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The National Anthem of Sri Lanka

Sri Lanka Matha
Apa Sri Lanka Namo Namo Namo Namo Matha
Sundara siri barinee, surendi athi sobamana Lanka
Dhanya dhanaya neka mal palaturu piri jaya bhoomiya ramya
Apa hata sepa siri setha sadana jeewanaye matha
Piliganu mena apa bhakthi pooja Namo Namo Matha
Apa Sri Lanka Namo Namo Namo Namo Matha
Oba we apa vidya
Obamaya apa sathya
Oba we apa shakthi
Apa hada thula bhakthi
Oba apa aloke
Apage anuprane
Oba apa jeevana we
Apa mukthiya oba we
Nava jeevana demine, nithina apa pubudukaran matha
Gnana veerya vadawamina regena yanu mana jaya bhoomi kara
Eka mavakage daru kela bevina
Yamu yamu vee nopama
Prema vada sema bheda durerada
Namo Namo Matha
Apa Sri Lanka Namo Namo Namo Namo Matha

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ආනන්ද සමරකෝන්

ஒர தாய் மக்கள் நாமாவோம்
ஒன்றே நாம் வாழும் இல்லம்
நன்றே உடலில் ஓடும்
ஒன்றே நம் குருதி நிறம்

அதனால் சகோதரர் நாமாவோம்
ஒன்றாய் வாழும் வளரும் நாம்
நன்றாய் இவ் இல்லினிலே
நலமே வாழ்தல் வேண்டுமன்றோ

யாவரும் அன்பு கருணையுடன்
ஒற்றுமை சிறக்க வாழ்ந்திடுதல்
பொன்னும் மணியும் முத்துமல்ல - அதுவே
யான்று மழியாச் செல்வமன்றோ.

ஆனந்த சமரக்கோன்
கவிதையின் பெயர்ப்பு.

Being innovative, changing with right knowledge,
Be a light to the country as well as to the world.

Message from the Hon. Minister of Education

The past two decades have been significant in the world history due to changes that took place in technology. The present students face a lot of new challenges along with the rapid development of Information Technology, communication and other related fields. The manner of career opportunities are liable to change specifically in the near future. In such an environment, with a new technological and intellectual society, thousands of innovative career opportunities would be created. To win those challenges, it is the responsibility of the Sri Lankan government and myself, as the Minister of Education, to empower you all.

This book is a product of free education. Your aim must be to use this book properly and acquire the necessary knowledge out of it. The government in turn is able to provide free textbooks to you, as a result of the commitment and labour of your parents and elders.

Since we have understood that the education is crucial in deciding the future of a country, the government has taken steps to change curriculum to suit the rapid changes of the technological world. Hence, you have to dedicate yourselves to become productive citizens. I believe that the knowledge this book provides will suffice your aim.

It is your duty to give a proper value to the money spent by the government on your education. Also you should understand that education determines your future. Make sure that you reach the optimum social stratum through education.

I congratulate you to enjoy the benefits of free education and bloom as an honoured citizen who takes the name of Sri Lanka to the world.

Akila Viraj Kariyawasam
Minister of Education

Foreword

The educational objectives of the contemporary world are becoming more complex along with the economic, social, cultural and technological development. The learning and teaching process too is changing in relation to human experiences, technological differences, research and new indices. Therefore, it is required to produce the textbook by including subject related information according to the objectives in the syllabus in order to maintain the teaching process by organizing learning experiences that suit to the learner needs. The textbook is not merely a learning tool for the learner. It is a blessing that contributes to obtain a higher education along with a development of conduct and attitudes, to develop values and to obtain learning experiences.

The government in its realization of the concept of free education has offered you all the textbooks from grades 1-11. I would like to remind you that you should make the maximum use of these textbooks and protect them well. I sincerely hope that this textbook would assist you to obtain the expertise to become a virtuous citizen with a complete personality who would be a valuable asset to the country.

I would like to bestow my sincere thanks on the members of the editorial and writer boards as well as on the staff of the Educational Publications Department who have strived to offer this textbook to you.

W. M. Jayantha Wickramanayaka,
Commissioner General of Educational Publications,
Educational Publications Department,
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2019.04.10

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Introduction

This textbook was compiled by the Educational Publications Department in accordance with the syllabus prepared by the National Institute of Education for the use of Grade 9 students in the Sri Lankan school system with effect from 2018.

An effort has made here to arrange the subject content to suit the national educational goals, common national competencies, the objectives of teaching science and the content of the syllabus.

The subject of science directs the student towards a more active learning process in a manner as to develop knowledge, skills and attitudes needed for a developmental scientific thought.

In the compilation of this textbook, subject content is largely arranged based on experiences of daily life. It has contributed to prove the fact that the subject of science is very much closer to the day to day life.

The compilation of this textbook based on activities is a distinctive feature. The activities are prepared based on the scientific method in order to develop knowledge, skills and attitudes. Activities that can be performed individually at home as well as in school are incorporated here. We believe that learning through activities would contribute to create a liking and an interest in the child towards learning science.

At the end of each chapter, a summary, a series of exercises and a glossary were included. It enables the student to identify the important details of the chapter as well as to self evaluate the achievement of learning outcomes.

For the purpose of directing the student to study further about the subject matter, more information is included in the "For extra knowledge". It is given only to broaden the subject area of the child and certainly not to ask questions at term tests.

Assignments and projects are given with the purpose of directing the student towards an explorative study. It enables the students to develop the higher order skills such as application, analysis and synthesis of the concepts achieved from the lesson.

We strongly believe that the duty of the teachers who teach science is to direct the student for self learning instead of teaching the student using traditional teaching methods. This textbook can be utilized by the teachers as a learning tool to execute their teaching role properly.

We would like to bestow our sincere thanks on the professional writer Dr. K. Ariyasinghe.

We kindly request you to forward your comments and suggestions on this textbook to the Educational Publications Department.

Board of Writers and Editors

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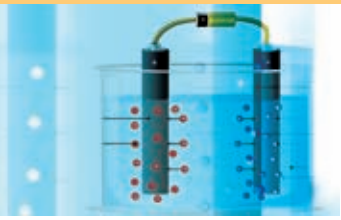
Cover Page :- Represents Green Concept

10 Electrolysis



10.1 Electrolysis

There was a news item of a woman who has been cooking food keeping an aluminum pan on a electric leaky hot plate was struck with an electric shock when she was pouring coconut milk into the curry. She had got the shock even though she was not touching the pan. How would this have happened? The leaking electric current should have passed through coconut milk and entered the woman's body. Your elders must have told you that connecting electric plugs with wet hands is dangerous. The reason for the electric leaks stated above should be the conduction of electricity through a liquid medium.

Let us do activity 10.1 to find out whether electricity is conducted through any substance in liquid state.

Activity 10.1

You will need :- A beaker, two carbon rods, an ammeter, two dry cells (1.5 V), connecting wires, kerosene, salt solution, acidified water, copper sulphate solution, distilled water

Method:-

- Connect the ammeter and the two dry cells to the two carbon rods as shown in the figure. 10.1. Dip the two carbon rods partially in the liquid/solution.
- Pour the liquids/solutions given above into the beaker.
- Observe whether there is a deflection in the ammeter.
- Tabulate your observation.

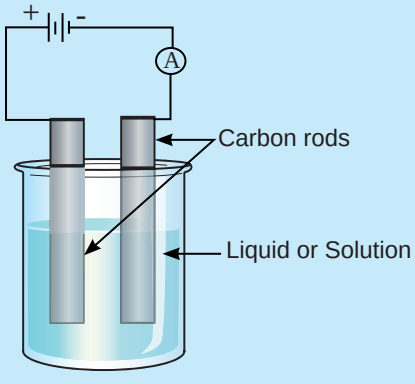


Figure 10.1

It is seen here that the ammeter deflects only when some liquids/solutions are used.

Table 10.1

Liquids/solution causing a deflection in the ammeter	Liquids/solutions not causing a deflection in the ammeter
Salt solution	Kerosene
Copper sulphate solution	Distilled water
Acidified water	

Indicator of the ammeter deflects when a current passes through it. Therefore, a current has passed through the solutions resulting a deflection in the ammeter. The solutions of salt, copper sulphate and acidified water, all contain mobile ions. These solutions conduct electricity through these mobile ions. Liquids or solutions which conduct electricity are called **electrolytes**.

Since kerosene and distilled water do not conduct electricity, they do not bring about a deflection in the ammeter. Such liquids/solutions do not conduct electricity as they do not contain mobile ions. Liquids/solutions which do not conduct electricity are referred to as **non-electrolytes**.

Compounds such as sodium chloride and copper sulphate are known as ionic compounds. They exist in the solid state. They are made up of oppositely charged ions formed by the relevant atoms. You will be able to learn more about them in grade 10.

Although, there are ions in solid ionic compounds they cannot move freely. Hence, those compounds do not conduct electricity in the solid state. But, if an ionic compound is dissolved in water to give an aqueous solution, the ions in it become mobile. Thus, aqueous solutions of ionic compounds are good conductors of electricity.

When an ionic solid is heated and brought to the liquid state, it is called a fused substance. Ions in a fused liquid also can move. Accordingly, Ionic compounds conduct electricity in the fused state.

10.2 Changes caused in a solution by an electric current

When electricity is conducted through an electrolyte, the conductors through which the electric current enters the electrolyte and exits are called electrodes. In the activity 10.1 above the electric current enters the solution by one carbon electrode and exits from the solution through the other carbon electrode.

Let us engage in activity 10.2 to study the changes brought about in a solution by an electric current.

Activity 10.2

You will need :- [A beaker, an ammeter, connecting wires, copper sulphate solution, carbon electrodes, two dry cells (1.5 V)]

Method:-

- Set up apparatus as shown in the figure 10.2 and pass electricity through the copper sulphate solution.
- Note down your observations.

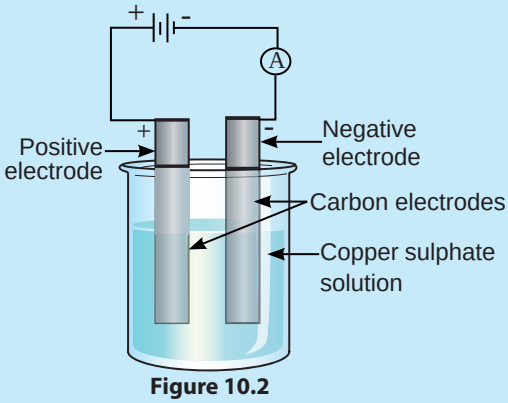


Figure 10.2

The electrode connected to the positive terminal of the external supply of electricity is called the **positive electrode**. The electrode connected to the negative terminal of the external supply of electricity is called the **negative electrode**. In the above activity it can be observed the deposition of a reddish brown substance at the negative electrode and the liberation of gas bubbles at the positive electrode. A gradual decrease in the blue colour can also be observed in the solution. Hence, it is clear that the compounds contained in the beaker undergo a chemical change.

This chemical change is caused by the electric current passed through the solution. Here, copper is deposited on the negative electrode and oxygen gas is liberated at the positive electrode. Copper sulphate undergoing the chemical change has turned into copper, a simpler substance. The chemical change effected by passing an electric current through an electrolyte is known as **electrolysis**. During this process, the electrolyte is converted into more simpler components.

A substance that doesn't react chemically with the electrolyte referred as inert electrodes. Carbon (graphite) and platinum electrodes are such examples.

Electrolysis of acidulated water

By activity 10.2, we learnt that in an electrolysis, an electrolyte is converted into more simpler products. To explore more about this, let us find out the products of the electrolysis of acidulated water. For this let us go ahead with activity 10.3.

Activity 10.3

You will need :- Distilled water with a few drops of a dilute sulphuric acid, a 9 V battery, two carbon rods, a plastic container, connecting wires, two test tubes.

Method:-

- Make two holes on the bottom of a plastic container. Pass two carbon rods through these holes and seal the holes with a substance such as wax.
- Add acidulated water into the container and arrange the apparatus as shown in Figure 10.3.
- Observe well
- Record observations.

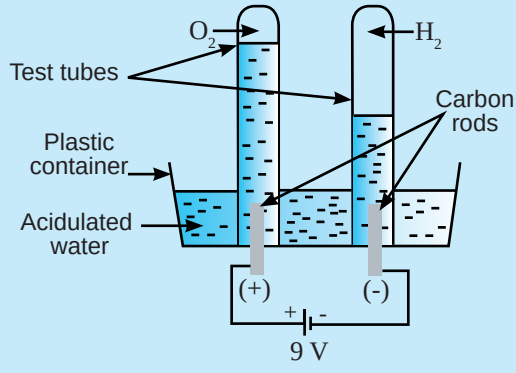


Figure 10.3

In this activity, it can be observed that gas bubbles evolve at the electrodes. The gases evolved get collected in the test tubes. The volume of the gas collected at the negative electrode is approximately twice the volume of the gas collected at the positive electrode.

It can be examined that hydrogen gas (H_2) evolves at the negative electrode and oxygen gas (O_2) evolves at the positive electrode.

If the gas evolved at the positive electrode is collected and tested with a glowing splint is put into it, the splint reignites. This verifies that the gas evolved at the positive electrode is oxygen. Similarly, if the gas evolved at the negative electrode is separated and a lighted splint is put into it, the gas burns with a squeaky "pop" sound. This confirms that the gas evolved at the negative electrode is hydrogen.

Thus, during electrolysis, water is splitted into more simpler substances, hydrogen and oxygen.

Applications of electrolysis

Electrolysis is frequently used in various industries.

- Extraction of various metals e.g. sodium, aluminum
- Industrial manufacture of caustic soda (sodium hydroxide)
- Electroplating

Let us now study electroplating which is an application of electrolysis.

10.3 Electroplating

Recall the observations of activity 10.2. you would have observed the deposition of copper on the negative electrode. By engaging in the activity 10.4, let us investigate whether copper can be deposited on a certain object.

Activity 10.4

You will need :- Aqueous copper sulphate solution, a clean copper plate, a cleaned iron nail, a beaker, connecting wires, two dry cells of 1.5 V

Method :-

- Connect dry cells to the copper plate and the iron nail as shown in figure 10.4 and dip them at once in the copper sulphate solution.
- Record your observations.

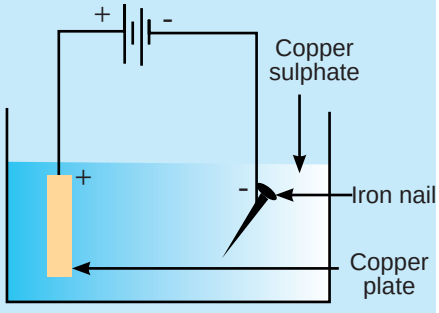


Figure 10.4

In the activity 10.4, you can observe that the copper plate gradually dissolves and copper is deposited on the iron nail. The plating of a certain metal on another surface using electricity is referred to as **electroplating**.

For electroplating, the metal that needs to be plated should be used as the positive electrode and the object that is plated should be used as the negative electrode. Further, the electrolyte used needs to be a solution of a salt of the metal that should be plated.

Assignment 10.1

1. Electroplating silver on an iron plate
2. Electroplating gold on a copper ring

Draw figures of suitable apparatus (as in figure 10.4) for no 1 and 2 instances stating the positive electrode, negative electrode and the electrolyte in each case.

Take the iron nail you used in activity 10.4 to your hand and touch its plating with your fingers. You will observe that the copper plating will get removed from the nail and comes to your finger tips.

This shows that the plating occurred in this way is not in good quality.
Let us consider the characteristics of a high quality electroplating.

- The coating should firmly adhere to the surface subjected to plating.
- The coating should be of confirm thickness.
- The coating should be shiny.

Such a high quality plating occurs when the electrochemical change take place very slowly. The electrolyte (salt solution) used for this has to be very dilute.

The chemical change occurring can also be slowed down by passing a very low current through the solution. This can be effected by applying a low potential difference.

In chemical industries, high quality electroplating is done by controlling the conditions appropriately.

Plating of metals like nickel and chromium on iron trays is an example. This gives a beautiful silver appearance to the tray.

Applications of electroplating

Pay your attention to vases, trays, cutlery and door locks offering a golden or silvery lustre which are being used at home. Very often the luster of these objects is due to a metal layer deposited on them. In order to prevent rusting of the parts of motor vehicles, they are coated with a thin metallic layer by electroplating. Mostly metals like copper (Cu), silver (Ag), gold (Au), nickel (Ni) and chromium (Cr) are plated like this. In such instances, the metal plate has a certain property which is lacking in the metal which is subjected to plating. Resistance to **corrosion, attractive colour, luster and good finish** are some of such properties.

- Electroplating nickel metal on iron tray protects it from rusting and also gives it an attractive appearance.
- Electroplating a copper jewellery with gold adds value to it and gives it a rich look.

Figure 10.5 - Some copper jewellery subjected to electroplating

Figure 10.6 - Some electroplated kitchen equipment

Figure 10.7 - Some electroplated spare parts

Summary

- Liquids/ solutions which conduct electricity are called electrolytes.
- The reason for the electrical conductivity of electrolytes is the presence of mobile ions in them.
- Liquids/solutions which do not conduct electricity are called non electrolytes. They do not contain mobile ions.
- Though ionic compounds contain ions, they cannot move in the solid state. Therefore, solid ionic compounds do not conduct electricity.
- Aqueous solutions and fused liquids of ionic compounds conduct electricity.
- The chemical changes taking place at the electrodes when an electric current is passed through an electrolyte is referred to as electrolysis.
- During electrolysis, chemical compounds are splitted into more simpler compounds or elements.
- By electrolyzing acidulated water, water can be turned into the elements, hydrogen and oxygen.
- Coating one metal with another metal by passing an electric current is called electroplating.
- When electroplating, always the metal that is subjected to plating should be kept as the negative electrode.
- During electrolysis the metal that is plated is kept the anode while a solution of a salt of that metal is used as the electrolyte.
- A high quality plating occurs when the chemical changes at the electrodes occur very slowly.
- To obtain a high quality plating in chemical industry, conditions are appropriately controlled.
- In electroplating, it is expected that the metal that is plated possesses superior qualities to that of the surface being plated.

Exercises

(01) Select the correct or most suitable answer.

1. What is the electrolyte, from the given liquids or solutions?
    1. Distilled water
    2. Sugar dissolved in distilled water
    3. Sodium chloride dissolved in distilled water
    4. Grease dissolved in kerosene
2. Petrol is not an electrical conductor because,

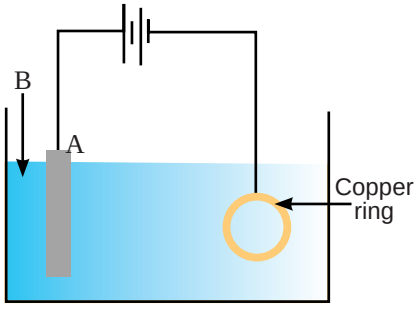
    1. It does not contain mobile electrons
    2. It does not contain mobile ions
    3. Its density is very low
    4. It is highly volatile

3. Select the correct statement, from the following statements.
    1. Solid sodium chloride (NaCl) is an electrical conductor
    2. Fused sodium chloride (NaCl) does not conduct electricity
    3. An aqueous solution of sodium chloride (NaCl) conducts electricity
    4. Solid sodium chloride (NaCl) consists of mobile ions.
4. Which of the following statement is correct about electroplating?
    1. To make a high quality electroplating, the concentration of the electrolyte must be high
    2. To electroplate a copper ring with silver, the copper ring must be kept as the positive electrode,
    3. To electroplate a copper ring with silver, a copper salt must be taken as the electrolyte
    4. When electroplating a copper ring with silver, the positive electrode erodes gradually
5. You are required to coat a silver bangle with gold. Which of the following set of substances is most suitable for it?
    1. A silver rod, a very dilute solution of a silver salt
    2. A gold rod, a very dilute solution of a silver salt
    3. A gold rod, a very dilute solution of a gold salt
    4. A gold rod, a concentrated solution of a gold salt
6. Which of the following is **not** an observation of the electrolysis of a copper sulphate solution?
    1. Decaying of the positive electrode
    2. Reducing the blue colour of the solution
    3. Deposition of copper on the negative electrode
    4. Liberation of gas bubbles at the positive electrode

(02) Give short answers.

1. Name three electrolytes.
2. Name three non-electrolytes.
3. Write three observations when electrolysis of a copper sulphate solution occurs using inert electrodes.
4. Name the gases liberated at the positive and negative electrodes during the electrolysis of acidulated water.
5. In addition to the liberation of gas bubbles at the electrodes, write an observation that can be made during this electrolysis.
6. Write a simple test to identify the gas liberated at each electrode.

(03) The diagram shows an electrolytic cell used to electroplate a copper ring with silver.

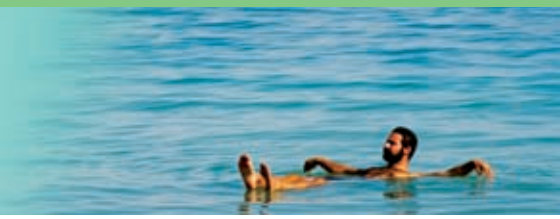


1. Name a metal that can be used as electrode A.
2. What is the sign of the electrode A? positive or negative?
3. Which solution of a salt of which metal can be used as solution B which, is the electrolyte?
4. What precautions can be taken to obtain a plating of high quality ?

Technical Terms

Electrolysis	-	විද්‍යුත් විච්ඡේදනය	-	மின்பகுப்பு
Electrolyte	-	විද්‍යුත් විච්ඡේද්‍යය	-	மின்பகுபொருள்
Non-electrolyte	-	විද්‍යුත් අවිච්ඡේද්‍යය	-	மின்பகாப்பொருள்
Positive electrode	-	ධන ඉලෙක්ට්‍රෝඩය	-	நேர்மின்வாய்
Negative electrode	-	ඍණ ඉලෙක්ට්‍රෝඩය	-	மறைமின்வாய்
Electroplating	-	විද්‍යුත් ලෝහාලේපනය	-	மின் முலாமிடல்
Inert electrodes	-	අක්‍රීය ඉලෙක්ට්‍රෝඩ	-	சடத்துவ மின்வாய்

11 Density



11.1 Introduction to density

In a glass of drinking water, contains a small volume of water and the mass of it is also small. In a well, there is a large volume of water and the mass of it is also large. But, when a reservoir is considered, the volume of water it contains is massive and the mass of it is also massive (figure 11.1).

(a) Glass of water

(b) Well

(c) Reservoir

Figure 11.1

Though the volume of a substance and its mass differs, there is a common relationship between those two. Let us do the activity 11.1 to reveal this.

Activity 11. 1

You will need :- Measuring cylinders of varied capacities 100 ml, 250 ml and 500 ml, a 500 ml beaker, a triple beam balance, water

Figure 11.2 (a) - A triple beam balance

Method :-

- Adjust the triple beam balance to its zero mark.
- Measure the mass of cleaned and dried 500 ml empty beaker using this balance.
- Measure 100 ml of water into the beaker using 100 ml measuring cylinder.
- Measure the mass of beaker with water.
- Measure the mass of 250 ml and 500 ml of water separately using the same beaker.
- Divide the mass of water by its volume and find the ratio in each instance above.
- Fill table 11.1 using the readings and calculations you obtained.

Figure 11.2 (b) - Measuring mass by a triple beam balance

- What can be concluded according to the results obtained?
  - * Consider that **1 ml = 1 cm^3**

The mass of empty beaker =……

Table 11.1

Volume of water (cm^3)	Mass of beaker with water (g)	Mass of water (g)	$\frac{\text{Mass of water}}{\text{Volume}}$ (g cm^{-3})

According to the above activity, it is clear that the ratio of mass of water to its volume is constant, though the volume taken differs. This constant value is specific for water. And this value is known as the **density**.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Density can be explained as the ratio between mass and volume.

The density can be defined as follows.

The mass per unit volume of a substance is known as the density of that substance.

Density, mass and volume are symbolized by ρ, m and v respectively.

The formula for density is $\rho = \frac{m}{v}$

11.2 Units of density

The measurements taken in activity 11.1 above, units of density can be deduced as follows.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$= \frac{\text{g}}{\text{cm}^3}$$

$$= \text{g cm}^{-3}$$

But, according to the Standard International (SI) units, mass is measured in kg and volume in m^3. Thus;

$$\text{Standard units (SI) of density} = \frac{\text{SI unit of mass}}{\text{SI unit of volume}}$$

$$= \frac{kg}{m^3}$$

$$= kg\ m^{-3}$$

The Standard Units (SI) of density is kg m^{-3} (kilogram per cubic meter).

Now let us do the activity 11.2 to compare the densities of several substances.

Activity 11.2

You will need :- A measuring cylinder of 250 ml, a beaker of 250 ml, enough water, coconut oil, kerosene, concentrated salt solution, a triple beam balance

Method :-

- Clean and dry the beaker of 250 ml and measure the mass of it using the triple beam balance
- Measure 250 ml of water by using the measuring cylinder of 250 ml. Then put into the beaker. Measure the mass of beaker with water.
- Remove water and measure 250 ml of concentrated salt solution. Then, put into the beaker. Measure the mass of beaker with salt solution.
- Same way, measure 250 ml of coconut oil and kerosene separately into the same beaker and measure their masses.
- Note that the beaker and the measuring cylinder should be well cleaned and dried before measuring coconut oil and kerosene.
- Tabulate your readings and work out the calculation as shown in the following table 11.2.

Mass of the empty beaker = ...

Table 11.2

Liquid/ Solution	Volume of the liquid/ Solution - V (cm^3)	Mass of the beaker with liquid/Solution (g)	Mass of liquid - m (g)	$\frac{\text{Volume (m)}}{\text{Scale (v)}}$ ($g\ cm^{-3}$)

- What can be concluded according to the results obtained?

According to this activity, it can be seen that the ratio of mass to its volume is different for different substances, though their volumes are equal.

Density of various substances differ from each other. It is a specific property of the respective substance. Substances can be identified by the value of their density. This is common for solids as well as for liquids. Therefore, density is a vital physical quantity of a substance.

Let us study how to solve the problems regarding density.

Solved example 01:- Mass of $2m^3$ of water is 2000 kg. Calculate the density of water.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$= \frac{2000\ \text{kg}}{2\ \text{m}^3}$$

$$= 1000\ \text{kg m}^{-3}$$

Solved example 02:- The mass of a solution, which has the density of 800 kg m^{-3}, is 200 kg. What is the volume of it?

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

$$\text{Volume} = \frac{200\ \text{kg}}{800\ \text{kg m}^{-3}}$$

$$= \frac{1}{4}\ \text{m}^3$$

$$= 0.25\ \text{m}^3$$

11.3 Hydrometers

If you want to find the density of a liquid, you can measure the volume and mass of it and calculate the density, as you have done in activity 11.2. But it is a time-consuming difficult process. Therefore, to measure the density of a liquid easily, an equipment known as **hydrometer** is used.

Figure 11.3 shows several types of hydrometers. Hydrometer is made of a thin glass tube, the lower part of which is blow to form a bulb. This bulb is filled with lead shots, so that a part of the tube is submerged and float vertically in the liquid.

Figure 11.3 - Different types of hydrometers

When a hydrometer is partially immersed and floating in a liquid, the length of the immersed part depends on the density of the liquid. It sinks less in high-density liquids and more in low-density liquids. The upper tubular part of the hydrometer is calibrated in such a way that density can directly read by the depth it immerse.

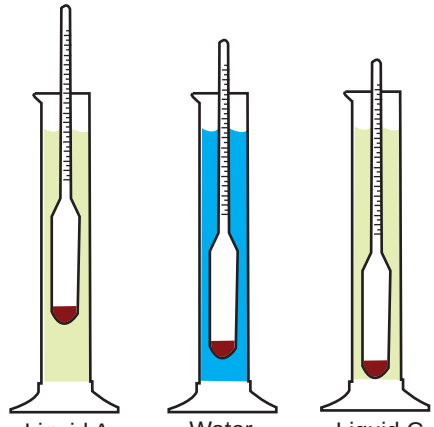


Figure 11.4

It is shown that the same hydrometer is made to float in three different liquids in figure 11.4. Figure 11.4 (b) shows how it floats in water. Immersed height of the hydrometer is less in liquid A, than in water (figure 11.4 (b)). It indicates that density of liquid A is higher than that of water. Immersed length of the hydrometer is more in liquid C than in water (figure 11.4 (c)). So, the density of liquid C is lower than that of water.

For extra knowledge

The density of the salty water of the dead sea located in between Israel and Jordan is very high. It has the ability of floating a man without sinking.

Let us do activity 11.3 by using a hydrometer to know the density of some common liquids.

Activity 11.3

You will need :- Three tall vessels, (measuring cylinders or lower part of plastic bottles), water, kerosene, coconut oil, hydrometer

Method :-

- Put water, kerosene and coconut oil in to three vessels.
- Dip hydrometer in each liquid and take down the reading of density (clean the hydrometer before you put it into each liquid).
- Compare your valves with the table 11.3.

Table 11.3

Liquid	Density ($kg\ m^{-3}$)
Mercury	13600
Glycerin	1262
Milk	1030
Sea water	1025
Water	1000
Olive oil	920
Coconut oil	900
Turpentine	870
Petrol	800
Liquor	791
Kerosene	790

A simple hydrometer can easily be made by you using a drinking straw. Engage in the activity 11.4.

Activity 11.4

You will need :- A drinking straw, a candle, several iron balls of the diameter of 3 mm, a measuring cylinder, 250 ml of coconut oil, 250 ml of concentrated salt solution and water.

Method :-

- Heat one end of the drinking straw in the candle flame to seal it.
- Add enough water into the density jar or the measuring cylinder.
- Put iron balls into the straw so that it floats vertically while 2/3 of its length is immersed in water.
- Mark the floating level on the straw, while it is in water. Now you have finished making the hydrometer.
- Add salt water into the measuring cylinder and float the hydrometer in it. Mark the level of floating on the hydrometer.
- Repeat the above step using coconut oil as the liquid.
- Decide whether the density of the liquids used is higher or lower than that of water, according to the levels of floating.

Use of hydrometers

Cow's milk contains approximately 90% of water. Other than water, it contains lipids, protein etc. Because of the contribution of the density of other constituents, density of milk is slightly higher than that of water. Amount of water in milk can be determined by measuring the density of it, using a hydrometer. This measurement can be used to decide whether water is added to milk. Hydrometers which are specially made to measure the density of milk are known as lactometers.

Hydrometers are also used to measure the percentage of alcohol in alcoholic drinks, like wine and beer. Those are known as alcoholmeters. These alcoholic drinks also contain high percentage of water. Therefore, the density of alcoholic drinks are slightly different from density of water.

The density of the acid, changes according to the changes in lead-acid batteries used in vehicles. Therefore, the condition of batteries can be examined by measuring the density with a hydrometer.

Soil hydrometer is used in determining composition of a soil sample. It can be concluded by dissolving a constant mass of soil, in a constant volume of water to calculate the density of soil solution.

Sea water contain high amount of salt dissolved in it. There is a special hydrometer called seawater hydrometer, used to measure the density of sea water. Due to high concentration of salts, the density of sea water is higher than normal fresh water.

Composition of Rubber is also measured by special hydrometer known as metrolac.

Summary

- Density of a substance is the mass per unit volume of that substance.
- $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$
- The standard unit of density is kilogram per cubic-meters (kg m^{-3}).
- Density is a vital, physical property of a substance. It differs from substance to substance.
- Hydrometer is used to measure the density of liquid.
- Density is a criteria to determine quality of liquids and solutions.

Exercises

(01) Select the correct or most suitable answer.

1. International unit (SI) of density is,

   (1) g ml^{-1} (2) g cm^{-3} (3) kg m^{-3} (4) kg m^{-2}

2. Four different liquids have equal masses of 8000 kg each. The volumes of them are given below.

   A. Liquid - 12 m^3 B. Liquid - 10 m^3

   C. Liquid - 8 m^3 D. Liquid - 6 m^3

   The liquid that has the highest density is;

   (1) A (2) B (3) C (4) D

3. Consider the following statements on the density of a liquid.

   a. Density of a liquid depends on its mass.

   b. Density of a liquid depends on its volume.

   c. Density of a liquid depends on the kind of liquid.

   The true statement/s out of those is/are,

   (1) a and b only (2) b and c only

   (3) c only (4) All a, b and c

4. Four different liquids have equal volumes of 0.5 m^3 each. The masses of these liquids are given below.

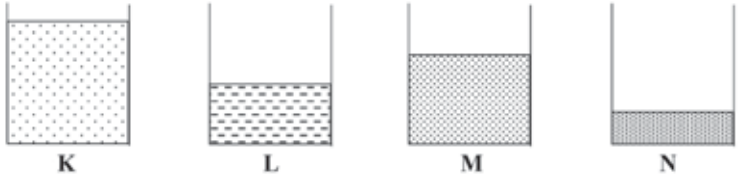
   Liquid P - 400 kg Liquid Q - 500 kg

   Liquid R - 550 kg Liquid S - 600 kg

   The liquid that has the lowest density is,

   (1) P (2) Q (3) R (4) S

5. Figure given below shows four liquids, that have equal masses, kept in equal containers.

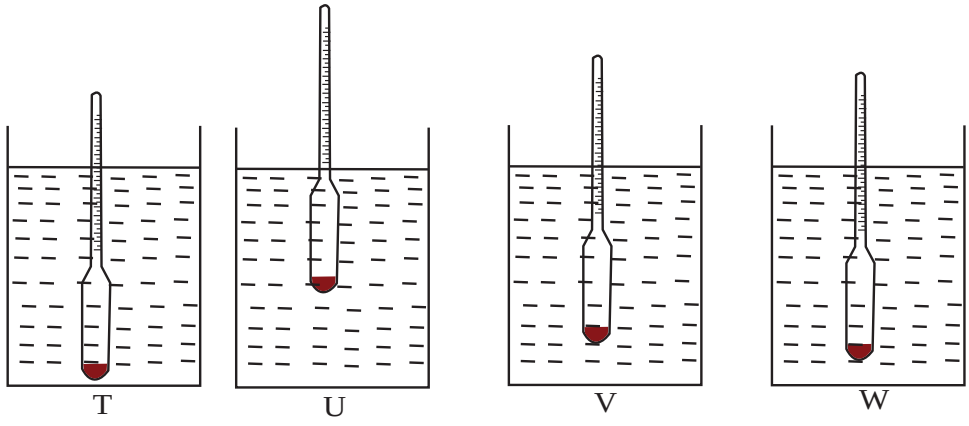


   Select the correct answer, which illustrate the ascending order of densities of four liquids.

   (1) K < L < M < N (2) K < M < L < N

   (3) N < L < M < K (4) N < M < L < K

6. Figure below shows four equal hydrometers floating in four types of liquids.



Out of those, the liquid that has the highest density is,

(1) T (2) U (3) V (4) W

(02) Observation received, while preparing an orange solution is given below.

Orange seeds which were at the bottom of glass, started floating when adding sugar.

Give reasons for this observation.

(03) Calculate the density of 4 m^3 volume of liquid with 3600 kg mass.

(04) Density of a solution is 2000 kg m^{-3}. Calculate the mass of 0.25 m^3 volume, of this solution.

Technical Terms

Density	-	ඝනත්වය	-	அடர்த்தி
Hydrometer	-	ද්‍රවමානය	-	நீரமானி
Lactometer	-	ක්ෂීරමානය	-	பால்மானி
Alcoholmeter	-	මද්‍යසාරමානය	-	மதுசாரநீரமானி
Liquid	-	ද්‍රවය	-	திரவம்
Solution	-	ද්‍රාවණය	-	கரைசல்

12 Bio-diversity

12.1 Introduction to bio-diversity

Recall the field visits you attended to study about the environment. During those field visits you would have experienced different types of environments. They can be beaches, mangrove environments, forests, monsoon forests and grasslands. A system that includes all living organisms (biotic factors) in an area as well as its physical environment (abiotic factors) interacting with one another as a unit is known as an **ecosystem**. Study the ecosystems in figure 12.1.

A forest

A mangrove environment

A grassland

A beach

Figure 12.1 - Some ecosystems

When different ecosystems are considered, the animals and plants in these systems are varied. The physical environment and climatic factors of those ecosystems are also different. The diversity among these ecosystems is known as **ecosystem diversity**.

Think about the living organisms in ecosystems. In ecosystems there are many species of animals and plants as well as many species of micro-organisms. With regard to these species, there is a great variety of characteristics in the body shape, size, nutritional patterns and reproduction. The diversity among the species is known as **species diversity**.

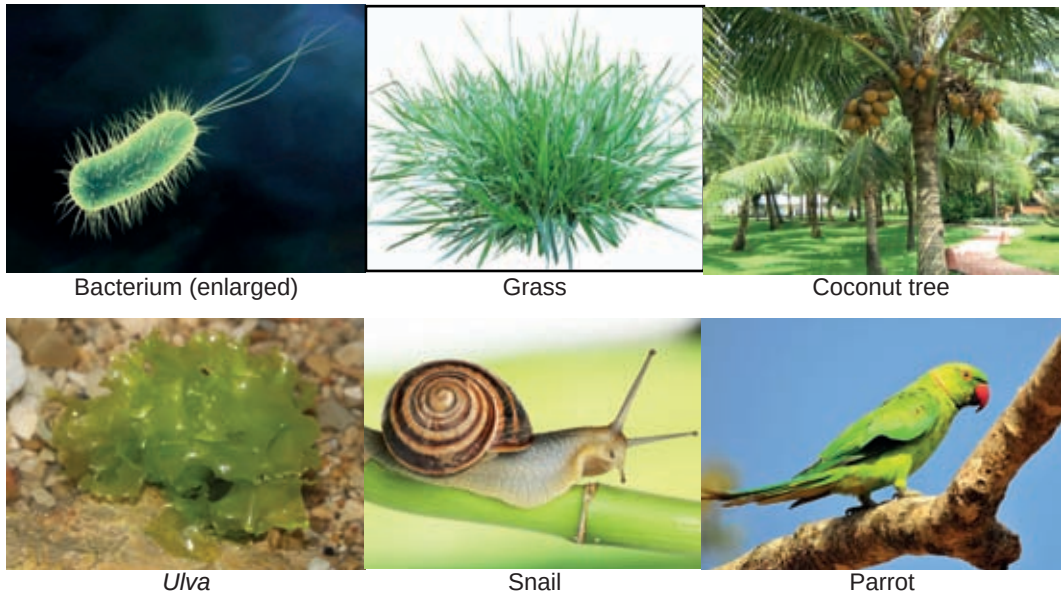


Figure 12.2 - Some species of living organisms

Let us do the assignment 12.1 to identify the diversity of plants and animals in an ecosystem.

Assignment 12.1

Select a plot of land in your area or school (thicket, grassland, pond). Study the species diversity in the selected plot of land. Using your observations fill in the table given.

Table 12.1

Plant species	Animal species	Micro-organisms

Living organisms are categorized as plants, animals and micro-organisms.

(In this field visit you should follow your teacher's advice, without harming the environment and ensure your safety.)

Are there any differences in living organisms of a same species? Let us do the activity 12.1 to find about it.

Activity 12.1

- Observe the external features (given within the table) of all your classmates and fill in the table 12.2.

Table 12.2

	Feature	Number of students
1)	a) have the ability to roll the tongue	
	b) no ability to roll the tongue	
2)	a) with free ear lobes	
	b) with attached ear lobes	
3)	a) with black eyes	
	b) with brown eyes	
4)	a) with straight hair	
	b) with curly hair	
5)	a) right handed	
	b) left handed	

Modern man belongs to the species *Homo sapiens sapiens*. Through the above activity you would have understood that even within the same species there are differences among the individuals.

You can understand the differences among the human by figure 12.3.

The reason for these differences of a certain species is **genetic diversity**. You will learn about genes in grade 10 & 11.

Figure 12.3 - Humans of *Homo sapiens sapiens* with different features

For extra knowledge

You already know that living organisms are made up of cells. Chromosomes are located in nucleus of these cells. Genes are located on these chromosomes. The features of living organisms are controlled by genes. Genetic diversity is the cause for the differences among organisms within the same species.

There is a diversity among the ecosystems that organisms live and there is a diversity among the living species. Not only that, there is a diversity among the organisms of a same species. **Bio-diversity** is a combination of ecosystem diversity, species diversity and genetic diversity.

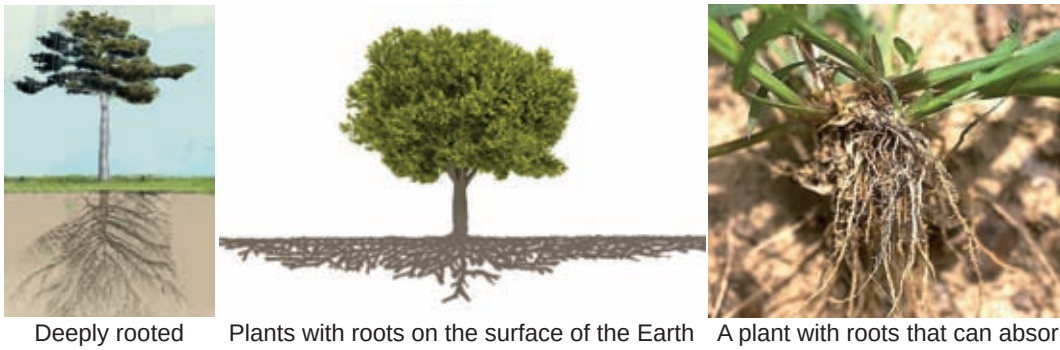
12.2 Importance of bio-diversity

Both large and small creatures in an ecosystem play a significant role in maintaining the equilibrium of the certain ecosystem. Higher bio-diversity in an ecosystem also increases the wellbeing and the stability of that ecosystem.

The beauty of the environment increases due to bio-diversity. We know that Sri Lanka is a country with a rich bio-diversity. Sri Lanka has been named as the country with the highest density of flowering plants, reptiles, amphibians, and mammals in the Asian region. Rich bio-diversity is a strong reason for tourist attraction.

Bio-diversity has reduced the competition between the species. Organisms are always in a competition for their needs. When considering the plant world, they are competing for the needs that should be used from the environment such as light, space, water and air. When considering the animal world, animals are competing for requirements such as habitat, food, security and choice of partners. Bio-diversity helps to minimize this competition among living organisms.

Let us see how bio-diversity acts, trees to minimize the competition for water. The roots of different trees are adapted to take water from different levels in the soil (figure 12.4).



Deeply rooted plants | Plants with roots on the surface of the Earth | A plant with roots that can absorb water from the atmosphere

Figure 12.4 - Roots adapted to minimize the competition for water

We know that the beaks of different bird species are of different shapes. This is important to reduce the competition for food. Various birds depend on various foods and their beaks are shaped according to their diet (figure 12.5).

Figure 12.5 - Diversity of beaks among birds

"The wild types" of most plants and animals used in agriculture are found in natural ecosystems. Genes that are resistant to pests, adverse environmental conditions and illnesses, are available in these "wild types". Because of bio-diversity it is possible to use this genetic materials in a favourable manner in agriculture.

Due to bio-diversity some species are endemic to each region. Species that can be seen only in one geographical region or country are known as **endemic species.** Humans conserve these endemic species due to this rich bio-diversity.

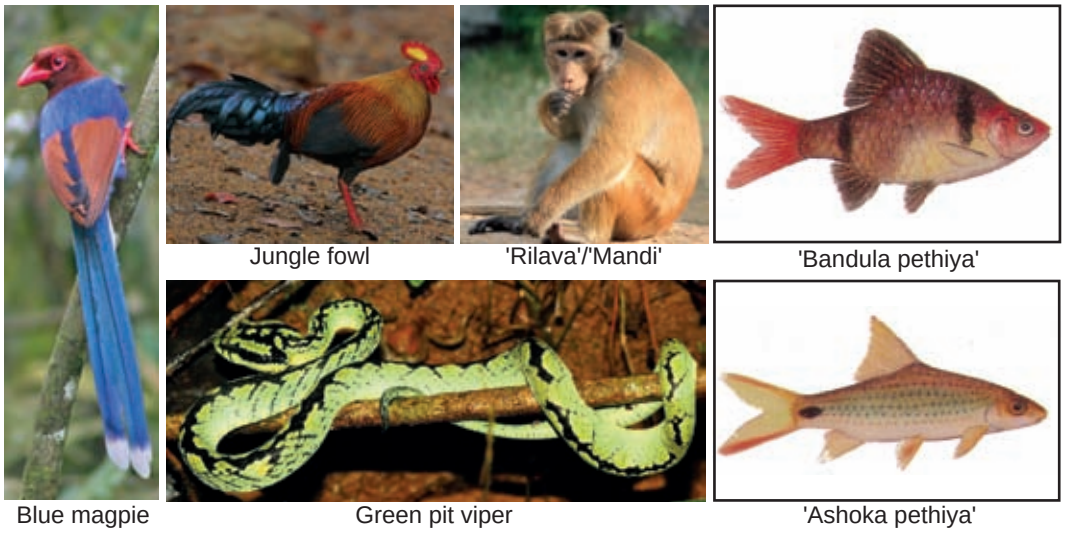


Figure 12.6 - Some species endemic to Sri Lanka

This bio-diversity helps to protect the water resources and soil to maintain favourable climatic conditions and minimize environmental pollution. Bio-diversity is very important for entertainment, various research works and educational activities.

12.3 Threats to bio-diversity

There are many threats for bio-diversity. These threats have caused deterioration in bio-diversity. The reasons for biodegradation can be discussed under two topics.

Natural reasons

Since ancient times, bio-diversity has been affected by the impact of various natural activities. Collapsing meteors, volcanic explosions, tsunami, earth slides and floods are some of these natural reasons.

e.g. It is considered that a meteor collapse caused for the extinction of dinosaurs. There is an argument that natural global warming was the reason for the extinction of mammoth.

Mammoth Dinosaurs

Figure 12.7 - Some extinct animals

Human activities

With the rapid increase in the human population, forests are destroyed extensively to meet their needs. Rapid deforestation destruct the habitats of living organisms. Also the construction of various buildings, streets and reservoirs splits the habitats of living organisms.

The increase in human population causes many environmental issues. Over use of resources and addition of pollutants to the environment are often caused by human activities. Soil, aquatic and airy ecosystems get so polluted and these ecosystems become unsuitable for survival of organisms. These reasons have a strong impact on bio-diversity.

Spreading of invasive organisms in an ecosystem too, make a strong impact on its bio-diversity (figure 12.8).

'Gandapana'/'Napunni' *Parthenium*

Tank cleaner fish

'Mannawa' fish

Figure 12.8 - Some species of invasive organisms

The introduction of genetically modified new organisms into the environment cause adverse impact on bio-diversity. Although, it is not yet possible to specify this, these organisms can be considered as a threat to bio-diversity in the future.

Climatic changes due to environmental problems such as ozone layer depletion and global warming will affect the bio-diversity.

These threats have caused bio-diversity degradation worldwide. Hence, some species of organisms are in a threat of extinction from the Earth. Therefore, bio-diversity should be conserved. The regions of higher density of living organisms are called **hotspots**. To be considered as a bio-diversity hotspot, a country or a region should be rich with high proportion of indigenous species and species with more threats. As Sri Lanka belongs to a hotspot region, it is our duty to contribute for the conservation of bio-diversity.

Assignment 12.2

Following are some threats for bio-diversity. Collect information on each topic and prepare an article for a newspaper.

- Increase of human population
- Destruction of forests
- Introduction of invasive organisms
- Environmental pollution
- Overuse of resources in the environment
- Depletion of ozone layer and climatic changes

12.4 Important features of ecosystems

Do the assignment 12.3 to get an idea about the living organisms and non-living organisms in an environment.

Assignment 12.3

- Select a plot of land in your school garden. Now draw separately the pictures of plants, animals and non-living components in that plot of land in 3 transparent sheets.
- Keep the 3 transparent sheets overlapping

Figure 12.8 shows some pictures of a similar assignment carried out around a pond.

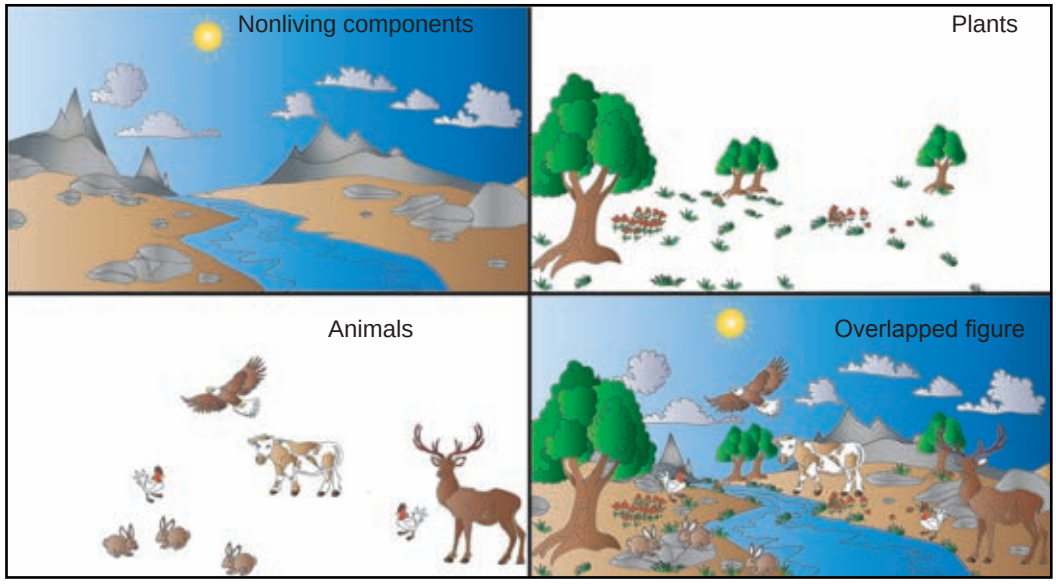


Figure 12.9

You will understand that the environment contains living organisms (animals and plants) and non-living components.

All living organisms in a community and the physical environment interacting with them considered together as an ecosystem.

e.g. :- A pond, a forest, decaying log, coral reef environment, a grassland

Features of an ecosystem

1. **Interaction occur between living components as well as between non-living components.**
   Living - living relationships, Living - non living relationships,
   Non living - non living relationships
2. **The energy flows through one way stream**
   The solar energy which is used by green plants in photosynthesis, is stored in the food produced during this process. The energy flows from lower consumer levels to the higher consumer levels through food chains or food webs.
3. **Recycling of materials**
   The materials that the organisms receive from the environment continue to be back to the environment. The continuous exchange of materials between the organisms and the environment is an important feature of an ecosystem.
4. **An independent Unit**
   Since there are constant interactions within the ecosystem it has ensured the existence in biosphere.

Let us see living - living relationships in an environment.

Living - living relationships

The interactions between the living organisms are known as living-living relationships. These interactions are to meet the following needs.

- Food
- Security
- Reproduction

Following are some such interactions.

- Animals consuming plants as food
- Some predators consuming other animals
- Certain micro-organisms depending on other living organisms
- Some animals use trees as their habitat
- Animals hiding among plants for protection
- Some plants use animals to spread their species
- Some plants fulfill their nitrogenous requirements from insects (insectivorous plants)
- Producing new creatures through reproduction for the continuous existence of life

Figure 12.10 - Living-living relationships

Living - non living relationships

The interactions between the living organisms and non-living components are known living-non living relationships. The organisms interact with their habitat to get non-living components such as water, air and light.

e.g. The plants use solar energy for photosynthesis

Plants absorb water from soil

Plants and animals use atmospheric oxygen for respiration

Plants use atmospheric carbon dioxide for photosynthesis

Plants release oxygen to the atmosphere as a result of photosynthesis

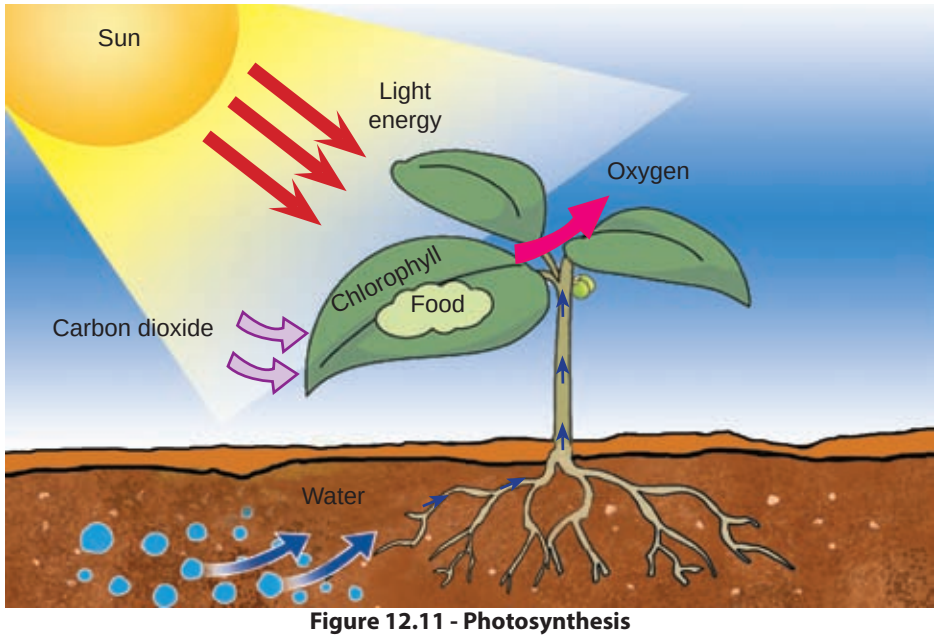


Figure 12.11 - Photosynthesis

The living creatures are also adjusted to match the specific environmental conditions of their habitats. This is known as adaptation.

e.g. Adaptations of plants to minimize transpiration in dry environment

Non living - non living relationships

The interactions between non living components are known as non living - non living relationships.

e.g.

- Soil erosion by water
- Rock weathering due to water and solar heat

Figure 12.12 - An environment subjected to soil erosion

Activity 12.2

- Name the plants, animals and non-living components that can be seen in the given plot of land.
- Write sentences about the interactions that exist between the living organisms and living-non living and non living materials.

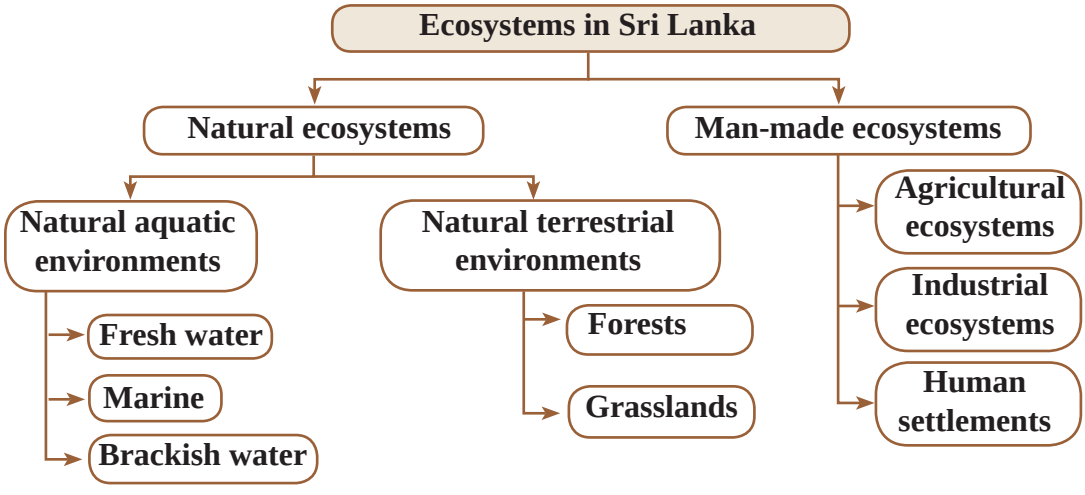
  e.g. Plants absorb solar energy for photosynthesis

Figure 12.13

12.5 Natural ecosystems and built environment

Sri Lanka is a country with a rich bio-diversity. Various ecosystems are found due to the location of Sri Lanka as an island and the location of the central hill country. The location of different ecosystems is a major cause for a higher bio-diversity.

A sketch of the ecosystem classification in Sri Lanka is given below.



Natural aquatic environments

Natural aquatic environments can be categorized into three groups as fresh water, marine ecosystems and brackish water environments. A vast number of living organisms live in these environments. Information about some aquatic ecosystems are given below.

Rivers

Figure 12.14 - A river

- They are fresh water aquatic ecosystems.
- Most rivers start from the catchment areas of the central highlands and flow to the sea.
- The water level of rivers fluctuate with the rainfall in the regions.
- Some rivers confine to a small stream during the dry season.
- Different species of plants and animals are living from the head wall ('Ismaththa') up to the estuary.

  e.g. 'Mahaweli' river, 'Kelani' river

Importance

- Fulfill the water needs for agriculture
- Generating hydro power
- For transportation

Estuary

Figure 12.15 - A river mouth

- A place where a river falls to the sea is known as an estuary.
- As marine water and fresh water are mixed at estuary, water becomes brackish.
- Various organisms live in brackish water.
- The deposition of mud and sand in river water cause triangular islands known as a Delta.

  e.g. Estuary of 'Mahaweli' – opens to 'Koddiyar' Bay and 'Thambalagam' Bay

Importance

- Prevents the mixing of marine water and fresh water
- Abundance of fish species with economic importance
- Rich in bio-diversity

Lagoon

- A lagoon is a shallow body of brackish water permanently separated from the sea by barriers of sand or reefs, but connected with the sea at one time during the year.

e.g. Negombo lagoon, Batticaloa lagoon, Puttalam lagoon

Figure 12.16 - Lagoon

Importance

- Used for fishing purposes because prawns, crabs, oysters are available in these places
- The mangrove plants common on lagoons prevent sea erosion.
- A place of tourist attraction

Riverine environment

- The environment on either sides of the river from starting point of the river to the point where it flows to the sea is known as the riverine environment.
- Flood plains, sandy lands, marshy lands belong to this environment.
- 'Villu' is a wet land in riverine environment.
- Due to over flow of a river during the rainy season flood plains are created.

Figure 12.17 - River side environment

e.g. 'Mahaweli' flood plain at East

Importance

- Used for inland fishing industry
- The soil is very fertile in flood plains as silt flowing along the river is deposited in these areas. So, this soil is used for agriculture as well as for tile and brick industry.

Inland water reservoirs

- Naturally formed lakes and ponds belong to inland water reservoirs. Man-made tanks are also considered inland water reservoirs. They can be seen in both wet zone and dry zone and are fresh water environments.

Figure 12.18 - Inland water reservoirs

- Plants such as Lotus, Lilly, 'Kekatiya'/'Kotti' and animals such as fish, frogs, snakes, otters and aquatic birds can be seen in this environment

e.g. 'Parakrama samudraya', 'Kala wewa'

Importance

- Used for inland fishery industry
- Provides water for agriculture

Ocean

- Marine areas that covers most of the Earth's surface is known as ocean.
- A large living community such as algae, polyps, oysters and fish live in the oceans.
  e.g.- Indian ocean, Atlantic ocean

Figure 12.19 - Ocean

Importance

- Rich bio-diversity
- Ocean water is used to produce salt
- For fishing industry
- Generates electricity by ocean waves
- A place of tourist attraction

Wet lands

- Marshy lands that are covered with water during a long period of time in the year are known as wet lands.
- There are fresh water wet lands, marine wet lands and man-made wet lands.
  e.g.- Anawilundawa, Muthurajawela

Figure 12.20 - A wet land

Importance

- Wet lands are important to control flood, maintain the stability of reservoirs, minimize climatic changes, make ground water nutritious and maintain the bio-diversity.
- Used for different industries and tourism industry

Assignment 12.4

- Arrange a field trip to visit a natural water resource in Sri Lanka.
- Study the bio-diversity in the particular environment.
- Make a booklet about the living species you observed and their special features.

Natural terrestrial environments

A vast bio-diversity can be observed in natural terrestrial environments in Sri Lanka. Some information about diversity in some terrestrial environments are given below.

Forests

Figure 12.21 - Tropical rain forests

Tropical rain forests (Tropical lowland rain forests/ Wet evergreen forests)

- There is a warm-wet climate with a rainfall throughout the year.
- Receives over 2000 mm of annual rainfall
- Mineral are cycling
- Located in areas with an elevation up to 900 m
- The trees with a higher economic value such as 'Hora'/'Ennai', 'Keena'/'Punnai', 'Milla'/'Kattamanakku', 'Halmilla'/'Chavandalai' and Teak are common in these forests.
- Vegetation reach about 40 m of height and grow densely.
- A canopy structure can be seen. Epiphytes and climbers are common on trees.
  e.g. 'Sinharaja', 'Kanneliya', 'Dediyagala', 'Nakiadeniya' forests

Importance

- Endemic plants and animal species are very common
- Can be considered as a special environment that protects the water resources of a country
- Acts as a catchment area

Montane forests

Figure 12.22 - Montane forests

- Located in areas above 900 m from the sea level
- Annual rainfall is about 4000 mm.
- As there is heavy wind the trees are stunted. Also they are with twisted stems and smaller leaves. The tops of the trees have become flat.
- Plant species such as 'Walsapu',' Veralu'/'Veralikkai', 'Mihiriya', 'Dan'/'Kirampu', 'Keena' and animal species such as monkeys, loris, giant squirrel, stag can be seen.
  e.g. 'Haggala', upper part of Knuckles

Importance

- Endemic plant and animal species are common
- Act as catchment areas and protects many water sources
- Minimize soil erosion

Dry-mixed evergreen forests / Monsoon forests

Figure 12.23 - Monsoon forests

- Can be seen in dry zone but not much arid
- Annual rain fall is about 1200 mm-1900 mm
- May to September is a long drought season
- Evergreen and deciduous plants are present
  e.g. Wasgamuwa, Yala, Willpaththu

Importance

- A lot of economically valuable plants such as 'Palu'/'Pasippayaru', 'Burutha'/'Mutirai', 'Weera'/'Veerai', 'Koan'/'Kula', Ebony, 'Welang'/'Taddaemarum', 'Kolong'/'Manchal-kadampa', 'Kalumadiriya', 'Halmilla', Neem are common.
- Also animals such as deer, monkeys, leopards, bears, giant squirrel and elephants can be seen in these forests.
- Act as catchment areas for reservoirs in dry zone

Thorn bushes and scrublands

Figure 12.24 - Thorn bushes and scrublands

- Annual rain fall is over 1250 mm and temperature is high over 34 ^{0}C
- Considered as semi xeric areas.
- There are many adaptations in trees to withstand the arid environmental conditions.
- Some of the adaptations are having smaller leaves, fleshy leaves, ability to store water in the stem and thorny bushes.
- 'Nawahandi'/'Kally', Cactus, 'Daluk'/'Sadurakkalli', 'Kaneru'/'Alari', 'Eraminiya', 'Andara'/'Vidaththal', *Aloe* are some of the trees that can be seen in these forests.
  e.g. Hambanthota District, Puttalam District, Killinochchi District

Grasslands

Given below are some information about the grasslands in different climatic zones of Sri Lanka.

Figure 12.25 - 'Wet patana'

'Wet patana'

- Located in areas of over 2000 m altitude. There is heavy rainfall in these areas.
- Normally located near forests. In addition to grass there are also trees grown alone. 'Maharathmal' plant is prominent among them. 'Usnia' lichens grow on these trees. The fern 'Pteridium' also can be seen in these grasslands.

  e.g. Horton plains, 'Bopaththalawa', 'Bagawanthalawa'

'Dry patana'

- Widely spread than wet Patana.
- The grass 'Mana'/'Narippul' is very common.
- Apart from small forests in the valley and hills, other areas are covered with grass only.
- Usually grass is burnt during the drought season. Soil gets eroded during the rainy seasons.

  e.g. 'Rakwana', 'Uva Basin'

Figure 12.26 - 'Dry patana'

'Damana'

- This is a type of grassland in the abandoned chena cultivation ('Hena') areas in the low country dry zone.
- Grasses such as 'Mana', 'Illuk'/'Tharppaipul', 'Bata' and trees such as wood apple, 'Palu', 'Myla'/'Aththi', 'Madan'/'Perunaval' are common in these areas.
- This is the most preferred area of the elephants.

  e.g. 'Wilpaththu', 'Maduru oya', 'Walikanda'

Figure 12.27 - 'Damana'

'Talawa'

- A type of a grassland formed as a result of chena cultivation in low country wet zone.

  e.g. Located in 'Kalutara' District, 'Haldummulla', 'Matara' District

Figure 12.28 - 'Talawa'

Let us engage in assignment 12.5 to study natural ecosystems in Sri Lanka.

Assignment 12.5

Following is a map that depicts the natural ecosystems in Sri Lanka. Study the map well and identify the ecosystems and their locations.

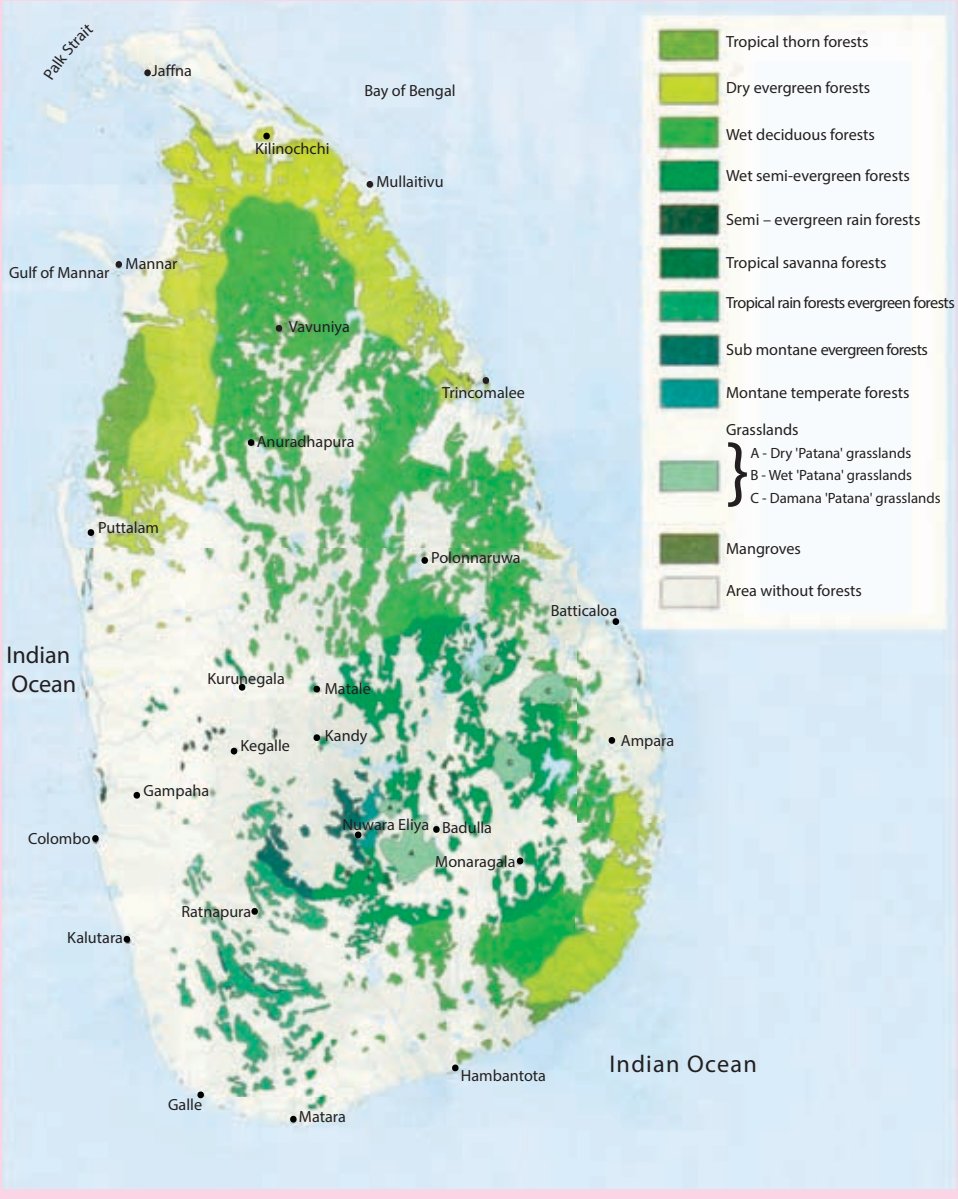


Figure 12.29 - Natural ecosystems in Sri Lanka

Source - The National Map Collection of Sri Lanka, School Edition, Survey Department

Man-made ecosystems in Sri Lanka

The man-made ecosystems in Sri Lanka can be categorized into 3 groups.

- **Agricultural environments**
- **Industrial environments**
- **Settlement environments**

Agricultural environments

Figure 12.30 - Agricultural environment

- An ecosystem designed for cultivation of crops and animal husbandry to meet the food requirement is called an agricultural environment.
- Occasions where humans have taken into their control of certain plants and animals that were distributed in natural environment are found in agricultural environments.
- For the cultivation of paddy, tea, vegetables particular land preparations should be carried out. Also lands must be allocated for animal husbandry. In this case when the grasslands are regularly grazed, the plants do not exist. Hence the bio-diversity is limited.

Assignment 12.6

- Compare and tabulate the differences between a natural environment and an agricultural environment.

Industrial environments

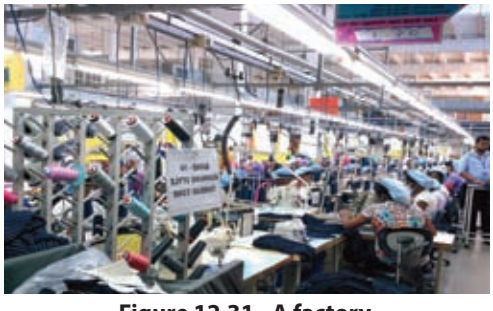


Figure 12.31 - A factory

- An ecosystem that has been built up by machines, raw materials and energy resources required for a product is called an industrial environment.
- When a community is being developed many productions (food, medicine, clothes, furniture, electrical equipment, sanitary materials) are produced, by many industries for betterment of living conditions of the citizens in a certain country.
- Even though these industrial products are useful to human they also have adverse effects.

Some of the adverse effects are,

- Heavy noise in the industrial environment
- Releasing poisonous gases and smokes
- Release of excessive heat and contamination of water bodies
- Harmful chemicals, released to the environment

Settlement environments

- A rural or urban environment where man has established his habitat is known as **settlement environments**.
- Migration to cities on a variety of needs and urbanization in cities have resulted more urban settlements.
- Many problems have arisen due to improper human settlements.

Figure 12.32 - A habitat

- Reduce the space
- Not enough light
- Less ventilation
- Diseases become to epidemic situation
- Insufficient sanitary facilities
- Difficulty in removing household garbage
- Damages from emergency fires
- Flooding
- Cultural and social issues

Assignment 12.7

- Man-made environments should be set up to ensure optimum utilization so as to minimize the damage to the natural environment. List the strategies you propose.

Summary

- Combination of plants, animals, micro-organisms, genetic materials of all these living organisms and the ecosystems is known as bio-diversity.
- There are various threats for bio-diversity. These threats have led to deterioration in bio-diversity.
- The living organisms as well as non-living components in an ecosystem often interact with each other. These interactions are living-living, living-non living and non living-non living.
- Fresh water environments, marine environments and brackish water environments are the natural aquatic environments that can be seen in Sri Lanka. Rivers, estuaries, lagoons, riverine environments, man made inland water bodies and oceans belong to these environments.
- The natural terrestrial environments in Sri Lanka can be grouped as forests and grasslands.
- There are four types of forests in Sri Lanka. They are tropical rainforests, montane forests, tropical dry mixed evergreen forests and tropical thorn forests.
- Wet 'Patana', dry 'Patana', 'Damana' and 'Talawa' are the types of grasslands in Sri Lanka.
- The man-made ecosystems are agricultural environments, industrial environments and settlement environments.
- It is our responsibility to protect the bio-diversity.

Exercises

(01) Select the correct or most suitable answer.

01. Select the correct statement about bio-diversity.
    1. Bio-diversity is the diversity of all the living beings in the environment.
    2. Bio-diversity is the diversity of plants, animals and the micro-organisms in the environment.
    3. Bio-diversity is the diversity of plants, animals, micro-organisms in the environment and their genetic materials.
    4. Bio-diversity is the combination of plants, animals, micro-organisms, their genetic materials and the ecosystem.

2. Which out of the following is **not** a threat for bio-diversity?

1) Environmental pollution 2) Spread of invasive species
3) Increasing human population 4) Study of biodiversity

3. Select the correct statement regarding bio-diversity.

a - High bio-diversity will increase the well-being and stability of an ecosystem.
b - Bio-diversity has reduced the competition for the needs of living species.
c - Man has focused to conserve endemic species due to rich biodiversity.

1) a and b 2) a and c 3) b and c 4) a, b and c

4. Which of the following can be considered as a man-made environment?

1) Montane forests
2) Ponds
3) Agricultural lands
4) Wet Patana

5. Consider the following statements about an ecosystem.

a - It is an independent unit.
b - Energy flows in one direction and materials are recycled
c - There are interactions between living-living and also living-non living.

The correct statements are,

1) a and b 2) a and c 3) b and c 4) a, b and c

(02) Match the features of column A with the relevant ecosystem in column B.

A	B
With smaller leaves and twisted stems	tropical rain forests
Canopy structure can be seen	wet 'Patana'
'Palu', 'Weera', 'Koan' are abundant	montane forests
'Maharathmal' plant is prominent	monsoon forests

(03) From ancient times man-made environmental systems have been created in addition to the existing natural ecosystems.

1. Name two important features of a natural ecosystem.
2. What are the man-made ecosystems that exist in Sri Lanka?
3. Write two common issues in a man-made ecosystem.
4. Write an example for a man-made ecosystem.
5. Given below is a picture of a man-made ecosystem. Suggest two possible issues and remedies in the given ecosystem.

Technical Terms

Bio-diversity	-	ජෛව විවිධත්වය	-	உயிர்ப் பல்வகைமை
Ecosystem	-	පරිසර පද්ධතිය	-	சூழற்றொகுதி
Natural ecosystem	-	ස්වාභාවික පරිසර පද්ධතිය	-	இயற்கைச் சூழற்றொகுதி
Man-made ecosystem	-	නිර්මිත පරිසර පද්ධතිය	-	நிருமாணிக்கப்பட்ட சூழற்றொகுதி
Ecosystem diversity	-	පරිසර පද්ධතිවල විවිධත්වය	-	சூழற்றொகுதிப் பல்வகைமை
Genetic diversity	-	ජාන විවිධත්වය	-	பரம்பரையலகுப் பல்வகைமை
Species diversity	-	විශේෂ විවිධත්වය	-	இனப் பல்வகைமை
Biotic factors	-	ජෛව සාධක	-	உயிரியல் காரணி
Abiotic factors	-	අජෛව සාධක	-	உயிரற்ற காரணி
Agricultural environments	-	කෘෂිකාර්මික පරිසර	-	விவசாயச் சூழல்
Industrial environments	-	කාර්මික පරිසර	-	கைத்தொழில் சூழல்
Settlement environments	-	ජනාවාස පරිසර	-	குடியிருப்புச் சூழல்

13 Artificial Environment and Green Concept

13.1 Artificial environment and green concept

Pay your attention to figure 13.1 which indicates built environments you have learnt in the chapter Bio-diversity.

Agricultural environment | Industrial environment | Urban environment

Figure 13.1

From the date of the origin of Earth, everything in it has been formed naturally. However with the advent of man on Earth and passage of time thereafter, an artificial environment or a built environment was taken place on the natural environment because of the man who changed the natural environment according to his requirements. Therefore, agricultural, industrial and urban environments are artificial environments made by man.

Assignment 13.1

- Figure 13.2 indicates how the area around Manhattan metropolis of New York in United State of America appeared in the past and is seen at present.
- List favourable and unfavourable features between these two environments.

Figure 13.2 - Town Manhattan

Instead of the Earth covered with green colour in the past, what is left today is an artificial environment crammed with settlements, factories and cultivated lands. Because of this, at present the humans all over the world are facing unsolve problems. Along with the advancement of science and technology of the human who is considered as the dominant living being on Earth, his/her life span too

has increased. Meanwhile, with the increase in human population and unlimited exploitation of limited resources on Earth, all organisms have confronted with many problems. Increase in global warming due to human activities has either directly or indirectly become the reason for all environmental problems.

At present, human attention has been drawn to follow guidelines and policies essential for maintaining goods and services without damaging the natural environment or causing minimal damage to the natural environment on the Earth. This has come to limelight as the green concept.

Green concept means, following guidelines and policies essential for maintaining goods and services so that the natural environment on Earth is minimally harmed or not harmed at all.

To get a better understanding about the green concept, let us find out information on several places in the world which adopt the green concept.

German Parliamentary building

Energy for this building is obtained from solar energy, geothermal energy and bio-fuel power houses. In addition, it has special ventilating devices and contrivances to retain warmth. 80% of the total electricity requirement is produced within the building itself. Because of such devices, it has reduced the annual emission of carbon dioxide from 7 000 tons to 1 000 tons (figure 13.3).

Figure 13.3 - German Parliamentary building

Figure 13.4 - Beijing National sports complex

Beijing National sports complex in China

It has employed methods to obtain electricity from solar energy and water requirements from rain water. Ventilation is effected naturally. Therefore, the maintenance of the sports complex is carried out by low cost (figure 13.4).

Figure 13.5 - Wayne L. Morse court complex

Wayne L. Morse court complex in USA

Irrigation required for plants is minimized by growing plants which can withstand drought conditions. Use of water has been cut down by 40% by the installation of waterless urinals, toilets and showers which use water minimally (figure 13.5).

K2 Housing project in Australia

This housing complex utilizes renewable energy only. Use of recycled timber, rain water, solar water heaters and photovoltaic panels can be seen in this. By such measures, it has been able to reduce electrical supply by 55%, water supply by 53% and petroleum gas supply by 46% (figure 13.6).

Figure 13.6 - K2 housing project

Bud Clark Commons housing complex in USA

This housing complex uses solar water heaters to get hot water, a roof with a plant cover absorbing heat and rain water, devices to purify bathroom effluents to be used in toilets and fiberglass windows opening under hot conditions. This project saves energy worth of 60 000 US dollars annually (figure 13.7).

Figure 13.7 - Bud Clark Commons housing complex

Concept Green

Figure 13.8 - Symbol of the Green Concept

You should not misunderstand that the aim of green concept is only enhancing the plant cover to appear in green. It may be quite clear to you from the above examples. Minimizing the emission of greenhouse gases (carbon dioxide, methane, nitrous oxide etc.) that cause increase in global warming is also a major aim of the green concept. Therefore, all processes supporting it belong to the green concept. Let us examine how the present agricultural and industrial processes can be geared for this.

13.2 Agricultural Process

Organic farming

The production process that promotes the wellbeing of the agricultural environmental system, microbial activity in soil, bio-diversity and biological cycles is called **organic farming**.

Use of organic fertilizers can be given as a major aspect of organic farming. As the harvest that flourishes by absorbing nutrients from the soil of the cultivated land is removed from it, the soil becomes deficient in nutrients. Therefore, the soil should be supplied with nutrients from outside. It is done by applying fertilizers, containing artificially prepared minerals and artificially synthesized chemicals, which are being applied more and more. But, instead of this, organic fertilizers such as compost formed by subjecting plant or animal materials to natural processes can be applied. Some facts regarding the importance of the use of organic fertilizers rather than inorganic fertilizers can be listed as follows.

- Application of inorganic fertilizers destroy many micro-organisms and macro-organisms such as earthworms which are helpful for the crop. It affects existence of the natural environment badly.
- Excessive application of inorganic fertilizers affects human health through plant products. Some heavy metals contained in, enter the human body giving rise to unfavourable effects.
- Organic fertilizers add nutrients falling within a wide range whereas inorganic fertilizers can provide only a few nutrients such as nitrogen, phosphorus, potassium and sulphur.
- Large amount of money need not to be spent for organic fertilizers. Fertilizers can be produced ourselves using refuse such as straw, plant debris, chaff and saw dust.
- There is a greater demand for rice, vegetables, fruits and leafy vegetables obtained from organic farming among the discerning people in Sri Lanka. Therefore, the farmers growing them as well as the traders who sell them can have a higher income.
- The structure of the soil will be improved with the time by using organic fertilizer.

Another fact of organic farming is the use of traditional agricultural practices for pest control. The pesticides used at present are highly poisonous chemicals that are synthesized artificially. Weedicides, insecticides and fungicides belong to them. Use of these pesticides causes inestimable environmental degradation and it can be prevented by employing traditional agricultural practices. These may be biological methods, mechanical methods or religious rituals. Some traditional agricultural practices used for pest control are given below.

- Spread other organisms that destroy eggs and larvae of pests
- Control pests using insect-repelling substances
  ('Dahaspethiya' flowers/'Sevvandipoo', juice of neem seeds, plants of citrus family)
- Water management (restrict water or excess water) to control pests

- In order to protect the cultivated land from harmful insects, an oil lamp is lighted in the land at night. Then the insects attracted to the flame are caught by it and die. Hence, this is known as a light trap.
- After sowing seed paddy in a paddy field, a 'diya holmana' is made below the 'vakkada' (overflow) to protect them from birds. Because of the sound it produces, the birds fly away.
- To protect paddy in a paddy field from mice, sticks each tied with a coconut husk are planted in several places in the paddy fields. Then, the birds such as owls perch on them and hunt the mice.
- Crop rotation avoid the establishment of pests in the crop land.

Assignment 13.2

Collect information about the traditional agricultural practices used for pest control either by consulting elders or electronic/print media and prepare a booklet.

As the side effects of present day agricultural practices carried out neglecting the traditional knowledge descended for long about farming in Sri Lankan society and without modern scientific knowledge farmers have to face tragedies like the chronic kidney disease. In addition to that, diseases such as dermatitis and neuro diseases are common.

Water management

"Let us not drain even a single drop of water falling from the sky into the sea without being used" declared so in the past by king 'Parakramabahu' the Great, was the importance of water management. We are the one and the only nation that did an environment friendly water management for agriculture from the past. Tanks, dams and irrigation canals which give supreme contribution to sustain lives of millions of people from thousands of years back to date, are magnificent examples for rain water conservation (figure 13.9 (a)).

Figure 13.9 (a) – 'Parakrama samudraya'

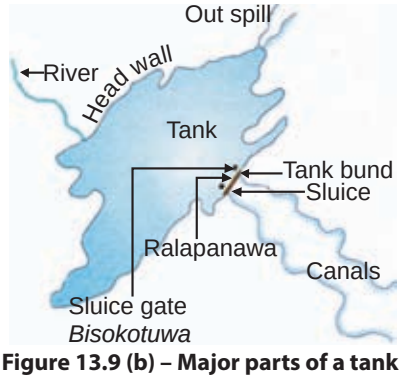


Figure 13.9 (b) – Major parts of a tank

A reservoir of water made by erecting a dam across a river, stream (oya) or a tributary of them with the aim of irrigating for farming an area which is short of water supply is used in earlier times.

Low level areas in large flat areas are made into tank systems where rain water got stored. These tanks are connected where rain water get collected and flow into nearby tanks. The stored water is used in dry zones during whole year. A tank is a system full of the green concept. This is confirmed by considering the components of a common plan of a tank (figure 13.9 (b)).

Collecting of rain water

As an individual person, there are courses of action which we can take to conserve rain water. One such measure is utilizing rain water falling on the roofs of houses and other buildings, during drought (figure 13.10).

Figure 13.10 – A device set up in a house to collect rain water

Figure 13.11 – Drip irrigation

Drip irrigation

This is the most efficient micro-irrigation method used at present. In this, lateral pipes connected to a main pipeline from the water source are laid closer to the root system of every crop plant. Water drips in the form of droplets from small devices called emitters in these pipes. Since water seeps only to the root system, water is not wasted and the growth of weeds is controlled (figure 13.11).

Land management

Management of use and development of the land resource is known as land management.

Land provides the environment for agriculture. But, when using it there may be favourable as well as unfavourable impacts on the environment. Especially the misuse of land leads to collapse of natural equilibrium including the increase in the emission of greenhouse gases. The reason for this is that if maximum use is not made from the existing land, lands with forests have to be used for cultivations. This causes deforestation, so the green cover is reduced. Therefore, land management should focus the green concept.

Some steps taken in land management are given below.

- Making a soil texture suitable for agriculture
- Improving the soil structure so that water and air are retained well
- Making a good draining system in the land
- Improving the quality of soil by applying fertilizers
- Cultivated better suited crops in respective places in the land.

Figure 13.12 – A managed cultivated land

Indicated below are a few advantages that can be obtained by sustainable management of agricultural lands.

- Improving productivity
- Reducing production risk
- Improving the quality of natural resources, soil and water
- Raising economic value
- Minimizing disasters
- Minimizing effects to the environment

Several green concept centered cultivation methods used in land management for high productivity are given in table 13.1.

Table 13.1

• Mixed crop cultivation 	Cultivating one or more crops along with one main crop in a same plot of land is referred to as mixed crop cultivation. This yields many advantages. • Since nutrients are absorbed in balance from the soil, the quality of soil is conserved. • Since there are different types of crops, the growth of weeds and damage caused by insect pests are minimized. • Crops withstand unfavourable climatic conditions and plant diseases are suppressed. • Increases the total yield • Affords maximum benefits out of limited resources
• Crop rotation 	In this method, several crops are grown in the same plot of land from season to season according to an order. Mostly in crop rotation, four crops, a cereal, a legume, a yam crop and a commercial vegetable crop are grown. • By growing different types of crops, nutrients in all the soil layers are exploited. • Different modes of land preparation improves the physical, chemical and biological features of the soil.
• Growing crops improved by bio-technology 	When improving plants by bio-technology, their tolerance to drought and resistance to diseases and pests increase while the nutritive value and taste of plant products also increase. e.g. • Developing high quality varieties of organisms through hybridization • Developing maize plants resistant to a harmful weevil species • Producing varieties of rice which are resistant to pests • Producing a variety of 'Ransahal' containing vitamin A • Making crop varieties which produce higher yield

Post-harvest technology

Figure 13.13 – Post-harvest arrangements

Cleaning, classifying and packaging the harvest immediately after harvesting so that its quality is preserved, is known as post-harvest technology (figure 13.13). The post-harvest process includes plucking the harvest, packing the harvest, transporting and selling.

In Sri Lanka, it can be seen that post-harvest technology operates at a very low level. It seems that, in our country people are little interested in plucking, packaging and transporting harvest scientifically. Therefore, a greater part of the harvest is disposed without consumption. This drops the income of the producer as well as the seller while increase the price of the products. Moreover, the opportunity to consume high quality food is reduced due to poor post harvest technology.

13.3 Industrial process

Use of chemical substances

We have accustomed to use chemical substances for various needs of our day to day life. They can be indicated as follows.

- Food additives
- Cleaning agents
- Medicines
- Disinfectants
- Cosmetics
- Paints

Most of these chemicals are artificially synthesized substances. Once added to the environment they retain for a long time in the same form. This disturbs the environmental balance. Because of this, we need to minimize the use of these chemical substances as much as possible or use natural substitutes instead of them. Some measures that can be taken in this regard are as follows.

- Avoid the consumption of flavoured food as much as possible and use home prepared natural flavours such as spices instead of artificial flavours.

- Use chemicals such as turmeric and asafoetida which have been used by our ancestors to kill germs.
- Using natural medicinal substances, instead of mercury containing carcinogenic creams available in the market to brighten the skin.

Construction of buildings

The aim of green building concept is to construct buildings with a green environment beset with plants. A few basic principles should be abided by when constructing green buildings. They are;

- Presence of green plants in the premises
- Get clean air through ventilation methods such as doors and windows
- Minimize the amount of waste
- Use energy efficiently
- Consume water efficiently
- Use natural materials for construction
- Make the maintenance cost minimal
- Device to reach natural light

Through the green buildings concept, environmental resources can be consumed causing minimum loss to the environment. Therefore, maximum benefit can be utilized from the nature. Technology also can be used for this.

e.g.

- Minimizing the amount of heat by a plant cover
- Producing electricity by solar cells
- Obtaining hot water to bathrooms from solar heaters
- Fixing large windows to receive more natural light and ventilation

Figure 13.14 – A building constructed according to the green concept

Green transportation

A massive revolution of transporting activities has been taken place with the technological development in modern world. It causes to increase the productivity, efficiency and the comfortable luxuries life pattern. But, unfavourable effects caused due to this development make long term disadvantageous results. Large amount of fuels burn daily for transporting goods and passengers. The result is collecting green house gases such as CO_2 and NO_2 more in the atmosphere.

Vehicles of turbo engines which combust compressed air with petrol, release more NO_2 gas in addition to CO_2. Hence, attention must be paid towards of minimizing the emission of greenhouse gases in transporting activities. This concept is known as green transportation.

e.g.

- Minimizing usage of vehicles individually
- Using transporting methods which do not consume fuels (walking, cycling)
- Aware and facilitate citizens to use hybrid vehicles
- Promote the concept of vehicles using solar cells and electricity among public
- Facilitating, transporting methods through water ways such as streams and rivers

When transporting food and other goods, it burns large amount of fuels that energy consumption is also need to cut down to decrease food miles. Consumption of local food is also need to appreciate. Every individual must take steps to minimize the emission of greenhouse gases in transporting activities so, that every body can contribute to solve global crises.

Assignment 13.3

Make a list of activities that you can engage for green transportation.

Get the ideas and proposals of your friends in classroom, by presenting the list you prepare.

The above discussion reveals us that, man has changed his living environment drastically for his luxurious life by exploitation of limited resources unlimitedly. Other organisms on the Earth has no privilege to use environmental resources as human population, although they live in the same land.

Number of global issues has been arisen from unusual exploitation of natural resources by some people. The serious threaten is global warming. Hence, it is the responsibility of man to avoid every activity which causes the emission of greenhouse gases.

From birth to death, every activity of man cause producing CO_2. It can be inferred that, there is no human activity which do not cause production of CO_2. This can be clearly understood by studying 'Carbon footprint' of an individual.

It states us the amount of CO_2 (metric tons) emitted by an individual. Through out a year, a large amount of carbon is being released by people during activities like taking food, drinking, clothing and occupation. Agricultural activities and transportation related with 'Food mile' is again related with transporting activities. Another major issue caused due to shortage of drinking water can be explained, by the concept of 'Water footprint'. You will learn more details about food mile, carbon footprint and water footprint in grade 11.

For extra knowledge

Carbon footprint

The amount of carbon dioxide released into the atmosphere within a given time period as a result of the activities of a particular individual, a production, an activity or an organization is a carbon foot print. Total carbon foot print cannot be calculated precisely as CO_2 is produced naturally and it needs more data to calculate.

Water footprint

The amount of fresh water utilized in the production or supply of the goods and services used by a particular person or group.

Food mile

The distance over which a food item is transported during the journey from producer to consumer, is known as food mile. This depends according to the amount of food consume per meal and the location where the food is produced.

Summary

- Following guidelines and policies required to maintain goods and services, not causing damage or causing minimum damage to the natural environment of the Earth, is referred to as green concept.
- Minimizing the emission of greenhouse gases which increase global warming is also a main objective of the green concept.
- In order to align with the green concept, the present agricultural and industrial processes should be subjected to a drastic transformation.
- The production process that improves the wellbeing of the agricultural environment, biological activity in soil, bio-diversity and biological cycles is called organic farming.
- Use of organic fertilizers is a main aspect of organic farming.
- Another aspect of organic farming is the adoption of traditional agricultural practices for pest control.
- Tank (wewa) is a system replete with the green concept. This is justified by considering the components of a common plan of a tank.
- Management of the use and development of the land resource is called land management
- Post-harvest technology is the cleaning, classifying and packing of the harvest of a crop immediately after packing the yields, so that its quality is preserved.
- The principle aim of green buildings or the sustainable construction concept is the construction of buildings with high efficiency of using energy, water and materials while minimizing the impact on man and the environment.
- Minimizing emission of greenhouse gases in transportation is called as green transportation.

Exercises

(01) Select the correct or most suitable answer.

1. The meaning of green concept is described by following statements.

   a - enhancing the plant cover appearing in green

   b - minimizing the emission of greenhouse gases that increase global warming

   c - maintaining goods and services not harming or harming minimally to the natural environment on Earth

   Out of these, select the correct statements,

   1. Only a 2. Only a and b 3. Only a and c 4. a, b and c

2. Utilization of solar energy supports the green concept because,

   1. it conserves resources on Earth
   2. it minimizes emission of greenhouse gases
   3. more energy can be produced
   4. it is available only during day time

3. Select the substance that **cannot** be used to produce organic fertilizers, from the following.

   1. Straw 2. Chaff 3. Plant litter 4. Polythene

4. Which of the following introduces the substances, that can be used for making compost fertilizers?

   1. Straw, plant litter, cow dung, animal urine
   2. Straw, plant litter, polythene, cow dung
   3. Plastic, straw, plant litter, animal urine
   4. Papers, straw, plant litter, cow dung

5. From the following statements, which one is **incorrect** about post-harvest technology?

   1. Post-harvest technology is the cleaning, classifying and packing of the harvest immediately after harvesting so that its quality is preserved.
   2. The major aim of post-harvest technology is the addition of preservatives to the harvest immediately after harvesting.
   3. Harvesting, packing, transporting and selling the yield belong to post-harvest technology
   4. Weakening of post-harvest technology causes hike in prices of the products.

6. Which one of the following is **not** followed in the construction of green buildings?

1. Collecting and using rain water
2. Heating water by solar heaters
3. Producing electricity by building natural gases
4. Purifying effluent water from bathrooms and to use in latrines

7. Some statements about organic farming are given below.

a - Organic farming is favourable for soil micro-organisms
b - The yield of organic farming is high quality
c - Organic fertilizers is a major application of organic farming

Of the above, the true statement(s) is/are

1. Only a 2. Only a and b 3. Only a and c 4. a, b and c

8. Which of the following is **not** a feature of a building constructed according to the green concept?

1. Using natural light more
2. Fixing large windows for better ventilation
3. Producing electricity by solar cells
4. Using an air conditioner to maintain a suitable temperature

9. Consider the following two statements.

Statement A - Increase in global warming is a main environmental problem seen at present
Statement B - The main reason for the increase in global warming is the exclusive emission of greenhouse gases to the environment

Of the above statements,

1. Only A is true and B is false
2. A is false and only B is true
3. Both A and B are false
4. Both A and B are true

10. Which of the following is **not** an environment-friendly method of pest control,

1. Use of bio pesticides
2. Collect and destroy the pests
3. Use natural 'Kem krama' (simple and occult treatment that's done secretly)
4. Destroy the pests by machines

(02) Answer the following.

i. Name a place where green concept can be well observed in Sri Lanka.
ii. The artificially synthesized, highly poisonous substances used to control pests are called ……..
iii. Write two methods of generating electricity according to the green concept.
iv. Write two advantages of the use of inorganic fertilizers.
v. Write five substances that are used in day to day life which contain artificial chemical substances.

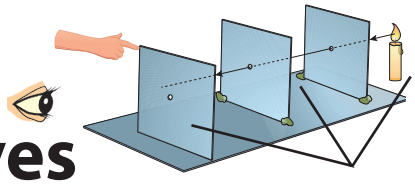
(03) Give short answers.

i. What is green concept?
ii. What is the aim of green concept?
iii. State two things which are important in land management.
iv. State two advantages brought about by promoting post-harvest technology.
v. Write one way by which you can contribute to green transportation.

Technical Terms

Green concept	-	හරිත සංකල්පය	-	பசுமை எண்ணக்கரு
Organic fertilizers	-	කාබනික පොහොර	-	சேதனப் பசளைகள்
Pest control	-	පළිබෝධ පාලනය	-	பீடைக் கட்டுப்பாடு
Water management	-	ජල කළමනාකරණය	-	நீர் முகாமைத்துவம்
Transportation of food	-	ආහාර පරිවහනය	-	உண்வுப் போக்குவரத்து
Food preservation	-	ආහාර පරිරක්ෂණය	-	உணவு நற்காப்பு
Food security	-	ආහාර සුරක්ෂිතතාව	-	உணவுப் பாதுகாப்பு
Post harvest technology	-	පසු අස්වනු තාක්ෂණය	-	அறுவடையின் பின்னரான தொழினுட்பம்
Eco - friendliness	-	පරිසර හිතකාමී බව	-	சூழல் நேயமுடைமை
Green transportation	-	හරිත ප්‍රවාහනය	-	பசுமைப் போக்குவரத்து

14 Reflection and Refraction of Waves



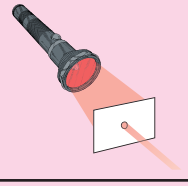
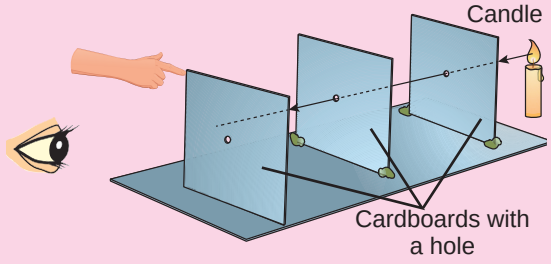
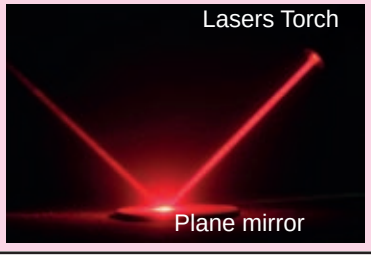
14.1 Reflection of light

Light is a very important form of energy for man. Let us briefly recall what we have learnt about light in grades 6 and 7. Let us do the assignment 14.1 for this.

Assignment 14.1

- According to the activities in table 14.1 what are the conclusions you can made regarding the characteristics of light.

Table 14.1

Activity	Conclusion
	
	
	

Light is composed of very thin light rays which travel in straight lines. Light travels through a vacuum or a transparent medium in straight lines, and reflects when strikes on a reflecting surface (mirror).

Bouncing back of light ray into the same medium, when strikes on a surface, is known as reflection of light.

Let us study further about the reflection of light.

14.1.1 Reflection of light by a plane mirror

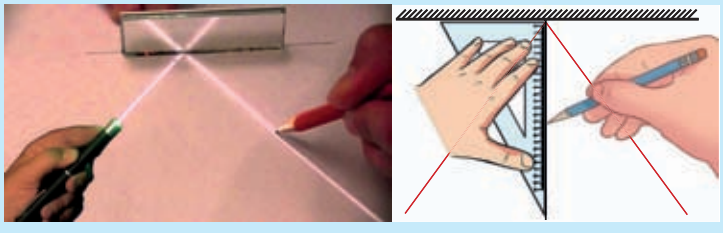
Let us do the activity 14.1 to study how light rays get reflected from a plane mirror.

Activity 14.1

You will need :- A plane mirror, a sheet of white paper, an electrical torch or a laser torch, a pair of scissors, a ruler, a protractor, a pencil

Method :-

- Place the sheet of white paper on the table
- Place the plane mirror perpendicular to the paper using a stand.
- Draw the mirror line on the paper
- Direct a narrow inclined beam of light, along the paper on to the mirror using the electrical torch or the laser torch.
- Observe how the beam of light reflects from the mirror
- Trace the incident and reflected rays on the paper using the pencil
- Remove the mirror and complete the rays using the ruler
- Construct the normal line to the plane mirror at the point of incidence
- Measure the angles at either sides of the normal line



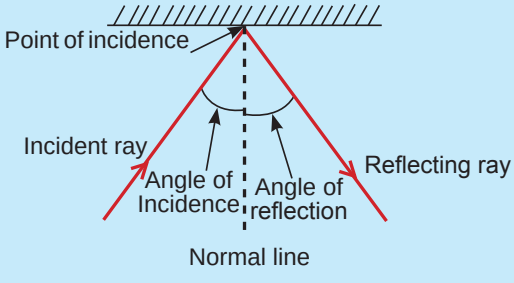


Figure 14.1

A diagram that shows the way the rays are traveling is known as a ray diagram.

In the activity 14.1, what you have constructed is a ray diagram to show the reflection of a light ray from a plane mirror after its incidence.

- The ray that falls on the mirror is called the incident ray.
- The point where the incident ray contacts with the mirror is the point of incidence.
- The ray that reflects away from the mirror is known as the reflecting ray.
- The perpendicular line drawn to the mirror at the point of incidence is the normal or the normal line.
- The angle between the incident ray and the normal line is called the angle of incidence and the angle between the reflected ray and the normal line is called the angle of reflection.

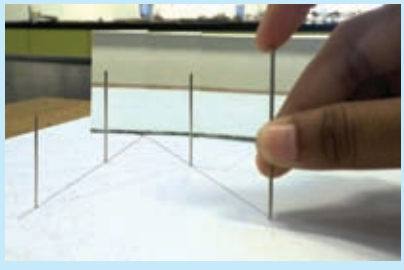
We can do the activity 14.1 using pins instead of using electrical torch. Let us do the activity 14.2 by using pins.

Activity 14.2

You will need :- A sheet of white paper, A plane mirror, four pins, a ruler, a pencil, a protractor, a stand

Method :-

- Place the sheet of paper on the table
- Place the plane mirror perpendicular to the paper using the stand
- Draw the mirror line on the paper
- Fix two pins in front of the plane mirror which should be on an inclined straight line to the mirror.
- Observe the images of the pins through the mirror
- Fix another two pins on the paper, which are in line with the two images.
- Now remove the pins and the mirror. Draw straight lines connecting the pin marks. Complete the ray diagram by constructing the normal line at the point if incidence, as done in activity 14.1
- Measure the angle of incidence and the angle of reflection.



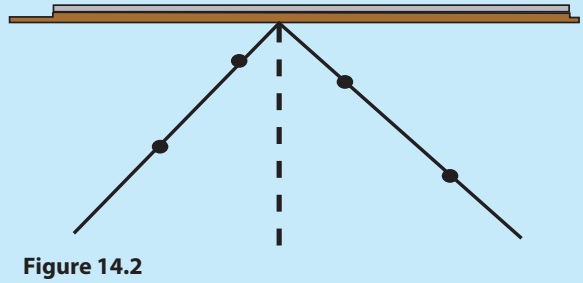


Figure 14.2

14.1.2 Laws of reflection

Observations of the activities 14.1 and 14.2 can be summarized as follows.

- When light is reflecting; that the incident ray, reflecting ray and the normal line are in the same plane.
- That the values of the angle of incidence and the angle of reflection are equal.

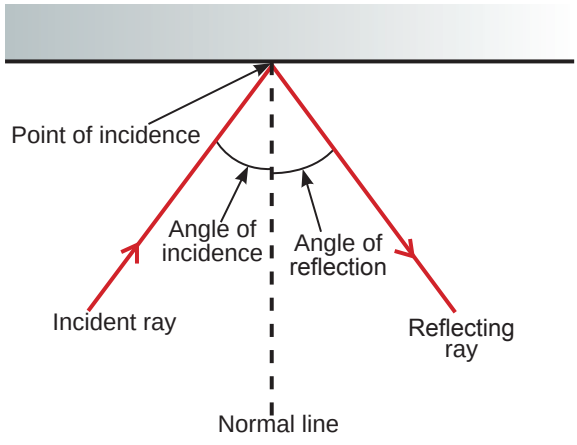


Figure 14.3

Above conclusions are true for all the instances of reflection of light. Therefore, they are considered as the laws of reflection. There are two laws of reflection.

1. The incident ray, the reflecting ray and the normal line drawn at the point of incidence are in the same plane.
2. The value of the angle of incidence is equal to the value of the angle of reflection.

14.1.3 Regular reflection and diffuse reflection

Let us observe how parallel rays of light are reflected from a smooth surface and a rough surface. Let us do the activity 14.3, using a plane mirror as a smooth reflecting surface and a crushed aluminium foil as a rough reflecting surface.

Activity 14.3

You will need :- An electrical torch or a laser torch, A plane mirror , an aluminium foil, a joss stick

Method:-

- Aim a beam of light on to the plane mirror and the crushed aluminium foil separately as shown in the figure 14.4
- Observe how the light is reflecting in each instance
- Discuss your observations in the class room

(For clear observation, spread some smoke near the set-up using the joss stick)

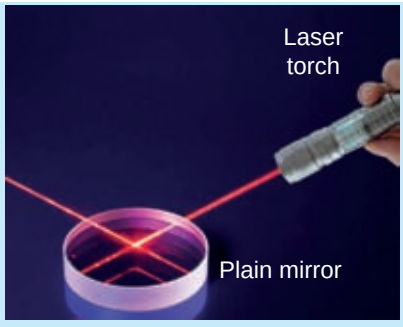


Figure 14.4 (a) - Regular reflection

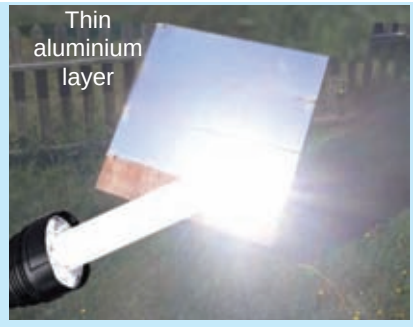


Figure 14.4 (b) - Diffuse reflection

Figure 14.4 - Regular and diffuse reflections

Note :- Do not aim the laser rays into eyes, as they are harmful to eyes.

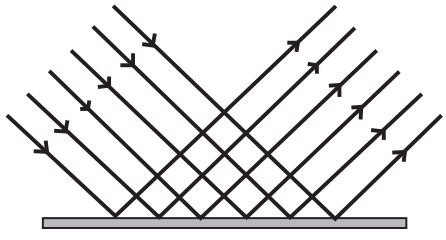
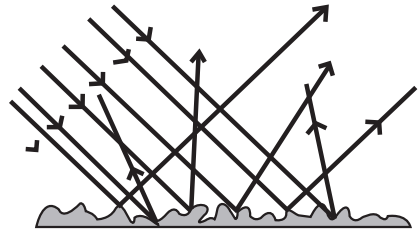
You may have observed that parallel light rays are reflected parallelly by plane mirror (figure 14.4 a) and parallel light rays are reflected to various directions by crushed aluminium foil (figure 14.4 b).

According to the activity 14.4, it is clear that light reflection is of two types.

1. Regular reflection 2. Diffuse reflection

More information of these two types are given in the table 14.2.

Table 14.2 - Regular and diffuse reflection

Regular reflection	Diffuse reflection
	
• This is done by smooth surfaces • Parallel light rays are reflected parallelly e.g. Reflection of sun light by a plane mirror Reflection of laser rays by a plane mirror	• This is done by rough surfaces • Parallel light rays are reflected to various directions e.g. Reflection of sun light by the pages of a book Reflection of sunlight by objects like the Earth, plants, buildings and rocks

Think whether regular reflection or diffuse reflection is commonly found in day-to-day life.

Both regular reflection and diffuse reflection are useful in day-to-day life.

Instances where regular reflection is useful

- Regular reflection is commonly found, when using mirrors
  e.g. To watch ones own face, to use light microscope
- To create vivid light patterns in various shows.
- To get information of the motion of machine parts in industrial plants

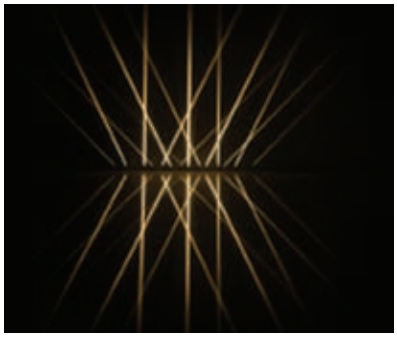


Figure 14.5 - Create vivid light patterns in various shows

Figure 14.6 - Using light microscope

Instances where diffuse reflection is useful

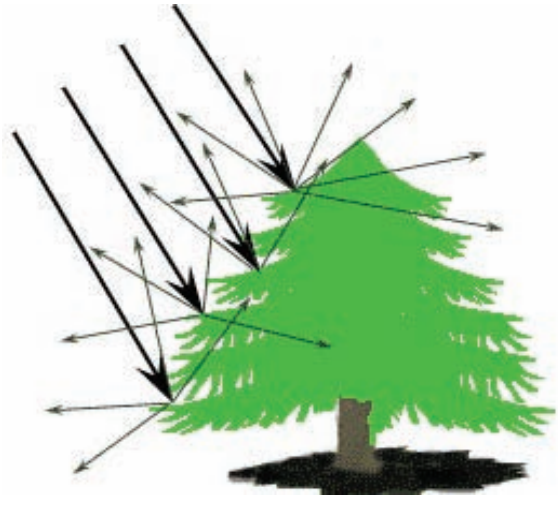


Figure 14.7 - Objects in the environment can be seen from all directions as they reflect sun light diffusely

Figure 14.8 - Letters in a book can be seen from all directions

Assignment 14.2

- Discuss in the classroom, the instances where regular reflection and diffuse reflection are useful. Tabulate the facts you discussed.

14.1.4 Images formed by plane mirrors

Images are formed because of the reflection of light, emitted by objects, from a plane mirror. For instance, the image of an electrical torch place before a plane mirror can be seen through it.

Let us do the activity 14.4 to study how an image is formed by reflection of light.

Activity 14.4

You will need :- A cardboard box, an electrical torch, plane mirror, a stand, piece of cardboard, a pair of scissors, white paper

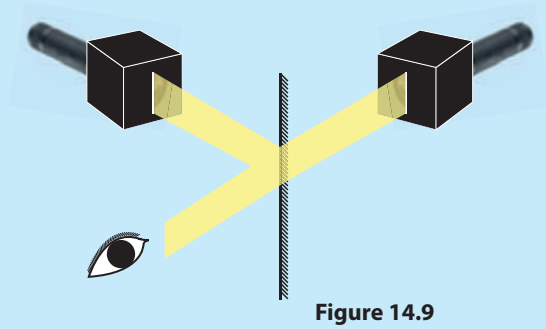


Figure 14.9

Method:-

- Place the white paper on the table.
- Fix the plane mirror, perpendicular to the white paper.
- Place the lighted torch inside the box, with a long slit. Focus the beam of light, to the slanted mirror plane, emitted by torch.
- Look at the reflected beam of light.
- What can you observe through the plane mirror.
- Get the help of teacher to explain your observation.

In this activity you observed, the image of lighted slit. The light reach to eye from object (slit) which get reflected from the mirror.
We see as the light reaches to eye from a point behind the mirror. It is known as image.

Let us draw the ray diagram for the image formed by plane mirror.

Two rays are enough for drawing a ray diagram.

Let us do the activity 14.5 to draw a ray diagram of an image of pointy object, kept infront of a plane mirror.

Activity 14.5

You will need :- Two laser beams, a white paper, a plane mirror, a stand, a pair of scissors

Method :-

- Make a slit in the piece of cardboard
- Place the white paper on the table and fix the mirror to the stand perpendicularly (figure 14.10)
- Direct two lazer beams through the slit, slantly to the mirror.
- Observe the reflected beams of light.

What can you observe now?

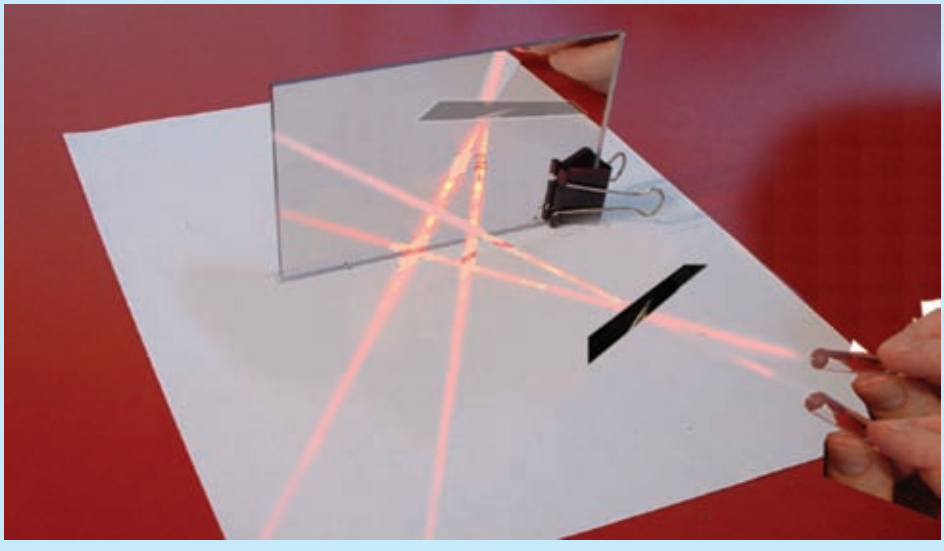


Figure 14.10

In the activity 14.5, the pointy object is the slit made in cardboard. The light rays reach from slit, get reflected by the plane mirror and from an object behind the mirror.

According to the observation done in activity 14.5 we can illustrate the ray diagram. For that let us engage in activity 14.6.

Activity 14.6

You will need :- A sheet of white paper, a ruler, a pencil, a protractor

Method :-

- Draw a straight line, on the sheet of paper to indicate the plane mirror.
- Mark a point, about 5cm away from the mirror plane (point-form object).
- Starting from this point, draw two inclined light rays to the mirror plane.
- Mark the points of incidence and construct the normal lines for the two rays drawn.
- Measure the angles of incidence and mark the angles of reflection equals to them.
- Now construct the reflecting rays.
- Extend back the reflecting rays by dotted lines to meet them together.
- Mark the point where the reflected rays meet together when extended back. That is the point where the image is formed.
- Connect the object and the image by a dotted line.
- Measure the distance between the mirror and the object (object distance) and the distance between the mirror and the image (image distance).
- Confirm the object distance is equal to the image distance.

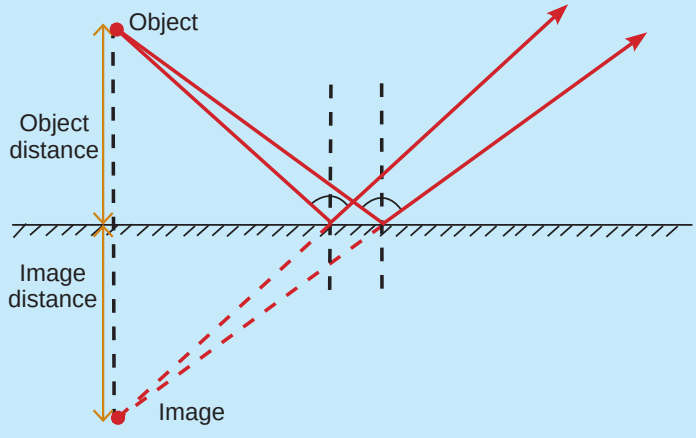


Figure 14.11

Assignment 14.3

Construct a ray diagram to show how the image is formed, of a point-form object kept 8 cm away from a plane mirror
(It is suitable to use an A4 sheet of paper for this)

Measure the object distance and the image distance

You have already learnt in grades 6 and 7, some of the characteristics of images formed by the objects kept infront of plane mirrors. Recalling them, let us do the activity 14.7 to study the characteristics of images formed by plane mirror.

Activity 14.7

You will need :- A plane mirror, a white screen, a ruler, a stand, pieces of cardboard on which letter **O**, **B**, **F** and **d** are drawn to the height of about 5cm (When you write the letter **O** draw a vertical line and colour half of it).

Method :-

- Fix the plane mirror vertically to the stand.
- Place each piece of cardboard, on which a letter is drawn, in front of the plane mirror. Observe the image of the letter through the mirror.
- See whether the image can be taken on to a screen.
- Repeat the activity, keeping some other objects in front of the mirror.
- Tabulate your observations in the table 14.3

Table 14.3

Letter/ Object	How the image is seen upright/inverted	Whether lateral inversion occur/not occur	Equality of the sizes of object and image	Whether image can be/cannot be taken on to a screen
B	upright	occur	equal	cannot be taken on to a screen (virtual)
F	.....	.....	.....	.....
d	.....	.....	.....	.....
O	.....	.....	.....	.....

Changing right hand side and the left hand side of the image is known as lateral inversion.

If the image can be taken on to a screen it is known as a real image, if it cannot be taken on to a screen, it is known as a virtual image.

According to the activity 14.7, the **characteristics of images** formed by the objects, kept in front of a plane mirror can be listed as below.

- Virtual (cannot be taken on to a screen)
- Upright
- Equal to the size of object
- Object distance and image distance are equal
- Lateral inversion occur

Letters like O, A and X cannot be identified under lateral inversion as these letters are symmetrical.

Assignment 14.4

Stand in front of a large mirror which is on a dressing table or any other place.

Observe the size and the lateral inversion of your image in the mirror.

Think whether your observations agree with the characteristics of the images formed by plane mirrors.

14.1.5 Use of plane mirrors

Plane mirrors are widely used for various tasks in day-to-day life. Some of them are given below.

1. Used in beauty salons and to watch ones own face, for dressing (figure 14.12)
2. In shops to show the number of items increased (figure 14.13)
3. To reflect light for laboratory activities (figure 14.14)
4. To produce multiple images (figure 14.15)
5. To observe the shape and the back side of costumes when selecting items for fashion activities (figure 14.16)
6. To observe backside of the head when one is having a haircut in a salon (figure 14.17)

Figure 14.12

Figure 14.13

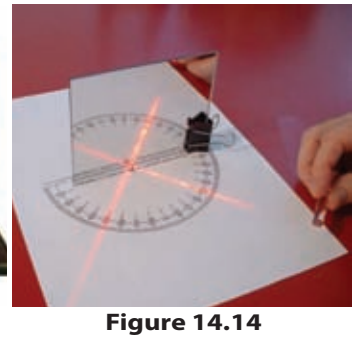


Figure 14.14

Figure 14.15

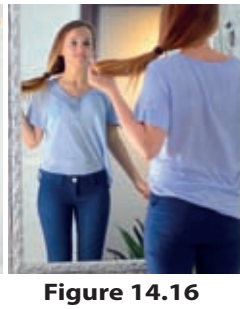


Figure 14.16

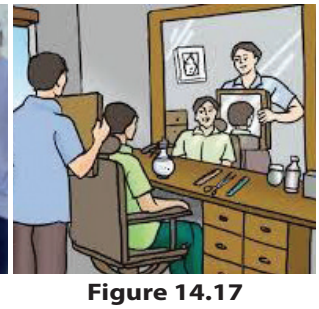


Figure 14.17

7. For making kaleidoscope

Various colourful patterns can be observed through this, when small pieces of petals, leaves or pieces of colourful papers are put into this.

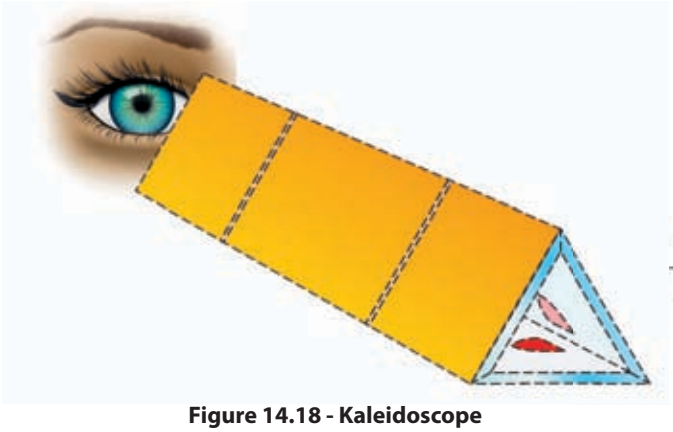


Figure 14.18 - Kaleidoscope

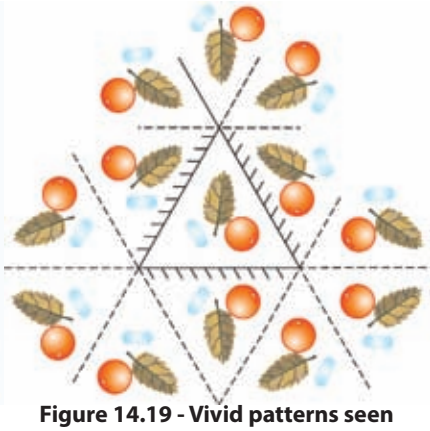


Figure 14.19 - Vivid patterns seen through a kaleidoscope

8. For making periscope

Periscopes are used to observe objects which are located above or below the position of the observer. (to watch out side from a submarine or a bunker)

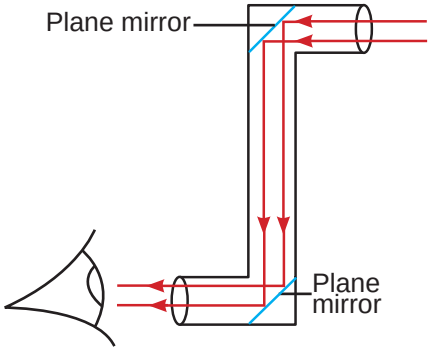


Figure 14.20 - Periscope

14.2 Sound

14.2.1 Reflection of sound

Be silent and listen to the environment for a moment. You may observe sounds generated by the vibration of various objects. Let us pay our attention to an important property of sound. Let us do the activity 14.8 for this.

Activity 14.8

You will need :-

A small mechanical clock or a stop watch, two pieces of PVC tubes to the length of 30cm each (dia.2.5cm), two stands, a piece of cardboard to the size of 30 cm × 50 cm, a smooth metal or glass sheet to the size of 30 cm × 30 cm

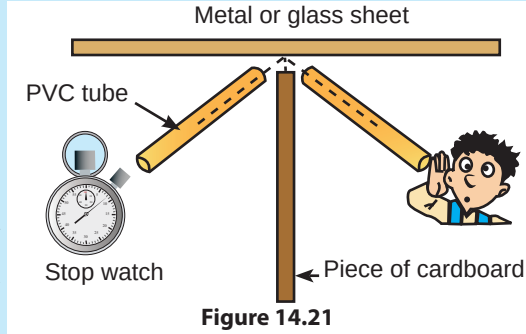


Figure 14.21

Method :-

- Place the metal or glass sheet vertically on the table.
- Place the cardboard sheet perpendicular to it.
- Fix the PVC tube to a stand as shown in figure 14.21 and place the stop watch closer to one end of it.
- Aim the other PVC tube to the glass sheet from the other side of the cardboard sheet. Adjust the position of the tube till a clear "tick" sound is heard through it. Mark the position of the tubes on the table.
- Now remove the glass sheet and listen for the "tick" sound of the watch.
- Repeat the activity, changing the position of the watch and using suitable sound sources instead of clock or stopwatch.
- Discuss in the classroom, the conclusions that can be made for the activity.
- Think of the reason for placing a cardboard sheet between the PVC tubes.
- What is the conclusion that can be made according to the results of this activity?

It is observed that the sound generated by the source was listened clearly at a certain point when the metals or glass sheet was there. And the sound could not be heard when the glass sheet was removed. The reason for this is the reflection of sound from the metal or glass sheet.

Bouncing back of sound from an obstacle is known as reflection of sound.

The obstacle that reflected sound, in the activity 14.8 was the metal or glass sheet.

Sound is in the environment are constantly subjected to reflection by various obstacles. Most of the sound reflecting instances cannot be noticed. But, there are some observable instances. Now let us consider some of them.

14.2.2 Echo

You may have observed that, when a strong sound is made in front of a large obstacle (a mountain/a building), it is heard over and over again. Let us do the activity 14.9 to experience this.

Activity 14.9

You will need :- A clapper used for starting running events or two wooden sticks

Method :-

- Select a place where there is a suitable obstacle like a tall building or a wall.
- Stand about 17 m apart from the obstacle (minimum distance between the obstacle and the observer to hear an echo is 16.5 m).
- Make strong sounds by striking the clapper several times.

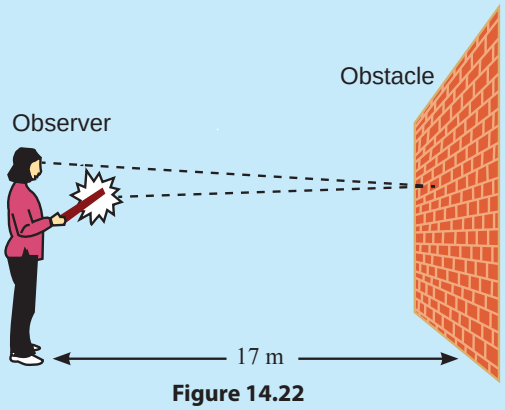


Figure 14.22

- Listen carefully after each instance of making the sound.
- Discuss the reasons for observations.
- Repeat the activity while coming closer to the obstacle.
- Make the sound while you are at a distance of 15 m or less to the obstacle (you can use even the walls of your classroom for this).
- Compare the latter observations with the earlier ones.

Sound generates by the clapper, was reflected by the obstacle. After hearing the first sound, the reflected sound was also heard after a short while later.

A second hearing because of the reflection of sound after the first one, is known as echo.

When the obstacle is too close the echo is not clear. This fact is confirmed in activity 14.9.

Sometimes several echoes can be heard, because of the reflection of the first sound. This happens when the sound is reflected several times. For instance, sound reflection in an auditorium can be mentioned.

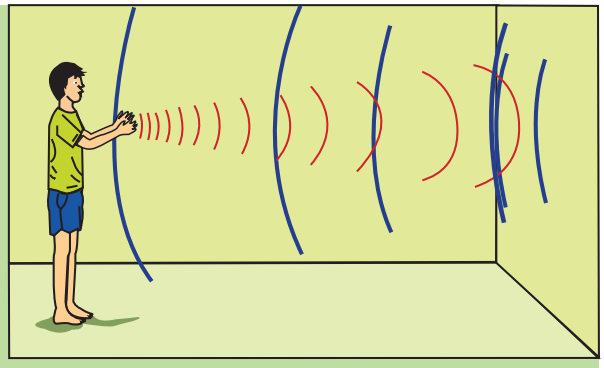
Assignment 14.5

- List out the instances of sound reflection that you have experienced in your day-to-day life. Mentioned the obstacle that is responsible for the reflection of sound in each instance.

For extra knowledge

Though the sound is reflected, clear echo is not heard when the obstacle is too close to the observer.

There is a minimum distance that should be maintained between the obstacle and observer to hear an echo. That minimum distance can be calculated as given below.



- The sense of sound is retained in human ear for 0.1 seconds.
- Sound travels 330 meters per second in air.
- To distinguish two sounds separately, difference between them should be more than 0.1 seconds.

The distance that sound travels in one second = 330 m

Distance that sound travels in 0.1 seconds $= \frac{330\ m \times 0.1s}{1s}$

Total distance that sound should travels to occur an echo = 33 m

∴ The distance that should be between the obstacle and the observer $= \frac{33\ m}{2}$

= 16.5 m

14.2.3 Reverberation

There are some instance in an auditorium or a cinema hall, that the sound emitted by the loud speaker is not clear. The reason for this is that the echo generated by the reflection of sound is heard before the initial sound fades off from the ear. Final result of this is, that the observe experiences a mixed unclear sound.

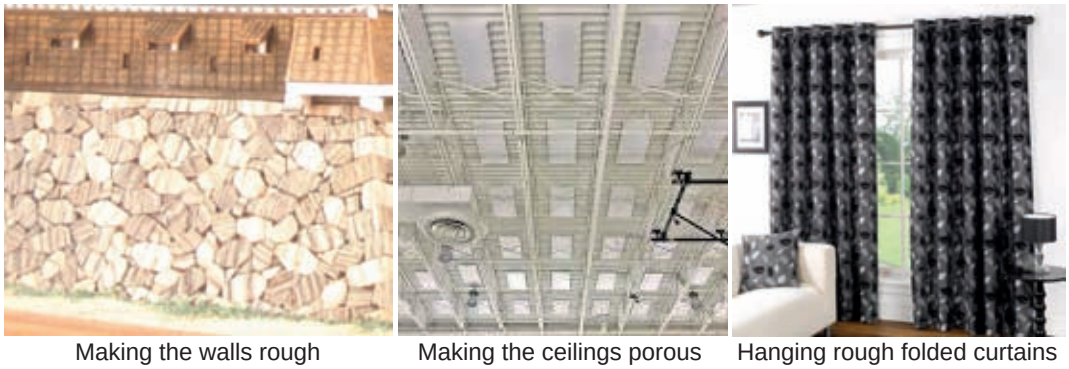
The persistence of sound for a long time because of the disability to distinguish the original sound and the echo is known as reverberation.

Reverberation is a disturbance for clear hearing. Therefore, methods are used to prevent the reflection of sound in auditoria, lecture halls and cinema halls where clear hearing is expected.

Reverberation occur because of the reflection of sound. Reflection of sound can be minimized by making the surfaces that sound strikes, to absorb it. Thus reverberation can be prevented.

Following methods are used in places like cinema halls, auditoriums and studios to absorb sound and thus prevent reverberation (figure 14.23).

Methods used to prevent reverberation



Making the walls rough | Making the ceilings porous | Hanging rough folded curtains

Figure 14.23 - Methods used to prevent reverberation

Instance where reflection of sound is applied usefully

Let us consider briefly some instances where reflection of sound is used.

1. Ultra sound scanning

Reflection of ultra sound waves is used to observe the shape of internal organs. This method is known as ultrasound scanning. Ultra sound waves are generated by a machine and are aimed at the relevant organ from outside of the body. Ultrasound waves that reflect from the organ are received by the machine. Those waves formulate the external appearance of the relevant organ on a screen.

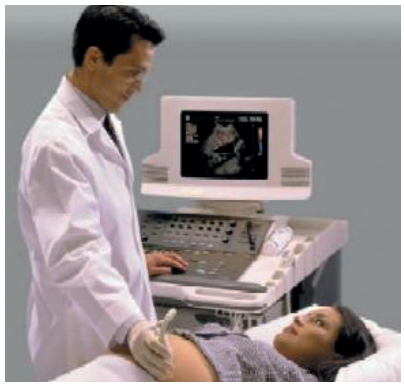


Figure 14.24 - Womb of a pregnant mother is being subjected to ultrasound scanning

Figure 14.25 - How the foetus developing in the womb is seen in ultrasound scanning

For extra knowledge

X-ray photographing may be harmful to organs and living body. But the harm is very less in ultrasound scanning.

2. Finding the depth of ocean bed

It is important to know the depth of the ocean bed in navigation. Reflection of ultrasound waves is used for this purpose. The method used is known as Sound Navigation and Ranging (SONAR). The equipment used for this is known Echo Sounder.

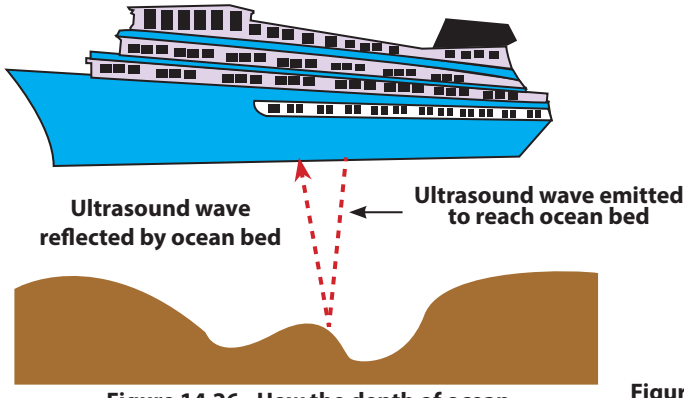


Figure 14.26 - How the depth of ocean bed is determined using echo sounder

Figure 14.27 - How the information of ocean depth is depicted in an echo sounder

The depth of the ocean is determined by the time taken to receive the wave, back to the equipment after reflecting from the ocean bed.

3. For bats, to identify obstacles at night

Reflection of ultrasound waves helps nocturnal animals like bats to identify obstacles at night. Ultrasound waves emitted by them, reflect after bouncing on the obstacles. According to the time taken for this, they can determine the distance to the obstacle.

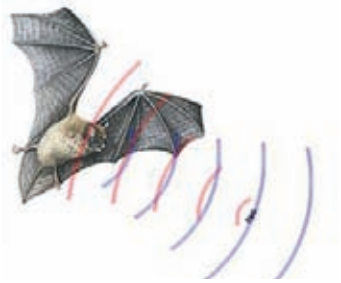


Figure 14.28 - How the ultrasound waves emitted by bat is reflected after bouncing on an obstacle

14.3 Refraction of Light

When light is travelling through a transparent medium, it travels rectilinearly. Now let us consider an instance that a light ray entering from one transparent medium to another transparent medium. Let us do the activity 14.10 for studying this phenomenon.

Activity 14.10

You will need :- A beaker of water, some soap, an electrical torch or a laser torch

Method : -

- Mix some soap in water in the beaker. (without allowing to form lather)
- Direct a thin inclined beam of light using the electrical torch or laser torch.
- Observe how the path of light beam changes when it enters into water.

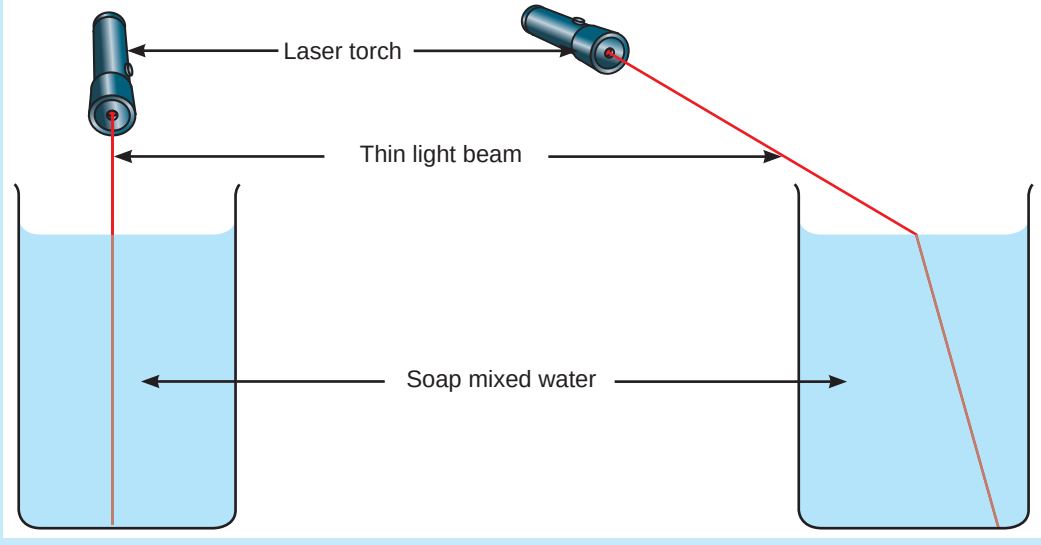


Figure 14.30 - Directing the light beam perpendicularly to the water surface

Figure 14.29 - Directing the light beam with an inclination to the water surface

- Carryout the activity changing the inclination of the thin beam of light
- Discuss your observations in the classroom.
- Answer the following questions while engaging in the activity.

1. What are the two transparent media that the thin beam of light travelled through?
2. At what place did the beam of light bend?
3. What is the reason for mixing soap into water?
4. What happens when light is directed perpendicular to the water surface?

In the activity 14.10, light rays have traveled from one transparent medium (air) into another transparent medium (water). The surface where two media come to contact each other is known as the interface. Light travels from one medium into another medium through the interface. It may be clear that, always the change of direction of light occurs at the interface.

It is important to mix soap into water to see the beam of light in water.

The change of direction of light when traveling from one transparent medium into another transparent medium is known as refraction of light.

The beam of light directed perpendicular to the interface, do not occur refraction.

- During refraction, the ray that is reaching the interface is the incident ray.
- The ray that travels after refraction is the refracted ray.
- The point on the interface where the incident ray falls, is the point of incidence.
- A normal line also can be constructed at the point of incidence.

The way of refraction occurs when a light ray enters from air to water can be shown by a ray diagram as in figure 14.31.

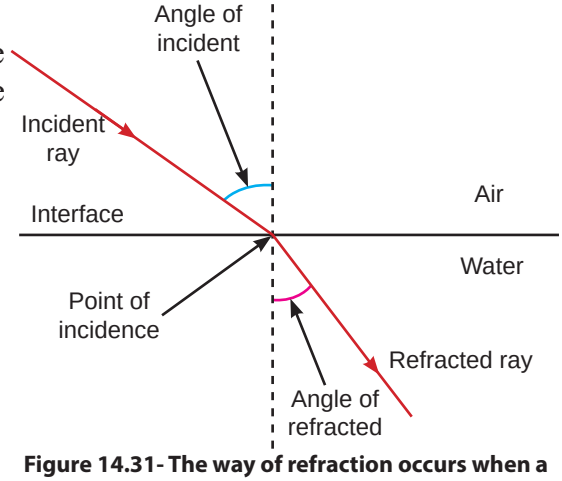


Figure 14.31- The way of refraction occurs when a light ray enters from air to water

For extra knowledge

Light travels in a definite velocity in a given medium. Velocity of light differs from medium to medium.

e. g.

Medium	Velocity of light (meters per second)
Vacuum or air	3.0×10^8
Water	2.25×10^8
Glass	2.0×10^8

Refraction of light occurs because of change of its velocity when traveling from one medium to another medium.

Refraction of light in a glass block

Let us study how a narrow beam of light (a pencil of light) refracts when directed into a glass block. Let us do the activity 14.11 for this.

Activity 14.11

You will need :- A glass block, a sheet of white paper, four pins, an electrical torch or a laser torch, a pencil, a ruler

Method :-

- Spread the sheet of white paper on the table and place the glass block on it.
- Direct an inclined beam of light on to the glass block as shown in figure 14.32.
- Fix two pins on the path of incident ray and the other two pins on the path of the light ray that travels away from the block.
- Sketch the position of glass block using the pencil
- Remove the glass block, the pins and the torch. Complete the ray diagram.

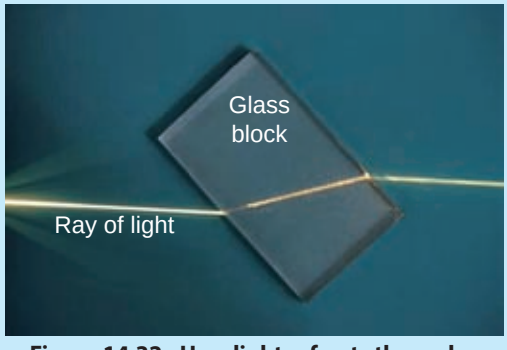


Figure 14.32 - How light refracts through a glass block

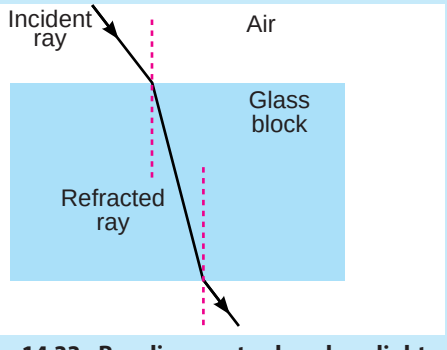


Figure 14.33 - Ray diagram to show how light refracts through a glass block

14.3.1 Effects of refraction of light

Let us consider briefly, some phenomena that can be seen in day-to-day life, due to refraction of light.

- **Apparent elevation of the bottom of a pond or a container of water**

Activity 14.12

You will need :- A tall glass tumbler or a beaker, water, a coin or a nail, a pencil

Method :-

- Put the coin or the nail into the glass tumbler or the beaker. Fill it with water.
- Observe the coin or the nail from above.
- Mark the apparent bottom (the coin or the nail) When viewed from top, on the side of the vessel using the pencil.
- Now measure the real depth and the apparent depth to the bottom of the vessel and note them down.

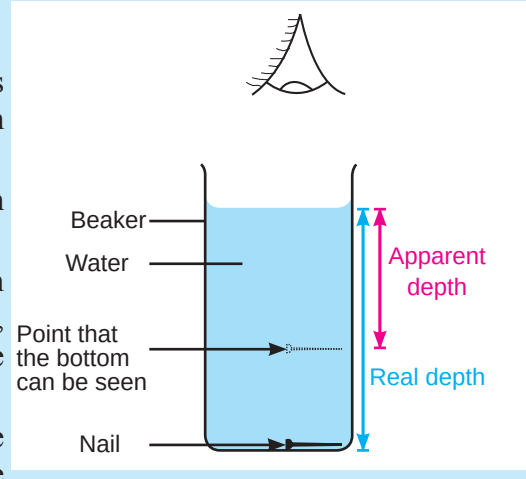


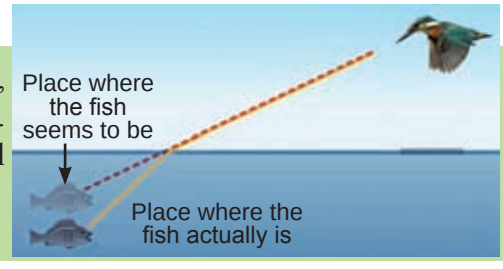
Figure 14.34 - Real depth and apparent depth

It is clear that the observable depth or the apparent depth when viewed from top, is always less than the real depth from the water surface to the bottom.

It is important to think carefully before step down into a well or a reservoir because the real depth of it is more than the apparent depth.

For extra knowledge

Birds like kingfisher observe fish in water, a little above than where they actually are. But, those birds have an idea of the real depth to the fish.



- **Pencil dipped partially in water seems to be broken at the water surface**

  A pencil which is partially dipped in water, seems to be broken at the liquid surface, when viewed from a side. The reason for this is the refraction of light when it comes from water to air.

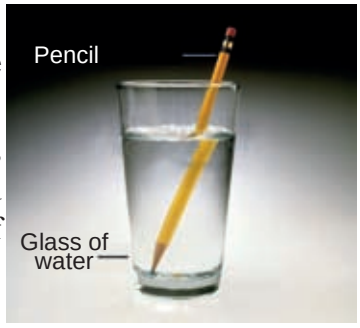


Figure 14.35 - How a pencil dipped in water seems to be

- **Refraction of white light through a prism**

  A wonderful occurrence can be observed when white light passes through a glass prism. Let us do the activity 14.13 to study about this.

Activity 14.13

You will need :- A glass prism (60 × 60 × 60), a white screen, a piece of cardboard, a plane mirror

Method :-

- Keep the glass prism on the table.
- Direct a narrow beam of light on to the prism using plane mirror and the piece of cardboard.
- Let the light that passes through the prism fall on the screen.
- Discuss the reason for your observations in the classroom.

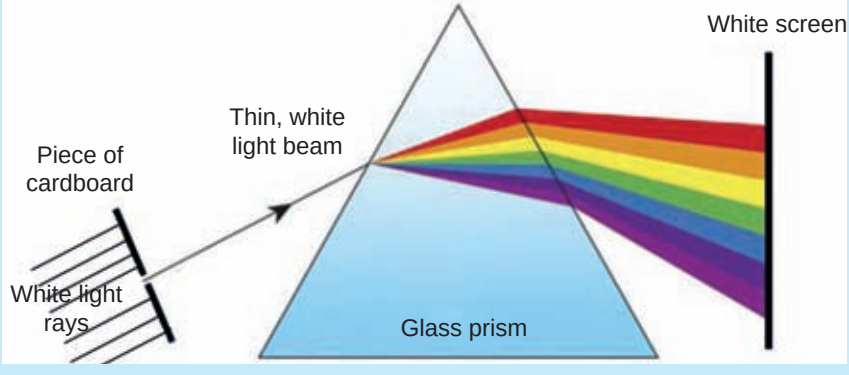


Figure 14.36 - How white light passes through the glass prism

A spectrum of seven colours can be seen on the screen during the activity 14.13. Separation of white light into seven colours when passing through a prism due to refraction is the reason for this. Colours of the spectrum are red, orange, yellow, green, blue, indigo and violet respectively.

Separation of white light when passing through a prism is known as **dispersion.**

For extra knowledge

Scientist Sir Isaac Newton showed that white light is composed of seven colours. The equipment he used for this is known as Newton's disc. Newton's disc is made by painting the segments, equally divided through the centre of a circle with the seven colours. When this painted circle is rotated the seven colours mix to give white colour. You also can make a Newton's disc of your own.

- **Occurrence of rainbow**

Rainbow is another elegant phenomenon that occurs due to refraction of light. There are various folktales among people that in connection with the rainbow.

When there is bright sunlight with mist or drizzle, a rainbow can be frequently observed. Rainbow occurs because of refraction and internal refraction of sunlight by water droplets in the sky. Here white sunlight is dissociated into colours by water droplets. A large number of water droplets in the sky contribute to form a rainbow.

Figure 14.37 - How a rainbow is observed

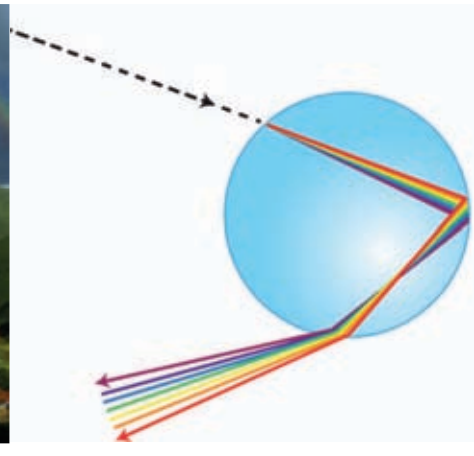


Figure 14.38 - Dispersion of light through a single water droplet

Summary

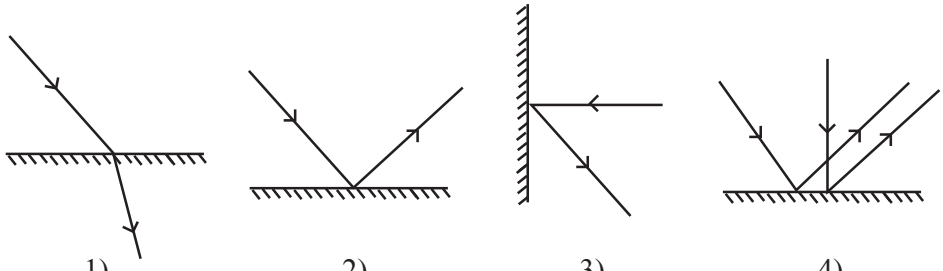
- Bouncing back of light to the same medium, after striking on a shiny surface is called reflection.
- Light reflects according to the laws of reflection.
- Regular reflection and diffuse reflection are the two ways of reflection of parallel light.
- Images are formed by reflection of light by mirrors.
- Images formed by plane mirrors are always upright, virtual and are subjected to lateral inversion.
- When images are formed by objects in front of plane mirrors, the size of the object is equal to the size of the image. Distance to the object is equal to the distance to the image.
- Instances of reflecting light by plane mirrors are used in day-to-day life.
- Bouncing back of sound by an obstacle is called the reflection of sound
- Echo and reverberation can be mentioned as two phenomena occurred by reflection of sound.
- Reverberation is a troublesome stage of echo.
- Various methods are used in auditoria, cinema halls and lecture halls to prevent reverberation.
- Ultrasound scanning and finding depth to ocean bed are some instances where reflection of sound is put into use.
- The change of direction of light when travelling from one transparent medium to another transparent medium is known as refraction of light.
- The apparent elevation of the bottom of a pond, dispersion of white light through prisms, forming of rainbow are some instances where refraction of light occurs.

Exercises

(01) Select the correct or most suitable answer.

1. Select the correct sentence out of the following.
   1. Regular reflection occurs well from rough surfaces.
   2. Angle of incidence is not always equal to the angle of reflection.
   3. Light rays that are falling perpendicular to a plane mirror do not get reflected.
   4. Angle of incidence is always equal to the angle of reflection.

2. Underline the correct ray diagram, which shows the reflection from a plane mirror.



1) 2) 3) 4)

3. Image formed by objects kept infront of plane mirrors are always;

   a - Upright and virtual

   b - Subjected to lateral inversion

   c - Distance to object is equal to the distance to the image

   of the above sentences which is/are true,

   1. Only a 2. Only a and b 3. Only b and c 4. a, b and c

4. Select the correct statement about echo.
   1. It can occur at any distance between the observer and the obstacle.
   2. Echo can be heard always when sound is reflected.
   3. Cause for reverberation is not the echo.
   4. Reverberation can be eliminated by preventing the reflection of sound.

5. White light can be separated into seven colours by a prism. Conclusion that can be made according to this phenomenon is;
   1. That light can be refracted by the prisms.
   2. That white light is harmful to the body.
   3. That white light is composed of seven colours.
   4. That white light is reflected by prisms.

6. Select the instances, out of those given below, which are associated with only the refraction of light.

a. Looking at the face using a plane mirror
b. Benching of light when passing through a block of glass
c. Seeing a pencil broken at the surface when it is put into a container of water
d. Occurrence of multi images in a kaleidoscope

1. a and b only
2. b and c only
3. c and d only
4. a and d only

(02) Explain briefly, the following terms which are associated with reflection of light.

i. Incident ray
ii. Reflecting ray
iii. Normal line
iv. Angle of incidence
v. Angle of reflection

(03) In a school where multi-storied halls are situated close to each other, the noise of students in classes at upper stairs are heard closely, by the students in down stairs. What is the reason for this?

(04) A student aimed a lighted electrical torch with an inclination from the top of a fish tank to observe its bottom. But unexpectedly the beam of light bent at the water surface. Explain this phenomenon scientifically.

Technical Terms

Reflection	- පරාවර්තනය	- தெறிப்பு
Uniform reflection	- සවිධි පරාවර්තනය	- ஒழுங்கான தெறிப்பு
Diffuse reflection	- විසාරී පරාවර්තනය	- பரவல் தெறிப்பு
Angle of incident	- පතන කෝණය	- படுகோணம்
Angle of reflection	- පරාවර්තන කෝණය	- தெறிகோணம்
Incident ray	- පතන කිරණය	- படுகதிர்
Reflecting ray	- පරාවර්තන කිරණය	- தெறிகதிர்
Normal line	- අභිලම්භය	- செவ்வன்
Refraction ray	- වර්තන කිරණය	- முறிகதிர்
Lateral apostrophes	- පාර්ශවික අපවර්තනය	- பக்க நேர்மாறு
Kaleidoscope	- බහුරූපේක්ෂය	- கலையுருகாட்டி
Periscope	- පරීක්ෂය	- சூழ்காட்டி
Light refraction	- ආලෝක වර්තනය	- ஒளி முறிவு
Dispersive	- අපකිරණය	- நிறப்பிரிகை
Hologram	- වර්ණාවලිය	- நேம வரையம்
Echo	- දෝංකාරය	- எதிரொலி
Reverberation	- ප්‍රතිනාදය	- தெறிப்பொலி
Echo sounder	- ප්‍රති ධ්වනි මානය	- எதிரொலி மானி

15 Simple Machines

Since ancient time, man used machines to make their jobs easy. Let us recall some instances where simple machines are used.

As you know, it is difficult to lift and remove a large log or a rock with hands. You may have experienced in your day-to-day life, that one end of a metal rod is kept under the rock or the log and pushed down from the other rod. This mechanical device is known as a **lever** (Figure 15.1).

Figure 15.1 – A lever

Can a single person lift a barrel of oil on to the deck of a lorry? It is difficult. Let us find out the amount of force that has to be applied to lift an object directly upwards.

Hang a piece of metal on a spring balance and take the reading. Then lift the piece of metal vertically up with your hand, while it is on the spring balance and observe the reading of the balance.

When the piece of the metal was hanging on the balance, a force which is equal to the weight of the piece of metal is exerted downwards on the balance. While you are lifting the piece of metal, you are applying a force, which is equal to the weight of it, upwards. Then, you will observe that the reading of the balance reaches zero. Thus, it is clear that a force which is equal to the weight of an object should be applied upwards to lift it vertically up.

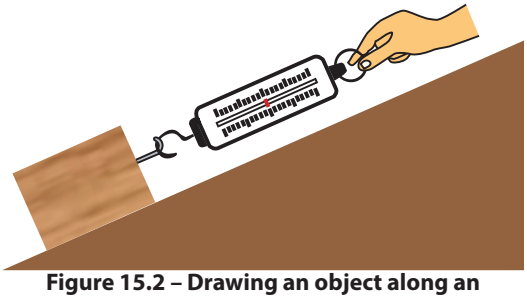


Figure 15.2 – Drawing an object along an inclined plane

Now keep a piece of long plank, inclined to the horizontal surface and draw the same piece of metals along it, as shown in the figure 15.2. Observe the reading of the spring balance. You will realize that the force exerted to draw the piece of metal along the ramp is less than the force exerted to lift it directly upwards. Here the job is made easy.

Figure 15.3 – Loading a barrel of oil to a lorry using an inclined plane

Here the device used to lift the piece of metal is known as **inclined plane**. When a barrel of oil is to be loaded to a lorry, it is easy to push it along a ramp as shown in the figure 15.3.

When you want to pull a bucket of water from a well, you can tie one end of a rope to the bucket, send the bucket into the well and draw it upwards by pulling it from the other end of the rope. Here the force that should be applied is equal to the weight of the bucket full of water.

Let us consider an easier way to do this job. Lifting the bucket of water can be easily done by sending the rope round a **pulley** and drawing the other end of the rope downwards, as shown in the figure 15.4. Drawing sometimes down is easier than drawing it up. Pulley is used to change the direction of force as we want.

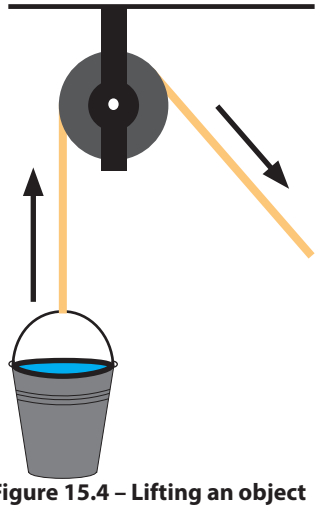


Figure 15.4 – Lifting an object using a pulley

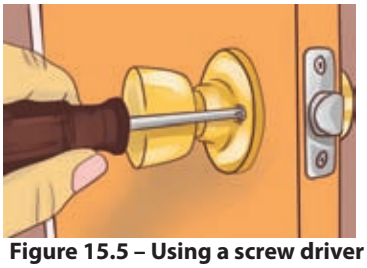


Figure 15.5 – Using a screw driver

To sink a screw nail into something, the force is applied by turning the handle of screw driver (figure 15.5). It is common experience that this job is made easier by the screw driver. Here the device used is known as the **wheel and axle**.

Strategies used to make the job easy are known as simple machines.

There are four types of simple machines;

- Lever
- Inclined plane
- Pulley
- Wheel and axle

Let us discuss about these simple machines, in detail.

15.1 Lever

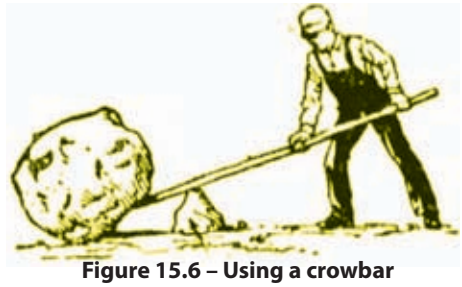


Figure 15.6 – Using a crowbar

As we have discussed earlier, a metal rod or a crowbar can be used to lift a wooden log or a rock. Let us consider it again.

It is difficult to lift the rock to some height. The force that should be applied to do it is very large, that a single person cannot do it.

It is easy to lift the rock or the log by using a crowbar as a lever (figure 15.6).

Here, why did the lever make the job easy? Let us do the activity 15.1 to find out about this.

Activity 15.1

You will need :- A book, a Newton spring balance, a ruler or a wooden strip

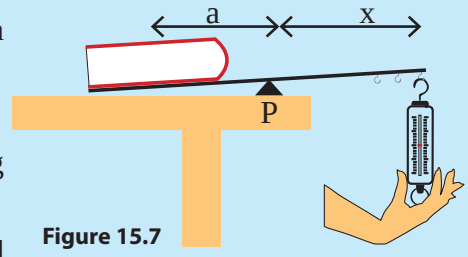


Figure 15.7

Method :-

- Weigh the book, using the Newton spring balance.
- Keep the wooden strip on a piece of wood as a support **P** to balance it.
- Place the book on the end of the strip as shown in figure 15.7. Couple the Newton balance to the other end of the strip using a book and pull the balance vertically downwards, holding its stem.
- Take the reading of the balance.
- Keep the distance from the book to the support **a** constant and take several readings by changing the distance from the support to the place where the balance **x** is coupled. (Take several readings by keeping the value of greater than a and less than **a**).
- In each situation, observe the movement of the place attached to the wooden strip when the book lifts a vertical distance comparatively.
- Measure the distance **x** and keep records.

You may have observed that the force necessary to lift the book is less than the weight of the book when **x** is greater than **a**. Here the lever helps to ease the job. When **x** is smaller than **a**, the force necessary to lift the book is greater than the weight of the book. But, in this case the book moves further than the point where balance is attached moves. This distance is advantageous in some instances.

In all the above instances, the force applied on the lever is downwards to lift the book upwards. This change of direction of force is also another advantage of a lever.

Parts of a lever

Let us consider the activity 15.1.

Here, the wooden strip is used as a lever. The force applied on the lever downwards is known as the **effort**. The lever lifts the weight of the book. Thus weight lifted by the lever is **load**.

Load is balanced by the effort other the wooden support. The point of the wooden strip that contact with the lever is called **fulcrum**.

Here we have considered three points of a lever. Load is at one end of the lever. Effort is at the other end. Load is balanced by the effort over the fulcrum.

Let us consider the lever shown in the figure 15.8 AB is a metal rod. Effort is applied downwards at B. Rod is balanced on C. So, C is the fulcrum.

Effort arm and load arm

The part of the lever from effort to fulcrum (CB) is known as effort arm. The part of the lever from load to the fulcrum (CA) is known as load arm.

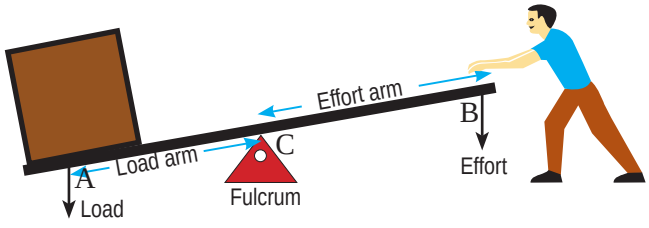


Figure 15.8 - Parts of a lever

Mechanical advantage

Mostly a large load can be balanced by applying a small effort on a machine. In the above activity, when the length of effort arm (x) is greater than that of load arm (a), the book could be lifted by applying a force less than the weight of the book. This advantage of the machine is calculated as the ratio of load to effort. This ratio is known as **mechanical advantage**.

$$\text{Mechanical Advantage} = \frac{\text{Load}}{\text{Effort}}$$

According to the figure 15.8, if a load of 36 N is lifted by applying an effort of 12 N, then the mechanical advantage is;

$$\text{Mechanical Advantage} = \frac{\text{Load}}{\text{Effort}}$$

$$= \frac{36\ \text{N}}{12\ \text{N}}$$

$$3$$

To remove the lid of a tin can, you can lift it with your fingers. But, it is difficult. An easier way is shown in figure 15.9.

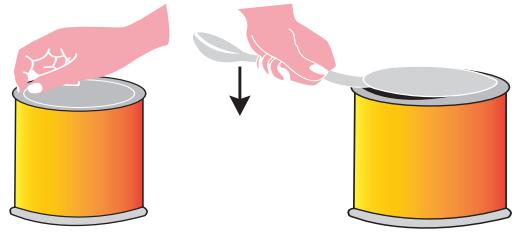


Figure 15.9

Here the handle of a spoon is used as a lever. One end of the handle of spoon holds the lid of tin (load). One point of the handle rests on the edge of tin can. This point is the fulcrum. When a small force (effort) is applied at the free end and of the handle, the lid is thrown up. So, the load of the can is removed easily.

Consider the position of the fulcrum of the levers mentioned above. It is positional between the effort and the load.

Let us consider following situation where effort arm is greater than load arm.

Thus, levers can be divided into three orders according to the positions of effort, load and fulcrum.

- First order lever
- Second order lever
- Third order lever

First order levers

Levers, in which the fulcrum acts between load and effort are called first order levers. All the levers we considered in this lesson, up to now, are first order levers. Figure below shows a first order lever.

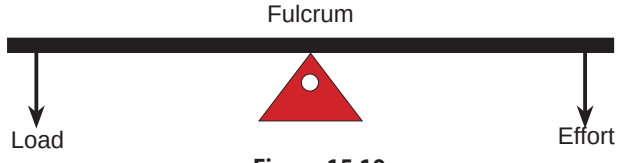


Figure 15.10

Some examples for first order levers are given below.

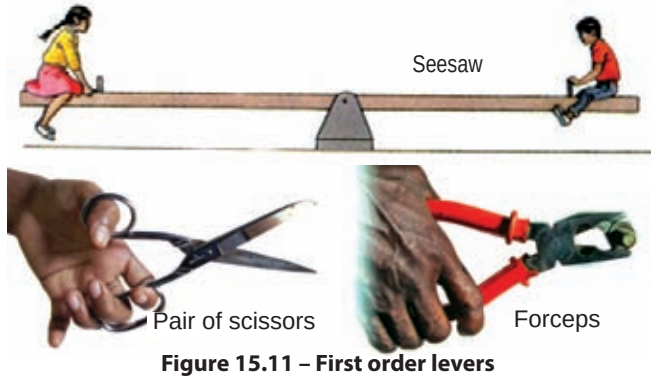


Figure 15.11 – First order levers

Second order levers

Levers in which the load acts between effort and fulcrum are referred to as second order levers. Nut cracker is an example.

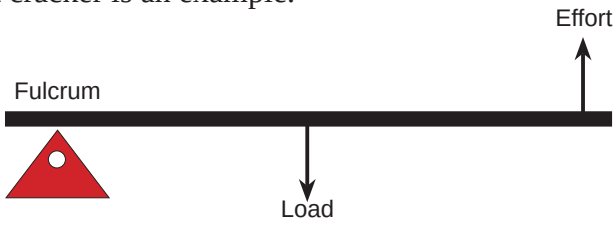


Figure 15.12

Some examples for second order levers are given in figure 15.13.

Figure 15.13 – Second order levers

The blade and the rod of the nut cracker turns round the pin, by which they are coupled. Therefore, that pin is the fulcrum. Load acts on the object that is to be cut. Effort is applied at the far end of the handle.

Third order levers

In third order levers, effort acts between the load and the fulcrum (figure 15.14). Broom, fishing rod (figure 15.15) and human arm are some examples for third order levers.

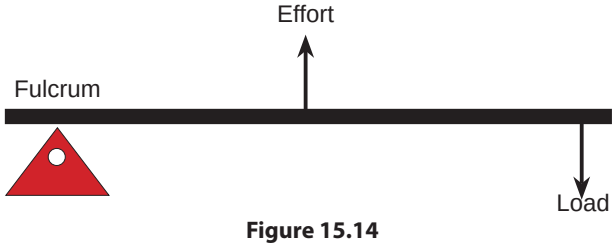


Figure 15.14

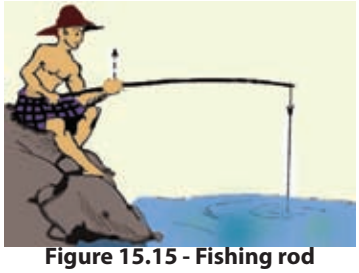


Figure 15.15 - Fishing rod

Load arm is always longer than the effort arm in third order levers. Therefore, an effort which is greater than the load has to be applied to balance that rod. Thus, the mechanical advantage is always less than one. But, these levers are advantageous because load moves more for a small motion of the effort.

Velocity ratio of a lever

Let us consider the lever device used to high a load up.

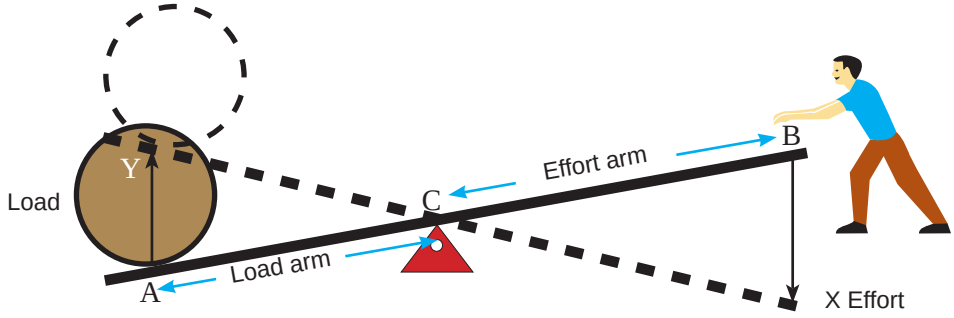


Figure 15.16

Effort is applied on the point B of this lever. Let the point B travels to point X, which is the displacement of effort. Sometimes load is lifted from A to Y. Therefore, A Y is the displacement of load.

Velocity ratio of a machine is the ratio of the displacement of effort to the displacement of load during the same time.

$$\text{Velocity ratio} = \frac{\text{Displacement of effort}}{\text{Displacement of load}}$$

According to mathematics, same value can be obtained by dividing the length of effort arm by the length of load arm.

The larger the velocity ratio of a machine the smaller the effort that should be applied on it.

If BX = 60 cm and AY = 15 cm in the above example,

$$\text{The velocity ratio of that lever} = \frac{60\text{ cm}}{15\text{ cm}}$$

$$= \underline{4}$$

If a velocity ratio of a machine is 4, then theoretically, the effort that should be applied to lift a load using that machine is 1/4 th of the load.

But, in practice the effort does not decrease down that much (1/4th of the load). The reason for this is the friction in the system. Thus the mechanical advantage of a machine is always less than its velocity ratio.

Work-input and work-output

When we have to get work done from a machine, we have to work on the machine. Work done on the machine is called work-input. When the work input is given to the machine, some amount of work is done by the machine also. That is known as work-output.

Let us consider the lever that we mentioned above.

Let the effort at B is 50 N and the load lifted at A is 150 N.

You already know, how to calculate the work done, when a force is acting along a certain distance.

Work done is the product of the force applied and the distance that the force travelled.

We can calculate the work done on the lever (work input) as follows.

Work done on the lever (work input) = effort × displacement of effort

$$= 50\ \text{N} \times 60\ \text{cm}$$

$$= 50\ \text{N} \times \frac{60}{100}\ \text{m}$$

$$= 30\ \text{J}$$

We can calculate the work done by the lever (work-output) as follows.

Work done by the lever (work output) = load × displacement of load

$$= 150\ \text{N} \times 15\ \text{cm}$$

$$= 150\ \text{N} \times \frac{15}{100}\ \text{m}$$

$$= 22.5\ \text{J}$$

Here, when 30 J of work is done on the machine, only 22.5 J of work is given out from the machine.

Therefore, the percentage of the work given out from the machine is for the work-input.

$$= \frac{22.5\ \text{J}}{30\ \text{J}} \times 100$$

$$= 75\ \%$$

What we calculated here is the efficiency of the machine. It is 75%.

$$\text{Efficiency of a machine} = \frac{\text{Work-output}}{\text{Work-input}}$$

$$= \frac{\text{Load} \times \text{distance travelled by load}}{\text{Effort} \times \text{distance travelled by effort}}$$

$$= \frac{\text{Load}}{\text{Effort}} \times \frac{\text{distance travelled by load}}{\text{distance travelled by effort}}$$

We can obtain velocity ratio by dividing the distance travelled by effort to the distance travelled by load. But, here it says other way around. It is similar to the reciprocal of velocity ratio.

This is; $\frac{1}{\text{Velocity ratio}}$

$$\text{Therefore, efficiency} = \text{Mechanical advantage} \times \frac{1}{\text{Velocity ratio}}$$

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}}$$

Generally efficiency of a machine is given as a percentage.

$$\text{Therefore, efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} \times 100\%$$

Following formulas can be used not only for levers but also for other machines.

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}} \times 100\%$$

$$\text{Velocity ratio} = \frac{\text{Distance travelled by effort}}{\text{Distance travelled by load at the same time}}$$

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} \times 100\%$$

15.2 Inclined plane

Inclined plane or a ramp can be used to make a job easy. Therefore, inclined plane is also a simple machine.

We realized earlier, that a force equal to the weight of an object should be applied to lift it up directly.

But less effort is enough to draw it along an inclined plane.

Let us do activity 15.2 to understand how effort that should be applied to draw an object along an inclined plane, changes with its inclination.

Activity 15.2

You will need :- A long piece of plank, a Newton spring balance, a block of wood, few bricks

Method :-

- Construct an inclined plane using several bricks and the piece of plank.
- Fix a loop to one side of the block of wood. Couple the block to the hook of Newton balance, find the force necessary to move the block of wooden along the plane.
- Reduce the inclination of the plane by removing one brick and repeat the above steps.
- Take several readings by reducing the inclination of the plane (by removing another brick).
- Compare how the effort changes with the inclination of the plane.

You may have realized that the effort decreases with the decrease of the inclination of the inclined plane and vice-versa. Mechanical advantage increases with the decrease of effort.

Examples for inclined planes used in day-to-day life

- The wedge
- The staircase
- The screw jack
- The screw nail
- The ladder

Let us consider the calculations regarding inclined plane.

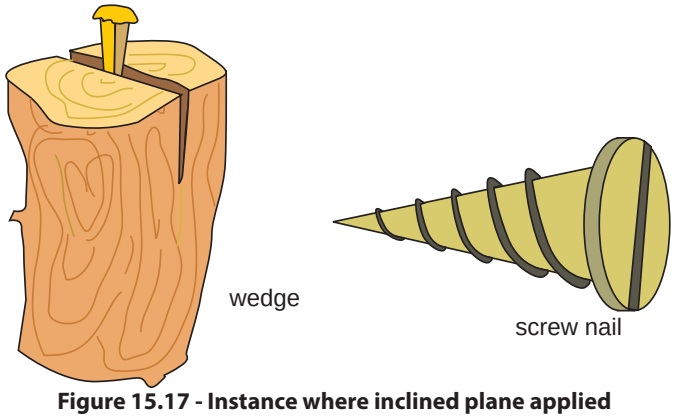


Figure 15.17 - Instance where inclined plane applied

The weight of a barrel of oil is 600 N. Using an inclined plane of 4 m long, it is lifted to the deck of lorry, which is 1 m high from the ground. The force exerted to push the barrel along the plane is 200 N.

i. Mechanical advantage of an inclined plane $= \frac{\text{Load}}{\text{Effort}}$

$= \frac{600\ \text{N}}{200\ \text{N}}$

$= 3$

ii. Velocity ratio of an inclined plane $= \frac{\text{distance travelled by effort}}{\text{distance travelled by load}}$

$= \frac{4\ \text{m}}{1\ \text{m}}$

$= 4$

iii. Efficiency of an inclined plane $= \frac{\text{Mechanical advantage}}{\text{Velocity ratio}}$

$= \frac{3}{4} \times 100\%$

$= 75\%$

iv. Work-input = Effort × distance travelled by effort

= 200 N × 4 m

= 800 J

v. Work-output = Load × distance travelled by load

= 600 N × 1 m

= 600 J

Efficiency can be calculated by using work-input and work-output also.

vi. Efficiency of an inclined plane $= \frac{\text{Work output}}{\text{Work input}} \times 100\%$

$= \frac{600\ \text{J}}{800\ \text{J}} \times 100\ \%$

$= 75\%$

15.3 Wheel and axle

Wheel and axle is a simple machine which can be used to make a job easy. As wheel and axle are connected, force applied on the wheel can be transferred to axle to do the job. Windlass, is such a machine with wheel and axle.

This windlass is made by fixing an L shaped handle to a long cylindrical stem, which is rested on the stands, so that it can be freely turned (figure 15.18).

Figure 15.18 - Windlass

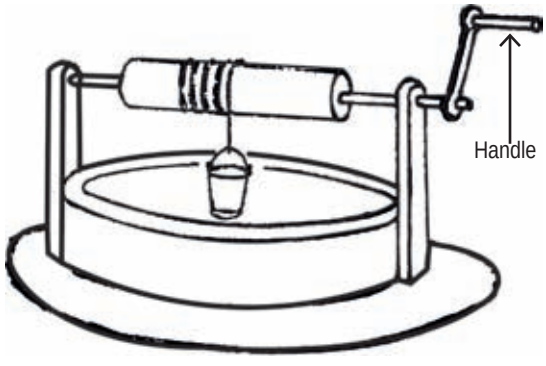


Figure 15.19

The rope is wound round the stem and a bucket is tied to the other end of the rope. When the handle of the windlass is turned, the bucket goes down into the mine. When the handle is turned the other way, bucket comes up with a load filled into it. When the handle is turned one round, the rope also winds once round the stem.

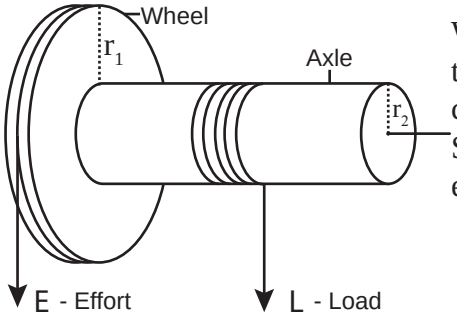


Figure 15.20

When the handle is turned once, the distance travelled by the effort is equal to the circumference of the circle of the handle turned. Same time load is lifted by a distance which is equal to the circumference of the stem.

Length of the handle equals to the radius of the circle (r_1). The diameter of the circle is $2r_1$. Then, its circumference is $2r_1 \times \pi$ $\left(\pi = \frac{22}{7}\right)$.

Therefore, the distance that effort travels for one turn of the handle is $2\pi r_1$

If the radius of the cylindrical stem is r_2, then its diameter is $2r_2$.

The distance that the load is lifted for one turn of the handle is $2\pi r_2$

$$\text{Therefore, the velocity ratio of the wheel and axle} = \frac{\text{Circumference of the circle with one turn of handle}}{\text{Circumference of the stem}}$$

$$= \frac{2\pi r_1}{2\pi r_2}$$

$$= \frac{r_1}{r_2}$$

$$\text{Velocity ratio of wheel and axle} = \frac{\text{Radius of wheel}}{\text{Radius of axle}}$$

Therefore, the velocity ratio of wheel and axle can be calculated by dividing the radius of wheel by the radius of axle.

Here are some examples for wheel and axle.

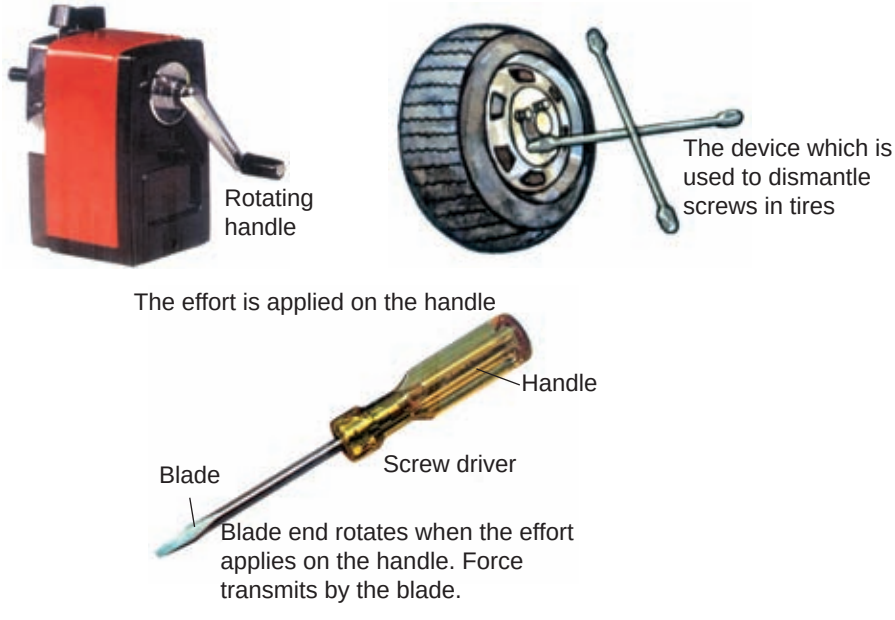


Figure 15.21 - Use of wheel and axle

15.4 Pulleys

It is mentioned earlier is this lesson, that it is easier to pull a bucket of water from a well using a pulley rather than pulling the bucketful of water directly with a rope. Thus you know that **pulley** is a simple machine.

Let us do activity 15.3 to compare the force that should be applied in the two situations above.

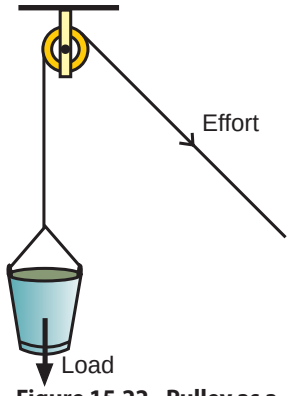


Figure 15.22 - Pulley as a simple machine

Activity 15.3

You will need :- A pulley, a suitable string, a Newton spring balance, a piece of stone or a suitable load

Method :-

- Measure the weight of stone using the Newton spring balance.
- Now tie the string to the stone and pull it over the pulley using the Newton spring balance as shown in the figure 15.23. Note down the reading of the balance.

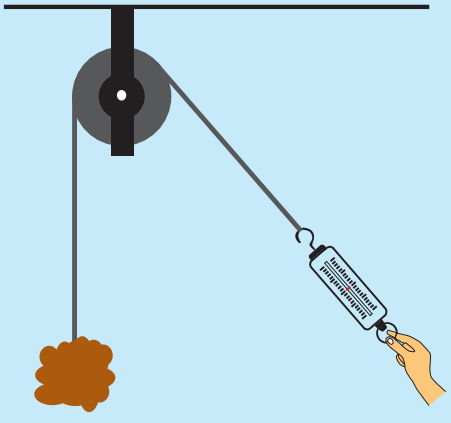


Figure 15.23

Compare the weight of the stone and the force necessary to pull it over the pulley. You will realize that both readings are more or less the same. (There may be a slight difference due to the friction of the pulley)

When we are lifting something straight upwards, the force should be applied upwards. However, when we are using a pulley for this purpose, the pulling force can be turned appropriately. Applying a force downwards is easier than applying it upwards. Therefore, it is easy to use a single pulley to lift a load.

Let us solve a simple problem associated with the simple machine, pulley.

The weight of a bucketful of water is 12 N. It is lifted up using a pulley (Assume that the pulley has no friction.)

Solved problem 1

i. Here, the effort is 12 N, to lift up the load.

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}}$$

$$= \frac{12\ \text{N}}{12\ \text{N}}$$

$$= \underline{1}$$

ii. Velocity ratio

When the effort travels same distance, load also travels the same distance. Therefore, velocity ratio is 1.

iii. Let us see the work-input for the machine.

The work-input for the machine = Effort × distance travelled by effort

Let us take the distance travelled by the effort as 0.8 m.

$$\text{Then, work-input} = 12\ \text{N} \times 0.8\ \text{m}$$

$$= \underline{9.6\ \text{J}}$$

iv. Let us see the work-output of the machine

$$\text{Work-output of the pulley} = \text{Load} \times \text{distance travelled by load}$$

$$= 12\ \text{N} \times 0.8\ \text{m}$$

$$= \underline{9.6\ \text{J}}$$

v.

$$\text{The efficiency of the pulley} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} \times 100\%$$

$$= \frac{1}{1} \times 100\%$$

$$= \underline{100\ \%}$$

Pulley systems

The motion of a pulley used to draw water from a well is turning round its axis only. Such pulleys are known as **stationary pulleys**. Other than these, there are pulley systems with moving pulleys.

The figure 15.24 shows a pulley system with a stationary pulley and a moving pulley.

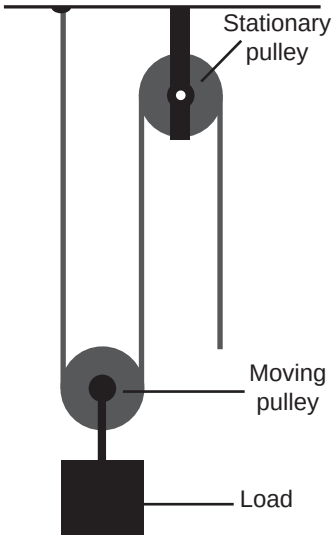


Figure 15.24

Here the force is exerted upwards by two strings on the moving pulley. Therefore, one string has to apply only a force which is equal to a half of the load. That force is directed downwards by the string running over the stationary pulley. Therefore, the mechanical advantage of this pulley system is 2. This mechanical advantage is gained only because of the moving pulley. The task of the stationary pulley is the change of direction of the force applied.

In any simple machine, velocity ratio increases with the increase of mechanical advantage. In the above pulley system, when the effort travels down with the string a certain distance, load travels only a half of that distance. Therefore, its velocity ratio is 2.

Mechanical advantage of a pulley system can be increased largely by using several stationary and moving pulleys. Crane is a complete machine that consists of pulley systems.

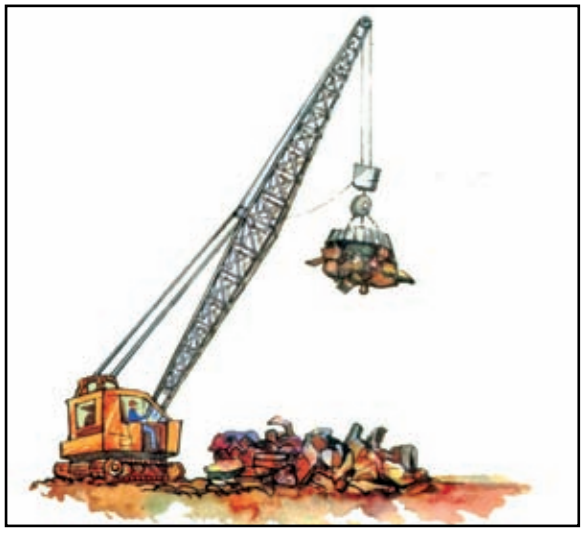


Figure 15.25 - Crane

Complex machines are assembled using several simple machines.
e.g. Bicycle

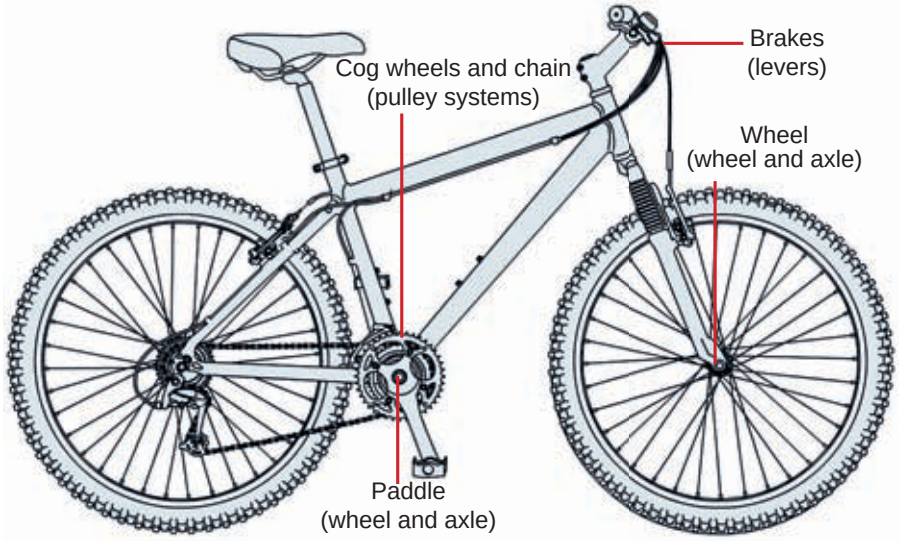


Figure 15.26 - Bicycle

Assignment 15.1

Observe and study about various machines (e.g sewing machine) used in daily activities. Name the simple machines applied in these machines.

Summary

- Machines are used to make the jobs easy.
- A force is applied on the machine which is transmitted to the load to perform work.
- Force applied on the machine is effort.
- Force applied by the machine is load.
- There are four types of simple machines. such as lever, inclined plane, wheel and axel and pulley.
- Complex machines are constructed by assembling simple machines.
- For simple machines the following formula can be used:

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}}$$

$$\text{Velocity ratio} = \frac{\text{Distance travelled by effort}}{\text{Distance travelled by load}}$$

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} \times 100\ \%$$

Exercises

(01) Select the correct or most suitable answer.

1. Which one of these is **not** a function of a machine?
   1. Effort is decreased than the load.
   2. Change the direction of effort appropriately.
   3. Getting a job done by applying a force on the machine
   4. More work is obtained by doing less work on the machine.

2. Which one out of the following is **not** a simple machine?
   1. Nut cracker 2. Pulley 3. Wedge 4. Engine of a motor vehicle

3. A lever can lift a load of 48 N by applying an effort of 12 N on it. What is the mechanical advantage of this lever?
   1. 1 2. 2 3. 3 4. 4

4. Which are of the following is an inclined plane?
   1. Screw driver, wedge, staircase
   2. Screw driver, staircase, crowbar
   3. Screw driver, wedge, ladder
   4. Staircase, screw driver, forceps

5. Following statements are forwarded by two students during a discussion on instances where effort is greater than the load.

   A - Effort is greater than load when screw jack is used.

   B - Effort is grater than load when single pulley is used.

   C - Effort is always greater than load when third order lever is used.

   What is the correct choice of the following?

	Statement A	Statement B	Statement C
1	Correct	Incorrect	Correct
2	Incorrect	Incorrect	Incorrect
3	Incorrect	Correct	Correct
4	Correct	Correct	Correct

(02) Copy into your exercise book and fill in the blanks.

The force exerted on a machine is the (a) …….. and the force controlled by the machine is the (b) ……..

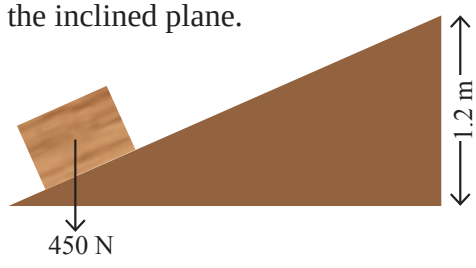
(03)

1. What are the two ways that a machine makes a job easy?
2. Draw lever diagrams separately to show the effort, load and fulcrum of the three orders of levers.
3. Mention two instances in day-to-day life where inclined plane is used.

(04) The figure here shows how a piece of plank, kept inclined, is used to lift a load of 450 N to a height of 1.2 m.

The effort applied is 150 N and the efficiency of the inclined plane is 60%.

i. Find the mechanical advantage of the inclined plane.
ii. Calculate the length of the plane.
iii. Find the velocity ratio.
iv. How much is the work-input?
v. How much is the work-output?



Technical Terms

Simple machines	-	සරල යන්ත්‍ර	-	எளியபொறி
Levers	-	ලීවර	-	நெம்புகோல்
Fulcrum	-	ධරය	-	பொறுதி
Load	-	භාරය	-	சுமை
Effort	-	ආයාසය	-	எத்தனம்
Inclined plane	-	ආනත තලය	-	சாய்தளம்
Pulleys	-	කප්පි	-	கப்பி
Mechanical advantage	-	යාන්ත්‍ර වාසිය	-	பொறிமுறை நயம்
Velocity ratio	-	ප්‍රවේග අනුපාතය	-	வேக விகிதம்
Efficiency	-	කාර්යක්ෂමතාව	-	திறன்
Work input	-	ප්‍රදාන කාර්යය	-	பொறி மீது செய்யப்பட்ட வேலை
Work output	-	ප්‍රතිදාන කාර්යය	-	பொறியினால் செய்யப்பட்ட வேலை
Complex machines	-	සංකීර්ණ යන්ත්‍ර	-	சிக்கலான பொறி

16 Nanotechnology and its Applications

Observe well, the figure 16.1 given below.

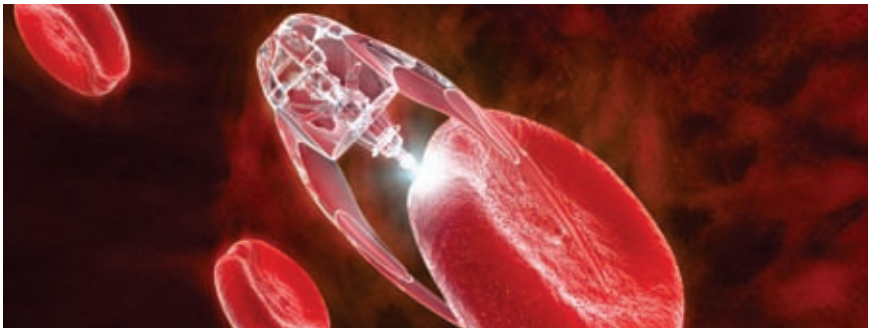


Figure 16.1 - How a red blood cell is being treated by a micro robot machine

In the above magnified figure, you observed how a human red blood cell is being treated by a micro robot machine. Machines which are dealing with such microscopic structures should be extremely small. How can such micro-machines be constructed? What is the technology used for this?

Science reached another important milestone in year 2016 with the award of the Nobel Prize in Chemistry to Jean-Pierre Sauvage, Sir J. Fraser Stoddart, and Bernard Feringa, three scientists whose groundbreaking work had spawned the idea of turning molecules into machines. Molecular Robots are not any more aliens to science.

Sir J. Fraser Stoddart Jean-Pierre Sauvage Bernard Feringa

Figure 16.2 - The scientists who won Nobel prize in Chemistry in year 2016

Now let us try to understand the science of tiny world which could do such miracles.

16.1 Nanometer

What is 'NANO'?

The word 'nano' is derived from Greek language, with the meaning dwarf. Therefore, nano refers to something very small. At this magic scale you'd not only see the atoms that everything is made from—you'd actually be able to move them around.

How small is 'NANO'?

It is a tiny world. It is quite hard to imagine a world that is small to see. We live on a scale of meters and kilometers. Nano means "billionth", so a nanometer is one billionth of a meter, i.e. 10^{-9} m.

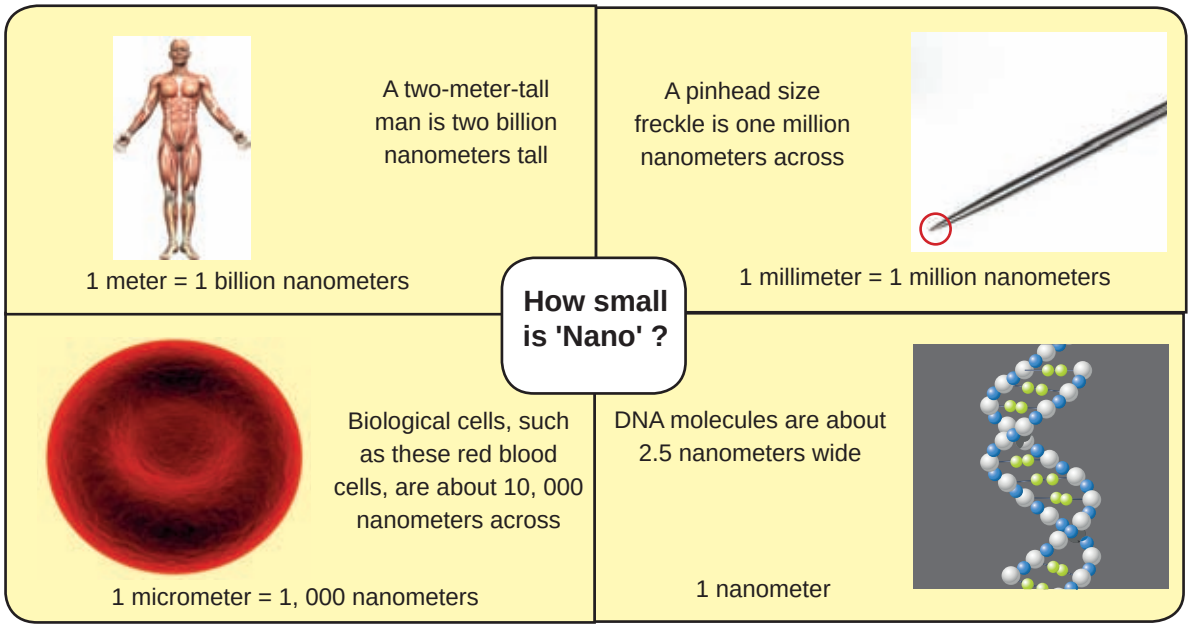


Figure 16.3 - Nano technology refers to inventions on the scale of small molecules or individual atoms

Individual atoms such as hydrogen, are only a few tenths of a nanometer in diameter.

For extra knowledge

Thickness of human hair is about 80 000 nm.

A paper has a thickness of about 100 000 nm.

16.2 Nanotechnology

Nanoscale science investigates the matter at the **critical range on 1 - 100 nm**. Making new things on this incredibly small scale is called nanotechnology and it's one of the most exciting and fast-moving areas of science and technology today. Nanotechnology is an enabling technology which has applications in a diverse areas from biology to aerospace.

History of nanotechnology

Nanoscience and technology are not new concepts to the nature. There are many natural phenomena based on nanotechnology. However, the American physicist Richard Feynman (1918–1988) is credited with kick-starting modern interest in nanotechnology. In 1959, in his after-dinner speech called "There's plenty of room at the bottom," Feynman speculated about an public speaking incredibly tiny world where people could use atoms and molecules as tools to make things. In 1974, Japanese engineering professor Norio Taniguchi named this field "**nanotechnology**."

Nanotechnology truly took off in the 1980s. That was when nanotech-evangelist Dr. K. Eric Drexler first published his groundbreaking book “Engines of Creation: The Coming Era of Nanotechnology”. Nanotechnology could not really took off until the electron microscopy became popular. It was also the decade when microscopes that were capable of manipulating atoms and molecules on the nanoscale were discovered.

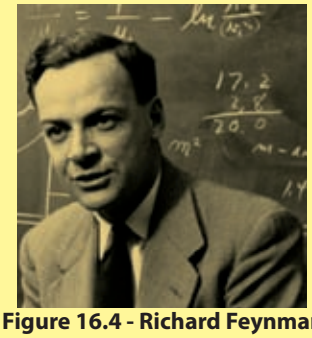


Figure 16.4 - Richard Feynman

There's plenty of room at the bottom - Richard Feynman

Likewise nanotechnology will, once it gets under way, depend on the tools we have then and our ability to use them, and not on the steps that got us there. - Eric Drexler

Figure 16.5 - Eric Drexler

Natural Nano-concepts

Nature has created things of nano scale. Let us do the activity 16.1 to get an idea of such things and their functioning.

Activity 16.1

You will need :- Untorn lotus or alocasia leaf

Method :-

- Put few drops of water on the leaf and observe.
- Record your observations.

Did you see that water droplets roll on the leaf without sticking and spreading on it? What can be the reason for this?

Fig. 16.6 - How water droplets are retained on a lotus/alocasia leaf

Lotus effect

The self cleansing activity of lotus leaves because of the hydrophobic condition on its surface is known as lotus effect. This hydrophobic nature on the lotus leaf is due to the fine arrangement of the particles of nano scale. Because of this, water, dirt and micro-organisms that fall on the leaf are automatically removed. Lotus effect can be seen on wings of insects like dragon flies.

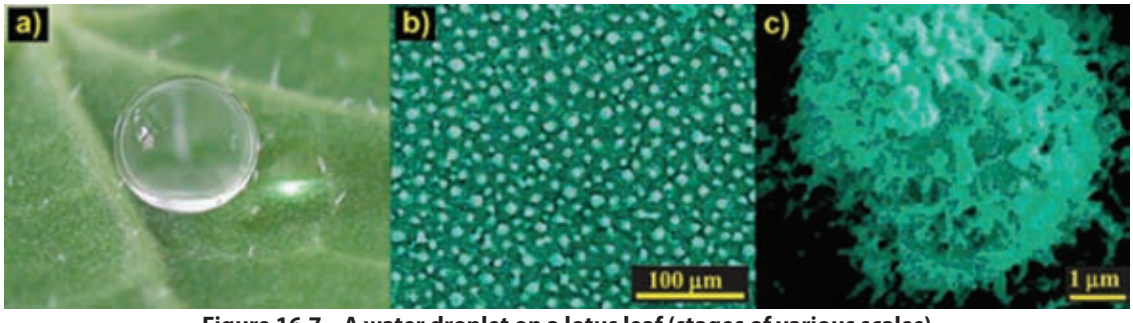


Figure 16.7 – A water droplet on a lotus leaf (stages of various scales)

Nature made nanomaterials

The best example is the functions taking place inside the cell, which is the structural and functional unit of living organisms (Remember the size of the cell is not at nano size). In a cell, a large number of nanoscale biological processes like respiration, excretion, nutrition, growth and photosynthesis are taking place continuously. Cell organelles, specially adopted for those biological functions can be considered as machines of nano scale.

Why 'Nano'? size matters!

Substances behave differently in the world of atoms and molecules. Both physical and chemical properties of matter substantially changes when the size reaches 100 nm or below although it is the same bulk material. For example, physical properties such as optical, mechanical, electrical and magnetic properties, change at the nano-scale while chemical reactivity significantly changes.

e.g.

- Metal copper is transparent on the nanoscale while gold, demonstrates a range of colours depending on the size and shape at the nanoscales.
- Chemically inert gold become highly reactive at the sizes below 100 nm.
- Carbon can be converted into resistance free conducting materials at nano-level.
- Strength of carbon nanomaterials could be several times higher than steel.

Figure 16.8 - Various colours are observed in gold nanoparticles when the size of particles are below 100 nm

Surface area of nano particles

The main reason for such changes in physical and chemical properties is the increase in the surface area (A) to volume (V) ratio (A/V) when the particles size decreases.

As an example let us consider a 1 cm length cube made of silver. The volume of the cube is 1 cm^3 and surface area will be 6 cm^2. This 6 cm^2 surface area is equal to the surface area of a stick of gum (chewing gum). But, if that volume of 1 cm^3 is filled with cubes of 1 mm length, that surface area of total cubes will be equal to the surface area of a single page in an exercise book. When the 1 cm^3 of volume is filled with 1 nm sized cubes, total cubes needed, have a surface area which is about one third of a football court. Nanoscale materials have far large surface areas than similar masses of large scale materials. As surface area per mass of a material increase, a greater amount of the material can come into contact with surrounding materials thus affecting reactivity (Figure 16.9).

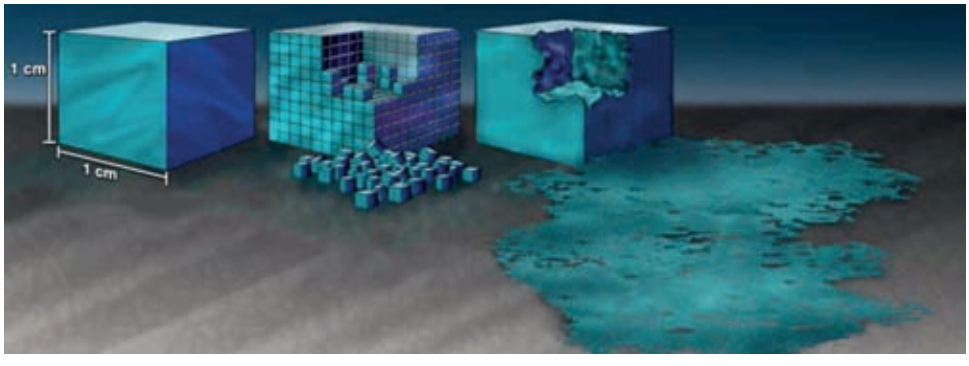


Figure 16.9

How to see the nano-scale?

Your fingers are millions of nanometers long, so it's no good trying to pick up atoms and molecules and move them around with your bare hands or see them using a common optical microscope. That would be like trying to eat your dinner with a fork 300 km long.

Scientists have developed electron microscopes that allow us to "see" things on the nanoscale and also manipulate them. They are;

- Atomic Force Microscopes (AFMs)
- Scanning Probe Microscopes (SPMs)
- Scanning Tunneling Microscopes (STMs)

Figure 16.10 - Electron Microscope

Figure 16.11 - Atomic Force Microscope

Nanomaterials

Key to developments related to nanotechnology innovations, are based on the availability of nanomaterials.

Carbon based nanomaterials

Out of the many available nanostructures, carbon based nanostructures are among the most exciting of nanomaterials. They can be rod shape, a foot ball shape or thin sheets.

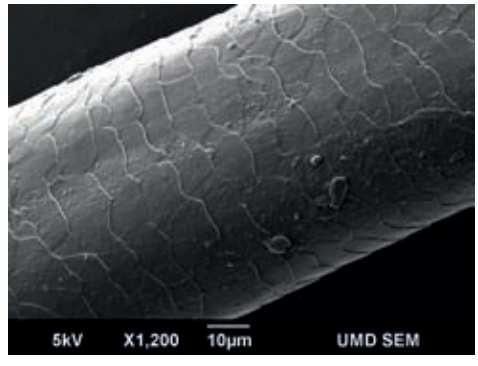


Figure 16.12 - Image of human hair under electron microscope

Forms of Carbon

Carbon exists as two distinct polymorphs, carbon graphite and carbon diamonds.

Activity 16.2

- Collect the information about carbon, graphite and diamond. Discuss them in classroom.

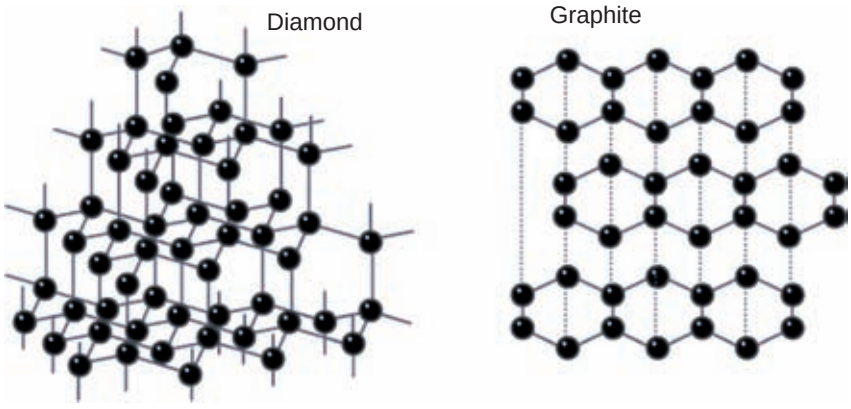


Figure 16.13 - Structures of diamond and graphite

Graphene

Figure 16.14 - Two scientists, Andre Geim and Konstantin Novoselov

Graphite has a layered structure and scientists have attempted to separate a single layer from the structure for several decades. It was one of the significant achievement of science when single layer of graphite was pealed off by two scientists, Andre Geim and Konstantin Novoselov from University of Manchester. They received the Nobel prize for physics in 2011 for this ground breaking innovation. It was a serendipity event in the history where they needed only a scotch tape and a piece of graphite for this innovation.

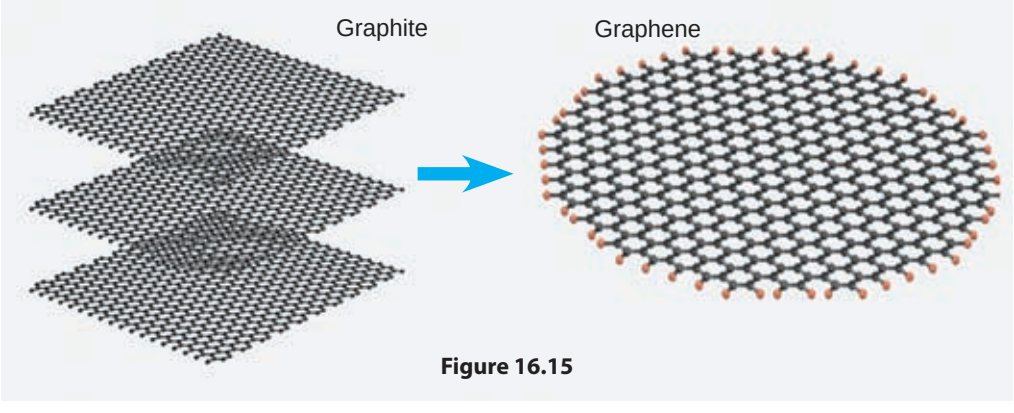


Figure 16.15

Graphene is a single layer thick graphite sheet (0.5 nm thickness) and has unique properties due to high surface area (figure 16.15). It is highly flexible while demonstrating very high mechanical properties. It also shows unexpected electronic and electrical properties. It is considered as the material that has the potential for revolutionizing the next generation flexible electronics.

Carbon Nanotube

A nanotube is formed when a single layer or few layers of graphene is rolled into a tube. When a single layer is rolled it is known as Single Wall Carbon Nano Tube (SWCNT) while few layers rolling into a tube leads to formation of Multi Wall Carbon Nano Tube (MWCNT).

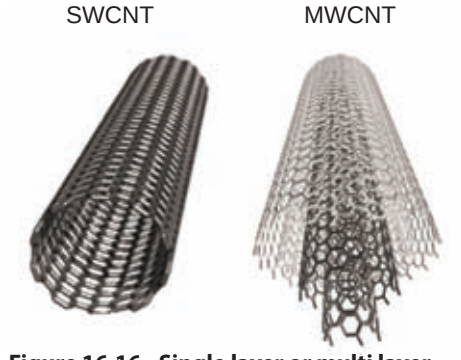


Figure 16.16 - Single layer or multi layer nanotubes

For extra knowledge

One of the worlds best graphite deposits is found in Bogala and Kahatagaha, Sri Lanka. Sri Lanka exports large tonnage of graphite without any further value addition at a very cheaper price. The price of graphene is $ 100 per gram while the price of carbon nanotube varies from $ 25 -100 in the global market.

Fullerene

One of the other forms of nano carbon is fullerene. Fullerene is a molecule which consists of about 60 carbon atoms arranged in a shape of a football. Its diameter is about 1 nm.

Let us engage in activity 16.4 to make a model of fullerene.

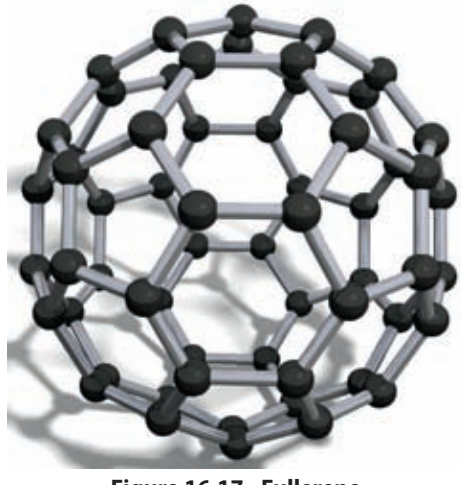


Figure 16.17 - Fullerene

Activity 16.4

You will need :- Bristol board, glue, a pair of scissors

Method :-

- Take a photocopy of the picture in figure 16.18. Paste it on a bristol board and cut the block.
- Join the letters together A-A, B-B, C-C and D-D, using glue on the foil-out tabs.
- You wiil end up having a ring and 2 caps.
- Stick the five flaps of each cap onto the 5 hexagon edges of the ring.
- Repeat on the other side.

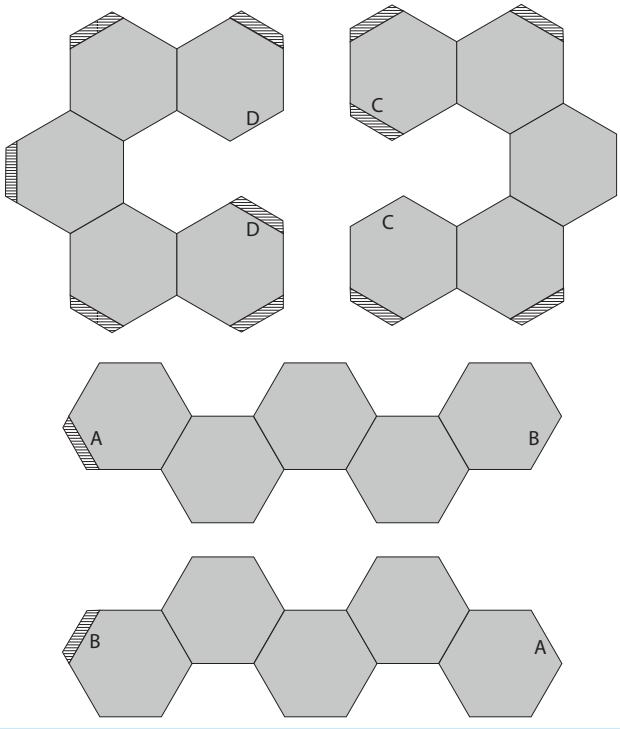


Figure 16.18

Active carbon with pores of nanoscale

Active carbon is processed using charcoal, coconut shell coal, coal, peat etc. as raw materials. The specialty of active carbon is, the presence of nanoscale pores. These pores of nanoscale in active carbon provide a large surface area. One gram of active carbon has a surface area in excess of 3 000 m^2. The pores in active carbon has high adsorption capacity.

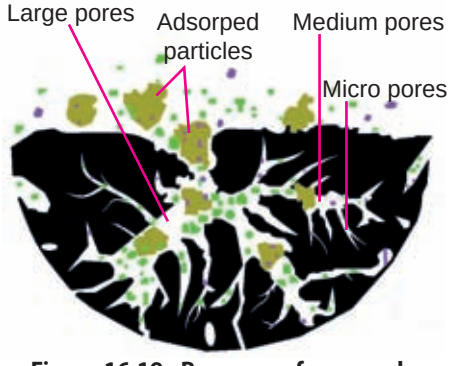


Figure 16.19 - Presence of nanoscale pores in active carbon

Due to these high adsorption capacity, it is used to purify water. Nanotechnology is applied in various fields such as medicine, agriculture, electronics, polymers, cosmetics, food and textile.

16.3 Applications of nanotechnology

According to the researches carried out for a long time, there are expected as well as unexpected uses of nanotechnology. Nanotechnology has contributed towards a revolutionary development in the fields of security, communication, energy, food, medicine, transportation, agriculture, textile, polymers, cosmetics, electronic science etc. Few of them are described below.

Field of medicine

- Diagnostic tools are considered by using nanotechnology. Thus the therapeutic efficiency can be increased. Nanotechnology is being used to diagnose and treat ailments like atherosclerosis. One way of doing this is the introduction of nano particles which are similar to HDL, a type of favourable cholesterol, to remove lipid deposits in blood vessels.

Figure 16.20 - Nanorobots with diagnostic and therapeutic ability used to treat ailments

- Clinical methods to treat directly to cancer cells, without damaging healthy tissues, is being developed using nanotechnology.
- Treatment to replenish bone tissues and nerve tissues are being developed using nanotechnology.
- Nanotechnology is used to inject drugs without using injection needles and also to introduce common vaccines for frequent diseases like common cold.
- Nanoparticles are introduced to skin ointments which are used to protect skin from harmful solar radiation, to increase their quality.
- Nanotechnology is used to detect the amount of sugar and cholesterol in blood.

Field of transport

- Very light and fuel economic motor vehicles, air crafts, boats and space crafts can be manufactured using nanotechnology.
- Nanotechnology is used in the industry of motor vehicles. Items like heavy duty rechargeable batteries, heat controllable electronic devices, wear-resistant tires, thin solar panels and very efficient and cheap sensors are some vehicle parts manufactured using nanotechnology.

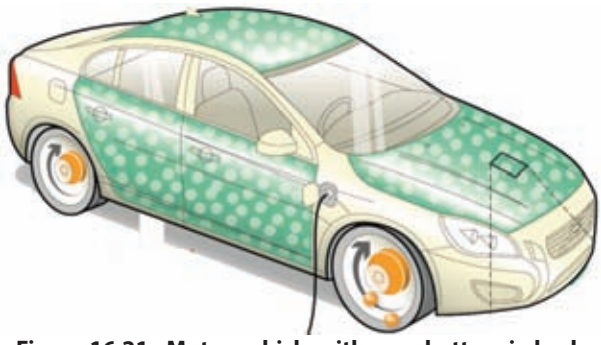


Figure 16.21 - Motor vehicle with nanobattery in body panels

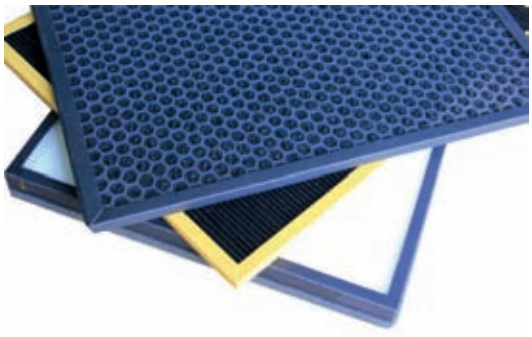


Figure 16.22 - Nanotechnology used in air filters in motor vehicles

Power generation

- Cellulose in saw dust, corn stem and grass can be converted to ethanol, which can be used as a fuel, with the help of enzymes produced by nanotechnology.
- Resistance and tension can be minimized by using wire codes which are made of carbon nanotubes to transmit electricity.
- Nanotechnology is used to manufacture efficient and inexpensive solar panels. Future solar panels may be flexible and are printable (paintable) like papers.
- Very thin solar panels can be made using nanotechnology to stick on computer covers and cloths. They can generate electricity using light, friction and body heat.

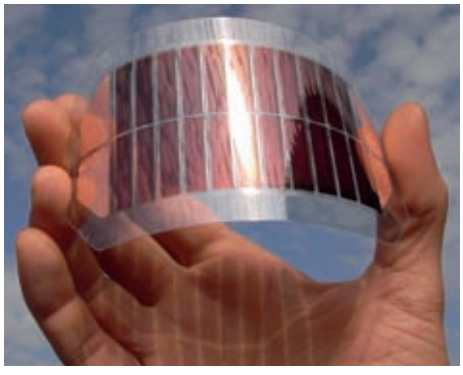


Figure 16.23 - Flexible solar panel

Electronic science

- Minute and speedy transistors in computers can be manufactured using nanotechnology. The size of an ordinary transistor is 130 nm – 250 nm. This size decreased down to 14 nm by 2014 and further decreased to 7 nm by 2015.
- Flexible, foldable, windable, stretchable and washable electronic components which are powered by solar energy can be made using nanotechnology. Therefore, it is possible to manufacture very thin, light, unbreakable, durable and smart electronic equipment.

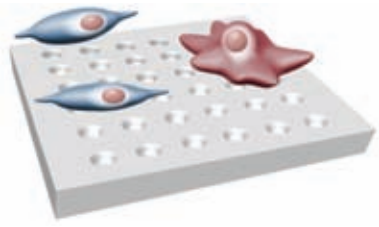
- Nanotechnology is used to manufacture memory chips, audio equipment, keyboards with antibacterial covers and mobile phone covers.

Flexible smart phone | Mobile phone covers | Memory chips

Figure 16.24

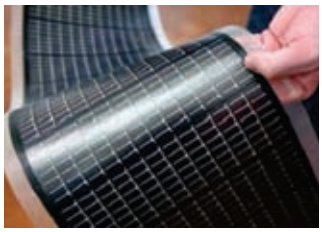
Producing consumer goods

- Eye spectacles, computer and television screen, door and window glasses made of nanotechnology are resistant to ultraviolet and infrared radiations. They do not retain water or micro-organisms and have the ability of auto cleaning.
- Nanopolymers are used to manufacture very light, hard and durable sports items, head gear, bicycles, vehicle spare parts and weapons.
- Household items like high quality detergents and bleaching agents, air filters, water filters, antiseptics, stain and dirt resistant paints can be manufactured using nanotechnology.
- Wearing off and cracking of machine parts can be minimized and life time of them can be considerably increased by using nanostructured ceramic coatings and lubricants made using nanotechnology.
- Textiles and cloths which are resistant to dust, dirt and oil particles are manufactured.
- Nanotechnology can be used in water purification plants to purify water economically and efficiently. Very thin filter membranes are used for this purpose.
- Air filters with pores of nanoscale are used to filter dust and micro-organisms in places like cockpits of air planes.
- Products like aluminum, steel, tar, concrete and cement which are durable, flexible and have a fine finish are manufactured using nanotechnology.



A surface with nanoplating

Piece of glass with nanotechnology



Keyboards with antibacterial covers

Figure 16.25

Assignment 16.1

Collect information on nanotechnology using books, media and internet. Present the information, thus collected, creatively as a booklet.

16.4 Future condition that may arise because of nanotechnology

As in any technical application, nanotechnology also may have adverse effects. These ill-effects may increase with the progress and usage of nanotechnology. Some such effects are mentioned below.

- Air, water and soil can be polluted by releasing particles of nanoscale, which are used in nanotechnology, to the environment. This is known as nano pollution.
- Health problems can arise because of the collection of nanoparticles in human and animal bodies.
- Calamitous situations in the society may increase because of the abundance of nanoscale equipment.
- Severe disasters can occur because of the production of chemical and biological armaments of nanoscale.

Figure 16.26 - Imaginary nano armaments

Various precautionary measures can be suggested to minimize the ill effects of nanotechnology.

- Release of nanoscale air pollutants with effluent smoke can be filtered using nanofilters.

- Natural pollutants like arsenic can be removed from the environment by using nanoscale particles.
- Unfavourable gases can be removed by using nanosensors which are sensitive to those gases.
- Judicial security can be provided by imposing new legislations to prevent ill uses of nanotechnology.

Further information on nanotechnology and applications can be obtained from Sri Lanka Institute of Nanotechnology. The address of this institute is Mahenwatta, Pitipana, Homagama.

Telephone – 011 4 650 500

Figure 16.27 - Sri Lanka Institute of Nanotechnology

Summary

- One billionth of a meter is the nanometer (nm).
- Manufacturing of materials and components using particles of nanoscale and their usage in known as nanotechnology.
- The best natural nanosystem is the cell, which is the structural and functional unit of organisms.
- The self cleansing ability of lotus leaves because of the hydrophobic condition on its surface is known as lotus effect.
- Non-wettable clothes, self-cleansing glass, self-cleansing paints are some items produced using lotus effect.
- High standard productions are made in nanotechnology by positioning atoms appropriately.
- Nanotechnology has contributed to a revolutionary development in various fields.
- Misuse of nanotechnology can results in adverse effects.

Exercises

(01) Select the correct or most suitable answer.

1. A nanometer is considered as;

   1. 10^{-3} m 2. 10^{-6} m 3. 10^{-9} m 4. 10^{-12} m

2. What are the instances below, that lotus effect is in action?

   a - Water does not retain on lotus leaves.
   b - Water does not retain on insect wings.
   c - Dirt does not retain on surfaces painted with self cleaning paints.

   1. a only 2. a and b only
   3. a and c only 4. a, b and c all

3. The particles that are used in nanotechnology are;

   1. The particles of 1 nm scale.
   2. The particles of 1 nm to 10 nm scale.
   3. The particles of 1 nm to 100 nm scale.
   4. The particles of 1 nm to 1000 nm scale.

4. Who put forward the idea of nanotechnology to the world?

   1. Eric Dexler 2. Albert Einstein
   3. Francis Bacon 4. Richard Faynman

5. Which of the following, is not considered as a measure to be taken to minimize the ill-effects caused by nanotechnology?

   1. Limiting the use of nanotechnology.
   2. Minimizing the spreading of nanoparticles using nanofilters
   3. Acting against production of nano armaments
   4. Testing the amount of nanoparticles in air using nanosensors.

(02) Fill in the blanks.

1. Nanometer is ..... of a meter.
2. What is the term used to describe the auto cleansing ability caused by the presence of hydrophobic nature on a lotus leaf ? .....
3. Mention two fields where nanotechnology is used .....
4. Name two products in day-to-day life that are made using nanotechnology. .....
5. Mention two obstacles that come across, when a country is to use nanotechnology .....

(03) Outbreak of nanotechnology is considered as the fifth industrial revolution. This technology is not fully used up to date.

1. Identify what nanotechnology is.
2. Who introduced nanotechnology to the world?
3. Name two natural nanosystems found in the environment.
4. Describe lotus effect.
5. Name two products made, using lotus effect.
6. What is the element mainly used for nanotechnology activities?

Technical Terms

Nanometer	-	නැනෝමීටරය	-	நனோ மீற்றர்
Nanotechnology	-	නැනෝ තාක්ෂණය	-	நனோ தொழில்நுட்பம்
Nanoparticle	-	නැනෝ අංශු	-	நனோ துணிக்கைகள்
Lotus effect	-	ලෝටස් ආචරණය	-	லோட்டஸ் விளைவு
Activated carbon	-	සක්‍රීය කාබන්	-	தொழிற்படும் காபன்
Fullerene	-	ෆුලරීන්	-	புளரீன்
Graphene	-	ග්‍රැෆීන්	-	கிரபீன்

17 Lightning Accidents

Recall what you have learnt about the accidents caused by lightning in grade 7. Pay your attention to the newspaper headlines on loss of lives and property caused by bolts of lightning.

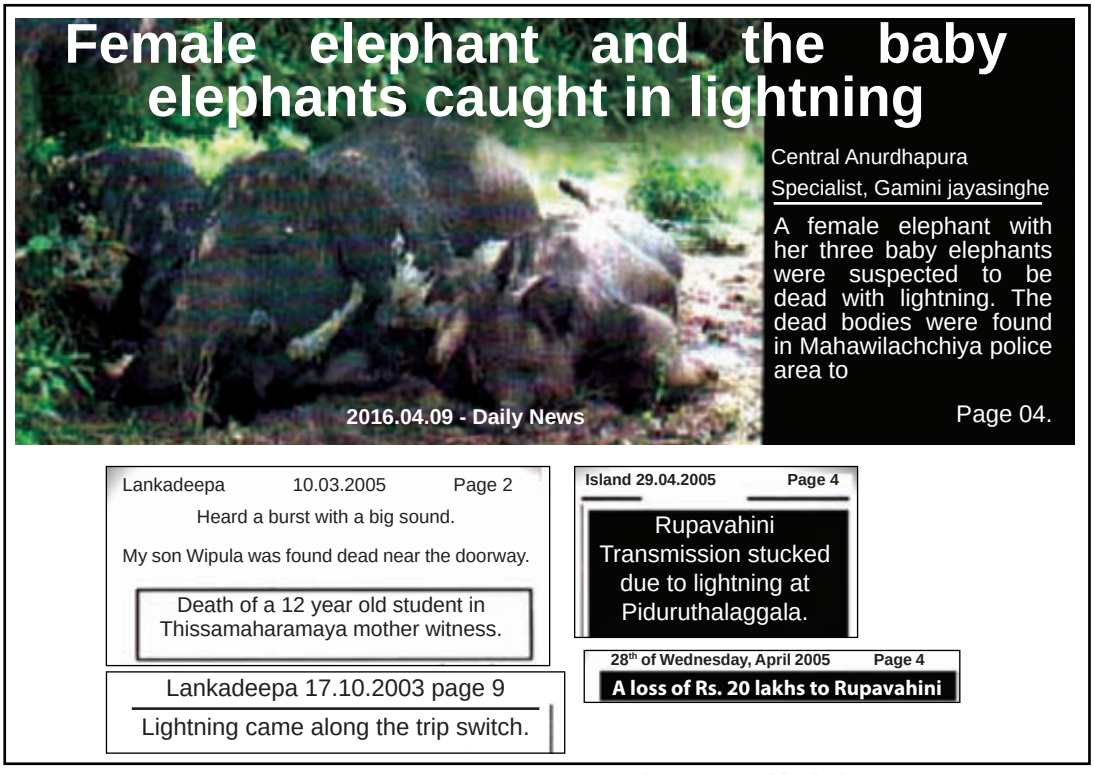


Fig. 17.1 - Some newspaper reports on accidents caused by lightning

Lightning causes loss of human, animal and plant life. Only a small part of the accidents brought about by lightning are reported by mass media.

Lightning claims loss of lives and property not only in Sri Lanka but also in other countries.

In United States of America, it is reported that 100 deaths and nearly 500 get injured within one year by lightning accidents. It has been observed that many lives were lost due to negligence of the precautions for preventing lightning accidents.

Therefore, it is important to have an understanding about lightning.

There are seasons in which the lightning accidents are more frequent. To investigate into it do the assignment 17.1.

Assignment 17.1

Collect information regarding lightning and thunder occurred in this year. Note down the months in which the lightning activity is highest.

According to the above newspaper reports (figure 17.1), it has been observed that the lightning activity is at its peak in the months of March-April and October-November. Meteorologists call those two periods **inter-monsoons**.

In these inter-monsoon periods the temperature of the atmosphere close to the Earth is high. Blowing of wind is low. This increases the amount of water vapour in the atmosphere. This water vapour rises up and also gets cooled forming **clouds**. Cumulonimbus is the type of cloud that contributes most to lightning. Generally, these are located at a height of about 15 000 m from the ground level.

Figure 17.2 - Cumulonimbus cloud

Assignment 17.2

Observe continuously the changes taking place in a cumulonimbus cloud formed in the afternoon during the inter-monsoonal period and Observe the following.

- General increase in height
- Flattening of the top
- Getting darker from the bottom to top.

17.1 How lightning occurs

Clouds contain crystals of snow and tiny droplets of water. Insides the clouds, wind blows fast from the bottom to the top. This makes crystals and water droplets rub each other. Because of this rubbing **electrostatic charges** are formed in the crystals and water droplets.

Recall what you have learnt about the electrostatic charges in grade 7. There are two types of electrostatic charges as positive and negative. It has been discovered that in a cumulonimbus cloud positive charges accumulate in the upper region whereas negative charges get collected in the lower region.

Figure 17.3 - How charges are distributed in a cumulonimbus cloud

The air in a cloud is an insulator. Hence electrical charges do not flow easily through air. Therefore, a large amount of electrical charges accumulate in the upper and lower regions of a cloud. When, very large amounts of charges are developed like this, a moment will arise where electricity can flow even through air. Then a jump of electrical charges or an electric discharge occurs. This phenomenon is known as lightning.

Types of lightning

Depending on the sites between which the charges jump, lightnings are classified into three types.

- Cloud to cloud lightning
- Cloud to air lightning
- Cloud to ground lightning

Photographs illustrating the above three types of clouds are given below.

Cloud to cloud lightning

Cloud to air lightning

Cloud to ground lightning

Figure 17.4

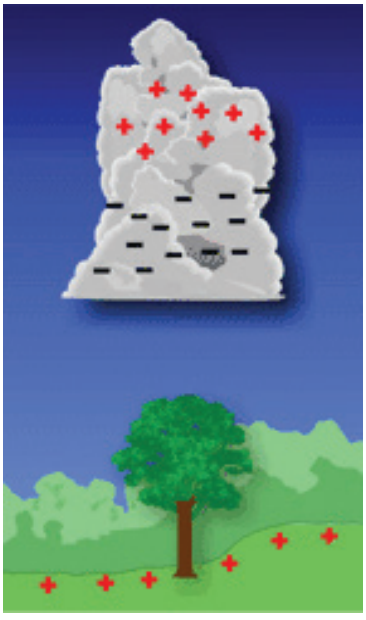


Figure17.5 - Induction of positive charges on ground due to negative charges in the cloud

A jump of charges either between two regions of a charged cloud or between two clouds with different charges is referred to as a **cloud to cloud lightning**. Sometimes a discharge of charges accumulated in a cloud occurs to surrounding air. It is a **cloud to air lightning**.

The most dangerous type is the **cloud to ground lightning**. Let us find out how it occurs.

When a charged cloud positions itself above a certain point on the Earth, positive charges are induced on the ground due to the influence of the negative charged accumulated in the lower part of the cloud. When the amounts of charges in the cloud and on Earth increase, at a certain moment negative charges from the cloud, jump to Earth. This is called a cloud to ground lightning.

Lightning and thunder

The voltage of a cloud to ground lightning is about 10 million volts. In such a lightning a current of nearly 25 000 amperes flows. The voltage of an LED lamp used in houses is 230 volts while the current flowing through it is less than even 0.1 amperes. Hence, you will be able to understand how high is the voltage and current of a lightning.

When such a large current flows through air in a very short time (about 10 milliseconds), air is heated up to a very high temperature. This temperature is about 30 000 ^{0}C. It is five times the temperature of the sun's surface.

Due to the high air temperature, around the lightning current expands instantaneously (same thing happens when a cracker explodes). When air expands at once like this, first a wave is generated followed by a sound wave. The result of the sound wave is the thunder.

In lightning, both light and sound are born simultaneously. But, light is seen first and sound is heard afterwards. The reason for this is that the speed of light is very high whereas the speed of sound is much less than the speed of light. Since the speed of light is very high, light travel from the place where lightning occurs to us is negligibly small. Sound takes more time to reach us. That is why sound reaches us later.

For extra knowledge

The speed of light is 300 000 000 m s^{-1} ($3x10^8$ m s^{-1}) and the speed of sound is 330 m s^{-1}.

During a lightning, if time is measured from the moment of observing light to the moment at which the sound is heard, the distance to the point at which the lightning occurred can be calculated approximately.

For extra knowledge

As the speed of sound is 330 m s^{-1}, it takes about three seconds to travel a distance of 1km (1000 m). So, if the time between the observation of light and hearing of sound (in seconds) is divided by three, we get the distance to the point of lightning in kilometers.

e.g. Let us assume that the sound was heard 12 seconds after the lightning. Then, the distance to the place of lightning is 12/3 = 4 km.

Let us do the activity 17.2 to produce an electric spark (a teacher demonstration).

Activity 17.2

- Produce an electric spark using the induction coil available in the laboratory.
- Observe the production of light and sound while doing it.
- If an induction coil is not available in the school, a spark plug in a motorcycle can be removed from the engine and the way a spark is produced in it can be observed.

Figure 17.6 - Producing sparks by the induction coil

Figure 17.7 - Sparking in a spark plug

Caution
Here, the participation of the teacher or an adult is essential.

In the above activity you would have observed an electric spark. You could have also observed the production of light and sound. The length of that spark is only a few millimetres or centimetres. But, the length of the spark produced in a lightning bolt would be several kilometers. Accordingly, you may understand that the thunder accompanying is also intense.

How lightnings get earthed

There are four ways by which lightnings get earthed harming humans and animals and damaging buildings.

- Direct strikes
- Side flashes
- Contact voltages
- Step potentials

Direct strikes

A strike of a lightning on a solitary man, tree or a building standing on a flat land is known as a **direct strike**.

If a human is struck by a direct lightning, it would seriously affect the person because the lightning current flows to the Earth through his/her body.

Figure 17.8 - A direct strike

Side flashes

A bolt of lightning hitting a tall building or a free passes into the Earth through it and during its passage may side-step from it and get earthed through the body of a man standing near by.

The reason for this is that the flow of the lightning current through a human body is easier than its flow through a building or a tree.

Figure 17.9 - Side flashes

Figure 17.10 - A contact voltage

Contact voltages

Being struck by a lightning at a time of its production because of touching domestic electrical appliances or using cellular phones is known as a **contact voltage**.

Besides, a person in contact with a tree at a time of the occurrence of a lightning may also fall prey to it when it hits the tree. This is also a contact voltage.

Figure 17.11 – Step potential

Step potentials

When a lightning strikes a building, a tree or the ground the lightning current spreads in every direction from that place. Suppose a person or an animal is standing within such a spread area. The lightning current that enter the body of that man or the animal from one leg will pass through the other leg. This phenomenon is called **step potential**.

The longer the distance between the two feet, the higher is the potential difference and hence the intensity of the current too. That is the reason why it is safer to keep the two feet closer at a time of lightning.

An ox is hurt more than a human by a step potential. This is because the distance between the fore limb and hind limb of an ox is greater than that between the two feet of a human. This increases the potential difference and hence the current flow through the body of the ox. Consequently the damage caused is also greater.

According to the newspaper reports shown to you at the beginning of this lesson, it would be clear to you that a lot of damage is caused on human, animals and property by lightning. Though a systematic calculation has not been carried out, the loss of property due to lightning per year in Sri Lanka may amount to billions of rupees.

Therefore, measures should be taken to minimize the losses caused by lightning.

17.2 Prevention of lightning accidents

Some precautions that can be taken to prevent accidents caused by lightning are given below.

- Fixing lightning conductors for tall buildings and maintaining them properly.
- Installing earth wires properly in domestic electrical circuits
- Disconnecting all electrical appliances from the circuit and keeping them away from sockets in situations in which lightning is likely
- Disconnecting television antennas from the television set and keeping them outside the house when there is likelihood of lightning.
- Identifying safe sites in advance when planning outdoor activities.

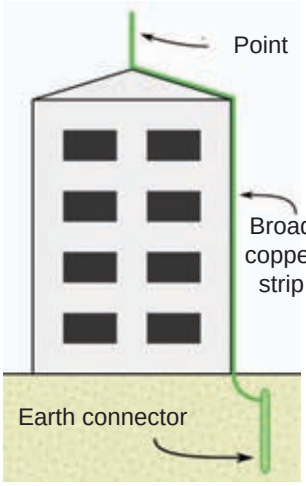


Figure 17.12 - A lightning conductor

Ensuring safety from lightning accidents

Following precautions can be taken to minimize the accidents caused by lightning.

For extra knowledge

The lightning conductor was invented by Benjamin Franklin.

Benjamin Franklin

- Not staying in open areas such as playgrounds, tea plantations and paddy fields
- Refraining from using equipment such as mamaty and crowbars
- If it is required to stay in an open area keeping feet closer and being in squatting position
- Wearing dry shoes or standing on insulator materials
- Not staying on trees or high lands
- Keeping away from the foliage if it is required to stay near a tree
- Staying away from flag posts, wire meshes, wire fences etc.
- Staying seated or reclined lessening the height above the ground
- Being seated if it is required to stay in an open boat
- Limiting the use of landline phones as much as possible
- Refraining from using electric irons, refrigerators, electric ovens etc.

A fully-enclosed vehicle is very safe place to be in, when lightning occurs. Be sure not to touch interior metallic parts in the vehicle.

Lightning victims do not carry an electrical charge and are safe to handle.

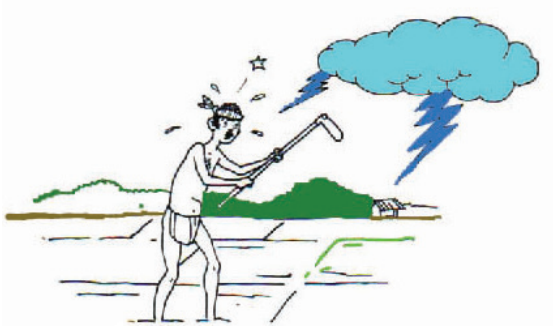


Figure 17.13 - Not staying in an open areas when lightning

Figure 17.14 - Avoid the use of landline phones when lightning

First aid for a person struck by lightning

- If the limbs are benumbed bring them back to normally by massaging
- If respiration has stopped, give artificial respirations
- If the heart beat has stopped, massage the heart

  It is very important to have a practice in artificial respiration and heart massaging. It is useful for you in day to day life.
- Take the patient to the hospital as soon as possible. Give first aid while taking the patient to the hospital

Summary

- Lightning is a natural disaster affecting Sri Lanka. It causes loss of human lives, animal lives and property.
- Lightning occurs mainly due to the accumulation of electrostatic charges in cumulonimbus clouds.
- When the clouds heavily laden with electric charges they get discharged.
- Lightnings are classified according to the way of discharge.
- Cloud of ground lightnings are the most harmful. They are further classified according to how they get earthed.
- In a lightning bolt, flow of a high current occurs instantaneously due to the high potential difference created between the clouds and the Earth.
- Thunder is the result of sudden expansion of air due to intense heat generated in an electric discharge.
- In a lightning through both light and thunder are produced simultaneously, an observer at a distance sees light first and hears the sound afterwards.
- The damage caused by lightning can be minimized by suitable precautions and following safety measures in the occasions of lightning.

Exercises

(01) State whether the following statements are true (√) or false (×).

i. Exact predictions cannot be made about the lightning strikes. ( )

ii. Only water vapour can be seen in clouds. ( )

iii. It is not suitable to be on a tall tree in an occasion where there is a risk of lightning. ( )

iv. Even a person inside a house can be hurt by a lightning. ( )

v. In a lightning bolt, both light and sound are produced at the same time. ( )

(02) Match the pairs correctly.

i. Direct strike	a. Hurting a person staying near a building when a lightning hits that building
ii. Contact voltage	b. A man standing under a tree being struck by part of a lightning that hits the tree
iii. Side flash	c. A lightning hitting a person staying alone in a flat land
iv. Step potential	d. A lightning hitting a man leaning against a tree or a person using a cellular phone

(03) Fill in the blanks of the sentences given using the following words.

(cloud to air, cloud to ground, cloud to cloud, large, greater)

i. A …….. lightning comes from a cloud to Earth.

ii. …….. lightnings are produced between clouds.

iii. The lightnings occurring between clouds and air are……..

iv. The temperature of a lightning is …….. than the temperature of the sun's surface.

v. A …….. amount of heat is generated by a lightning.

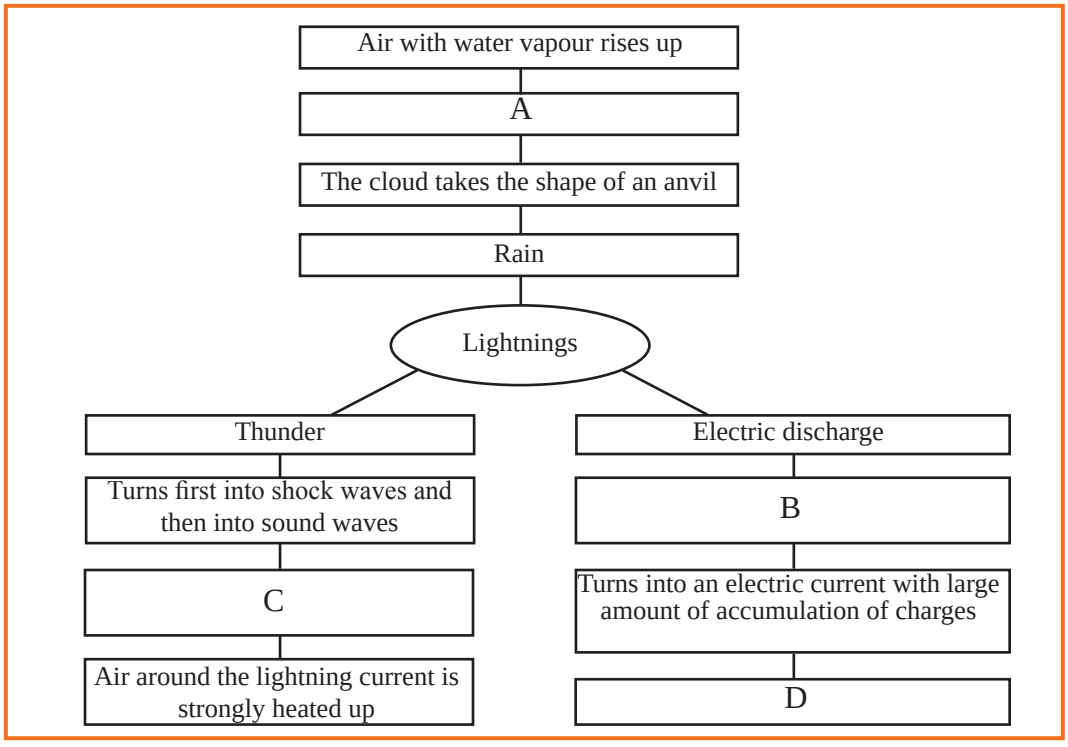
(04) Match the following sentences with the blank spaces A,B,C and D in the concept map given as approximate.

i. Air gets heated up and expands suddenly ( )

ii. Charges jump within a cloud, between cloud or from a cloud to ground. ( )

iii. Electrical charges accumulate in a cloud. ( )

iv. Air with water vapour moving up gets cooled to form clouds. ( )



Technical Terms

Discharge	-	විසර්ජනය	-	மின்னிறக்கம்
Lightning	-	අකුණ	-	மின்னல்
Thunder	-	ගිගුරුම	-	இடிமுழக்கம்
Inter monsoon	-	අන්තර් මෝසම්	-	பருவக் காற்று காலப்பகுதி
Cumulo nimbus clouds	-	කැටි වැහි වලාකුළු	-	திரள் முகில்
Snow crystals	-	හිම ස්ඵටික	-	பனிப் பளிங்குகள்
Static electric charges	-	ස්ථිති විද්‍යුත් ආරෝපණ	-	நிலை மின்னேற்றங்கள்
Cloud to cloud lightning	-	වලා අකුණු	-	முகில் மின்னல்
Cloud to ground lightning	-	පෘථිවි අකුණු	-	புவி மின்னல்
Cloud to air lightning	-	වා - අකුණු	-	படிமுறை மின்னல்
Induction coil	-	ප්‍රේරණ දඟරය	-	தூண்டற் சுருள்
Lightning rod	-	අකුණු සන්නායකය	-	மின்னற் கடத்தி
Direct strike	-	සෘජු අකුණු	-	நேரடித் தாக்கு
Side flash	-	පාර්ශ්වික අකුණු	-	பக்கப் பாய்ச்சல்
Step potential	-	පියවර අකුණු	-	படிமுறை அழுத்தம்
Contact voltage	-	ස්පර්ශක අකුණු	-	தொடுகை வோல்ற்றளவு
Shock wave	-	කම්පන තරංග	-	அதிர்வலை

18 Natural Disasters

The losses brought about on humans, animals and property by a natural process without the interference of man is named a natural disaster.

There is a number of natural disasters affecting Sri Lanka. Of them, here we study about the below mentioned **natural disasters**.

- Cyclones
- Earthquakes
- Tsunami
- Wild fires

18.1 Cyclones

When the pressure of the air at a certain place in the atmosphere closer to the Earth's surface drops below the pressure around that place, a **low pressure area** is created.

If this low pressure situation develop further, it becomes a **depression**. If situation develops further it gives rise to a **cyclone**.

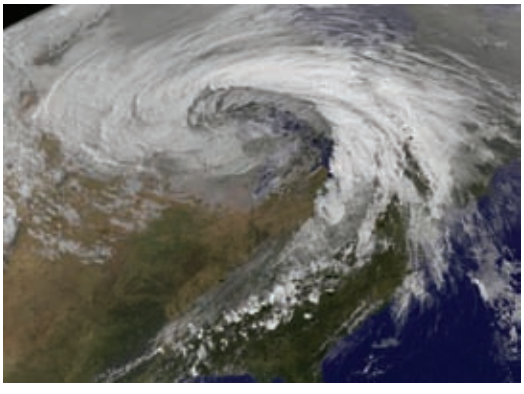


Figure 18.1 (a) – Satellite picture showing the movements of clouds during a cyclone

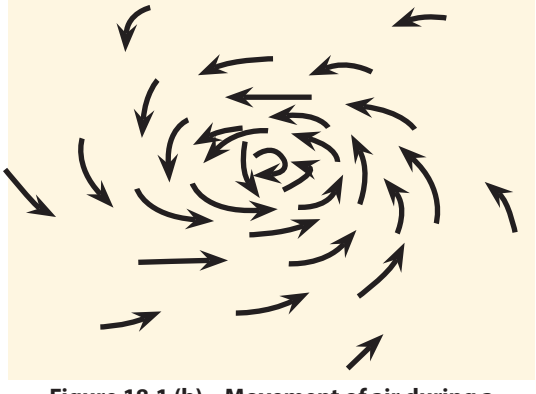


Figure 18.1 (b) – Movement of air during a cyclone

Factors that cause cyclones

- Existence of a large oceanic area and its temperature being above 27 ^{0}C to a depth of 60 m.
- Occurrence of convection current in the atmosphere
- Minimal tendency of the horizontally blowing wind to sweep vertically

- Location of the point at which the depression is closer to the equator. (cyclones are not formed on the equator)
- Increasing humidity of the atmosphere beginning from surface of the ocean to higher atmospheric levels (higher than 60%).

As cyclones are born on meeting the above conditions, they are restricted only to some oceanic regions on the Earth.

For extra knowledge

Types of cyclones

- The cyclones formed in the North and South Asian oceans are known as tropical cyclones.
- The cyclones generated in the Northern Pacific Ocean are called as typhoons.
- Cyclones produced in the North Atlantic Ocean are termed as hurricanes.

Structure of a cyclone

In addition to the circulation, air rises up in the central part of the whirl of the cyclone. This upward movement of air gives rise to a cylindrical **cloud wall**. The central part of the whirlwind is called as the **eye**. It would have spread within a region of 30 - 60 km from the centre of the whirl. This eye is a region with little wind and free of rain and clouds. In satellite photographs this appears as a black circle.

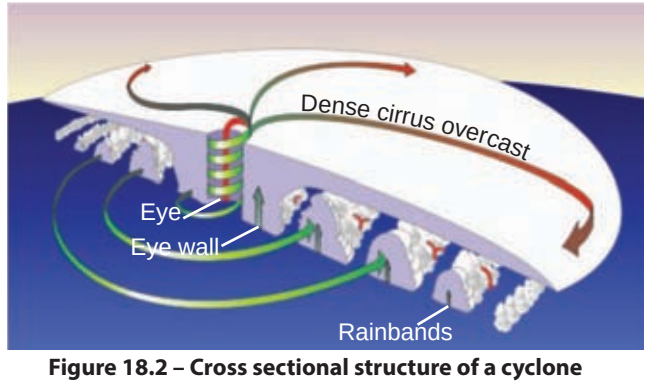


Figure 18.2 – Cross sectional structure of a cyclone

The cylindrically arranged cluster of clouds around the eye is known as the eye wall. In this region heavy rains and fast blowing winds occur. Due to the eye wall, a few spiral bounds of clouds can be seen. In these regions too, heavy and speedy winds occur.

Cyclone is the main mechanism that distributes the huge solar energy received by the regions close to the equator of the globe. Cyclones originating time to time in Indian, Pacific and Atlantic oceans provide the factors essential for the life of plants and animals on the Earth. Though in nature, cyclones is a favourable phenomenon like this, today more attention is focused on the disasters brought about by it.

An experience of a cyclone

The date was 26th December 2000. It was a sunny day for Trincomalee town. The residents of the town were involved in their daily routing as usual. Although the weather forecasts of that day had informed that a cyclone would occur, some seemed not to be concerned about it.

At about eight o'clock a black cloud appeared from the sea side. Before half an hour passed, a fast blowing wind swept across the town. At the same time it started to rain heavily. Roofs of buildings flew away with the wind. Trees were uprooted. Electricity was cut off. Residents of the town ran to safer places.

After some time rain stopped and the wind also subsided. Some people came out from the safe places. But, again a strong wind started to blow in the opposite direction as earlier. Rain started again. Buildings which were not destroyed by the wind which blew first were devastated by this second.

Given below are numerical data about the losses caused by the cyclone described above.

- Number of families hit - 170 419
- Number of houses fully damaged - 57 273
- Number of houses partly damaged - 20 860
- Amount of cultivated land destroyed - 20 810 acres
- Number of deaths - 17
- Loss caused to the national economy - Rs. 1500 million

Now let us compare the above experiences with the action of a cyclone. Within the cyclone winds, the whirl is very fast and that whirl moves in a certain direction with a certain speed.

After a strong blowing of wind from one direction, comes a state of tranquility. That is when the eye of the cyclone passes through that point. When the other part of the whirl passes that point, a speedy wind, as was the one blew first, blows in the opposite direction.

Table 18.1 - Information about some cyclones that affected Sri Lanka in the past 50 years

Year	Date	Area from which the cyclone entered Sri Lanka	Number of deaths
1964	22 December	Trincomalee	More than 1000
1978	22 November	Batticaloa	915
1992	12 November	Pottuvil	04
2000	26 December	Trincomalee	17
2008	25 November	Eastern coast	15
2016	15 May	Eastern coast	101

According to the above table, what are the months in which most of the cyclones affected to Sri Lanka had occurred? From which areas had cyclones entered to Sri Lanka most?

It may be clear to you that most of the cyclones that defected Sri Lanka had occurred in November and December and they had entered Sri Lanka from the Eastern coast.

In 1978, the death toll due to cyclones was 915. However, since warnings could be given because of the development of technology, the number of deaths could be reduced in subsequent cyclones.

For extra knowledge

Most of the storms affecting Sri Lanka are born in the Bay of Bengal.

Let us do the activity 18.1 to demonstrate the movement of air during cyclones, using water.

Activity 18.1

You will need :- Two identical transparent plastic bottles, water, gum tape small pieces of paper or colourant

Method :-

- Take two identical, transparent plastic bottles.
- Fill about 3/4 of one of them with water. Colour the water or put some pieces of paper into water.
- Place the mouth of the empty bottle on the mouth of the bottle containing water and connect those two tightly with gum tape.
- Now rotate the apparatus slowly in anticlockwise.

You will be able to understand how air moves during a cyclone by the movement of water in the bottle placed on top.

During the past century, 13 cyclones have entered to Sri Lanka from the Eastern coast of the country. Among those cyclones, three were very powerful cyclones.

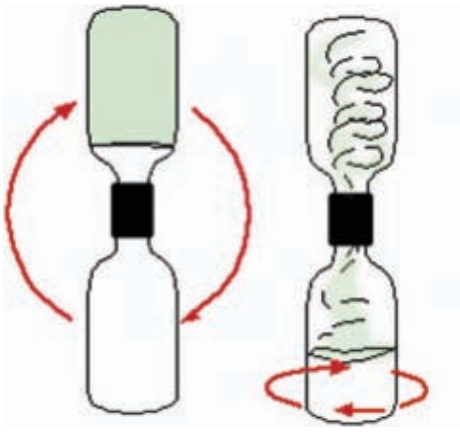


Figure 18.3

Figure 18.4 - Paths of cyclones which entered Sri Lanka from 1901 to 2000

Figure 18.5 - A cyclone

Assignment 18.1

Study the above map and prepare a list of districts in Sri Lanka which are prone to cyclones.

Using high technology, the Department of Meteorology keeps vigilance over the cyclones around 24 hours. In occasions of a probable cyclonic situation to Sri Lanka, the latest information about it are communicated to the relevant government institutions. The telephone number of the Department of Meteorology is 011 2 686 686.

18.2 Earthquakes

An earthquake is a jolt or shoulder like movement of the Earth's surface. Less violent earthquakes are known as **tremors**.

Earthquakes and **Earth tremors** are caused by releasing of the energy stored in the Earth's crust.

Earthquakes bring heavy damages to man-made creations on Earth.

Figure 18.6 – Photographs of the same area before and after the Earthquake

In order to understand how earthquakes are happening, we need to know about the structure of the Earth. The figure 18.7 shows the internal structure of the Earth.

The Earth is composed of three main structures.

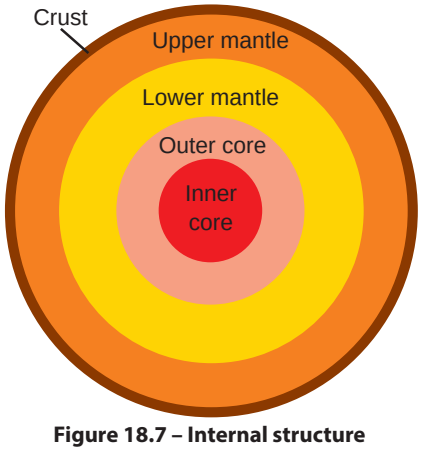
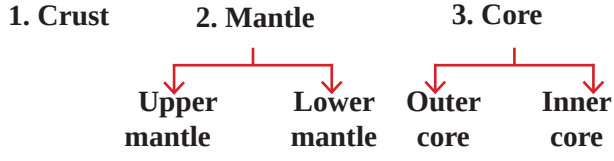


Figure 18.7 – Internal structure of the Earth



Evidences support the fact that the crust, the topmost layer of the Earth is composed of a number of tectonic plates which move relative to one another. The Earth's crust consists of a few large tectonic plates. They can be identified by the following map (figure 18.8).

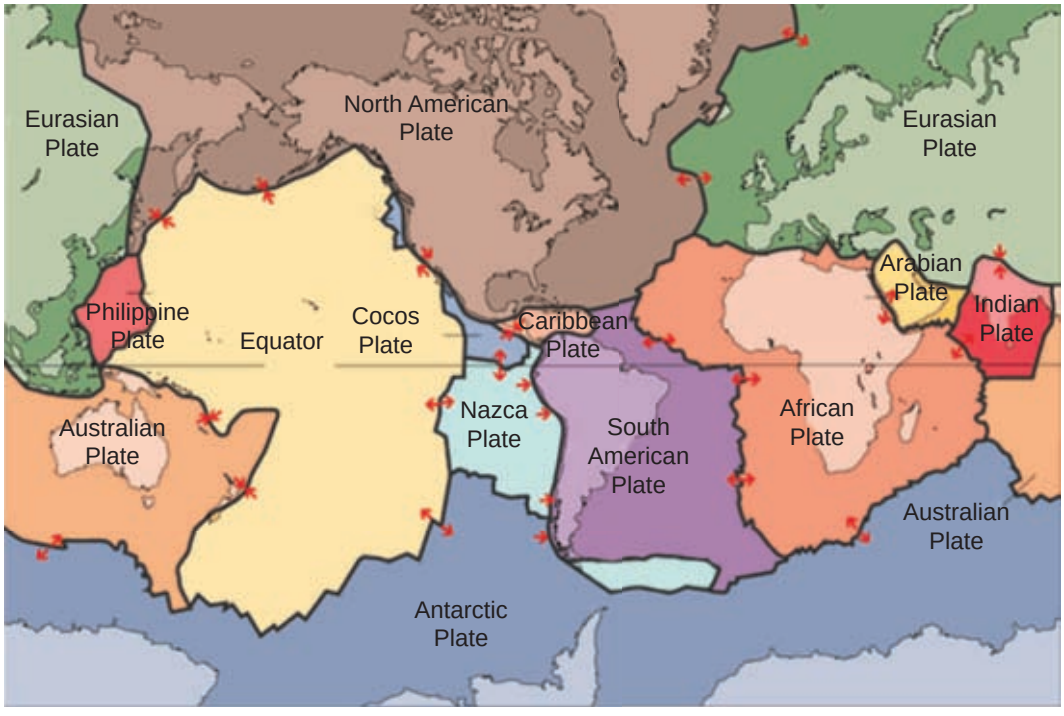


Figure 18.8 – The map of tectonic plates

The tectonic plates which form the Earth's crust move relative to one another. By the activity 18.2 you can understand how this happens.

Activity 18.2

You will need :- Plate or a shallow basin, water, colourant, piece of styrofoam

Method :-

- Pour water into a plate or a shallow basin. Add some colour to water.
- Cut a polystyrene sheet into pieces and float them on water.

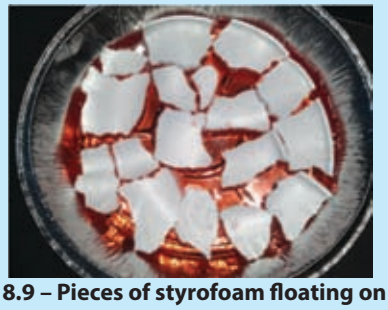


Figure 18.9 – Pieces of styrofoam floating on water

- Now shake the container gently.
- Observe the way the piece of polystyrene move.

The movement of the pieces of polystyrene corresponds to the way the tectonic plates move on semi-solid **magma** in the upper part of the mantle.

How tectonic plates move

It has been identified that there are three ways of movement of tectonic plates relative to one another at the boundaries.

- Divergent border
- Convergent border
- Slip border

Divergent border

At this border, the two tectonic plates move away from each other.

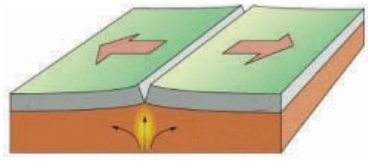


Figure 18.10 – Illustration of a divergent border

Figure 18.11 – Mid Atlantic Ridge

At divergent borders, magma in the upper mantle rises up between the two tectonic plates and therefore a new crust is created. Most of such tectonic plate borders are located in the oceanic floor.

e.g. Mid Atlantic ridge

Convergent border

At this border, two tectonic plates collide and one plate moves underneath the other. Volcanoes erupt in the regions in which these movements occur.

e.g. Saint Helen's mount (Figure 18.13)

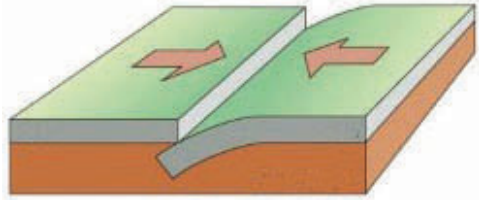


Figure 18.12 – Illustration of a convergent border

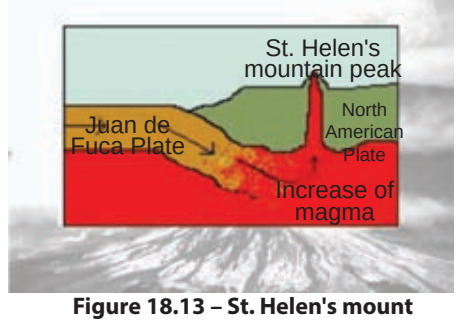


Figure 18.13 – St. Helen's mount

Slip border

At this border, the two tectonic plates move away from each other while being in contact.

Sometimes, the tectonic plates cram into each other during the movements. Violent earthquakes may happen when lot of energy is collected during such movements.

e.g. Saint Andrea's fault (Figure 18.15)

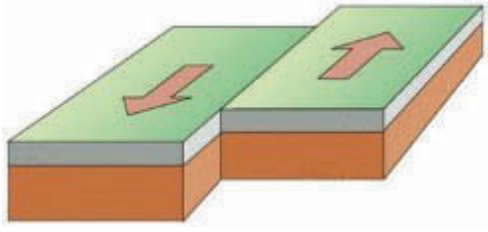


Figure 18.14 – A slip border

Figure 18.15 – Saint Andrea's fault

By the activity 18.3, you may have an understanding about how the tectonic plates move on the Earth's crust.

Activity 18.3

You will need :- A boiled egg

Method :-

- To Demonstrate the Earths' crust and the movements of tectonic plates,
- Tap a boiled egg on the table and make several cracks on it.
- The shell of the egg corresponds to the Earth's crust and the egg white underneath it, corresponds to the upper mantle.
- Colour the boundaries of the cracks using a marker. Take the egg onto the palm and squeeze it gently, so that the edges move back and forth.

Figure 18.16

When squeezed, it can be seen that at some pints of the cracks the pieces of shells move apart. Those points correspond to **divergent borders**. At some other places it appears that some pieces come closer. Such places illustrate **convergent borders**.

In some other places it appears that the pieces of the shell move forward and backward relatively. Those places correspond to **slip borders**.

For extra knowledge

Compared to the Earth, the thickness of the crust is 2% of its diameter. Compared to the diameter of an average egg, the thickness of the shell is also 2% of it.

Intensity of earthquakes

At the points at which the tectonic plates have colloid impact, the layers of rocks bend. When the force exerted to bend them exceeds the yield point of the rocks, the rocky layers break. This point of breakage is the **focus** of the earthquakes. The point on Earth above the focus is the **epicenter**.

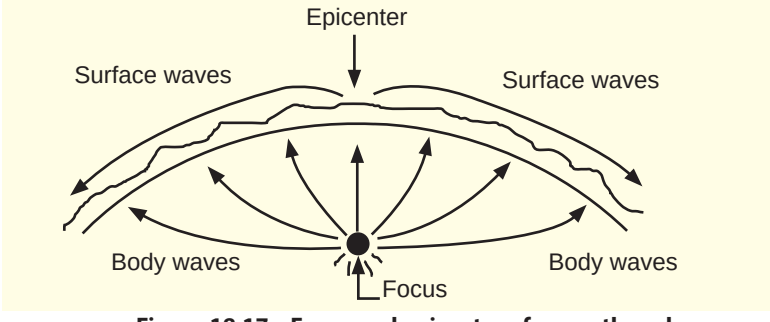


Figure 18.17 – Focus and epicenter of an earthquake

Seismic waves spread in all directions from the focus of an earthquake. These waves convey energy along the surface of the Earth and also through the interior of the Earth.

The strength of these seismic waves can be measured by the **seismometers** installed at various places of the Earth. The apparatus which automatically records the information related to seismic waves is called the **seismograph**.

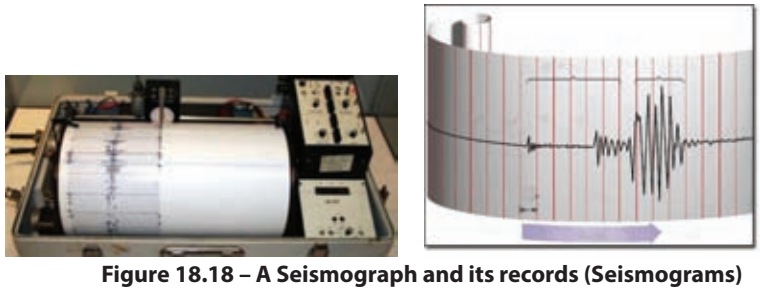


Figure 18.18 – A Seismograph and its records (Seismograms)

The scale that is calculated on the basis of the information recorded by the seismograph and the damage inflicted to buildings, ground and humans is called the **Richter scale**.

This scale has been introduced by Charles F. Richter in 1953.

Table 18.3 gives a short description of the intensities of earthquakes and their results as against the Richter scales values.

Table 18.3 - Intensities of earthquakes and their results

Richter scale value	Result
2.0 - 3.5	Not felt by human but is recorded in the seismograph
3.5 - 5.5	Felt by everybody
5.5 - 7.3	Buildings may be destroyed
7.4 - 8.0	A big damage may be caused
above 8.0	Can cause a complete destructtion

Worlds' regions prone to earthquakes

Study well the map (figure 18.19) indicating the regions where strong earthquakes occurred in the world.

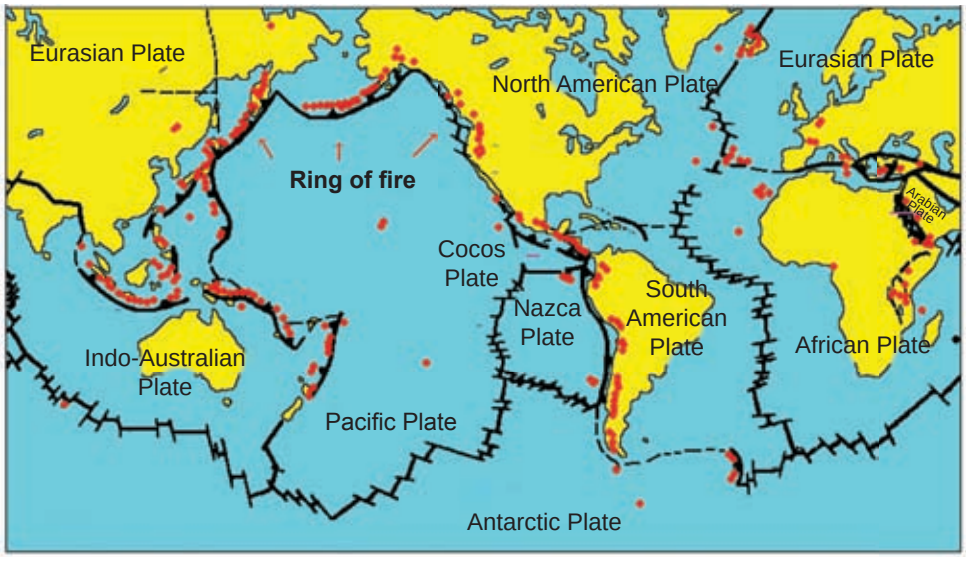


Figure 18.19 – Map indicating the regions subject to strong earthquakes

From the above map, it may be clear to you that earthquakes have occurred mostly in the borderland regions. Of them, too most of the earthquakes have broken out in the region called 'Pacific Ring of Fire'. From the map it can be seen that, this region is the border of the very large Pacific tectonic plate.

For extra knowledge

Table 18.4 shows the information on strong earthquakes that took place during the past few years.

Table 18.4

Value on the Richter scale	Date	Region/Country of occurrence	Number of deaths
6.4	2004.02.24	Morocco	631
9.1	2004.12.26	Sumatra	250 000
6.4	2005.02.22	Iran	612
8.6	2005.03.28	Sumatra	1 313
7.6	2005.10.08	Pakistan	87 000
6.3	2006.05.26	Java Islands	5 782
8.0	2007.08.15	Peru	519
7.9	2008.05.12	China	69 197
6.3	2009.04.06	Italy	308
8.1	2009.09.29	Samoa Islands	189
7.6	2009.09.30	Sumatra	1 115
7.0	2010.01.12	Haiti Islands	160 000
8.8	2010.02.27	Chile	1 525
6.9	2010.04.13	China	698
7.7	2010.10.25	Indonesia	408
6.1	2011.02.21	New Zealand	185
7.9	2011.03.11	Japan	18 184
6.9	2011.03.24	Myanmar	150
6.9	2011.09.18	India-Nepal border	111
6.4	2012.08.11	Iran	306
6.6	2013.04.20	China	193
7.1	2013.10.15	Philippine	222
6.2	2014.08.03	China	617
7.8	2015.04.25	Nepal	9 018
7.3	2015.05.12	Nepal	218
7.5	2015.10.26	Afghanistan	398
7.8	2016.04.16	Ecuador	673
6.2	2016.08.24	Italy	297
6.4	2016.02.05	Taiwan	117

Study the above table and find out the following information.

1. How many earthquakes have occurred during past 13 years which above 7.4 in Richter scale?
2. What are the countries in which, those earthquakes occurred?
3. What is the country in which, the highest number of earthquakes have occurred?

Assignment 18.2

Find the tectonic plate borders of above countries based on the location and prepare a table. Seek assistance of the Geography teacher if required.

e.g. Sumatra Islands are located on the border between Indo-Australian plate and Eurasian plate

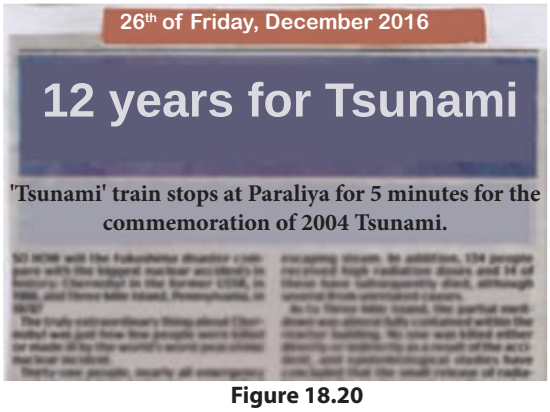
Human activities that would cause earthquakes

Recently, scientists have observed that, in addition to natural causes, some activities of human could also be the reasons for earthquakes.

- Testing nuclear weapons underneath Earth
- Drilling Earth to great depths to mine oil and minerals
- Erecting dams and constructing large water reservoirs
- Constructing very large buildings of great heights and weights

18.3 Tsunami

On the 26th December 2004 we had to face the most ruinous natural disaster which affected Sri Lanka in recent times. It was the tsunami disaster. A part of a newspaper article published 12 years after the incident is given in the figure 18.20.


26th of Friday, December 2016

12 years for Tsunami

'Tsunami' train stops at Paraliya for 5 minutes for the commemoration of 2004 Tsunami.

Figure 18.20

In this disaster, 250 000 people died in countries bordering the Indian Ocean. In Sri Lanka about 40 000 were died. The way that tsunami was formed, has been explained by geologists as follows.

That day at 6.58 a.m. in Sri Lankan time, an earthquake of Richter scale value 9.1 occurred in the sea bed near Sumatra Island of Indonesia. The process taking place at a convergent border occurred there. Indian tectonic plate moved underneath the Burmese tectonic plate. Owing to the upward moment of the Burmese tectonic plate and the vast amount of energy released by the earthquake, the oceanic water

raised up. The tsunami wave created by it was spreaded throughout the Indian ocean at a speed greater than 800 kilometers per hour.

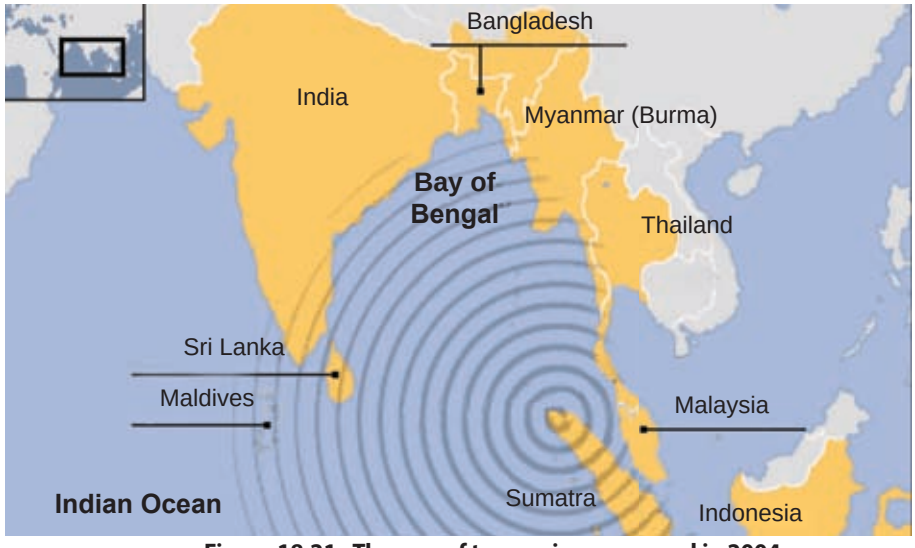


Figure 18.21 –The way of tsunami wave spread in 2004

Let us do the activity 18.4 to demonstrate an event of tsunami.

Activity 18.4

You will need :- A rectangular basin, air filled balloons with different sizes, a pin

Figure 18.22

Method :-

- Pour water about 2/3 the volume of a rectangular basin.
- Sink an air-filled balloon at a narrow end of it and burst it by piercing with a pin.
- Observe the waves formed in water.
- Burst small, medium and large balloons like this and observe if there is any difference in waves created.

Incidents causing tsunami

- Earthquakes occurring in the oceanic bed
- Volcanic eruptions in the ocean floor
- Earth slips in the ocean floor
- Falling of a large meteorite to sea

Of the above, the greatest ruin would be caused by the fall of a gigantic meteorite to the sea. Such a devastation may also be caused by the collision of an asteroid with the Earth.

Table 18.5 shows information regarding tsunami occurred during the past 20 years.

Table 18.5 - Tsunami occurred during the past 20 years

Date	Region/Country in which the tsunami occurred	Strength (height of waves)
1994.06.03	Indonesia	5 m
1998.07.17	Papua New Guinea	10.5 m
2004.12.26	Sumatra Islands	50 m
2006.07.17	Java Islands	21 m
2006.11.15	Kuril Islands	2 m
2007.04.02	Solomon Islands	12 m
2009.09.29	Samoa Islands	14 m
2010.02.27	Chile, Argentina	2 m
2010.10.25	Sumatra Islands	3 m
2011.03.11	Japan	2 m
2013.02.06	Solomon Islands	1 m
2014.04.02	Chile	2 m
2015.09.16	Chile	4 m
2016.11.13	New Zealand	2 m

Study the above table and answer the following questions.

1. According to this table, name the country that was hit by the highest number of tsunami disasters.
2. What are the countries that were subjected to tsunami disasters twice?
3. What was the date that the tsunami with highest height occurred?
4. What are the effects caused by the tsunami mentioned in question number 3 to Sri Lanka?

Assignment 18.3

Find the margins of crustal plates where the above countries are located and prepare a table. Get the assistance of the Geography teacher if required.

e.g. Chile is situated at the boundaries of Nazca plate and the South American plate

Nature of a tsunami wave

Tsunami waves are a type of water waves. Figure 18.23 illustrates the characteristics of a normal water wave.

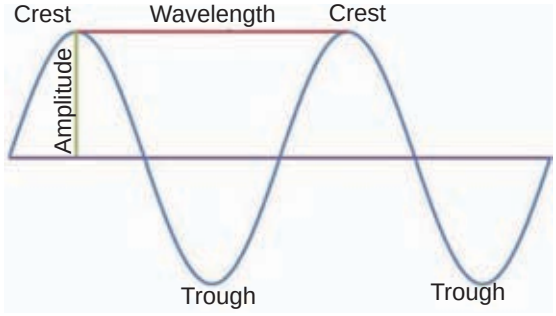


Figure 18.23 – Characteristics of a normal water wave

A water wave comprises of an alternate series of **crests** and **troughs**. The distance between two successive crests or troughs is called the **wavelength**. The depth from the mid point of a wave to its crest is known as the **amplitude**.

Figure 18.24 shows how the wavelength, amplitude and the speed of tsunami waves change from deep sea to shallow sea.

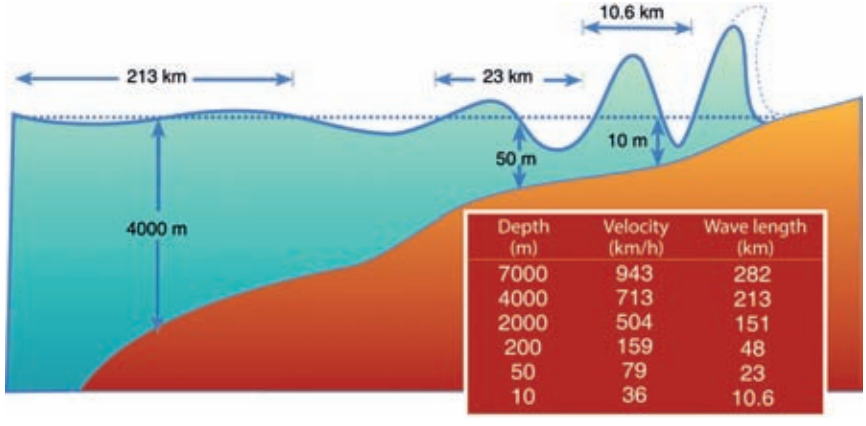


Figure 18.24 – How wave length, and speed of the tsunami waves change when they move from deep sea to shallow sea

The affect of the move which occur in sea surface depend on the depth of water column. In the deep sea, the speed of tsunami waves is high. Their wavelength is also high. But, the amplitude or the height of the waves is low. Therefore, tsunami waves cannot be identified in deep sea. Further the ships streaming in deep sea are not damaged by the tsunami waves.

In the shallow sea, the speed of tsunami waves decreases. Their wavelength also decreases. But, the amplitude or the height of the waves increases. Hence the boats near the coast are damaged by the tsunami waves.

In tsunami waves, the trough first approaches the shore. Then the sea is drawn backwards. This is a forwarding of an imminent tsunami.

Coral reefs and mangroves retard the speed of tsunami waves. Therefore, the coral reefs and mangroves should be protected live without causing damage to them.

Since there is a possibility of tsunami following an earthquake, people should be vigilant about them. Investigations must be made about the sites which have been already damaged by tsunami and the people living in such areas should be made aware about them.

18.4 Wild fires

Wild fires have occurred out in jungles from the distant past. When a forest is dry, wild fires may erupt due to natural reasons such as lightning or setting fire deliberately or by mistake.

Figure 18.25 – A wild fire

There are three factors that should be met for a fire to break out.

- Availability of a combustible substance
- Availability of a supporter of combustion or oxygen
- Heating the combustible substance to the ignition temperature

Several factors are affecting the spread of wild fires.

- Existence of dry plant leaves or tree stems as the combustible materials
- Prevalence of a high temperature
- Low humidity (water vapour content) in air
- Profuse supply of oxygen to the fire due to blowing wind
- Slopy land that helps upward spread of the fire

A wild fire is a terrifying scene. In a wild fire, a very tall column of fire moves forward very fast. The smoke produced in this, rises to a height of thousands of meters in the atmosphere. More and more fires also would break out because fire flames are carried through air to distant places from the fire.

Plants and animals have been damaged due to wild fires. Organisms are adversely affected even by the smoke produced by wild fires. It has been reported that respiratory difficulties and even deaths have occurred in certain instances. In Sri Lanka approximately 4 000 acres of land has been destroyed in 2016 owing to wild fires.

18.5 The relationship between increase in global warming and natural disasters

During the past 100 years, the average temperature of the world has been increased. This condition is known as global warming. The graph in figure 18.26 shows how the average temperature changed from 1860 to 2000 in the world.

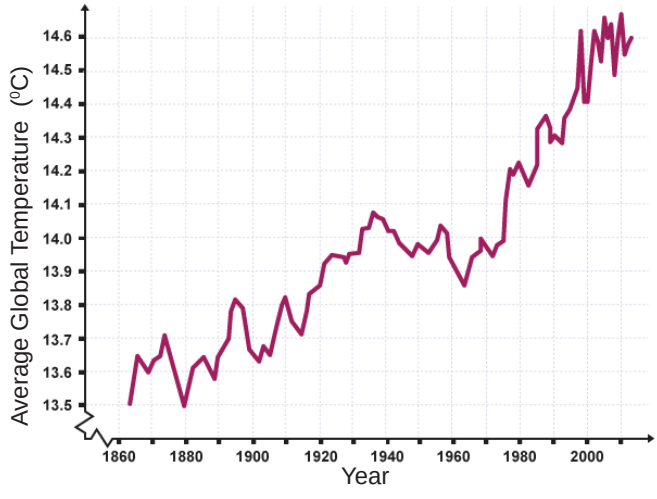


Figure 18.26 – The change of average temperature from 1860 to 2000 in the world

From the above graph it is clear that the average temperature of the world has increased during this period. Scientists indicate that a main reason for this increase in temperature is the greenhouse effect.

Generally, during day time the Earth gets heated up by sun rays. During night, heat is lost to space, so the Earth gets cooled. But, since the carbon dioxide gas and water vapour in the atmosphere absorb and retain a part of the heat released from the Earth, they help to keep the Earth warm. This is called the greenhouse effect. This effect creates favourable environment for the living beings on the Earth.

However, because of the increase in the concentration of greenhouse gases such as carbon dioxide, methane, Nitrogen dioxide sulfur dioxide, the temperature of the Earth is gradually increasing. In addition to the gases mentioned above, ozone and chlorofluorocarbons (CFC) also contribute to the greenhouse effect.

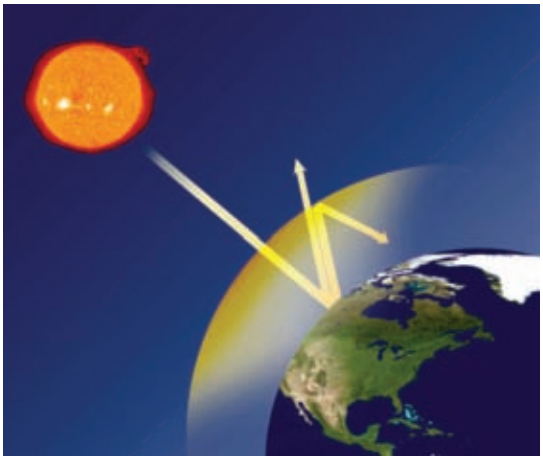


Figure 18.27 - Green house effect

The ways by which greenhouse gases are added to the environment

- Release of carbon dioxide by volcanic eruptions, thermal power plants and combustion of fuels in vehicles
- Release of methane from heaps of garbage, marshes etc.
- Release of CFC from refrigerators, air conditioners etc.

Global warming and cyclones

The graph in figure 18.28 indicates the change in the number of the incidence of cyclones in the world from 1850 to 2015.

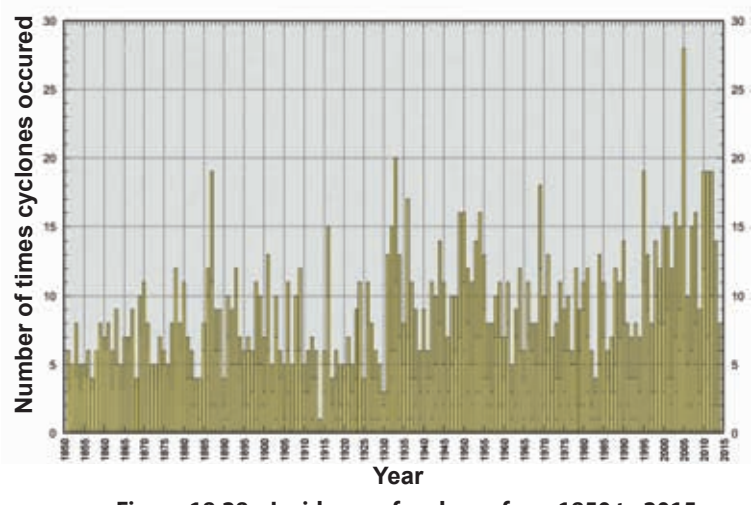


Figure 18.28 – Incidence of cyclones from 1850 to 2015

The above graph brings to light the fact that, the number of the events of cyclones in the world has gradually increased during this period.

Figure 18.29 is a histogram which depicts how the number of natural disasters changed during the period 1980-2010.

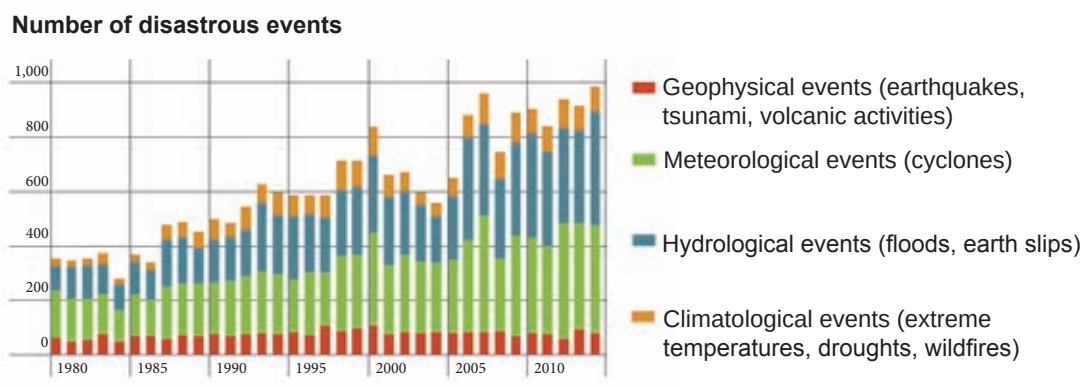


Figure 18.29 - Histogram which depicts the number of natural disasters during 1980-2010

The chart indicates that the number of natural disasters has gradually increased during this period.

From the above information it is clear that, there is a relationship between the increase in global warming and the increase in the number of natural disasters.

For extra knowledge

- During the period from 2000 to 2009, natural disasters have occurred three times more than the number of those occurred from 1980 to 1989.
- Globally, the number of natural disasters reported in 1970 was 78, whereas the number of those reported in 2004 was 348.
- During the period from 1980 to 2009, the number of natural disasters related to weather has increased by 80%.

What we can do to prevent the increase in global warming

- Forestation and conservation of forests
- Usage of public transport instead of private transport
- Consumption of more plant food and obtaining them from areas close to the residence
- Economizing electricity - using energy saving electrical appliances
- Reducing the amount of materials consumed daily
- Living a simple life style without using more materials
- Raising the awareness of others about the above facts

Summary

- The damage caused by natural disasters can be minimized by keeping vigilant over one's environment, use of standard safety methods and maintaining connection with media of communication.
- Because of the development of depressions in the atmosphere, cyclones and storms are created.
- Lot of damages to property and loss of lives have been brought about by cyclones from time to time in Sri Lanka.
- Earthquakes would be resulted when the crustal plates of the Earth move relative to one another.
- Tsunami is mainly caused by the lifting of oceanic water due to the earthquakes in the sea bed.
- Earthquakes and tsunami mainly occur in the regions associating with the borders of Earths' tectonic plates.
- In other countries wildfires break out due to natural causes. In Sri Lanka, the wildfires are occurred mostly due to human activities.
- It is considered that, the number of natural disasters increased due to the increase in global warming.

Exercises

(01) Select the correct or most suitable answer.

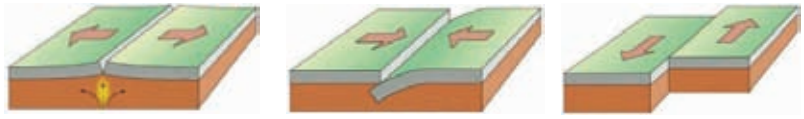
1. Which ocean associated with the earthquakes and tsunami that occur mostly?

   1. Atlantic
   2. Pacific
   3. Indian
   4. Arctic

2. The factor /factors causing a tsunami is/are,

   1. Earthquakes
   2. Volcanic eruptions
   3. Fall of meteorites
   4. Above all

3. Which option indicates the tectonic plate movements shown in the following figures respectively.

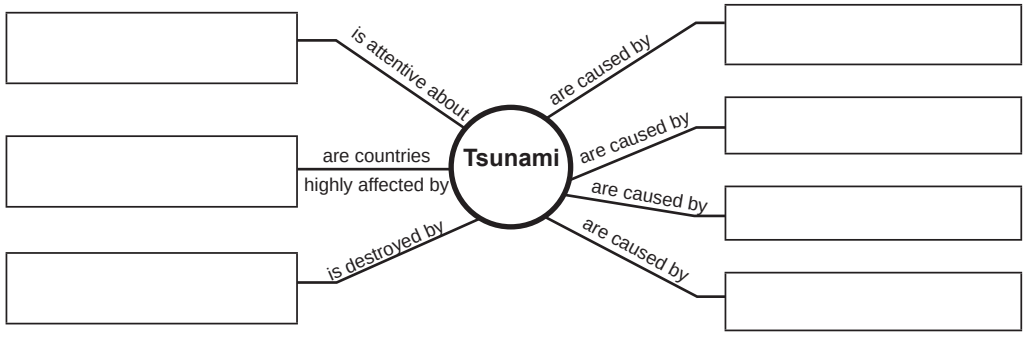


1. Convergent, divergent, slip border
2. Divergent, convergent, slip border
3. Slip border, convergent, divergent
4. Slip border, divergent, convergent

(02) Mark whether the following statements are true (√) or false (×).

1. Mangroves near the sea shore reduces the speed of tsunami waves. ( )
2. Greenhouse effect has an influence on the rise of sea level. ( )
3. In deep sea, the height of tsunami waves is about thousand meters. ( )
4. Cyclones occur on the equator. ( )
5. The direction of spin of the cyclones occurring in the Northern hemisphere is anticlockwise. ( )

(03) Insert the words/phrases given below into the rectangular boxes of the following concept map as appropriate



Words/phrases

Volcanic eruptions, coastal environment, earthquakes, earthslips under sea, fall of meteorites, Chile, Indonesia, Japan, Geology and Mines Bureau

(04) Two identical ships A and B were sailing in the sea. When ship A was sailing in deep sea and ship B was sailing in shallow sea, only one ship was damaged by an earthquake erupted in a distant place of the sea bed.

1. What is the phenomenon resulted by the earthquake which caused the ship damage?
2. Which ship, A or B got damaged ?
3. Explain the reason why the ship you mentioned above got damaged while the other was not.

Technical Terms

Cyclones	-	සුළි සුළං	-	சூறாவளி
Earthquakes	-	භූමිකම්පා	-	புவியதிர்வு
Tsunami	-	සුනාමි	-	சுனாமி
Wild fire	-	ලැව්ගිනි	-	காட்டுத் தீ
Depression	-	පීඩන අවපාතය	-	அமுக்க இறக்கம்
Storm surge	-	වාසුළි උත්සර්ජනය	-	சுழல் காற்று
Crust	-	කබොල	-	புவியோடு
Mantle	-	ප්‍රාවරණය	-	மென்மூடி
Core	-	හරය	-	அகணி
Tectonic plates	-	භූතැටි	-	புவித்தட்டு
Convergent border	-	අභිසරණ තැටි මායිම	-	ஒருங்கும் எல்லை
Divergent border	-	අපසරණ තැටි මායිම	-	விரியும் எல்லை
Slip border	-	තීර්යක් තැටි මායිම	-	வழுக்கும் எல்லை
Seismometer	-	භූකම්පන මානය	-	புவியதிர்வுமானி
Seismograph	-	භූකම්පන රේඛය	-	புவியதிர்வு வரையி
Asteroid	-	ග්‍රහකය	-	எரிகற்கள்
Wave length	-	තරංග ආයාමය	-	அலைநீளம்
Amplitude	-	විස්තාරය	-	வீச்சம்
Focus	-	නාභිය	-	குவியம்
Epicentre	-	අපිකේන්ද්‍රය	-	மேன்மையம்
Seismic Waves	-	භූකම්පන තරංග	-	புவியதிர்வு அலைகள்

19 Sustainable Use of Natural Resources

Name several things that you can see in your classroom. Find out and tabulate the basic things that used to make them. Compare the table you made with the table 19.1.

Table 19.1

Things in the classroom	Basic things used to make them
Wall	Bricks, cement, lime
Table and chairs	Timber, iron
Pens	Plastic, metal, ink
Pencils	Wood, graphite
Books	Paper
Bags	Cloth, metal, plastic
Water bottles	Glass, plastic

Find out about the natural substances that were based to make the things in the classroom. Tabulate your findings and compare your table with Table 19.2 given below.

Table 19.2

Substance	Natural substances based to make them
Bricks	Clay, water
Lime	Limestone
Cement	Limestone, clay, gypsum
Timber (Wood)	Plants
Iron	Iron ore
Plastic	Petroleum (mineral oils)
Paper	Plant fibre
Cloths	Plant material, petroleum
Glass	Silica sand (minerals)

Study well, the things given in the second column of the table 19.2. Those are known as **natural resources**.

Natural resources are the substances generated naturally, without the influence of human activities.

There are some basic natural resources.

- Water
- Minerals and rocks
- Plants
- Timber

The conservation of water for the future generation while we are using water today is known as sustainable utilization of water.

Now let us find out about these resources in detail.

19.1 Water

Man cannot live without air more than few minutes. Further, he cannot survive without water more than a week. Thus, the second most important resource on the Earth is water.

The base of life on the Earth is water. When finding life on other planets, scientists find whether there is water on them. The reason for this is that the life we know is based on water.

Figure 19.1 – Some uses of water

Assignment 19.1

Make a list of some other uses of water, that can be added to the above diagram and present it creatively.

How water is used sustainably in the past

The natural way that the Earth's surface gets water is the rain. If rain water is not properly used, it flow through rivers and streams upto the sea. It was the slogan of great king 'Parakramabhahu', that "Even a single drop of water should not be allowed to flow into sea without being used by man or animals".

A water tank can be introduced as a great creation of our ancient ancestors, used for conservation and sustainable use of water.

Figure 19.2 (a) - 'Parakrama samudraya'

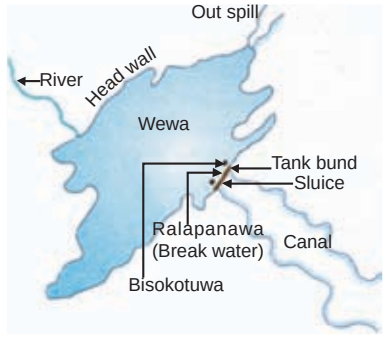


Figure 19.2 (b) - Important parts of a tank

A reservoir or a water body that is constructed by building a dam across a river or a stream is known as a 'wewa'.

There are evidences to prove that Sri Lanka had a unique irrigation technology, uncomparable to any other country in the world. Even now we have more than 12 000 large and small 'wewa' and embankments that irrigate the farmlands of our country.

Assignment 19.2

Find the special terms used for the components related to 'wewa' and make a report.

If there is no air pollution, the purest water that we can receive, is the rain water. Now in Sri Lanka, as well as in some other countries, rain water is collected to be used.

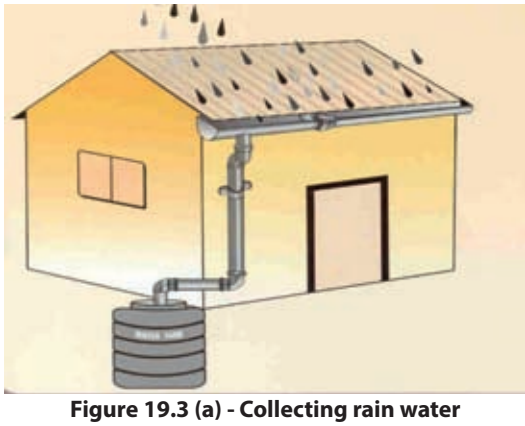


Figure 19.3 (a) - Collecting rain water

Figure 19.3 (b) – Using collected rain water

Rain water collection in domestic level is very important for the people in small islands like maldive islands, where there are no natural reservoirs.

Activity 19.1

Create a model to collect rain water, draining from the roof into a tank. Use the Figure 19.3(a) for this.

In dry zone, for the economical use of water in agriculture, clay pots filled with water are buried near the plants.

Try this method in your home garden also.

Scientist forecast that pure water will not be available for the people in the world in near future if recycling and reuse of water is not put into practice.

Figure 19.4 – Economical use of water in agriculture

Assignment 19.3

Construct a poster or make a booklet including the steps that can be followed to use tap water in an economical way.

Now let us study about minerals and rocks which can be considered as another natural resource.

19.2 Minerals and rocks

A mineral is an inorganic solid substance with a definite chemical composition having a crystalline shape. Minerals occur naturally in our environment.

Figure 19.5(a) – A crystal of gem

Figure 19.5(b) – A giant crystal of quartz

Some useful minerals found in Sri Lanka are graphite, quartz, ilmenite, rutile, zircon, feldspar, apatite and silica sand.

A rock is a collection of minerals

e.g. Gneiss, Granite

Some rocks are made of a single mineral.

e.g. Limestone, Quartz

The map in figure 19.6 shows the locations of largely found minerals resources of Sri Lanka.

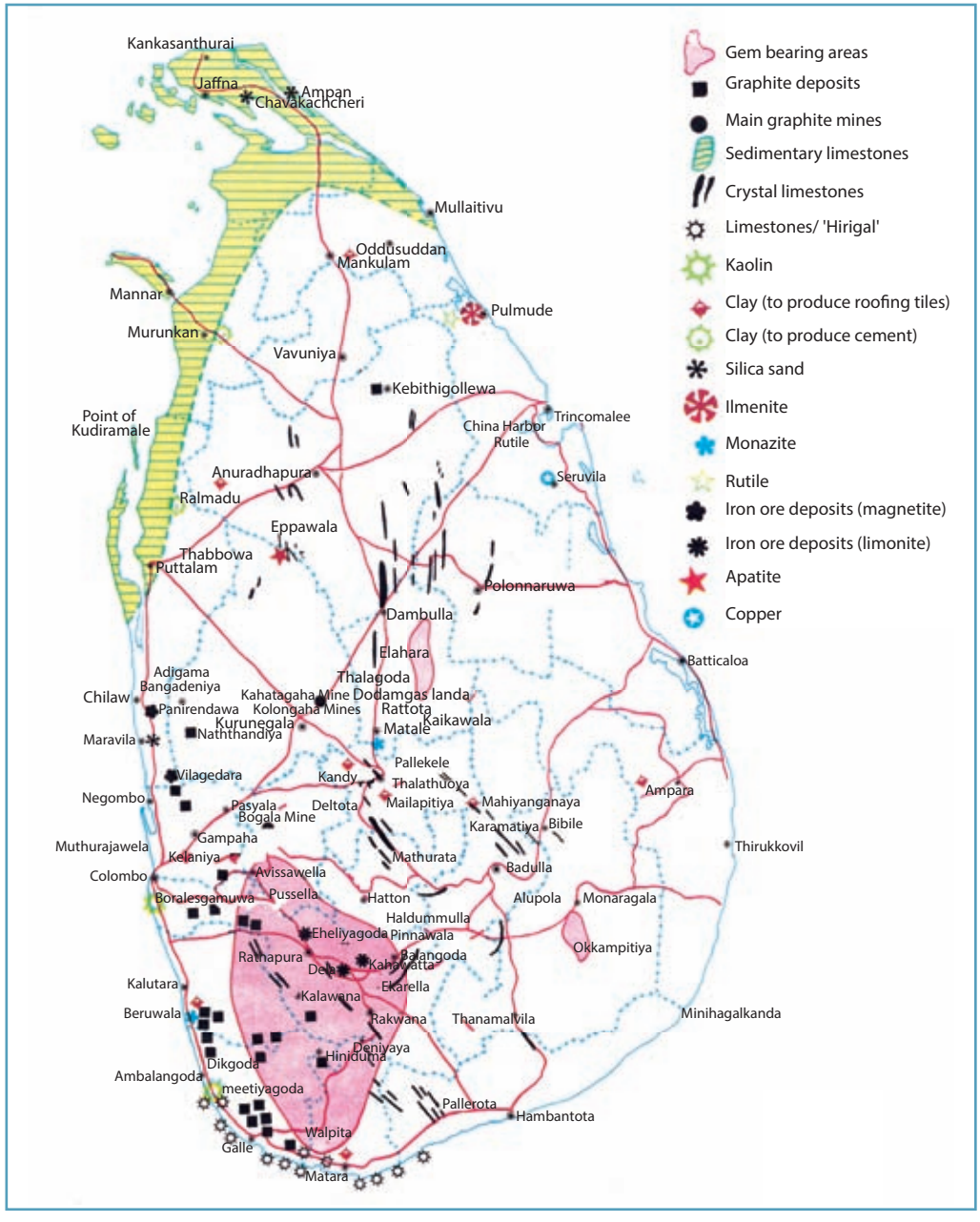


Figure 19.6 – The map which display the location of minerals in Sri Lanka

Source - The National Map Collection of Sri Lanka, School Edition, Survey Department

Assignment 19.4

Study the map carefully. Name 10 sources of minerals and rocks found in Sri Lanka. Mention the places where each of those resources are found. State an industry where each of those resources are used.

For extra knowledge

There are about 5 300 minerals identified in the world up to date. Number of minerals registered in the International Union for Minerals is about 5 070.

Sri Lanka exports most of its mineral resources not as end products, but as raw materials. Therefore, we get only the raw material value of those minerals, though our country is rich in minerals.

Now let us study about gems which are very important among the minerals found in Sri Lanka.

19.2.1 Gems

Gems are a sort of mineral crystals which are used in making jewellery after cutting and polishing.

Gem industry in Sri Lanka has a history of more than 2 500 years. There are more than 200 kinds of gems identified in the world. It is amazing to mention that, more than 70 types out of them are found in our small island.

Blue Sapphire is named as the national gem of Sri Lanka.

Figure 19.7 - Blue Sapphire

Assignment 19.5

Make a list of the kinds of gems found in Sri Lanka.

Sri Lanka is the only country that export high quality large blue sapphire with natural colour to the world market.

Gem mining

Gems are formed in the Earth, attached to large rocks. As the rocks in the mountains get eroded, gems detach from them. Those gems then carried away with rain water and are buried in plains of down hill. The deposit of gems and other pieces of rocks is known as the vein of 'illama'.

First a proposed place for gems is selected and the mine, which is like a pit is dug. When the vein or 'illama' is found, horizontal tunnels are excavated. Mixture of substances collected from the vein is taken out of the mine and is sifted to separate gems.

Figure 19.8(a) – A gem mine

Figure 19.8(b) – Sifting of gems using a sifting pan

Activity 19.2

Demonstration of gem sifting method

Method :-

Get a milk strainer woven of bamboo peels as a small substitute for a gem sifting pan. Using it, sift a mixture of soil, sand and small pieces of pebbles, to separate the pebble from the rest (even a separating pan made of clay can be used for this).

Characteristics of gems

Some important characteristics of gems are mentioned below.

- Hardness
- Resistance to be worn out
- Colour
- High refractive index

An unerasable streak can be drawn on a sheet of glass using a piece of quartz. The reason for this is that the hardness of quartz is higher than that of glass. Mohr's Scale is prepared to compare the hardness of minerals. Hardness index 10 is assigned for diamond, which is the hardest mineral. Hardness index 01 is assigned for talc, which is the least hard mineral.

Table 19.3 - Mohr's Hardness Scale

Hardness index	Substance
01	Talc
02	Gypsum
03	Calcite
04	Fluorite
05	Apatite
06	Feldspar
07	Quartz
08	Topaz
09	Corundum
10	Diamond

Study the Table 19.3 and answer the following questions.

1. Hardness index of finger nail is 2.2. Name two minerals that can streak a finger nail.
2. Hardness index of a pile is 6.5. Name three minerals that cannot be streaked by a pile.

Gems like blue sapphire, Ruby, Topaz and yellow sapphire found in Sri Lanka belong to the Corundum family.

Gems do not ware out because of their hardness. Gems are used as bearings in mechanical watches because of their resistance to be worn out.

Figure 19.9 – Gems used in a mechanical watch

Figure 19.10 – Gems of various colours

Gems found in Earth are of various colours. Gems acquire their characteristic colour because of the trace impurities trapped in them, while they are forming in the Earth. Colour is a main factor that increase where an impurity caused to increase the value of a material. Hence, this is rare instance, where the value of a material increases when mix impurities.

Refractive index of gems is used to identify them scientifically.

When a light ray enters from one transparent medium to another transparent medium, its pathway changes at the interface. Refractive index is a measurement of that change. Refractive indices of some transparent substances are given in the table 19.4.

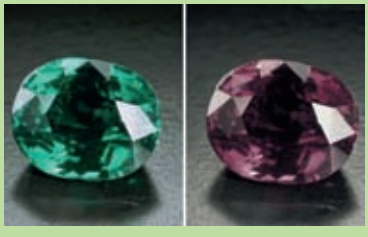
Table 19.4 – Refractive indices of some substances

Substance	Refractive index
Water	1.3
Glass	1.5
Topaz	1.6
Blue sapphire	1.7
Diamond	2.4

Because of high refractive index of gems, light rays are reflected repeatedly when they are entered through the cut and polished gems. This gives a shine to the gem.

For extra knowledge

Gems with special characteristics



Alexandrite
Emit green colour in natural light and red colour in artificial light.

Cat's eye
When this gem is cut in a special pattern, it looks like a cat's eye in light.

Star sapphire
When this gem is cut in a special pattern, six lines of light are visible in it.

Though gems are beautiful and attractive, various problems have raised because of gem industry.

Problems associated with gem industry

- Soil erosion because of irregular mining.
- Mud deposition and water pollution in streams and water bodies, which are used for gem sifting.
- Sudden depression of land and land slides occur due to over mining in some areas.
- Extinction of fauna and forest cover depletion due to mining in forest areas.

- Reduction of crop production as most of gem mining is done in paddy fields.
- Collapsing of river banks due to mining near river banks.
- Spreading of some diseases like dengue, because of the breeding of mosquitoes in abandoned gem pits.
- Decreasing of the population of certain trees like coconut, rubber and bamboo because of their usage in gem mines to avoid collapsing of fits and tunnels.
- Existence of social discrimination between the owners and the workers of gem mines, because of the difference of their income level.
- Absence of a permanent way of income for the labourers as gem mining industry is not done uniformly through out the year.
- Deterioration of educational status of relevant area due to the attraction of youngsters to gem industry.

National Gems and Jewellery Authority has taken certain measures to solve some of the above problems associated with gem industry. When issuing permits for gem mining, a cash deposit has to be made. If gem pits are abandoned without filling government utilize the money deposited to fill the abandoned gem pits.

19.3 Trees

Voluntary contribution of school children is taken for replanting those areas.

Plants as a natural resource from cradle to grave, man extensively uses plants. Some services rendered by plants to man and environment are shown in figure 19.11.

Study figure 19.11 well and answer the following questions.

1. Mention five **material benefits** provided to man by plants which are shown in the figure.
2. Mention five **non-material benefits** shown here.
3. Write three **benefits** provided to man by plants, which are **not mentioned in the figure**.

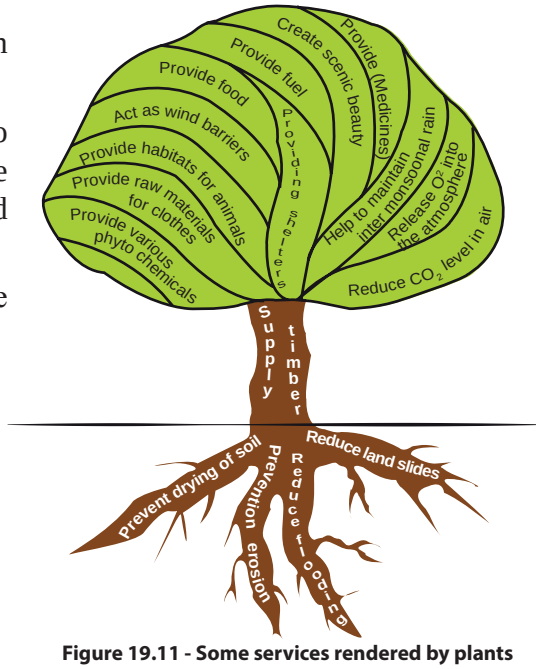


Figure 19.11 - Some services rendered by plants

Some services given in figure 19.11 are provided by all plants.

e.g. Release oxygen to the atmosphere, removal of carbon dioxide from air

There are specific plants for certain activities or services. Information on such plants are given in table 19.5.

Table 19.5

Supply food	paddy, wheat, corn, pulses, yams, fruits, vegetables
Provide drinks	tea, coffee, 'Polpala'/'Thengapookeerai', 'Ranawara'/'Ponnawarasu', wood apple
Supply fuel	coconut, rubber, *Gliricidia*
For scenic beauty	Flowers and other horticultural plants
For medicine	'Aralu'/'Kadukkai', 'Bulu', 'Nelli'/'Nellikkai', 'Katuvelbatu', 'Venival'/'Maramanjal', margosa etc.
Chemicals	'Kekuna'/'Pakkili pal', pinus, 'Gammalu'/'Thanakku', agarwood (Vallapatta)
Raw materials for clothes	cotton, jute, malberry
To manufacture paper	paddy, pinus
Supply spices	coriander, curry seed, turmeric, 'Goraka'/'Koraka puli', cumin seed
Beauty cultural substances	turmeric, 'Cocum', sandle wood, *Aloe*

Assignment 19.6

Display common names and scientific names of plants/trees grown in school garden, in a suitable manner. Do not harm trees when labelling them.

19.3.1 Timber

The oldest building material is timber. Timber is the only building material that is recyclable and renewable. Some special characteristics of timber are as follows.

- Durability
- Resistance to heat, electricity and sound
- Ability of creating attractive patterns due to the streak and the colour

Ancient times, Sri Lanka was famous for valuable timber. Timber like ebony, satin wood and calamander wood which were in the dry zone of our country, were extensively used by colonial rulers to manufacture furniture. Now such types of timber are very rare in the country.

Therefore, the existing amount of timber should be used with maximum efficiency. Selection of timber, according to the durability, which is needed for different uses of timber, will lead to a sustainable utilization of timber that brings economical advantage.

Diversity of timber in Sri Lanka is very high. We have more than 400 kinds of plants in our country, that can be used for timber.

Assignment 19.7

Take leaves of plants in your area that can be used for timber. Insert the leaves between two pages of paper to press. Make a booklet using pressed leaves (make sure not to harm the plants when taking leaves).

For extra knowledge

State Timber Corporation has more than 250 samples of Sri Lankan timber.

Satin wood | 'Nedun'/ 'Samandalei' | 'Colon'/ 'Mansal kadampu' | 'Kumbuk'/ 'Marudha' | Mango

Activity 19.3

Study of various types of timber

Method :-

- Collect samples of various types of timber.
- Note down their colour.
- Test whether they have any odour.
- Find out the uses of those types of timber.
- Find out whether there is any specific use of any of those types of timber.
- Present your findings attractively.

Specific use of some types of timber

Each types of timber is used for specific purpose according to its properties. Some examples are given below.

- **Jak** timber is used for front doors of houses because of its strength, durability and shine.
- **Persian lilac ('Lunumidella')** timber is used for ceilings because it is very light.
- **'Panakka'** timber is used for making umbrellas because the stem of panakka is thin and strait.
- Ancient times pegs made of **agar wood ('Vallapatta')** timber are used to split granite rocks.
- **'Hora'** timber is used for underwater structures because it last long under water.

- **'Rukattana'/'Elilaippalai'** timber is used to carve masks because of the lightness and workability.
- **'Paaramara'** timber is suitable to make the frame of "rabana" because of its lightness and sonorousness.
- **Alexandrian lawrel ('Domba')** timber is resistant to vibrations, bending and twisting. Therefore it is used for masts of yachts, neck-pole of bullocks carts and yoke pole of ploughs.

For extra knowledge

Wooden bridge of Bogoda

This bridge is located at Hali-Ela in Badulla district. Even though it is about 400 years old, still it is in use.

Wooden bridge of Bogoda

Jak and **'Kumbuk'** timber were used to construct this bridge. Wooden nails were used to connect its beams. **Ebony** and **'Milla'/'Kattamanakku'** timber were used for its wood carvings.

Assignment 19.8

Prepare a collection of information about plants used for specific purpose. Get the assistance of the elders of your area for this task.

Decaying of timber

Fungi can grow inside the timber. Timber is decayed because of the degradation of complex carbohydrates which timber are made of due to the activity of enzymes secreted by those fungi.

Fungi can retain inactively, even for many years inside timber. They grow when favourable conditions are available. Such favourable conditions are the presence of oxygen, moisture and nutrients. Out of those, the most important factor is the moisture. Though other factors are available, fungi do not grow in the absence of moisture.

Food is stored in some cells of tissues of timber. Timber can be destroyed by termites and weevils who come in search of food.

Figure 19.12 (a) – Fungi that grow on timber

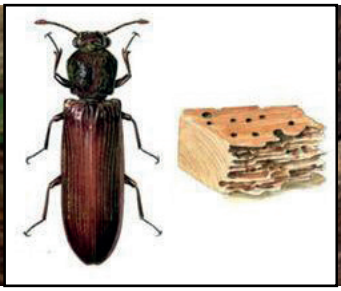


Figure 19.12 (b) – Weevil that bores timber (enlarged)

Figure 19.12 (c) – Termites that make timber decay

Prevention from timber being decayed

Long lasting types of timber were abundant in ancient Sri Lanka. Therefore, timber preservation methods are not necessary.

With the increase of human population and human needs, such types of timber have become very rare, due to over usage.

For example timber like ebony, 'Nadun' and Teak are now classified as luxurious types of timber.

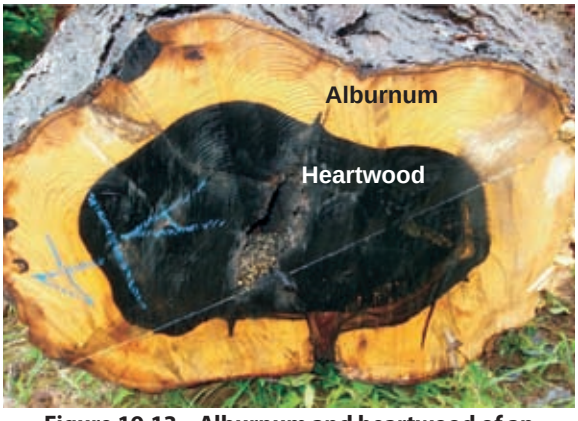


Figure 19.13 – Alburnum and heartwood of an Ebony tree

Therefore, we are compelled to use fast growing types of timber like rubber, Persian lilac, mango, alstonia, eucalyptus and pinus. But, such types of timber do not last long in the environmental conditions of our country. They are easily damaged by insects and fungi. Therefore, we have to use wood preservative methods.

Generally the heartwood of a tree lasts longer than its alburnum. Therefore, heartwood of a tree should be used when making furniture to minimize them from decaying.

Now let us find out how decaying of timber can be prevented.

Methods of preventing the timber decay

- Prevention of absorbing moisture into timber
- Seasoning of timber
- Usage of wood preservatives

Prevention of absorbing moisture into timber

Moisture absorption into timber can be prevented by applying enamel paint on them.

e.g. Enamel paints are applied on school desks and chairs to prevent decay.

Seasoning of timber

Timber can be seasoned by allowing it to dry slowly in controlled conditions. Timber can be kept for long time by reducing the moisture content below 20%.

You can get a knowledge of this method by observing a timber stores or a carpenters workshop.

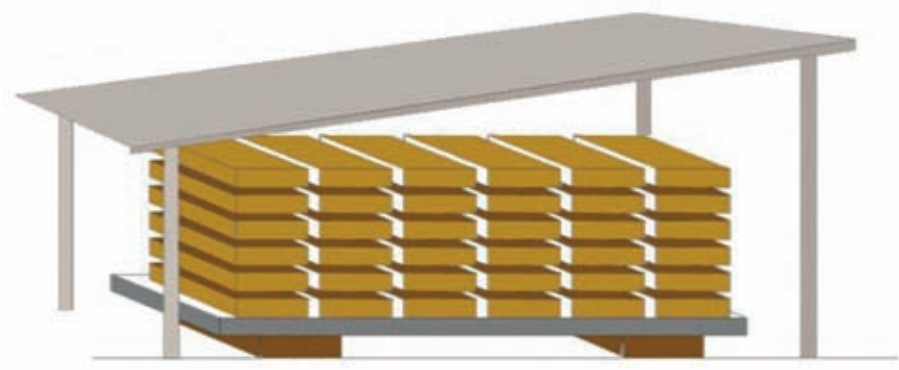


Figure 19.14 – Seasoning of timber

Usage of wood preservatives

Timber can be preserved for a long time by soaking in suitable chemicals.

One such chemical is creosote, which is extracted from coal. This chemical is used by State Timber Corporation when they are treating sleepers for railway lines and wooden electrical posts.

Figure 19.15 (a) – Sleepers on railway line

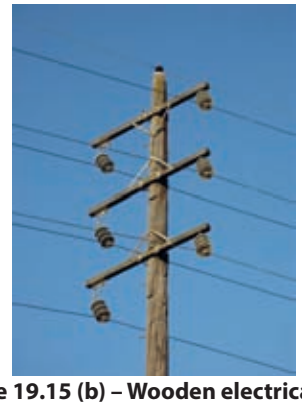


Figure 19.15 (b) – Wooden electrical posts

Boron treatment is done for the longer life of rubber and pinus timber. Here the timber is soaked in a mixture of boric acid, borax and a fungicide.

Forest conservation is promoted by proper usage and preservation of timber. Increasing the lifetime of timber can be reduced tree felling.

Water, minerals and rocks, plants and timber are ours valuable resources. Therefore, it is our responsibility to use them sustainably, while leaving their potential of existence for the generations to come.

Summary

- Water, minerals and rocks, plants and timber are some examples for natural resources.
- Construction of 'wewas' and using rain water collected in tanks are two methods practiced by man for sustainable use of water.
- Minerals like gems are separated from other soil particles by sifting.
- Hardness, resistance to be worn out and high refractive index are some identical properties of gems.
- Gem pits have adversely affected the environment and man.
- A large number of plants that can be used for various purposes are found in Sri Lanka.
- Hundreds of timber plants are found in Sri Lanka and are used for various purposes.
- Timber is destroyed by fungi and insects.
- There are several methods to prevent decaying timber.
- Natural resources should be used sustainably for the fulfilment of the future generations.

Exercises

(01) Select the correct or most suitable answer.

1. What can be a mineral, out of those given below?
   1. Coal 2. Mineral oil 3. Apatite 4. Gneiss
2. The uses of graphite are,
   1. Manufacturing pencil rods 2. Manufacturing electrodes of electrical cells
   3. Using as a lubricant 4. All the above
3. Gems are valuable natural resource obtained from the Earth of our country, which one below is not a cause for its high value?
   1. Its beauty 2. Its hardness
   3. Its rareness 4. Being a mineral
4. What is the national gem of Sri Lanka?
   1. Blue sapphire 2. Yellow sapphire 3. Tourmaline 4. Cat's eye

5. Which one is the order, when graphite, gems and quartz are arranged in the descending order of their hardness?

1. Gems, graphite, quartz
2. Gems, quartz, graphite
3. Quartz, gems, graphite
4. Quartz, graphite, gems

(02) Give short answers.

1. What are natural resources?
2. Why scientists pay attention to water, when they are in search of life on a certain planet.
3. What is the purpose of building tanks ('wewas') in dry zone?
4. What is the type of water that exists in nature in its purest form?
5. Mention three characteristics of pure water?
6. Is granite a mineral or a rock? Give reasons for your answer.
7. What is the special property of gems, that leads to its separation method of sifting?
8. Mention three adverse effects to the environment caused by the gem industry?
9. What is the plant in Sri Lanka, that a maximum number of uses can be obtained from? Mention five plant parts of it and their uses.
10. Mention one specific use that can be obtained from each of following types of timber.

i. Agar wood ('Wallapatta') ii. 'Paremara' iii. Alexandrian laurel ('Domba')
iv. 'Rukattana' v. Persian lilac ('Lunumidella')

11. Write one difference that you can observe between the heartwood and alburnum of the stem of a plant.
12. Persian lilac ('Lunumidella') timber floats on water while ebony timber sink. Thus arrange persian lilac timber, ebony timber and water according to the ascending order of their densities.

Technical Terms

Natural resources	- ස්වාභාවික සම්පත්	- இயற்கை வளம்
Sustainable use	- තිරසර භාවිතය	- நிலைபேண் பயன்பாடு
Hardness	- දැඩිබව	- வன்மை
Refractive index	- වර්තනාංකය	- முறிவுச்சுட்டி
Recycling	- ප්‍රතිචක්‍රීකරණය	- மீள்சுழற்சி
Regenerative	- පුනර්ජනනීය	- மீளுருவாக்கம்
Seasoning of timber	- දැව පදම් කිරීම	- மரம்பதனிடல்
Wood preservatives	- දැව ආරක්ෂක	- அரிமர நற்காப்பு பதார்த்தங்கள்
Wood preservation	- දැව ආරක්ෂණය	- மரக்காப்பு