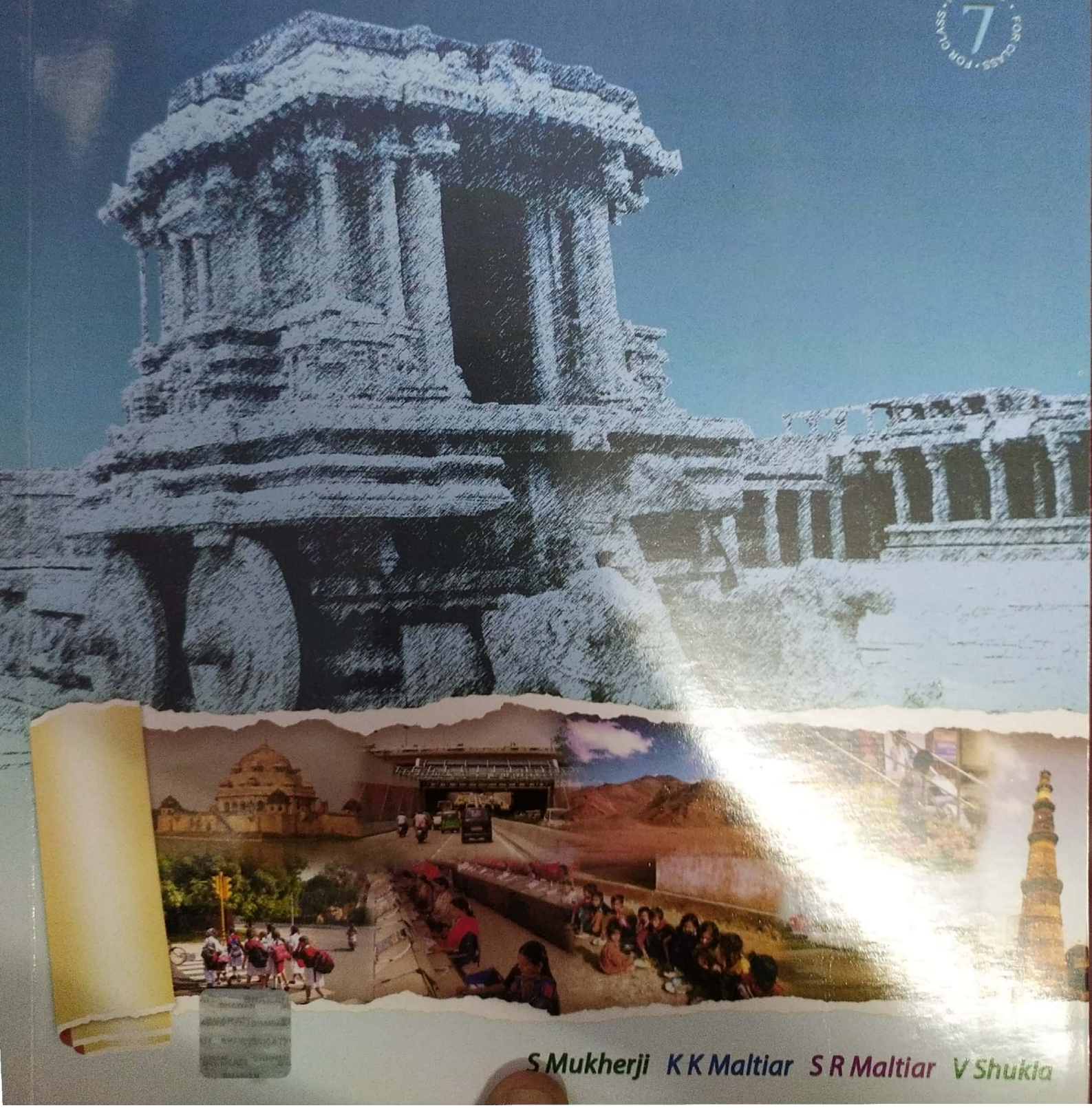
BHARATI BHAWAN (P & D)

Our World Then and Now

Book 2

FOR CLASS 7



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1

The Earth's Structure and Landforms

Environment

The earth is the only planet in the solar system that supports life. This is because conditions suitable for life are found only on the earth. However, the conditions are not the same everywhere on earth. It is hot at some places, while at others it is cold. The landforms, soil and other conditions also differ from place to place. Different organisms live and thrive in different places. This is because each organism is made in such a way that it can live under a particular set of conditions. *The physical and biological conditions in which an organism lives make up its environment.*

Those components of an organism's environment that are provided by nature form its *natural environment*. Our natural environment has two types of components. Physical components such as temperature, light, air, water, soil, landforms, etc., make up our physical environment. And, plants and animals around us make up our biological environment.

Not everything around us is nature's gift. Roads, bridges, buildings, electricity, and so on, are man's creations. They affect our lives. We are also affected by the social, economic, political and other conditions in which we live. All these conditions and man-made things are also a part of our environment.

Changes in the environment Any change in the environment affects an organism. The environment, too, is affected by the actions of the organisms that are a part of it. Usually, nature works in such a way that the components of the environment hardly change over long periods of time. For example, respiration of living organisms, decay of organic matter and burning of fuels use up oxygen and release carbon dioxide into the atmosphere. At the same time, green plants absorb carbon dioxide and release oxygen during photosynthesis. This keeps the amounts of these gases in the air constant. However, we are cutting down trees in large numbers and at the same time burning more fuel. This is increasing the amount of carbon dioxide and upsetting the balance of gases in the air. This is one way in which we are changing our environment. And this change, as we will see in a later chapter, has harmful effects.

Spheres of the earth The land and water bodies of the earth and the layer of air surrounding the earth form a part of our natural environment. You know that the earth can be divided into three zones, or spheres—the lithosphere (sphere of rock), the hydrosphere (sphere of water) and the atmosphere (sphere of air). Life exists only in some parts of these spheres. For example, organisms can survive only up to a certain

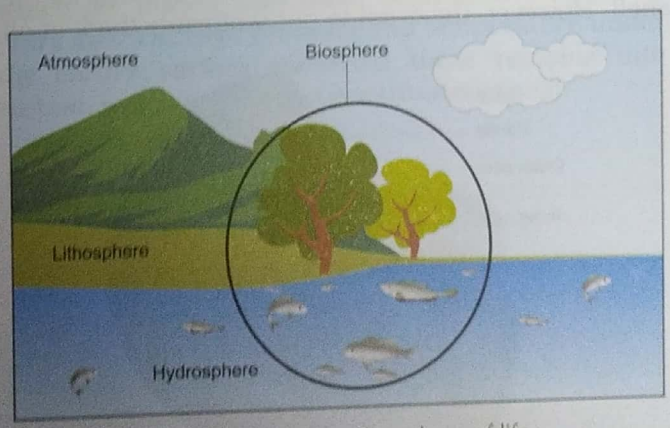


Fig. 1.1 Biosphere—the sphere of life

height in the atmosphere and up to a certain depth below the surface of the earth. The parts of different spheres in which life exists together form the biosphere, or the sphere of life. In other words, the biosphere is the part of the earth where living organisms are found. Any change in the biosphere affects all living beings.

There are some natural processes that change landforms and thus the environment in which we live. To understand them we first need to know about the structure of the earth.

Structure of the Earth

Layers of the Earth

The earth is a huge sphere with a radius of about 6,400 km. To find out the inner structure of the earth, we would have to go down right up to its centre. Obviously, that is not possible. So, scientists have taken the help of earthquakes to determine the structure of the earth. During earthquakes, vibrations are produced. Just as the vibrations of a string of a musical instrument produce sound waves, the earth's vibrations produce *seismic waves*. Seismic waves travel through different materials inside the earth at different speeds. They also get bent when they pass from one kind of material to another. By observing the path and speed of a seismic wave, scientists can find out the types and arrangement of the materials through which it passed. From such observations we now know that the earth consists of three concentric layers—the *crust*, the *mantle* and the *core*.

The crust The uppermost layer of the earth is known as the crust. The crust is very thin, with an average thickness of about 35 km. If we could think of the earth as an egg, the crust could be regarded as the shell. However, the crust is not uniformly thick at all places. It is thinner under the oceans and thicker under the continents.

The upper part of the continental crust, which is rich in silica and aluminium, is called *sial* (*si* is for silica and *al* is for aluminium). The lower part of the continental crust and the whole of the oceanic crust are composed mainly of denser materials rich in silica and magnesium. They are together called *sima* (*si* is for silica and *ma* is for magnesium). The surface of the crust is also quite uneven. For example, Mount Everest, the highest mountain peak in the world, is 8,848 metres above sea level, while the world's deepest point, located in the Mariana Trench in the Pacific Ocean, is 11,034 metres below sea level.

The mantle Below the crust lies the mantle. It extends up to a depth of about 2,900 km. Its chief constituents are silicates of iron and magnesium. Both the temperature and the density of the mantle increase with increasing depth towards the centre of the earth.

The mantle has two parts—the upper mantle and the lower mantle. The upper mantle is about 670 km thick, while the lower mantle is nearly 2,200 km thick. The top layer of the upper mantle is solid. Below this layer lies a soft layer. Because of the high temperatures in this layer, the rocks here are in a soft state, a stage they reach just before melting. This layer begins at a depth of about 50 km and extends roughly up to a depth of 300 km. The lithosphere, which comprises the crust and the hard uppermost part of the mantle, floats on this soft layer. Below this layer, the rocks of the upper mantle become harder with depth.

The lower mantle is a solid region starting at about 700 km. Unlike the upper mantle, it is composed of rocks of uniform hardness.

The core The innermost layer of the earth is called the core. It is about 3,500 km thick. It is the densest layer. It is believed to be made up of heavy metals like

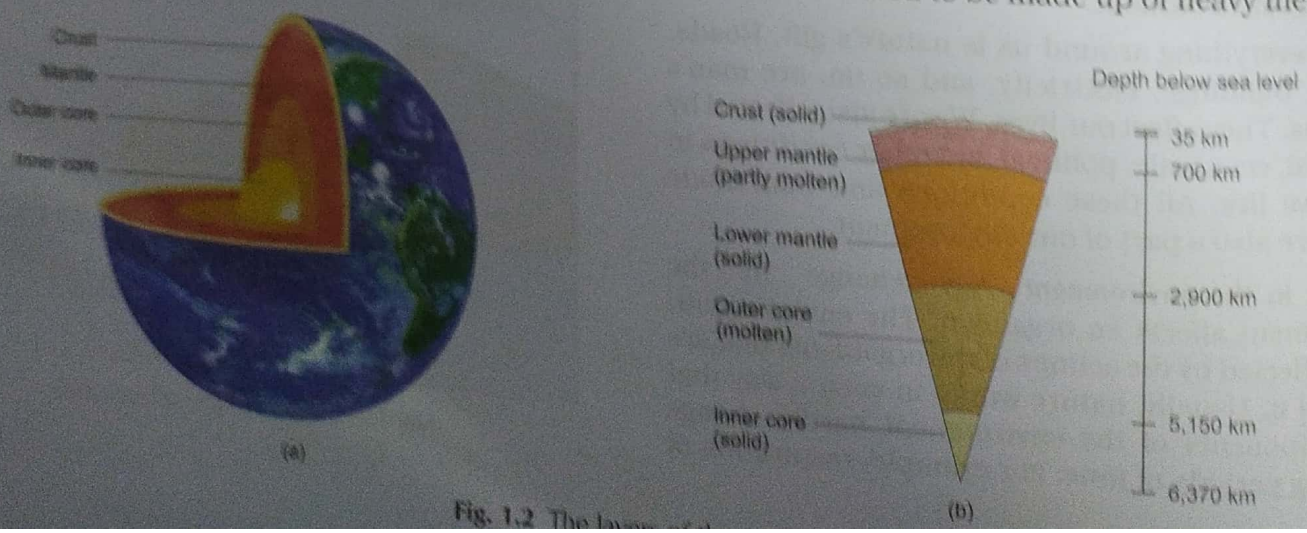


Fig. 1.2 The layers of the earth

iron and nickel, and is called *nife* (ni is for nickel and fe is for ferrum—Latin for iron).

The temperatures at the core are high enough to melt all metals. The study of seismic waves shows that the outer part of the core is molten, while its innermost part is solid.

Rocks

The earth's lithosphere is made up of rocks. Actually, 'lithos' in Greek means rock. The word 'rock' usually brings to mind hard materials like marble, granite and sandstone. However, for geoscientists, rock also includes soft and loose materials like clay, sand, gravel, silt, and in fact everything that forms the lithosphere of the earth.

Rocks are made up of *minerals*. Minerals are naturally occurring chemical compounds. The minerals feldspar and quartz (silica) are common constituents of rocks. Minerals vary in colour, texture, hardness and lustre. Diamond is the hardest known mineral. Even some edible substances, like halite, or rock salt, are minerals. Some rocks contain useful minerals from which metals, like iron, copper and gold, can be extracted. These minerals are called ores. Rocks like marble, granite, basalt and sandstone are good building materials.

Based on how they were formed, rocks may be of three types—*igneous*, *sedimentary* and *metamorphic*.

Igneous Rocks

Deep below the earth's surface, rocks are in a molten state called *magma*. When magma cools and solidifies, it forms a very hard rock known as igneous rock (igneous means 'of fire'). Much of the earth's crust is made up of igneous rocks. Igneous rocks are called primary rocks, as these were the first rocks formed when the earth's crust solidified. Igneous rocks are formed either on the surface of the earth or below it.

Extrusive igneous rocks are formed when magma cools and solidifies on reaching the surface. The magma that reaches the surface is known as *lava*. As the lava cools and solidifies rapidly on the surface, the minerals present in it form very small crystals. Rocks formed in this manner have a fine-grained texture due to the presence of these tiny crystals. The texture, however, is not visible to the naked eye. Basalt, andesite and rhyolite are examples of extrusive igneous rocks.

Below the earth's surface, the process of cooling of magma is much slower. The slow cooling allows large

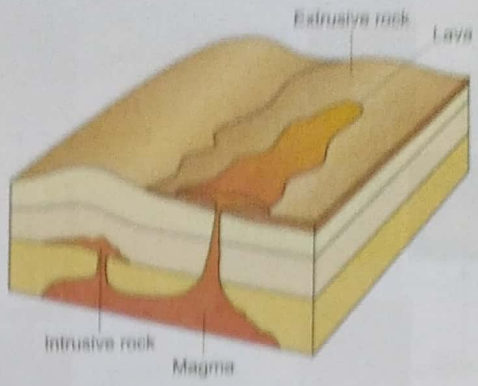


Fig. 1.3 Formation of extrusive and intrusive igneous rocks

crystals of minerals to form. Igneous rocks formed in this way are, therefore, coarse grained. They are known as *intrusive igneous rocks*. Granite and gabbro are examples of such rocks.

Sedimentary Rocks

Running water, wind and moving ice carry small particles of rock. When these rock particles are deposited on land or on the beds of oceans or rivers, they are called *sediments*. Sediments are deposited in layers. They harden over the years because of the weight of the layers above and the presence of cementing materials like lime. When the layers are formed under water, the weight of the water also helps in hardening. Rocks formed by the deposition and hardening of layers of sediment are called sedimentary rocks. Such rocks are usually made up of layers of different composition. Sandstone, limestone, shale, gravel, clay and conglomerate are examples of sedimentary rocks.

Coal, too, is a sedimentary rock. But unlike other sedimentary rocks, the coal that we see today was formed by the remains of organisms, mainly plants, which got buried with other sediments millions of years ago. The high pressure and temperature under the earth's surface converted these remains into carbon, which is the main constituent of coal.

Fig. 1.4 You can clearly see the layers in this specimen of sedimentary rock.

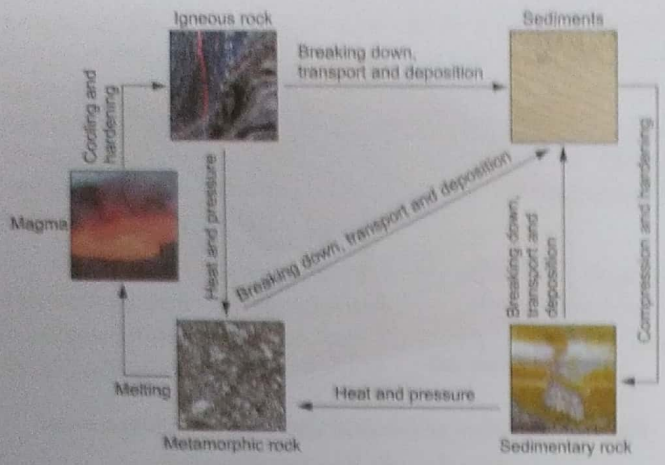


Fig. 1.5 The rock cycle

Petroleum occurs in sedimentary rocks. Petroleum has been formed by the decay of plant and animal remains that were buried with sediments millions of years ago. The remains of plants and animals trapped within layers of rock are called *fossils*. Hence, petroleum and coal are called *fossil fuels*.

Metamorphic Rocks

The word 'metamorphosis' means change of form. Igneous and sedimentary rocks change their form under very high temperature or pressure. Such 'changed' rocks are known as metamorphic rocks. Metamorphic rocks are usually very hard. Some common examples of such rocks are marble (formed from limestone), slate (formed from shale), and quartzite (formed from sandstone).

Rocks undergo a cycle of transformation, often called the *rock cycle*. Magma rising from depths below the earth's surface produces igneous rocks. The breaking down of different types of rocks produces sediments from which sedimentary rocks are formed. Extreme heat and pressure may cause igneous and sedimentary rocks to form metamorphic rocks. When rocks are melted by heat, new magma is formed.

Development of Landforms

Major landforms like mountains develop mainly due to forces that originate below the earth's surface. Such forces lead to slow earth movements, which build new landforms, and sudden earth movements, which modify existing landforms. We will now study some processes that create or modify landforms.

Volcanoes

A volcano is a *vent*, or an opening, at a weak spot in the earth's crust, through which magma erupts onto the surface as lava. Sometimes, lava comes out through long, deep cracks, or *fissures*, in the earth's crust.

During a volcanic eruption, gases, ash, steam and even pieces of rock are spewed out along with lava. Gradually, ash, rocks and solidified lava pile up around the vent, forming a conical hill known as a *volcanic cone*. The word 'volcano' is also sometimes used to refer to a volcanic cone. Mount Etna in Sicily, Kilimanjaro in Tanzania, and Kilauea and Mauna Kea in Hawaii are examples of volcanoes.

The top of the volcanic cone has a cuplike depression called a *crater*. Magma reaches the crater through a vertical pipelike passage. The original volcano may undergo changes over time. New cones may develop, and the original crater may become wider and shallower after a fresh eruption. Such an enlarged crater is called a *caldera*.

Volcanic islands The top of a volcanic cone formed on the sea floor may rise above the water to form a new island. The island of Surtsey near Iceland is such an island. Such an island will disappear if the top of the volcano is blown off by a violent eruption.

Tectonic Processes

The earth's lithosphere is broken up into several pieces, just like the pieces of a large jigsaw puzzle. These pieces, known as *plates*, float on the soft layer of the mantle. The flow of partially molten material within the mantle causes the plates of the lithosphere to move relative to each other. As the plates move, they push, pull, slide, rise, sink, bend and break. Such processes act over millions of years, and create major landforms. They are called *tectonic processes*, after the Greek word '*tekton*', which means builder. Plate movement causes

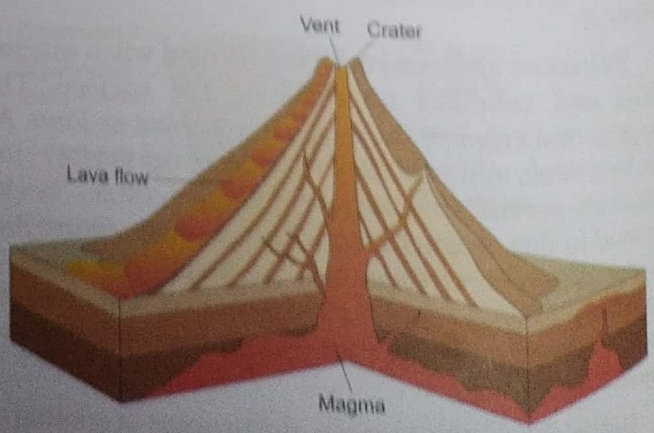


Fig. 1.6 A volcanic cone

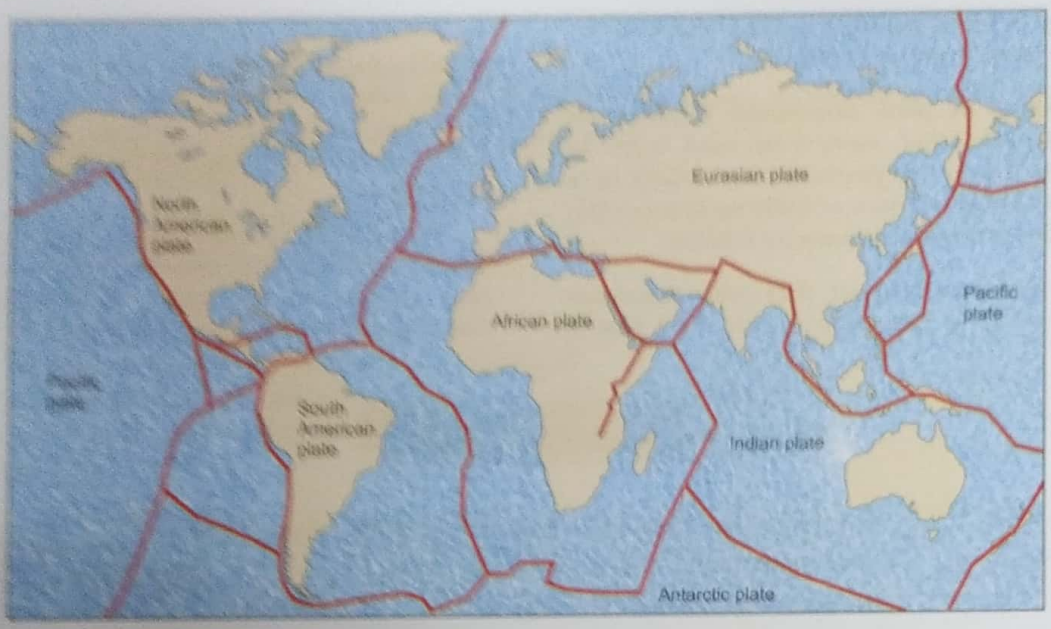


Fig. 1.7 Major plates of the lithosphere

volcanic activity and earthquakes, especially at the margins of the moving plates.

Earthquakes An earthquake is a sudden and violent shaking of the earth's surface. Most earthquakes are caused by the movement of the plates of the lithosphere. Volcanic eruptions also cause earthquakes. An earthquake usually lasts for only a few seconds, but may be violent enough to cause extensive damage to life and property.

The point at some depth below the earth's surface where the vibrations of an earthquake begin is called the *focus*. From there the vibrations spread in all directions, much like the ripples caused by the dropping of a stone into a pool of water. The point on the earth's surface that lies directly above the focus is called the *epicentre*. The vibrations reach this point first and then spread outward over the surface. Thus, the epicentre usually suffers the maximum destruction.

Earthquakes do not create major landforms. They can, however, cause changes in the existing landforms. For example, they may cause cracks to open up in the ground. They may also lead to landslides or cause giant waves in the oceans.

Measuring earthquakes The instrument used for recording and measuring the vibrations of an earthquake is called a *seismograph*. The magnitude of an earthquake depends on the energy released. It is measured, usually from 0 to 10, on a scale called the Richter scale. Consecutive whole numbers on this scale represent about 30 times increase in energy released during an earthquake. Thus an earthquake measuring 7 on the Richter scale is 30 times more severe than one that measures 6. However, the damage an earthquake causes depends on many factors such as the type of soil, type of buildings, quality of construction, population density, etc. Generally, earthquakes measuring 2 or less on the Richter scale are not even felt by us. The ones that cause damage usually measure 5 or more.

Surviving an earthquake During an earthquake, get away from stoves and fireplaces, glass objects, windows and things that can fall. Crawl under a table or a bed or crouch near an inner wall. Cover your head and face with your arms. Do not use the lift. If you are outdoors, move away from buildings, trees, poles, hoardings, etc. If earthquakes are frequent where you live, you and your friends and family should regularly take part in drills to practise what to do during earthquakes.

Earthquake at Bhuj in 2001 A powerful earthquake measuring about 7 on the Richter scale hit the Indian state of Gujarat on 26 January 2001. It caused great damage, killing more than 20,000 people and destroying nearly 400,000 houses. About 16 million people were directly or indirectly affected by the earthquake. The earthquake had its epicentre near Bhuj in Kachchh. The region around Bhuj, therefore, suffered the maximum damage.

Going by records of previous earthquakes and their effects, the risk of violent and destructive earthquakes is very high in the Bhuj region. So, the rules for constructing quake-resistant buildings should have been strictly followed. This could have restricted the collapse of buildings, which is the main cause of deaths in any earthquake. Besides, the Bhuj

region is fairly densely populated. This was another reason for the large number of deaths.

Landforms created by plate movement Plates may move towards each other, away from each other or past each other. When two plates move towards each other, the rocks between them wrinkle up to form *fold mountains*. The process is known as *folding*.

When two plates move apart, they cause fractures, or *rifts*, to open up in the earth's crust. The flow of molten material underneath may cause chunks of the crust to collapse or be pushed up along a rift. A rift along which adjacent blocks of rock have been displaced is known as a *fault*. The raised blocks form *block mountains* and the sunken blocks form *rift valleys*.

Sometimes, two plates may slide past each other. Such movement does not create major landforms but may change existing ones by forming faults and causing earthquakes and landslides.

Things to Remember

environment	the physical and biological conditions in which an organism lives
natural environment	those components of environment that are provided by nature
crust	the uppermost solid layer of the earth
mantle	the layer of the earth below the crust
lithosphere	the solid layer comprising the crust and the uppermost part of the mantle, which floats on the soft layer of the mantle
core	the innermost layer of the earth, with a molten outer part and a solid inner part
magma	molten rock found below the earth's surface
lava	magma which has come out onto the earth's surface
igneous rock	a type of rock formed by the cooling and hardening of lava or magma
sedimentary rock	a type of rock formed by the deposition and hardening of layers of sediment
metamorphic rock	a type of rock changed from its original form due to heat or pressure
volcano	a vent, or an opening, out of which lava, ash, gases, etc., erupt
tectonic processes	landform-building processes like folding, faulting, etc., caused by the movement of the lithospheric plates

Exercises

A. Answer the following questions orally.

1. Name the three main layers of the earth.
2. What are rocks?
3. Give one example each of igneous, sedimentary and metamorphic rocks.
4. How are metamorphic rocks formed?
5. What is a volcano?

B. Answer the following questions in not more than 20 words.

1. Define environment.
2. What are rocks made of? Name the three main types of rocks.
3. Define magma and lava.
4. What are fossils?
5. What are tectonic processes?

C. Answer the following questions in not more than 40 words.

1. How does the upper mantle differ from the lower mantle?
2. What is a volcanic cone?

3. What are plates? What causes them to move?
4. What are the effects of earthquakes on landforms?
5. Which region suffered the maximum damage due to the earthquake that hit Gujarat in 2001? Why?

D. Answer the following questions in not more than 100 words.

1. Briefly describe the earth's crust.
2. What are igneous rocks? How are they formed?
3. What are sedimentary rocks? Explain how they are formed.

E. Think and answer.

1. Why are fossils found in sedimentary rocks?
2. Why is the upper part of the continental crust called sial?
3. Coarse-grained igneous rocks are formed below the earth's surface. Why?
4. Volcanic activity and earthquakes are common near the margins of plates. Why?

F. Fill in the blanks.

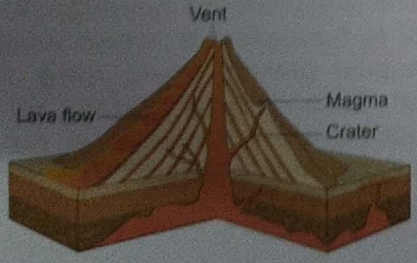
1. The ..... is the sphere of life.
2. ..... waves help to determine the structure of the earth.
3. The average thickness of the earth's crust is about ..... km.
4. In spite of its high temperature, the innermost part of the earth's core is ..... .
5. ..... igneous rocks are formed on the surface of the earth.
6. ..... is a sedimentary rock formed by the decay of plant and animal remains that got buried millions of years ago.
7. Limestone is to marble what ..... is to slate.
8. Fold mountains are formed by ..... processes.
9. Blocks of rock pushed up along a rift form ..... mountains and sunken blocks form ..... valleys.

G. State whether the following statements are true or false.

1. The core lies between the crust and the mantle.
2. Basalt is an intrusive igneous rock.
3. Petroleum is found in sedimentary rocks.
4. An island may be the top of a volcanic cone rising from the sea floor.
5. The plates of the lithosphere float on the soft layer of the mantle.
6. The word 'tectonic' comes from a Greek word which means 'builder'.

H. Choose the correct options. More than one option may be correct.

1. Which of the following is not a component of the physical environment?
   (a) light (b) water (c) plants (d) temperature
2. The oceanic crust is composed mainly of materials rich in
   (a) nickel and iron (b) silica and aluminium
   (c) silica and magnesium (d) iron and magnesium
3. Sandstone, clay and shale are
   (a) metamorphic rocks (b) sedimentary rocks (c) igneous rocks (d) fossil fuels
4. A rock whose original form has been changed due to heat or pressure is called
   (a) sedimentary rock (b) metamorphic rock (c) igneous rock (d) fossil
5. Kilimanjaro is a
   (a) fold mountain (b) block mountain (c) volcanic cone (d) rift valley
6. In the following diagram, which parts have been wrongly labelled?



(a) vent
(b) lava flow
(c) crater
(d) magma

Things to Do

Activity

- Collect a few specimens of rocks from your surroundings. Try to find out whether they are igneous, sedimentary or metamorphic rocks.
- Make a model of a volcanic cone showing the vent, a crater and lava flows.

Project

- Look at the map showing the lithospheric plates. Find out which parts of India lie near plate margins. Mark these earthquake-prone regions on an outline map of India. In the same map, mark the places where major earthquakes have occurred in the past hundred years. Find out which of the earthquakes caused the largest number of deaths.
- From the Internet, find the locations of the five most devastating earthquakes in history. Mark these places on a world map and write a few lines on each incident.

Group discussion

- Organise a group discussion on the topic 'Taking precautions during an earthquake'.

❑

2

The Atmosphere

The blanket of air that surrounds the earth is known as the atmosphere. The atmosphere extends more than a thousand kilometres above the earth's surface. It is held in place by the earth's force of gravity.

Composition of the Atmosphere

Air, which makes up the atmosphere, is a mixture of several gases. Nitrogen makes up about 78% and oxygen about 21% of the total volume of the atmosphere. Carbon dioxide makes up about 0.03%, and the remaining 0.97% includes other constituents such as argon, ozone and water vapour. Some dust particles are also present in the atmosphere. Although the gases present in the atmosphere are used up in certain processes, they are also released back in the atmosphere in other processes. Thus, the composition of the lower part of the atmosphere remains fairly constant.

Atmospheric nitrogen is converted to nitrogen compounds by lightning and by certain types of organisms such as nitrogen-fixing bacteria present in the soil or in the roots of some plants. Plants absorb nitrogen compounds and convert them to proteins. Animals take in proteins by eating plants or other animals. Nitrogen returns to the atmosphere when denitrifying bacteria act on animal wastes and the dead bodies of plants and animals.

Oxygen is used up in processes like the respiration of organisms, the burning of fuels and the decay of organic matter. It is replaced by the oxygen released by green plants during photosynthesis. Similarly, the carbon dioxide used up during photosynthesis is replaced by the carbon dioxide released by the respiration of organisms, the burning of fuels and the decay of organic matter. Thus, nature has ways of maintaining the balance of gases in the atmosphere. However, human activities are disturbing this balance by polluting the air.

Air pollution Any undesirable change in the composition of air is known as *air pollution*. This may happen if the processes regulating the composition of air are disturbed or if harmful substances are added to the air. Substances that cause pollution are called *pollutants*.

In cities and industrial areas, automobiles and factories are the chief polluting agents. They emit large amounts of gases such as carbon dioxide, carbon monoxide and sulphur dioxide. They also emit solid pollutants such as unburnt carbon particles from fuels. Some of the emitted substances such as carbon monoxide, sulphur dioxide and compounds of poisonous metals like lead are harmful for us.

Natural agents may also cause pollution. Volcanoes, for example, release huge amounts of dust, ash and poisonous gases into the atmosphere.

The Layers of the Atmosphere

On the basis of composition, temperature and other properties, the atmosphere may be divided into five layers. Starting from the bottom, the layers are called troposphere, stratosphere, mesosphere, thermosphere and exosphere. However, the boundaries between these layers are neither fixed nor well defined. The layers overlap, and vary in thickness.

Troposphere The lowest and densest layer of the atmosphere is known as the troposphere. About three-fourths of the mass of the atmosphere is contained within this layer. The extent of this layer is about 18 km above the equator, but only about 8 km above the two poles. The troposphere acts like a blanket. It prevents days from becoming very hot and nights from becoming very cold. Within the troposphere, the temperature decreases as we move up. Most of the water vapour, clouds and dust particles of the atmosphere are found in this layer. The troposphere gets its name from the Greek word 'tropos' which means 'turning'. This is because all the weather changes that we experience take place in the troposphere. The upper limit of the troposphere is marked by the tropopause, where the general decrease in temperature with altitude stops.

Stratosphere The stratosphere lies above the troposphere and extends to about 50 km above the earth's surface. A part of the stratosphere is known as the ozonosphere, as it has the maximum concentration of ozone in the atmosphere. Ozone protects us by absorbing the harmful ultraviolet rays of the sun. The ozonosphere becomes quite warm by absorbing these rays.

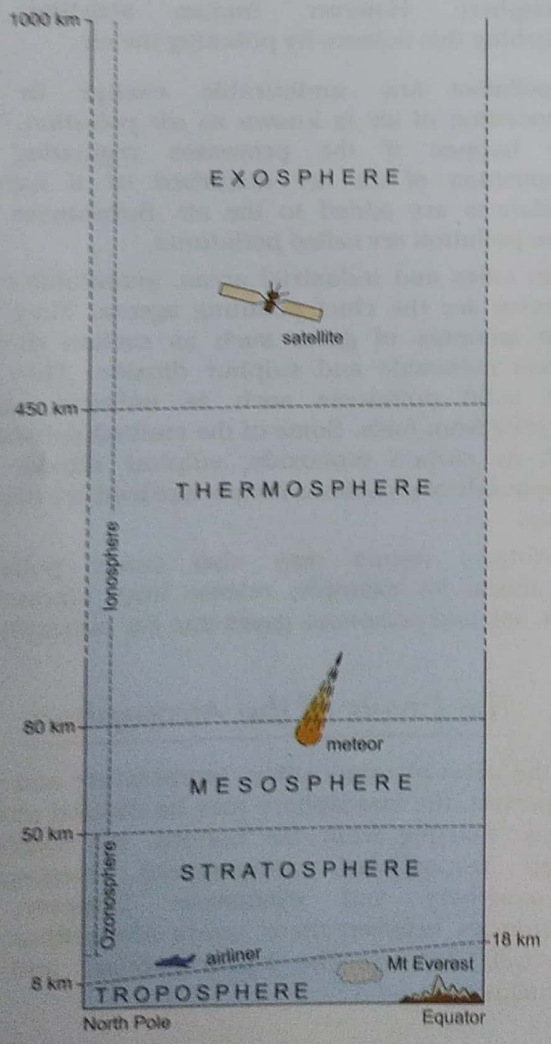


Fig. 2.1 Layers of the atmosphere

Mesosphere The mesosphere lies above the stratosphere. It extends to about 80 km above the earth's surface. In this layer, the temperature decreases with altitude and falls as low as –85°C. Meteors entering the atmosphere usually burn up in the mesosphere.

Thermosphere Above the mesosphere lies the thermosphere, which extends to a height of about 450 km above the earth's surface. The temperature rises rapidly with altitude in this layer.

Exosphere The outermost layer of the atmosphere is called the exosphere. The upper reaches of this layer merge with outer space. The temperature in the exosphere is very high.

There is a layer in the atmosphere in which the molecules of the atmospheric gases are broken into charged particles called ions. This layer is called *ionosphere*. It reflects, or sends back, radio waves towards the earth and, thus, helps in radio transmission. The ionosphere starts at about 50 km and extends to about 1,000 km above the earth's surface.

Weather and Climate

The term *weather* means the state of the atmosphere at a particular place at a particular time. It includes information on weather elements such as temperature, air pressure, winds, humidity, cloud cover and rainfall. We usually get information about the weather from weather reports and forecasts published in newspapers or broadcast over radio and television. Weather forecasts are particularly helpful, as they warn us in advance about approaching storms and heavy rains. This enables us to take precautions. The *climate* of a place is the average weather of the place. In other words, climate is the regular pattern of weather conditions at a place over a period of time. Let us now learn about some of the elements that determine weather and climate.

Air Temperature

The sun is the chief source of heat and light for the earth. It radiates, or sends out, energy in all directions. Being far away from the sun, the earth receives only a very small fraction of this energy. The solar energy received by the earth is called *incoming*

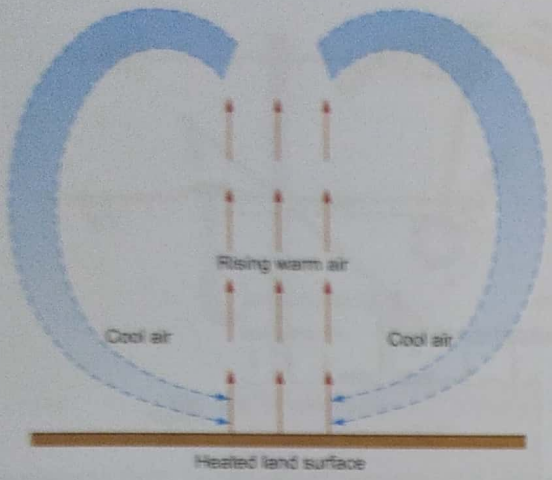


Fig. 2.2 Rising warm air being replaced by cool air at the heated land surface

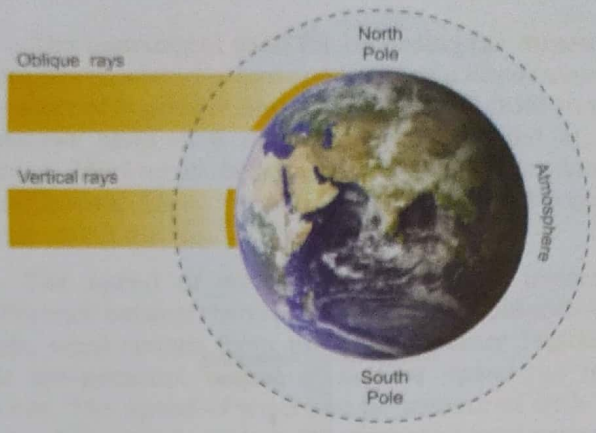


Fig. 2.3 The sun's rays falling on earth. Observe the rays falling on higher and lower latitudes. In higher latitudes they spread over a larger area.

solar radiation, or *insolation*. The energy that reaches the earth passes through the atmosphere before reaching the earth's surface. But it heats up the atmosphere only slightly. The earth's surface, however, gets heated on absorbing this energy. The heated surface then starts radiating heat. The air around us is heated by this radiation. We use special thermometers to measure air temperature. The scale most commonly used to measure air temperature is the Celsius scale, named after its inventor Anders Celsius. It is also called the centigrade scale. The unit is written as °C. On this scale, the freezing point of water is taken as 0°, while its boiling point is taken as 100°.

The heating of the atmosphere has important consequences. For example, the warm air near the earth's surface expands, becomes lighter and rises. As it rises, it gradually gets cooled. The cool air, being heavy, sinks down. Thus, as warm air rises from the surface, cool air from above comes down to replace it. This results in a cyclic movement of air near the earth's surface.

Variations in Temperature

The temperature at a particular place does not remain constant. It varies with the time of the day and the time of the year. You have learnt in the previous class that this is because of variations in the inclination of the sun's rays and the duration of sunlight. The maximum and minimum temperatures recorded at a place on a particular day can be used to calculate the mean, or average, temperature for that day. For example, suppose the maximum and minimum temperatures at a place on a certain day are 36°C and 24°C respectively. Divide the sum of these temperatures by 2. The result is 30°C, which is the mean temperature of the place on that day. Similarly, one may calculate the mean monthly and mean annual temperatures.

The difference between the maximum and minimum temperatures gives the *range of temperature*. In the case mentioned above, the range of temperature for the day, that is, the *diurnal range of temperature*, is 36°C – 24°C = 12°C. The difference between the mean temperatures of the hottest and coldest months of a year is called the *annual range of temperature*.

Temperature also varies from place to place, mainly due to variations in latitude, altitude and distance from the sea.

- The higher the latitude of a place the lower is its temperature.
- The higher the altitude of a place the lower is its temperature.
- The greater the distance of a place from the sea the higher is its range of temperature (both diurnal and annual).

Greenhouse Effect and Global Warming

You know that solar energy heats up the earth's surface. Once heated, the earth's surface radiates heat. Much of this radiated heat is reflected towards the earth, mainly by the carbon dioxide present in the atmosphere. As a result, the heat gets trapped. This effect is similar to the heating of a greenhouse. Hence, it is known as the *greenhouse effect*. Without this trapping of heat, the earth would have been so cold at night that we could not have survived on it.

You know that green plants absorb carbon dioxide and release oxygen during photosynthesis. However, as the human population is growing, we are cutting down more and more trees for wood. We are clearing forests to use the land for buildings and agriculture. Our factories and vehicles are emitting

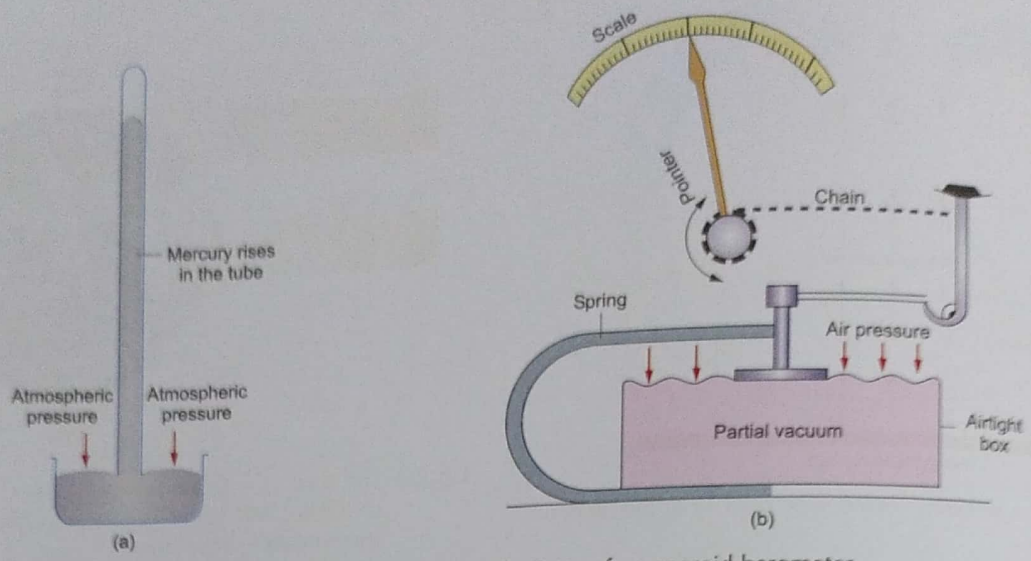


Fig. 2.4 (a) Mercury barometer (b) Parts of an aneroid barometer

more carbon dioxide than ever before. In other words, we are increasing the emission of carbon dioxide, but reducing the number of trees. This is gradually increasing the amount of carbon dioxide in the air. As a result, the greenhouse effect is increasing gradually, causing global temperatures to rise. This is known as *global warming*. It is feared that continued global warming may cause much of the polar ice to melt. If that happens, the water level of the oceans will rise and many islands and coastal areas will get submerged.

Atmospheric Pressure and Winds

Like all things around us, air has weight. Although air weighs very little, the weight of all the air in the atmosphere is huge. This huge weight pushes down on the earth's surface but, fortunately, it is spread over a large area. *The weight of the atmosphere pushing down on a unit area on the earth's surface is called atmospheric pressure.* Atmospheric pressure is measured with the help of a *barometer*.

A simple barometer consists of a long, mercury-filled glass tube inverted over a cup of mercury. The pressure of air on the mercury in the cup pushes up the mercury in the tube. Atmospheric pressure is measured in terms of the height of the mercury column. At sea level, atmospheric pressure is about 1 kg per square centimetre. This pressure supports a column of mercury 760 mm high. The atmosphere is densest near the earth's surface. As one climbs higher, the air becomes less dense and exerts lesser pressure. Therefore, atmospheric pressure decreases with increasing altitude.

The simple mercury barometer is large and not very portable. The *aneroid barometer* is more commonly used. It does not use any liquid, and is, therefore, easier to handle. This type of barometer has a partially evacuated metal box which expands when the pressure is low and gets compressed when the pressure is high. The box is connected to a pointer that moves over a scale to indicate the atmospheric pressure.

Permanent Pressure Belts

Air pressure varies with temperature. Air when heated expands and becomes less dense. Hot air, being lighter, rises, or flows upwards. Hence, it exerts lesser pressure. On the other hand, air when cooled becomes dense and heavy. Cold air sinks, or flows downwards. Hence, it exerts more pressure.

In the equatorial region, especially between 5°N and 5°S latitudes, it is hot throughout the year. So the atmospheric pressure in this area is always low. This low-pressure zone is called the *equatorial*

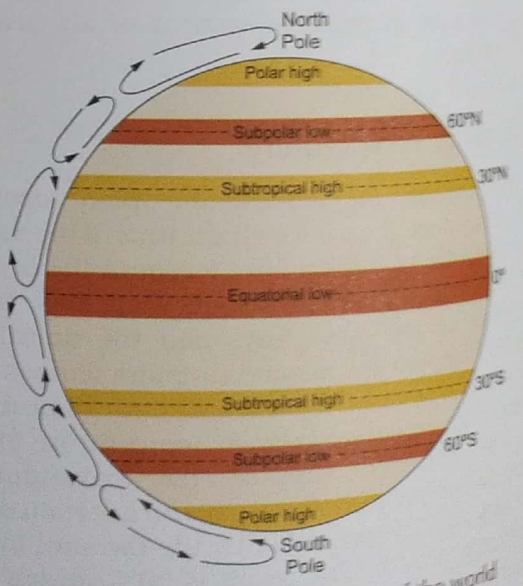


Fig. 2.5 Permanent pressure belts of the world

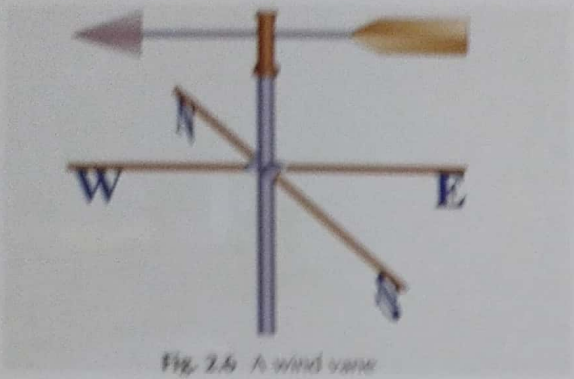


Fig. 2.6 A wind vane

low-pressure belt. In the polar regions, it is extremely cold throughout the year, and the atmospheric pressure is always high. These regions are called *polar high-pressure belts*.

The hot air rising over the equatorial belt moves towards the poles. By the time the air streams reach the latitudes around 30°N and 30°S, they become cool and heavy, and begin to sink. This creates belts of high pressure, known as the *subtropical high-pressure belts*, in these two regions. Cold air from the polar regions and comparatively warm air from the subtropical regions meet near the 60° latitudes in both the hemispheres. The larger mass of warm air rises, creating a strong upward current. The cold polar air gets pulled up by this current. This creates belts of low pressure, called the *subpolar low-pressure belts*, in these regions.

The permanent pressure belts do not remain at the same positions throughout the year. They shift slightly northward when the Northern Hemisphere tilts towards the sun, and a little southward when the Southern Hemisphere tilts towards the sun.

Wind

When hot air rises and creates a region of low pressure, cold air from neighbouring high-pressure areas moves towards the low-pressure area. The horizontal movement of air is called *wind*.

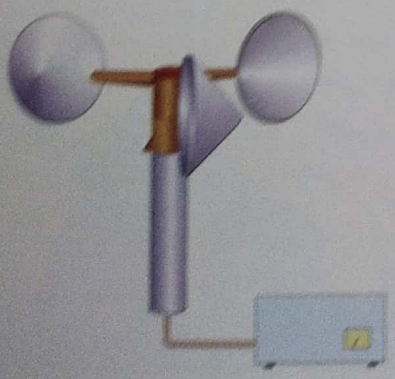


Fig. 2.7 An anemometer

The instrument used for recording the direction from which a wind is blowing is called a *wind vane*. It consists of a pointer and a vane (or tail) fixed to the opposite ends of a horizontal rod, pivoted at its centre. Wind turns the vane towards the side to which it is blowing. Thus, the pointer points to the direction from which the wind is blowing.

The speed of wind depends on the pressure difference between two regions. When the difference is high, wind rushes from the high-pressure region to the low-pressure region at a great speed, as in a storm. The speed of wind can be measured with the help of an *anemometer*. An anemometer consists of three or four cups attached to a rotating shaft. When wind blows, the cups and the shaft rotate. The shaft is connected to a meter, similar to a car's speedometer, which shows the speed of the wind.

Winds can be broadly classified as permanent winds and local winds.

Permanent Winds

The winds that blow from the permanent high-pressure belts towards the permanent low-pressure belts maintain their directions of flow throughout the year. They are called *permanent, prevailing* or *planetary winds*. Due to the rotation of the earth, these winds are deflected to the right of their paths in the Northern Hemisphere and to the left of their paths in the Southern Hemisphere. Thus, the winds blowing towards the equator are deflected towards the west, and the winds blowing towards the poles are deflected towards the east. There are three types of permanent winds—the *trade winds*, the *westerlies* and the *polar winds*.

Trade winds The trade winds blow from the subtropical high-pressure belts to the equatorial low-pressure belt. Winds are named after the

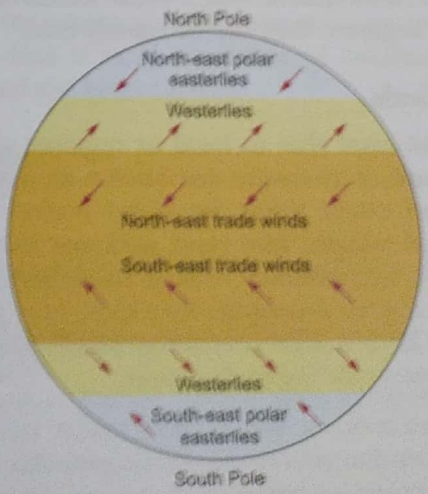


Fig. 2.8 Permanent wind belts of the world

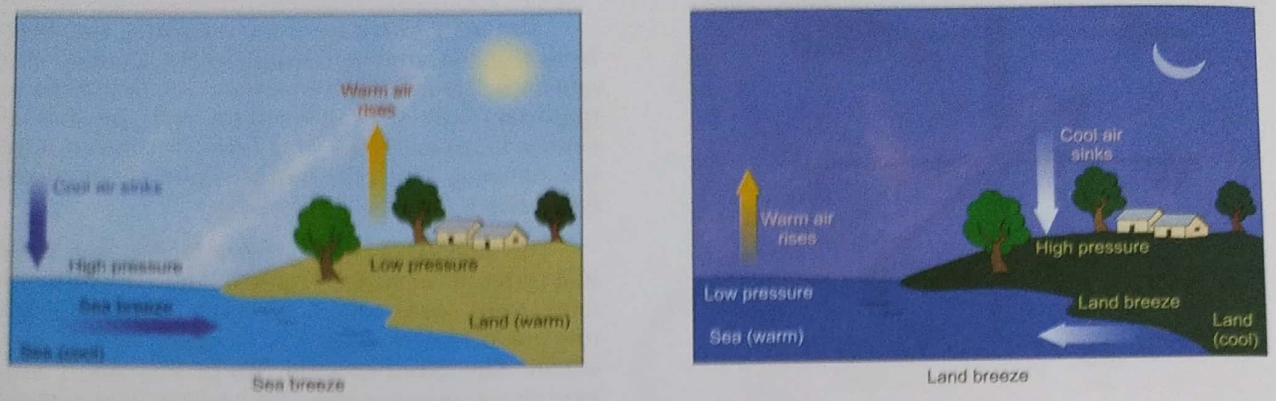


Fig. 2.9 Land and sea breezes

direction from which they blow. In the Northern Hemisphere, the trade winds blow from the north-east and are known as the north-east trade winds. In the Southern Hemisphere, they blow from the south-east and are known as the south-east trade winds. The trade winds blow with great regularity.

Westerlies The winds blowing from the subtropical high-pressure belts to the subpolar low-pressure belts are known as the westerlies, as they blow from a somewhat westerly direction in both the hemispheres. The westerlies blow from the south-west in the Northern Hemisphere and from the north-west in the Southern Hemisphere. Since these winds originate in the warm tropical regions and blow towards cooler regions, they are experienced as warm winds. They are not, however, as regular as the trade winds.

Polar winds The polar winds blow from the polar high-pressure belts to the subpolar low-pressure belts. They are also known as the *polar easterlies* because they blow from a somewhat easterly direction. They blow from the north-east in the Northern Hemisphere, and from the south-east in the Southern Hemisphere. Since these winds originate in the polar regions, they are extremely cold.

Local Winds

Winds that arise due to local or regional changes in temperature or pressure are known as *local winds*. They affect small areas for short periods of time. Some local winds, like land and sea breezes and monsoons, are periodic. For a fixed period, which may be a day or a season, they blow in a particular direction. But, unlike prevailing winds, they do not always blow in the same direction.

Land and sea breezes Water takes longer than land to get heated and to cool down. During the day, the land, therefore, becomes hotter than the sea. The air above the land becomes hot and rises, leading to low pressure over the land. Since the air above the sea is cooler, the pressure over the sea is higher. So, the cooler air from the sea moves towards the land during the day. This breeze, called *sea breeze*, brings down the temperature in coastal areas during the day.

At night, the land cools down much faster than the sea. The air over the sea is, thus, warmer and lighter. The warm air over the sea rises. So, the pressure over the sea is lower than the pressure over the land. Air from the land, therefore, blows out towards the sea. This is known as *land breeze*.

The monsoon The monsoon is a seasonal wind. It blows in a fixed direction during a particular season but reverses its direction with the change of seasons. Monsoons are like land and sea breezes on a large scale. They are mainly associated with southern and south-eastern Asia. During summer, the interior of the continent of Asia gets extremely heated, and a low-pressure zone develops in this region. Moist winds from the high-pressure zone over the Indian Ocean blow towards this zone and cause heavy rainfall in summer. In winter, the temperature falls sharply, and a high-pressure zone develops over the interior of Asia. The sea remains warmer than the land, so the pressure over it is much lower. As a

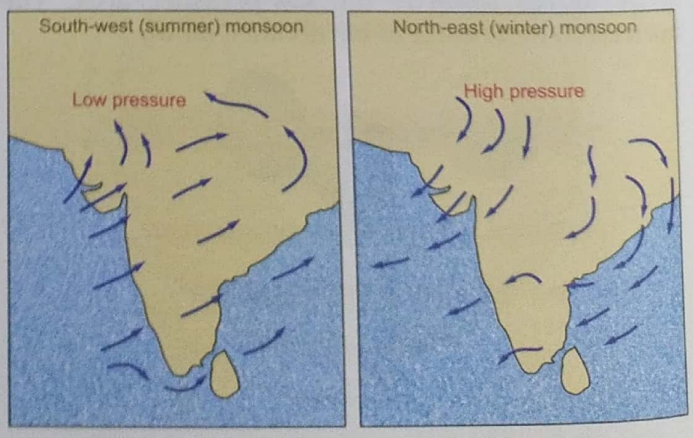


Fig. 2.10 The summer and winter monsoons in India

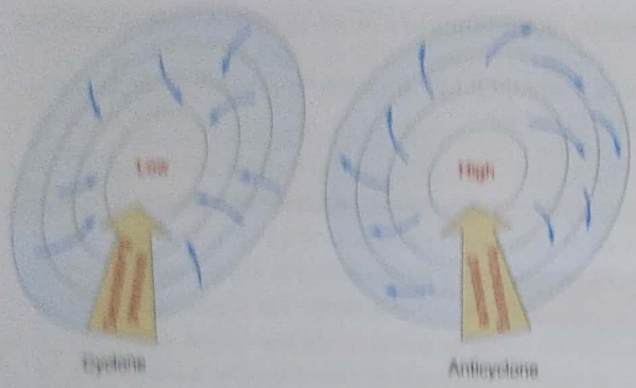


Fig. 2.11 Cyclones and anticyclones in the Northern Hemisphere. Cyclones and anticyclones are shown by lines joining places having equal atmospheric pressure. The word 'high' or 'low' written at the centre of a system indicates the pressure at its centre.

result, cool dry winds from the interior of the continent blow towards the sea.

Cyclonic winds Cyclonic winds are irregular winds of short duration. They are caused by pressure systems known as *cyclones* and *anticyclones*.

In a cyclone, strong winds blow in a spiral towards the low-pressure area at the centre. In the Northern Hemisphere winds blow in an anticlockwise direction around the centre of the cyclone, while in the Southern Hemisphere they blow in a clockwise direction. Cyclones bring heavy rains and cause damage to places over which they pass.

In an anticyclone, gentle winds blow from the high-pressure area at the centre towards the surrounding low-pressure areas. In the Northern Hemisphere winds blow in a clockwise spiral, away from the centre of the anticyclone, while in the Southern Hemisphere they blow in an anticlockwise spiral. Anticyclones bring stable weather and clear skies.

Super Cyclone (1999) The eastern coast of India is one of the most cyclone-hit regions of the world. Cyclones that develop over the Bay of Bengal generally strike this region during the months of May, October and November. One such cyclone, named the Super Cyclone, hit the state of Odisha on 28 October 1999.

Fig. 2.12 Damage caused by a cyclone

During the Super Cyclone, wind speeds reached up to 300 kilometres per hour. These winds pushed a high wall of water onto the shore, flooding large areas along the coast.

The region hit by the cyclone was inhabited mostly by poor fishermen, who lived in thatched huts. Their homes were easily destroyed by the strong winds and the following flood. More than 10,000 people and large numbers of domestic animals were killed. About 15 million people were left homeless. Vast areas of farmland were flooded, causing a huge loss of crops.

The weather office had broadcast warnings days before the cyclone struck. However, proper steps had not been taken to move people to safety. Many of those killed were poor fishermen, who could not afford to lose the day's catch and had gone out to sea to fish ignoring the warnings. Also, the damage would have been far less if large stretches of Odisha's coastal forests had not been cleared.

Things to Remember

- The blanket of air surrounding the earth is known as the atmosphere. It is divided into five main layers: troposphere, stratosphere, mesosphere, thermosphere and exosphere.
- Weather is the state of the atmosphere at a particular place at a particular time. Climate is the regular pattern of weather conditions at a particular place, observed over a period of time.
- The solar energy that reaches the earth first heats up the earth's surface, which then radiates heat to the atmosphere.
- The temperature of the atmosphere is measured with the help of a thermometer.
- At a particular place, temperature varies with the time of the day and with seasons. This is due to variations in the inclination of the sun's rays and the duration of sunlight.

- Locationwise variations in temperature are caused by the latitude and altitude of a place as well as its distance from the sea.
- Atmospheric pressure is the weight of the atmosphere pushing down on a unit area on the earth's surface.
- A barometer is an instrument used for measuring atmospheric pressure.
- Atmospheric pressure decreases with increasing altitude. It also decreases with increase in temperature.
- Air moves from high-pressure areas to low-pressure areas. The horizontal movement of air is called wind.
- A wind vane shows the direction from which a wind is blowing, and an anemometer shows wind speed.

Exercises

A. *Answer the following questions orally.*

1. What are the five main layers of the earth's atmosphere?
2. How would you calculate the mean temperature of a place on a certain day?
3. Name the permanent pressure belts of the world.
4. What are the three main types of winds?
5. What is the monsoon?
6. Which part of India is one of the most cyclone-hit regions of the world? In which months are cyclones most frequent here?

B. *Answer the following questions in not more than 20 words.*

1. What is the atmosphere?
2. What are the two main constituents of the earth's atmosphere?
3. What is meant by air pollution?
4. Define atmospheric pressure.
5. Name the instrument used for measuring atmospheric pressure.
6. How does temperature affect pressure?

C. *Answer the following questions in not more than 40 words.*

1. What do you understand by weather and climate?
2. What is meant by range of temperature?
3. Explain the greenhouse effect.
4. What is wind and how is it caused?
5. What are planetary winds? Name the three types of planetary winds.

D. *Answer the following questions in not more than 100 words.*

1. How does the atmosphere receive nitrogen, oxygen and carbon dioxide?
2. Describe the layer of the atmosphere nearest to the earth's surface.
3. How does temperature vary from place to place?
4. State the locations of the important pressure belts of the world.
5. Write briefly about the Super Cyclone.

E. *Think and answer.*

1. Although atmospheric gases are used up in certain processes, the composition of the lower part of the atmosphere remains fairly constant. Why?
2. How does the heating of the atmosphere result in the cyclic movement of air near the earth's surface?
3. The higher the altitude of a place the lower is its temperature. Why?
4. Is it possible for a mountain near the equator to have snow at the top? Give reasons for your answer.
5. Why do you think Delhi has a higher range of temperature than Mumbai?
6. Why do the permanent wind belts change their positions slightly from season to season?

F. *Fill in the blanks.*

1. The atmosphere is held to the earth's surface by ..... .
2. ..... protects us from the harmful ultraviolet rays of the sun.
3. A thermometer is for air temperature what a ..... is for atmospheric pressure.
4. The equatorial low-pressure belt lies between the ..... and ..... latitudes.

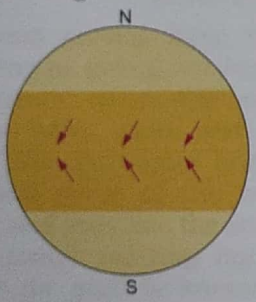
5. Winds blow from regions of ..... pressure to regions of ..... pressure.
6. A wind is named after the direction ..... which it blows.
7. The speed of wind blowing between two regions depends on the ..... difference between the regions.
8. The ..... is an instrument for measuring the speed of wind.
9. The ..... blow from the polar high-pressure belts to the subpolar low-pressure belts.

G. State whether the following statements are true or false.

1. The higher the altitude of a place, the lower is its temperature.
2. Permanent winds are also called prevailing or planetary winds.
3. The polar winds are extremely hot winds.
4. The polar winds are also known as polar easterlies.
5. A local wind always blows in the same direction.
6. During an anticyclone, winds blow in an anticlockwise direction in the Northern Hemisphere.

H. Choose the correct option.

1. The ionosphere helps in radio communication as it contains
   (a) dust particles (b) charged particles called ions
   (c) water vapour (d) ozone
2. The temperature varies with seasons because of variations in
   (a) the number of daylight hours (b) the inclination of the sun's rays
   (c) both (a) and (b) (d) neither (a) nor (b)
3. The atmospheric pressure over a cold region is
   (a) high (b) low (c) normal (d) none of these
4. A wind vane shows
   (a) wind speed (b) wind direction (c) air pressure (d) all of these
5. In both the hemispheres, the subtropical high-pressure belt develops near the latitude
   (a) 40° (b) 30° (c) 80° (d) 60°
6. The diagram shows the



   (a) westerlies (b) polar winds
   (c) trade winds (d) westerlies and trade winds
7. A sea breeze moves towards the land during
   (a) day (b) night (c) both day and night (d) winter
8. The monsoon is a type of
   (a) planetary wind (b) trade wind (c) seasonal local wind (d) westerly wind
9. Which of the following would you find in a cyclone?
   (a) clear weather (b) high pressure at the centre
   (c) low pressure at the centre (d) none of these

I. Match the following by putting a suitable number from Column A in each row of Column B. One has been done for you.

	A	B	
1.	Monsoons	High pressure	
2.	Trade winds	Seasonal winds	1
3.	Cyclones	Permanent winds	
4.	Anticyclones	Local winds	
5.	Land and sea breezes	Low pressure	

Things to Do

Experiment

- Find the maximum and minimum temperatures in your town during any week in May. Compare these figures with those of any week in July. In which month is there a greater variation in day and night temperatures?

Group discussion

- The average monthly temperatures of three places—one each from the three heat zones—are given below. Have a group discussion on the conclusions you can draw from this data.

	Average monthly temperature (°C)											
	J	F	M	A	M	J	Jy	A	S	O	N	D
Singapore (tropical)	26.1	26.7	27.2	27.6	27.8	28.0	27.4	27.8	27.3	27.2	26.7	26.3
London (temperate)	4	4	7	9	13	16	18	17	15	11	7	5
Eismitte, Greenland (frigid)	-43	-47	-40	-33	-24	-17	-13	-11	-11	-36	-43	-38

- Organise a group discussion in your class on the topic 'Global warming must be stopped'.

Project

- Make a chart illustrating the monsoon's effects and its importance to India.
- Cyclone Phailin had devastated the eastern part of India in October 2013. Write a report on the effect of the cyclone on crops, animals and people, and the measures taken by the government to rehabilitate those affected.

3 Water

Water is essential for life. The earth has this necessary ingredient of life in the form of the hydrosphere. On earth, water exists in three states—solid, liquid and gaseous. The ice caps in the polar regions, the waters of the oceans and rivers, and the water vapour in the atmosphere are all part of the hydrosphere.

Evaporation

Water can change from one form to another by absorbing or giving out heat. In summer, when the temperature rises, the snow on the mountains absorbs heat, melts and runs down in streams. During the day, water bodies on the earth absorb heat, and some of the water changes into water vapour and goes into the atmosphere. *The process by which water (or any liquid) changes into water vapour (or gas) is known as evaporation.* Water evaporates continuously from oceans and other water bodies, and from the land surface. Evaporation is highest on hot, windy and dry days. Water vapour is also emitted by plants, mainly from the leaves. This process is called *transpiration.*

Humidity

The amount of water vapour present in the atmosphere is known as humidity. Humidity varies from place to place and from time to time.

- It is lesser over land than over the oceans.
- It is greater over hot regions than over cold regions.
- It increases in summer and decreases in winter.
- It also decreases as one goes higher up into the atmosphere.

When it is hot, we perspire, or sweat. The sweat evaporates, and this has a cooling effect. However, if the humidity is high, the rate of evaporation is reduced. Therefore, on a hot, humid day, we perspire but the sweat does not evaporate. This makes us feel uncomfortable.

Evaporation is a continuous process, but the atmosphere cannot keep storing an endless amount of water vapour. At a particular temperature, the air can hold only a certain amount of water vapour. When the air contains as much water vapour as it can hold at a given temperature, it is said to be *saturated.* Warm air can hold more water vapour than cold air can.

Condensation

With a fall in temperature, the capacity of the air to hold water vapour decreases. Thus, air may become saturated when cooled. Air may get saturated even without cooling, if evaporation keeps on increasing the amount of water vapour in the air.

When the temperature of saturated air falls, the air is no longer able to hold all the water vapour it is carrying. The excess vapour then changes into tiny droplets of water. This process is called *condensation.*

Condensation of water vapour leads to the formation of clouds, fog, mist and dew. For condensation to occur, not only must the air be saturated, but there must also be a surface on which the water vapour can condense. For example, water vapour may condense around the dust particles present in the air.

Clouds When warm, moist air rises upwards, it gets cooled. Ultimately, it gets saturated. When its temperature falls further, some of the water vapour in it condenses around dust particles and forms minute droplets of water. If the temperature is low enough, the vapour may condense into tiny crystals of ice. These droplets or crystals are so light that they float in the air, carried by air currents. Visible masses of floating water droplets or ice crystals are called clouds.

Fog, mist and dew A fog is a very dense cloud of minute water droplets. Fogs occur when condensation takes place in the lower layers of the atmosphere, very close to the surface of the land or above a body of water. Fogs reduce visibility. They create difficulties for drivers, and hinder air and water traffic. A mist is similar to a fog but is less dense, as the droplets formed are larger than those of a fog. In industrial areas, the smoke from factories mixes with fog to form what is called *smog*.

On cold, clear nights, the surface of the land cools down rapidly after sunset. The air in contact with the cold ground also cools. This may cause the air to become saturated. Condensation begins on further cooling. The droplets of water so formed are deposited on cold surfaces like leaves and blades of grass, and are known as dew. In very cold weather dew is deposited as tiny crystals of ice. This is known as *frost*.

Precipitation

Clouds have millions of tiny water droplets. Some of these droplets fall very slowly, while some are carried up by air currents. The moving droplets bump into each other and stick together to form larger droplets. In this way, the droplets grow in size until they are too heavy to float. Then they fall as rain. Like water droplets, ice crystals present in clouds may also grow in size, become heavy and fall as flakes of snow.

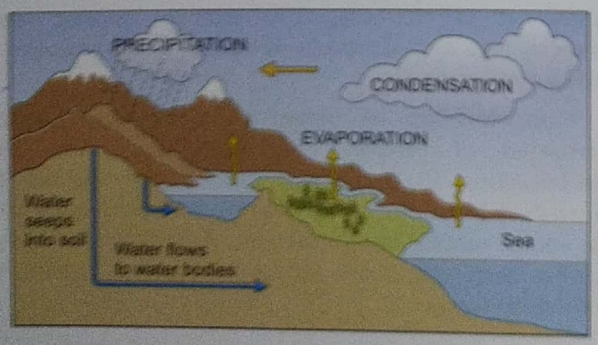


Fig. 3.1 Evaporation, condensation and precipitation

The falling of condensed water vapour is called precipitation.

Water Cycle

The water that evaporates goes into the atmosphere as water vapour. Some of this water vapour condenses to form clouds, and ultimately comes back to the earth's surface as precipitation. The cycle of evaporation, condensation and precipitation goes on all the time, and is known as the *water cycle*.

The natural supply of water varies from place to place and from season to season. However, at any given place, it follows a more or less regular pattern. Our activities sometimes affect the natural supply of water. For example, when we cut down trees, transpiration is reduced and lesser water vapour is released into the atmosphere. Due to the shortage of water vapour, cloud formation is reduced and there is lesser rainfall. We also pollute water by adding dirty or harmful substances to it. It then becomes unfit for use. This causes a shortage of water even when the natural supply is abundant. So, we must make sure that the natural supply of water is maintained, and keep the natural sources of water free from pollution. In other words, we must *conserve* water.

Measurement of Precipitation

Rainfall is the most common form of precipitation. It is usually measured in millimetres. Annual rainfall is generally expressed in centimetres. Suppose the weather report in a newspaper says that 15 millimetres of rainfall occurred in a town on a particular day. This means, if the rain falling in that town on that day were allowed to collect over a plane surface, the level of rainwater over that surface would be 15 millimetres high.

Generally, the rain falling over an area does not get a chance to collect. It either seeps into the soil, flows into water bodies or evaporates. The amount of rainfall at a place over a particular period is measured with the help of a *rain gauge*. A rain gauge consists of a cylinder fitted with a collecting vessel at the bottom and a funnel at the top. Rain falls into the funnel and gets collected in the vessel below. At the end of the day or the period of time for which the rainfall is being measured, the rainwater collected in the vessel is poured into a measuring jar to find out the amount of rainfall.

Types of Rainfall

Broadly speaking, there are three types of rainfall depending upon how air is lifted upwards into the atmosphere.

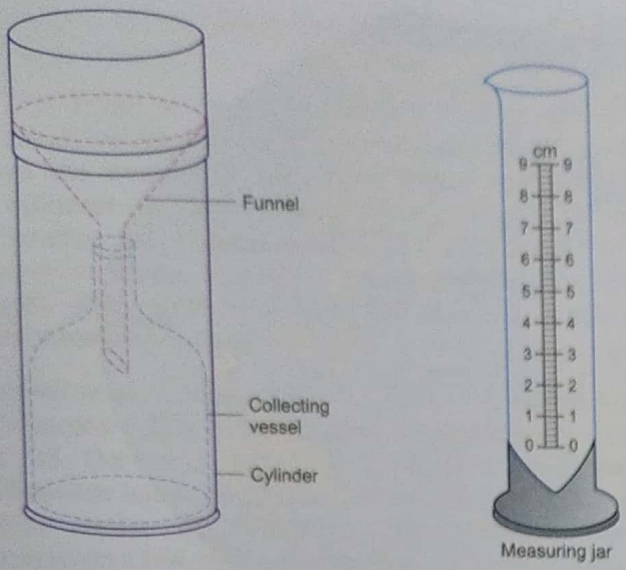


Fig. 3.2 A rain gauge

Relief rainfall Relief rainfall occurs when a mountain or highland lies in the path of moist winds. The side of the mountain that faces the wind is called the *windward* side. The warm, moist air is forced to rise along the windward slope of the mountain. As the air ascends it cools and gets saturated, and finally there is condensation and rainfall. As the air descends down the other side of the mountain, known as the *leeward* side, it becomes warmer and drier. So, the leeward side receives little or no rainfall. Hence, this area is known as the *rain-shadow* area. In India, the western side of the Western Ghats receives heavy rainfall. But, the eastern side, being a rain-shadow area, receives only moderate rainfall. Relief rainfall is also called orographic rainfall ('*oros*' in Greek means mountain).

Convectional rainfall Convectional rain occurs throughout the year in the equatorial belt. During the day, the nearly vertical rays of the sun heat up the land surface. The air near the surface also gets heated and rises. The cooler air from above sinks, only to be heated and forced to rise again. Thus, a convectional air current is set up. As the hot air rises, it cools and gets saturated. Clouds form when the air cools further to form water droplets or ice crystals. These clouds lead to very heavy rainfall towards the afternoon or evening. This kind of rain is often accompanied by thunder and lightning.

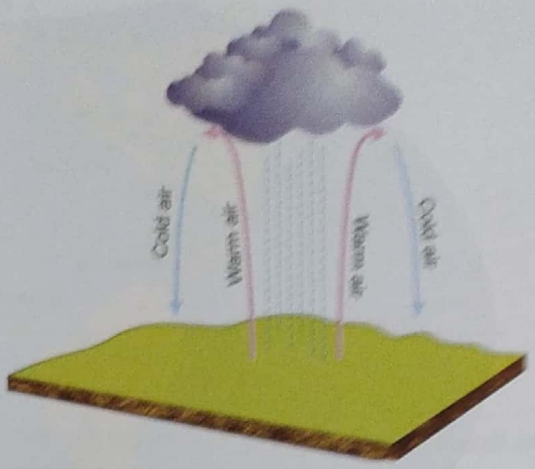


Fig. 3.4 Convectional rainfall

Frontal, or cyclonic, rainfall Within a cyclone, warm air and cold air from opposite directions often meet. Where they meet, a zone of separation, called a *front*, is formed. Warm air, which is lighter, rises obliquely over the heavier cold air. As the warm air rises, it cools, condenses and causes rain. Frontal rainfall is very common in the subpolar low-pressure belts. Here, cyclones occur when the warm westerlies are forced to rise over the cold polar air.

Major Water Bodies

Water bodies cover about 71 per cent of the earth's surface. At present, the Southern Hemisphere has much more water and much less land than the Northern Hemisphere has. However, the distribution of land and water bodies changes slowly with time. Tectonic processes create mountains where once there were oceans and separate lands that were once parts of the same land mass. Spells of warm climate cause ice caps to melt, raising the sea level and submerging lowland areas. And, spells of cold climate

Fig. 3.3 Relief rainfall—warm, moist air is lifted along the windward side of the mountain, leading to the formation of clouds and rainfall.

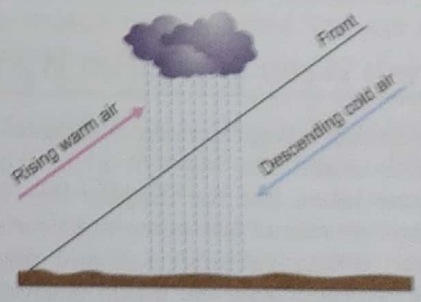


Fig. 3.5 Frontal rainfall

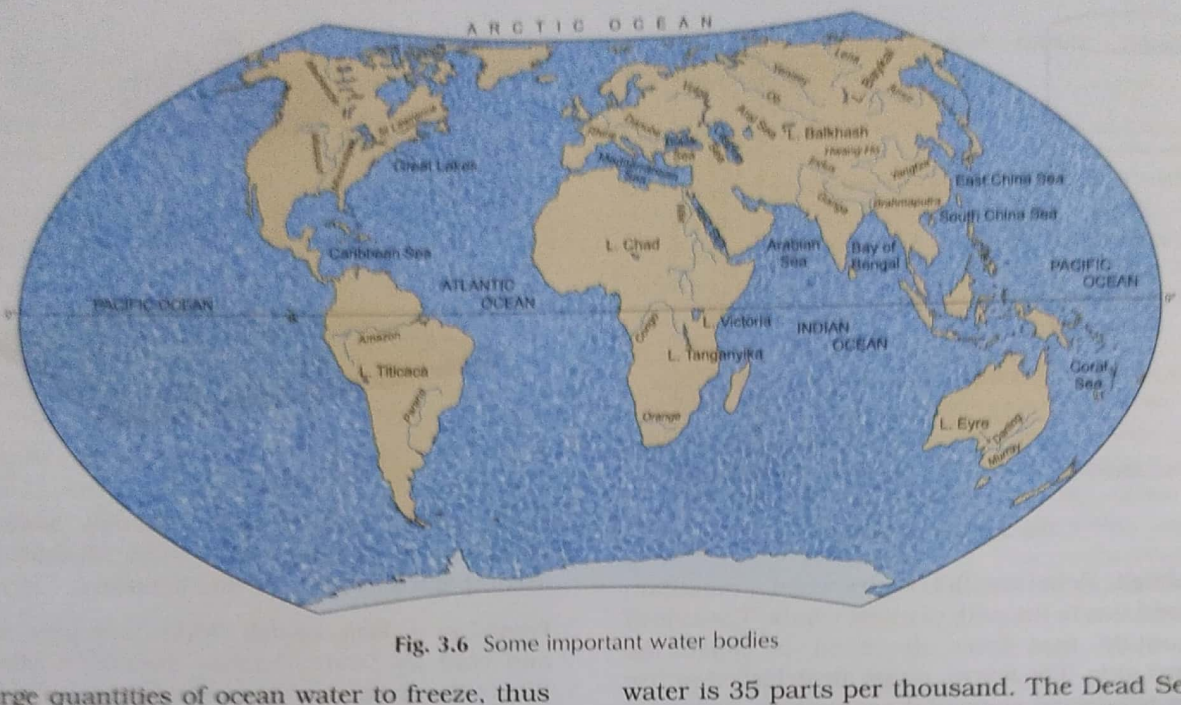


Fig. 3.6 Some important water bodies

cause large quantities of ocean water to freeze, thus lowering the sea level and exposing new lands.

Oceans account for about 97 per cent of the water present on earth. Oceans heat up and cool down much more slowly than land. They can store much more heat than the atmosphere can. They are also the main source of water vapour in the atmosphere. These properties of oceans influence the climate. Places near the coast do not usually experience extreme temperatures, and also get more rainfall than places located further inland. The mineral deposits found on ocean floors and many of the marine organisms living in oceans are economically important to us. Besides, the oceans have been used for trade and transport between countries and continents for centuries.

The major water bodies found on land are rivers, lakes and glaciers. They hold only a small percentage of the water on earth. Rivers influence human life to a great extent. They provide water for drinking, irrigation, power generation, etc. They also serve as transport routes.

Fresh Water and Saline Water

Water containing a large amount of dissolved salts is called *saline water*. The water of oceans and seas is saline. Some lakes, like the Caspian Sea, also have saline water. We cannot use saline water for drinking. But we can obtain common salt and many other chemicals by evaporating sea water. Normally, every 1,000 grams of ocean water contains about 35 grams of dissolved salts. So, the average salinity of ocean water is 35 parts per thousand. The Dead Sea, lying between Jordan and Israel, however, has a salinity higher than 240 parts per thousand! As saline water is denser than ordinary water, it is easier for swimmers to float in the Dead Sea. Water that contains very little dissolved salts is called *fresh water*. Only about 3 per cent of the earth's water is fresh water. Of this, about 2 per cent is ice. Most of the remaining 1 per cent is present underground. Only a very small part of it is found on the earth's surface in rivers and freshwater lakes.

Motions of Ocean Waters

The waters of the oceans are never still. In fact, there are three types of motions of these waters—waves, tides and currents.

Waves

The action of winds causes disturbances on the surface of water. When a wind blows over the ocean surface, it pushes down the small particles of water. Each particle is pushed down and it comes up again. So, it actually moves up and down in a circular path. But the particles are all tightly packed together. So, every particle passes on its motion to the next. The rhythmic movement of the water particles produces a pattern, which we see as *waves*. The disturbance, or the wave, travels in the direction of the wind. It is important to note that water actually does not travel with the wave. This is somewhat like the spectators in a stadium doing the Mexican wave. Each spectator

only moves up and down, but the wave passes right round the stadium.

The height of the waves depends on the speed of the wind. During a storm the waves are very high, and when the weather is calm, the waves are gentle. A *tsunami* is a very long wave caused by a submarine or coastal earthquake, landslide or volcanic eruption. As it nears the coast, it builds up in height. When it crashes onto the shore, it causes enormous destruction.

Tsunami in the Indian Ocean in 2004 A powerful earthquake occurred on the floor of the Indian Ocean on 26 December 2004. It originated near the Indonesian island of Sumatra, where the Indian plate slides under the Eurasian plate. While most earthquakes last only a few seconds, this one lasted nearly ten minutes. It raised a part of the ocean floor by several metres, causing tsunamis that killed more than 275,000 people.

The regions worst affected were the coasts of Indonesia, South India, Sri Lanka and Thailand. Some places in these regions were hit by waves almost 30 metres high. The tsunamis also travelled across the globe, causing deaths on the eastern coast of Africa. They were even noticed on the western coasts of North and South America.

Tsunamis are rare in the Indian Ocean. So, a tsunami warning system, like the one for the Pacific Ocean, had not been developed for this region. Most of the victims were, therefore, caught unprepared. And, they could not recognise warning signs such as the temporary receding of the ocean from the shore and frothing bubbles near the water's edge. However, Tilly Smith, a British schoolgirl holidaying in Phuket, Thailand, did recognise the warning signs. She saved many lives by raising a timely alarm.

In India, about 16,000 people were killed. The Andaman and Nicobar Islands were the worst affected. Some islands in the region were completely washed away. On the mainland, tsunamis travelled several kilometres inland, causing widespread destruction and deaths in Andhra Pradesh, Pondicherry (Puducherry), Tamil Nadu and Kerala.

Tides

The level of water in a sea or ocean rises and falls alternately at regular intervals every day. These changes in the level of sea water are called *tides*. When the level of sea water rises, and water moves further up the shore, it is *high tide*. When the level of water falls, and water recedes from the shore, it is *low tide*. A place usually has high and low tides twice in a day.

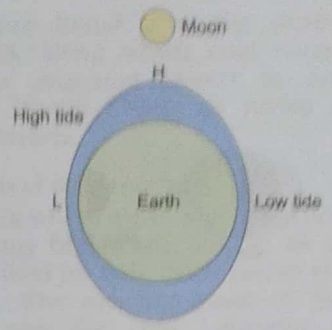


Fig. 3.7 Tides

Tides are caused by the gravitational pull of the moon and the sun on the earth. The attraction of the moon is stronger because the moon is much closer to the earth than the sun is. In Figure 3.7, note how the moon's attraction on the ocean waters causes water to move from regions like L to regions like H. As a result, water piles up in certain regions, producing high tides. In other regions, the water recedes, producing low tides.

Sometimes the pulls of the moon and the sun act in the same line. This happens during each full moon (*purnima*) and new moon (*amavasya*), when the sun, the moon and the earth are practically in a line. On such days, the high tides are higher than usual and the low tides, lower than usual. Such tides are called *spring tides*.

When the moon is in the first quarter or the third quarter, the positions of the moon and the sun with respect to the earth are at right angles to each other. The height of the tide produced by the moon's attraction is reduced by the sun's attraction on the waters in the low-tide regions. On such days, high tides are not as high as usual, and low tides are not as low. Such tides are called *neap tides*.

How tides are useful Tides are helpful to us in the following ways:

- The rise in water level during high tide allows big ships to enter or leave harbours safely. The ports of Kandla in Gujarat and Diamond Harbour in West Bengal depend on such tides.
- During high tide, water rushes up the mouths of rivers. This helps large ships to move in and out of river ports like Kolkata, London, Hamburg, Rotterdam, and New York.
- The saline waters of the sea freeze at a lower temperature than river water does. In cold countries, the sea water rushing in during high tide prevents harbours from freezing in winter. The harbour of London is one such harbour.

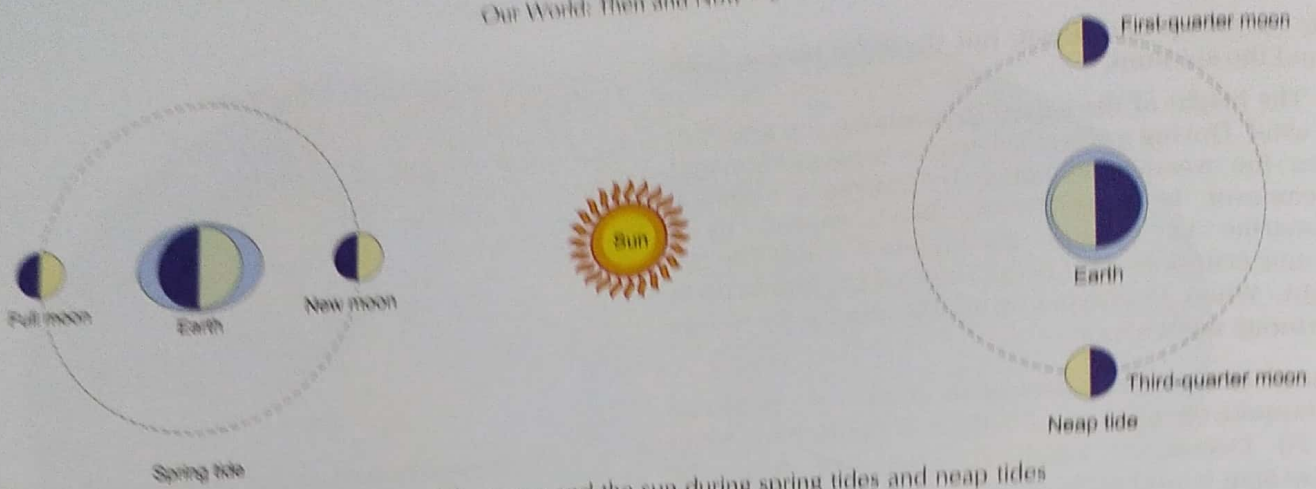


Fig. 3.8 Positions of the moon and the sun during spring tides and neap tides

- The water at high tide can be stored behind specially built dams and used for hydroelectric power generation.

Ocean Currents

In certain parts of the oceans, the waters move along a definite direction. These masses of ocean water moving in definite directions are called *ocean currents*. Comparatively slow-moving masses of water are called *drifts*. Often, as a current moves away from its origin, it becomes a drift.

Ocean currents are caused chiefly by the action of the planetary winds on the surface waters of the oceans. The shapes of the land masses modify the courses of ocean currents. Due to the rotation of the earth, the currents in the Northern Hemisphere are deflected to the right of their paths, while in the Southern Hemisphere they are deflected to the left. Generally, the currents move clockwise in the Northern Hemisphere and anticlockwise in the Southern Hemisphere.

The currents that carry warm waters from the tropical region to the higher latitudes are warm currents. The currents that carry colder waters from the higher latitudes to the lower latitudes are cold currents. Generally, warm currents flow along the east coasts of the continents, while cold currents flow along the west coasts.

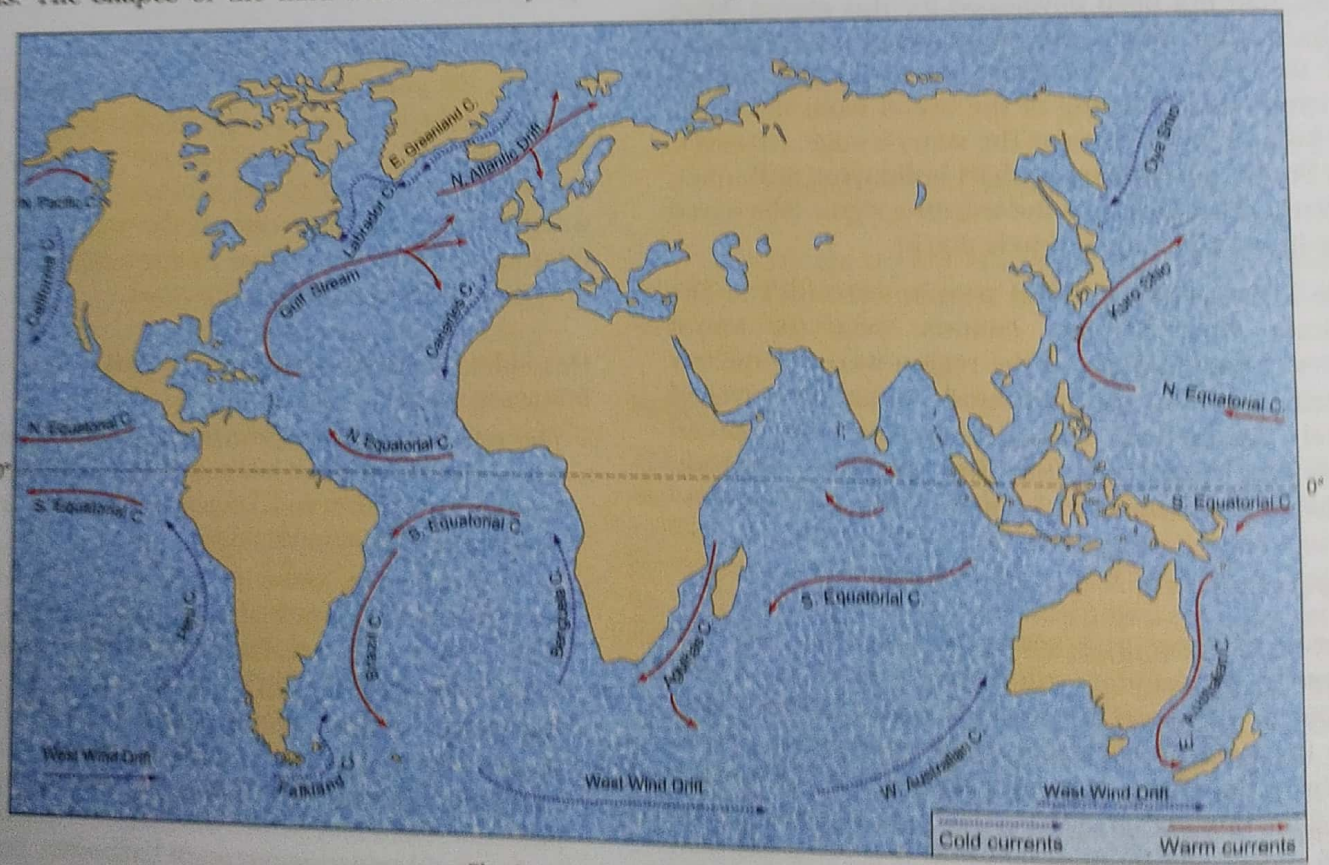


Fig. 3.9 Major ocean currents

The colder and saltier waters of the polar regions, being heavy, sink below the surface waters. They are carried by deep ocean currents towards the lower latitudes.

Climate and ocean currents Ocean currents influence the climate of coastal regions. In fact, winds blowing from the sea often carry the influence of ocean currents far inland.

- Cold currents make a place colder than other places on the same latitude. Warm currents make a place somewhat warmer. For example, the ports of Norway located within the Arctic Circle remain free of ice in winter due to the warming influence of the North Atlantic Drift. Yet, ports on the Labrador coast of North America, lying at much lower latitudes, freeze over in winter under the influence of the cold Labrador Current.
- Ocean currents also influence rainfall. Winds passing over warm currents pick up moisture and cause heavy rainfall. Eastern USA and the western coast of Europe receive such rainfall. On the other hand, winds passing over cold currents become cool and dry, and bring hardly any rainfall. Hence, deserts are found near the western coasts of continents, along which cold currents generally flow. The Atacama Desert in South America and the Namib Desert in Africa are examples of such deserts.

Other effects of ocean currents

- The places where warm and cold currents meet are rich in tiny organisms, known as plankton, that serve as food for fish. Such places are good fishing grounds. The meeting place of the warm Gulf Stream and the cold Labrador Current near Newfoundland, and the meeting place of the warm Kuro Shio and the cold Oya Shio, or Kuril Current, near Japan are good fishing grounds.
- Ocean currents influence navigation, too. If a ship sails along a current, its speed increases. If it sails against a current, its speed decreases. So, in order to save time and fuel, ships generally sail with the current. Warm currents also help to melt icebergs, which are dangerous for ships. Sometimes, however, ocean currents cause problems for ships. Thick fogs occur where cold and warm currents meet. This reduces visibility.

Things to Remember

evaporation	the process by which a liquid changes into a gas
humidity	the amount of water vapour present in the atmosphere
condensation	the process by which a gas or vapour changes into a liquid; it causes the formation of clouds, fog, mist and dew
precipitation	the falling of condensed water vapour, as water droplets or ice crystals, onto the earth's surface
rain gauge	an instrument for measuring rainfall
relief rainfall	rain caused by the rising of moist air along the slope of a mountain
convectional rainfall	rain caused by the rising of air heated on contact with the hot ground
frontal rainfall	rain caused by the rising of warm air over cold air
wave	a disturbance on the surface of water, caused by the rhythmic movement of water particles due to the action of winds
tides	the alternate rise and fall in the level of sea water
ocean current	mass of ocean water moving in a particular direction

Exercises

A. Answer the following questions orally.

1. What is evaporation?
2. How is a fog different from a mist?
3. What is frost? On what kind of night would you expect it?
4. What kind of rainfall occurs when warm and cold air meet?
5. How much of the earth's surface is covered by water bodies?
6. What are waves?

7. What kind of ocean current is called a drift? Give an example.
8. Name one warm ocean current and one cold ocean current.

B. Answer the following questions in not more than 20 words.

1. Define humidity.
2. When is air said to be saturated?
3. What is meant by water cycle?
4. What are the three main types of rainfall?
5. In which general directions do ocean currents move in the Northern and Southern hemispheres?

C. Answer the following questions in not more than 40 words.

1. How does humidity vary from place to place and from time to time?
2. Why is frontal rainfall common in the subpolar low-pressure belts?
3. What do you understand by saline water and fresh water?
4. What are tides and why do they occur?
5. Why does the harbour of London not freeze during winter?

D. Answer the following questions in not more than 100 words.

1. What is condensation? How are clouds formed?
2. Define precipitation. Explain how it occurs.
3. What is a tsunami? What caused killer tsunamis in the Indian Ocean in December 2004? Which regions were the worst affected? Why did so many people die?
4. How do ocean currents modify the climate of coastal regions? Give one example.

E. Think and answer.

1. Why do clothes dry faster on hot, dry and windy days?
2. Mumbai on the western side of the Western Ghats gets more rainfall than Pune on the other side. Why?
3. Do all the ports located within the Arctic Circle freeze over during winter? Give reasons for your answer.

F. Fill in the blanks.

1. When the temperature of saturated air ..... the water vapour in the air starts condensing.
2. A mixture of fog and smoke is known as ..... .
3. Relief rainfall is also called ..... rainfall.
4. A ..... is an instrument used for measuring rainfall.
5. Waves are caused by the action of ..... .
6. Ocean currents are caused chiefly by the action of the ..... winds.
7. Warm ocean currents move from ..... latitudes to ..... latitudes.

G. State whether the following statements are true or false.

1. Condensation of water vapour leads to the formation of clouds, fog, mist and dew.
2. Fogs occur when condensation takes place in the higher layers of the atmosphere.
3. Oceans account for about 97 per cent of the water present on the earth.
4. Neap tides occur during new moon and full moon.
5. Deserts are found near the eastern coasts of continents, along which warm currents generally flow.

H. Choose the correct option.

1. When the temperature rises, the capacity of the atmosphere to hold water vapour
   (a) rises (b) falls (c) remains constant (d) may rise or fall
2. Smog is common in
   (a) industrial areas (b) agricultural areas (c) high mountain areas (d) forest areas
3. Convectional rainfall is most common in the
   (a) polar regions (b) equatorial region (c) subpolar regions (d) subtropical regions
4. The forces of the moon and the sun act in the same line giving rise to spring tides every
   (a) full moon day (b) new moon day
   (c) full moon and new moon day (d) spring season
5. Deserts are found near the western coasts of continents because
   (a) warm currents flow along these coasts

(b) the winds passing over the cold currents flowing along these coasts are dry
(c) cold and warm currents meet near these coasts
(d) no currents flow in these regions

6. Plankton thrive in areas where
(a) two cold ocean currents meet
(b) two warm ocean currents meet
(c) warm and cold ocean currents meet
(d) the salinity of the water is very high

7. The region near Newfoundland is a rich fishing zone because
(a) unusually high tides occur here
(b) the warm Gulf Stream and the cold Labrador Current meet in this region
(c) the warm Gulf Stream flows along this region
(d) the North Atlantic Drift raises the temperature of the waters

Things to Do

Assignment

- From your local newspaper, note the temperature and humidity of your place on a dry, sunny day and a wet, cloudy day in summer. Write which day is more uncomfortable and why.

Mapwork

- On an outline map of the world, show the important warm and cold ocean currents of the world. Use red for warm currents and blue for cold currents.

Group activity

- Nantes in France is warmer than St John's in Newfoundland, although they are approximately on the same latitude. Can you say why? Look at a world map in your atlas. Try to find three pairs of coastal towns, each pair lying approximately on the same latitude but with different ocean currents flowing near them. Discuss which place in each pair would be warmer.

Group discussion

- Organise a group discussion in your class on the topic 'Ocean water can be used for drinking, agriculture and power generation'.

Project

- Prepare a report on the destruction of life and property caused by the tsunami that affected India in 2004.
- Select two major ports from two different continents. Prepare a report on how they are affected by the following.
(a) Tides
(b) Ocean currents in summer and winter

❑