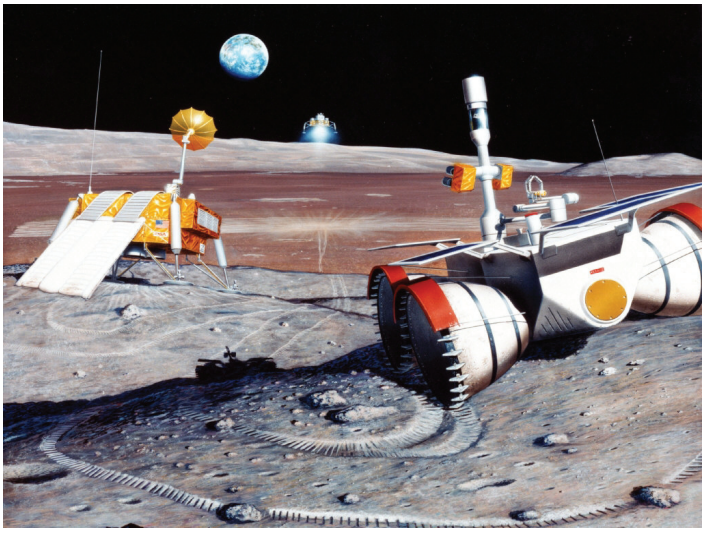
04 Nature of the earth and space



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

- investigate the components in the interior of the earth
- contribute to conserving the soil while maintaining its quality
- expand your knowledge about the solar system
- broaden your interest in space explorations.

The earth we live in was formed around 4.5 billion years ago. It is the only known planet which contains liquid water and life. On earth, there are waterfalls, mountains, rocks, plains, deserts, rivers, lakes and oceans. Fig 4.1 is a photograph of the earth which was taken from the moon.

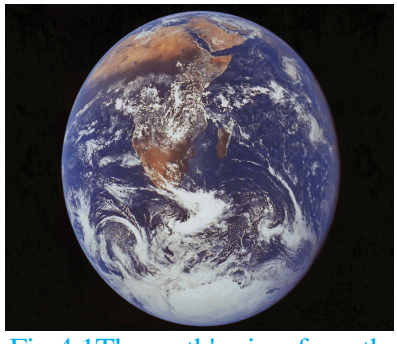


Fig.4.1The earth's view from the surface on the earth moon

As seen in Fig 4.1, the earth is spherical. Its surface is made up of solid rock, soil and minerals. Earth is made up of a series of concentric shells. Going from the surface to the center, the outermost layer is the **crust,** next the **mantle,** and finally the **core.**

4.1 Interior of the earth

Now let us go on a journey to the interior of the earth. Now we are ready to start our journey to the center of the earth. The journey is a very long one, going down to about 6378 kilometres. As we go down the temperature and pressure increases. Hence, we get very low air for breathing. Since we cannot bear up such conditions, we will have to be suitably equipped.

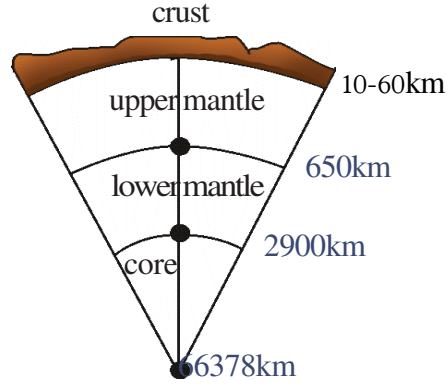


Fig 4.2 - Cross section of earth

First stop: Here we are at the outermost surface. It is called the crust. Crust is comparatively thin (Fig 4.2). Thickness of the crust varies from 10 to 60 km. but it is only 10 km underneath the oceans. If you imagine the earth as a large orange, the crust would be the size of its outer skin. The crust consists of hard rocks and soil. The major element which consists in crust is oxygen.Now let us hurry-up to the next stop, because we are on a very long journey.

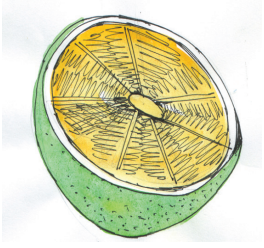


Fig 4.3 Section of an orange

Do you know?

- The highest place on earth is Mount Everest in India. It is about 8848 metres above sea level.
- The lowest place on earth is the Mariana Trench in the Pacific ocean. It plunges about 11,034 metres below sea level.

Second stop:

This stop is at a depth of about 650 km from the surface. This part is called the upper mantle. Like the crust this part is made up of solid rock.Here is the boundary of the lithosphere (crust and upper mantle together).This part consists of the tectonic plates. These plates can move in relation to one another like rafts.

Third stop:

We are now deep within the mantle, on the border of the mantle and the core. Temperature at the centre of the earth is estimated to be about 4800 ^{0}C. It is about 2900 km deep. Even though the upper mantle is dense (Fig. 4.3) the lower part is viscous. The heat and pressure here is unbearable. So let us hurry-up!

Fourth stop:

Now we are in the centre of the earth. From here to about 3478 km. upwards is called the core. About 80% of this part is made up of Iron and Nickel. Temperature at the centre of the earth is estimated to be about 4800 ^{0}C. It is about 6378 km back to the surface of the earth. It was a very long journey. Therefore let us get back directly to the surface of the earth.

4.1.1. Components of the Lithosphere

Lithosphere consists of the earths crust and the upper mantle. About 71% of the surface of the earth is covered with water, contained in the oceans, glaciers, rivers , lakes and other water bodies. This part is called the **hydrosphere**. The remaining part of about 29% of the earth is the continental surface. Lithosphere is made up of rock, minerals and soil.

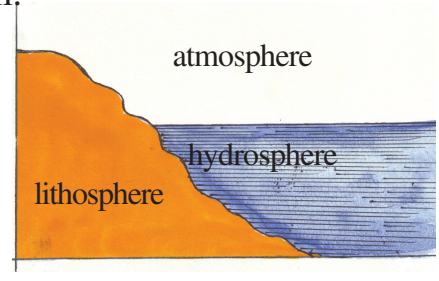


Fig 4.4 - Lithosphere, hydrosphere, atmosphere

Rock

The types of rock you see around is made up of one or more minerals.These minerals have taken a long time to form.

Manohari: - Today our teacher said that we can find three types of rock in our surroundings, namely **igneous rock**, **sedimentary rock** and **metamorphic rock**.

(a)

(b)

(c)

Fig 4.5 a) Igneous rock b) Sedimentary rock c) Metamorphic rock

Sirimal :- Yes. Let us see the pictures above. Fig (a) shows igneous rock. Granite is a component of this type of rock.

Manohari :- Fig (b) shows sedimentary rock and (c) shows metamorphic rock.

Sirimal :- Yes, sedimentary rock is not a hard rock like igneous rock. It is made up of layers and the layers may come off. Limestone is a kind of sedimentary rock. Metamorphic rock on the other hand is a very hard rock.

Manohari :- How are these rocks formed?

During volcanic activity, molten rock called magma comes to the surface. When it comes out it is called lava. This lava solidifies and forms igneous rock. Sedimentary rock is formed by pieces of rock, sand and various minerals settling down as layers over a long period of time. Metamorphic rock is made up of either igneous or sedimentary rock getting subjected to extremes of temperature and pressure over a long period of time.

Manohari :- Now I understand what a rock is. Thank you, Sirimal.

Minerals

Rocks are made up of minerals. Minerals are formed naturally by silicon and variuos inorganic elements and compounds getting arranged in a regular manner. Therefore they take a crystalline form. There are about 3000 types of minerals on earth. The most abundant of these are the minerals with silicates in them. Mica, feldspar, quartz are those containing silica while limestone belongs to the group which has no silicates. Minerals are used to prepare objects needed for our daily life as well as food and medicines. Sri Lanka is rich in minerals of which limestone and common salt takes an important place.

Soil

Soil is the topmost layer of the earth's crust. Soil is mostly silica along with certain other minerals.In addition it contains organic substances, air and water. Soil contributes a great deal for the survival of organisms.

Soil can be divided into several layers according to it's nature namely the top soil, sub soil and bed rock/ parent rock. (Fig 4.6)

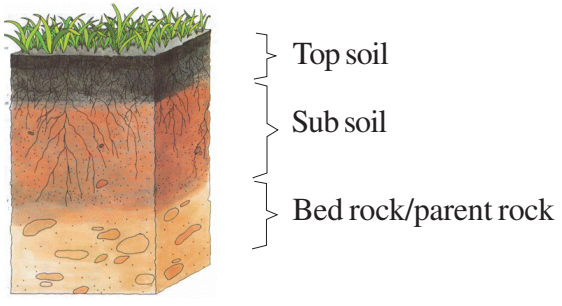


Fig. 4.6 - Soil profile

Top soil is rich in plant nutrients. So it is a good medium for plant growth. Sub soil is fairly sticky and hard. It acts as a store for water and minerals needed for plants. The lowest layer is the bed rock with broken pieces of rock and pebbles above it.

Assignment 4.1

- Collect pieces of rock around you. Try to classify them according to their nature.
- Collect information about the minerals of Sri Lanka. Make a study about the products made from them.

4.1.2. Uses of rock, minerals and soil

Rock - Different kinds of rock are used for constructing buildings, roads, decorate houses, and various artistic creations.
e.g. Granite, Limestone

Minerals - Some minerals are needed to make fertiliser. e.g. Apatite, Gypsum. Some minerals are needed to make pharmaceutical drugs. e.g. Sodium Sulphate. Some are needed to flavour food. e.g. Salt

Soil – Soil is used for growing food crops and other plants, building construction and as a raw material for making glass and ceramic tiles.

4.2 Using the soil productively

4.2.1 Types of soils

Soil is the outer surface of the earth's crust. Soil can be classified into three types based on the size of particles. Clay consists of the smallest particles. Sand is of medium size and gravel are formed of coarse particles. Soil is formed by the mixing of these three types in various percentages. According to the amount of each type in a particular soil, three kinds of soil can be identified.They are clayey soil, sandy soil and loamy soil. The three types of soil differ in their properties. All of the three types may be found in our environment in different amounts.

Let us see the properties and uses of each type .

Type of soil	Nature of soil	Properties of the soil	uses of soil
Clayey soil	Has more clay particles. Sticky.	Retains water well. Spaces between particles are small hence does not retain air.	Making of bricks, clay vessels and ceramic goods.
Sandy soil	Has more sand. Loose soil.	Water retention is low because spaces between soil particles are large. Not suitable for plant growth.	In building construction work.
Loamy soil	Mixture of sand, silt, and clay. Plenty of organic material(humus)	Humus retains sufficient air and water. Plenty of soil organisms and plant nutrients. Therefore soil is rich and suitable for plant growth.	Ideal for plant growth and agriculture.

Table 4.1 Types of soil

Activity 4.1

- Take a sample of soil from your environment.
- Observe it's properties.
- Take an empty jam bottle, add some water to it, add the soil.
- Stir and keep aside for some time. Now observe.
- List out your observations.
- Repeat the activity with soil samples from different places.

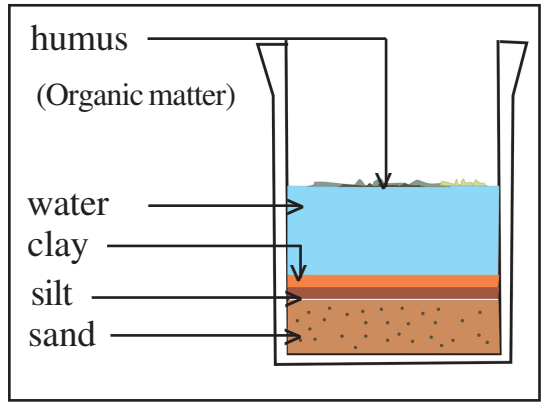


Fig. 4.7
separation of layers in a soil sample

Here you will be able to see the different layers (Fig 4.7). At the bottom you will see sand which is the heaviest. Above that will be silt and then clay. The organic part (humus) will float on the surface.

You already know that loamy soil is the best for agricultural activities. Sandy or clayey soil can be converted into an agricultural soil by adding the correct quantities of clay, sand and organic matter. Sand, silt and clay are the solid mineral particles in soil. Rather than that, there are organisms living inside the soil. They are soil organisms. In a good agricultural soil, sufficient amount of air and water should be there inside the soil pores.

4.2.2 Soil erosion

You have already learnt in Chapter 1.4, that soil erosion is shifting of top soil from its place of origin to another place by means of water or wind. Various human activities too help to speed up this process. Let us see the factors which effect soil erosion.

- Nature of the soil – If the soil is a very loose type the slightest rain would cause erosion.
- Nature of the land – If the land is a sloping land, the steeper the slope the more erosion there will be.
- Lack of plant cover – In cleared land, rain falls directly on to the soil and causes it to get washed away.
- Rain – If the speed of rain is fast, erosion may occur.
- Wind – Strong wind causes soil to get blown away causing erosion.

Fig 4.9 A site subjected to soil erosion

Similarly ocean waves cause erosion of the beaches and land gets washed away. This is speeded up by high tides and low tides of the sea. Human activities such as clearing up of forests, cutting down trees, building on mountain slopes etc, will accelerate the soil erosion.

Ill effects of soil erosion

- Soil erosion causes the surface soil to get washed away removing the fertility of the soil.
- Soil erosion brings about landslides , resulting in loss of lives and property.
- Soil erosion brings about instant floods by the filling up of river beds with the sand carried over.

Activity 4.2

- Collect information about the natural disasters of Sri Lanka. Classify them into those caused by human activity or natural causes.
- Discuss with your teacher about the ways of controlling them.

4.2.3 Soil conservation

Continous rain and excessive farming causes the soil to erode which brings about loss of fertility of the soil. Therefore in order to leave behind a fertile soil for future generations soil has to be conserved.

Some of the ways we can help to do this are: Preventing deforestation, creating new forests, planting trees and grass on mountain slopes, building stone hedges and cutting contour drains for the water to drain off, strengthening the edges of roads with wire mesh and growing trees as wind breaks.

We can enrich the depleted soil by adding compost to increase the fertility. This will help to retain water and air as well as promote the growth of soil organisms in the soil.

Use of chemical fertilizers and should be minimized to reduce acidity of the soil as well as prevent the destruction of soil organisms. Rotation of crops is another way to retain the fertility of the soil. Growing leguminous plants is a very good practice to improve soil fertility.

Assignment 4.3

Construct a model to show ways of preventing soil erosion along a slopy land.

4.3 Our solar system

When we observe the night sky there are innumerable numbers and types of celestial bodies in the sky. Among them will be objects that twinkle, some emit light but do not twinkle, some may move while some may be stationary.

In the past, people had many questions about these celestial bodies. Therefore, they observed the sky frequently and collected information about them.They produced new equipment for the purpose. Because of their efforts, we are now able to understand our position as well as that of the other celestial bodies in the solar system.

We know that the earth revolves round the sun.The other celestial bodies too revolve round the sun in their own orbits. These are all held in place by the gravitational force of the sun. This system is called the solar system.

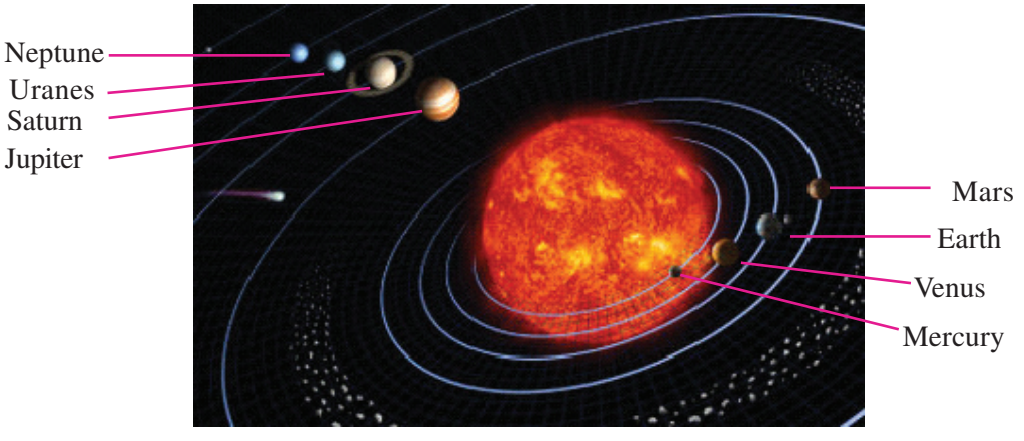


Fig 4.10 Our solar system

The solar system belongs to a galaxy called the milky way. Sun is situated at the center of the solar system. Revolving round the sun are eight planets, their satellites, several dwarf planets and their satellites and a large number of meteors, meteorites, comets, pieces of rock and dust.

4.3.1 Sun

Sun is a star, made up of mostly hydrogen and helium gases. The sun emits light energy and heat energy. Rays of the sun helps to support life on earth. It causes the seasonal and the weather changes on earth. The temperature near the surface of the sun is about 6000^0 degrees centigrade while at the centre it is estimated at around 15 million degrees Centigrade.

Do you know?

The time taken for the rays of the sun to reach the earth is 8 minutes and 18 seconds.

4.3.2 Planets and their satellites

Planets are large spherical bodies. Planets do not emit light but since they reflect light falling on them they shine.
Let us find out more about each of the planets.

Fig 4.10
Mercury

Mercury
Planet closest to the sun is mercury.(Fig 4.10) It has no atmosphere around it. Therefore, suns's rays fall on it without any obstruction. There is no evidence of life on mercury. It has no satellites.

Venus
The second planet from the sun is venus. You can see this planet at sunset and sunrise. Therefore, it was called the morning star or the evening star. It is little smaller than the earth. Since it is close to the earth, we can see it clearly.

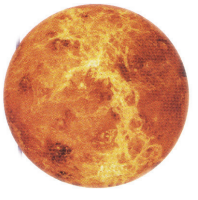


Fig 4.11
Venus

As it receives heat and light well, hence appear bright. The atmosphere around venus has a large amount of carbondioxide and smaller amounts of water vapour and oxygen. This atmosphere reflects the sunlight falling on it, as a result of which venus appears very bright.

Earth

Earth is at the third place from the sun. (Fig 4.12). So far it is the only planet that has life. Atmosphere of the earth is composed of many gases. These help to filter out the harmful rays of the sun as well as to maintain a temperature suitable for life. Earth has one satellite. It is the moon that shines in the night. When viewed from the earth the position of the moon varies. Let us do the following activity to understand this.

4.12 Earth

Activity 4.2

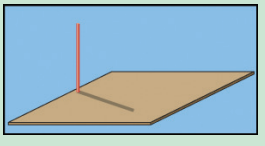


Fig 4.13 (a)

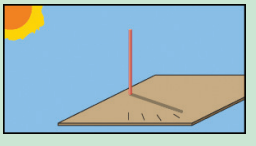


Fig 4.13 (b)

- As seen in the Fig. 4.13 (a) take a stick and get its shadow on to a piece of cardboard and fix it as shown.
- Place this set-up in a place with good sunlight.
- Note the date and time.
- Note the position of the shadow and draw a line as shown in Fig 4.13 (b).
- Repeat this daily at the same time.(Do not change the position of the stick).
- Connect up the lines you have noted.

Mars

Planet that lies after the earth in the solar system is mars (Fig 4.14). It consists of mainly nitrogen gas and small amounts of oxygen. Recent space explorations show that there is frozen water on mars. Therefore scientists assume that there may be some form of life on mars. Mars has two satellites, namely Deimos and Phobos.

Fig 4.14 - Mars

Jupiter

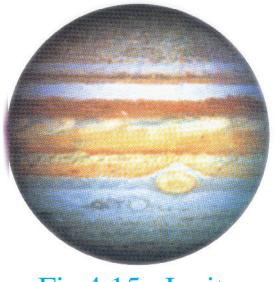


Fig 4.15 - Jupiter

This is in the fifth place from the sun. It has an atmosphere of bands of clouds. It is the largest planet in the solar system. Jupitor has 63 satellites. More important ones are Ganymede, Io, Europa, and Calisto.Ganymede is the largest satellite in the solar system and is even larger than planet mercury.

Saturn

Saturn is famous for its cloud rings. (Fig 4.16). Its atmosphere is similar to that of Jupitor.It has 62 satellites while the largest is Titan. Titan is bigger than mercury.

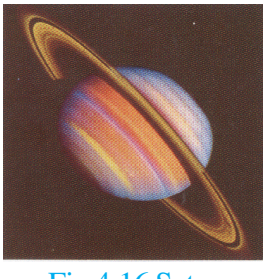


Fig 4.16 Saturn

Uranus

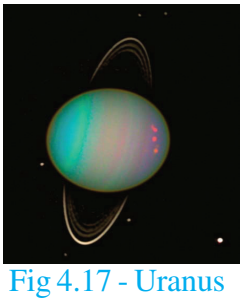


Fig 4.17 - Uranus

Uranus is a very cold planet as it is far away from the sun. Its atmosphere reflects only very little light. Hence it is not a bright planet. It has 27 satellites.

Neptune

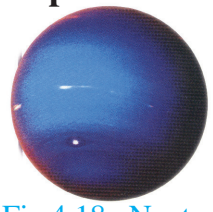


Fig 4.18 - Neptune

Neptune is the furthermost planet in the solar system. It has 17 satellites. The largest of them is Triton. Triton has volcanoes and liquid nitrogen on its surface. Titan is one of the sub planets which is geographically active.

Up to 2006, Pluto was also considered as a planet. But now it has been classified under dwarf planets considering several features of it.

Some important information about planets are given in Table 4.2.

Planet	Distance from sun in	Largeness Compared to earth	Time of revolution		Time of rotation		
			Years	Days	Days	Hours	Min.
Mercury	58	0.38	-	88	58	15	30
Venus	108	0.95	-	224	243	0	0
Earth	150	1.00	-	365	-	23	56
Mars	228	0.53	01	362	-	24	37
Jupitor	778	11	11	314	-	9	50
Saturn	1427	9	29	168	-	10	14
Uranus	2871	4	84	04	-	10	49

Table 4.2 Some information about planets

4.3.3. Dwarf Planets

Dwarf planets are smaller than planets and larger than the comets. In 2006 Eris, Pluto and Ceres were named as dwarf planets.

Eris, is the largest of them. It has one satellite called Disnomia.

Pluto has three moons. Charon is the largest of them. The other two are Nix and Hydra.These two satellites revolve round both Pluto and Charon.

Fig 4.19-Pluto with its moons

4.3.4 Other celestial bodies in the solar system

In our solar system there are some objects which are neither planets, satellites nor dwarf planets. They are the comets. meteors, meteorites and clouds of dust. Let us study about some of them.

Comets

Comets are made up of frozen dust, ice and gases. When they travel towards the sun or away from the sun, a tail can be seen on the side away from the sun.(Fig 4.20). The reason for this is because dust and the gases reflect the rays of the sun falling on them.

Meteors

Meteors are made up of minerals and dust. Meteors are fairly large. They too revolve round the sun, If these come under the earth's gravitational force they come towards the earth. When it enters the earth's atmosphere the friction causes them to burn up and get destroyed. The pieces which do not get destroyed are the meteorites, which fall towards the earth.

Fig 4.20 Comet

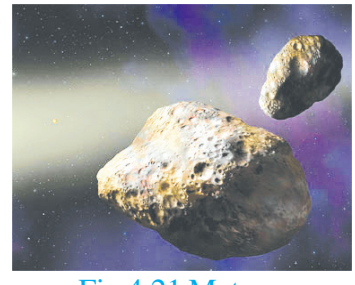


Fig 4.21 Meteors

4.4 Space explorations

Man started exploring space from space for the first time in 1957. The information collected from earth regarding space using telescopes was very limited because celestial bodies are billions of miles away from the earth. Clear pictures of them could not be taken. Hence man had to get into a rocket and travel into space.

4.4.1 Space travel

The main purpose of space travel was to find out about the solar system, to find about any life in the other planets, the threats to our planet and how we can overcome them as well as how we can make use of the space for the benefit of man.

Scientists have sent rockets with telescopes in order to get clear pictures. The Hubble telescope was the first of such equipment (Fig 4.22). In 1990 it was taken to the space by the space shuttle Discovery. It revolves round the earth in an orbit at a height of 596 km from earth. It sends back amazing photographs of Mars, Venus, our own galaxy and various other celestial bodies. (Fig 4.22)

Fig 4.22 - Hubble telescope

Space crafts

Space flights have been attempted with people as well as without people.With the discovery of liquid fuel in the 20th Century, scientists were able to construct crafts Engine suitable for space travel.

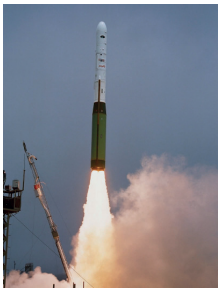


Fig 4.23 - Rocket

Fig 4.24 - Columbia spacecraft

The first reusable spacecraft was Columbia. It was also called a space shuttle.(Fig 4.24)

Its speciality was that it could go off into space as a rocket and come back as a normal aeroplane.

Fig 4.25-Mir space station

The first manned space station was Mir. It was possible to conduct research from this space station. It was orbiting round the earth from 1986 to 2001(Fig 4.25).

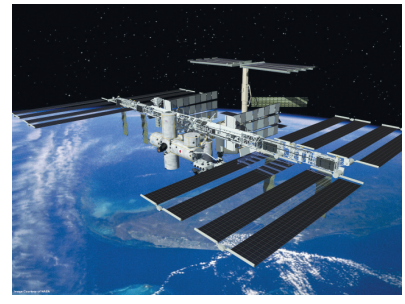


Fig. 4.26 - International space station

Fig 4.26 shows the International space station which is still in space. It is used as a lodging place for research workers and much valuable research has been conducted from there.

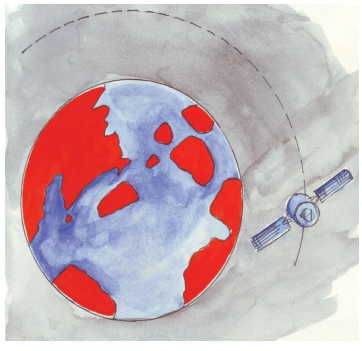
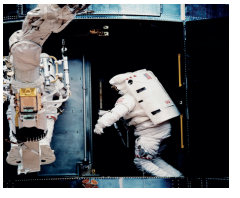


Fig 4.27 - Satellite in space and observation.

As shown in Fig. 4.27, there are many artificial satellites orbiting the earth. These are mostly for the purposes of communication.

Challenges faced in space explorations and ways of overcoming them

Challenges	How to overcome the challenge
1. The speed of a rocket entering the atmosphere has to be controlled. If not the friction created by the atmosphere will cause it to explode.	Design the rocket to be able to control the speed.  Fig. 4.28 -Rocket leaving the earth's atmosphere
2. Astronauts working outside the spacecraft are subject to changes of pressure. This may produce air bubbles in his body which will be fatal.	Design the space suit to provide the necessary pressure artificially.
3. Astronauts have to bear weightlessness inside the space. Hence even a slight force on them may make them float to far away places.	When working outside the spacecraft astronauts are connected to that by cables  Fig. 4.29 - working outside the space ship

4.	Space has little friction. Hence it is difficult to move arms and legs.  Fig 4.30 - space suit	Movement of the astronauts are controlled by 24 nozzles at the back of the space suit. This is done by sending out nitrogen gas. Nozzles are controlled by a switch at the sleeve of the suit
5.	Astronauts may float while sleeping without their knowledge.	A sleeping bag is provided, to which the astronauts are tied by their feet, abdomen and forehead.  Fig 4.31 - How the sleeping bag is used
6.	When the engine is switched off and the spacecraft begins to float round the earth the astronauts will feel as if they are floating.	Astronauts are trained on earth to live in a floating situation  Fig 4.32 -Training to be in a floating situation
7.	Weightlessness causes problems in the sensations of the ear, skin and muscles. Spinal column increases about 1 inch, heart beat increases, swelling of the face, wasting away of muscles causing the legs to become thin and dizziness.	Pace makers are used to control the heart beat. Doing exercise at least two hours per day

8. Being isolated in a limited space over a long period of time may affect their mental health.  Fig 4.33- Enjoying music in space	Inner part of the spacecraft is coloured in an attractive way. A window through which they can see the earth. Facilities for enjoying music, reading etc. Fresh fruits are provided by service crafts. Exchange of letters and presents with their family members.

Table 4.3

Since providing people with all the above facilities is extremely costly scientists are probing the possibility of unmanned spacecrafts.

4.4.2. Progress of space travel

Spacecraft, year, and country	Astronauts and importance of voyage
1. Sputnik- 1, 1957, Soviet Russia.	Unmanned. First artificial satellite.
2. Vostok -1. 1961, Soviet Russia.	First man to go to space- Yuri Gagarin
3. Mariner -5 1967, America.	Unmanned spacecraft. Purpose to find information about Venus.
4. Apollo- 11 1969, America.	First landing on the moon with Neil Armstrong, Edwin Aldrin and Micheal Collins.
5. Mariner – 9 1971, America.	Un-manned. Orbited round Mars. First flight to orbit round a planet.

Spacecraft, year, and country	Astronauts and importance of voyage
6. Rohni-1, 1980, India.	Un-manned. India became the 8th country to launch a satellite.
7. Pioneer – 10, 1983, America.	Un-manned. First craft to leave the solar system
8. Pathfinder, 1997, America.	Un-manned. Landed on Mars.
9. Discovery shuttle, 1998,America.	John Glenn (77) is the oldest person to go to space.
10. Nir, 2000, America	Un-manned. First craft to go near Eros for research.First craft to land on Eros.
11. Columbia shuttle, 2003, America.	David Brown, Ilan Ramon, Kalpana Chaula Loren Cleark, Micheal Anderson,William Macquily, Rick Huswand were the crew. In 2003 it went up to space for the 28th time. On its way back it got destroyed in the upper atmosphere along with all 7 of the crew.

Table 4.4 - Some landmarks in space explarotion

Exercises

1. Name the minerals used by us in our day to day activities.
2. What are the properties that should be present in an agricultural soil?
3. What are the soil conservation methods you can adopt to conserve soil in you area?
4. i) What is the largest satellite in the solar system?
   ii) What is the planet which possess water and air ,other than planet earth?
   iii) What is the planet which may have an atmosphere?
   iv) Which planet is the largest in the solar system?
5. Why did people get motivated for space travel? - Give your views.