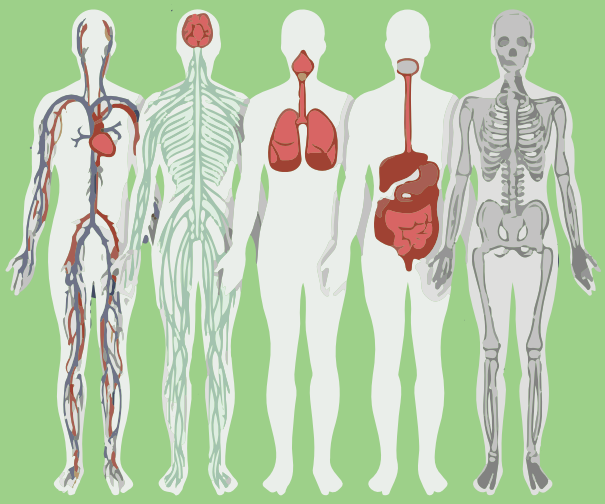
General Science

Student Textbook







Grade 8

General Science

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UNIT ONE

BASICS OF SCIENTIFIC INVESTIGATION

Learning Outcomes:

At the end of this unit, You will be able to:

- identify the basic and derived units of measurements;
- explain the concept of measuring physical quantities;
- describe the components of a scientific investigation;
- demonstrate ability to work effectively and respectfully with others in performing fair testing.

Main contents

1.1 Scientific Measurments

1.2 Doing Scientific Investigation

Introduction

This unit contains two sub units: scientific measurement and doing scientific investigation. Under scientific measurement the indigenous and modern methods of measurement, the classification of physical quantities into fundamental and derived quantity and the difference between accuracy and precision will be discussed. Under doing scientific investigation, the importance, procedures and ethical issues of a scientific investigation will be discussed. Finally using locally available materials, a simple investigation will be conducted.

1.1 Scientific Measurements

At the end of this section, you will be able to:

- explain the concept of measuring physical quantities;
- describe the various indigenous methods of measurement;
- distinguish between the basic and derived physical quantities;
- categorize the basic and derived units of measurements (length, mass, time, temperature, volume, area, density, force);
- identify prefixes and perform conversions among units of measurements;
- distinguish between accuracy and precision in measurements.

Introduction

Making observation is common experience in science. Similarly, it is usual asking the basic questions like how big an object is? How tall are you? To answer these questions, measurements have to be made. Measurement is the process of obtaining the magnitude of a quantity relative to an agreed standard.

In this section both the indigenous and modern methods of measurement will be discussed. The indigenous method of measurement refers to a measurement practiced locally while the modern method refers to a measurement applied by the scientific community.

Indigenous Methods of Measurements

An indigenous method of measurement refers to measurement methods that are practiced locally for a long period of time and are passed from generations to generation. In this section, we will pay attention to the measurement of length, mass, and time.

A. Length

Length is a measure of the distance between two points. In Ethiopia we use different indigenous units of length measurement. The commonly used ones are:

1. **Hand-span:** The hand-span is the measure from the tip of your little finger to the tip of your thumb when your hand is stretched out, Fig 1.1 (a).
2. **Digit:** A digit is the width of an adult human male fingertip, Fig 1.1 (b).
3. **Cubit:** A measure of distance from the tip of one's elbow to the tip of the middle finger when your arm is extended, Fig 1.1 (c).
4. **Foot:** A measure of distance from the back of the heel to the tip of the big toe, Fig 1.1 (d).
5. **Pace:** A linear distance measure of a person's extended walk. A pace is a unit of length consisting either of one normal walking step. The pace is the distance measured from the heel of one foot to the heel of the same foot when it next touched the ground, Fig 1.1 (e).
6. **Arm span:** Arm span also known as fathom is the distance from the middle fingertip of the left hand to that of the right hand when you stretch your arms out as far as they can reach, Fig 1.1 (f).

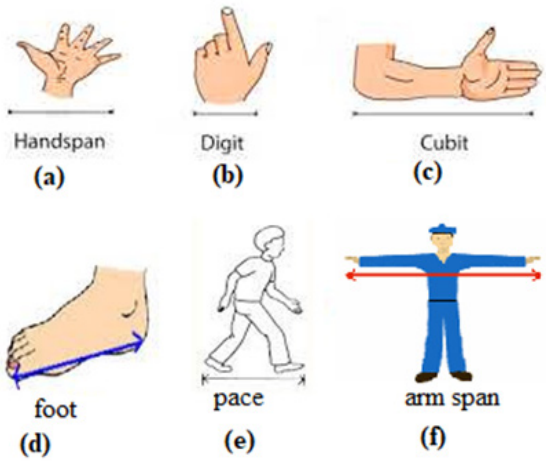


Figure 1.1 Indigenous Measurement Length

Activity 1.1: Make a group containing 5 students. Using your hand span, cubit and digit measure the width of a table or a desk in your classroom. Record your measurement in the table below.

No	*Name of the student making measurement*	*Measurement result*
1		
2		
3		
4		

Question: Did each of you obtain the same measure for that table or desk? Justify the difference of students' measurement.

Exercise1.1: Compare the size of your hand-span,digit,cubit,foot,pace and arm-span and write them in order of increasing value.

B. Mass

The amount of matter present in a substance is called mass. Like length, there is also an indigenous method of measuring mass. The following are some examples of the indigenous unit of mass measurement used in Ethiopia.

1. **Weqet-** Weqet is a mass measuring unit usually used to measure the mass of powder of gold in local markets.
2. **Quntal –** Quntal (may be taken from the English word quintal) is a bag used to measure the mass of grains. It is equal to a hundred kilogram.
3. **Feresula:-** is used to measure the mass of pepper and coffee. It is equal to 17 kilogram.



Figure 1.2 Indigenous mass measurements

Exercise 1.2:

Discuss about the reliability of the above three indigenous mass measuring methods.

C. Time

Time is the measure of the duration for an interval.There is also an indigenous method of measuring time. Our elders were used the shadow of a tree to measure time. As the position of the Sun changes from morning to evening the length of the shadow of a tree varies. In the morning and late in the afternoon, the length of the shadow is high. At noon when the Sun is overhead no shadow will be seen.

Using this fact they could tell the approximate time of the day by just looking at the position of the shadow of a tree found at or near their home.

Activity 1.2:

Using a long tree found in your school, mark the time at different height of the shadow of the tree. Use this shadow clock for some time. Discuss your observation.

Project 1.1: In ancient time three commonly known time measuring devices were used: They are known as sundial, sand clock and water clock. Using internet and other sources explore how these devices were used to measure time and report your finding to the class.

D. Volume

Volume is the measure of the space occupied by an object. In the local markets of Addis Ababa the following tools are used for different size volume measurements.

1. **Jog:** A plastic cup used for measuring the volume of liquids.
2. **Tassa:** A can used to measure cereals, pulses ,liquids and solids.
3. **Sini:** A small ceramic cup often used for measuring coffee, pulses and spices.
4. **Birchiko:** A glass often for measuring pulses and liquids.
5. **Kubaya:** A mug, often used for measuring cereals, pulses and liquids.



Figure 1.3 Some examples of Indigenous volume measurements

Exercise 1.3:

1. Discuss about the problems there could be in using the above indigenous volume measuring devices.

2. Discuss in group about the pros and cons of indigenous measurements used in your locality

Project 1.2: With the help of your teacher go to the local market found near to your school. Gather information about the indigenous measuring devices used for different measurements in the market. You can also ask your elder family members and present a report to your classmates.

Physical Quantities and Scientific Methods of Measurement

In our day to day life, we measure many things such as the mass of vegetables, the volume of liquids, the speed of a car, the temperature of the day etc. Such quantities which could be measured are called **physical quantities.** A physical quantity is a property of an object that can be measured or calculated from other physical quantity. Examples of physical quantities are: length, mass, time, temperature, area, volume, density, force etc.

Generally, physical quantities are classified into two types, namely: fundamental quantities and derived quantities

1.Fundamental Physical quantities and their units

Fundamental quantities, also known as base quantities, are quantities which cannot be expressed in terms of any other quantity. They are the bases for other quantities. There are seven fundamental (basic) physical quantities: length, mass, time, temperature, electric current, luminous intensity and amount of a substance.

In this section we will discuss only about the first four commonly measured fundamental quantities: length, mass, time and temperature. The names and symbols of the units of the fundamental quantities in the International System of units (SI) are shown in table 1.1.The International System of Units (SI, abbreviated from the French Système international (d'unités)) is a system of measurement based on base units. An International System of units (SI) is currently used all over the world.

Measurement is the comparison of an unknown quantity with some known quantity. This known fixed quantity is called a **unit.** Thus, the result of a measurement is expressed in two parts. One part is a number and the other part is the unit of the measurement. For example, if a student has a mass of 32 kg:

the quantity being measured is mass, the value of the measurement is 32 and the unit of measure is kilograms (kg).

This tells us that any measurement consists of two parts. The first is the number which indicates the magnitude of the quantity and the second indicates the unit (standard) of that quantity.

Units can be classified into two groups: fundamental units and derived units. The units used to measure fundamental quantities are called fundamental units. It does not depend on any other unit.

Table 1. 1 Fundamental quantities and their SI units

Quantity	**Name of Unit**	**Symbol of the unit**
Length	Meter	m
Mass	kilogram	kg
Time	Second	S
Temperature	Kelvin	K

2.Derived Physical Quantities and their Units

Physical quantities which depend on one or more fundamental quantities for their measurements are called **derived quantities.** Speed, area, volume, density and force are examples of derived quantities. The units used to measure derived quantities are called **derived units.** It depends on fundamental units for their measurement. SI derived units are described by mathematically combining (dividing, multiplying or powering) the base units. Some of the derived quantities and their units are given in table 1.2.

Table 1. 2 Derived quantities and their SI units

No.	Derived quantity	Symbol	Unit
1	Area	A	$m \times m = m^2$
2	Volume	V	$m \times m \times m = m^3$
3	Speed	V	m/s
4	Density	ρ	Kg/m^3

Example 1.1: Show how the unit of (a) area and (b) speed is derived from the fundamental units.

Solution:

(a) The equation for the area of rectangular surface is

Area = length x width.

Both length and width are length measurements. Hence they are measured in meter.

Unit of area = unit of length x unit of width

Unit of area = m x m = m^2

(b) The equation for speed is

Speed = distance/time

Thus the unit of speed is the unit of distance (m) over the unit of time (s) = m/s

Activity 1.3: Discuss in group about the importance of scientific measurement to the study of science. Let the representative of your group present what you have agreed to your classmate.

Exercise 1.4: Show how the units of the following derived quantities are derived from the unit of base quantities. (a) volume, (b) density and (c) force.

Prefixes and Conversion of Base Units

Prefix

In science we deal with quantities which are both very large and very small. A short hand form of writing very large and very small numbers is known as a **prefix.** A few of the prefixes used in the SI system of units are shown in Table 1.3.

Table 1.3. prefixes

Prefix	Symbol	Name	Decimal representation
Mega	M	million	1 000 000
Kilo	k	thousand	1 000
Centi	c	hundredth	0.01
milli	m	thousandth	0.001
micro	**μ**	**millionth**	0.000001

Conversion of base units

It is often necessary to convert between units of measurement. For example, a mass measured in grams may be required to convert into kilogram.

To convert from one unit to another within the SI, usually means moving a decimal point. If you can remember what the prefixes mean, you can convert within the SI system relatively easily by simply multiplying or dividing the number by the value of the prefix.

Example 1.2: Convert 6.5 kilogram (kg) to gram (g).

Solution: Since killo (k) is a prefix representing 1000, so:

6.5 kg = 6.5 × (1000) g = 6500 g

Example 1.3: Convert 200 meters to kilometers.

We know that 1 km = 1000m. Then we will ask if 1000m is 1km then what will be 200m in km?

Solution: 1 km = 1000 m

? = 200m ⇨ $200\,m = \frac{1\,km \times 200\,m}{1000\,m} = \frac{200\,km}{1000} = 0.2\,km$

Exercise 1.5

1. Convert the following:
   a) 0.6 km to cm b) 500 g to kg c) 30 min to hour
   d) 50 m to mm e) 0.25 kg to g f) 0.5 hour to second
2. Write the following quantities in units with the appropriate prefixes:
   a) 3500 m b) 0.0012 sec c) 0.01 g

Measuring Physical Quantities

The measurement of a physical quantity is done by using measuring instruments. In this section we will discuss how to measure mass, length, time, and temperature using their appropriate devices.

Measuring the mass of objects

Instruments which are used to measure mass are known as ***balances.*** The balance compares the mass of an object with a known mass. Different types of balances are there, see Fig 1.4.



Figure 1.4 Instruments Used to Measure Mass

Note that, before taking measurement check that the balance is on a level surface, and reads zero when no load is placed on it.

The SI unit of mass is **kilogram** (kg). For small mass we use gram (g). To measure the mass of objects less than 1 gram, we can use milligram. To measure the mass of big objects we use quintal and tone.

The relationship between different units of Length.
1 kg = 1000 g.
1 g = 1000 mg
1 quintal = 100 kg
1 tone = 1000 kg

Example 1.4: How much is 1200 gram in kilogram?

Solution: $1200\,g = 1200 \times \frac{1}{1000} kg = 1.2\,kg$

Exercise 1.6: Convert the following measurement:
(a) 2.5 kg to gram, (b) 200 gram to milligram.

Measuring Length

Length is a measure of how long an object is. Depending on the size of the length of the object, we are going to use different types of length measuring instrument, see Fig 1.5.

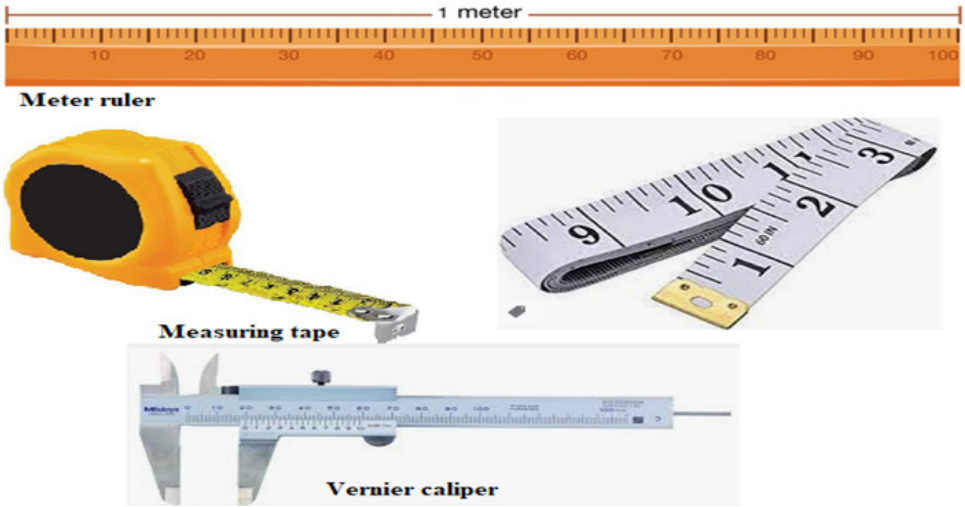


Figure 1.5 Instruments used to Measure Length

The SI unit of length is meter (m). When we want to measure larger lengths, we can use kilometers. If we want to measure small lengths, we can use centimeters or millimeters.

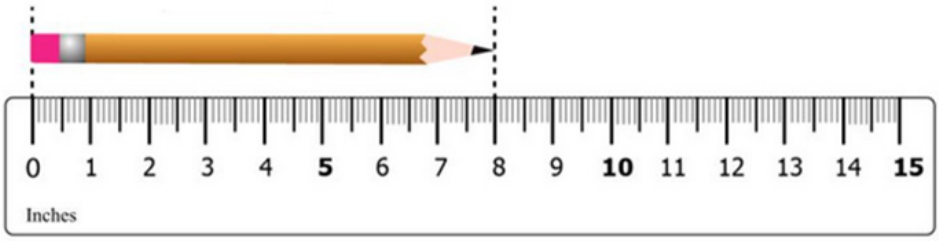
The relationship between different units of Length.

1km = 1000 m

1 m = 100 cm

1cm = 10mm

Note that when we are measuring length using these device do not forget to place the zero mark exactly at one end of the thing you are measuring and read the scale at the other end.



Example 1.5: How many millimeters are there in a meter?

Solution: 1m = 100 cm = 100 x 10 mm = 1000 mm

Exercise 1.7: Convert the following into the required measures:

(a) 8 meters to millimeter. (b) 5500 meters to kilometer.

Measuring time

Time is used to quantify the duration of events. Time is measured with a stop watch or clock.



Figure 1.6 Time measuring Instruments

The SI unit of time is second (s). For longer intervals of time we use: day, month , year, decades, century and millennium.

The relationship between different units of time

1 hour = 60 minutes
1 minute = 60 seconds
1 day = 24 hours
1 week = 7 days
1 year = 365 or 366 days

Example 1.6: Convert one hour into seconds.
Solution: 1 hour = 60 minutes = 60 × 60 second = 3600 seconds.

Exercise 1.8:
How many (a) minutes, and (b) seconds are there in one day?

Measuring Temperature
Thermometer is the device used to measure the temperature of an object or place. The SI unit of temperature is Kelvin. Degree Celsius (°C) and degree Fahrenheit (0F) are other units of temperature Thermometers could be analogue or digital, see Figure 1.7



Figure 1.7 Temperature Measuring Devices

Activity 1.4: Measuring body temperature.
- measure the body temperature of two students by using thermometer.
- Compare the two temperatures with the standard temperature of a body which is 37°C
- Discuss about your observations.

In using thermometer, hold the thermometer at the top, do not hold the bulb of a thermometer and do not let the bulb touch the glass.

Activity 1.5: Measuring the temperature of water.

- Using a laboratory thermometer, measure the temperature of a warm water.
- Record your observations

Safety!! Never put a laboratory thermometer into your mouth.

Accuracy and Precision in Measurement

Accuracy refers to how close a measurement is to its accepted or known value.

Example 1.7: If in a laboratory you obtain a mass measurement of 8.2 kg for a given substance, but the actual or known mass is 10 kg, is your measurement accurate?

Answer: This measurement is not accurate, because your measurement (8.2 kg) is not close to the known value (10kg).

Precision refers to how close two or more measurements are to each other, regardless of whether those measurements are accurate or not.

Example 1.8: In the above example 1.4, if you measure the mass of the given substance five times, and get 3.2 kg, 3.1 kg, 3.25 kg, 3.3 kg and 3.2 kg. Is your measurement precise?

Answer: This measurement is precise, because the values are close to each other but not accurate because it is far from the known value (10 kg). This shows that precision is independent of accuracy. You can be very precise but inaccurate. You can also be accurate but not precise.

Exercise 1.9: The figure below shows 3 results of a student playing a dart game. In the space provided below each figure, write whether the result is

(a) accurate but not precise
(b) accurate and precise
(c) precise but not accurate
(d) neither precise noraccurate

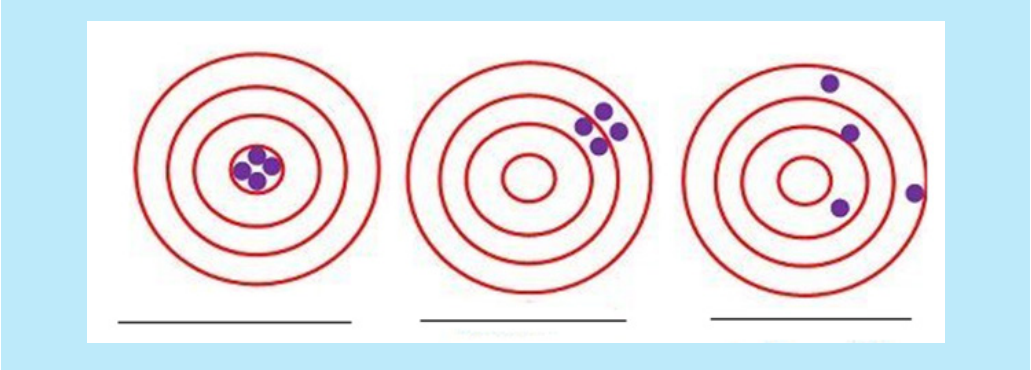


Figure 1.8 Dart game

Exercise 1.10:

1. Define the following terms: physical quantity, fundamental quantity, derived quantity.
2. State the various indigenous methods of measurement used in Addis Ababa.
3. What are prefixes?
4. What is the difference between accuracy and precision in measurements?

1.2 Doing Scientific Investigation

At the end of this section, you will be able to:

- describe the components of a scientific investigation;
- demonstrate ability to work effectively and respectfully with others in performing fair testing;
- practice scientific investigation procedures using appropriate contents to their age levels.

Introduction to Scientific Investigation

Science is a process of learning about the world through observation, inquiry, formulating and testing hypotheses, gathering and analyzing data, and reporting and evaluating findings.This process is referred as the scientific investigation or scientific method.

1.2 Scientific Method

Activity 1.6
What are the applications of scientific method?

All sciences, including the social sciences, employ variations of what is called the **scientific method.** Scientific method is the process by which scientists approach their work.

The Steps of the Scientific Method

Based on the type of question being asked, the type of science being applied and the laws that apply to that particular branch of science, you may need to modify the method and alter or remove one or several of the steps.

1. Ask Questions

A scientific investigation typically begins with observations. Observations often lead to questions. This question will include one of the key starters, which are, how, what, when, why, where, who or which. The question you ask should also be measurable and answerable through experimentation. It is often something that can be measured with a numerical result, although behavioral results are part of the scientific method as well.

2. Perform Background Research

With your question formulated, conduct preliminary background research to prepare yourself for the experiment. You can find information through online searches or in your local library, depending on the question you are asking and the nature of the background data. You may also find previous studies and experiments that can help with your process and conclusions.

3. Establish your Hypothesis

Based on the data that were gathered, the researcher formulated a hypothesis. A hypothesis is a tentative explanation for a set of observations. Your hypothes should also include your predictions that you can measure through experimentation and research.A hypothesis must be based on scientific knowledge, and it must be logical.

4. Test your Hypothesis

Next, test your hypothesis by conducting an experiment. Your experiment is a way to quantifiably test your predictions and should be able to be repeated by another scientist. Assess your scientific process and make sure that the conditions remain the same throughout all testing measures. If you change any factors in your experiment, keep all others the same to maintain fairness. After you complete the experiment, repeat it a few more times to make sure the results are accurate.

5. Analyze the Results and Draw a Conclusion

You can now take your experiment findings and analyze them to determine if they support your hypothesis or not. Drawing a conclusion means determining whether what you believed would happen actually happened. If it did not happen, you can create a new hypothesis and return to step three, then conduct a new experiment to prove your new theory. If what you hypothesized happened during the experimentation phase, the final step is putting together your findings and presenting them to others.

6. Communicating Results

The last step in a scientific investigation is communicating what you have learned with others. This is a very important step because it allows others to verify your methods and results. If other researchers get the same results as yours, the hypothesis becomes stronger. However, if they get different results, they may not support the hypothesis. When scientists share their results, they should describe their methods and point out any possible problems with the investigation. Finally, communicating results can be done in a variety of ways including scientific papers, blogs, news, articles, conferences, etc.

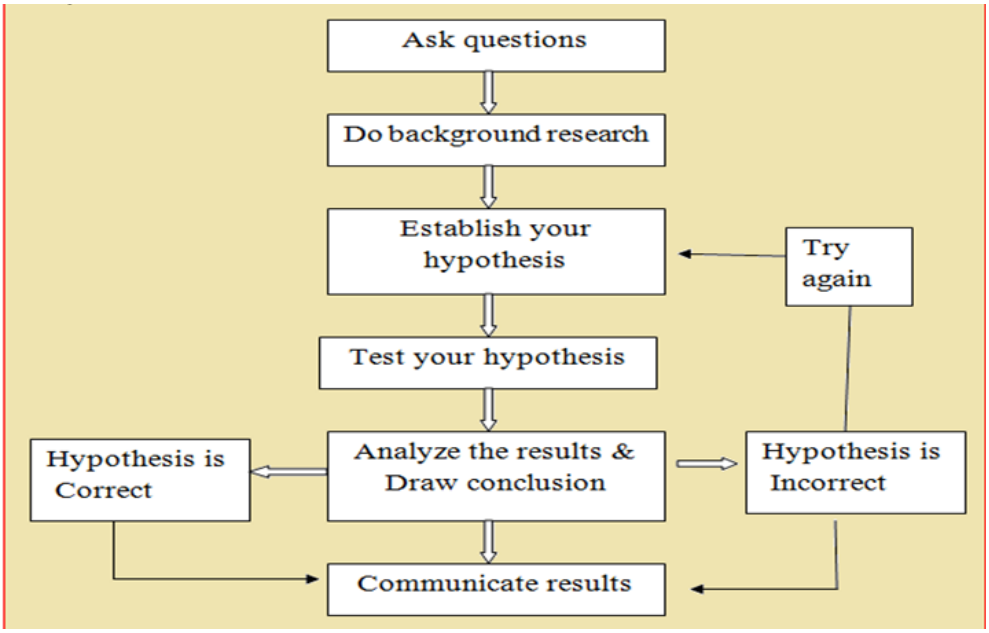


Figure 1.9 Steps in Scientific Method

Example1.9: Simple experiment with candle that shows the necessary of air for burning. Consider how the scientific method applies in this simple experiment with air necessary for burning under two different conditions.

1. **Ask Question:** Is air necessary for burning?
2. **Do back ground Research:** From different literatures "air is necessary for burning."
3. **Formulate Hypothesis:** The null hypothesis is that there wil be no air needs for burning. The alternative hypothesis is that there will be air needs for burning.
4. **Test Hypothesis by Experiment and Collect Data:** Take a candle and fix it on a table. Light the candle. The candle will continue to burn due to continuously available fresh air providing the required oxygen for combustion.Now cover the burning candle by putting an inverted gas jar over it. After a short time, the candle stops burning and gets extinguished.
5. **Analyze the Results and Draw Conclusion:**
   When the burning candle is covered with gas jar, then the candle takes away the oxygen necessary for burning from

the air enclosed in the gas jar. After some time, when all the oxygen of air inside the gas jar is used up, then the burning candle gets extinguished. This proves that air is necessary for combustion or burning of substances.

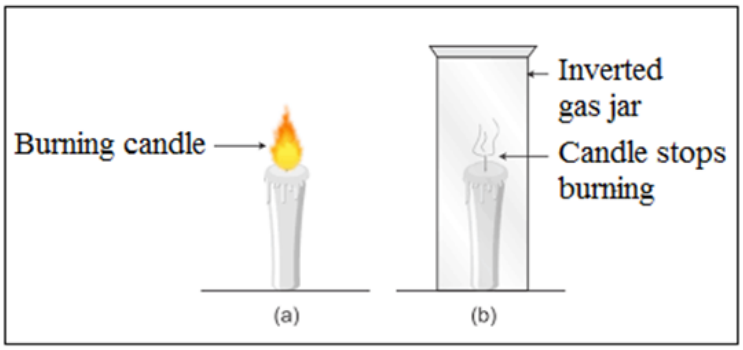


Figure 1.10 a) Burning of candle b) Candle stops burning

6. Communicate Results: Report your findings in the form of a written report as an oral presentation. Air is necessary for burning.

Activity 1.7

Form groups and conduct investigations on activities listed below. After investigation present your findings to the class.

a. What is the effect of sunlight on the growth of bean plant?
b. Does a coiled nail act like a magnet?
c. How do plants store their food in their leaf?

Exercise 1.13

Describe the components of a scientific investigation.

Project 1.3

Conduct some investigations (for example, making injera) using local materials and methods (procedures) in groups by reading different reference books or asking a person who is knowledgeable and experienced in the area.



Figure 1.11Injera



Figure 1.12 Injera being cooked on a griddle

Key Terms: -Fundamental quantity,
-Derived quantity,
-Fundamental unit,
-Derived unit,
-Prefix, Accuracy
-Precision, and
-Scientific method.

Summary

- Measurement is the process of obtaining the magnitude of a quantity relative to an agreed standard.
- Indigenous units of measurement for length: cubit, span, digit, foot and pace, for mass weqet and quntal, for time length of a shadow are used.
- Fundamental quantities are a set of physical quantities which cannot be expressed in terms of any other quantities. Their corresponding units are called "Fundamental units".
- The physical quantities which can be obtained by mathematically combining (i.e., multiplying and dividing) the fundamental quantities are known as "Derived quantities". Their corresponding units are called "Derived units".
- Prefixes are a short hand form of writing very large or very small numbers.
- Accuracy refers to how close a measurement is to the accepted value while precision refers to how close measurements are to each other.
- Scientific method is the process by which scientists approach their work.

Review Exercise

I. Choose the correct answer from the given alternative

1. Which of the following quantities is a fundamental quantity?
   a) Area b) volume
   c) temperature d) force
2. The difference between fundamental and derived unit is
   a) Fundamental units are big in value but derived units are small in value.
   b) Fundamental units are derived from derived units.
   c) Derived units are derived from fundamental units.
   d) There is no difference between them.
3. Which of the following is a derived quantity?
   a) mass b) area
   c) time d) length
4. The SI unit of density is
   a) kg/m^2 b) kg/m^3
   c) kg/m d) g/m^3
5. The prefix that represents $\frac{1}{1000}$ is_____.
   a) kilo b) mega
   c) centi d) milli

II. Fill in the blank spaces with an appropriate word.

1. Length, mass, time and temperature are _____quantities.
2. Area, volume, density and force are _____ quantities
3. One million centimeter is equal to _____ meter.
4. The prefix for a number 0.01 is _____.
5. The SI unit of volume is _____.

III. Match the quantities in column-I to their units in column-II:

	Column I	Column II
1	Area	(a) K
2	Temperature	(b)m^3
3	Density	(c) m2
4	Volume	(d)kg
5	Mass	(e) kg/m3

IV. Give short answer

1. Write four fundamental quantities with their units.
2. Write four derived quantities with their units.
3. Write the measurement 0.005 m using prefix.
4. Convert 1000 cm to kilometer.
5. The value of acceleration due to gravity on the surface of Earth is known to be 9.81 m/s^2. In an experiment students have found the following results. 12.2 m/s^2, 12.3 m/s^2, 12.1 m/s^2 and 12.08 m/s^2. Is this measurement accurate or precise?
6. List the steps used in scientific method.

UNIT TWO
COMPOSITION OF MATTER

Learning Outcomes:

At the end of this unit, you will be able to:

- narrate the historical development of the atomic nature of substances;
- appreciate that atoms are the building blocks which make up all substances;
- demonstrate understanding of the idea that the identity of a substance is determined by its atomic structure;
- differentiate molecules of elements from molecules of compounds;
- demonstrate scientific inquiry skills along this unit: communicating, asking questions, drawing conclusions, applying concepts.

Main contents

2.1 Early thinking about the composition of matter

2.2 Inside of an atom

2.3 Molecules

2.1 Early Thinking about the Composition of Matter

At the end of this section, you will be able to:

- Give a short history of the concept of the atom;
- Compare and contrast the continuity and discreteness (discontinuity) theory of matter;
- Compare earlier conceptions of the structure of matter with their conceptions.

Activity 2.1

Form groups and discuss the following and present your opinion to the class.

1. What is matter?
2. What do you think matters made up of?

The earliest recorded discussion of the basic structure of matter comes from ancient Greek philosophers, the scientists of their day. Some of them argued that matter is continuous i.e., it could be divided endlessly into smaller pieces. Others believed that matter is discrete; i.e., it cannot be infinitely divided.

Democritus (460 - 370 B.C) expressed the belief that all matter consists of very small, indivisible particles, which he named atomos (meaning uncuttable or indivisible). He thought of atoms as moving particles that differed in shape and size which could join together. *According to Democritus matter is discrete.*

Aristotle (384 – 322 B.C) argued that matter is divided into smaller and smaller parts, the division continuous forever without any limit. He did not believe in microscopic building particles of matter. Therefore, according to Aristotle, matter is continuous and he believed that matter consisted of the combinations of fire, earth, air, and water.

Activity 2.2

Form two groups and debate on one of the following ideas assigned to your group. After discussion present your reasons to the class.

1. If matter is divided and subdivided again and again, what would ultimately be obtained?
   a. Group 1: According to Aristotle's believe
   b. Group 2: According to Democritus's believe

Table 2.1 Comparison between the discrete and continuous theory of matter

Discreteness Theory	Continuous Theory
➢ Proposed by Democritus	Proposed by Aristotle
➢ There is a limit to which matter is broken	Matter is infinitely divisible
➢ Believed in the existence of atoms	Rejected the idea of atoms

Exercise 2.1

1. Compare and contrast the continuity and discreteness theory of matter.

2.2 Inside of an Atom

At the end of this section, you will be able to:

- describe the structure of an atom as a nucleus containing protons and neutrons, surrounded by electrons in shells (energy levels);
- state the relative charge and approximate relative mass of a proton, a neutron and an electron;
- draw hydrogen atoms, including the location of the protons and electrons, with respect to the nucleus;
- differentiate between mass number and atomic number;
- determine the number of protons, neutrons, and electrons in an atom.

What are the two parts of atom?

An atom consists of a tiny dense **nucleus** surrounded by **electrons**. The nucleus contains positively charged protons and neutral neutrons, so it is positively charged. The electrons are negatively charged. Protons and neutrons have approximately the same mass and are about 1800 times more massive than an electron. This means that most of the mass of an atom is in its nucleus. However, most of the volume of an atom is occupied by its electrons.

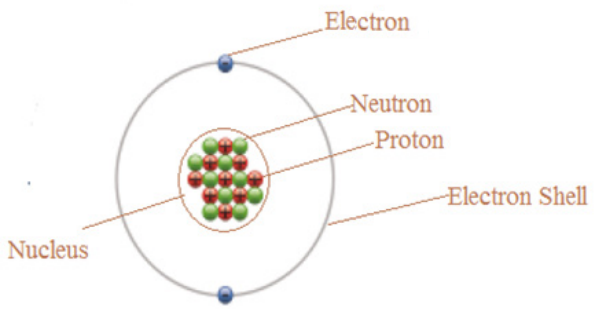


Figure 2.1 Diagrammatic representation of the atom

The subatomic particles

Activity 2.3

Draw a simple sketch of hydrogen atom model on your exercise book by using coloured pen following the instructions listed below.

i. Draw a small circle labeled ‘‘nucleus’’.
ii. Add a smaller circle labeled ‘‘proton’’ inside the nucleus.
iii. Add another circle around the nucleus and add a symbol such as a dot for the electron

Atoms possess internal structure; that is, they are made up of even smaller particles, which are called subatomic particles. A subatomic particle is a very small particle that is a building block for atoms.

An atom contains three fundamental sub atomic particles: proton, electron and neutron. An atom has a definite number of protons, electrons and neutrons. The structure of the atom describes how these particles are arranged to make an atom.

The relative charge of a proton is +1. The electron is assigned a charge of −1. The neutron is assigned zero charge. Since an atom has equal number of protons and electrons, it is electrically neutral. A proton has a mass of 1.673×10^{-24} g, and a neutron has a mass of 1.675×10^{-24} g. Thus, a proton and a neutron have almost the same mass. Since the mass of an electron is very small, 9.109×10^{-28} g, its mass is assumed to be negligible or approximately zero because it is ≈ 2000 times less heavier than both the proton and neutron.

Table 2.2Nature and location of sub-atomic particles

Particle' Name	Location	Actual Mass (g)	Relative Mass (amu)	Actual Charge (C)	Relative charge (C)
Proton	Nucleus	1.673×10^{-24}	1.00728 ≈1	$+1.60218\times10^{-19}$	+1
Electron	Outside nucleus (shell)	9.109×10^{-28}	0.00055 ≈ 0	-1.60218×10^{-19}	-1
Neutron	Nucleus	1.675×10^{-24}	1.00866 ≈ 1	0	0

Project Work 2.1

Prepare hydrogen model by using locally available materials in groups and present your model to the rest of class.

Atomic Number and Mass Number

Activity 2.4

Form groups and discuss the following activity. Share your opinion with your group members and present your group opinion's to the class. Determine atomic numbers and mass numbers of common elements by using periodic table.

All atoms can be identified by the number of protons and neutrons they contain. The atomic number (Z) of an atom equals the number of protons in its nucleus. The atomic number is also the number of electrons that surround the nucleus of a neutral atom.

Atomic number (Z) = Number of protons= number of electrons

Mass number (A) is the sum of the number of protons and the number of neutrons in the nucleus of an atom.Except for the most common form of hydrogen, which has one proton and no neutrons, all atomic nuclei contain both protons and neutrons.

Mass number (A) = Number of protons + Number of neutrons.
= Atomic number + Number of neutrons.

The mass and atomic numbers of a given atom are often specified using the notation:



Example: ${}^{12}_{6}C$, mass number = 12, atomic number = 6, and C is the symbol of carbon.

Determination of the electrons, protons and neutrons

Activity 2.5

Form groups and discuss the following activity. Share your opinion with your group members.

1. Use a periodic table to tell the atomic number, mass number, proton numbers, neutron numbers and electron numbers of the first 10 elements.

Proton is equal to the atomic number of atoms.

Number of protons = atomic number (Z)

Electron: The atom is neutral therefore the number of electrons is equal to the number of protons.

Number of electrons = atomic number (Z) = number of protons

The number of neutrons in an atom is equal to the difference between the mass number and the atomic number or proton number.

Number of neutrons = Mass number (A) - Number of protons

Exercise 2.2

Give the appropriate answers for the following questions.

1. Complete the following table.

Particle	Location	Actual Mass (g)	Relative Mass (amu)	Relative Charge
Proton				
Electron				
Neutron				

2. A nucleus consists of 9 protons and 10 neutrons. Determine:
   i. The element by referring periodic table
   ii. Mass number
3. How many neutrons, protons and electrons are there in an atom of the element $^{14}_{7}N$?

2.3 Molecules

At the end of this section, you will be able to:

- define molecules;
- give examples of monatomic, diatomic and polyatomic molecules;
- use models or particles model diagram to represent molecules of elements and compounds.

Activity 2.6

Form groups and discuss the following activiy. Share your opinion with your group members. After discussion present your findings to the class.

1. What is molecule?
2. Mention some examples of monoatomic, diatomic and poly atomic molecules.

Molecules of Elements

A molecule of an element consists of only one type of an atom. Molecules of elements can be classified as monoatomic, diatomic and polyatomic.

1. **Monoatomic molecules are** molecules that contain one atom of the element. Examples: He, Ne, Ar, Kr, Xe and Rn are monoatomic molecules
2. **Diatomic molecules are** molecules that contain two atoms of the element. Examples: O2, H2, F2, Cl2, I2 are diatomic molecules.

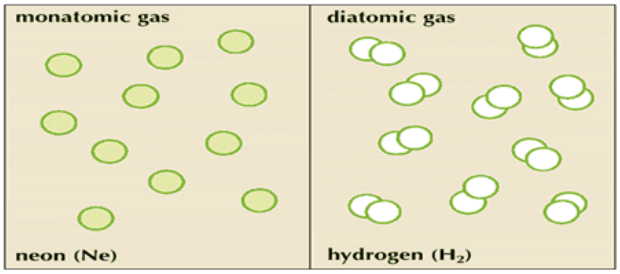


Figure 2.2 Diagrammatical representations of Ne and H_2.

3. **Polyatomic molecules** are molecules that contain more than three atoms of the element. Examples: O_3, P_4, S_8 are polyatomic molecules.

Molecules of compounds

A molecule of a compound always contains two or more atoms of different elements combined chemically. Water (H2O), ammonia (NH3), carbon dioxide (CO2), etc. are some examples of molecules of compounds.

Exercise 2.3

Give the appropriate answers for the following questions.

1. What is a molecule?
2. Classify the following molecules as monoatomic, diatomic or polyatomic?
   a. Ar
   b. N_2
   c. S_8
   d. O_3
   e. He
   f. Br_2

3. Draw the diagram representation of ozone (O_3) molecule.
4. Which of the following molecules are molecules of elements? Which of them are molecules of compounds?

a. Ne	d. Br2
b. H2O	e. NH3
c. HCl	f. P4

Key Terms

- Atom
- Atomic nucleus
- Atomic number
- Continuous theory
- Diatomic molecule
- Discreteness theory
- Electron
- Electron shell
- Mass number
- Molecule
- Monoatomic molecule
- Neutron
- Polyatomic molecule
- Proton

Summary

- Democritus (460-370 BC) introduced the idea that matter consists of very small indivisible particles called "atoms".
- The three fundamental subatomic particles are protons, neutrons and electrons.
- Protons are positively charged.
- Neutrons are chargeless.
- Electrons are negatively charged.
- A proton and a neutron have approximately the same mass; but the mass of an electron is negligible.
- The atomic number of an element is the number of protons in the nucleus of an atom of the element.
- An atom is electrically neutral because the amount of positive charge on a proton equals the amount of negative charge on an electron.
- The mass number is the sum of the number of protons and the number of neutrons in the nucleus of an atom.
- The number of neutrons in an atom is equal to the difference between the mass number and the atomic number or proton number.
- An atom is represented by the notation, ${}^{A}_{Z}X$ in which X is the symbol of an element Z is the atomic number, and A is the mass number.
- A molecule is the smallest particle of an element or a compound that can exist freely in nature.
- Molecules of elements consist of only one type of atoms and can be classified as monoatomic, diatomic or polyatomic.
- Molecules of compounds consist of two or more different type of atoms.

Review Exercise

I. Write "True" if the statement is correct and write "False" if the statement is incorrect.

1. Nucleus consists of protons and neutrons.
2. Atomic number is the number of protons in the nucleus.
3. Molecules of elements consist of two or more different type of atoms.
4. Proton and electron have approximately the same mass.
5. Different elements have the same number of protons.

II. Choose the correct answer from the given alternatives.

6. The idea that matter is 'continuous' was proposed by
   A. Democritus
   B. Aristotle
   C. Dalton
   D. None
7. The idea of 'atoms' first proposed by the Greek philosopher----
   A. Aristotle
   B. Plato
   C. Dalton
   D. Democritus
8. Which of the following particles located in the nucleus of an atom?
   A. Proton and electron
   B. Neutron and proton
   C. Electron and neutron
   D. Proton, electron and neutron
9. The sum of the number of protons and neutrons in an atom is known as
   A. Atomic number
   B. Atomic mass
   C. Mass number
   D. Number of electron

10. The number of neutrons in $^{24}_{12}Mg$ are

A. 12 B. 11

C. 24 D. 13

11. Which of the following statements concerning the nucleus of an atom is correct?

A. Contains only neutrons

B. Contains all protons and all electrons

C. Is always positively charged

D. Accounts for most of the total volume of an atom

12. Which of the following molecule is diatomic molecule?

A. O_2

B. O_3

C. P_4

D. S_8

13. Which of the following statement is false?

A. Molecules of elements consist of only one type of atoms.

B. Nucleus is positively charged.

C. Molecules of compounds consist of only one type of atoms.

D. Neutrons have no charge.

14. Which of the following molecule is molecule of elements?

A. H_2O

B. NH_3

C. H_2

D. HCl

III. Give short answers for the following questions.

15. What are the two main parts of an atom?
16. What are the fundamental sub-atomic particles?
17. Determine the atomic number, number of protons, number of neutrons, number of electrons and mass number for $^{16}_{8}O$.

UNIT THREE

CLASSIFICATION OF COMPOUNDS

Learning Outcomes:

At the end of this unit, you will able to:

- explain the classification of compounds into organic and inorganic;
- write the formulas and names the first ten alkanes, alkenes alkynes and list the uses some important common organic compounds;
- classify oxides into different groups and give examples of each group;
- develop skills in identifying acidic, basic and neutral solutions;
- define, and apply the concept of neutralization;
- explain the safety precautions while working with acids and bases;
- demonstrate scientific inquiry skills along this unit: observing, classifying, comparing and contrasting, communicating, asking questions, designing experiment, drawing conclusion, applying concepts and problem solving.

Main contents

3.1 Introduction
3.2 Organic compounds
3.3 Inorganic compounds
3.4 Neutralization reaction and salts

3.1 Introduction

At the end of this section, you will be able to:

- define organic compounds as carbon containing compounds and give examples;
- define inorganic compounds as compounds of elements other than carbon.

Activity 3.1

Form groups and discuss the following activity. After the group discussion, choose a group representative to present the group's opinion to the class.

1. State earlier definitions of organic and inorganic compounds.
2. Do you agree with the notion that says: "organic compounds can be synthesized only from animals and plants"?
3. State modern definitions of organic and inorganic compounds.

During the latter part of the eighteenth century and the early part of the nineteenth century, chemists began to categorize compounds into two types: organic and inorganic. Compounds obtained from living organisms were called organic compounds, and compounds obtained from mineral constituents of the earth were called inorganic compounds. During this early period, chemists believed that a special "vital force" supplied by a living organism was necessary for the formation of an organic compound. This concept was disproved in 1828 by the German chemist Friedrich Wöhler. Wohler prepared urea, an organic compound, from the reaction between solutions of inorganic compounds ammonium chloride and silver cyanate.

$$\underset{\text{Ammonium chloride}}{NH_4Cl\,(aq)} + \underset{\text{Silver cyanate}}{AgCNO\,(aq)} \longrightarrow \underset{\text{Ammonium cyanate}}{NH_4CNO\,(aq)} + \underset{\text{Silver chloride}}{AgCl\,(s)}$$

$$NH_4CNO\,(aq) \xrightarrow{\text{Heat}} \underset{\text{Urea}}{(NH_2)_2CO\,(s)} \quad \text{Or} \quad H_2N-\overset{\overset{O}{\|}}{C}-NH_2$$

Soon other chemists had successfully synthesized organic compounds from inorganic starting materials. As a result, the vital-force theory was completely abandoned.

The terms organic and inorganic continue to be used in classifying compounds, but the definitions of these terms no longer reflect their historical origins.

All organic compounds contain carbon and hydrogen, along with other possible elements such as oxygen, nitrogen, sulphur, halogens and phosphorus except the oxides of carbon, carbonates, hydrogen carbonates, cyanides and cyanates.

Inorganic compounds are the compounds consisting of mineral constituents of the earth or generally found in non-living things. The term inorganic compound refers to all compounds that do not contain carbon. Although, carbon dioxide, carbon monoxide, carbonates and hydrogen carbonates are carbon-containing compounds, which are classified as inorganic compounds.

Exercise 3.1

Classify each of the following compounds as organic or inorganic.

a. $C_{12}H_{22}O_{11}$
b. NaCl
c. CaO
d. C_2H_5OH
e. CH3Cl
f. C_2H_4

3. 2 Organic Compounds

At the end of this section, you will be able to:

- Define hydrocarbons and mention at least one source of hydrocarbons;
- Write the general formula of alkanes, alkenes and alkynes;
- Write the specific chemical formulas of the first ten members of alkanes, alkenes and alkynes;
- Describe a homologous series and its general characteristics;
- Name the first eight members of alkanes, alkenes and alkynes;
- Identify some common uses of organic compounds.

Hydrocarbons

Activity 3.2

Form a group and perform the following activity. Share your opinion with your group members.

1. What is hydrocarbon?
2. List the sources of hydrocarbons and indicate their location in Ethiopia.

A hydrocarbon is a compound that contains only carbon atoms and hydrogenatoms.Hydrocarbons divided into three large classes:***alkanes, alkenes*** and ***alkynes.***

Alkanes

Alkanes are hydrocarbons that have the general formula $C_nH_{2n+2,}$ where, n is the number of carbon atoms present, n = 1, 2, 3…..

For example, the molecular formulas of the first four alkanes are $C_1H_{2\times1+2} = CH_4$, $C_2H_{2\times2+2} = C_2H_6$, $C_3H_{2\times3+2} = C_3H_8$, and $C_4H_{2\times4+2} = C_4H_{10}$, respectively.

When we compare the formulas of CH4 and C2H6 or C2H6 and C3H8, they differ by one carbon and two hydrogen atoms or **– CH2 –** group called the **methylene group.** A family of compounds in which each member differs from the next by one methylene ($-CH_2-$) groupis called **homologous series** (homo is Greek for "the same as). The members of a homologous series are called **homologues.**

Exercise 3.2

1. Write the formulas of alkanes that contain 5, 7 and 9 carbon atoms.

Alkenes

Alkenes are hydrocarbons that have the general formula C_nH_{2n}, where, n is the number of carbon atoms present, n = 2, 3….. For example, the molecular formulas of the first three alkenes are $C_2H_{2\times2} = C_2H_4$, $C_3H_{2\times3} = C_3H_6$, and $C_4H_{2\times4} = C_4H_8$, respectively.

Exercise 3.3

1. Write the formulas of the alkenes that contain 6, 8 and 10 carbon atoms.

Alkynes

Alkynes are hydrocarbons that have the general formula C_nH_{2n-2}, where n = 2, 3, 4, etc. For example, the formulas of the first three alkynes are $C_2H_{2\times2-2} = C_2H_2$, $C_3H_{2\times3-2} = C_3H_4$, and $C_4H_{2\times4-2} = C_4H_6$, respectively.

Exercise 3.4

1. Write the formulas of the alkynes that contain five-eight carbon atoms.

Nomenclature (Naming) of Hydrocarbons

Activity 3.3

Form a group and perform the following activity. Share your opinion with your group members.

1. How do we give specific name to a hydrocarbon?
2. Are hydrocarbons named based on certain rules or randomly?

The name of hydrocarbons is derived from the number of carbon atoms present (prefix) and the ending it contains (suffix).The names of alkanes, alkenes and alkynes end with the suffixes '-ane', '-ene' and '-yne', respectively.

i. a ***prefix***- indicating the number of carbon atoms (listed in Table 3.1) and
ii. a **suffix** indicating the type of the functional group present in the molecule or the type of hydrocarbon.

Table 3.1 Prefixes commonly used to indicate one to ten carbon atoms.

Number of carbon atoms	Prefix	Number of carbon atoms	Prefix
1	Meth-	6	Hex-
2	Eth-	7	Hept-
3	Prop-	8	Oct-
4	But-	9	Non-
5	Pent-	10	Dec-

Example 1: Write the names of alkanes; CH_4 and C_3H_8.
Solution:

- CH_4 contains one carbon atom. So, we use the prefix 'meth-' and adding the suffix '-ane' i.e. meth + ane. Thus the name of CH_4 becomes **methane.**
- C_3H_8 contains three carbon atoms. So, we use the prefix 'prop-'and adding the suffix '-ane' i.e. prop + ane. Thus the name of C_3H_8 becomes **propane.**

Example 2: Write the names of alkenes; C_2H_4 and C_4H.
Solution:

- C2H4 contains two carbon atoms. So, we use the prefix 'eth-' and adding the suffix '-ene' i.e. eth + ene. Thus the name of C_2H_4 becomes **ethene.**
- C_4H_8 contains four carbon atoms. So, we use the prefix 'but-' and adding the suffix '-ene' i.e. but + ene. Thus the name of C_4H_8 becomes **butene.**

Example 3: Write the names of alkynes; C_3H_4 and C_4H_6.
Solution:

- C_3H_4 contains three carbon atoms. So, we use the prefix 'prop-'and adding the suffix '-yne' i.e. prop + yne. Thus the name of C_3H_4 becomes **propyne.**
- C_4H_8 contains four carbon atoms. So, we use the prefix 'but-' and adding the suffix '-yne' i.e. but + yne. Thus the name of C_4H_6 becomes **butyne.**

Exercise 3.5

1. Write the formulas and names of alkanes, alkenes and alkynes containing five to ten carbon atoms.

Uses of Common Organic Compounds

Many organic compounds are very useful in our daily life. Some important organic compounds and their uses are described in the following section.

Methane, CH_4

Methane is used primarily as fuel for cooking, heating and generating electricity. Methane is the main constituents of biogas that is used as a domestic fuel.

Propane (C_3H_6) and Butane (C_4H_{10})

The mixture of propane and butane is compressed at a moderate pressure and stored in steel cylinders. It is marked as bottled gas and commonly known as "butagas". It is mainly used for cooking and heating.

Ethyne (C_2H_2)

One of the main uses of ethyne is to produce oxyacetylene flame, which is used in the cutting and welding of steel and iron.



Figure 3.1 Oxyacetylene torch

Ethanol (Ethyl alcohol)

Ethanol is used in the intoxication ingredient of many alcoholic beverages such as beer, wine, tella, ouzo, teji, etc. Nowadays ethanol mixed with petrol is used as a fuel. It is also used in the production of acetic acid, and in hospitals and clinics for cleaning wounds.

Ethanoic Acid (Acetic acid)

Activity 3.4

Form a group and perform the following activity. Share your opinion with your group members.

Why we add 'acheto' or 'vinegar' when we eat uncooked vegetables such as salad?

Table vinegar contains 4% to 8% acetic acid. Vinegar is used as food flavoring agent. It is also used as a disinfectant. For use in preserving vegetables (pickling) it typically ranges up to 18%.



Figure 3.2Adding vinegar

Formalin

When formaldehyde is dissolved in water it is called formalin. Formalin contains 40%, by volume, of formaldehyde. Formalin is used for the preservation of biological specimens, because it makes proteins hard and insoluble.

Exercise 3.6

Give the appropriate answers for the following questions.

1. Classify each of the following hydrocarbons as alkane, alkene or alkyne.
   a. C_5H_{10}
   b. $C_{10}H_{22}$
   c. C_8H_{14}
   d. C_8H_{18}
   e. $C_{10}H_{18}$
   f. C_9H_{18}
2. Write the uses of methane, ethyne, formalin, acetic acid and ethanol.

3.3 Inorganic Compounds

At the end of this section, you will be able to:

- state that inorganic compounds are classified into oxides, acids, base and salts;
- classify oxides into metallic and nonmetallic;
- describe the properties of acidic oxides and basic oxides;
- predict the nature of common oxides;
- prepare sulphur dioxide in the laboratory by burning sulphur in air and use moist blue litmus paper to test its acidic nature;
- prepare magnesium oxide in the laboratory by burning magnesium ribbon in air and use red litmus paper to test its basicity in water solution;
- define acid and base;
- describe properties a of acids and bases;
- relate acidic properties to the presence of hydrogen ions and basic properties to the presence of hydroxide ions.
- name and write formulas for some common acids (HCl, HNO_3, H_2SO_4) and bases (NaOH, KOH, NH_4OH), using the periodic table, a list of ions, and rules for naming acids;
- describe how indicators can be used to classify solutions as acidic or basic;
- investigate properties of bases/alkalis experimentally;

- in group, with guidance, prepare their own indicator by extracting the colour from a vegetable, such as beetroot, or flowers and evaluate the indicator;
- investigate household chemicals using locally prepared indicators;
- explain the safety precautions while working with acids and bases;
- create a safety booklet dealing with the handling of acids and alkali.

Inorganic compounds can be classified into four groups according to their composition and their properties. These include ***oxides, acids, bases*** and ***salts.***

Oxides

Activity 3.5

Form groups and discuss the following activity. After the group discussion,choose a group representative to present the group's opinion to the class.

1. Define oxides and give some examples that are not listed below.
2. Are all compounds containing oxygen oxides? Why?

Oxides are binary compounds containing oxygen and any other element.

Element + Oxygen → Oxide

Some common examples of oxides are water (hydrogen oxide, H_2O), carbon dioxide (CO_2), lime (calcium oxide, CaO), rust (iron (III) oxide), etc.

Exercise 3.7

Give the appropriate answers for the following questions.

1. Define oxides.
2. Which of the following compounds are oxides?

a. $CaCO_3$	d. rust	g. SO_3
b. KOH	e. H_2CO_3	h. CO_2
c. H_2O	f. CaO	

Types of Oxides

Most oxides are classified as metallic oxides and non-metallic oxides.

i. Metallic oxides are binary compounds containing only metals and oxygen.

Metal + Oxygen → Metallic Oxide

Examples: CaO, Na_2O, Al_2O_3, MgO, etc.

ii. Non-Metallic Oxides are binary compounds containing only non-metals and oxygen.

Non-metal + Oxygen → Non-metallic Oxide

NO2, H2O, CO_2, SO_2, SO_3, etc are common example of non-metallic oxides.

Oxides are also classified as acidic and basic oxides depending on their properties or behaviours.

Acidic oxides are oxides that react with water to form acids or acidic solutions. They are mostly non-metallic oxides. Some examples of acidic oxides are SO_2, $P4O_6$, CO_2, etc.

Basic oxides are oxides that react with water to form bases or basic solutions. They are mostly metallic oxides. Some examples of basic oxides are Na_2O, Li_2O, CaO, MgO, etc.

Exercise 3.8

Give appropriate answers for the following questions.

1. Predict whether or not the oxide formed from each of the following elements is a basic oxide and an acidic oxide.
   a. Calcium
   b. Carbon
   c. Sodium
   d. Magnesium
   e. Sulphur
   f. Phosphorus
2. Classify the following oxides as metallic or non-metallic oxides.
   a. CO_2
   b. MgO
   c. SO_3
   d. CaO
   e. NO_2
   f. K_2O

Properties of Oxides

Properties of Acidic Oxides

Activity 3.6

Form groups and discuss the following activity. After the group discussion, choose a group representative to present the group's opinion to the class.Predict the nature of the oxides formed by some non-metals such as arbon and phosphorus.

An *acidic oxide* or acid anhydride dissolves in water, to form acidic solution or an acid.

Acidic oxide + Water → Acid

Examples:

$SO_3 + H_2O \rightarrow H_2SO_4$ $CO_2 + H_2O \rightarrow H_2CO_3$

Acidic oxides react with bases to form salts and water.

Acidic oxide + Base → Salt + Water

Examples:

$SO_3 + Ca(OH)_2 \rightarrow CaSO_4 + H_2O$

$CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$

Acidic oxides react with basic or metallic oxides to form salt.

Acidic oxide + Basic oxide → Salt

Examples:

$CO_2 + Na_2O \rightarrow Na_2CO_3$ $SO_3 + CaO \rightarrow CaSO_4$

Properties of Basic Oxides

Activity 3.7

Form groups and discuss the following activity. After the group discussion, choose a group representative to present the group's opinion to the class. Predict the nature of the oxides formed by somemetals such as sodium, potassium and calcium.

A basic oxide or basic anhydride reacts with water to produce a base or alkali.

Basic oxide + Water → Base (alkali)

Examples:

$CaO + H_2O \rightarrow Ca(OH)_2$ $K_2O + H_2O \rightarrow 2KOH$

Basic oxides react with acidic oxides to form salts.

Basic oxide + acidic oxide → salt

Examples:

$CaO + CO_2 \rightarrow CaCO_3$ $Na_2O + SO_3 \rightarrow Na_2SO_4$

Basic oxides react with acids to form a salt and water.

Basic oxide + Acid → salt + water

Examples:

$CaO + 2HCl \rightarrow CaCl_2 + H_2O$ $Na_2O + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$

Exercise 3.9

1. What are the missing products 'X', 'Y' and 'Z' in the following equations?
   a. $CO_2 + H_2O \rightarrow X$
   b. $CaO + H_2O \rightarrow Y$
   c. $CaO + CO_2 \rightarrow Z$

Laboratory Preparation of Sulphur dioxide and Magnesium Oxide

Sulphur dioxide and magnesium oxide can be prepared in the laboratory by using direct synthesis method.

Direct synthesis involves the combination of oxygen with active metals and non-metals.

Non-metal + Oxygen → Non-metallic oxide

Example: $S + O_2 \rightarrow SO_2$

Metal + Oxygen → Metallic oxide

Example: $2Mg + O_2 \rightarrow 2MgO$

Experiment 3.1

Title: Preparation of Sulphur Dioxide

Objective: To prepare sulphur dioxide and test whether it is an acidic oxide or a basic oxide.

Materials required: Sulphur, litmus paper (blue and red), gas jar, Bunsen burner, deflagrating spoon.

Procedure:

1. Place a small amount of powdered sulphur in a deflagrating spoon and heat it as shown in Figure 3.3.
2. When it starts burning, put it into a gas jar.
3. When the burning stops, add 5 mL of water to the gas jar and shake it.
4. Put blue and red litmus paper, one after the other, in the jar.
5. Record your observations

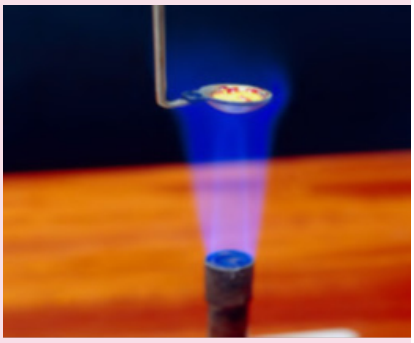


Figure 3.3 Burning of sulphur in air

Observation and Analysis:

a. What is the color of the flame when sulphur burns in air?
b. What happens to the color of blue and red litmus papers in step 4?
c. Write the chemical equation for this combustion reaction.
d. Classify the oxide formed by the combustion of sulphur as acidic or basic.

Experiment 3.2

Title: Preparation of Magnesium Oxide

Objective: To prepare magnesium oxide and test whether it is an acidic oxide or a basic oxide.

***Materials required*:** Magnesium ribbon, red and blue litmus papers, Bunsen burner, tongs, crucible, sand paper, and goggle.

Procedure:

1. Cut about 2-4 cm of magnesium ribbon.
2. Clean the surface of it properly with sand paper.
3. Hold the magnesium ribbon with the help of a pair of tong and burn it over a flame from the Bunsen burner as shown in ***Figure 3.4.*** The moment it starts burning, put the burning metal into a crucible and collect the product.



Figure 3.4 Burning of magnesium in air

4. Add a small amount of water to the resulting powder in the crucible and shake it.
5. Take red and blue litmus paper and bring them turn by turn in contact with the solution.
6. Record your observations.

Observation and Analysis:

a. Why you were cleaned the magnesium ribbon with sand paper?
b. What is the color of the flame produced when magnesium burns in air?
c. Write the chemical equation for the reaction.
d. What happens to the color of the red and blue litmus papers?
e. Is the resulting solution basic or acidic?

Exercise 3.10

1. Describe how you could prepare each of the following oxides.

a. MgO b. SO_2

Acids and Bases

Acids

Activity 3.8

Form a group and perform the following activities.

Imagine a taste experiment using orange and lemon. After tasting, present your feeling to the class.

1. What do you feel during tasting lemon?
2. What do you feel during tasting orange?
3. Are they having the same taste?
4. Are they acidic in nature? Why?

Acids are a group of substances that release hydrogen ions (H^+) when they are in aqueous solution. Acids have sour taste.

Examples: lemon juice, vinegar, sour tella and milk are some acidic substances in our daily life. HCl, H_2 SO_4 and HNO3 are common laboratory acids. They are also called mineral acids.

Bases

A base is an oxide or hydroxide of a metal which neutralizes acid to form salt and water. Bases which are soluble in water are called alkalis. An alkali is a substance that releases hydroxide ion (OH^-) when dissolved in water. Bases have bitter taste.

Examples: NaOH, $Ca(OH)_2$

Naming and Writing Formula of Acids and Bases

Activity 3.9

Form groups and discuss the following activities. After the group discussion, choose a group representative to present the group's opinion to the rest of the class.

1. Write the formulas of hydrochloric acid, sulphuric acid and nitric acid.

2. Write the formulas of sodium hydroxide, calcium hydroxide, potassium hydroxide and ammonium hydroxide.

When naming an acid, you can consider the acid to consist of an anion combined with as many hydrogen ions are needed to make the molecule electrically neutral. Therefore, the chemical formulas of acids are in the general form $\boldsymbol{H_nX}$, where ***X*** is a monoatomic or polyatomic anion and n is a subscript indicating the number of hydrogen ions that are combined with the anion.

The rules that used to named an acid with the general formula H_nX.

1. When the name of the anion (X) ends in –ide, the acid name begins with the prefix hydro-. The stem of anion has the suffix –ic and is followed by the word acid.
2. When the anion name ends in –ite, the acid name is the stem of the anion with the suffix –ous, followed by the word acid.
3. When the anion name ends in –ate, the acid name is the stem of the anion with the suffix –ic followed by the word acid.

Table 3.2 Naming of common acids

Anion ending	Example	Acid name	Example
-ide	Chloride, Cl^-	Hydro-(stem)-ic acid	HCl (Hydrochloric acid)
-ite	Sulfite, SO_3^{2-}	(Stem)-ous acid	H_2SO_3 (Sulfurous acid)
-ate	Nitrate, NO_3^- Sulphate, SO_4^{2-}	(stem)-ic acid (stem)-ic acid	HNO_3 (Nitric acid) H_2SO_4 (Sulphuric acid)

Bases are named in the same way as other ionic compounds: the name of the cation is followed by the name of the anion i.e. ***hydroxide.***

Examples:

NaOH (sodium hydroxide), Ca(OH)2 (calcium hydroxide), NH4OH (ammonium hydroxide)

Exercise 3.11

Give the appropriate answers for the following questions.

1. Define the following terms and give some examples for each.
   a. Acid b. Base
2. Which ion is a characteristic of all acids in water solution?
3. Copy and complete the following table in your exercise book.

Name	Formula	Name	Formula
Hydrochloric acid		Calcium hydroxide	
	HNO_3		KOH
Sulfuric acid			NaOH

Acid – Base Indicators

Acid-base indicators are dyes extracted from plants that show the presence of an acid or a base by undergoing specific color changes when placed in a solution. Litmus, methyl orange and phenolphthalein are common indicators.

Properties of acids and bases

Properties of Acids

Acids generally have the following properties:

1. ***Acids have a sour taste***
2. ***Acids change the colour of indicators***

Experiment 3.3

Title: Effect of acids on acid-base indicators

Objective: To investigate the effect of dilute hydrochloric acid and sulphuric acid on the colors of litmus paper, phenolphthalein and methyl orange.

Materials required: Blue and red litmus papers, phenolphthalein, methyl orange, test tubes, test tube rack, dilute solutions of hydrochloric acid and sulphuric acid.

Procedure:

1. Label three clean test tubes.
2. Pour about 5 mL of dilute H_2SO_4 into three test tubes.
3. Hold the first test tube in inclined position and put blue and red litmus papers turn by turn into it and see if there is any colour change.
4. Add few drops of phenolphthalein in the second and few drops of methyl orange in the third and observe if there is colour change.
5. Repeat the above procedure using dilute HCl and HNO_3 solution.

Observation and analysis:

Record your findings in the following table.

Acid	Color of the indicator in the acid solution		
	Litmus	**Phenolphthalein**	**Methyl orange**
Dilute H_2SO_4			
Dilute HCl			
Diluted HNO_3			

Write a laboratory report in groups and submit it to your teacher.

3. Reaction of Acids with metals

Dilute acids react with active metals like zinc, magnesium, iron and aluminum to form salts and liberate hydrogen gas.

Active Metal + Dilute Acid →Salt + Hydrogen

Example

$Ca + 2HCl \rightarrow CaCl_2 + H_2$

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

Experiment 3.4

Title: Reaction of an acid with a metal
Objective: To investigate the reaction of zinc metal with hydrochloric acid.
Materials required: Test tube, narrow jet test tube, candle, cork, zinc metal, dilute HCl, lighter or match, steel wool, and stand and clamp.

Procedure:

1. Set up the apparatus as shown in **Figure 3.5.**
2. Pour about 5 mL of dilute HCl into a test tube.
3. Clean a piece of zinc with the steel wool until it is shiny.
4. Add zinc to the test tube containing dilute HCl, close the test tube with a cork, deep narrow jet tube through cork and record your observations.
5. Light a candle using lighter or match and bring near the lighted candle in to the mouth of the narrow jet tube.
6. Repeat the above procedure using dilute sulphuric acid solution.

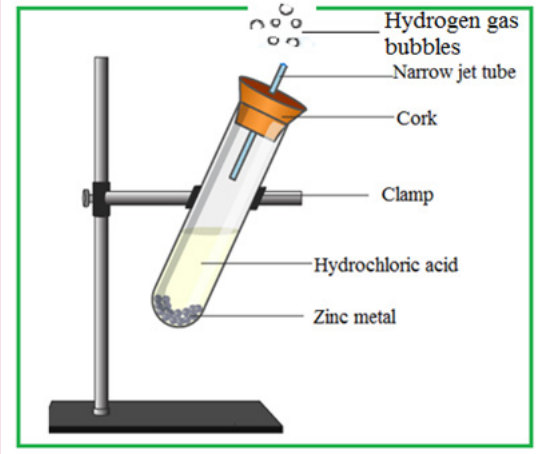


Figure 3.5 Reaction of Zn with HCl

Observation and analysis:

a. Why was the piece of zinc cleaned with steel wool?
b. What happens when you drop zinc metal into the test tube containing dilute HCl?
c. How do you know that a gas is produced in the reaction?

d. What is the colour of the gas?
e. What happens when the lighted candle is brought near the mouth of the narrow jet tube?
f. Write the chemical equation for the reaction between:
i. Zinc and hydrochloric acid.
ii. Zinc and sulphuric acid.

Write a laboratory report in groups and present to the rest of the class.

4. Reaction of Acids with Carbonates and Hydrogen Carbonates

Acids react with carbonates and hydrogen carbonates to form salts, water and carbon dioxide gas.

Acid + Carbonate → Salt + Water + Carbon dioxide

Example

$2HCl\ (aq) + CaCO_3\ (s) \rightarrow CaCl_2\ (aq) + H2O\ (l) + CO_2\ (g)$

Example

Acid + Hydrogen carbonate →Salt + Water + Carbon dioxide

$H_2SO_4\ (aq) + Ca(HCO_3)_2\ (aq) \rightarrow CaSO_4\ (aq) + 2H_2O\ (l) + 2CO_2\ (g)$

Experiment 3.5

Title:Reactions of acids with carbonates and hydrogen carbonates

Objective: To investigate the reactions of carbonates and hydrogen carbonates with dilute hydrochloric acid and sulphuric acid.

Materials required: Dilute hydrochloric acid, dilute sulphuric acid, calcium carbonate, sodium hydrogen carbonate, test tubes, test tube rack, lime water (calcium hydroxide solution), spatula, and rubber stopper.

Procedure:

1. Using a spatula, add calcium carbonate powder or a lump of calcium carbonate into the first test tube and 5 mL of lime water into the second test tube.
2. Add 5 mL of dilute hydrochloric acid into a test tube containing calcium carbonate cover its mouth with rubber stopper immediately and hold it in inclined position.
3. Bring the mouth of the test tube containing lime water with your other hand holding it in an inclined position closer to that of the test tube which you covered with rubber stopper.

4. Remove the stopper so that the gas produced can escape into the test tube containing lime water. Shake the test tube and see if there is any colour change.
5. Repeat the above procedure using sodium hydrogen carbonate and dilute sulphuric acid.

Observation and analysis:

a. Is there formation of bubbles in step 2?
b. If yes, what does the formation of bubbles indicate?
c. What happens to the lime water used in step 4? Why is that so?
d. Write the equation for the reaction:
   1. between hydrochloric acid and calcium carbonate.
   2. between sodium hydrogen carbonate and sulphuric acid.
   3. that occurs in step 4.

5.Acids neutralize bases.

Acids react with bases and basic oxides to form salts and water.

Acid + Base →Salt + Water.

Examples:

$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

The reaction of an acid with a base is called neutralization reaction.

Experiment 3.6

Title: Neutralizing effect of an acid on a base.

Objective: To investigate the neutralizing effect of sulphuric acid on sodium hydroxide.

Materials required: Dilute hydrochloric acid, sodium hydroxide solution, conical flask, phenolphthalein, burette, stand, clamp, measuring cylinder, blue and red litmus papers.

Procedure:

1. Set up the apparatus as shown in Figure 3.6
2. Fill the burette with dilute hydrochloric acid.
3. Measure 20 mL of sodium hydroxide solution, pour it into a conical flask and add about five drops of phenolphthalein.

4. Open the stop cock of the burette; add hydrochloric acid to the sodium hydroxide solution with your one hand, while shaking the conical flask with your other hand.
5. When the colour begins to disappear, add the acid drop by drop shaking the flask continuously.
6. When the colour disappears, completely, close the stop cock of the burette immediately and check the solution in the conical flask using blue and red litmus papers

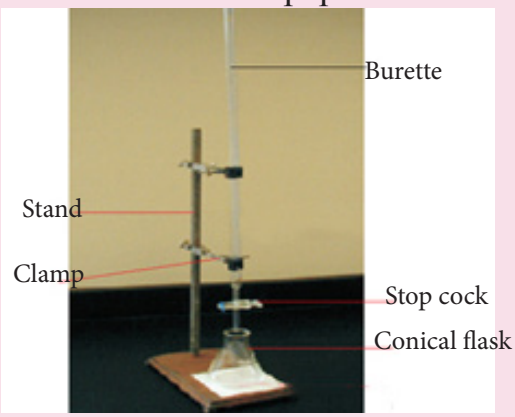


Figure 3.6 Neutralization reaction of hydrochloric acid with sodium hydroxide

Observation and analysis

a. What colour appeared when phenolphthalein is added to the solution in the conical flask in step 3.
b. Why does the colour disappear in step 6?
c. Does the solution obtained in step 6 affect the colour of either blue or red litmus paper?
d. Write the balanced chemical equation for the reaction that takes place in this experiment.

Write a laboratory report in groups and present your findings to the rest of the class.

Properties of Bases

1. Bases have bitter taste.
2. Effect on acid-base indicators

Alkalis change the colour of indicators.

Experiment 3.7

Title: The effect of a base on indicators

Objective: To study the effect of a base on indicators

Materials required: Red and blue litmus papers; phenolphthalein solution, methyl orange, diluted sodium hydroxide (NaOH) solution, test tubes, test tube holder and test tube rack.

Procedure:

1. Take four clean test tubes.
2. Add about 5 mL NaOH solution in each of the test tubes and label the test tubes as 1, 2, 3, and 4 as shown in Figure 3.7.
3. Put red litmus paper, blue litmus paper, 2 drops of phenolphthalein solution and 2 drops of methyl orange solution in test tubes 1, 2, 3 and 4, respectively.
4. Observe the colour change and record your observation.
5. Repeat the above procedure using ammonia solution.

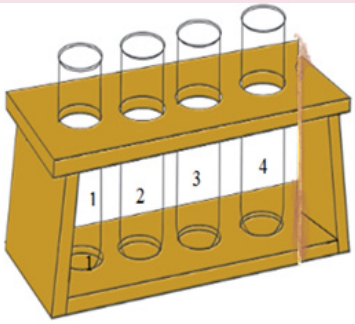


Figure 3.7 Testing the effect of a base on indicators

Observation and analysis:

a. Record your findings in the following table.

a. Record your findings in the following table.

Base	Color of the indicator in the base solution			
	Red litmus	Blue litmus	Phenolphthalein	Methyl orange
Dilute NaOH				
NH_4OH solution				

b. What do you conclude from this experiment?

Write a laboratory report in groups and present your findings to the rest of the class.

3. Bases neutralize acids.

Bases react with acids (acidic oxides) to form salt and water.

Base + Acid →Salt + Water

Example

$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H2O$

Experiment 3.8

Title: Neutralizing effect of a base on an acid

Objective: To investigate the neutralizing effect of sodium hydroxide on hydrochloric acid.

Materials required: Sodium hydroxide solution, hydrochloric acid, conical flask, phenolphthalein, burette, stand, clamp, measuring cylinder, blue and red litmus papers.

Procedure:

1. Set-up the apparatus as shown in Figure 3.8.
2. Fill the burette with sodium hydroxide.
3. Measure 20 mL of hydrochloric acid solution, pour into a conical flask and add five drops of phenolphthalein.
4. Open the stop cock of the burette; add sodium hydroxide to the acid solution with your one hand, and shaking the conical flask with the other hand.
5. When the colour begins to appear, add the base drop by drop and shaking the flask continuously.
6. When the colour becomes intense, close the stop cock of the burette immediately and check the solution in the conical flask using blue and red litmus papers.

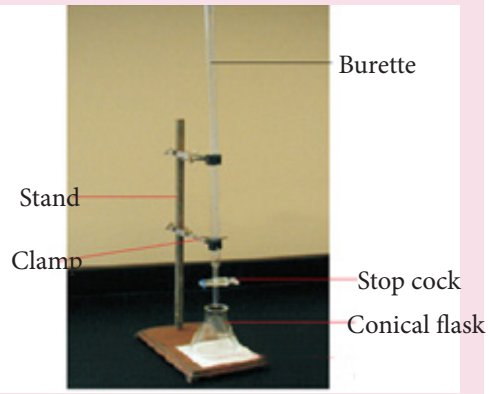


Figure 3.8 Neutralization reactions of hydrochloric acid and sodium hydroxide

Observation and analysis:

a. What colour appeared when phenolphthalein is added to the solution in the conical flask in step 3?
b. Why does the colour appear in step 6?
c. Does the solution obtained in step 6 affect the colour of blue or red litmus paper?
d. Write the balanced equation for the reaction that take place in this experiment.

Write a laboratory report in groups and present your findings to the rest of the class.

Project work

Preparation of natural indicator from beetroot

How do you prepare your own indicator using beetroot at home? Explain.

Hint:-

Materials you will need:

Beetroot 2-3, knife, water, spoon, boiler, lemon juice (citric acid)

Procedure:

1. Take some beetroots, wash them and peel them with the help of a knife.
2. Chop or cut the beetroot into pieces.
3. Put these pieces into a boiler and boil it 30-60 minutes.
4. Filter and collect only juice.
5. Add 5 to 6 drops of beetroot juice to lemon juice and mix it.

Observation and analysis

1. What colour is appear in step 5?
2. Why the colour of orange juice changed after the addition of beetroot juice?
3. Is your indicator effective?
4. What do you conclude from this project work?discuss the characteristics of a good indicator.

Write your report in groups and present your findings to the rest of the class.

Precautions while Working with Acids and Bases

Safety Precautions while Working with Acids

Acids can cause severe burns to exposed skin or severe eye injury or blindness if splashed in your eyes. If taken by mouth, they will cause severe internal irritation and damage. Especially hydrochloric acid, sulphuric acid and nitric acid are dangerous, poisonous and corrosive. Therefore, they must be handled with great care.

The following measures are immediately taken if a concentrated acid is spilled on your skin, enter your eyes or accidentally drink.

- If a concentrated acid is spilled or splashed on your skin, wash thoroughly the affected part with water, and then wash it with 10%

Na_2CO_3 solution.

- If an acid enters your eye, wash thoroughly with water for a long time and then seek medical treatment.
- If you accidentally drink corrosive acids, take a base such as $Mg(OH)_2$ which is available in the pharmacy to neutralize the acid.

Safety Precautions while Working with Bases

Just like acids, bases can cause severe burns to exposed skin or severe eye injury or blindness if enters in your eyes. For example, NaOH and KOH are corrosive and poisonous. Therefore, they must be handled with great care and you have to avoid contact with your skin and other parts of your body while working with bases.

The following measures are useful if a concentrated base is spilled on your skin or enters your eyes.

- If a base is spilled on your skin, wash the affected area with plenty of water and then treat the affected part with a weak acid such as dilute acetic acid to neutralize the base.
- If a base comes into contact with your eyes, wash the eyes with plenty of cold water and advice medical doctor.
- If you drink a base by accident, neutralize it by drinking 1 – 2% dilute solution of acetic acid or lemon juice and then seek medical treatment.
- If a base is spilled on your working table wipe the spillage immediately.
- Whenever bases are splashed on your cloth wash the affected part with running tap water.

Activity 3.10

In this activity you are expected to perform the following task in groups by reading different chemistry reference books. After the discussion, present the group's opinion to the class.

Write laboratory safety rules dealing with the handling of acids and alkalis.

Exercise 3.12

Give the appropriate answers for the following questions.

1. Define acid-base indicator.
2. Write the colour of each of the following indicators in acidic and basic solution.
   a. Litmus paper b. Methyl orange c. Phenolphthalein
3. Complete and balance the following reactions:
   a. $2HNO_3 + Na_2CO_3 \rightarrow$
   b. $2NaOH + H2SO_4 \rightarrow$
   c. $2HCl + Zn \rightarrow$
4. What measures should you take if:
   a. a base enters your eyes?
   b. you accidentally drink an acid?

3.4 Neutralization Reaction and Salts

After completing this section, you will be able to:

- identify some everyday uses of neutralization;
- define and give examples of salts;
- name and write formulas for some common salts using the periodic table, a list of ions, and rules for naming salts.

The reaction of acids with basic oxides or bases to form salt and water is called neutralization reaction.

Applications of Neutralization in Daily Life

Activity 3.11

Form a group and perform the following activity. After the discussion, present the group's opinion to the class.

1. What are the important uses of neutralization in daily life?
2. Why our hairs get rough after applying shampoo and again turn shiny after we add conditioner?

In our everyday life we come across many situations which involve neutralization reactions. The following examples will illustrate common neutralization reactions that occur around us.

Neutralization at Home

- Toothpaste contains bases that neutralize the acid produced by bacteria in our mouth.
- Baking powder is usually used to help the cake rise.
- Conditioner is used with shampoo to prevent small scales on hair which make your hair unmanageable.

Neutralization in Health

- Antiacids contains bases such as aluminum hydroxide ($Al(OH)_3$ and magnesium hydroxide (Mg(OH)2 to neutralize the excess acid in the stomach.
- Vinegar is acidic in nature which is used to cure wasp stings that are alkaline in nature.
- Baking powder is alkaline which is used to cure bee stings and ant bites that are acidic in nature.

Neutralization in Agriculture

- Acidic soil is treated with powdered lime, CaO, limestone, $CaCO_3$ or ashes of burnt wood.
- The acidic gas from the decomposition of compost neutralizes the alkalis in basic soil.

Project Work

Collect different soil samples from different locations and measure their PH values. Which soil sample is more acidic and how to prepare the soil to produce good yields of crops? Write your report in groups and present your findings to the rest of the class.

Salts

What are salts?

The term 'salt' does not refer only to the table salt which we use to make our food. Salts are group of chemicals that are obtained by the reactions of acids and bases. These reactions are called neutralization reactions.

Salt is defined as a compound consisting of the positive ion of a base and the negative ion of an acid. The positive ion in the salt can be that of a metal ion or ammonium ion. Sodium chloride (NaCl), calcium carbonate ($CaCO_3$), potassium nitrate (KNO_3), sodium bicarbonate ($NaHCO_3$), diammonium phosphate ($(NH_4)_2HPO_4$) are examples of salts.

Naming and Writing Formula of Salts

Activity 3.12

Form groups and discuss the following activity. After the group discussion, choose a group representative to present the group's opinion to the rest of class.Write names and formulas of some common salts.

The group names of salts are related to the names of the acids from which they are derived.

Table 3.5 Names of some acids and group names of their salts

Name of the acid	Group name of salt	Example of salt
Carbonic acid, H_2CO_3	Carbonates, CO_3^{2-}	Calcium carbonate, $CaCO_3$
Hydrochloric acid, HCl	Chlorides, Cl^-	Sodium chloride, NaCl
Sulphuric acid, H_2SO_4	Sulphates, SO_4^{2-}	Calcium sulphate, $CaSO_4$
Nitric acid, HNO_3	Nitrates, NO_3^-	Sodium nitrate, $NaNO_3$

The name of a salt is derived from the names of two parts. The first part comes from the base. The second part comes from the acid. You can always work out the name of the salt by looking at the reactants. As illustrative examples, see the following chemical equations:

Sodium hydroxide (base) + Hydrochloric acid (acid) → Sodium chloride (salt) + Water

The name of the salt sodium chloride is obtained by taking the word 'sodium' from the name of the base and 'chloride' from the name of the acid by dropping the word 'hydro' and changing the ending '-ic acid' to '-ide'.

Follow the following simple rules to write the formula of salts.

1. Break the name of the salt up into the name of the cation (positive ion) which is derived from base and the name of anion (negative ion) which is derived from acid.
2. Use the cation's name to determine the formula for the cation and anion's name determine the formula for anion.
3. Now criss cross the charges and put the numbers below the formulas.

Example:

a. Write the formula of Calcium carbonate.

1. Name of cation is calcium and name of anion is carbonate.
2. Formula or symbol of cation is Ca^{2+} and anion is CO_3^{2-}

3. $Ca^{2+} \nearrow\!\!\searrow Co_3^{2-} = Ca_2(CO_3)_2$, Simplify and write the simplest formula of the salt.Thus, the formula of calcium carbonate is $CaCO_3$

Exercise 3.13

Give the appropriate answers for the following questions.

1. What are the applications of neutralization in everyday life?
2. Write the formula of the following salts.
   A. Sodium chloride B. Potassium nitrate
   C. Calcium carbonate

Uses of Some Salts

Activity 3.13

In this activity you are expected to perform the following tasks in groups by reading different chemistry reference books.

1. Prepare a table as shown below and fill in with required information. Prepare five minutes presentation on the uses of the salts listed below.

Name of the salt	Formula of the salt	Uses
Sodium chloride		
Sodium bicarbonate		
Potassium nitrate		

Key Terms

- Acid
- Acidic oxide
- Alkali
- Alkane
- Alkene
- Alkyne
- Base
- Basic oxide
- Hydrocarbon
- Indicator
- Inorganic compound
- Metallic oxide
- Neutralization
- Non-metallic oxide
- Organic compound
- Oxide
- Salt

SUMMARY

- Chemical compounds can be broadly divided into two groups called organic and inorganic compounds.
- Organic compounds contain primarily carbon and hydrogen atoms, plus nitrogen, oxygen, sulphur, and atoms of other elements except the oxides of carbon, carbonates, and hydrogen carbonates.
- Hydrocarbons are compounds of carbon and hydrogen only.
- Hydrocarbons are classified as alkanes, alkenes and alkynes.
- Alkanes (paraffins) have the general formula C_nH_{2n+2} where n = 1, 2,3,…
- Alkenes (olefins) have the general formula C_nH_{2n} where n = 2, 3, 4, ….
- Alkynes have the general formula C_nH_{2n-2} where n = 2, 3, 4, ….
- Inorganic compounds are non-carbon containing compounds except the oxides of carbon, carbonates, and hydrogen carbonates.
- Inorganic compounds are classified as oxides, acids, bases, and salts.
- Oxides are binary compounds containing oxygen and any other element such as metal, non-metal or metalloid.
- Oxides are classified as acidic and basic oxides depending on their properties.
- Acidic oxides are non-metallic oxide that reacts with water to form acidic solution.
- Basic oxides are metallic oxide that reacts with water to form basic solution.
- Acids are compounds that release hydrogen ions (H^+) when dissolved in water.
- Alkalis are substances that release hydroxide (OH^-) ions in aqueous solution.
- Bases are compounds that neutralize acids to form salt and water.

- An alkali is a substance that releases hydroxide ions in aqueous solution.
- Acids and bases are dangerous and corrosive. Therefore, they must be handled with great care and you have to avoid contact with your skin and other parts of your body while working with bases and acids.
- Indicator is a substance that indicates whether a solution is acidic or basic by undergoing specific color changes when placed in a solution.
- Neutralization is the reaction of acids with bases to form salt and water.
- Neutralization is very important in our daily life. For example, at home, in health and in agriculture.
- Salts are compounds that contain positive ions derived from bases and negative ions derived from acids.
- The names of inorganic compounds can be deduced from a set of simple rules. The formulas can be written from the names of the compounds.

REVIEW EXERCISE

I. Choose the correct answer from the given alternatives for each of the following questions.

1. Which of the following is the first organic compound synthesized from inorganic compounds?
   A. NH_4CNO B. $(NH_2)_2CO$
   C. AgCNO D. NH_4Cl
2. All of the following compounds are hydrocarbons except:
   A. ethane B. ethene
   C. ethyne D. alcohol
3. The general formula of alkene is:
   A. C_nH_{2n} B. C_nH_{2n+2}
   C. C_nH_{2n-2} D. C_nH_{2n+1}
4. Which one of the following formula represents an alkene containing eight carbon atoms?
   A. C_8H_8 B. C_8H_{16}
   C. C_8H_{18} D. C_8H_{14}
5. Which of the following formula represents an alkane containing six carbon atoms?
   A. C_6H_{12} B. C_6H_{14}
   C. C_6H_{10} D. C_6H_{13}
6. The general formula of alkyne is:
   A. C_nH_{2n} B. C_nH_{2n+2}
   C. C_nH_{2n-2} D. C_nH_{2n+1}
7. Which of the following compound is found in all alcoholic beverages?
   A. Ethanol B. Formalin
   C. Butanol D. Propanol
8. Which of the following compounds can be used for oxyacetylene torch?
   A. Propane B. Ethene
   C. Ethyne D. Acetic acid

9. The characteristic property of a base is due to the presence of:
   A. hydride ions B. hydroxide ions
   C. hydrogen ions D. all
10. Which of the following is an example of acidic oxide?
   A. Sulphur dioxide B. Calcium oxide
   C. Barium oxide D. Sodium oxide
11. Which of the following is an example of basic oxide?
   A. SO_3 B. N_2O_5
   C. P_4O_6 D. Na_2O
12. Which of the following oxides reacts with water to form an acidic solution?
   A. CaO B. Na_2O
   C. CO_2 D. NO
13. Which one of the following statements is true about oxides?
   A. Oxides are binary compounds containing oxygen.
   B. All non-metallic oxides are acidic oxides.
   C. All metallic oxides are basic oxides.
   D. all
14. What is the missing product 'X' and 'Y' in the following equation?
   $NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow X + Y$
   A. Na_2SO_4, H_2O
   B. Na_2SO_4, H_2
   C. NaCl, H_2O
   D. Na_2SO_4
15. Which of the following salts is used as making gun powder?
   A. NaCl B. $NaHCO_3$
   C. $CaCO_3$ D. KNO_3
16. Which one of the following cannot be used for neutralizes the acidic soil?
   A. CaO B. $CaCl_2$
   C. $CaCO_3$ D. $Ca(OH)_2$

17. Nitrates are salts of:

A. Hydrochloric acid B. Sulphuric acid

C. Phosphoric acid D. Nitric acid

II. Give short answers for each of the following questions.

18. Give the name of:
    a. an alkyne containing 10 hydrogen atoms.
    b. an alkene containing 10 carbon atoms.
    c. an alkane containing 8 carbon atoms.
19. Write the molecular formula of:
    a. Nonane b. Heptene c. Decyne
20. Define the following words:
    a. Organic compound
    b. Hydrocarbon
    c. Inorganic compound
    d. Acid
    e. Base
    f. Salt
21. Write the formulas of the following compounds.
    a. Nitric acid b. Sodium sulphate c. Potassium hydroxide
22. Write the names of the following compounds.
    a. $H2SO_4$
    b. Ca(OH)2
    c. KNO3

UNIT FOUR

HUMAN BODY SYSTEMS AND HEALTH

Learning Outcomes:

At the end of this unit, you will be able to:

- list down the major organs that constitute the human body systems;
- explain the main functions of the major human body systems.
- list down the main diseases or disorders associated with the major human body systems;
- discuss the effects of diseases of the major human body systems;

Main contents

4.1 Integumentary System
4.2 Muscular System
4.3 Skeletal System
4.4 Digestive System
4.5 Respiratory System
4.6 Circulatory System
4.7 Reproductive System

Introduction

Human body parts must be keeping healthy by take care with different methods. In human there are different types of body systems with specific types of functions like that of integumentary systems, muscular systems, skeletal systems and so on. In this unit you will learn about the components, function and disease or disorders of some types of human body systems.

4.1 Integumentary Systems

At the end of this section, you will be able to:

- distinguish the major structural components of human integumentary system;
- describe the main functions of human integumentary sytem;
- explain, by giving examples, how structure and function are related;
- identify and discuss the main diseases or disorders associated with human integumentary system.

Key term:-
Wax:- substance produce in ear and prevent entrance of dust and pathogens in to ear.

Did you know?
Skin is body's largest and heaviest organ covers 1.5 to 2m2; composes 15% of body weight.

Activity 4.1:-
Identify and discuss on the parts of integumentary systems
- The teacher show for you the charts of integumentary systems.
- Then, present your observation results for the class mate

What are integumentary systems?

The integumentary systems are the organ of the body that forms a physical barrier between the external environment and the internal body part that it serves to protect and maintain. The integumentary system includes the skin, associated glands, hair, and nails.

4.1.1 Components of integumentary system

The integumentary systems are the human body systems that used to perform different types of functions such as protection and excretions. These systems have some components like skin, hair, nail, and glands.

Table 4.1: parts of integumentary systems and their functions

Parts	Functions
Skin	covers the internal parts of the body
Hair	keeps your skull warm,beauty in women
Nail	Protect inner part of finger and toe
Glands	Secret important substances

Key term:
Thermoregulation:- The process of temperature regulations in body.

Activity 4.2

Discuses on the layers of human skin

In groups discuss on skin layer and their functions

-and then present for the class mate.

1. Skin: -

The skin is the outer layer of the body that covers the internal parts of the body. Human skin has three major layers. These are:-

A. Upper layer

This layer is the outer most layer of the skin and called epidermis which is made up of dead cells. These used to reduce excess water loss, protect from light ray (UV light) and entry of disease causing microorganisms.

B. Middle layer

This layer is the dermis which containing blood vessel (which are responsible for thermoregulation), lymph vessel, sweat gland, sensory receptors and hair follicles.

C. Lower layer

This layer of skin also called hypodermis, which contains fatty tissue that used to store energy and act as an insulation layer that means protecting you from loss of excess heat.

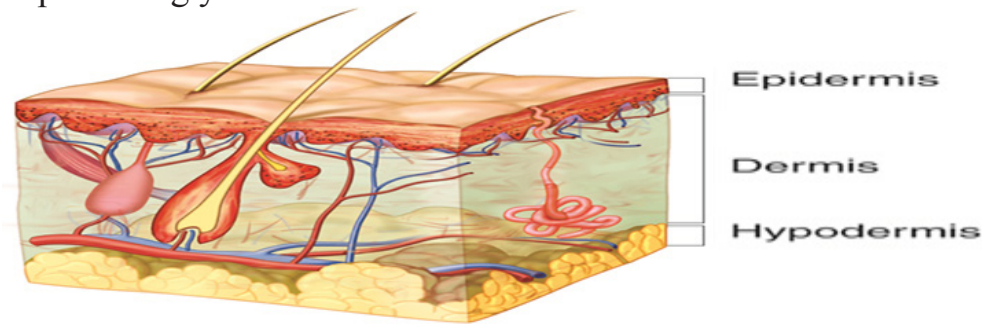


Figure 4.1 Layers of human skin

2.Hair: -

Haircome from follicles,which are simple organs made up of cell called epithelial cells. Hair is made up of different structures and layers. The outer layer of hair is shaft that made up of dead cell that turned in to keratin and binding materials.The hair shaft is formed from three layers.

A. Medulla: deepest layer of hair shaft, only seen in large and thick hairs.

B. Cortex: middle layer of hair shaft which provide strength, color and texture of hair fibre.

C. Cuticle: outer layer of hair shaft is thin and colorless. It serves as protection of the cortex. These hairs are used to help protect the skin, regulate body temperature, and lend itself to the evaporation and perspiration process.

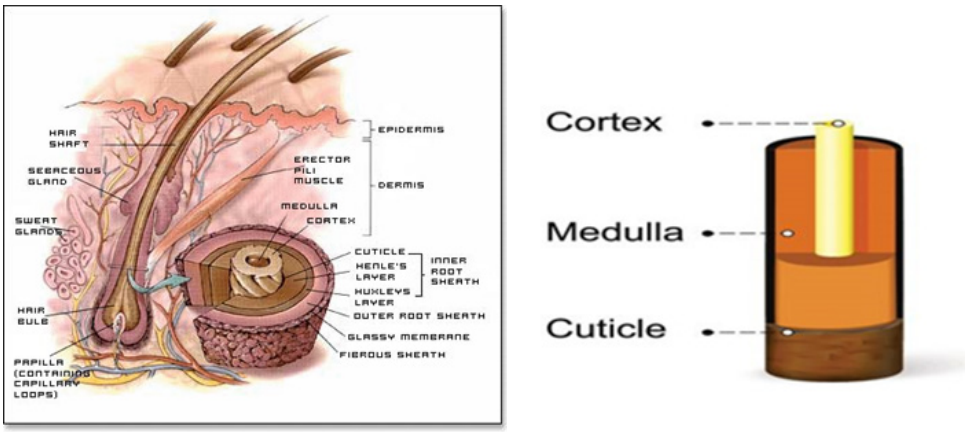


Figure 4.2 layers of hair shaft

3. Nail: It is the hard covering at the end of the finger or toe. Like other body parts, it consists of several parts including:

- **The nail plate:** The part of the nail that is visible.
- **The nail bed:** The skin that lies beneath the nail plate.
- **The cuticle:** The thin line of tissue that is located at the base of the nail and overlaps the nail plate.
- **The nail folds**: The folds of the skin located on the sides of the nail plate.
- **The lunula:** The white-colored half-moon-shaped area.
- **The matrix:** Part of the nail that is not visible, located underneath the cuticle, this is the area responsible for the growth of the fingernail.

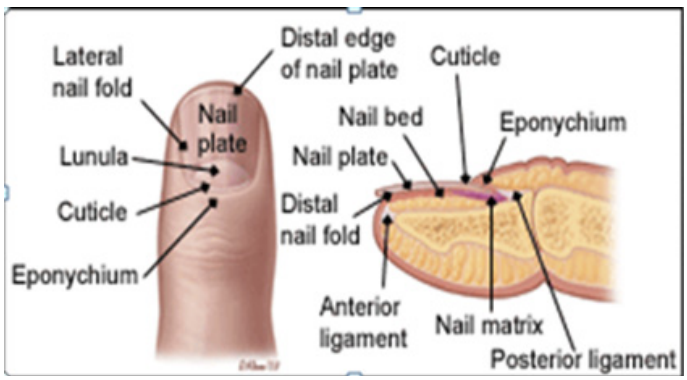


Figure 4.3 structures of human nail

4. Gland: is an organ that make one or more sustances such as hormone digestive juice, sweat, tear, saliva or milk. Integumentary systems have four types of exocrine glands, that secrete some type of substances outside the cell and body. These includes

- **Sudoriferous glands:** sweat glands that are hollow, cylindrical under skin, that excrete sweat through small opening at the skin surface.
- **Sebaceous glands:** very small tubular shaped glands in dermis which used to release oil in to the hair follicle to help lubricate and protect the hair shaft, keeping it from becoming hard and brittle.
- **Ceruminous glands:** located in ear canal and it produce ear wax (medically coined cerumen) for protections.
- **Mammary glands:** In female, the gland functions to produce breast
- milk after giving birth.

Key term:-
Exocrine gland:-a gland that release their secretion through ducts or openings.

Exercise 4.1

Part I:choose the best answer from the given alternatives

1. Which of the following is not parts of integumentary
   A/ hair B/ skin C/ glands D/ nail E/ kidney
2. The outer layer of the human body is _____
   A/ gland B/ skin C/ nail D/ all
3. The middle layer of the skin is _____
   A/ dermis B/ hypodermis C/ epidermis D/ endodermis
4. Layers of skin that made from dead cell are called _____
   A/ upper layer B/ lower layer C/ meddle layer D/ all
5. The outer layers of the hair is _____
   A/ medulla B/ cuticle C/ cortex D/ none

Part II: describe briefly

1. Briefly describe the structural components of the integumentary systems with their functions.
2. List the functions of the sweat glands.

4.1.2. Functions of Integumentary Systems

The skin is remarkably complex organ which carries out a number of important functions in your body. Some of these functions are, include serving as an enclosing barrier and providing environmental protection, regulating temperature, producing pigment and vitamin D, sensory perception and homeostasis. Besides the skin also contain many numbers of sense organ which are sense of touch, temperature, pressure and pain.

The primary function of human hair is to insulate the human body. It does this in two ways. First it serves as a physical barrier between external cold air and the skin, and in the second it also traps warm air in between the skin and the hair, keeping the body warmer. The nail used to protecting the upper end of each finger and toe of humans and most other organisms from injury and also used for sensation with sense of touch.Glands in the body are used to secret different chemicals. Some types of glands are used to excrete wastes, cooling down the body, release oil in to the hair follicle, produce ear wax for protections, and also used to produce breast milk for feeding the baby.

Activity 4.3

Brainstorming on the disease of the skin

Procedure:-

- make a groups and list skin diseases from you personal knowledge
- and then list them for the class mate students.

4.1.3. Major Skin Diseases and Disorders

Skin diseases are a broad range of conditions affecting the skin, and include diseases caused by bacterial infections, viral infections, fungal infections, allergic reactions, skin cancers, and parasites.

Skin disorders vary greatly in symptoms and severity. They can be temporary or permanent, and may be painless or painful. While most skin disorders are minor, others can indicate a more serious issue. There are many different types of skin disorders. Here is some list:

- **Acne:**

Commonly located on faces, neck, shoulders, chest, and upper back. May leave scars or darken the skin if untreated. Its symptoms are tips, large, solid, painful,lump under the skin. Caused by when the pores of your skin become blocked with oil, dead skin or bacteria



Figure 4.4 Acne

- **Rosacea:**

The skin condition rosacea is most commonly associated with redness. However, there are four sub types that cause other symptoms as well.

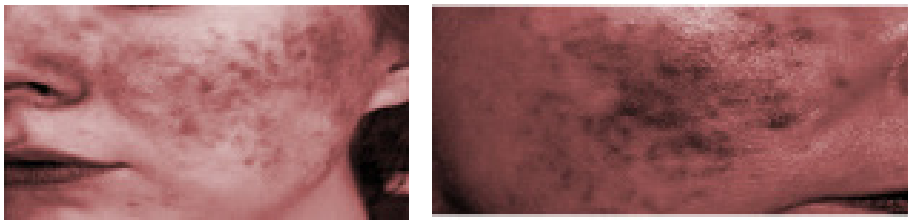


Figure 4.5 rosacea

- **Eczema:**

These are the range of persistent skin conditions. These includes dryness and recurring skin rashes that characterized by red ness, skin swelling, itching and dryness, crusting, cracking or bleeding etc.

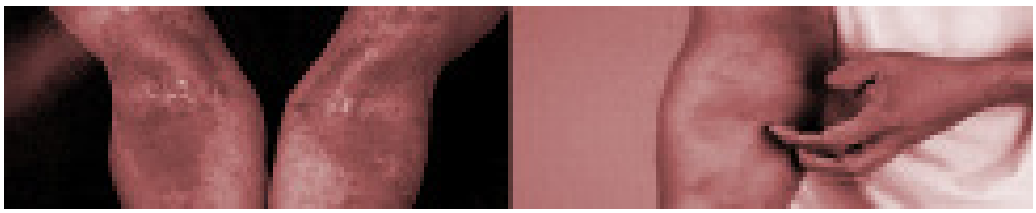


Figure 4.6 Eczema

- **Hives:**

Hives are itchy welts that are raised up from the normal layer of the skin. It is frequently caused by allergic reactions in the body but it also caused by outside factors such as stress, illnesses, or tight clothes.

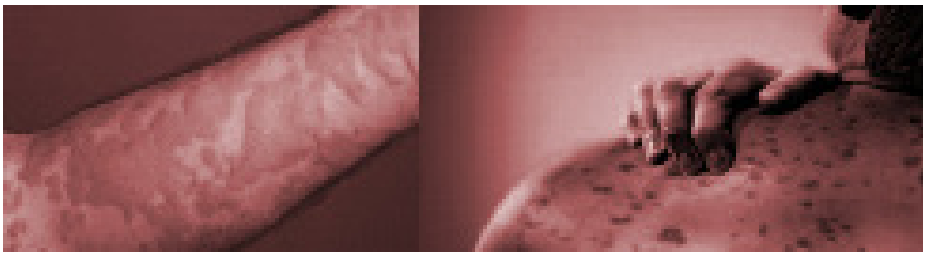


Figure 4.7 Hives

- **Warts:**

It typically occurred on humans' hands or feet but often in other locations. It caused by viral infections especially by human papilloma virus (HPV). They often go away on their own, though unsightly warts can be treated with liquid nitrogen or medicated creams.



Figure 4.8 Warts

- **Cold sore**:

A cold sore is a red, fluid-filled blister usually found near the mouth. The sore itself is painful or delicate. Other symptoms include itching or burning sensations on the site before the sore is visible. Cold sores are caused by the herpes simplex virus, and there is no known cure for the virus.



Figure 4.9 Cold sore

- **Carbuncle:**

When Staphylococcus aureus bacteria make their way into the hair follicles and cause an infection, a carbuncle is produced. This is a red, irritated lump underneath the skin. Carbuncles can be nearly any size, and the lump quickly fills with pus and becomes swollen. Other symptoms include tiredness, itching on the site of the lump, and fever. Carbuncles are treated with antibiotics and antibacterial washes.

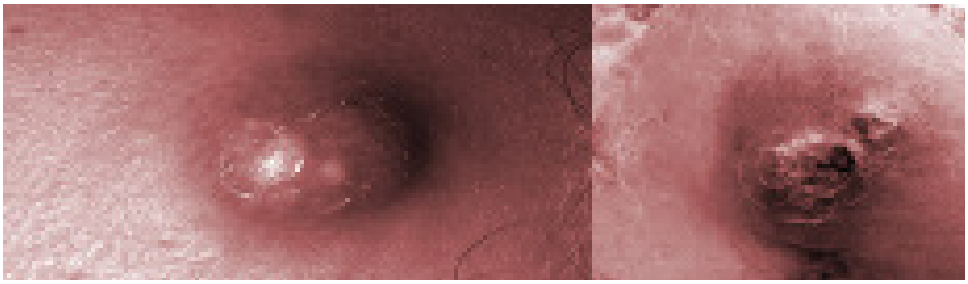


Figure 4.10 Carbuncle

- **Blister:**

A blister is a bubble of fluid under the skin. The clear, watery liquid inside a blister is called serum. If the blister remains unopened,serum can provide natural protection for the skin beneath it. Blisters exactly heal by

1. Wash hand and blister by soap warm water
2. Swap blister by iodine
3. Sterilize clean, sharp needle with rubbing alcohol etc.

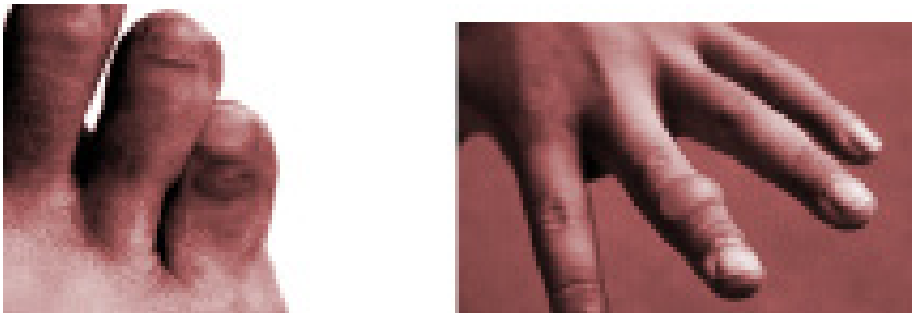


Figure 4.11 Blister

- **Actinic keratosis:**

An actinic keratosis is a rough, scaly patch on the skin that develops from years of sun exposure. It's often found on the face, lips, ears, forearms, scalp, neck or back of the hands.

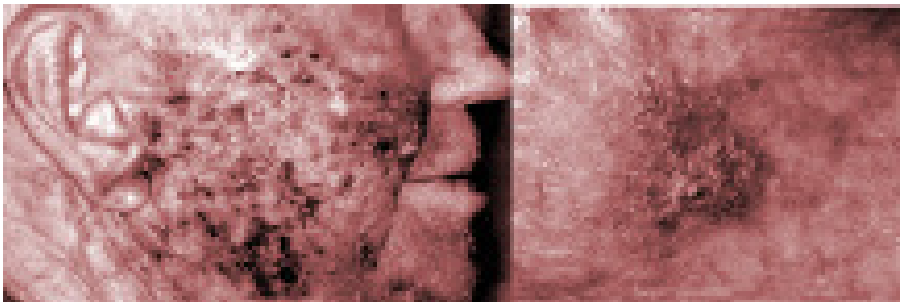


Figure 4.12 Actinic keratosis

- **Latex allergy:**

Latex allergy is a reaction to certain proteins found in natural rubber latex, a product made from the rubber tree. Latex allergy may cause itchy skin and hives or even anaphylaxis, a potentially life-threatening condition that can cause throat swelling and severe difficulty breathing.

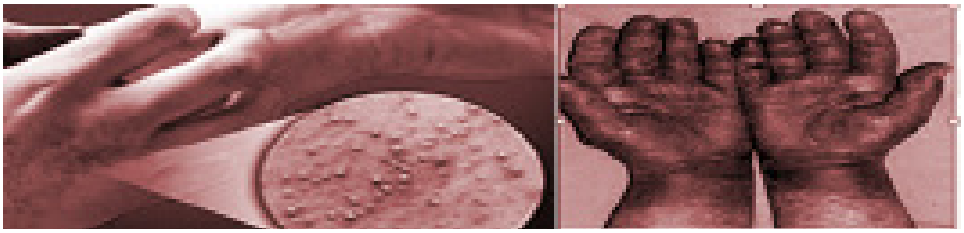


Figure 4.13 Latex allergy

- **Chickenpox:**

Chickenpox consists of an itchy, red rash that breaks out on the face, scalp, chest, back and, to a lesser extent, arms and legs. The spots quickly fill with a clear fluid, rupture and then turn crusty. Chickenpox is an infection caused by the varicella-zoster virus.



Figure 4.14:- Chickenpox

Exercise 4.2

Part: I: choose the best answer from the given alternative

1. Which of the following is outer layer of skin?
   A. lower B. hypodermis C. epidermis D. dermis
2. The outer layer of the body is called _____
   A. lung B. hair C. skin D. gland
3. Which one of the following is not used to prevent skin diseases?
   A. washing B. keep skin moist C. avoid smoking
   D. good sanitations E. none
4. ___is a skin disease and characterized by bubble of fluid under the skin
   A. hives B. rosacea C. cold sore D. blister

Activity 4.4:

1. Compare and contrast in your groups on the severity of different skin diseases.
2. What do you do, if your skin color is changed to redness?
3. How you take care about your skin?

4.2 Muscular System

At the end of this section, you will be able to:

- distinguish the major structural components of human muscular system;
- describe the main functions of human muscular system;
- identify and discuss the main diseases or disorders associated with human muscular system.

What are muscular systems?

Muscles are tissues that composed of cells that are called muscle fibers. Muscles can be used to perform different types of body movements like pumping blood, stability, posture, digestions, circulations, breathing air in and out etc. Muscular systems are the collection of systems.



Figure 4.15 Muscular structures of human

4.2.1. Components of Muscular System

There are three distinct components of muscular systems these are skeletal muscles, cardiac or heart muscles, and smooth (non-striated) muscles

Skeletal muscle

What are skeletal muscles?

Skeletal muscles are the only muscles that can be consciously or voluntarily controlled. They are contracting the muscles causes' movement of those bones. E.g chewing, talking, facial expressions, drinking. They found attached to the end bone.

Smooth muscle

What are muscular muscles?

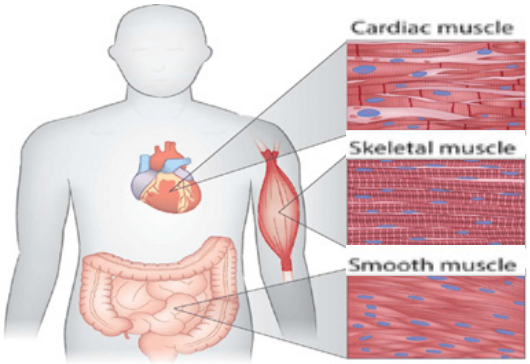
Smooth muscle lines the inside of vital organ blood vessels, eye, air-way and organs such as the stomach, digestive, reproductive, urinary tracts, and others. Smooth muscle acts involuntarily and cannot be consciously controlled.

Key term:
Auto rhythmic:- capable of contracting spontaneously without hormonal control.

Cardiac muscle

What are cardiac muscle?

Located only in the heart, cardiac muscle pumps blood around the body by involuntary action. They are auto rhythmic. Cardiac muscle stimulates its own contractions that form our heartbeat.



Did you know?
The muscles account for around 40 percent of a person's weight with the largest muscle in the body being the gluteus Maximus in the buttocks.

Figure 4.16 human muscle

Activity 4.5:
Discuss on the properties of muscle cell
Procedure: discuss in groups about the property of muscle cell
- Then present your results for the class

Exercise 4.3
Part I: describe briefly the following questions
1. Brainstorming and list on the structure and functions of muscle cell from previous class.
2. List some types and functions of your muscle from your previous class.
3. Identify special properties of muscle cell that allow movements.
4. Discuss and mention in your groups about muscle disease from your experiences.

4.2.2 Function of Muscular Systems

The muscular system consists of various types of muscle that each plays a crucial role in the function of the body. Muscles allow a person to move, speak, and chew. They control heartbeat, breathing, and digestion. All muscles cells can share the different types of properties for functions and used commonly by each muscles. Some of these properties are:-

- **Contractility:** is the ability of muscle cells to forcefully shorten. In order to contract or flex the angle of your joint is decrease then your elbow contract or shorten. Then your muscle can only pull but never push.
- **Extensibility:** is the power of the muscle to be stretched. In human body the extensibility of muscle is very high at the age of adults. But when the age goes up extensibility reduced and it is called spasticity.
- **Excitability:** is ability of muscle to give response to stimuli which come from motor neuron and hormone.
- **Elasticity:** it is the quality or state of being elastic and capability of strained body to recover its size and shape after deformations.

Activity 4.6:-

1. Discuses on the disorders of the muscle
2. What happen on the muscle when the age of human is increased?

Procedures: discuss in groups and present for class mate students.

- Explain briefly in your groups and present in class

4.2.3. Major Muscle Disease and Disorders

Muscle Disorders are the diseases that affect the human muscle system and their main manifestation is skeletal muscle weakness. They can be caused by different types of factors and make the muscle weak and reduction of its strengths. There are many disorders but some of these are:-

- **Muscular dystrophy**

A group of inherited diseases characterized by weakness and wasting away of muscle tissue, with or without the breakdown of nerve tissue. Its different types involving an eventual loss of strength, increasing disability, and possible deformity.

- **Muscle strains**

A muscle strain is an injury to a muscle or a tendon the fibrous tissue that connects muscles to bones. Sometimes called pulled muscles, strains commonly occur in the lower back and in the muscles at the back of the thigh (hamstrings).

Exercise 4.4:-

Part I: choose the best answer from the given alternatives

1. Muscle are tissue that composed of cells are called _____.
   A. long B. muscle fibers C. muscle fatigue D. all
2. One of the following is not common for all muscles.
   A. contractility B. excitability C. extensibility D. none

Part II: fill in the blank space

1. The quality of muscle being elastic is called _____
2. _____ is a type of muscle located on the hearts
3. The disease that infected muscle systems is called _____.

4.3. Skeletal System

AT the end of this section, you will be able to:

- distinguish the major structural components of human skeletal system;
- describe the main functions of human skeletal system;
- identify and discuss the main diseases or disorders associated with human skeletal system;

The skeletal system interacts with other systems by holding up your body and giving it support. The muscular system is what connects bones to bones, and the nervous system controls our movements.

4.3.1. Structural Components of Skeletal System

The skeletal system consists of components of bones and connective tissue, including cartilage, tendons, and ligaments. It's also called the musculoskeletal system.

A. Bone: It is mineralized connective tissue that contains collagen and other minerals like calcium phosphate and mineral crystal. Because of calcium phosphate the bones are firmness, compact or spongy, provide and protection of body's organ. They are made up of living cells and so called living organs. An adult human skeleton contains 206 bones.



Figure 4.17 human bone

Types of bone

Bones are a major component of the skeletal system. Based on their shape bones can be divided in to four major groups:-

1. **Long bones:** it is hard and compact, tubular filled with yellow bone marrow. E.g. Upper and lower limb, arm, leg, finger, and thigh bones.

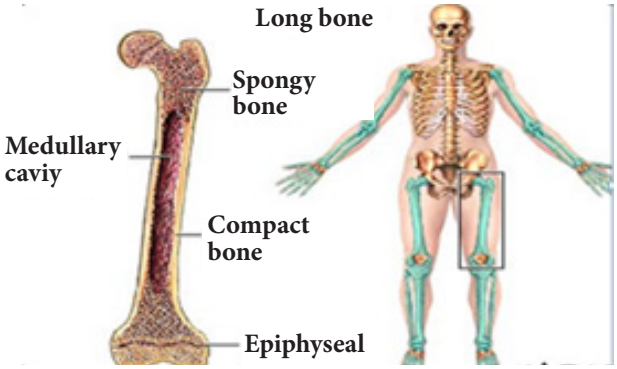


Figure 4.18 long bone

2. Short bone: are compact bones with chambers or partitions but without marrow. E.g wrist, finger, toes and ankle bone.

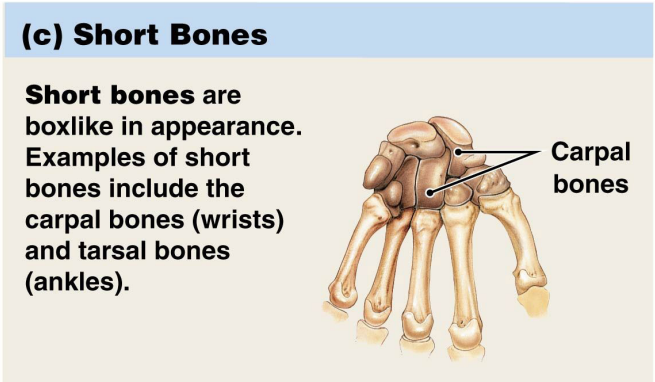


Figure 4.19 short bone

3.Flat bones: are thin, flat, compact and typically curved. They have no cavity or hollow.E.g ribs, sternum, cranial bone and scapula.

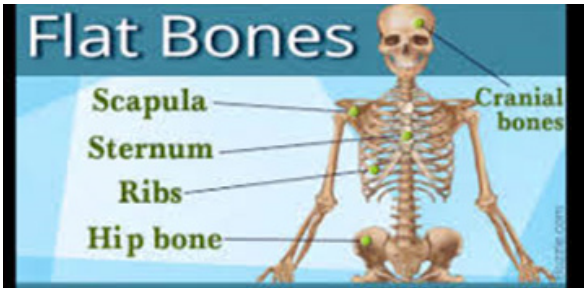


Figure 4.20 flat bone

4. Irregular bones: they are typically thin membranes which have nerves and blood vessels that nourish the bone. On their surface there are small holes for entry and exit of materials in to and out of bone.E.g hip bones, facial bones and vertebrae



Figure 4.21 irregular bone

Additionally bones are also divided into two major groups by based on their positions.

1.Axial skeleton: That divides the body into equal right and left regions. They include skull, hyoid, vertebral column, and thoracic cage.

• Skull: include bone of cranium, face, and ears (auditory ossicles).

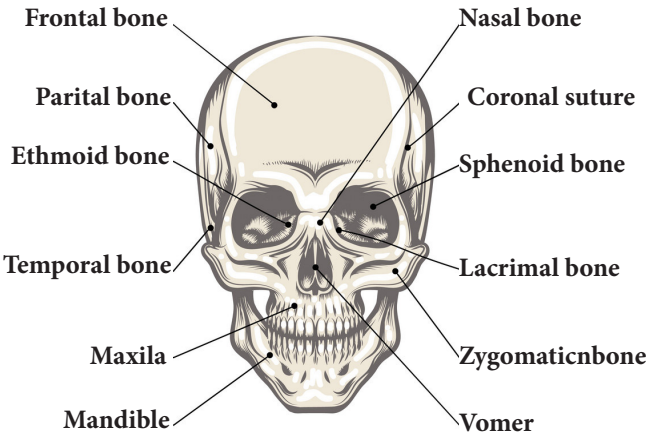


Figure 4.22 human skull

• Hyoid: U-shaped bone in neck between larynx and chin.

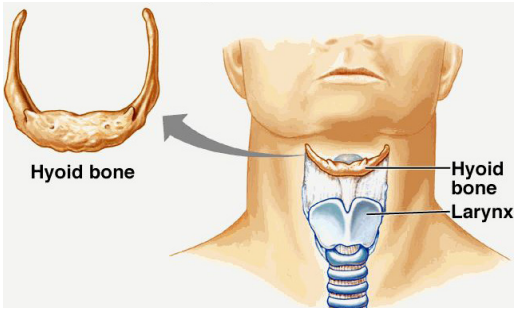


Figure 4.23 hyoid bone

• Vertebral column: Include spinal vertebrae.

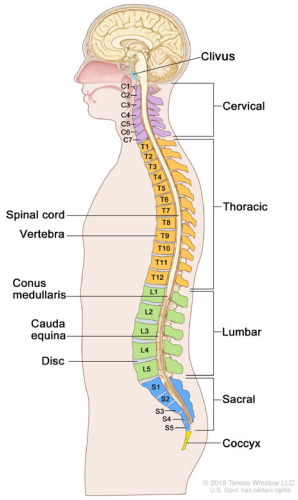


Figure 4.24 Vertebral column

- ***Thoracic cage:*** includes ribs and sternum (breast bone).

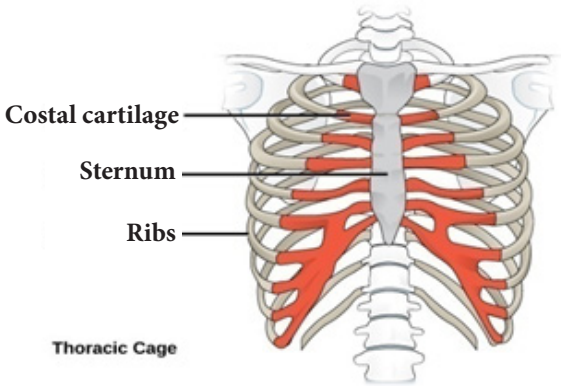


Figure 4.25 Thoracic cage

2. ***Appendicular Skeleton:*** It supports the limbs and connects them to the axial skeleton. It composed of bones of the upper and lower limbs, pectoral girdles, and the pelvic girdle. The main functions of this skeleton are body movements, protections of digestive, execratory and reproductive organ systems.

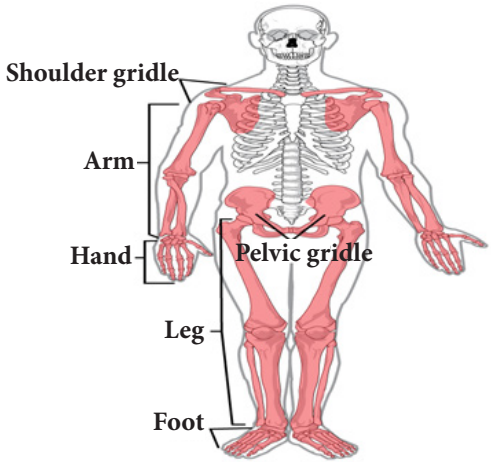


Figure 4.26 Appendicular skeleton

Major components of appendicular skeletons are:

- ***Shoulder bones:*** The shoulder bones are composed of clavicle and scapula. The clavicle or collar bone is connected to the sternum in front while the scapula bone is at the back. E.g pectoral girdle.



Figure 4.27 Pectoral girdle

- ***Limbs or appendage:*** The fore limbs are the front limbs that refer to the arms, the forearms and the hands. It consists of various types of bones such as Humerus (upper arms), Radius (inner lower arms), Ulna (outer lower arms), Carpals (wrists), and Metacarpals (hands) and Phalanges (fingers).

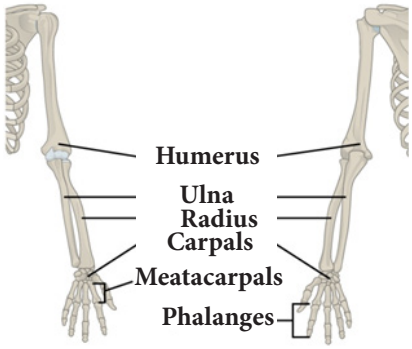


Figure 4.28 Limbs or appendage

- ***Hip bones:*** This bone also called hip girdle and composed of two hip bones. E.g pelvic girdle

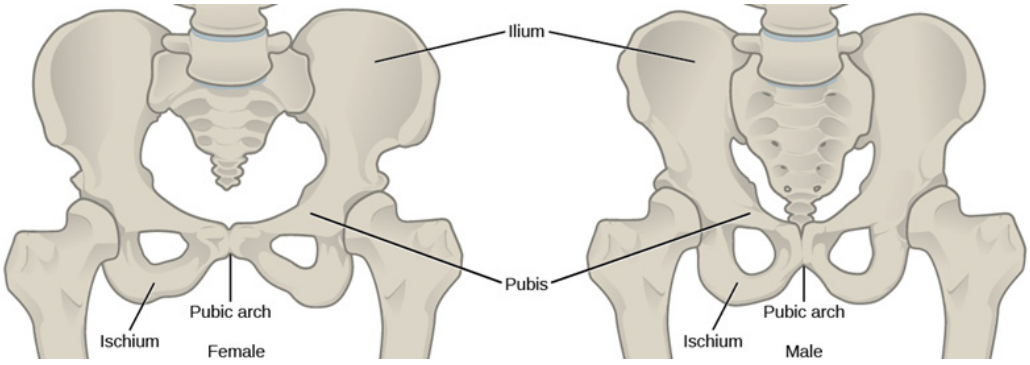


Figure 4.29 Pelvic girdle

- **Hind limbs:** The hind limbs are the back limbs or appendages and consist of different bones. These bones include: Femur (upper leg or thigh), Tibia and Fibula (lower legs or shin), Patella (kneecap) Tarsals (ankles), Metatarsals (feet), and Phalanges (toes). E.g lower limbs.

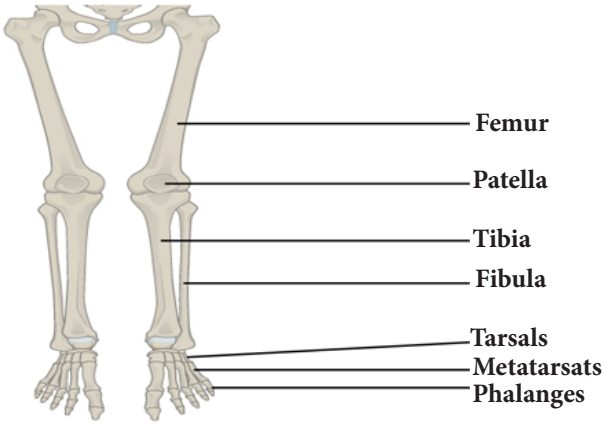


Figure 4.30 lower limb

B. Cartilage: Cartilage provides flexible and elasticity structures support for certain structures in adult humans, including the nose, trachea, and ears.

C.Tendon: It is a fibrous band of connective tissue that is bonded to bone and connects muscle to bone.

D.Ligament: It is stretchy and flexible band of tissue which held together at the joints or in between the bones of a joint and it is a firm rubbery tissue.

E. Joints: It is a site where two or more bones or other skeletal components are joined together. It has two main jobs, which are keep bone far apart and to hold bone in place as they move or rotate.

Types of joints

There are two different types of joints, namely immovable and movable joints.

1. **Immovable joints:** are fixed in place and do not move at all. E.g skull.
2. **Moving joints:** permits to move up and down or twist and bend in some directions. It grouped in to two. E.g hinge joint, ball and socket joints.

- **A hinge joint:** it looks like a hinge on a door which permit the movements front and back in a single direction. The joints that located on elbow, knee, fingers, and toes are the best examples.
- **A ball and socket joint:** it made from the round end of one bone that fitting into a cup shaped socket in another. These types of joints can permit movements in every directions. E.g. shoulder and hips joints

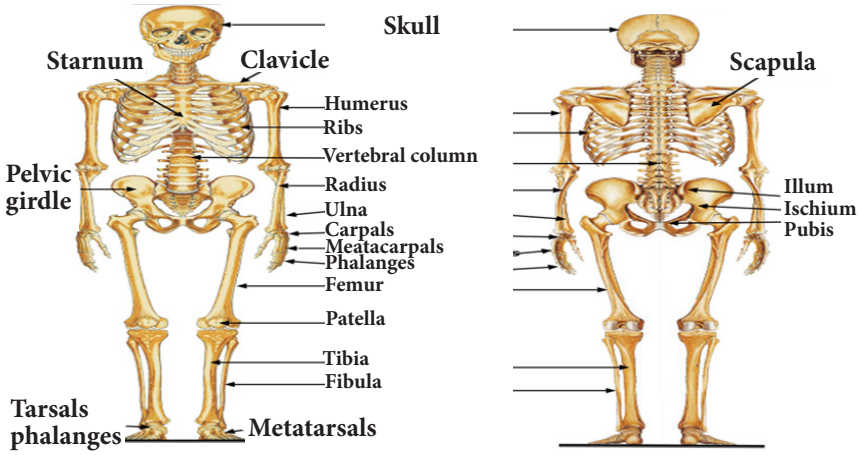


Figure:-4.31 human skeletal systems

4.3.2 Functions of Skeletal System

Human skeleton are extends throughout the body like other vertebrates which have spine for supporting the body, skull protecting the brain, and ribs protecting the organ of heart and lung. Some functions of skeleton systems for organisms are:-

Movements

The skeleton supports your body weight to help you stand and move. Joints, connective tissue and muscles work together to make your body parts mobile and transport from one place to the other places.

Produces blood cells

One of the components of skeleton, the bone contains bone marrow. They are site of blood cell formation (WBC and RBC) and occur in normal adult.

Protection and supports

The skeletal systems mainly protect and support the body of an organism. They also give the form and structure of the body.

Storage substance

It stores different types of minerals, like mineral salt, calcium, fats in bone marrow and calcium phosphate that is needed for blood clotting, nerve function, and muscle activity.

Activity 4.7:- briefly identify and explain the following questions

- Explain the role of the human skeletal system
- Labelle and identify bone of body parts from the chart when your teacher show for you.

4.3.3 Major Diseases of Skeletal System

There are a numbers of diseases which can affect the skeletal systems of human. Some of these are:-

- **Leukemia:** Leukemia is cancer of the body's blood-forming tissues, including the bone marrow and the lymphatic system.
- **Osteopenia,** osteitis, deformans and osteomalacia : similar to osteoporosis, these are other types of bones loss.
- **Osteoporosis:** Osteoporosis literally means 'porous bone'. It is a condition where bones become thin and lose their strength, as they become less dense and their quality is reduced.
- **Osteoarthritis:** is involving degradation of joints. Its symptom is joint pain, tenderness, stiffness, locking and sometimes an effusion.
- **Fracture:** is in which there is a break in the continuity of the bone. It may be a partial or complete break in the bone.

Exercise 4.5

Part I: choose the best answer from the given alternatives

1. How many numbers of bones are found in adult human?
   A. 126 B. 80 C. 206 D. 106
2. Which of the following is not examples of axial skeleton
   A. skull B. hyoid C. thoracic D. none
3. _____ is a joint that fix in place and do not move.
   A. movable joint B. immovable joint C. ligaments D. all

Part II:Match descriptions in column B with the items in column A.

"A"	" B"
1. Irregular bone	A. filled with yellow bone marrow
2. Flat bone	B. finger, toes, wrist
3. Long bone	C. have blood vessel and nerve
4. Short bone	D. cranium, scapula, ribs

Part III: fill in the blank space

1. Shoulder bone composed of _____and _____
2. _____ run through your body from front to back and divide the body into equal right and left regions.

Part VI: briefly describe

1. During which stage of development that we tend to have less total number of bones? Why?

Activities 4.8:- briefly identifies and explain the following questions

1.What are the differences between axial and appendicular skeletons?
2. Discuss and report on some roles of bone of lower extremities.
3. Reason out, why joints are important at articulations of two or more bones?
4. List and discuss many skeletal system diseases.

4.4. Digestive System

At the end of this section, you will be able to:

- distinguish the major structural components of human digestive system;
- describe the main functions of human digestive system;
- identify and discuss the main diseases or disorders associated with human digestive system.

What does it mean digestions?

Digestion is the process in which the larger, complex, hard and insoluble food substances are changed into smaller, simpler, easier and soluble by the action of the digestive organs.

Such types of food molecules are can be easily usable by the body cells. In the activity of digestion there are the involvements of different digestive enzymes and digestive organs.

4.4.1. Structural Components of Digestive System

The digestive system is an organ system which is made up of the alimentary canal or several organs including the mouth, esophagus, stomach, small intestine, large intestines, and anus. It also has associated organs such as salivary glands, liver and pancreas. The two types of digestion are physical and chemical digestions. Physical digestion includes cutting and gridding food molecules in mouth by teeth.

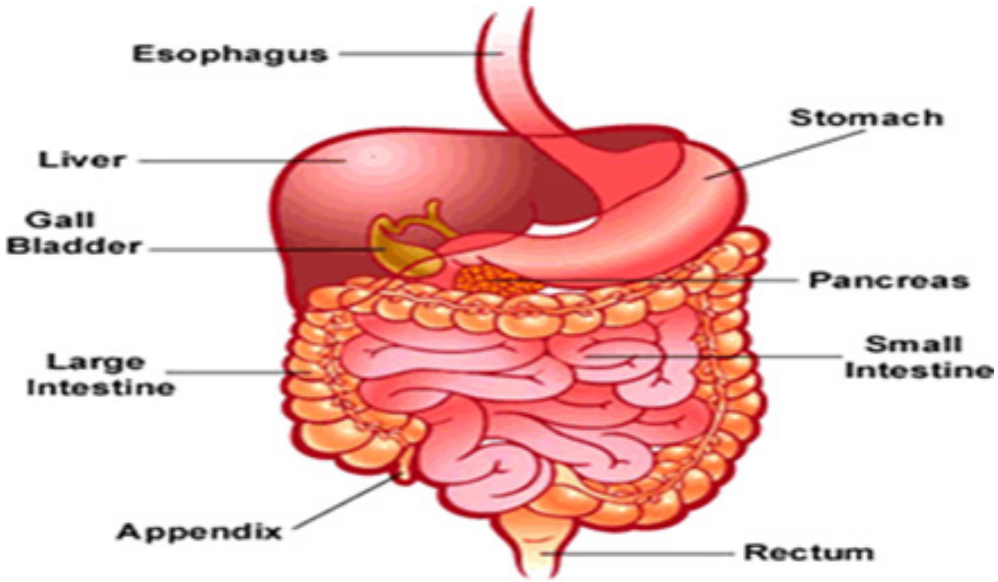
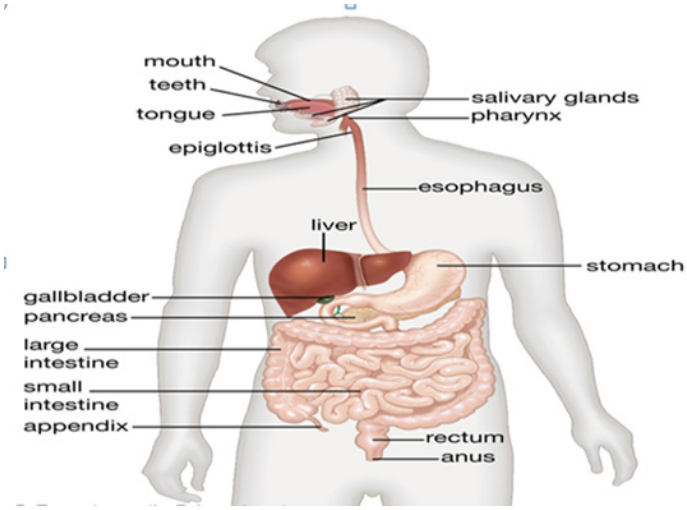


Figure:-4.32 Human digestive systems

4.4.2. Functions of Digestive System

The major function of digestive system is the breakdown of food molecules in to smaller and usable forms. The muscular contraction and relaxation of wall of alimentary canal produce movements of digested food along in one direction.



Key words:
Alimentary canal:-the whole passage along which food passes through the body from mouth to anus during digestion.

Figure 4.33 human digestive organs

Mouth

It is the first anterior opening parts of the gut which contains teeth. In mouth both types of digestion physical (mechanical) and chemical digestion occurs.

Teeth

Teeth of humans and other animals are hard structures that grow from jaw bone. They are used to bite and chew food. Each tooth consists of crown, neck and root.

The true human teeth are made up of three layers these are

1. **Enamel:** the outer layers, white and hardest substances in the body.
2. **Dentine:** isthe living layer under the tooth enamel.
3. **Pulp cavity:** it is the central parts of the teeth. It contains the living tissue with blood vessels and nerves which supply the living tooth with nutrients

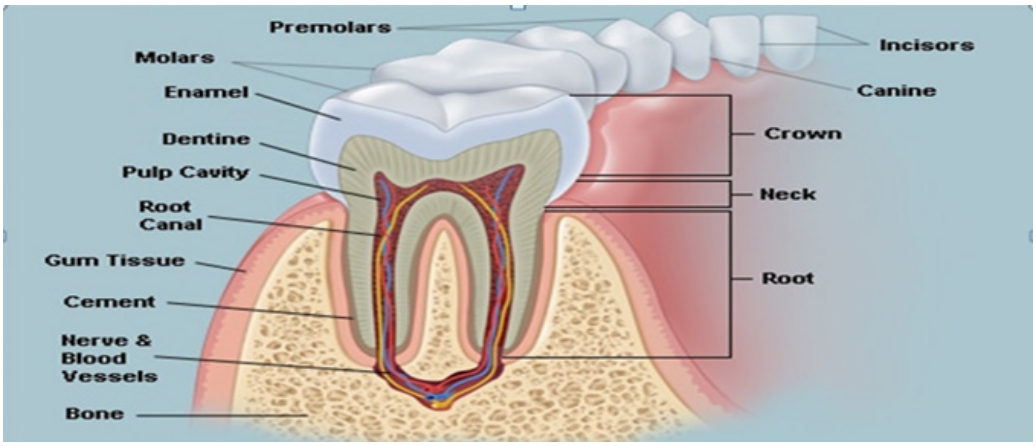


Figure 4.34 human teeth structure

Mammals have two sets of teeth in their life. In human the first set has 20 teeth is called milk teeth. These milk teeth are appear first but loose and fall out when a child is about 6 years old and replaced by the second or permanent teeth which is not replaced when once decay or loose. The permanent teeth set have 28 teeth. When person is around 20 – 25 years old, four additional back teeth grow called wisdom teeth. This development and arrangement of teeth is known as dentition.

Types of teeth

Human have four types of teeth. These are:

1. **Incisors (I):** chisel shaped and frontal teeth with sharp edge. They are four on each jaw and used for biting, cutting and grinding food.
2. **Canines (C):** is long, sharp, pointed edge and located beside incisors. They are two on each jaw. Used to tear, piercing food and it is prominent in predator organisms like lion.
3. **Premolars (P):** located behindcanines with relatively flat edge. They are four in each jaw. Used for chewing, crushing, or grinding food.
4. **Molars (M):** with wider and stronger ridges having depressions. There are six in each jaw. Their function is similar to premolars.

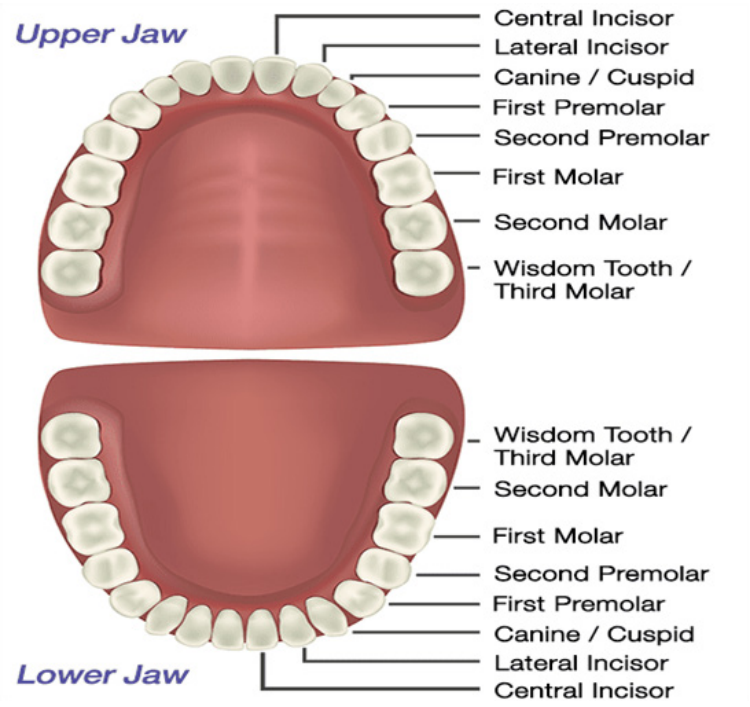


Figure 4.35 types of human teeth

Dental formula is the representing of the number, type and arrangement of teeth. It shows the number and type of teeth in one half of the upper and lower jaws. Because of these the teeth on the upper jaw are listed above the lower jaw. They listed as:- incisors (I), canines (C), premolar (P) and molar (M). Therefore the dental formula of adult human is:

I= 2/2, C= 1/1, P= 2/2, M= 3/3

Therefore, the total number of teeth in a given mammal can be calculated. First add the number of teeth in upper and lower jaws, and then multiply each jaw by two. Finally, sum up the product.

Stomach

The stomach is a muscular bag that produces enzymes like pepsin for protein digestion. It also produces another solution which is called hydrochloric acid.

Small intestine

The first section of small intestine which is called duodenum is used to join the food with two liquids: bile and pancreatic enzymes.

Bile is made by the liver cells and stored in gall bladder until it is needed. This bile has two important jobs.

1. Neutralize the acid from stomach and make the semi digested food alkaline.
2. Emulsifies the fats in the food, which means breakdown of fat in to smaller droplets.

The small intestine has much finger like projection which called villi for absorption of digested food in to blood vessels.

Where is the digestion end products go next?

Digestion end product of protein is amino acids and butter (fat) is fatty acids and glycerol entering in to small intestine to store for short times and absorptions in to blood.

Large intestine

It is parts of alimentary canal between small intestine and anus.

Its main function is absorption of water and formation of faeces.

Undigested food substances are unusable by cells and removed out through anus which is the last part of gut. This type of process is

Key term:
Defecation:- removal of wastes from body parts (egestion).

Exercise 4.6:- Answer the following questions

1. In your groups record and Labelle the various parts of alimentary canal from the chart when your teacher show you.
2. Brainstorming on how food move through alimentary canal and discuss in groups.
3. Students look their friend's teeth and determine their function, types and numbers.
4. Briefly discuss on parts of alimentary canal.
5. Students observe on associated glands of alimentary canal and their functions from the charts.

4.4.3. Major Diseases of Digestive System

The organs of digestive systems are can be affected by disease causing pathogens. There are a numbers of disease and some of them are:-

Constipations

If the faeces in the large intestine stay too long, too much water absorption will take place and it cause constipations. The most common causes are lack of fiber food (roughage) and not drinking of enough water.

Prevention

- Eating food which has more roughage gives the gut muscle work on.
- Drinking sufficient amount of water.

Key term:-

Roughage:-fibrous indigestible material in vegetable foodstuffs which aids the passage of food and waste products through the gut

Diarrhea

It is also called watery faeces. It caused by an infectious of the gut and then the gut more contracts strongly and hardly than the usual. It can cause dehydration.

Prevention

- Treat patients by giving enough water salt to replace the loss fluid.
- Stool examination and early treatment by the proper medicines.

Hemorrhoids

Are swollen veins in your lower rectum.Internal hemorrhoids are usually painless, but tend to bleed. External hemorrhoids may cause pain. Hemorrhoids also called piles are swollen veins in your anus and lower rectum.

Prevention

- To prevent hemorrhoids and reduce symptoms of hemorrhoids,eat high-fiber foods. Eat more fruits, vegetables and whole grains, drink plenty of fluids and do regular exercise.

Gastritis

Is an inflammation, irritation, or erosion of the lining of the stomach. It can occur suddenly (acute) or gradually (chronic).

Prevention

Gastritis can be prevented by avoiding known trigger foods,quitting smoking, managing and reducing stress, avoiding alcohol, maintaining a healthy weight, avoiding abuse of over-the-counter pain medications.

Key term:
Chronic:-happening or existing frequently or most of the time.
Acute:-very serious, strong, sensitive or dangerous.

Peptic ulcer disease

Peptic ulcer disease is a condition in which painful sores or ulcers develop in the lining of the stomach or the first part of the small intestine. Normally, a thick layer of mucus protects the stomach lining from the effect of its digestive juices.

Prevention

In order to prevent peptic ulcer it is recommendable to avoid tobacco products and alcohol. Don't ignore your ulcer symptoms. Protect yourself from infections by washing hands regularly and consuming foods that have been cooked thoroughly.

Exercise 4.7:

Part I:-Choose the best answer from the given alternatives

1. One organism have I=3/3 C=2/2 P=3/3 M=2/2. Then what is the total number of teeth? A. 34 B. 38 C. 40 D. 30
2. Which one is a chemical produced in stomach?
   A. bile B. HCl C. HS2O D. amylase
3. Removing of acid from stomach is called _____
   A/ emulsification B/ acidification C/ neutralization D/ all

Part II:- Explain briefly the following questions

1. Where does digestion start in human?
2. What will be undigested food molecules?
3. What types of digestion take place in stomach? Why?
4. List and discuss on digestive system diseases in your groups from your personal experiences.

1. Give assignments to draw diagrams of human alimentary canal and label each part.

4.5 Respiratory System

At the end of this section, you will be able to:

- distinguish the major structural components of human respiratory system;
- describe the main functions of human respiratory system;
- identify and discuss the main diseases or disorders associated with human respiratory system.

What are respirations?

In single cell and small living organisms like amoeba and paramecium, oxygen diffuse from the air or water in to the cell. In other ways carbon dioxide diffuse out of the cell. But in larger organisms like human, diffusion of oxygen from air is enough. Breathing is a process of bring oxygen into organism's body (inhalation) and removal of the waste carbon dianoxide (exhalation)from the body to the environments.

Key term:
Inhalation:- taking oxygen into the body.
Exhalation:-removal of carbon dioxide out of body.

4.5.1. Structural Components of Respiratory System

The human respiratory systems have well developed and adapted structures for breathing of air. They have nose with large surface area, good blood supply, lots of hair and mucus. Each structures of nose have specific functions like:-

The hair: filter out dust particles and pathogens from inhaled air.

The large surface area: used to moist the air and increases the humidity of the air.

The mucus: filter inhaled air and collects bacteria and dust particles.

Good blood supply: helps to warm the air that we inhale into the body.

Organs of breathing includes: nose, pharynx, larynx, trachea, bronchi, bronchioles, alveoli, lung etc. The trachea which is one part of the respiratory organs has series of incomplete rings of cartilage (which are C shaped) that used to support it and hold it open. They are incomplete so that you can swallow your food

Key term:
Cellular respiration:- combination of food and oxygen inside the body

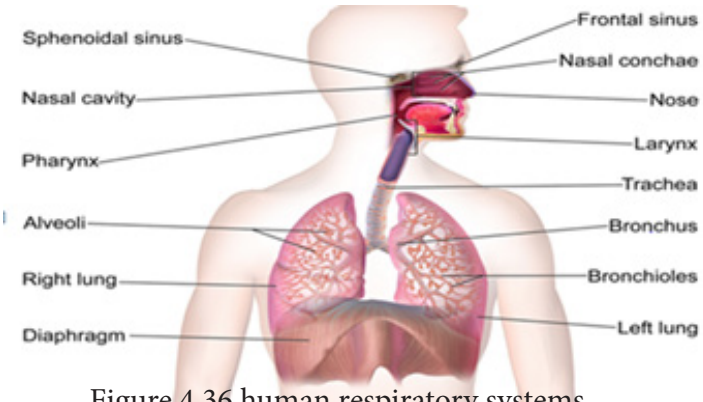


Figure 4.36 human respiratory systems

4.5.2. Functions of Respiratory System

Respiration is the process by which a body gets and uses oxygen and releases carbon dioxide and water. Respiration is divided into two parts. The first part is breathing which involves inhaling and exhaling. The second part is cellular respiration, which involves chemical reactions or burning of food by oxygen that release energy from food.

Pharynx- is the membrane-lined cavity behind the nose and mouth, connecting them to the esophagus.

Larynx- the hollow muscular organ forming an air passage to the lungs and holding the vocal cords in humans and other mammals.

Trachea- a large membranous tube reinforced by rings of cartilage, extending from the larynx to the bronchial tubes.

Bronchus- any of the major air passages of the lungs that diverge from the windpipe or trachea.

Bronchioles: are smaller tubes branching from each bronchus in the lung.

Alveoli- are any of the many tiny air sacs in the lungs where the exchange of oxygen and carbon dioxide takes place.

Lung- is to provide a place where oxygen can reach the blood and carbon dioxide be removed. The shape of the lung can be controlled by the relaxation and contraction of the diaphragm and intercostal muscle.

Activity 4.9:

1. Observe and record various labeled parts of respiratory tract.
2. Discuss on parts of respiratory systems and present for class mate students.
3. Discuss on roles of hair, cartilaginous rings of trachea and alveoli.
4. List and discuss on respiratory disease from your personal experiences in groups.
5. Give students an assignment to draw a diagram of human respiratory tract, label with the major parts, and submit it individually.

4.5.3 Major Diseases of Respiratory System

Respiratory diseases range from mild and self-limiting, such as the common cold, influenza, and pharyngitis to life-threatening diseases such as bacterial pneumonia, pulmonary embolism, tuberculosis, acute asthma, lung cancer, and severe acute respiratory syndromes, such as COVID-19.

Asthma- it is the chronic lung disease or disorders that are marked by recurring episodes of airway obstruction manifested by labored breathing. It accompanied especially by wheezing and coughing and by a sense of constriction in the chest and that is triggered by hyper reactivity to various stimuli.

Sinusitis- it is a pain full swelling of the tissues inside the sinus or nose. It can be due to infections, allergies, or autoimmune problems. It is also an inflammation of the mucous membrane that lines the Para nasal sinuses.

Influenza- Influenza is a viral infection that attacks your respiratory system your nose, throat and lungs. Influenza is commonly called the flu, but it's not the same as stomach "flu" viruses that cause diarrhea and vomiting.

Chronic obstructive pulmonary disease, or COPD:- refers to a group of diseases that cause airflow blockage and breathing-related problems. It includes emphysema and chronic bronchitis. Mainly it can be caused by smoking cigarette.

Bronchitis- Bronchitis is an inflammation of the lining of your bronchial tubes, which carry air to and from your lungs.

Exercise 4.8

Part I: Choose the best answer from the given alternatives

1. Which of the following is used to filter inhaled air
   A. mucus B. blood C. hair D. A& C
2. Breathing through nose is better than breathing through_____
   A. lung B. trachea C. mouth D. esophagus
3. One of the following is parts of respiratory organs
   A. large intestine B. stomach C. bronchi D.liver
4. Large membrane tube reinforced by ring of cartilage is _____
   A. larynx B. trachea C. pharynx D. alveoli
5. Millions of air sacs in lung are called _____
   A. alveoli B. bronchus C. blood vessel D. all

Part II:- Explain briefly the following questions

1. What are the functions of alveoli in respiration?
2. Discus in your groups on how the human lung gets oxygen and carbon dioxide and present for other groups.
3. List the respiratory disease and their causes.
4. Discuss in detail about the transmission of COVID 19 and present the results for the class mate.

4.6 Circulatory System

At the end of this section, you will be able to:

- distinguish the major structural components of human circulatory system;
- describe the main functions of human circulatory system;
- identify and discuss the main diseases or disorders associated with human circulatory system.

What is a circulatory system?

Circulatory system is the systems of transports substances in the body of an organism. Mainly these systems are used to transport air, food, mineral, vitamin,

and other liquid materials and solutions between cells in the body. They also used to transport the waste materials in order to remove in to the outside.

4.6.1. Components of Circulatory System

The blood can flow from the organ heart to the other body parts by blood vessel. The contraction and relaxation of the heart muscle can pump blood from heart to different body part. In human being there are two different types of blood circulation systems which are so called double circulations. These are:-

1. **Systematic circulations:** blood flows between hearts and other body parts.
2. **Pulmonary circulations:** the blood flows between only heart and lungs.

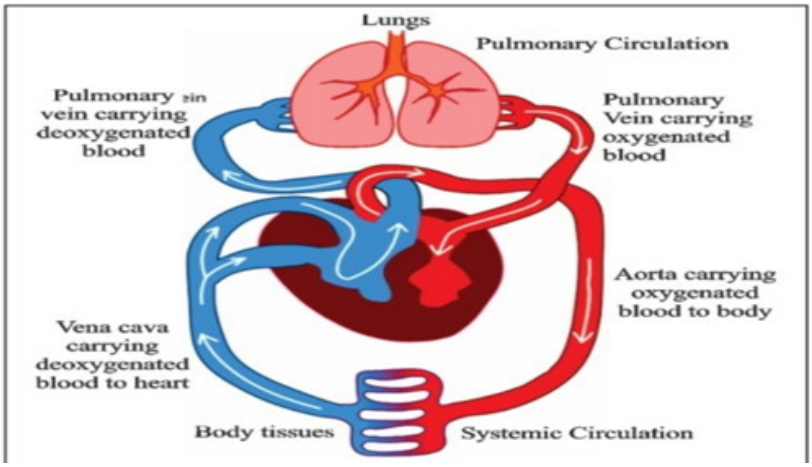


Figure 4.37 double circulatory systems

4.6.2. Functions of Circulatory System

Blood circulation systems consist of the three elements that are: heart, blood vessel and blood. In circulation systems the left side of the heart is always pump oxygenated blood while the right side of the heart receives the deoxygenated blood.

A/ Heart

It is the muscular blood pumping organ which made from involuntary muscles which is called cardiac muscle. Heart has four chambers.

1. Right atrium: upper parts of the heart and carry deoxygenated blood to lung. It has thin wall.
2. Left atrium:it is also the upper parts of the heart. It used to receive oxygenated blood from lung and pump to left ventricle.
3. Right ventricle: lower chamber and pumps deoxygenated blood in to the lung.
4. Left ventricles: it pumps the blood at long distance of the body because of these it has thicker and muscular walls.

Inside the heart the oxygenated and deoxygenated blood cannot be mixes together because the heart chamber can be separated by valves. Valves are the structures that used to prevent the back flow of the blood.

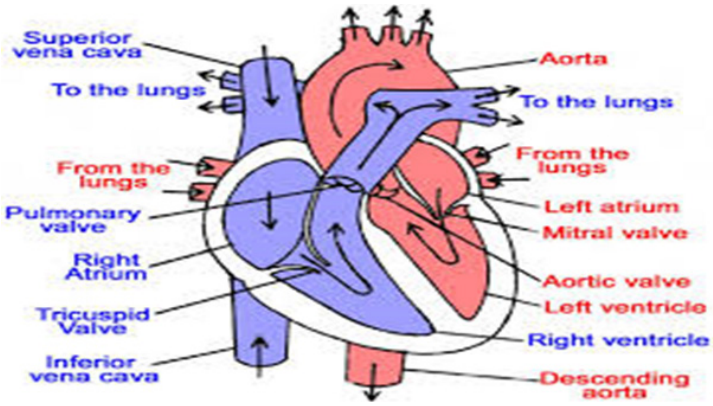


Figure 4.38 parts of human circulatory systems

Pathway of oxygenated blood flow:- lung ⟶ pulmonary vein left atrium ⟶ left ventricle ⟶ aorta ⟶ body tissue.
Deoxygenated blood:- body ⟶ venacava ⟶ right atrum right ventricle ⟶ pulmonary artery ⟶ lung.

B/ Blood vessel

They are the pathway through which transportation of substances take place in the body. Based on their functions there are three major groups of blood vessels.

1. **Artery:** used to carry blood away from the heart in to different body parts. They have thick and elastic wall. Except pulmonary artery and umbilical artery all artery carry oxygenated blood.

2. **Vein:** used to return the blood back to the heart. Most of them carry deoxygenated blood except pulmonary vein and umbilical vein.
3. **Capillaries:** used to connect artery and vein and carry blood to the tissues and cells. They are narrow and thin wall blood vessel.

C/ Blood

The blood is one of the three elements of circulations. It is a fluid tissue that used to carry nutrients, respiratory gases, metabolic wastes and other substances. Blood made from 45% solid and 55% liquid which is called plasma. The liquid parts of the blood plasma are composed of 90% water and the remaining 10% is dissolved substances such as amino acid and glucose. The solid part of the blood is made from the three types of blood cell.

1. ***Red blood cells (erythrocytes):*** are disc shape, non-nucleated, and used to transport oxygen and carbon dioxide in human body. They are smaller and 6.2-8.2 μm in diameters. Have red pigmented substances called hemoglobin which carry oxygen in the blood.
2. ***White blood cells (leucocytes):*** are colorless, irregular shaped and nucleated. These cells are 12-17 μm in diameters larger than RBC. They used to prevent the body from disease causing pathogens.
3. ***Platelets (thrombocytes):*** are colorless and non-nucleated. They have 2-3μm in diameter and have biconvex shape. They are important for inciating the blood clotting when blood vessel is cut or damage.

4.6.3 Major Diseases of Circulatory System

There are different types of disease or disorders which affect the human circulation systems. Some of the diseases are:

1. **Hypertensions:** it is also called high blood pressures. It caused by age, obesity, high salt consumption, drug addiction, stress, kidney problem, diabetes, etc.

But it can treat by: less consumption of salt and fat, regular exercise, avoiding the use of drugs, regularly checkup in nearest clinic etc.

2. **Heart attack:-** occurs when blood stops flowing to a part of the heart and the heart muscle is injured because of not receiving enough oxygen.
3. **Strokes:-** A stroke occurs when the blood supply to part of your brain is interrupted or reduced, preventing brain tissue from getting oxygen.
4. **Heart failure:-** is a chronic, progressive condition in which the heart muscle is unable to pump enough blood to meet the body's needs for blood and oxygen.

Exercise 4.9:

Part I:- choose the correct one among the given four alternatives for the following quastion

1. Which chamber of heart pump blood to the body
   A. left atrium B. left ventricle C. right atrium D. right ventricle
2. In pulmonary circulation blood flow from _____ to _____
   A. body to heart B. lung to heart C. lung to kidney
   D. heart to lung E. B&D
3. Which blood vessels carry oxygenated blood from heart to body
   A. platelets B. vein C. artery D. all
4. The only vein that carry oxygenated blood is called _____
   A. umbilical vein B. large vein C. pulmonary vein D. A&C

Part II: describe briefly

1. What are the functions of blood circulations?
2. List elements of blood circulation, with their functions.
3. describe parts of circulatory systems
4. Explain types of blood cell, heart chamber and reason of partitions.
5. Discuss the role of heart, blood vessel, blood and blood cells.
6. Eexplain the circulatory diseases.

4.7 Reproductive System

At the end of this section, you will be able to:

- distinguish the major structural components of human reproductive system;
- distinguish between the primary and secondary sexual characteristics;
- describe the main functions of human reproductive system;
- identify secondary sexual characteristics of males and females;
- explain the concept of menstruation and menstrual cycle;
- identify and discuss the main diseases or disorders associated with human reproductive system;

What is reproduction?

The unicellular organisms have no reproductive organs as they are made up of one cell. They are smaller in size than the smallest animal and plant cell. However, most types of multicellular organisms that reproduce sexually have distinct male and female reproductive organs. In this topic you will learn about human reproductive systems and its function.

4.7.1. Male and Female Reproductive Organs

The reproductive cells of human produced by male and female gonads, respectively, are sperm cells and egg cells. When these sperm cells and egg cells unite together during sexual intercourse they produce offspring.

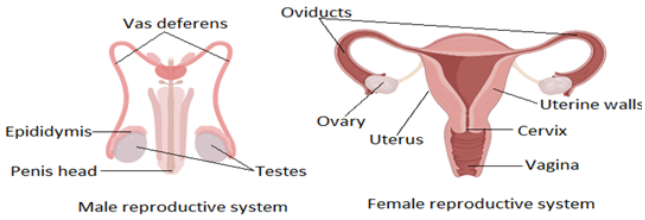


Figure 4.39 male and female reproductive organ

A. Male reproductive organ

The human male reproductive system consists of the testes and other sex organs like penis, scrotum, vas deferens, urethra, prostate glands, and Cowper's glands.

Key term:-

Graafian follicle:-are ovarian follicles rounded enclosures for the developing ova in the cortex near the surface of the ovary.

4.7.2 Functions of Male Reproductive Structures

- ***Testes:*** are two male reproductive glands. In addition to sperm cells, testes produce the sex hormone, testosterone.
- ***Penis:*** is an erectile cylindrical organ for sexual intercourse during which it ejaculates semen (sperm cells and fluid).
- ***Scrotum:*** a sac-like structure on the lower end of the penis.
- ***Epididymis*** It stores sperm cells for maturation.
- ***Vas deferens or (sperm ducts):*** is a long tube extending from each epididymis to the urethra for transportation of sperm cells and fluid.
- ***Sperm:*** is a mass of male reproductive cells produced by the testis.

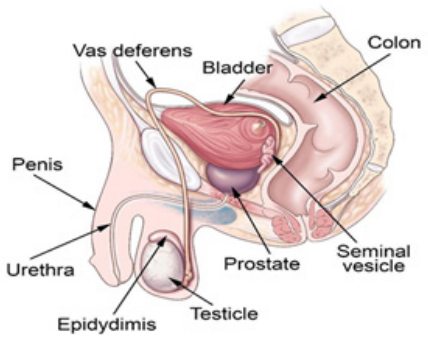


Figure 4.40 Male reproductive organ

B. Female reproductive organ

It consists of ovary and other structures such as vagina, uterus, fallopian tube, cervix, clitoris, and vulva.

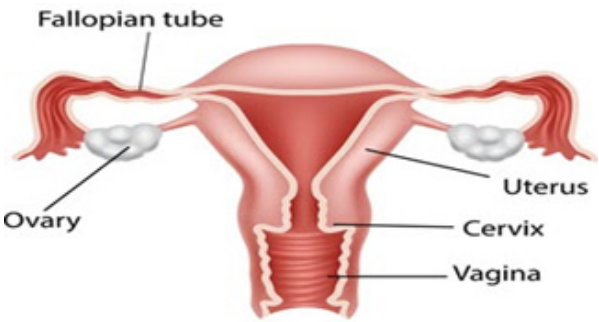


Figure 4.41 Female reproductive organ

4.7.3 Function of Female Reproductive Structures

- ***Ovaries:*** are two female reproductive glands made up of follicle cells, called graafian follicle to produce ova or egg cells and sex hormones.
- ***Vagina:*** used for sexual intercourse and serves as birth canal.
- ***Fallopian tube (oviduct):*** is a narrow tube from the ovary to uterus for movement of an egg and fertilization. It is a site for fertilization.
- ***Uterus (womb):*** is wide muscular tube for implantation of the fertilized egg and development of an embryo. It is a site for pregnancy.
- ***Cervix:*** is a ring of muscles at the lower end of the uterus. It opens at the time of menstruation and child birth.
- ***Clitoris:*** an erectile and sensitive tissue like a penis.
- ***Vulva:*** is the external genital of the female reproductive system.

Key term:-
Ejaculates:- release of sperm from male during sex.

Activity 4.10:-
Discuss on the importance of reproduction in human and other organisms.
Procedures:- make a groups in your class and discuss briefly and present your results in the class

The Primary and Secondary Sexual Characteristics

Primary and secondary sexual characteristics are physical traits that make males and females look and behave differently from each other in certain species, including humans. Primary sexual characteristics are those that are present at birth. Primary sexual characteristics are being of maleness and femaleness. Secondary sexual characteristics appear during puberty.

Secondary Sexual Characteristics

When the boy and girl are reach at puberty age the follicle stimulating hormone (FSH) from the pituitary gland stimulates the testis and ovary to produce male sex hormone testosterone and female sex hormone estrogen. These two hormones can promote the development of secondary sexual characteristics of male and female.

Secondary sexual characteristics of male

Puberty in boys usually begins somewhere between the age of 9 and 15 years old because it control by chemical change in body. The pituitary glands in human brain start to produce increasing amount of FSH. In turn it stimulate the male gonad or testis to begin developing and producing the male sex hormone testosterone. The rising of this hormone trigger many changes that affect body during puberty, and cause the development of secondary sexual characteristics.Some of these secondary sexual

- Whole body undergoes the adolescence growth spurt and become tall.
- Growth of pubic hair, body hair, and facial hair.
- Larynx enlarges and cause voice deepens.
- Shoulder and chest broaden.
- Penis enlarges & its skin of penis and scrotum becomes darken.
- Testis begins to produce sperm cell.
- Developed more muscles.
- Adolescents become more questioning and independents.
- Look beyond their family.
- Feel young and insecure, confused and angry.

Key term:

Testosterone: male sex hormone produces during puberty.

Secondary sexual characteristics of female

Female also have gonad which is called ovary. Ovaries are the two female gonads located in the abdomen. It is associated with fallopian tube (oviduct) and uterus but not directly attached to them.

The girls go in to puberty stage in between the age of 8-14. FSH from pituitary stimulates ovaries to become active and producing female sex hormone which is called oestrogen. When oestrogen level rise in female body, all kind of change take place and female secondary sexual characteristics develop. Some of these characteristics are:-

- Developments in height and whole body structure.
- Hair grow around pubic and armpits.
- Breast developments.
- Widening of hips.
- Voice becomes thinner.
- Egg matured and start of menstruations.
- Feeling of independent and questioning.

Key term:

Estrogen and Progesterone:-female sex hormone produced during puberty.

Activity 4.11:

1. Briefly explain the difference between primary and secondary sexual characteristics with example.
2. Observe and label parts of reproductive systems of both sexs from the charts when your teachers show you and create a table then list this organ with their functions and present for class mate students.
3. Students Discuss on bodily changes then compare and contrast in male and female.

4.7.4 Menstruation

What does it means menstruation?

The menstrual cycle is a sequence of events which takes place approximately every four weeks throughout the fertile life of women, which is from the age of puberty to around 50 years of age. At puberty stage of female the FSH hormone from pituitary gland in brain start the ova to develop. FSH also make ovary to produce female hormone oestrogen. In turn it stimulates the uterus to build up thick, spongy lining with enough of blood vessel ready to support a pregnancy. About 14 days before the ova start ripening, one of them burst out of its follicle. This process is called ovulation.

After ovulation the hormone level begin to reduce. The remaining of follicle forms the corpus luteum (yellow body) which secret hormone called progesterone. Progesterone keeps the thick,

spongy wall and makes more blood vessels, ready to receive fertilized ovum. If pregnancy does not occur about ten days after ovulation, oestrogen and progesterone level decrease blood vessel which built on uterus wall close down and discharged through vagina in the form of blood which is called menstruation. After around the age of 50 years the women stop ovulation and menstruation cycle. This phenomenon is called menopause.

Key terms:

Menopause:- stopping of menstruation and ovulation in female.

Ovulation:- movements of egg from ovary to fallopian tubes.

Activity 4.12:

1. Discuss in your groups about the concepts of menstruation and menstrual cycle.
2. Make a group then list and discuss many reproductive diseases from your personal experiences and present in the class.

4.7.5 Reproductive Health

What is reproductive health?

Reproductive health is the physical, mental, and social health status of an individual related to reproductive system at all stages of life. Due to lack of knowledge, there are a number of reproductive health problems in our country.

These problems mainly affect the reproductive health of women. The problems include female genital mutilation, early marriage, rape, illegal abortion and sexually transmitted infections.

Activity 4.13

1. Discus on how you prevent STDs.
2. Briefly describe the impacts of HIV on the society and community
   Procedures:- list the discussion and then present in class.

Key term:-

Rape:- is a type of sexual assault usually involving sexual intercourse.

Female genital mutilation:-partial or total removal of female external

Sexually transmitted diseases are the disease that can be transmitted from infectious person to healthy person during sexual contacts. Some of these diseases are:

HIV/AIDS

HIV (Human Immunodeficiency Virus) is the virus that causes the disease AIDS or Acquired Immune Deficiency Syndrome. So far, for this disease, caused by HIV and those damages the immune system white blood cell specially T-cell, there is no cure or vaccine. Basically, the high-risk groups include homosexual men and women, intravenous drug users, sex workers, and hemophiliacs; as well as the sexual partners of persons in these groups. HIV virus mainly transmitted from infected to healthy person by four ways. These are during breast milk, sharing of contaminated needles, unprotected sexual intercourse and from infected mother to baby during birth.

Prevention

Biological knowledge is quite important for controlling the spread of HIV/AIDS. Producing vaccine, creating awareness in the community about the issues related to responsible sexual behavior. The most effective method is

abstain from sex befor marriage are the use of ABC rules that are:

A =abstain from sex
B =be faithful to one sexual partner
C =condomise

Gonorrhea

Gonorrhea are the other types of STDs and caused by bacterium which called Neisseria gonorrhea. These bacteria are found on mucus area of body such as vagina, penis, throat and rectum. It transmitted during unsafe sexual intercourse.

Symptoms

The symptoms are may appear after a week and it is burning sensation during urination and yellowish discharges from reproductive organ. If pregnant women are not treated, gonorrhea transmitted to her bay and cause blindness.

Preventions

At the early stage it can be treated by the use of antibiotics. Remove sexual intercourse after infected until completely treatment. But the effective prevention methods are the respect of ABC methods.

Chancroids

It is a disease which caused by Hemophilus ducreyi bacteria. Chancroid is the most common types of disease for men. It increased risk of HIV/ AIDS.

Symptoms

Its symptoms are occurs in two stages of first and second stage. These are ulcer elation on reproductive organs, bleeding and painful of ulcers, swollen gland filled with pus, and may cause of loss of penis or groin.

Prevention

In first stage it prevented by the use of antibiotics but in addition to this it prevented by: good sanitation mechanisms, accepting and using of ABC rules, appropriate use of drugs which are prescribed and check up in clinic.

Syphilis

It is one of the most too dangerous STDs. It caused by bacterium called Treponema palladium. It is common for the adult age of human. It transmitted by unsafe sexual intercourse. It also transmitted from mother to her fetus.

Symptoms

The symptoms of syphilis have different stages. At the first stage, there is painless sore on penis, vagina, mouth and rectum. At the second stage, tiredness, fever, sore on throat, headaches, loss of appetite, etc. Finally change to irreversible problems, like illness of skin, bone, brain, and other organ.

Preventions

The prevention methods of syphilis are the same as to the other prevention methods of sexually transmitted disease.

Exercise 4.10:

Part I:- choose the correct answer from the given alternatives

1. Male sex hormone that produced during puberty stage is known as _____
   A. estrogen B. progesterone C. testosterone D. none
2. Which of the following is female reproductive cell
   A. sperm B. egg C. ovary D. penis
3. The male gonad is called _____
   A. testes B. ovary C. testosterone D. estrogen
4. The monthly discharge of blood through vagina is called_____
   A. ovulation B. ejaculation C. excretion D. menstruation
5. One of the following is reproductive diseases, which one
   A. syphilis B. gonorrhea C. chancroids D. HIV E.all

Unit summary

- The integumentary system includes the epidermis, dermis, hypodermis, associated glands, hair, and nails.
- The skin has three major layers of hypodermis, dermis and epidermis is the outer layer of the body that covers the internal parts of body.
- Human Hair come from follicles, which are simple organs made up of cell called epithelial cells.
- Nail is the hard covering at the end of the finger or toe, a finger or toe nail and used to protecting the upper end part of humans and most other organisms.
- Integumentary systems have four types of exocrine glands that secrete some type of substances outside the cell and body these gland are -sudoriferous, -Sebaceous, -Ceruminous, -Mammary.
- There are many different types of skin disorders and disease like -Acne, Rosacea, - Eczema etc.
- Muscles can used to perform different types of body movements like pumping blood, stability, posture, digestions, circulations etc.
- There are three distinct types of muscles: skeletal muscles, cardiac or heart muscles, and smooth (non-striated) muscles.
- The skeletal system gives the body its shape, allows movement, makes blood cells, provides protection for organs and stores minerals.
- Bones are a major component of the skeletal system and grouped in to four.
  - Long bones, - Short bone, - Flat bones, - Irregular bone.
- In addition to these bone also divided in to two major groups of the axial skeletal bone and appendicular skeletal bones.
- There are two different types of joints, namely immovable and movable joints.
- Osteoporosis is a disease in which the bones become fragile and prone to fracture and leukemia is a cancer of the white blood cells.
- Digestion is the process in which the larger, complex, hard and insoluble food substances are changed into smaller, simpler, easier and soluble by the action of the digestive organs.

- Human have four types of teeth these are Incisors, Canines, Premolars and Molars.
- Mouth, esophagus, stomach, small intestine, large intestine and anus are components of gut.
- Respiration is the exchange of gas between organisms and their environments.
- Humane respiratory organ are nose, pharynx, larynx, trachea, bronchi, bronchioles, alveoli and lung.
- Respiration is divided into two parts namely breathing and cellular respiration.
- The shape of the lung can be controlled by the relaxation and contraction of the diaphragm and intercostal muscle.
- Circulatory systems are used to transport different materials such as air, food, mineral, vitamin, and other liquid materials and solutions between cells in the body.
- In human being there are two different types of blood circulation systems: Systematic circulation and pulmonary circulations.
- Blood circulation systems consist of the three elements that are blood, blood vessel and heart.
- There are different types of disease or disorders which affect the human circulation systems such as hypertension.
- The human reproductive organs produce reproductive cells within gonads.
- The human male reproductive system consists of the testes which two glands are made up of mass of tubules called seminiferous tubules.
- Female reproductive system consists of ovary and other structures such as vagina, uterus, fallopian tube, cervix, clitoris, and vulva.
- The primary and secondary sexual characteristics are used to determine the puberty stages of male and female.
- Secondary sexual characteristics appear during puberty.
- Menstruation is discharged of blood through vagina.
- Menopause is the stop of ovulations when the age is above 50.

- There are a numbers of sexual transmitted diseases like HIV and syphilis.
- STDs are very dangerous disease because it affect other organ and in all age of peoples.
- HIV/AIDS, Gonorrhea, Chancroids, Syphilis and others are examples of STDs.

Review exercise

Part I: Choose the best answers for the following questions

1. Which of the following is larger organ of the body?
   A . ligament B. skin C. bone D. joints
2. Which layer of skin is external?
   A. hypodermis B. dermis C. epidermis D. all
3. The parts of the skin that store energy is _____
   A. epidermis B. dermis C. upper layers D. hypodermis
4. One of the following is not layers of hair?
   A. Medulla B. Cortex C. matrix D. cuticle
5. _____ is the gland which secret oil in to hair follicles
   A. sebaceous B. Ceruminous C. thyroids D. all
6. Which of the following are skin disease?
   A. Rosacea B. Hives C. Warts D. all
7. Which of the following are self -care for skin disease?
   A. Washing with cool water
   B. Applying cool compresses
   C. Limiting contact with common allergies
   D. Applying calamine lotion
   E. all
8. _____ is the weakest type of muscle
   A. skeletal muscle B. smooth muscle C. heart muscle D. all
9. Which of the following is called musculoskeletal systems?
   A. circulatory B. respiratory C. digestive D. skeletal
10. _____ is hard and compact with yellow bone marrow
   A. long bone B. short bone C. flat bone D. none

11. The following one is parts of one of axial skeleton
    A. skull B. hyoid C. thoracic cage D. all
12. _____ bone is composed of scapula and clavicle
    A. hip bone B. limb bone C. shoulder D. appendage
13. The place where two bone meet together are called _____
    A. ligament B. scapula C. joints D. tendon

Part II: Fill the blank space

14. The mouth has the cavity called_____
15. The major function of alimentary canal is_____
16._____ is parts of teeth which are found above the gum.
17._____ is the living layer under the tooth enamel.
18. The two important functions of bile are _____and _____
19. Breathing through the nose is better because _____
    _____ _____ _____
20. A millions of tiny air sacs that used to for exchange of gas in the lung is called _____
21. The two types of blood circuits are _____ and _____
22. Blood vessel that carry oxygenated blood is called _____
23._____ is male sex organ that produces sperm cells.
24. The flow of blood from vagina approximately every four weeks are called _____

Parts III:-write short answer

25. How can you prevents yourself from different types of STDs?

UNIT FIVE

ECOSYSTEM AND CONSERVATION OF NATURAL RESOURCES

Learning Outcomes:

At the end of this unit, you will be able to:

- define ecosystem and components of ecosystem;
- identify and describe the types of biological interactions of organisms in an ecosystem;
- construct simple food chain and explain its components;
- differentiate between food chain and food web ;
- distinguish between the different components of food chain;
- describe the role of nutrient recycling in nature;
- explain how energy flows from producers to consumers;
- explain why nutrients are said to recycle while energy flows (does not recycle);
- summarize the characteristics of soil;
- describe the various types of soils;
- explain the various uses of soil in nature and to human being;
- engage in the Environment Club of School and participate in awareness creation campaigns;
- explain the various uses of soil in nature and to human being;
- list down and describe the various water conservation strategies;

- describe the various components of atmospheric air;
- identify and discuss the various human activities that cause air pollution;
- discuss the impacts of air pollution with examples;
- explain the various uses of air in nature and to human being;
- explain the cause and impacts of global warming;
- list down and describe the various actions that can be taken to reduce the emission of carbon dioxide to atmosphere;
- define forest and give examples of natural forests in Ethiopia
- explain the various uses of forest in nature and to human being
- identify and discuss the various human activities that cause deforestation
- discuss the impacts of air pollution with examples
- devise and coordinate various forest conservation actions
- organize groups that would campaign to teach the community on environmental protection
- organize plantation campaigns in their school compound and its environs
- list and describe the values of biodiversity
- list down and describe the various in-situ and ex-situ conservation strategies in biodiversity conservation
- give examples of the various indigenous knowledge and practices that are used in the conservation of various natural resources such as soil, forest, etc.

Introduction

Environments are a place where organisms are found. In this unit you will learn about ecosystems and their components and also for types of interaction in that ecosystem. So ecosystems are the place which contains both biotic and abiotic components. In ecosystems there are interaction between organisms and their environments.

5.1. Ecosystem and Interactions

At the end of this section, you will be able to:

- define ecosystem and components of ecosystem;
- identify and describe the types of biological interactions of organisms in an ecosystem;
- construct simple food chain and explain its components;
- differentiate between food chain and food web;
- distinguish between the different components of food chain;
- describe the role of nutrient recycling in nature;
- explain how energy flows from producers to consumers;
- explain why nutrients are said to recycle while energy flows (does not recycle).

What is an ecosystem?

Different types of living organisms can be interacts one another and with non-living things in their habitats for the purpose of survive. The interactions are studied by science called ecology. Ecosystems involve all organisms in the given habitat and their interactions between their physical environments. The main physical components that are vital for all form of living organisms are water, sunlight, air, temperatures, and others.

Key term:

Ecology:- branch of biology that study about the interaction between organisms and their habitat.

5.1.1. Definition and Components of Ecosystem

Environment is the sum of all living (biotic) and non-living (abiotic) components in a given habitat. Ecosystems can be affected by living (biotic) and nonliving things or physical components (abiotic) of an environment. Therefore an ecosystem has two major components are biotic and abiotic.

1. Biotic components

These components include all living organisms living in particular ecosystems like plant, animal, bacteria, algae etc.

1.1 Types of biological interactions

Each organism is the parts of other organism's environments thus they interact in various ways. These interactions of organism can be intra specific or inter specific.

1. Intra-specific interaction

These type of interaction occur between the same species. These may be for competition for food, territory, and for finding mate. E.g lion and lion, birds with birds for food.



Figure 5.1 intra-specific interaction

2. Inter-specific interaction

These are the interaction between one group of species with the other group of species for various numbers of purpose. e.g. hyena and lion.



Figure 5.2 nter-specific interaction

- **Predators:** predator animals like hyena feed on others animals prey like cow.
- **Symbiosis:** any type of biological association between two organisms that interact. The association could be beneficial to both, beneficial to one without benefiting or harming the other or beneficial to one and harmful to the other.

There are different types of symbiosis or biological interactions. These includes

A. Mutualism: the relationships in which both organisms are get benefitted and it is an obligatory relationship. E.g. fungi and algae, cow and some birds. Fungus digests dead body to release chemicals and algae do photosynthesis.



Key term:-
Epiphytes:- are plants that drive its moisture and nutrients from the air and rain and grow usually on other plants

Figure 5.3 mutualism

B. Commensalism:- in this relationship one organism is get benefit while the other is neither benefited nor harmed. E.g. big tree and epiphytes.





Figure 5.4 commensalism

C. Parasitism:- the relations in which one organism is benefited (the parasite) and the other is harmed (host). E.g. relation between human and tape worms.

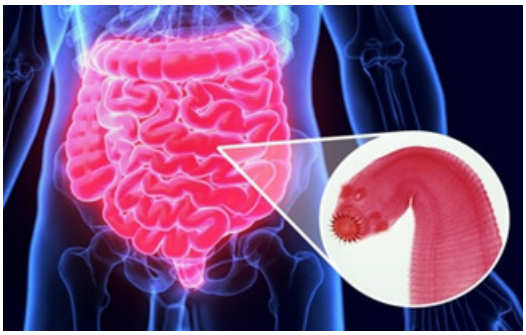


Figure 5.5 parasitism

D. Protocooperations:-the relation in which both organisms are benefitted but it is not obligatory relationships. E.g. between teeth cleaning birds and crocodile.



Figure 5.6 Protocooperations

E. Competition:-two populations compete for resources indirectly by efficient exploitation or directly by physical forces. In this both populations are harmed. E.g sport man



Figure 5.7 Competition

Activity 5.1

- Discuss on ecosystems and biological interaction.
- Categories the components of ecosystems.

In groups discuss on the following points

- How do you understand ecosystem
- Explain your summary about biological interactions.
- Then present outcome of your discussion in the class

2. Abiotic components

What is abiotic?

They are the physical or nonliving things that can affect the living condition of a given ecosystems. Some of these components are water, sunlight, air, soil, temperature, land topography and others.

A. Water:- is most important components of an ecosystems. It serves as a habitat, sources of drinking water and for irrigation in farming activities.

B. Sunlight:- is primary source of energy for all life on earth during the process of photosynthesis by green plants.

C. Air:- is the combination of different components of gases like oxygen, nitrogen, carbon dioxide and water vapor.

D. Soil:- which mainly control the growth of vegetation by its fertility, pH level and other. It determines the distribution of life in the ecosystems.

E. Temperatures:- it may be higher for some organisms and lower for other organism so greatly affect organisms' distributions.

F. Land topography:-which may be the arrangements of land.

Exercise 5.1

Part I: choose the correct answer from the given alternatives

1. _____ is used to sources of food for plant
   A. soil B. temperature C. topography D. all
2. Which is not abiotic?
   A. temperature B. water C. plant D. all
3. The students compare with other students in question and answers in order to get awards. Then this is what types of interactions?
   A. mutualism B. competition C. parasitism D. all
4. All types of animal can grouped in to _____
   A. heterotrophs B. autotrophs C. decomposers D. none
5. The interaction between cat and rat is called _____
   A. parasitism B. mutualism C. commensalism D. predators

Part II: explain briefly the following questions.

1. Briefly explain the importance of biotic and abiotic factor for ecosystems.
2. Discus how ecosystems are affected by nonliving things.
3. Compare the advantage and disadvantage of biological interaction
4. Going to the school compounds and observe types of components.

5.1.2Trophic (Feeding) Relationships

Based on the mode of nutrition living organisms can be grouped in to two major groups namely autotrophs and heterotrophs organisms.

1. Autotrophs: are organisms which can synthesize their own energy from the raw materials in their surrounding environments. They also classified as

A /photo autotrophs:- use sunlight for primary sources of energy to synthesize organic food materials. Also called producers because they are source of food for other. E.g green plants, algae and photosynthetic bacteria.

B /chemoautotrophs:-these type of organisms release energy from simple chemical reactions. E.g nitrifying bacteria.

2. Heterotrophs: cannot make foods & feed on other organisms so called consumers. They are herbivores, carnivores, decomposer or omnivores.

Key term:
Consumer:-organism which does not make their own food.

5.1.3. Food Chain and Food Web

Food chains

What is food chain?

A food chain is the direct and simple feeding systems that involve the transfer of nutrient and energy. In food chain the energy flows from one organism to the other organisms in one direction autotrophs (producer) to heterotrophs (consumers). In the food chain each organisms occupies specific trophic level.

1. **Producer (first trophic level):-** all organisms directly or indirectly depend on first trophic level. Sun is the main source of energy for all food chain.
2. **Primary consumers (second trophic level):** it contains herbivores and omnivores. They feed on producers.
3. **Secondary consumers (third trophic level):** they are carnivores that mainly eat herbivores and omnivores.
4. **Tertiary consumers (fourth trophic level):-** they are carnivores and mostly feed on other carnivores.

Examples;- The wheat(producer) produce food by photosynthesis is eaten by goat. Then the goat eaten by tigers. The tiger also eaten by lion.

Wheat → goat → tiger → lion

1st trophic level	2nd trophic level	3rd trophic level	4th trophic level
Producer	primary Consumer	secondary consumers	tertiary consumers

Food web

What is food web?

It is too complex feeding interrelation among the organisms which consists of many food chains. It is differ from food chains because in food chain the energy flows in only one direction. But in food webs there are more than one food chains. E.g:-

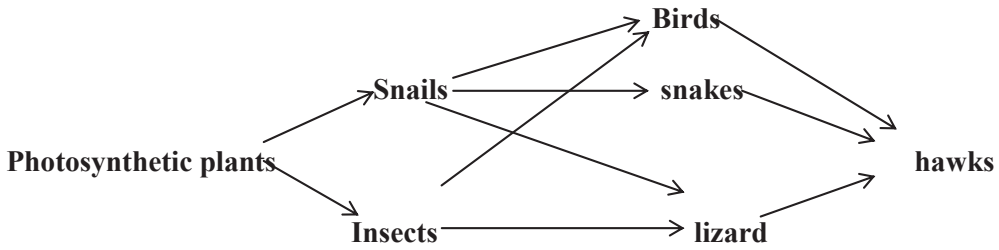


Figure 5.9 food web

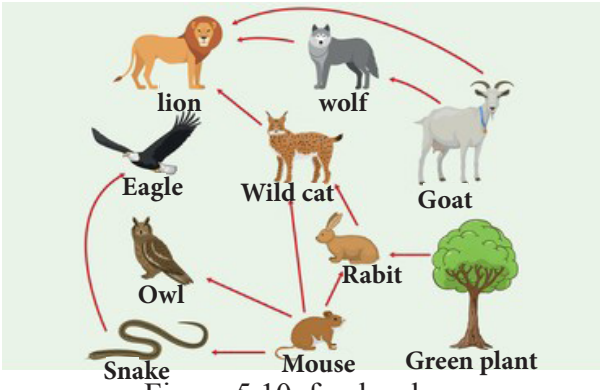


Figure 5.10 food web

Exercise 5.2

Part I: choose the correct answer from the given alternatives

1. Which of the following are consumers?
   A. flower B. grass C. sheep D. plants
2. Autotrophs can be _____
   A. primary consumer B. secondary consume
   C. producers D. all
3. The organisms that feed on dead body parts are _____
   A. producer B. consumer C. decomposer D. B &C

4. The following one is found at the end of food chain, which one?
   A. flower B. fungus C. grass D. all

Part II: explain the following questions

1. Compare and contrast food web and food chain.
2. Define the function of decomposers in the environment.

5.1.4. Trophic Pyramids

Pyramid is the diagram that used to express the amounts of organisms presents in each trophic level. It can be used to express the number of biomass, amount of energy and number of organisms in the trophic level.

A/ pyramid of numbers:-The pyramid made based on the number of organisms at each trophic level. A pyramid of numbers shows the total number of individual organisms at each level in the food chain of an ecosystem.

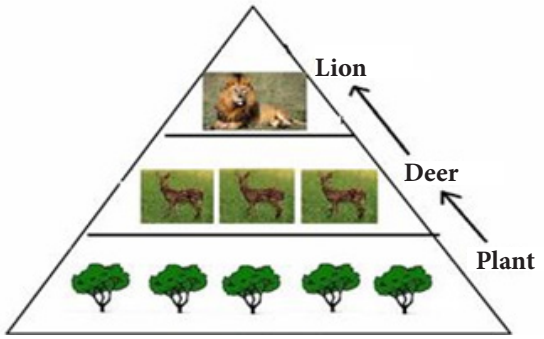


Figure 5.11 pyramid of number

B/ pyramid of biomass:- It provides more accurate representation of the energy contents at each trophic level.It shows the mass of producers that are needed to support primary consumers, the mass of primary consumers required to support secondary consumers, and so on.

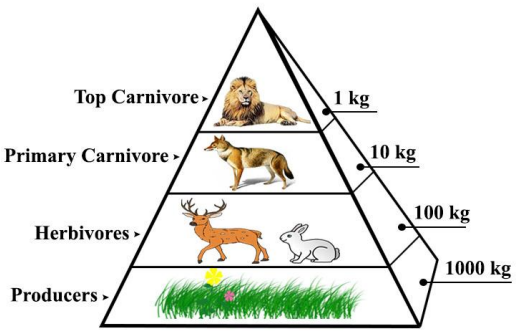


Figure 5.12 pyramid of biomass

C. pyramid of energy:- An energy pyramid, also known as a trophic or ecological pyramid, is a graphical representation of the energy found within the trophic levels of an ecosystem. The energy can be flow not recycled because its main sources are the sun and then energy cannot be returned to the sun.



Figure 5.13 pyramid of energy

Activity 5.2

1. Identify and explain the components of food chain and food web with their roles.
2. Brain storming on function of plant during photosynthesis.
3. Discuss and reason out why the number of organisms in each group (level) decreases from bottom to top.

5.1.5. Nutrient Cycles and Energy Flow

Living organisms require different kinds of chemical elements like nitrogen, oxygen, carbon, hydrogen etc for their metabolic and biological processes. The cyclic of elements from environment to organism and back to environment are called nutrient cycle.

Nitrogen cycle

The nitrogen cycle is a repeating cycle of processes during which nitrogen moves through both living and non-living things: the atmosphere, soil, water, plants, animals and bacteria. This atmospheric nitrogen must convert to ammonia and nitrates by chemical synthesis especially by decomposers. Producers use soil nitrates to synthesis protein for the consumers.

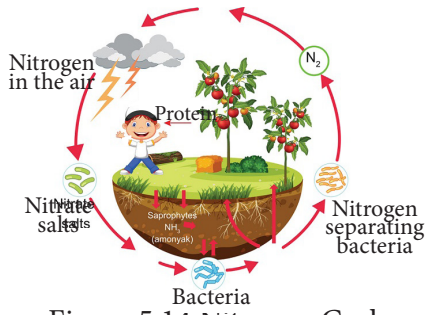


Figure 5.14 Nitrogen Cycle

The process of nitrogen cycle

Many of the process are carried out by microbes either to produce energy or to accumulate nitrogen in the form needed for growth.

Nitrogen fixation:-Decomposers can break down prote in which is found in wastes and in dead body of plant and animals in to ammonium compounds. Then it oxidized in to nitrates which return in to soil by nitrifying bacteria.

Ammonification:- when plant and animal die or from their waste, the organic nitrogen is convert to ammonium by decomposers. The processes are called ammonification or mineralization.

Nitrification:- conversion of ammonia to nitrates by soil living bacteria. These are the oxidation of ammonia by nitrosomonas bacteria in to nitrites (NO2). Then also there is oxidation of nitrite in to nitrates (NO3) by nitrobacter bacteria. The nitrate is usable forms of nitrogen by plants.

Denitrification:-is reduction of nitrate back to inert nitrogen gas (N2) completing the nitrogen cycle. This process is performed by pseudomonas and clostridium bacterial species in anaerobic conditions.

Oxygen cycle

Oxygen cycle refers to the movement of oxygen through the atmosphere (air), biosphere (plants and animals) and the lithosphere (the earth's crust). The oxygen cycle demonstrates how free oxygen is made available in each of these regions, as well as how it is used. The main driving factors of the oxygen cycle are the process of photosynthesis which has responsible for life.

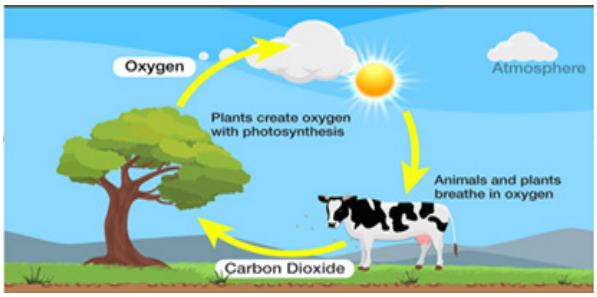


Figure 5.15 oxygen cycles

Carbon cycle

Carbon is released back into the atmosphere when organisms die, volcanoes erupt, fires blaze, fossil fuels are burned, and through a variety of other mechanisms. It is one of the most important cycles of the earth and allow for the most abundant elements to be recycled and reused throughout the biosphere and all of its organisms. In carbon cycles, carbon move from atmosphere to plants, from plant to animal, from plant and animal to soil, from living thing to atmosphere and from atmosphere to ocean.

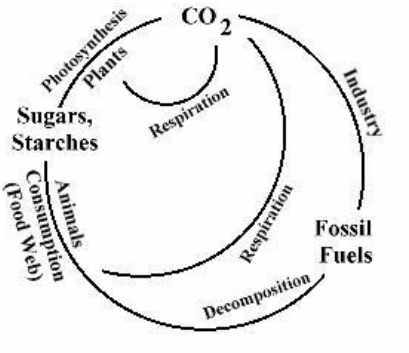


Figure 5.16 carbon cycles

Hydrogen cycle

The hydrogen cycle begins with the evaporation of water from the surface of the ocean. The hydrogen cycle consists of hydrogen exchanges between biotic (living) and abiotic (non-living) sources and sinks of hydrogen-containing compounds.

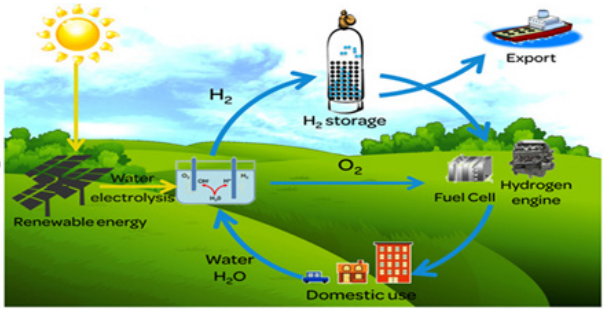


Figure 5.18 water cycle

Water cycle

Water cycle is the continuous movements of water on above and below the surface of the earth. Water can change its states among liquid(water), vapor (gas), and solid (ice) at various places in the water cycle. The water evaporates and turns to clouds. It falls down in the form of rain, snow or ice. The water that flow into river and streams eventually flows back in to the oceans. From the ocean it evaporates back in to clouds and starts the whole cycle over again and becomes rain.

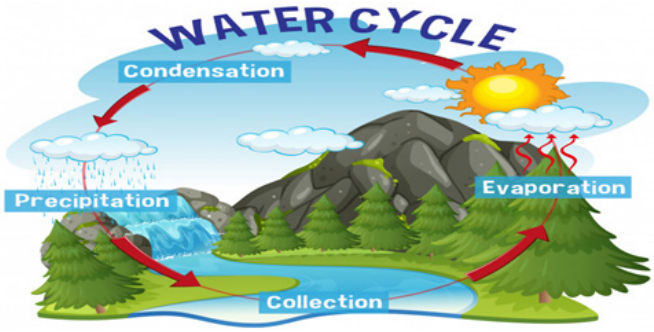


Figure 5.19 water cycle

Exercise 5.3

Part I:- choose the best answer from the given alternatives

1. The following one is not cyclic in nature
   A. oxygen B. nitrogen C. carbon D. none
2. The organisms that play great role in all nutrient cycle is called
   A. producer B. plant C. decomposer D. herbivores
3. The main driving factor in oxygen cycle is _____
   A. photosynthesis B. chemosynthesis C. heterotrophs D. all

4. The convert of carbon from air to earth and back to air is called__
   A. element cycle B. nitrogen cycle
   C. oxygen cycle D. carbon cycle
5. Which types of element are more needed by plants
   A. phosphorous B. sulfur C. oxygen D. nitrogen

Part II:- discuss and explain briefly

1. Briefly discuss on the role of decomposers in nutrient cycle.
2. Explain how energy flows in trophic relationship in ecosystems.
3. Explain and discuss why energy said to flow but not cycle?

5.2. Conservation of Natural Resources

At the end of this section, you will be able to:

- summarize the characteristics of soil
- describe the various types of soils
- explain the various uses of soil in nature and to human being
- list down and describe the various soil conservation strategies
- engage in the Environment Club of School and participate in awareness creation campaigns.
- explain the various uses of soil in nature and to human being
- list down and describe the various water conservation strategies
- describe the various components of atmospheric air
- identify and discuss the various human activities that cause air pollution
- discuss the impacts of air pollution with examples
- explain the various uses of air in nature and to human being
- explain the cause and impacts of global warming
- list down and describe the various actions that can be taken to reduce the emission of carbon dioxide to atmosphere
- define forest and give examples of natural forests in Ethiopia
- explain the various uses of forest in nature and to human being
- identify and discuss the various human activities that cause deforestation
- discuss the impacts of air pollution with examples

- list down and describe the various actions that can be taken to conserve forests
- list and describe the values of biodiversity
- list down and describe the various in-situ and ex situ conservation strategies in biodiversity conservation
- give examples of the various indigenous knowledge and practices that are used in the conservation of various natural resources such as soil, forest, etc.

What is natural resource?

Any natural substance that humans use can be considered a natural resource e.g oil, coal, natural gas, metals, stone and sand. It grouped in to two namely renewable and non-renewable. Renewable natural resources are capable of being produced, reused and replaced e.g. vegetation, animal. Nonrenewable resources are cannot be easily made or produced if they are used once. e.g. petroleum, coal.

What is conservation of natural resources?

Conservation is the care and protection of natural resources so that they can persist for future generations. If the natural resources is not conserved and not managed their number reduces and finally become extinct.

Key term:
Humus:-is dark, soft, and rich in nutrients decaying organic matters of plant and animals.

5.2.1. Soil

Soil is the loose surface material that covers most land. It consists of inorganic particles and organic matter. Soil is a mixture of broken rocks and minerals, living organisms, air, water and decaying organic matters which called humus. Soils are home to myriad micro-organisms that fix nitrogen and decompose organic matter, and armies of microscopic animals as well as earthworms and termites.

Types of soil

Soil is used in agriculture activities where it serves as the primary sources of nutrients for plants. The different types of soil that used in agriculture are varying with respect to the species of plants which are cultivated. It provides minerals and water to plants. There are three common types of soil namely: loam, sandy and clay soil.



Figure 5.19 types of soil

Physical and chemical property of soil

Soil horizon

A soil horizon is a layer parallel to the soil surface whose physical, chemical and biological characteristics differ from the layers above and beneath. Horizons are defined in many cases by obvious physical features, mainly color, root quantity, pH, structure, size and texture. Humus is the biochemical substance that makes the upper layer of the soil become dark.

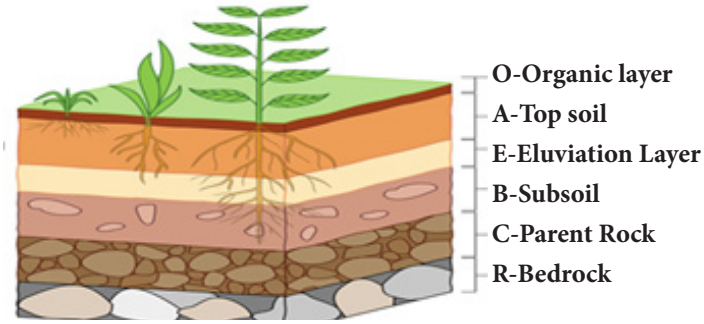


Figure 5.20soil horizons

Soil texture

It refers to the size distribution of the mineral particles found in a representative sample of soil. Particles are normally grouped into three main classes namely: sand, silt and clay. These all mineral particles have different size. Soil texture (such as loam, sandy loam or clay) refers to the proportion of sand, silt and clay sized particles that make up the mineral fraction of the soil

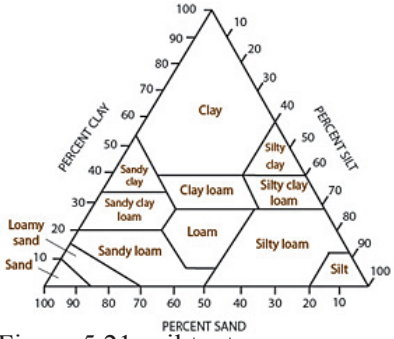


Figure 5.21 soil texture

The soil's ability to retain water is strongly related to particle size. So, sandy soils have relatively poor ability to hold water. Soils that are high in clay content can hold relatively large amounts of water for extended periods of time. Because clay-rich soils have the largest pore space, hence the greatest total water holding capacity.Silt is intermediate in its water holding properties.

Soil fertility

A loam soil contains more nutrients, moisture, humus and has better drainage of water air, and is easier to till. It is suitable for growing plants. So it is the most fertile soil. The major causes to soil fertility decline are a land degradation which is caused through the different agents such as soil erosion, deforestation, overgrazing, sedimentation, continuous farming and pollution.

Soil conservations

Is a set of management strategy for prevention of soil being eroded from the earth's surface or becoming chemically altered. It can do through the use of various methods. Some are:-

1.Afforestation:- it also called reforestationas tree grow tall, it also keep rooting deeper in to the soil. When the root spread deep in to soil layer, they contribute to the prevention of soil erosion.




Figure 5.22 afforestation

2.Terracing:- it is very good methods of soil conservations and leveling section of a hilly cultivated area. It gives the landmass a stepped appearance thus slowing washing down of the soil.




Figure 5.23 terracing

3. Contour ploughing:- it is a method of ploughing across the contour line of a slop. This method helps in slowing the water runoff, prevents the soil from being washed away along the slop and in percolation of water in to the soil.




Figure 5.24 contour plouphing

4. Crop rotation:- continuous cultivation of the same crop leads imbalance fertility demand of soil. Crop rotation is growing of dissimilar crops. This method used to help for improvements of soil structure and fertility

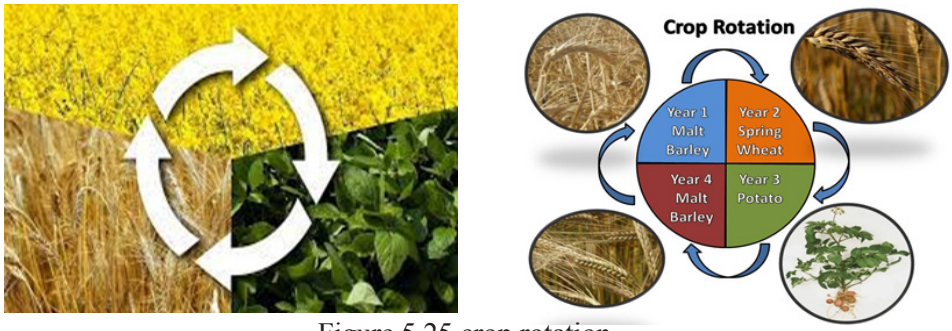


Figure 5.25 crop rotation

Activity 5.3:-demonstration

1. The students bring some types of soil from their surrounding and observe the color, size, texture etc. Then discuss in groups about their observation.
2. Ordered students to take part in soil conservations programs around their home and schools.
3. Student demonstrates on which types of soil pass water, which is intermediate and which is hold more water and then discuss on the results.

Procedure:-make a group and bring soil sample, water from surrounding

- Observe and clearly understand on characteristics of soil and present the result
- Present the result in class
- Demonstrate carefully and record the results.

5.2.2. Water

It is the main constituent of living cell and also used as a habitat for most organisms. Water used as universal solvents so it used for metabolic reactions. It has cooling effect, temperature regulation, lubricating body, transport food, hormone, waste product etc. It helps for hydrolysis reaction, osmoregulation and removal of wastes. Animals need water for drinking, washing and living and as sources of oxygen. Water also used for plants to manufacturing of food and rigidity.

Key term:

Pesticides:-chemicals that is used to kill insects that damage plant.
Herbicides:-chemicals used to destroy plants or stop plant growth.

Water pollution

Increased human activity, agricultural and industrial wastes pollute water, when they drain in to lakes, rivers, streams and seas. These wastes contain toxic compounds, salts, solvents are industrial wastes. Sewage, garbage and pathogens are domestic wastes. Agricultural wastes also contain pesticides, herbicides, fungicides and fertilizers.

Key term:
Fungicides:-substance that kill fungi.



Figure 5.26 water pollutants

Impact of water pollution

Toxic chemicals like mercury and lead, salts like phosphorous compounds etc are not broken down inside living things. They build up in tissues of aquatic organisms. When human eat this organisms lead is stored in liver, kidney and damage nervous systems. Finally they cause severe birth abnormality. If agricultural wastes enter into water body, they are dangerous for living things. Because these accumulate in the fats and body tissue. Domestic wastes may contain urine, faces, viruses and bacteria. It transmitted the disease of cholera, typhoid, and others for living organisms.

Activity 5.4:

1. Students discuss briefly on the purposes of water for living things and present for the class.
2. List and discuss on human activity which cause water pollutions and their conservation methods.
3. How you celebrate water conservation day on 22nd March?

- Present for the other groups and receive the comments.

Water Conservation

Water must be conserved by the use of various methods for the continuity of life on earth. Some of these methods are:-

1. ***Cover vegetation:-*** vegetation used to absorb and hold water. It reduce the rune off and decrease force of rain drops allowing the rain fall to reach the ground gently.
2. ***Contour ploughing:-*** is ploughing the hill across the slope but not up and down. It prevents waters from running off.
3. ***Terracing:-*** collect water in the channel and prevent erosion and increase the crop yield.
4. Building artificial mechanical barriers, check dams prevent running off.
5. Preventing water pollution by educating people and formulating water policy.

Ground water is water that found under the ground. This water must be conserved by different methods. Some are by

- Use native plants in your landscape. They look great, and don't need much water or fertilizer
- Use fewer chemicals around your home and make sure to dispose of them properly - don't dump them on the ground.
- Properly dispose of potentially toxic substances like unused chemicals, pharmaceuticals, paint, motor oil, and other substances.
- Get involved in water education! Learn more about groundwater and share your knowledge with others.
- Keeping it safe from contamination
- Using it wisely by not wasting it.

These and others method of ground water conservation are make the water sustainably used for long period of time.

Exercise 5.4:

1. Student guess which type of soil is more fertile reason out.
2. Briefly explain on the functions of the three types of soil.
3. Brainstorming on loss of soil fertility and their conservations.
4. Engage and participate in environmental protection club.

5.2.3 Air

Air is made up of 78.09% nitrogen, 0.93% argon, 0.04% carbon dioxide, and other gases in very small amounts. Air comprises almost 21% oxygen. Water vapor is also a constituent of air in varying amounts along with dust particles. The required gas for breathing and respiration are also found in the air.

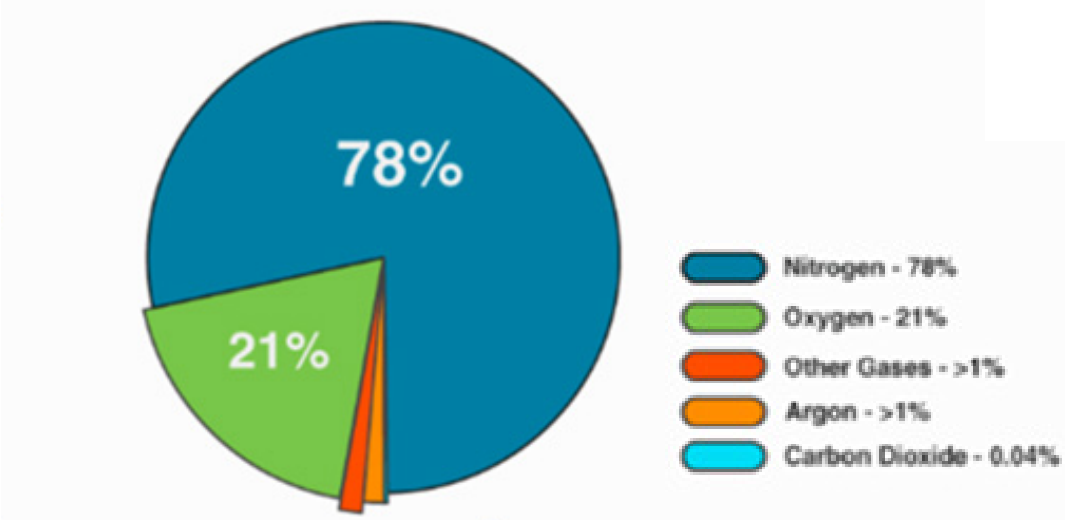


Figure 5.27 air compositions

Activity 5.5:-

1. List the importance of air for living things.
2. Discus in groups on impact of human to air pollution and way of preventions.
3. Discuss on impacts of air pollutions.

Carbon Dioxide

Carbon dioxide is a trace gas with a concentration of just about 0.04%. Carbon dioxide is produced through respiration and also through the decomposition of organic materials. It is also produced through some natural sources like geysers, volcanoes, burning of fossil fuel, deforestation, and hot springs. During the combustion of petroleum and natural gases, carbon dioxide is evolved. CO_2 is used in food industry as an additive in order to regulate acidity. Carbon dioxide is a great choice for use in soda products as it easily absorbs into a liquid including soft drinks to forms tiny bubbles. The CO_2 also serves as a protective measure that keeps the soft drink fresh and prevents the growth of bacteria in the liquid while stored.

Oxygen

Oxygen is the most important chemical element of air. Oxygen is a highly reactive gas which readily forms bonds known as oxides with other elements. It is also highly combustible (quick to catch fire). Oxygen plays a critical role in respiration, the energy-producing chemistry that drives the metabolisms of most living things. We humans, along with many other creatures, need oxygen in the air we breathe to stay alive. Oxygen is generated during photosynthesis by plants and many types of microbes.

Nitrogen

The most abundant, pure component of air is nitrogen with a concentration of around 78%. Nitrogen is produced through a process called nitrogen fixation which is a continuous cycle between the living organisms and the atmosphere. It is also produced in industries by fractional distillation of air in its liquid form.

Water Vapor

The water vapor concentration in the atmosphere varies from about 0.01% to 3% depending upon the temperature. When we respire we also release some amount of water vapor. In many chemical reactions, water vapor is evolved as a by-product. Apart from carbon dioxide and methane, water vapor also contributes to the greenhouse effect as it absorbs and emits radiations.

Water vapor is used as steam which helps in cooking and also in producing energy.

Key term:-
Greenhouse effect:-a natural process that warms the Earth's surface

Effects of Air Pollution

The effects of air pollution on the human body vary depending on the type of pollutant and the length and level of exposure as well as other factors, including a person's individual health risks and the cumulative impacts of multiple pollutants or stressors. Air pollution can cause different forms of effects on living and non-living things. Some are:-

1. ***Global warming:-***it is the rising of temperatures on the surface of earth as a result of accumulation of greenhouse gas like carbon dioxide.These greenhouse gases can trap heat from sun and make earth's temperature high.
2. ***Global dimming:-*** is worldwide blockage or reduction of sunlight from reaching the earth's surface as a result of unborn hydrocarbon released in to the air.
3. ***Acid rain:-***it caused by release of toxic substance in to the air like sulphuric and nitrogen oxide from factories and vehicles. During rain, the falling water combines with the oxides of sulphur and nitrogen. The acid rain causes killing leaves, soil depletion, polluted the water body and damage on building materials. The acid rain also can be the cause of volcanic eruption and lightening. It is oxidized in the atmosphere to SO_2, which can then be converted to sulfate. H_2S is some what soluble in water, resulting in formation of sulfhydric acid, which is corrosive to metals, and contributes to acidic deposition to soil and water.

Air pollution greatly affect our health by causing of lung cancer, heart disease, respiratory inflammations, brain damage, skin cancer etc.

How prevent air pollutions?

Any persons have responsible for the reduction of air pollution because it is worldwide problems. By using different methods like: Avoid use of traditional fuels, using solar wind and hydroelectric powers, reforestation or planting trees, take care for water pollutions, educating society and establish law of pollution control etc must prevent pollutions.

Activity 5.6;-

1. Plantation used to reduce carbon dioxide and global warming from the atmospheres. Briefly discuss how it reduces?
2. Brainstorming and discuss how photosynthesis is important for air pollutions?

Procedures: list way of reduction by plants

- Explain in their groups about the role of photosynthesis on air pollution

5.2.4. Forests

What is forest?

The forest is a complex ecosystem consisting mainly of trees that buffer the earth and support a variety of life forms. Harenna forest is one example of natural forests in south eastern Ethiopia. The trees help create a special environment which, in turn, affects the kinds of animals and plants that can exist in the forest. They clean the air, cool it on hot days, conserve heat at night, and act as excellent beauty of the earth.






Figure 5.29 forests

Plants provide a protective canopy that lessens the impact of raindrops on the soil, thereby reducing soil erosion. The layer of leaves that fall around the tree prevents runoff and allows the water to percolate into the soil. Roots help to hold the soil in place. Dead plants decompose to form humus, organic matter that holds the water and provides nutrients to the soil. Birds build their nests on the branches of trees, animals and birds live in the hollows, insects and other organisms live in various parts of the plant. They produce large quantities of oxygen and take in carbon dioxide.Transpiration from the forests affects the relative humidity and precipitation in a place.

Key term:
Transpiration:- Process of water movements through plants parts to environments during evaporations.

Activity 5.7:
1. Discuss on the role of forests in nature and present in the class.
2. Brainstorming on way of deforestations and discuss conservation methods.

Effects of human on forests

Human can affects the forests at different types of ways for various reasons. They cut down the trees for different purpose like for farming activities, furniture, wood, selling, building of home, and for others. These cut down of plant is called deforestation.



Figure 5.30 deforestation of forests

Reforestation is the process of planting trees in a forest where the number of trees has been decreasing. It's helping to bring forest back to an area where it was destroyed. Because forests are the best and most cost-efficient method for removing and storing consequential amounts of climate-warming carbon dioxide (CO_2).

5.2.5. Biodiversity

What is biodiversity?

The term bio diversity or biological diversity refers to the collection of life and habitat in ecosystems. They interact together between different species from ecosystem and ecological process. Biodiversity represents the most fundamental library in support of the life science. They are used as a bank of gene and species. Biodiversity is also the measure of the wealth of species in a given place or habitats. Biodiversity includes all types of living organisms ranging from smaller microorganism to largest organisms.

Importance of biodiversity

Ecological life support biodiversity provides functioning ecosystems that supply oxygen, clean air and water, pollination of plants, pest control, wastewater treatment and many ecosystem services.

Biodiversity is important to humans for many reasons.

• **Economic—**biodiversity provides humans with raw materials for consumption and production. Provisioning services—the production of food, fiber and water. Many livelihoods, such as those of farmers, fishers and timber workers, are dependent on biodiversity.

• **Ecological life support—**biodiversity provides functioning ecosystems that supply oxygen, clean air and water, pollination of plants, pest control, regulating services—the control of climate and diseases wastewater treatment and many ecosystem services.

• **Recreation—**many recreational pursuits rely on our unique biodiversity, such as bird watching, hiking, camping and fishing. Our tourism industry also depends on biodiversity.

• **Cultural—**cultural services—such as spiritual and recreational benefits.

• **Scientific—**biodiversity represents a wealth of systematic ecological data that help us to understand the natural world and its origin

Key terms:
Botanical garden: - institutions holding documented collections of living plants.
Seed banks:- the principle of conserving local varieties on farm.



Figure 5.31 biodiversity

Exercise 5.5

Explain and discuss briefly

1. List some example of organisms for each of the five kingdoms.
2. Discuss and explain types of national park and zoos and present in the class.
3. Ask and collect any indigenous practice from other persons that used to conserve natural resources.

Biodiversity conservation

The protection and efficient management of wild species and their environment is the prime objective of conservation. This conservation is usually carried out in two ways namely in-situ and ex-situ.

What is In situ Conservation?

It means the conservation of biodiversity in their natural habitats itself. It aims to enable biodiversity to maintain itself within the context of the ecosystem. Establish a protected area network, with appropriate management practices, corridors to link fragments restore degraded habitats within and outside. It helps in the multiplication of the species through the process of evolution and adaptation. It provides greater mobility to the animal species because of the large habitat area. Example- national parks, biosphere reserves, parks, sanctuaries.

What is Ex-situ conservation?

It means the conservation of biological diversity outside their natural areas. Artificial conditions are created to make their habitat almost like a natural habitat. It involves the maintenance of genetic variation (Genetic Conservation) away from its original location. Established botanical and zoological gardens, conservation stands; banks of germplasm, pollen, seed, seedling, tissue culture, gene, and DNA, etc. It identifies and rehabilitates threatened species; launched augmentation, reintroduction, or introduction programs. This method will enhance the probability of reproductive success for endangered species. It provides less mobility to the organism because of the small habitat area. Example- Zoo, aquarium, seed banks, botanical gardens, etc.

Hence, we can say that both In situ and Ex-situ are the method of conservation. The basic difference between in situ and ex-situ lies in the habitat place where the process is carried out.

Key terms:
Sanctuaries:-an area where animal habitats and their surroundings are protected from any sort of disturbance.
Germ plasm:-living tissue from which new plants can be grown.

5.2.6. Indigenous knowledge and Conservation of Natural Resources

Local and indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural and indigenous peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life. This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource use practices, social interactions, ritual and spirituality. These unique ways of knowing are important facets of the world's cultural diversity, and provide a foundation for locally-appropriate sustainable development.

Key term:
National park:- an area set aside by a national government for the preservation of the natural environment.

Indigenous Conservation and Management

The recognition that local and indigenous people have their own ecological understandings, conservation practices and resource management goals has important implications. It transforms the relationship between biodiversity managers and local communities. While previously they were perceived simply as resource users, indigenous people are now recognized as essential partners in environmental management.

For example, indigenous knowledge conservation of soil are terracing, contour ploughing, crop rotation, mixed cropping and fertilization some methods. The lands on which they live and the natural resources on which they depend are inseparably linked to their identities, cultures and livelihoods. Therefore, even small changes in their environment can have dramatic impacts on their lives. With the increasing pressure of global development, many countries are conserving these rich forest areas to protect their nature and biodiversity. These areas are called protected areas. Creating protected areas can increase biodiversity and benefit the ecosystem at the national or global level. However, at the local level, conservation can come at a cost to indigenous peoples' physical and spiritual well-being. This is the root cause of many conflicts over conservation objectives. Several examples across the globe show that conflicts with indigenous groups challenge the sustainability of conservation programs. Most recently, tension between large international conservation groups and local communities has been growing.

How does indigenous knowledge help in environmental conservation?

Indigenous knowledge is one of the greatest assets of a community. In a time when the climate is changing this knowledge can help them to adapt to these changes and control the environment around them. Indigenous knowledge means local knowledge that is unique to a given society and is embedded in their cultural traditions.

Key terms:

Aquarium:- a transparent tank of water in which live fish and other water creatures and plants are kept.

Exercise 5.6:

Part I: choose the correct answer from the given alternatives.

1. The interaction between similar species is called _____
   A. inter B. intra C. predator D. prey
2. Which of the following is more important in nature cycle
   A. algae B. fungus C. cyanobacteria D. all
3. One of the following is not components of food chain
   A. producer B. primary consumer
   C. secondary consumer D.none
4. Which of the following is renewable resources
   A. fossil B. petroleum C. charcoal D. food

Part II: Match descriptions in column B with the items in column A

A	B
1. Renewable resources	A/ sandy soil
2. Poor ability to hold water	B/ clay soil
3. Hold large water	C/ solar energy
4. Nitrogen	D/ 21 %
5. Oxygen	E/ 78%

Parts III: fill blank space

1. _____ is complex ecosystems containing many trees.
2. Conservation of organism in their habitat is called _____
3. _____ is a knowledge that local person used to perform different tasks.

SUMMERY

- Any living organisms cannot be survive or live without the interaction each other and with their environments.
- Ecosystems can be affected by living (biotic) components and nonliving things or physical components (abiotic) of an environment.
- Biological interaction of organism can be intra specific between the same species or inter specific between members of different species.
- Decomposers are organisms that can breakdown dead body part of other organisms to get their nutrients. Because of these they found at the end of each food chain.
- Food chain is the direct and simple feeding systems that involve the transfer of nutrient and energy while food web is too complex feeding interrelation among the organisms which consists of many food chains.
- Pyramid is the diagram that used to express the amounts of organisms presents in each trophic level.
- The cyclic of elements such as nitrogen, oxygen, hydrogen, carbon from environment to organism and back to environment are called nutrient cycle.
- Any naturally occurring substance on the earth that humans use can be considered a natural resource.
- It grouped in to two major groups namely renewable and non-renewable.
- Conservation is the care and protection of these resources so that they can persist for future generations.
- Soil consists of inorganic particles and organic matter which provides the structural support to plants and source of water and nutrients.
- Water is the main constituent of living cell and also used as a habitat for most organisms.
- Increased human activity, agricultural and industrial wastes pollute water, when they drain in to lakes, rivers, streams and seas.
- Carbon dioxide is produced through respiration and also through the decomposition of organic material.
- The most abundant, pure component of air is nitrogen with a concentration of around 78%.

- Air pollution is caused by solid and liquid particles and certain gases that are suspended in the air.
- Acid rain, global warming, and global dimming are the results of air pollutions.
- Forests clean the air, cool it on hot days, conserve heat at night, and act as excellent sound absorbers.
- Human can cut down the trees for different purpose like for farming activities, for furniture, wood, selling, building of home, and for others and it is called deforestation.
- The term bio diversity or biological diversity refers to the collection of life and habitat in ecosystems and it is also the measure of the wealth of species in a given place or habitats.
- The maintenance of species and ecosystems is a keystone to sustainable development. This conservation is usually carried out in two ways namely in-situ(in their natural habitats) and ex-situ (outside their natural habitats).
- Local and indigenous people have their own ecological understandings, conservation practices and resource management goals have important implications.

Review exercise

Part 1: For the following questions choose the best answer among the choices given.

1. The collection of living and nonliving things are called _____
   A. plant B. animal C. ecology D. ecosystems
2. All living things also called _____
   A. physical component B. biotic
   C. abiotic D. microorganism
3. The relation between two different species in which one or both are benefited is called _____
   A. competition B. decomposers C. symbiosis D. all
5. One of the following is not biotic component
   A. disease B. plant C. food D. water
6. ___is used to mainly control the growth of vegetation by its fertility.
   A. soil B. water C. air D. all

7._____ is an organism that release energy from simple chemical reactions.
A. decomposers B. heterotrophs
C. photoautotrophs D. chemoautotrophs
8. All organisms can directly or indirectly depend on first trophic level.
A. producer B. primary consumer C.decomposer D.carnivours
9._____ is the main sources of energy for all food chain.
A. plant B. animal C. temperature D. sun
10. The food chain that contain more than one food chain is called_____
A. interaction B. relation C. food web D. food chain
11._____ is reduction of nitrate back to inert nitrogen gas
A. ammonification B. nitrification
C. denitrification D. nitrogen fixation
12. The movement of elements in the atmosphere is called _____
A. carbon cycle B. nature cycle
C. nitrogen cycle D. water cycle
13. The wise use of natural resource is called _____
A. conservation B. management C. protection
D. preservation E. all
14. Conservation is only protection of nonrenewable resources
A. non renewable B. renewable C.water D.all

Part II:- fill in the blank space

1._____ refers to the size distribution of the mineral particles found in a representative sample of soil.
2._____ is the process of growing trees to prevent soil erosion.
3.The contaminated of water with toxic substances are called_____
4. The major components of gas in the atmosphere is called_____
5._____ is a chemical that is toxic for other natural resources.
6.The collection of shrubs and large trees are called _____

Part III:- write short answers

1.List and discus briefly about the prevention of water and air pollution.
2. How can be human activity cause pollution of air?
3. List advantages of biodiversity throughout the world.

UNIT SIX

THE SOLAR SYSTEM

Learning Outcomes:

At the end of this unit, learners will be able to:

- explain family of the solar system;
- name all planets in the solar system;
- show the position of each planet in the solar system;
- develop the model of solar system;
- describe how satellites move around the earth;
- explain the motion of large bodies in the solar system;
- differentiate the motion of satellites and planets in the solar system;
- compare the distance, size, position and behavior of each planate from the Sun;
- explain the unique characteristics of the earth;
- describe the suitability of earth for life.

Introduction

This unit deals about the families and formation of the Solar System. The solar system includes the Sun, planets, satellites, dwarf planets, Asteroids, comets and Meteors.

Then, the distance, size, position and behavior of each planet from the sun will be discussed. Finally, the suitability (uniqueness) of Earth for life will be discussed.

Main contents of the unit

6.1 Family of the Solar System
6.2 Formation of the Solar system.
6.3 Earth in comparison with solar system
6.4 Our planet's Suitability for Life.

6.1 Family of the Solar System

At the end of this section you will be able to:

- explain family of the solar system;
- name all planets in the solar system;
- show the position of each planet in the solar system;
- develop the model of the solar system.

The Solar System

The Sun and all celestial bodies that revolve around it form the solar system. Thus, our solar system includes the Sun, eight planets including their moons, dwarf planets, smaller bodies such as asteroids, comets and meteors. Figure 6.1 shows a schematic view of the solar system.

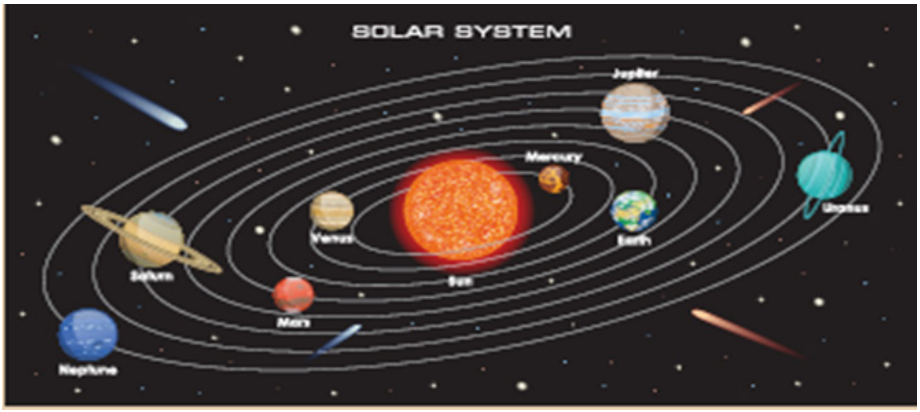


Fig. 6.1 The solar system

The Sun

The Sun is a star closest to our Earth. It is located at the very center of our solar system. The Sun is mostly made up of hydrogen gas (about 71%), helium gas (about 27%) and other gases(2%). The temperature at the surface of the Sun is very high, around 5500 °C. It is about 15 million °C at its center. The Sun is the largest and most massive object in our solar system making up 98% of the total mass of the solar system.

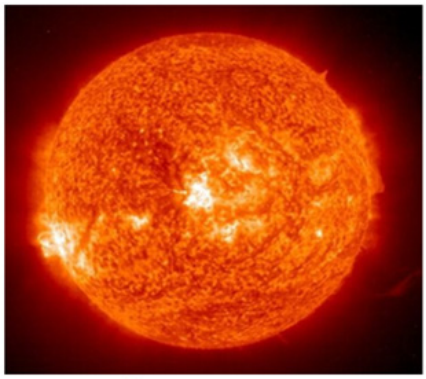


Fig 6.2 The Sun

The Planets

Planets are celestial bodies that revolve around the Sun in a well-defined path. This path is known as the orbit of the planet. In 2006, the International Astronomical Union (IAU) declared the number planets to be eight. In addition to this, as of 2014, this union has recognized five dwarf planets.

Based on their distance from the Sun, planets in our solar system classified into two.
1. Terrestrial (inner) planet: mercury, Venus, earth and mars.
2. Jovian (outer) planet: Jupiter, Saturn, Uranus, and Neptune.

1. Mercury

Mercury is the closest planet found at a distance of 57.9 million km from the Sun. It is the smallest planet of our solar system. Mercury has no satellite of its own. Mercury has the most extreme temperatures in the solar system, reaching 426 °C during the day and -173 °C during the night. It takes 88 days for Mercury to make one complete revolution around the Sun.

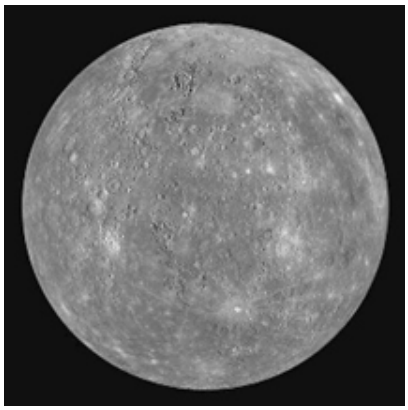


Figure 6.3 mercury

2. Venus

Venus is the nearest planet to earh. It is found at a distance of 108.2 million km from the sun. Venus has a thick dense atmosphere mostly made up of carbon dioxide which is an effective greenhouse gas. That is why Venus has the highest surface temperature and it is the hottest planet in the solar system. Venus has mountains, volcanoes and dunes just like Earth. Venus has no moon. Rotation of Venus on its axis is some what unusual. It rotates in the opposite direction to all other planets. It takes 243 days for Venus to make one complete revolution around the Sun.



Figure 6.4 Venus

Project 6.1: With the help of your General Science teacher find out the time when Venus is visible in the sky. You can easily recognize Venus by its brightness. You must try to observe Venus either 1-3 hours before sunrise or 1-3 hours after sunset. Prepare a report to your class.

3. The Earth

Our home planet, the Earth is found at a distance of 149.6 million km from the sun. The Earth is the third nearest planet to the sun. Having a look from space, it appears blue green due to the reflection of light from water and landmass on its surface. The Earth has only one moon. It takes 365.25 days for the Earth to make one complete revolution around the Sun.



Figure 6.5 Earth

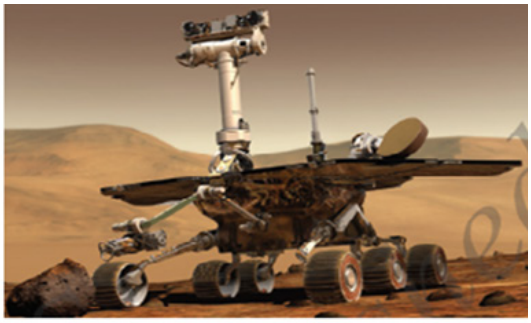
4. Mars

Mars is found at a distance of 227.9 million km from the sun. It is the fourth planet from the Sun and the second smallest planet in the solar system. Mars is known as the ***Red Planet,*** because of its reddish color. It has only two moons. Mars has mountains, volcanoes and valleys just like the Earth.

It takes 687 days for Mars to make one complete revolution around the Sun.



Fig 6.6 (a) Mars



(b) Robot on Mars

Scientists are interested in visiting Mars thinking that there may be some water in cracks and tiny holes in underground rock. For this purpose, they send Robots to Mars, see Figure 6.6.

Tip. *The largest volcano in the solar system, Olympus Mons, is on Mars and it is three times taller than Mount Everest. Mars also has the deepest and longest valley in the solar system, known as Valles Marineris.*

5. Jupiter

Jupiter is found at a distance of 778.3 million km from the sun. It is the fifth planet from the sun, found next to Venus. Jupiter is the largest planet of the solar system. Jupiter has 79 moons. It also has faint rings around it. Jupiter appears quite bright in the sky, for this reason you can easily recognize it. It takes 11.89 years for Jupiter to make one complete revolution around the Sun.



Figure 6.7 Jupiter

6. Saturn

Saturn is found at a distance of 1432 million km from the Sun.We get Saturn next to Jupiter. Saturn has the largest number of moons,which are 82 moons. One interesting thing about Saturn is that it is the least dense among allthe planets.

Its density is less than that of water. Saturn is known for its rings. These rings are not visible with the naked eye. It takes 29.37 years for Saturn to make one complete revolution around the Sun.

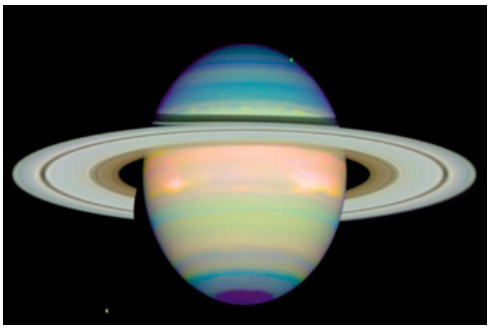


Figure 6.8 Saturn

7. Uranus

Uranus is found at a distance of 2871 million km from the Sun. It is the seventh planet from the sun. It is blue-green in color. Uranus is the third-largest planet in our solar system. It has 27 moons. Uranus was the first planet discovered using a telescope and it can be seen only with the help of large telescopes. Like Venus, Uranus rotates from east to west. The most remarkable feature of Uranus is that it has highly tilted rotational axis. It takes 84.099 years for Uranus to make one complete revolution around the Sun.

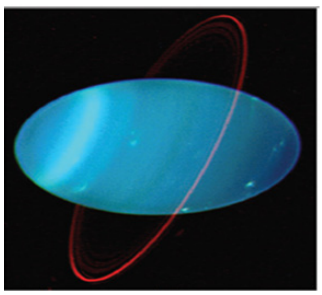


Figure 6.9 Uranus

8. Neptune

Neptune is the eighth and farthest planet of the solar system. It is found at a distance of 4498 million km from the Sun. In the Solar System, it is the fourth-largest planet by diameter, the third-most massive planet, and the coldest. Neptune has 14 moons. It can be seen only with the help of large telescopes. It takes 165 years for Neptune to make one complete revolution around the Sun.

Table 6.1 Solar system data

Name of Planet	Distance from the Sun (million km)	Number of moons	Temperature (^{0}C)	Period of Revolution	Period of Rotation
Mercury	57.9	0	167	88 days	59 days
venus	108.2	0	464	243 days	243 days
Earth	149.6	1	15	365.25 days	23.9345 hours
Mars	227.9	2	- 65	687 days	24 hours 37 min
Jupiter	778.3	79	- 110	11.89 years	9 hour 50 min
Saturn	1432	82	- 140	29.37 years	10 hours 13 min
Uranus	2871	27	- 195	84.099 years	17.2 4hours
Neptune	4498	13	- 200	165 years	16.1 hours

Source: Ethiopian Space Science and Technology Institute

Dwarf planets

Dwarf planets are bodies that are too small to be considered full-fledged planets, but too large to fall into smaller categories. The five dwarf planets that have got acceptance by IAU are: Pluto, Eris, Ceres, Haumea, and Makemake.

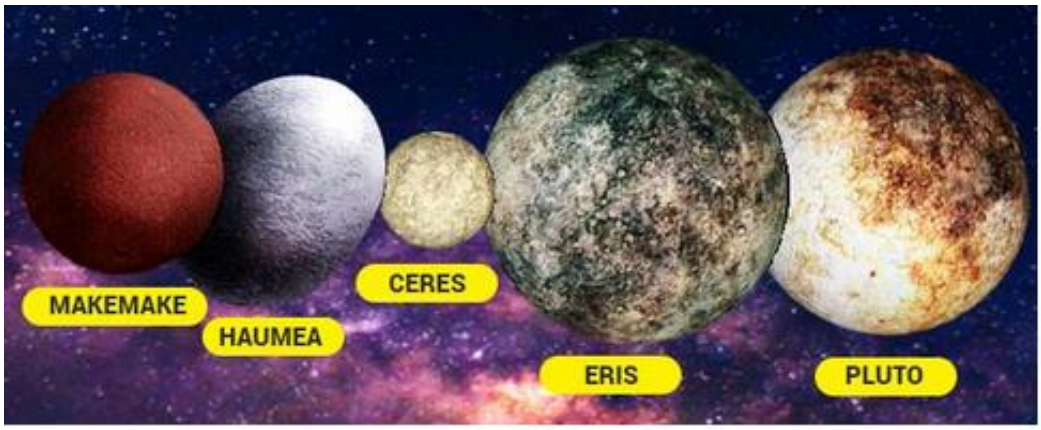


Figure 6.10 Dwarf planets

Terrestrial (inner) and Jovian (outer) planets

According to their orbits, planets are grouped into two classes: The inner and outer planets. The inner planets are also called **terrestrial (or rocky)** planets because their surfaces are made of rock. The first four planets closest to the sun (Mercury, Venus, Earth, and Mars), are the inner planets. They have the following characteristics.

- Low mass: Earth is the heaviest.
- High densities (4000 to 5500 kg/m^3).
- • They are made of rock and have metallic cores.

The remaining four planets further from the sun (Jupiter, Saturn, Uranus, and Neptune) are called the outer planets. They are also called **Jovian planets.**



Figure 6.11 (a) Inner planets (b)Outer planets

The outer planets are very different from the four inner planets. They have the following behaviors:

- Large diameters (4 to 11 times Earth's size)
- High mass (14 to 318 times Earth's mass)
- Low average densities (700 to 1700 kg/m^3)
- They are mainly made of hydrogen and helium without a solid surface.
- The outer planets have large number of moons.

Project 6.2: In earlier times, the numbers of planets in the solar system was nine. But now a days, although Pluto orbits the Sun, it is no longer a planet of the solar system. Explore the reason why Pluto is discarded from the list of planets.

Exercise 6.1:

Choose the word from the list to fill in the blank spaces.

Mercury	Pluto	Sun	Jupiter

1._____ is a star in the solar system.
2._____ is a dwarf planet.
3. The planet closest to the sun is _____.
4.The largest planet in the solar system is _____.

Some Other Members of the Solar System

There are some other bodies which revolve around the Sun. They are also members of the solar system. They are Asteroids, comets and meteors.

Asteroids

Asteroids are large number of small objects that revolve around the Sun. Most asteroids are found in the asteroid belt, which lies between the orbits of Mars and Jupiter (Fig 6.12). Asteroids closest to the Sun are mainly metallic objects. Those further away are rocky objects. Asteroids can only be seen through large telescopes.

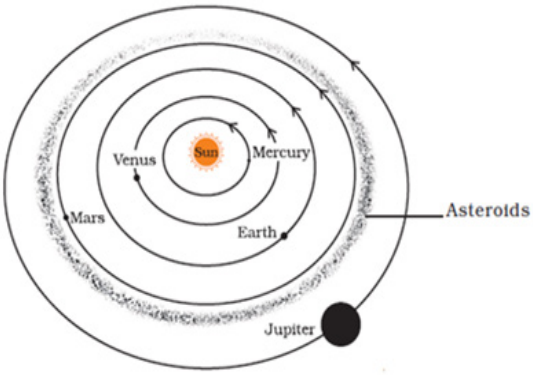


Figure 6.12 Asteroids

Comets

Comets are icy and dusty objects that revolve around the Sun in highly elliptical orbits. Their period of revolution round the Sun is usually very long. A comet appears generally as a bright head with a long tail. The length of the tail grows in size as it approaches the sun. The tail of a comet is always directed away from the sun (Fig. 6.13).

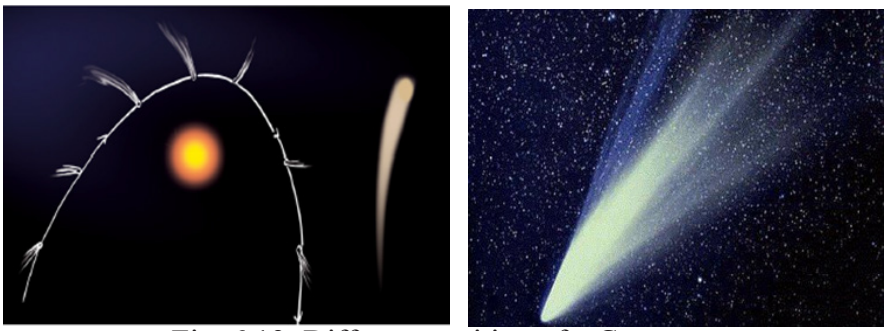


Fig. 6.13: Different position of a Comet

Tip: *Edmund Halley and His Comet*

The most well known comet in the Solar System is known as Halley's Comet. The comet is named after English astronomer Edmond (or Edmund) Halley, who examined reports of a comet approaching Earth in 1531, 1607 and 1682. He concluded that these three comets were actually the same comet returning over and over again. Halley predicted the comet would come again in 1758. Halley's Comet appears after nearly every 76 years. The last time it was seen was in 1986, and the predicted next appearance of Halley in the inner Solar System will be in 2061



Meteors and Meteorites

Meteors are commonly known as shooting stars, although they are not stars. A meteor is usually a small object moving around the sun. When a meteor occasionally enters the Earth's atmosphere, it gets heated up because of friction and evaporates in a very short period of time. Some meteors are so large that a part of them reaches the surface of the Earth before they evaporate completely. These are called **meteorites.**



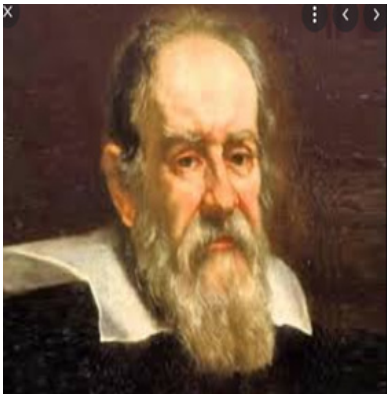
Figure 6.14 Meteors

Tip: Galileo Galilei (1564–1642)

Galileo is an Italian astronomer, mathematician, physicist, inventor and philosopher. In 1609 Galileo built his first telescope, though he is not the first inventor of the telescope, and began making observations. His observations of the night sky changes mankind's view of the universe, and our place in it. With his telescope Galileo discovered the four primary moons of Jupiter (now known as the Galilean moons). He also discovered many new stars, the phases of Venus and Saturn's rings.

Galileo was also known to discover the craters and mountains on the Moon and Sun-centered solar system, against Earth-centered solar system. This view of Galileo brought him into serious conflict with the Church. Because of this Galileo was arrested at home at the end of his lifetime. Galileo became completely blind by the age of 74, but ***NOT*** *because he looked at the Sun through his telescope.*

Remember, like Galileo, you should NEVER look directly at the Sun!



Exercise 6.2:

1. What are the differences between inner and outer planets?
2. Name all planets in the solar system.
3. Locate the position of each planet and other member of the solar system by writing their name corresponding to the numbers labeled in the figure 6.15 below

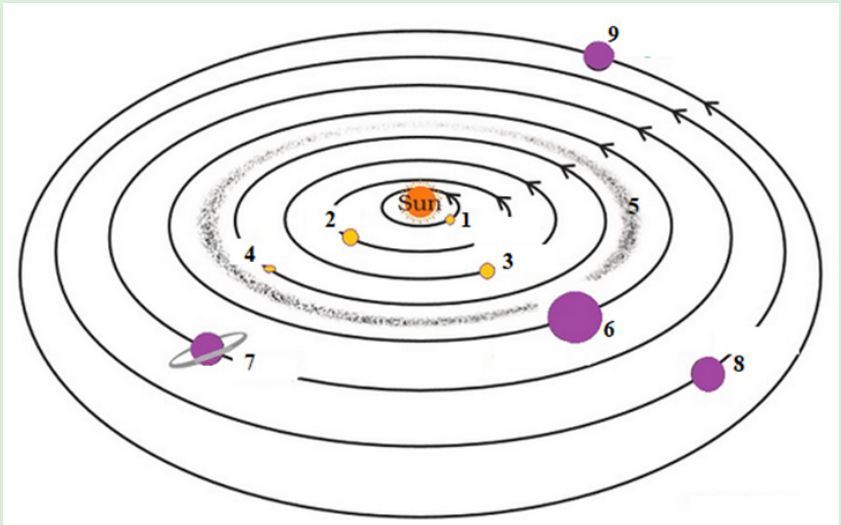


Figure 6.15 Solar system

1. _____	4. _____	7. _____
2. _____	5. _____	8. _____
3. _____	6. _____	9. _____

4. Which type of planet (inner or outer) tends to be denser? Explain why.
5. Which planet has more moons?
6. Which planet tends to have the shortest time taken to make one complete rotation around Sun? Why is this?
7. Which planet have the least temperature? Why is this?
8. Which planet rotates fastest around its axis of rotation?

6.2 Formation of the Solar System

At the end of this section, you will be able to:

- describe how satellites move around the Earth;
- explain the motion of large bodies in the solar system;
- differentiate the motion of satellites and planets in the solar system.

Scientists believe that our solar system is formed approximately 4.6 billion years ago from the cloud of dust and gas, mainly hydrogen and helium. This cloud of dust and gas was slowly rotating in space. At that time the cloud was disturbed by the explosion of a star known as **supernova.** The energy of this explosion causes the cloud to start contracting. As the contraction increases, the particles of the cloud were squeezed into less space. As a result, the cloud's density becomes greater and the increased attraction of gravity pulled more gas and dust towards the center of the cloud. This caused the cloud to rotate faster and there it causes a solar nebula. A solar nebula is a large cloud of gas and dust from which the sun, planets and other solar system (asteroids, meteors and moons) be formed.

The Birth of the Sun

At the heart of the nebula, the contraction proceeds. As a result, ball of hydrogen gas whose pressure and temperature become quite huge become formed. Most of the contracting mass is collected in the center, forming the Sun. The fact that most of the material was pulled toward the center, accounts for 99.8% of the mass of the solar system to be that of Sun. The figure below shows the formation of the solar system with a diagram.

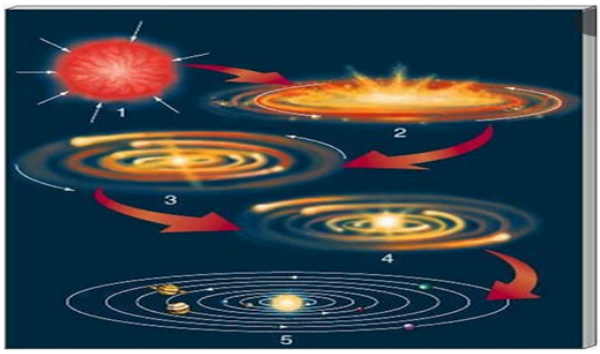


Figure 6.16 The process of the Formation of Solar

The Birth of the Planets

The planets are formed from the same cloud of gases and dust as the Sun. Not all the nearby gas and dust were drawn into the core of the cloud. The infinitely large number of left over gas and dust particles will also began to stick together by their mutual gravity. This forms clumps. These clumps smashed into one another, forming larger and larger objects that led to the birth of Earth, other planets and moons in our Solar System.

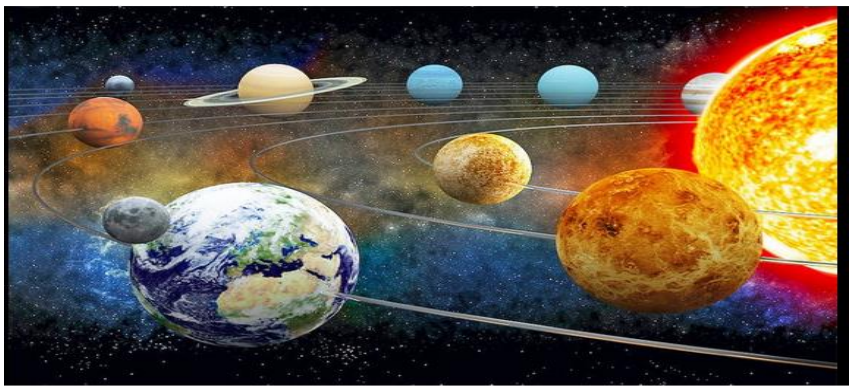


Figure 6.17 Formation of Planets

The comets, asteroids, and meteorites are surviving remnants from the processes that formed the solar system.

Motion of satellites around earth

Planets are celestial bodies that revolve around Sun, whereas a celestial body that revolves around a planet is called a **satellite.** Moon is the natural satellite of the Earth. There are many man-made satellites revolving round the Earth. These are called **artificial satellites.** Artificial satellites are launched from the Earth.

Artificial satellites have many practical applications. They are used for weather forecasting, and transmitting television and radio signals. They are also used for telecommunication and remote sensing. **Our country, Ethiopia,** has launched two artificial satellites. The 1st Earth Observation satellite of Ethiopia (ETRSS-1) was launched on the 20th of December 2019 in collaboration with the government of China.

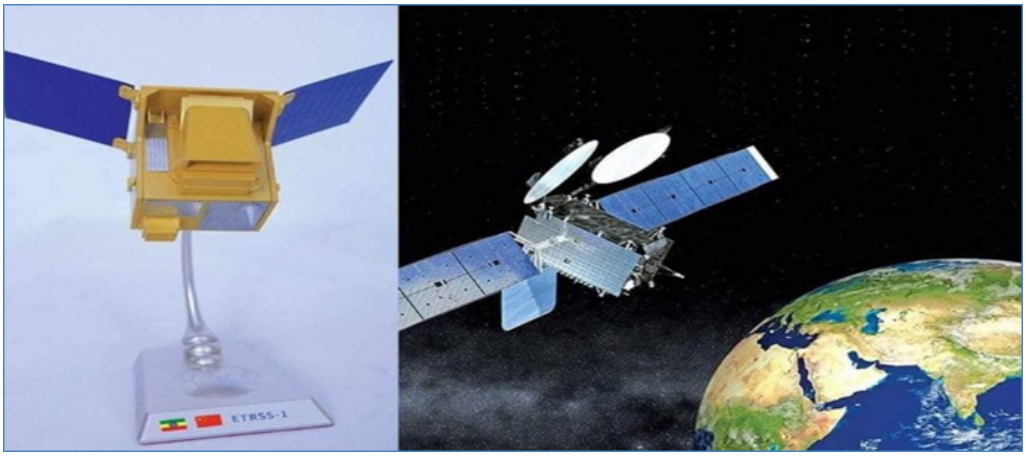


Figure 6.18 Symbol figure of the Ethiopian Remote sensing Sateallites-1.

ET-SMART-RSS is the second Ethiopian satellite, launched followed by ETRSS-1. ET-SMART-RSS has a higher resolution than ETRSS-1. The naming ET-SMART-RSS is ETfor Ethiopia /ESSTI, SMART is for Beijing Smart Satellite Technology and RSS stands for Remote Sensing Satellite. It is launched on December 22, 2020.

The main mission of the Ethiopian space satellite is for addressing urgent national challenges in the areas of natural resource management, climate change and variability, weather forecasting and monitoring, different forms of natural disasters mitigation (like drought, landslides, and flood), mapping and exploration of minerals, water resource availability and supply, transport infrastructure monitoring, energy and tourism development, agriculture modernization, forestry, ecosystems as well as border surveillance and national security.

Exercise 6.3

1. Describe what motion does a satellite make around Earth?
2. Discuss the difference between the motion satellites and planets.

6.3 Earth in Comparison with Solar System

At the end of this section you will be able to:

- Compare the distance, size, position and behavior of each planet from the Sun

The Earth is the planet we are living in. It is the third planet from the Sun and the only planet in our Solar System that is known to support life. The Earth is about 12,750 km in diameter. The Earth is the fifth-largest planet in our Solar System (after Jupiter, Saturn, Uranus, and Neptune).

Compare the distance of each planet from the sun

The distance of each planet from the Sun varies because all the planets orbit the Sun on different elliptical paths.

Activity 6.1: Creating a model of distances of planets from the sun.
Make a group that contains 10 students. One student will represent the Sun and the other 8 will represent the eight planets. The other team members will put the planet students in the correct order, from closest to furthest from the Sun, using the data on the table below. If you do not have enough space to do this model, you can modify this activity by using a string model in the classroom. Have students tie beads in place to represent planetary distances. You can also modify the scale.

Table 6.2 Distance of planets from Sun

Planet	Distance from the sun (in million km)	Distance using a scale (1 cm = 2 million km)
Sun	0	0 cm
Mercury	57.9	30 cm
Venus	108.2	50 cm
Earth	149.6	75 cm
Mars	227.9	1.0 m
Jupiter	778.3	3.70 m
Saturn	1432	6.75 m
Uranus	2871	13.7 m
Neptune	4498	22.2 m

Source:Ethiopian Space Science and Technology Institute

Exercise 6.4:

Answer the following questions using your model of activity 6.1

1. What did you notice about the distance of planets from the sun?
2. Compare the position of each planet from the sun.
3. Locate the position of Earth in the solar system?
4. Write the name of all planets, outward from the sun.

Compare the size of Earth with other planets in the solar system
How big is Earth?

Earth is the fifth-largest planet in the solar system. It's smaller than the four gas giants: Jupiter, Saturn, Uranus and Neptune, but larger than the three other rocky planets, Mercury, Mars and Venus.

Size of the Planets

Below are the estimated diameter of the eight planets in our solar system, in order of size. The diameter sizes relative to Earth is also given to help you picture them better.

Table 6.3: Planets Radius

No.	Name of planet	Diameter of planet	Size relative to Earth
1	Mercury	4 880 km	0.383 x size of Earth
2	Mars	6 794 km	0.533 x size of Earth
3	Venus	12 104 km	0.949 x size of Earth
4	Earth	12 750 km	
5	Neptune	49 528 km	3.883 x Earth's size
6	Uranus	51 118 km	4.007 x Earth's size
7	Saturn	120 536 km	9.449 x Earth's size
8	Jupiter	142 984 km	11.209 x Earth's size

Source: Ethiopian Space Science and Technology Institute

Project 6.3: Developing the model of solar system
Form a group containing at least 5 students. Let each student make a ball using clay or newspaper. Each ball should have a size in proportion to the size of the Sun and planets (Use Table 6.3). You can arrange the balls on the floor of your classroom. You can cover these balls with paper of different colors. Exhibit your models to your class and to the school community.

Exercise 6.5:

Answer the following questions based on the above project 6.3.

1. What do you notice about the size of the planets?
2. Which planet is smallest in size?
3. Which planet is largest in size?
4. Write the name of planets in order of increasing their size.
5. Revising through what we have discussed up to now, write the behavior (temperature, density, etc.) of each planet in the solar system.

6.4 Our planet's Suitability for Life (Uniqueness)

At the end of this section you will be able to:

- explain the unique characteristics of Earth;
- describe the suitability of Earth for life.

What Makes Earth Suitable for life?

Earth is the only planet that has life. There are many factors which make Earth suitable for life. These are:

• Earth has right amount of liquid water. About 71 percent of the Earth's surface is covered with oceans and lakes. This liquid water is not too much to cover the mountains, and not so little that it's a dry desert.

• Earth is found at the right distance from the Sun.The distance of the Earth from the Sun makes it to receive enough energy to allow water to exist as a liquid on its surface. If it was too close, the Earth would be too hot. It would lose all the oceans. If it is too far, then the oceans would freeze over.

• Earth has the right temperature that allows liquid water to exist, and also provides a relatively stable environment for organisms. Earth's temperature average is 15°C.

• Earth has the right moon. Because of our moon, Earth is titled , this results to the formation of seasons.

Without the moon, the rotation of the Earth would result in a day that averages about 4 hours.

• Earth has the right Sun. Our Sun is the most important source of energy for life on Earth. It's also a stable and long-lasting star.

• Earth has the right core. Earth's solid inner core and liquid outer core play crucial roles in protecting life from solar radiation. Earth has a strong magnetic field which deflects most of the solar wind (charged particles that flow from the Sun). Without it, solar winds would strip away Earth's oceans and atmosphere.

• Because of its huge mass, Jupiter attracts most of the asteroids towards itself and away from Earth. Jupiter shields Earth from constant stellar bombardment.

• The Earth's atmosphere is rich in oxygen, Nitrogen, Carbon Dioxide, and other compounds that are essential for life.

- Earth has an ozone layer to block harmful rays coming from Sun.

The unique Characteristics of the Earth

The Earth is the only planet in the solar system on which life is known to exist. Some special environmental conditions are responsible for the existence and continuation of life on the Earth. These include just the right distance from the Sun, so that it has the right temperature range, the presence of water and suitable atmosphere and a blanket of ozone. Thus, we must take special care to protect our environment so that life on Earth is not disturbed.

Exercise 6.6:

Give a brief explanation for the following questions.

1. Discus what makes Earth to be suitable for life?
2. Discuss the unique characteristics of Earth.

Key term: Solar system, Sun, planet, Earth, and satellite

Summary

- The solar system consists of eight planets with their moons, dwarf planets, asteroids, comets and meteors.
- Mercury is the least and Jupiter is the largest planet of the solar system.
- Mercury is the nearest and Neptune if the farthest planet in the solar system.
- A body revolving around another a planet is called a satellite.
- Artificial satellites revolve around the Earth. They are much closer than the moon.
- Artificial satellites are used for weather forecasting, long distance communication and remote sensing.
- Earth is a unique place for because of its suitable climatic condition, land forms and water body which supports life in all forms. Earth has a moderate temperature, with liquid water on its surface. There is also abundant oxygen for respiration and plenty of sunlight (energy) for plants to grow.

Review Exercise

Part I:Write True for Correct and False for Incorrect statements

1. Mercury is the smallest planet of the solar system.
2. Uranus is the farthest planet in the solar system.
3. Moon a natural satellite.
4. The Sun and the celestial bodies form Solar system.
5. The Earth can be said the satellite of the Sun.

Part II: Choose the correct answer from the given alternatives:

1. Which of the following is NOT a member of the solar system?
   a) An asteroid b) A satellite
   c) A constellation d) A comet
2. Which of the following is NOT a planet of the sun?
   a) Meteors b) Mercury
   c) Saturn d) Earth
3. Everything in the solar system revolves around
   a) Earth b) Moon
   c) Stars d) Sun
4. Small heavenly bodies that revolve around the Sun in highly elliptical orbits are called _____.
   a) comets b) asteroids
   c) pole star d) none of the above
5. The third planet from the sun is _____.
   a) Mars c) Venus
   b) Earth d) Jupiter

Part III: Match items in column A with one or more items in column B:

"A"	"B"
1. The planet we live in	(a) Neptune
2. A planet with no moon	(b) Moon
3. Satellite of the Earth	(c) Venus
4. Dwarf planet	(d) Earth
5. A planet with longest revolution time.	(e) Pluto

Part IV:Fill in the blanks with the appropriate word.

1. The planet which is farthest from the Sun is _____ .
2. The planet which appears reddish in color is _____ .
3. A celestial body that revolves around a planet is known as _____.
4. Asteroids are found between the orbits of _____ and _____.
5. The second largest planet, in the solar system is _____ .

Part V: Give short answer for the following questions.

1.Define a solar system.
2. Write the families of the solar system.
3. Name all planets in the solar system.
4. Compare the distance of planets from the Sun.
5. Compare the size of all planets.

UNIT SEVEN

PHYSICAL PHENOMENA IN THE SURROUNDING

Learning Outcomes:

At the end of this unit, you will be able to:

- list some sources of light;
- describe reflection and refraction;
- explain dispersion of light;
- show colors formed on the other side of the prism;
- determine the purpose of light;
- classify materials as transparent, translucent and opaque;
- demonstrate how image is formed;
- define sound as a form of energy;
- explain how sound is formed;
- demonstrate the formation of sound;
- identify material medium for sound propagation;
- prioritize sound propagation in solid, liquid and gases;
- explain the cause of sound pollution;
- identify hearing level for different sound;
- list strategies of sound pollution;
- define echo and demonstrate its application;
- define the term heat;
- explain mechanism of heat transfer;
- classify materials as good conductors of heat and poor conductors of heat (insulators);
- define magnetism;
- do simple experiment and construct magnetic lines of force;
- explain the use of magnet;
- list all material used to construct simple circuit;
- construct simple circuit;

- explain the use of magnet;
- list all material used to construct simple circuit;
- construct simple circuit.

7.1 Phenomena of Light (Source & Properties)

At the end of this section you will be able to:

- list some sources of light;
- describe reflection and refraction;
- explain dispersion of light;
- show colors formed on the other side of the prism.

Key terms: Light, sources of light, reflection of light, refraction of light, dispersion of light

Light

Activity 7.1: How do we see objects? Can we see objects in a dark room? Based on your observation discuss in group what light is.

Light is a form of energy that enables us to see objects surrounding us. We see object when light from a source or from a reflecting body enters our eyes.

Sources of Light

Object which emits its own light is called a **source of light.** It is also known as a luminous object. The main natural source of light is the sun. Objects which do not emit light are known as **non -luminous** objects. At night, we use bulbs, lamps, candles and other artificial sources to get light because there is no sunlight.

There are two types of sources of light: Natural sources of light and artificial (man-made). Natural light sources produce light naturally without any human involvement. Examples of natural sources of **light: Sun, Stars, Lightning etc.**

Artificial sources are man – made light sources. Examples of artificial sources of light are: candle, electric bulb, and burning wood etc., see Figure 7.1

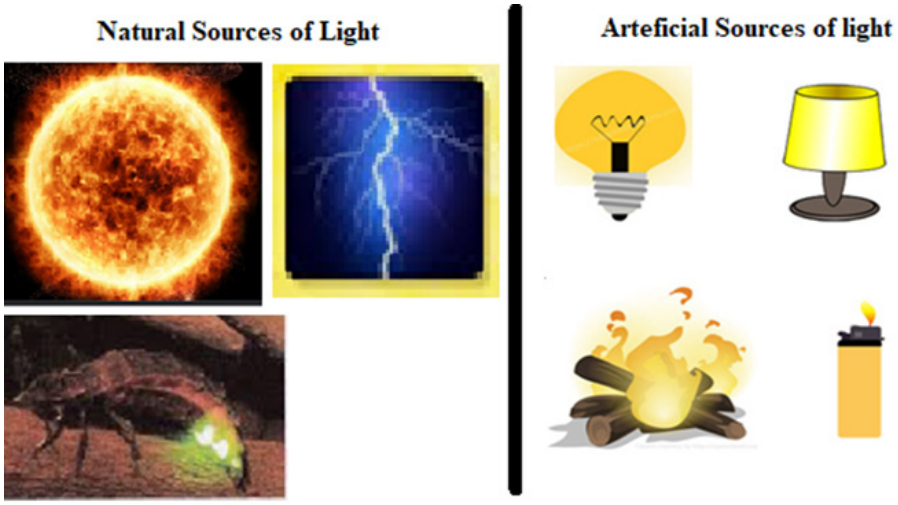


Figure 7.1 Sources of light

Project 7.1: There are living organisms that have the ability to produce light. Using internet and by asking your teacher bring a report to your class the name of living organisms that produces light.

Exercise 7.1:

1. What is main source of light for Earth?
2. Is the moon a source of light? Discus in pairs and present your groups opinion to your class.
3. List natural sources of light.
4. List artificial sources of light

Properties of Light

Activity 7.2: What properties of light did you know? Discuss in group.There are about seven properties of light, but here you will discuss only three of them: Reflection of light, refraction of light and dispersion of light.

Reflection of Light

Reflection is the phenomenon in which light travelling in one medium, falls on the surface of another medium and returns back to the first medium. Depending on the nature of the reflecting surface, reflection could be either regular or diffused.

Regular reflection also known as Specular reflection happens when light is reflected from smooth and shiny surfaces. Diffuse reflection happens when light is reflected from a rough, unpolished surface. Reflection from a mirror forms regular reflection and reflection from a wall, wood, paper etc. forms diffused reflection. Mirrors are excellent reflectors of light.

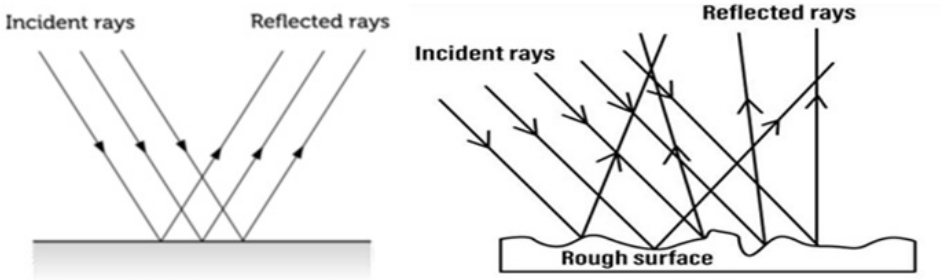


Figure 7.2 (a) regular reflection (b) diffused reflection

In regular reflection, all the rays are reflected in the same direction. This explains why regular reflection forms a clear image that can be seen. In diffused reflection, the rays are reflected in many different directions. This is why diffused reflection forms, a blurry image or no image.

Activity 7.3: Discuss in group about real life situation where we use reflection of light.

We see non-luminous objects when the light from a source of light falling on the object is reflected into our eyes.

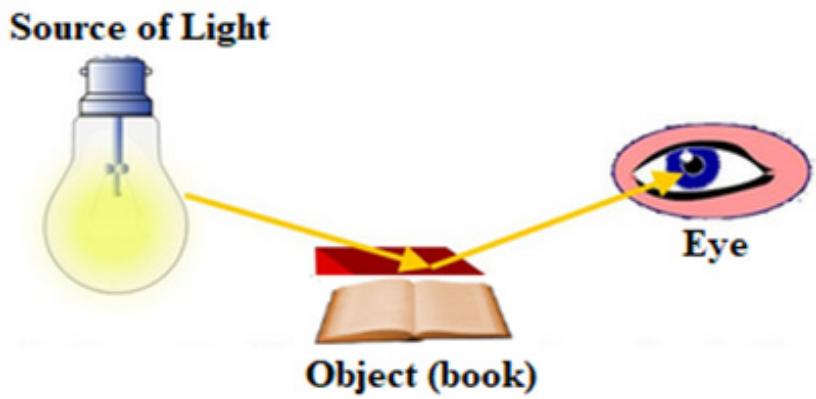


Figure 7.3 Seeing non-luminous objects

Refraction of light

Activity 7.4: Put a pen or pencil on a glass partially filled with water. Discuss in group about your observation.

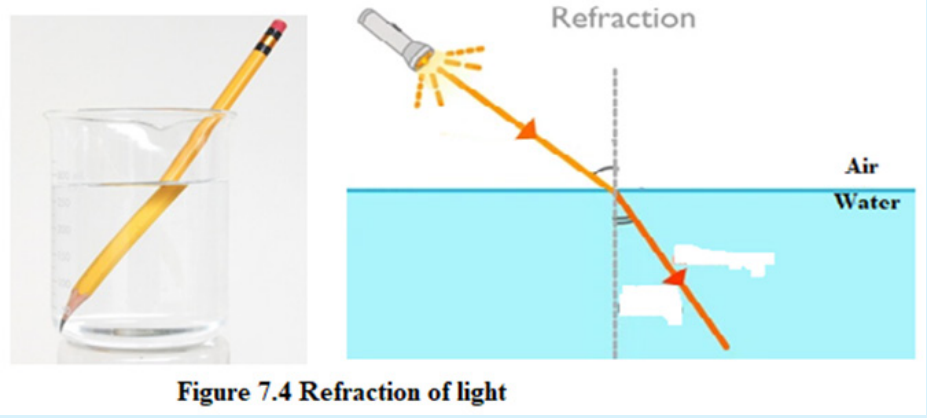


Figure 7.4 Refraction of light

Refraction is a phenomenon in which there is a bending of light rays as it travels from one medium to another. Figure7.4 shows a pencil placed in a beaker of water. The pencil looks as if it is broken at the point where it enters the water. This is because the light bends when it goes from air to water.

Activity 7.5: The hidden coin

1. Set a coin on a flat surface like a table.
2. Place the base of a clear drinking glass over the coin.
3. Cover the mouth of the glass with a small saucer. Looking in through the side of the glass, you can still see the coin.
4. Now, tilt the saucer back and fill the glass with water.
5. Once you've filled the glass, replace the saucer. Can you still see the coin through the side of the glass? It's disappeared!
6. Take the saucer off the mouth of the glass. Look straight to the bottom of the glass through the water. Now you will see the coin.



When the cup is filled with water, the coin disappears. This happens because of refraction. When light bounces off an object, it reaches our eyes and we see the object. As light travels through the sides of the glass and the water, it's refracted and never reaches our eyes, which makes the coin seems to disappear.

Dispersion of light

Activity 7.6: Place a prism on a sheet of paper and a few centimeters in front of a source of light (torch battery). Rotate the prism slightly until a clear and wide combination of colors is visible. Using coloring pencil, draw what you observe on the sheet of paper.

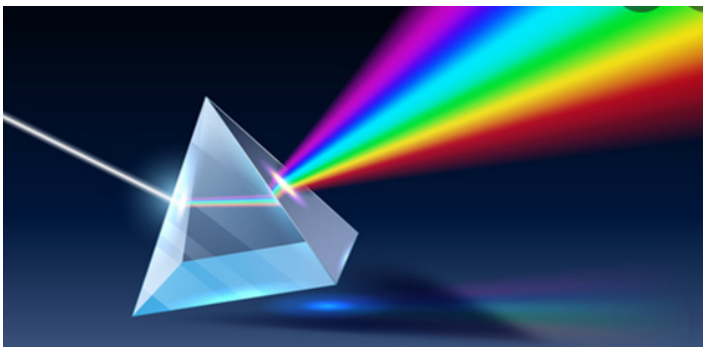


Figure 7.5 Dispersion of white light by a prism

Based on your observations of activity 7.6 answer the following questions.

a) What colors do you see?

b) Draw on the paper the path of the colored beams.

c) Which color is bent the most?

d) Which color is bent the least?

The splitting of white light into its constituent colors is called **dispersion.** Sunlight is white light. We can split white light into its colors by passing it through the prism. The band of seven colors obtained is called **spectrum of white light.** We can see these colors in a rainbow. These colors in order of appearance are: red, orange, yellow, green, blue, indigo and violet.

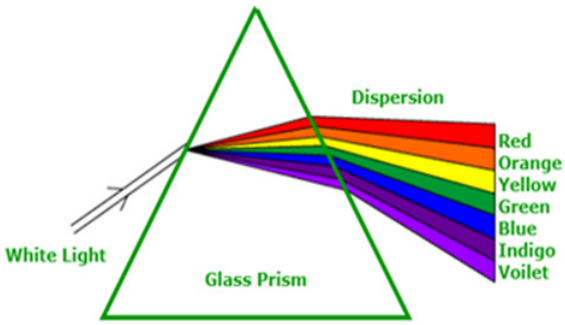


Figure 7.6 Dispersion by a prism



Figure 7.7 Refraction causes rainbow

Activity 7.7: Creating the colors of the rainbow in the class?
Take water in a flat vessel and place it under direct sunlight near a wall. Place obliquely a plane mirror in the water to reflect the sunlight on the wall. Don't you see beautiful colors on the wall? What is the reason for it?

A rainbow is reflection, refraction and dispersion of light in water droplets. A rainbow is evidence that sun light is a combination of colors.

Activity 7.8: Discuss in group how white light is dispersed by a prism?

Dispersion appears because of refraction. When a beam of white light enters a prism, all the colors of white light refract at different angles. This causes the white light to split into its component colors. Red light bends the least and violet light bends the most. In this way, white light disperses into its component colors.

Exercise 7.2

Part I: Write TRUE for correct and FALSE for incorrect statements

1. Moon is the source of light.
2. Sun light is an example of a natural sources of light.
3. Mirrors do not produce light but can be seen because they reflect light into our eyes.
4. The change in direction of light as it moves from one medium to another is called reflection.

Part II. Choose the correct answer from the given alternatives.

1. A source of light is _____.
   A. an object which reflects light.
   B. an object which emits its own light.
   C. an object which refracts light.
   D. none of these
2. What is our main source of light energy?
   A. Stars B. Fire C. Sun D. Moon
3. The splitting of white light into its constituent colors is called
   A. refraction. C. dispersion.
   B. reflection D. transparent.
4. Objects that can make their own light are called _____.
   A. Luminous C. non-luminous
   B. Transparent D. Translucent

7.2 Vision and Imaging

At the end of this section you will be able to:

- determine the purpose of light;
- classify materials as transparent, translucent and opaque;
- demonstrate how image is formed.

Activity 7.9: What is the purpose of light? Discuss in group and present your group's opinion to the class.

As discussed in the previous section in order to see our surrounding we need to have either a source of light or a reflector that reflects light from the source to our eye. This show that light is essential for vision.

Activity 7.10: What requirements should be fulfilled to have vision?

Even in the presence of light, if we close our eyes we cannot see our surrounding. So, to have a good vision, not only light but also the eye is important. Thus, the main factors which are needed for vision are the source of light and the eye.

Imaging

Imaging is the process of forming images. Images are formed either by reflection (using mirrors) or by refraction (using lenses). X-rays, CT scans (Computed Tomography), ultrasound and MRIs (Magnetic Resonance Imaging) are imaging tools used by doctors to diagnose injury or illness. They produce images of internal structures of the body for the purpose of accurate diagnosis.



Figure 7.8 MRI (Magnetic Resonance Imaging)

Image Formed by a Human Eye

The human eye is also an imaging tool. It forms a real picture of the observed object on the retina by optical system of the eye. When the image finally reaches the retina, it is inverted, but the brain will correct this. For the vision to be clear, the image has to be formed directly on the retina.



Figure 7.9 Image formed by a plane mirror is laterally inverted

Image formation by Plane Mirror

An image is a visual representation of an object which is placed some where in front of a mirror or lens. A mirror with a plane surface is called a ***plane mirror.*** It forms an image by reflection.

Activity 7.11: Standing in front of a plane mirror, raise your left hand. Which hand of your image is raised? Lower the left hand and raise the right hand. What change occurs to the image?

When our right side appear left and our left side appear right, such a shift of the lateral side of the images in the opposite direction is called lateral inversion.

Real image versus virtual image

Real images can be placed on a screen, but virtual images can't be placed on a screen. Real images are always inverted but virtual images are erect.

Activity 7.12: Place a mirror perpendicular to a table. Hold different objects like pen, pencil etc. in front of the mirror. Observe their images.

Is the size of the object and the image the same?

Keeping a ruler in front of the mirror, place these objects at different positions and observe. Does the distance of the image change when the distance of the object from the mirror changes?

The characteristics of the image formed by a plane mirror may be summarized as follows:

(i) the image is virtual and erect.

(ii) the image is of the same size as that of the object.

(iii) the image is laterally inverted. Right side appear to be left and left side appeared to be right.

(iv) the image is as far behind the mirror as the object is in front of it.

Exercise 7.3:

1. What is the purpose of light?
2. Look at the picture. What is the reason for writing AMBULANCE in that way?.



Transmission of Light through Objects

Different types of materials transmit light differently. Based on the way they transmit light, materials can be divided into transparent, translucent, and opaque.

Transparent Material: Materials that allow light to pass through them completely are known as ***transparent material.*** We can see through these materials very clearly. Example: Glass, clean water, clear plastic and air are transparent materials.

Translucent Material: Objects that allow light to pass through partially (transmits some amount of light) are called ***translucent materials***. An object cannot be seen clearly through a translucent **material.** Oiled paper, waxed paper, and frosted glass are examples of translucent materials.

Opaque Material: Materials that do not allow (completely blocks) light to pass through them are called **opaque materials.** We can't see through these materials at all. Metal sheet, wood sheet, wall, thick card board, stone, etc. are examples of opaque objects.

Activity 7.13: Investigating the transmission of light in different objects.Materials you need: Clean glass, oiled paper, frosted glass, wooden sheet, metal sheet, waxed paper, a black color paper, tissue paper, newspaper and the like.

Transparent material	Translucent Material	Opaque material

Note that not only through solids light could pass through water and air.

Tip: *On foggy conditions air is translucent. So, when there is a lot of fog, it is very difficult to travel on roads as drivers of a car can't see us clearly. For such situation there is a new type of lamp in modern vehicles known as "fog light". Drivers should use this light when the atmosphere becomes translucent because of the mist.*

Exercise 7.4

Part I: Choose the correct answer

1. Which of the following best describes the image formed by a plane mirror?
   A. virtual, inverted and enlarged
   B. real, inverted and reduced
   C. virtual, upright and the same size as object
   D. real, upright and the same size as object
2. Materials which doesn't allow any light to pass through them are called_____.
   A. transparent materials C. translucent material
   B. opaque materials D. reflecting materials
3. A clear plastic allow light to pass through it, so it is_____.
   A. transparent materials C. translucent material
   B. opaque materials D. reflecting materials
4. Which one of the following is an example of translucent material?
   A. Wall C. Cover of book
   B. Brick D. Frozen glass

Part II: Fill in the blanks with the correct word.

Light is a type of _____. It travels in a straight line. Light does not travel through some objects. Such objects are known as _____. Objects through which light could pass are called, _____ . The other group of objects through which light passes only partially are called _____.

Part III: Give a short answer

1. Write the difference between transparent, translucent and opaque materials.
2. Classify the following materials as transparent, translucent and opaque. Metal, stone, book, window glass, oiled paper, water, air, and waxed paper.

7.3 Sound

At the end of this section you will be able to:

- define sound as a form of energy;
- explain how sound is formed;
- demonstrate the formation of sound;
- identify material medium for sound propagation;
- prioritize sound propagation in solid, liquid and gases;
- explain the cause of sound pollution;
- identify hearing level for different sound;
- list strategies of sound pollution;
- define echo and demonstrate its application.

Sound is a form of energy which produces a sensation of hearing in our ears. This energy is produced by vibrating objects. Vibration means a kind of back and forth motion of an object. This back and forth motion of the body causes the substances around it to vibrate.

How do Objects Produce Sound?

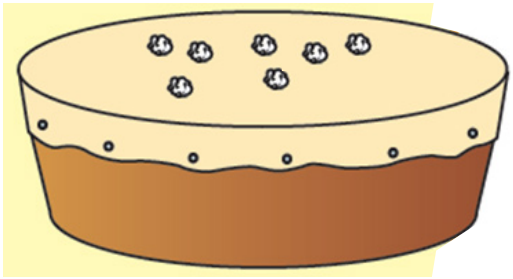
Any of the Ethiopian traditional musical instruments shown in the figure below have something to vibrate: string, skin or air. When these things are made to vibrate, sound is produced. When it stops vibrating, it does not produce any sound.



Figure 7.10 Musical instruments produce sound by vibration

Activity 7.14: Take a drum. Touch it when not in use. Again touch it when producing sound. What do your hands feel when drum is beaten and produce sound? Can you feel the skin of the drum vibrating?

If you place small pieces of papers on the drum and play it, you may observe that the pieces of paper are moving here and there. That is because the skin of the drum is vibrates when it is beaten. Therefore, it is clear that sound is produced by vibrating bodies. The objects that produce sound are called sources of sound. Animals, various types of objects, musical instruments are examples for sources of sound.



Observing sound propagation in solids

Activity 7.15: Strike one end of the table and ask your friend to listen to the sound produced keeping his/her ear touching the table at other end. Ask him/her to listen to the sound by lifting his/her head slightly from the table.

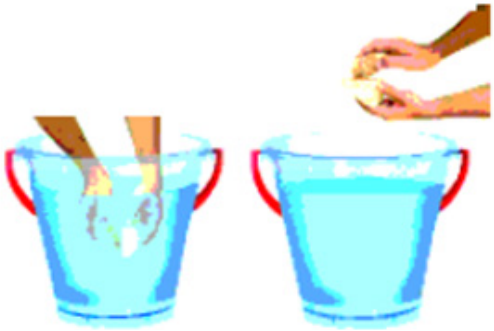
Ask your friend what difference he/she noticed while hearing the sounds when his/her ears were away from the table and touching the table.



In this activity you observed that sound travels in solid medium like wood, metal, thread, etc.

Propagation of sound through liquids

Activity 7.16: Take a glass and fill it with water. Take two stones and strike them against each other keeping your hands inside the water. (Take care not to break the glass). Ask your friend to listen to the sound by keeping his / her ears touching walls of the glass. Ask your friend about the difference between sounds produced by striking the stones against each other in water and striking them in air.



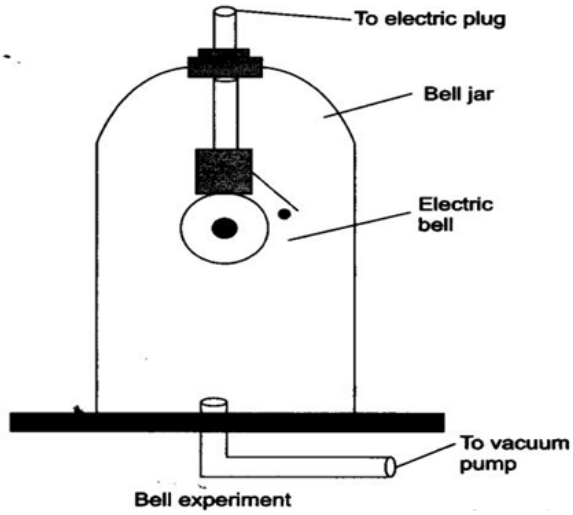
From the above activities we can conclude that sound propagates through matter in all the three states – solid, liquid and gas

Sound des not travel through vacuum

Activity 7.17: To show Sound needs a medium (recommended to do this activity in a laboratory)

.

- Take an electric bell and airtight jar.
- The electric bell is suspended insidethe airtight bell jar.
- With air still in jar ring the bell.
- Now take out air by using vacuum pump.
- Ring the bell again. What difference did you observe?



Bell experiment

Observation: Sound of bell can be heard when air is inside the jar. When air is taken out then sound cannot be heard. This shows that sound can't travel through vacuum, empty space.

Medium

The above activities gave us an idea about the need of a medium for propagation of sound. The material or substance through which sound is transmitted is called a ***medium.*** It can be solid, liquid or gas. Sound travels more quickly through solids than through liquids and gases because the molecules of a solid are closer together and, therefore, can transmit the vibrations (energy) faster. Sound travels most slowly through gases because the molecules of a gas are farthest apart. Sound cannot travel through vacuum.

Hearing

We hear sound through our ears. The eardrums of our ears sense the vibrations produced by a vibrating object and send them to the brain. This process is called a ***hearing.*** The structure of the ear plays an important role in hearing the sound.



Figure 7.11 The human ear

Exercise: 7.5: When we speak, does any part of our body vibrate? Mention them.

Noise and music

We hear different types of sounds around us. Some sounds are pleasant to the ear, whereas some are not. Such unpleasant sounds are called ***noise.*** The sounds which are pleasant to hear are called ***music.***

Sound Pollution

The presence of excessive or unwanted sounds in the environment is called ***sound pollution.*** Major causes of sound pollution are sounds of vehicles, explosions, machines, loudspeakers etc. In the home, Television and radio at high volumes, some kitchen appliances, all contribute to sound pollution.

Exercise 7.6: After discussing in group, write some more sources of sound pollution in your surroundings.

Effects of sound pollution

Sound pollution is a serious problem like air or water pollution. It is harmful to human beings. We express the loudness of the sound coming from various sources in decibels (dB). The sound produced in our normal conversation is about 60 dB. If a person is being exposed to the sound of 80dB continuously it may lead to hearing problems. A whisper is about 30 dB, normal conversation is about 60 dB, and a motorcycle engine running is about 95 dB. Loud noise above 120 dB can cause immediate harm to your ears. The table below shows decibel (dB) levels everyday sources of sound.

Noise	Average decibels (dB)
Soft music, whisper	30
Average home noise	40
Normal conversation	60
Heavy traffic, noisy restaurant	80–89
A very loud radio, stereo, or television	105–110
Standing beside or near sirens	120
Gun shot, jet engine	140

Sound pollution creates some health hazards. Some of them are listed below.

- Noise may cause irritation, stress, nervousness and headache.
- Long term exposure to noise may disturb the sleeping pattern of a person, hearing ability and may leads to loss of hearing.
- Noise causes lack of concentration in one's work. .

Measures to Control Sound Pollution

We cannot stop production of sound but we can reduce sound pollution by some measures. Sound pollution can be significantly reduced by adopting the following steps.

- Strict guidelines should be set for the use of loudspeakers on social, religious and political occasions.
- All automobiles, air craft engines, transport vehicles, industrial machines and home appliances should have effective silencers
- Use of automobile horns should be minimized.
- All communication systems must be operated in low volumes.
- Residential areas should be free from heavy vehicles.
- People working in noisy factories should wear ear plugs.
- Noise producing industries, and heavy vehicles should be set up away from residential areas.

- Trees must be planted along the roads and around buildings to cut down on the sounds reaching the residents.

Project 7.2: Discuss with your friends about some other measures to limit sound pollution and tabulate them.

Echo

A repeated sound that is caused by the reflection of sound waves from a surface is known as ***echo***. A hard and flat surfaces (wall, mountain and buildings) are a good reflector while soft surfaces such as clothes, papers, curtains, carpet, furniture, etc. absorb sound.

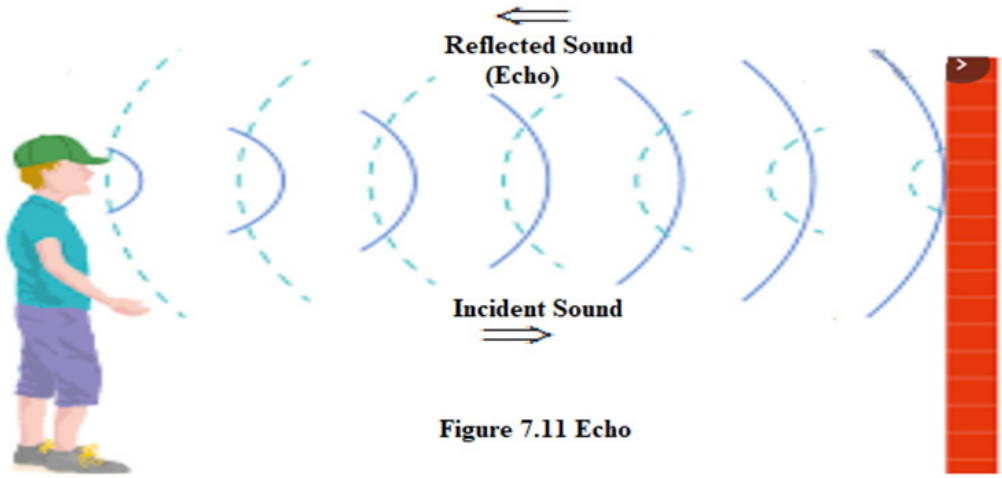


Figure 7.11 Echo

Some of the real life applications echo are:

- ***Hearing aid:*** It is a device used by the people who are hard of hearing. Here the sound waves, which are received by the hearing aid are reflected into a narrower area leading to the ear.
- ***Sound boards:*** Curved surfaces can reflect sound waves. This reflection of sound waves is used in auditorium to spread the waves uniformly throughout the hall.
- ***The working of a stethoscope:*** It is based on the reflection of sound. In a stethoscope, the sound of the patient's heartbeat reaches the doctor's ear by multiple reflections of sound.

Exercise 7.6

Part I: Choose the correct answer from the given alternatives

1. Sound is produced by_____.
   A. Non-Vibrating objects only
   B. Vibrating and non- vibrating objects
   C. Vibration has no relation to sound
   D. Vibrating objects only
2. Sound is a kind of_____.
   A. work C. energy
   B. force D. pressure
3. Sound cannot travel through_____.
   A. air C. water
   B. solids D. vacuum
4. Above _____ dB the sound becomes physically painful
   A. 40 B. 80 C. 120 D. 60

Part II: Fill in the blank spaces with appropriate word.

1. Sounds which are unpleasant to the ear are called _____.
2. The speed of sound is maximum in _____.
3. Plantation on the roadside can reduce _____.
4. Sound requires a _____ to travel.
5. When we touch a source of sound, we can feel the _____.

Part III. For the following questions, give a short answer

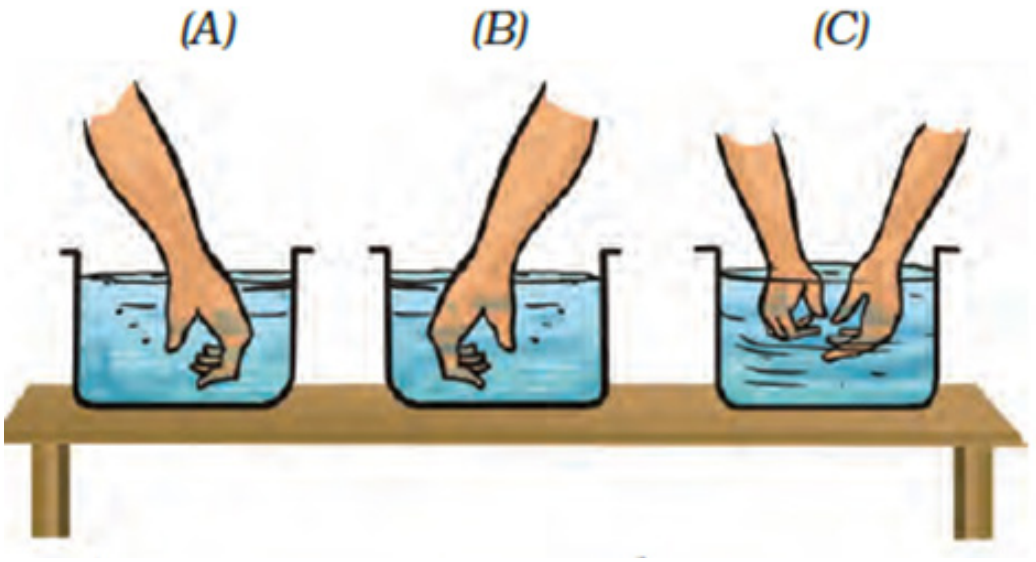
1. When does a body produce sound?
2. What are the different mediums through which sound can travel?
3. Name any two practical applications of reflection of sound-echo.

7.4 Heat

At the end of this section you will be able to:

- define the term heat;
- explain mechanism of heat transfer;
- classify materials as good conductors of heat and poor conductors of heat (insulators).

Activity 7.18: Take three small containers. Label them as A, B and C. Put cold water in container A and warm water in container B. Mix some cold and warm water in container C. Now dip your left hand in container A and the right hand in container B. After keeping the hands in the two containers for 2–3 minutes, put both the hands simultaneously in container C. Do both hands get the same feeling?



Warning! Make sure that the warm water is not too hot that it should not burns your hands.

Our left hand which was in the cold water feels hotter, while our right hand which was in the hot water now feels colder. That is, the hotter object cools down and the colder object warm up. This means the colder water gains energy, while the hotter water loses energy.

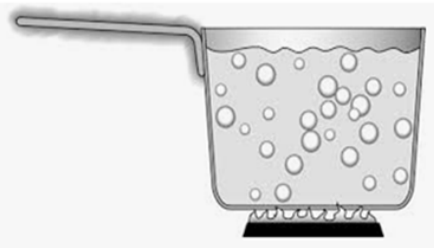
Based on this observation we can define heat as a form of energy that flows from a body at a higher to a body at a lower temperature.
Note that, the energy transfer will continue until both objects are at the same temperature. When the two objects attain the same temperature, then the flow of heat stops.

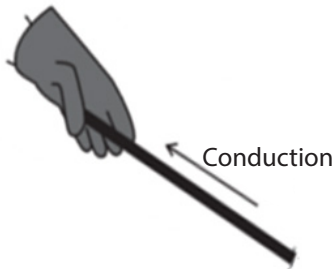
Mechanisms of Heat Transfer

There are three ways through which heat can be transferred from a hot object to a cold object. These are conduction, convection and radiation.

1.Conduction

Activity 7.19: Pour some water in a dish and boil it. Then insert a metal stick into the boiled water. When you put a cold, metal stick into hot water, the metal stick handle warms up after a while. How this warmth "moved" from the hot water to the cold metal stick?





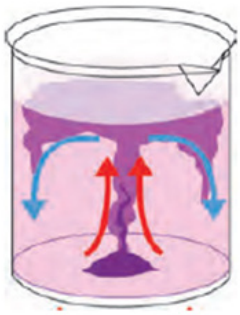
The water is hot and the metal stick is cold. When you put the metal stick into the hot water some of the heat energy from the water is transferred to the metal particles. As a result, the particles of the metal start to vibrate and collide with their neighboring particles. These collisions spread the energy through the stick. In this way, energy is transferred from the end which is in contact to the source to the other end. This process is called conduction.
Conduction is the mode of transfer of heat from hotter part of a material to its colder part with successive particle collision. In all solids, heat is transferred by the process of conduction.

2.Convection

Activity 7.20: In the above case of a metal stick in a hot water, only the bottom of the dish touches the source of heat, but all of the water inside the dish, becomes warmer. Discuss how does the energy transfer throughout the water in the dish?

When heating begins, the water near the bottom becomes warm and its density decreases. Meaning it is lighter than the cold water. This causes the heated liquid to move upwards and the colder liquid moves downwards. When the warm liquid reaches the top it cools down again and therefore moves back down. The warm water is rising and being replaced by cooler water. This transfer of energy is called convection. You can observe this process by placing potassium permanganate or food dye in the water, as shown in the Figure below.

Convection is the mode of heat transfer from the hotter part of a fluid (liquid or gas) to its colder parts by the movement of the liquid (or gas) itself.



3.Radiation

Activity: 7.21: Discuss in group how heat from the sun reaches to Earth?

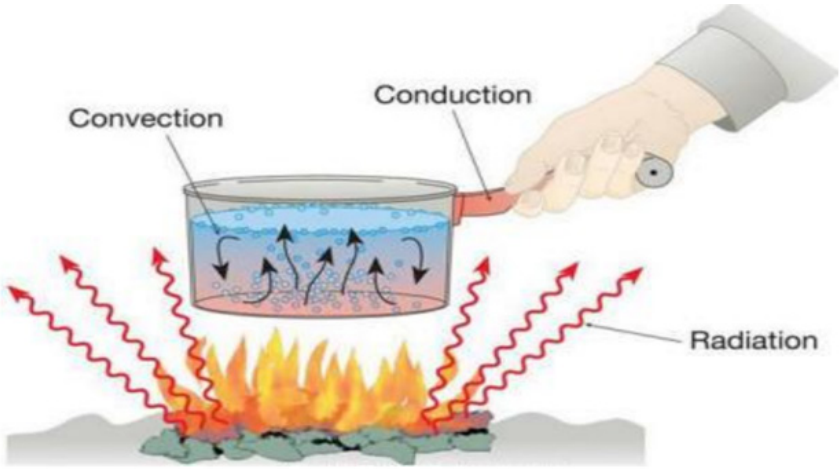
Heat transfer from a body at high temperature to a body at a lower temperature, without any material medium between them, is called radiation. Convection and conduction, require the presence of a material medium to transfer heat, but radiation occurs without any medium at all. Radiation takes place through a vacuum or transparent medium which can be either solid or liquid.



Activity 7.22: Whenever we want to heat our room, we place a burning charcoal at one corner of the room.

Discuss how heat is transferred to the whole air found in the room.

In the figure below, heat flows through the hands of the dish to the person's hand by conduction, though the boiling water by convection and to the environment by radiation.



Exercise 7.7:

Give examples from daily life for each mechanism of heat transfer.

Conductors and Insulators

Substances that allow heat energy to be transferred through them are called conductors. Substances that do not allow heat energy to be transferred through them are called insulators. Poor conductors are known as insulators.

Activity 7.23: Pour heat water in a small beaker. Collect some articles such as a steel spoon, plastic ruler, glass rod and pencil. Dip one end of each of these articles in hot water. Wait for few minutes. Touch the other end. Record your observations in the table below.

Object	How hot is the outer end?

What conclusions will you draw from your observation? Classify the materials you tested as conductors and insulators.

Activity 7.24: Discuss in group why, the metallic pan for cooking pan has a plastic or wooden handle. Why our families wear woolen clothes like Gabi in winter?



Insulation

Insulation is the way that is used to reduce heat loss or heat gain by providing a barrier between the inside of your home or body with the outside found at different temperature.

Exercise 7.8:

Part I: Choose the correct answer.

1. What is the term that describes the flow of energy from a hot body to a colder body?
   A. Sound C. Conduction
   B. Convection D. heat
2. Any material that does not allow heat to pass through it easily is called .
   A. conductor C. heater
   B. insulator D. heat
3. The direct transfer of heat from one substance to another substance that is touching is referred to as .
   A. convection C. conduction
   B. radiation D. insulation
4. Which of the following is the transfer of heat by the movement of a fluid?
   A. radiation C. insulation
   B. convection D. conduction

Part II: Give a short answer.

1. Define the term heat.
2. Explain the three different mechanisms of heat transfer.
3. Mention three examples of conductors and insulators.

7.5. Simple Circuit

At the end of this section you will be able to:

- list all material used to construct simple circuit;
- construct simple circuit.

A circuit is the complete path, from one terminal of the electric cell through the bulb and back to the other terminal of the electric cell. A circuit could be open or closed. If there is any gap in the path of a circuit, the bulb does not light up. Such a circuit is called an *open circuit.* The bulb lights up only when a bulb and wire form a complete path. Such a circuit is called a **closed circuit.**

The following materials are used to have a functioning electric circuit.

Electric cell or battery: A cell is a source of electricity and a battery is a combination of two or more cells.

Bulb: An electric bulb is a device which glows and emits light, when electric current is passed through it.

Conductors (wire): Materials that allow electric current to pass through them.

Resistor: is any device in the circuit that produces light or heat, when current is flowing through it.

Switch: is a simple device that either breaks the circuit or start the flow of current.

Electrical Safety

Never play with electrical wires and sockets. Do not connect the two terminals of a cell directly through a wire or conductor. .

Making a Simple Electric Circuit

Project 7.3: Using the following steps, construct a simple circuit.

1. Take a cell having a positive terminal (+) and a negative terminal (-).
2. Connect the positive terminal of the cell to one end of the switch with a piece of copper wire and other ends of the switch to one end of a bulb with another piece of copper wire.
3. Connect the negative terminal of the cell directly to the other end of the bulb with a wire, as shown in the figure.

Electric Schematic Circuit Symbols

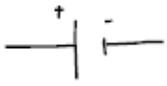
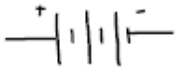
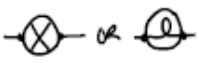
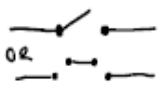
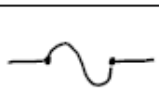
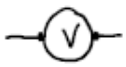
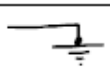
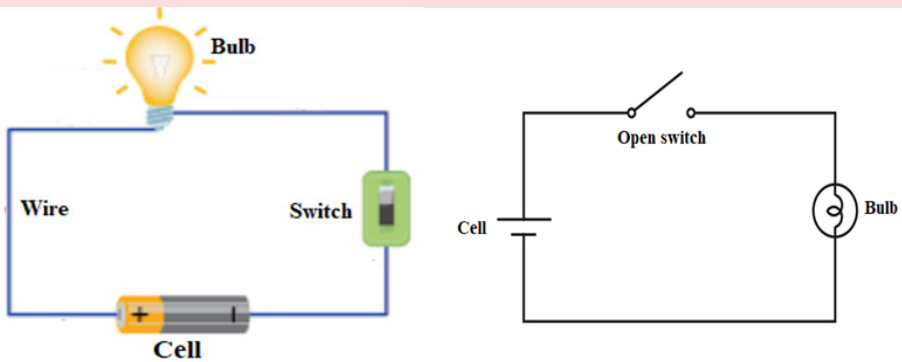
Symbol	Function	Description
	Cell	• Source of current electricity
	**Battery**	• Two or more cells joined together. • This battery is made of three cells.
	**Light Bulb**	• Converts electrical energy into light & thermal energy
	**Motor**	• Converts electrical energy into mechanical energy
	**Switch** • Knife or button	• Can be opened to stop a current or closed to allow current to flow.
	**Fuse**	• Prevents too much current from flowing through a circuit • Will break during a surge and protect the circuit
	**Ammeter**	• Measures current (amperage) ○ Flow of electrons
	**Voltmeter**	• Measure voltage (volts) ○ Potential energy
	**Resistor**	• A device the impedes (slows) the flow of electrons
	**Ground Connection**	• Connects the circuit to the earth

Figure 7.13:Electric symbols and their uses



(a) actual components (b) symbols

Figure 7.14 Simple Circuit diagram

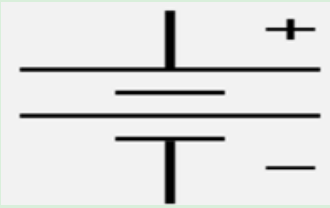
Exercise 7.9

Part I: Write TRUE for correct and FALSE for incorrect statements.

1. An electric circuit is a closed loop or pathway that allows electric charges to flow.
2. A cell is a device that controls current in electric circuits.
3. For current to flow, the circuit should be closed.

Part II: Choose the correct answer.

1. When we turn the switch to the off position the circuit is _____.
   A. closed B. open C. negative D. positive
2. A device for opening or closing the flow in a circuit is _____.
   A. an insulator B. a battery charger C. a switch
3. The path that electricity flows from the battery to the light bulb and back to the battery is called the _____.
   A. circuit B. components C. wires D. switch
4. The symbol shown below represents_____.
   A. light bulb B. switch
   B. battery D. resistor



5. A conductor is_____.
   A. material that current can pass through easily
   B. material that current cannot pass through easily
   C. magnet
   D. electric current

7.6 Magnetism

At the end of this section you will be able to:

- define magnetism;
- do simple experiment and construct magnetic lines of force;
- explain the use of magnet.

The branch of physics which deals with the property of a magnet is called magnetism. Magnets are materials which have the property of attracting metals like iron, cobalt and nickel.

Magnetism was discovered about 4000 years back in ancient Greece. Materials such as iron and nickel that are attracted by a magnet are called ***magnetic materials***. Materials that are not attracted by a magnet called ***non-magnetic materials.***

Classification of Magnets

Magnets are classified into two types: natural magnets and artificial magnets

Natural Magnets

Magnets found in nature are called natural magnets. They are permanent magnets i.e., they will never lose their magnetic property. ***Lodestone*** is the first discovered natural magnet.



Figure 7.15 Natural magnet

Artificial Magnets

Magnets that are made by people in the laboratory or factory are called artificial or man-made magnets. Artificial magnets can be made in various shapes and dimensions. Bar magnets, U-shaped magnets, horseshoe magnets, cylindrical magnets, disc magnets, and ring magnets are some examples of artificial magnets. Artificial magnets are usually made up of iron, nickel, cobalt, steel, etc.

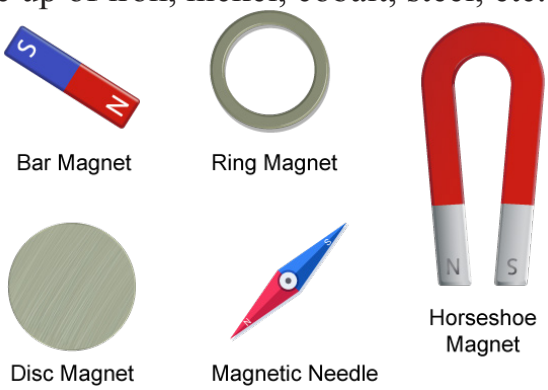


Figure 7.16 Artificial magnet

Magnetic Field

The region around a magnet where its influence is felt is called the magnetic field of the magnet. Any magnetic material placed in the field will be attracted by the magnet. We cannot see the magnetic field, but it can be represented by a set of curves around a magnet called magnet field lines. The shape of a magnetic field can be shown using iron filings or small compasses.

Activity 7.25: Plotting magnetic field lines using iron filings.Iron filings are tiny pieces of iron cluster together and line up to show the pattern of the field.

Procedure:

- Place the magnet on the wooden table or desk.
- Put sheet of white paper over it and scatter iron filings lightly onto the paper.
- Tap the paper now and again so that the filings move into position. You can see the field pattern beginning to show. What do you see?

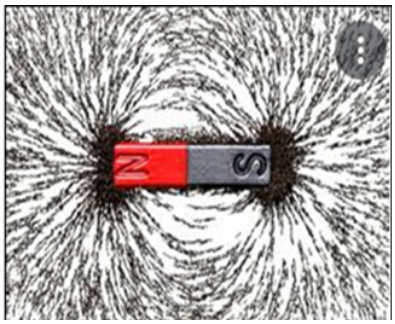


Figure 7.17 Ploting magnetic field lines using iron filings

Activity 7.26: Magnetic fields can also be mapped using small plotting compasses. This activity can be carried out in group.

Procedure:

- Place the plotting compass near the magnet on a piece of paper.
- Mark the direction the compass needle points.
- Move the plotting compass to many different positions in the magnetic field, marking the needle direction each time.

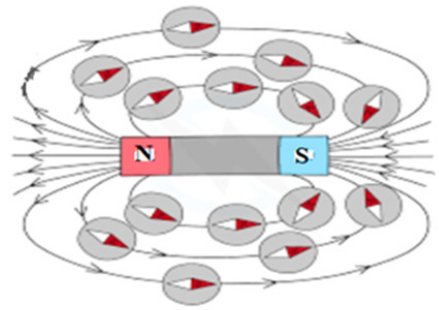


Figure 7.18 Ploting magnetic field lines using compass needles

Properties of magnetic field lines

- The arrow shows the direction of the field.
- Magnetic field lines do not intersect one another.
- The two poles of a magnet always exist in pairs.
- Outside the magnet filed lines point from north to south pole but inside the magnet they point from south to north pole.
- Where the filed lines are closest together is where the magnetic field is strongest.

Magnetic force

Like poles of a magnet reple each other. Unlike poles of a magnet attract with each other.

Uses of Magnets

Today magnets play an important role in our lives. Some of the important uses of magnets are given below.

- Magnets are used to hold objects (like stickers, refrigerator doors, etc.).
- Magnets are used to separate magnetic materials from non-manetic materials.
- Magnets are used for making compasses.
- Magnets are used to store data in computers.
- Magnets are used in scanning machines called MRI (Magnetic Resonance Imaging) which doctors use to look inside peoples body.
- Using magnets, we can do heavy lifting which is not humanly possible to do.
- Magnets are used inside TVs, loud speakers and radios, electric motors and generators.
- The debit and credit cards is of magnetic nature and are used to store data just like computers' hard drives.
- Magnetically levitated trains, known as maglev trains, use magnets under the cars to float above the magnetic tracks.
- Both magnetic attraction and repulsion are used to move the train car along the guide way. This days such kinds of trains are being used in developed countries. Maglevs can move with a speed of 500 km/h.Magnets are used in telephones, hair driers, door belts, mixer and grinder, fans, washing machines, television sets, tape recorders, and in headphones and loudspeakers.





Figure 7.19 Uses of a magnet

Project 7.5: After discussing in group list some other uses of magnets from your experience.

Exercise 7.12

Part I. Write TRUE for correct and FALSE for incorrect statements

1. Iron and cobalt are magnetic substances.
2. Opposite poles of two magnets attract each other.
3. An isolated magnetic pole (N or S) could exist.
4. Two magnetic field lines could cross each other.

Part II: Choose the correct answer

1. An example of a natural magnet is _____.
   A.Iron B. Steel C. Lodestone
2. The space around a magnet where its influence is felt is called as _____.
   A.Electric field C. Magnetic field
   B.Magnetic Field lines D. Magnetic pole
3. A freely suspended magnet always points in the –
   A. easiest direction. C. east-south direction.
   B. north-south direction. D. north-west direction.

Summary

- Light is a form of energy that enables us to see objects surrounding us.
- Object which emits its own light is a source of light. It is also known as a luminous object. Objects which do not emit light are known as non -luminous objects.
- The three properties of light are reflection of light, refraction of light and dispersion of light.
- Reflection of light is the turning back of light back to the original medium when it faces an obstacle.
- Refraction is a change in direction or bending of light rays as it travels from one medium to another.
- Dispersion is the splitting of a white light into its constituent colors.
- Light is essential for vision.
- Images a visual representation of something. It is formed either by reflection (using mirrors) or by refraction (using lenses).
- The natures of the image formed by a plane mirror are: virtual, erect, laterally inverted and the same size as the object.
- Materials that allow light to pass through completely are known as transparent material.
- Materials that allow light to pass through partially (transmits some amount of light) are called translucent material.
- Materials that do not allow (completely blocks) light to pass through, are called opaque material.
- Sound is a form of energy which produces a sensation of hearing in our ears.
- Sound is produced by a vibrating body.
- Sound can travel through solids, liquids and gases but can't travel through vacuum.
- Sound propagates faster through solids than through liquids and least through gases.
- The material or substance through which sound is transmitted is called a medium.
- Sound Pollution can produce ear damage.

- A repeated sound that is caused by the reflection of sound waves from a surface is known as echo.
- Heat is a form of energy that flows from a body at a higher to a body at a lower temperature.
- Heat can transfer through solids by conduction, through liquids and gases by convection and through vacuum by radiation.
- A complete path through which electricity flows is called an electric circuit. A simple circuit consists of a source, a conducting wire, a switch and a lamp.
- Magnets are materials which have the property of attracting metals like iron, cobalt and nickel. The branch of physics which deals with the property of a magnet is called magnetism.
- The region around a magnet where its influence is felt is called the magnetic field.

Key terms:

bulb	cell	circuit
conduction	conductor	convection
echo	Heat	image
insulator	magnet	magnetic field
Magnetism	opaque	radiation
sound	sound pollution	switch
translucent	transparent	vision
wire		

Review Exercise

Part I: Write TRUE for correct and FALSE for incorrect statements

1. Water and glass are transparent materials.
2. The spectrum of light produced by a prism is due to reflection.
3. Sound is produced by vibrating bodies.
4. Sound travel faster in air, slower in iron.
5. Heat is a form of energy.
6. Aluminum, copper and silver are magnetic substances.
7. A battery is a source of electricity.
8. Magnets are used only for fun, they don't have practical applications.

Part II: Choose the correct answer.

1. Which of the following lists is in the order of appearance of the colors of the visible spectrum?
   A. Red, Orange, Yellow, Green, Blue, Violet
   B. Red, Orange, Yellow, Violet, Green, Blue
   C. Violet, Blue, Green, Yellow, Orange, Red
   D. Violet, Blue, Green, Red, Yellow, Orange.
2. The bouncing off or return of light after striking a surface is called
   A. reflection of light C. refraction of light
   B. light emitting D. dispersion of light
3. The speed of sound in solids, liquids and gases can be correctly compared as
   A. speed in gas > speed in liquid > speed in solid
   B. speed in Liquid > speed in gas > speed in Solid
   C. speed in Liquid > speed in solid > speed in gas
   D. speed in solid > speed in liquid > speed in gas
4. A pathway for electricity to travel is called_____.
   A. current C. electricity
   B. circuit D. source of electricity
5. A component which is used to close or break a circuit, is
   A. bulb C. switch
   B. wire D. electric cell

Part III: Fill the blank spaces with an appropriate word.

1. Objects which emit their own light _____.
2. In a normal eye, images are formed on _____.
3. Sound is a form of _____.
4. A mechanism of heat transfer through an empty space is _____.
5. Electricity can flow through _____.
6. The regions on a magnet where the attraction power of the magnet is maximum are called _____ of the magnet.

Part IV: Give a short answer.

1. Define the terms reflection, refraction and dispersion of light.
2. Write the purpose of light.
3. Explain the cause of sound pollution.
4. List the material needed to construct a simple circuit.
5. What is magnetism?



Addis Ababa City Administration Education Bureau