did not fit in either kingdom. So, they made five kingdoms.

- Monera includes tiny unicellular organisms like bacteria.
- Protista has other unicellular organisms like Amoeba.
- Fungi includes mushrooms and yeast.
- Plantae is the plant kingdom.
- Animalia is the animal kingdom.



Each kingdom is divided into smaller groups.

Phylum → Class → Order → Family → Genus → Species

Carolus Linnaeus

To name living beings clearly, Carolus Linnaeus, a Swedish botanist (someone who studies plants), started a two-name system in the 18th century. This is called binomial nomenclature.

Each organism gets a scientific name with two parts—its genus and its species. For example, humans are *Homo sapiens*. *Homo* is the genus, and *sapiens* is the species. The genus name starts with a capital letter. The species name starts with a small letter. If you write these names by hand, you should underline them. In books, like this one, they are printed in italics (slanting letters).

Species is the smallest group. It includes living beings that can have babies together. For example, all dogs are one species. They may look different but can still have puppies. A dog and a cat cannot have babies. They are not the same species.

Genus is a bigger group. It includes species that are very similar. For example, onion and garlic are from the same genus, *Allium*. Onion is *Allium cepa*. Garlic is *Allium sativa*.

A poodle and a spaniel are of the same species but different breeds of dogs.

Fig. 8.19 Aurora borealis (northern lights). Here, it appears as curtains of lights.

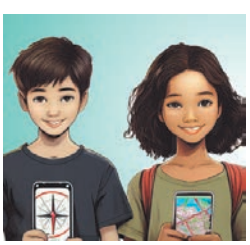
Auroras Near the polar regions, you see beautiful displays of light up in the sky. These are the northern lights and the southern lights (aurora borealis and aurora australis). The earth's magnetism causes these. Charged particles from the sun get trapped by the earth-magnet and are guided towards the poles. When they hit the atmosphere, they create those amazing light shows. Some days it may be just a glow, on the other as a curtain of light.

Animal magnetism Did you know that many animals, including birds, bees and even turtles, have a sense of magnetism? They use the earth's magnetism to help them navigate during migrations around the world or find their way around. It is like having a built-in compass!

Magnetism in space The strongest magnets in the universe are stars called magnetars. These are incredibly dense stars with magnetic fields billions of times stronger than anything we can create on the earth. If a magnetar were as close to us as the moon, it could wipe the data off all ATM cards, credit cards, etc. Luckily, they are very far away!

KNOWLEDGE BOOSTER

Risks from magnets We have discussed safe ways to store magnets and what can damage them. But do magnets pose risks? Yes, they do. Problems happen only if they are very strong, like neodymium magnets and not with ordinary magnets like fridge magnets.



- Modern gadgets like phones and tablets have an electronic device called a magnetometer. It senses the earth's magnetism, which compass software uses to find directions. The directions are used in things like map apps. A strong magnet can fool a magnetometer, but the effect ends when you move away.

The Water Cycle

Water is important for homes, farming and industries. Even though we use a lot of it, the amount of water on the earth stays the same because of the water cycle. This is a continuous process that circulates water from the earth to the atmosphere and back again.

The sun heats water in oceans, rivers, lakes and ponds. The water evaporates, changing into water vapour. The air containing this vapour is warmed by the sun and rises because hot air is lighter. When water vapour rises, it cools and turns into tiny water droplets. These droplets come together to form clouds. As more droplets combine, they grow heavier and fall to the ground as rain. This is called precipitation.

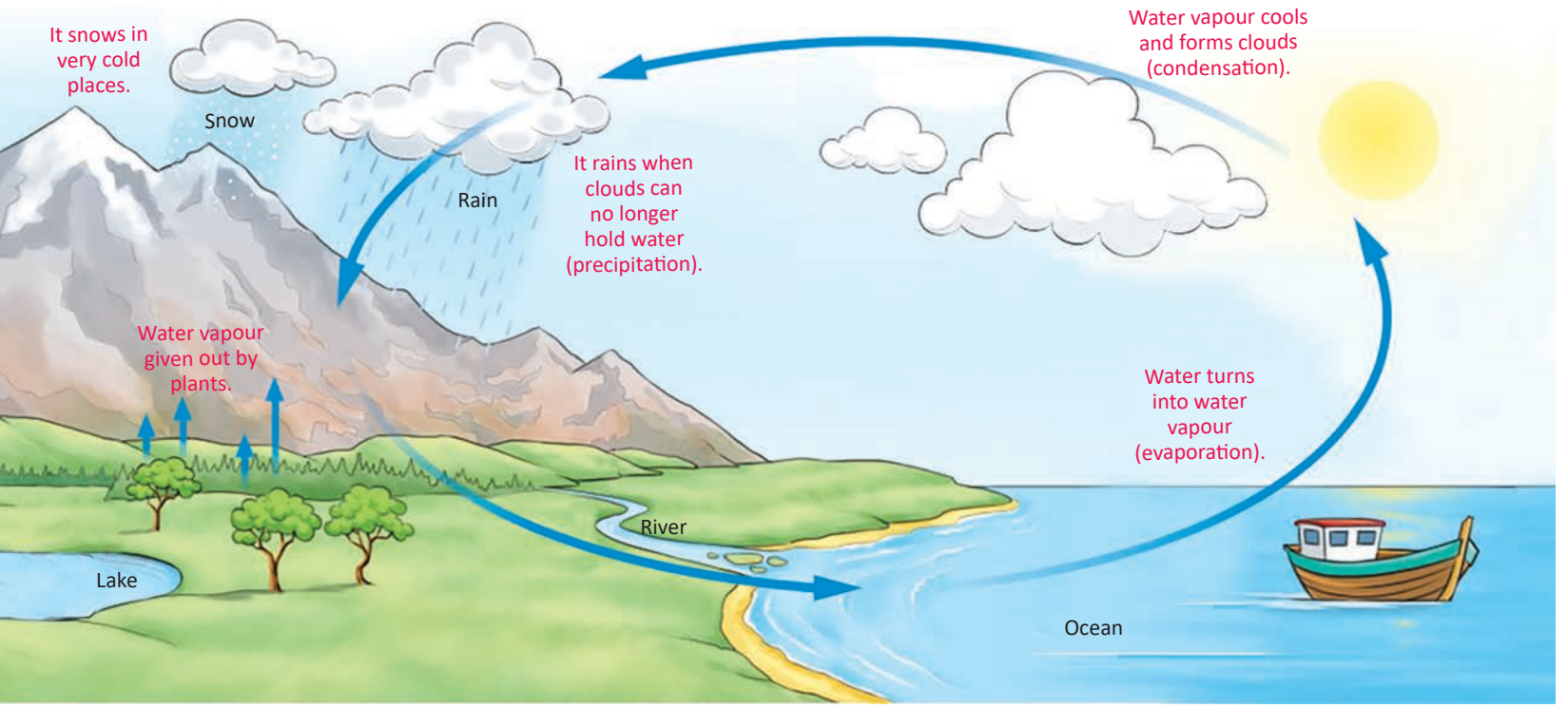


Fig. 12.13 The water cycle

In very high clouds, the water can freeze into tiny ice crystals and fall as snow. During thunderstorms, strong winds carry raindrops into very cold parts of the cloud. The drops freeze into hard ice pellets, grow bigger and fall as hailstones. Snow usually falls in winter, but hail can occur anytime, especially in spring and summer.

On cold nights, water vapour cools and forms tiny droplets on surfaces outside. This is called dew. You might see it on the grass or on cars in the morning. Dew evaporates as the day gets warmer.

After it rains, the water flows into rivers, lakes and oceans. Some water seeps underground and becomes groundwater. Snow stays frozen until the weather warms up. When snow melts, the water either seeps into the ground or flows into rivers and oceans.

- Animals get energy by eating plants or other animals. So, the sun's energy flows through all living beings in a chain.
- The sun also drives the water cycle. It heats water in oceans, lakes and rivers, turning it into vapour that forms clouds. This eventually brings rain, which supports life.

Solar energy

The sun's energy can also be used to generate electricity. This is called solar energy. It is clean, renewable and sustainable (able to last a long time). Solar panels capture sunlight and turn it into electricity. We can use this power in many ways.

- It can power lights, fans and other appliances.
- Solar water heaters use sunlight to warm water for bathing, washing or cooking.
- In factories, solar energy can power machines. This reduces the need for electricity generated from coal or oil.

Fig. 14.9 Mahoba solar power plant, UP

In remote villages or deserts, solar panels can power schools, hospitals and homes. For example, solar lamps light up rural areas after dark.

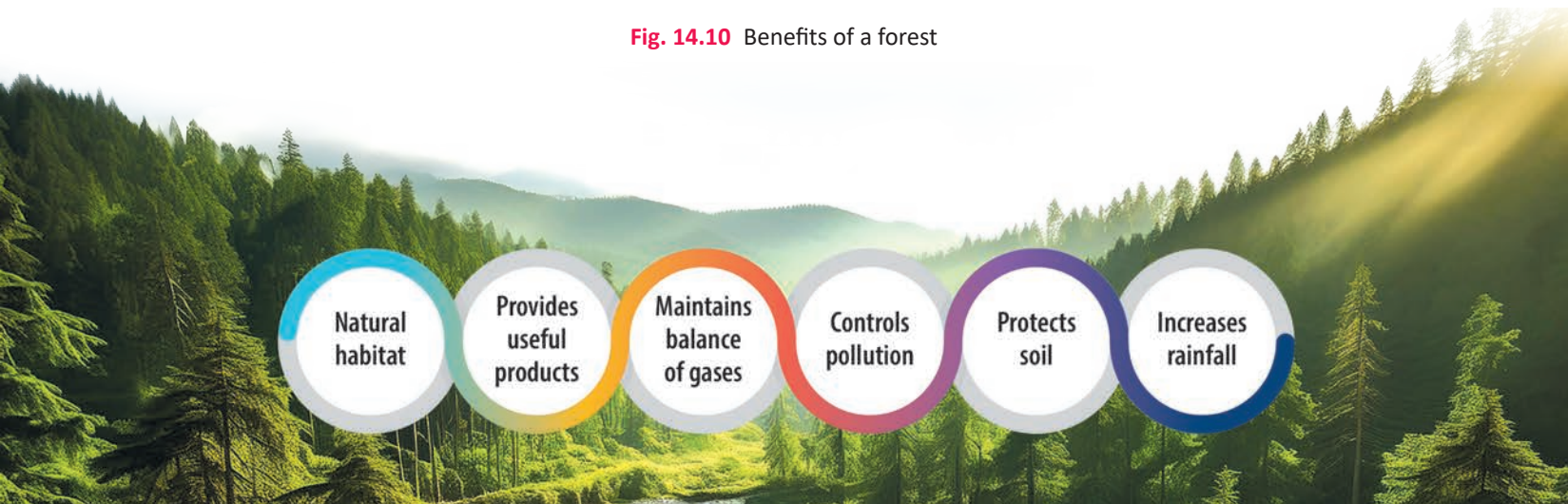
Solar energy is also used in large-scale solar farms. These farms have thousands of solar panels that generate electricity for cities and industries. One such example is the Bhadla Solar Park in Rajasthan, one of the largest solar farms in the world.

Forests

Forests are large areas full of trees and plants. They help keep our environment balanced. Let us see some ways forests help us.

1. **Natural habitat** Forests are home to many animals like tigers, elephants, monkeys and birds. These animals live and find food among the trees and bushes.

Fig. 14.10 Benefits of a forest



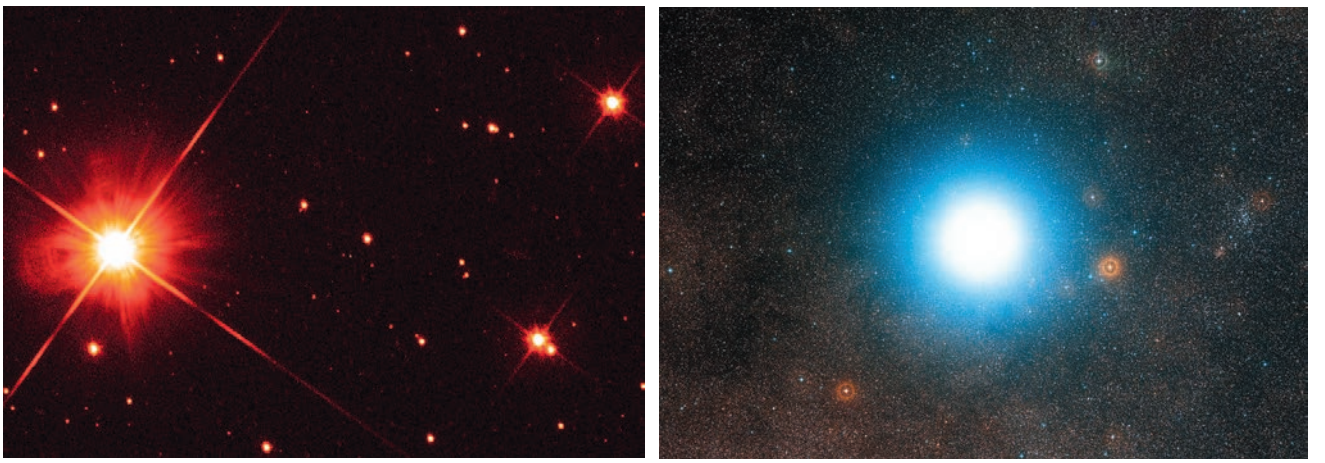


Fig. 15.2 On the left: Image of Proxima Centauri taken from the Hubble Space Telescope. On the right: Image of Alpha Centauri, the closest star system to our Solar System.

Galaxy

The universe has trillions of stars, but they are not spread out evenly. Instead, stars gather together in huge groups called galaxies.

A galaxy is like a big family of stars, gas and dust that move together through space.

A galaxy can have millions or even billions of stars!

Our galaxy is called the Milky Way. In India, it is called the Akashganga. On a dark and clear night, you might see a faint, milky band of light stretching across the sky. This band is the Milky Way. The light comes from many stars so far away that we cannot see them individually. Together, they look like a whitish band.

The galaxy closest to ours is the Andromeda Galaxy, which is about 2.5 million light years away from the earth.

A light year is the distance light travels in a year.

Fig. 15.3 The Milky Way, our home galaxy, is a spiral galaxy. Its stars orbit the centre in a spiral pattern.

Info Flash

At the centre of the Milky Way Galaxy, there is a supermassive black hole called ***Sagittarius A***. It has a mass equal to about four million suns! A black hole is a special place in space where gravity is so strong that it pulls in anything that comes too close. Once something is pulled in, it cannot escape—not even light. This is why black holes look completely dark.

KNOWLEDGE BOOSTER

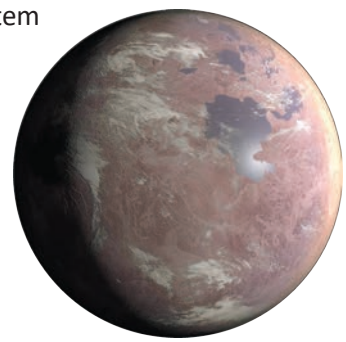
Dwarf planets They are small celestial bodies that are similar to planets but not quite the same. Like planets, dwarf planets are nearly round and move around the sun in an orbit. However, they are not large enough to clear other objects from their path.

A well-known dwarf planet is Pluto. It was considered the ninth planet in the solar system for many years. But in 2006, the IAU reclassified it as a dwarf planet. Other dwarf planets include Ceres, Eris, Haumea and Makemake.

A composite image showing the five dwarf planets

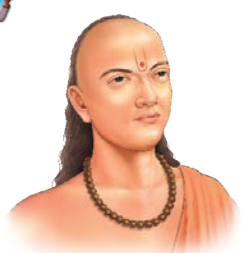
Exoplanets Planets that exist outside our solar system are called exoplanets. Most exoplanets orbit other stars, just like planets in our solar system orbit the sun. But some, known as rogue planets, float freely in space. Scientists have discovered over 5,000 exoplanets so far.

Exoplanets vary in size. Some are rocky like the earth, while others are gas giants like Jupiter. The closest known exoplanets are Proxima b, Proxima c and Proxima d. They all orbit in the habitable zone (the area around a star where liquid water and life may exist) of their star, Proxima Centauri. This makes them interesting for scientists studying the possibility of life beyond our solar system.



Kepler-1649c, an earthlike exoplanet

SCIENCE SUPERHEROES



Aryabhata I

Aryabhata I (476–550) Also known as Aryabhata the Elder, was an ancient Indian astronomer and mathematician. He is best known for his work, *Aryabhatiya*. He proposed that the earth revolves around the sun. This idea was revolutionary at the time and came nearly 1,000 years before a similar idea by Polish astronomer Copernicus. His calculations of planetary positions and eclipses were impressively accurate for his time. He also suggested that a solar day begins at midnight.

Nicolaus Copernicus

Nicolaus Copernicus (1473–1543) Widely considered the father of modern astronomy, he is best known for developing the heliocentric model of the universe. At that time, most scientists believed that the earth was at the centre of the universe. Copernicus's proposed a different idea: the sun, not the earth, is at the centre of the solar system and that the earth and the other planets orbit around the sun. This theory changed how we understand our place in the universe.