General Science

Student Textbook
Grade 8

General Science Student textbook Grade 8

Amhara National Regional State Education Bureau

ISBN No -
Price -

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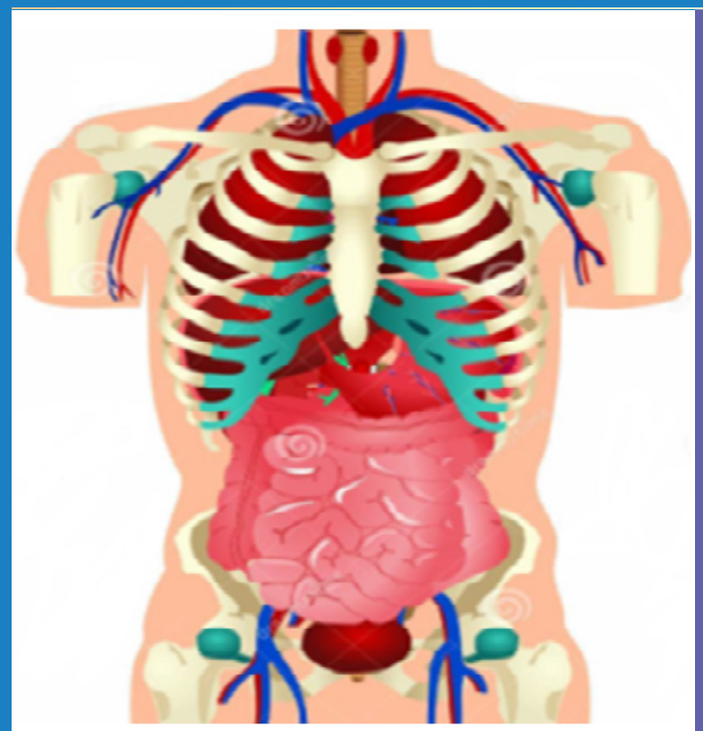



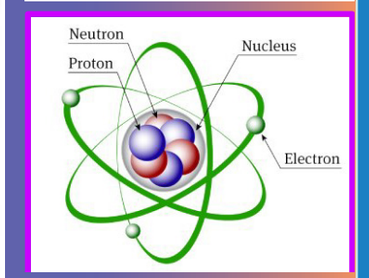

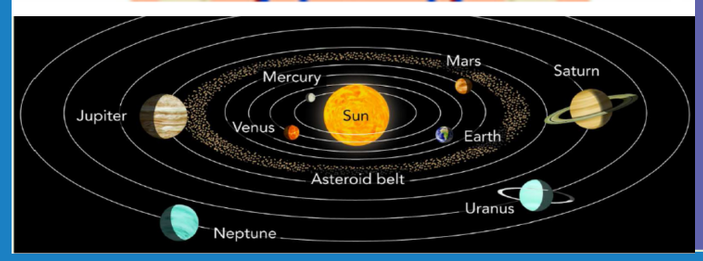

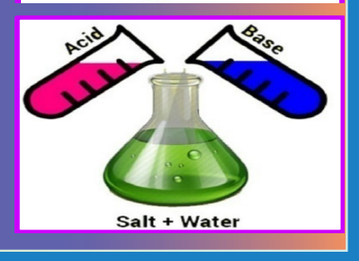

Amhara National Regional State Education Bureau

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The textbook is prepared by Amhara National Regional State Education Bureau and the Scholars Council with budget allocated by the Amhara National Regional State Government.

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Introduction

Rationale for the Curriculum Reform

Different studies have been conducted to improve the relevance and quality of Ethiopian general education. Worth mentioning are the Education Road-map (2018) and Cambridge Assessment Studies (2019). On top of these, the Ministry of Education and Amhara National Regional State Education Bureau carried out repeated monitoring and assessment of the school curriculum. The study and assessment reports consistently reiterated that the previous general education curriculum had weaknesses. Some of the weaknesses were: The curriculum focused on low-level cognitive domain of learning; the presentation of some contents in the curriculum did not consider students' age and maturity level, and the curriculum did not acknowledge indigenous knowledge systems. Furthermore, the curriculum did not adequately encourage students to develop scientific thinking skills such as observing, classifying, inferring, measuring, communicating, predicting, identifying variables, constructing hypotheses, tabulating and graphing data, defining variables, designing investigations, and experimenting. It also did not provide adequate opportunity for students to develop 21st-century skills such as critical thinking, problem-solving, global and cultural awareness, digital literacy, oral and written communication, creativity, collaboration, decision making, and the like. To alleviate these shortcomings, a new curriculum framework and syllabus have been developed. General science textbooks are developed on the bases of the new curriculum framework and grades 7 and 8 general science syllabus.

General science curriculum

Based on the new curriculum framework, general science textbooks are prepared for middle school students (grades 7 and 8). General Science education includes physics, chemistry, and biology subjects. General Science education aims to equip students with foundational science knowledge and skill that serve as a base for secondary education . It intends to nurture scientific inquiry skills which students use on their day to day lives and in learning science. In addition, it aims to cultivate among students science processes and 21st-century skills that can be used in their day-to-day life and academic career.

To achieve these major goals of general science education, the textbooks are prepared based on the principles of inquiry-based, problem-based and context-based learning. Inquiry is the intentional process of identifying problems, critiquing experiments, distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments. Inquiry-based learning involves posing questions, making observations, reading books to find out what others have learned, planning investigations, gathering, and analyzing information, reflecting on what was learned in the light of new evidence, and proposing explanations and predictions. It encourages students to use critical thinking skills that include designing and carrying out investigations, interpreting data as evidence, creating arguments, building models, and communicating findings to deepen students understanding through logic and evidence.

Problem-based learning allows students to become the drivers of their learning. Problem-based learning uses complex, real-world issues as the classroom's subject matter, encourage students to develop problem-solving skills and learn concepts instead of just absorbing facts. It promotes students' conceptual learning and skill development. It helps students to acquire knowledge and skill in the context of real-world problems. It engages the students in solving meaningful problems.

Context-based learning is using students' prior knowledge, experience, and context as a base for the new knowledge and skill development. It encourages students to recall, relate, describe, or apply knowledge from relevant prior experience that can be used as a foundation for the new knowledge.

Teachers, students, and parents will take part in the knowledge construction process. It is important that teachers, students, and parents engage in observations, experiments, and construction of knowledge. Hence, the textbooks are intended not only to provide adequate knowledge and skill but also develop among students learning to learn skills.

Implementation of the new learning and teaching techniques and methods

General science textbooks include many activities that are helpful to put into practice the aforementioned learning-teaching methods. The activities are designed based on students' prior knowledge, skill, and experiences. They are aimed to connect students' life experience with classroom science, to develop students' science process, inquiry, and 21st-century skills. To achieve the aims of these activities, students should prepare themselves before class, and should be active participants in the classroom. Teachers should encourage students to work on the activities before class. During the teaching-learning process, the teachers are not expected to provide answers for each activity before the students work on it. The students should be given enough time, needed materials, and clues while they are working on the activities. The teachers should lead students' work very closely and scaffold them when necessary.

Contents in the textbooks require appropriate utilization of instructional time and extending learning to home and libraries. It is also indispensable that every student brings his or her textbook to class. Parents should also assist students in carrying out different activities. It is critical that teachers ensure that all activities and contents in textbooks are properly covered and learned by students.

Dear students, please take good care of the textbook!

Learning requires effort, experimenting, and exercise!

We wish you a successful academic year



Basics of Scientific Investigation

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

- Describe the components of a scientific investigation
- Describe the meanings of some basic scientific concepts such as observation, hypothesis and variables
- Differentiate the dependent and independent variables
- Demonstrate ability to work effectively and respectfully with others in performing fair testing



Keywords:

- Scientific method
- Observation
- Hypothesis
- Variables
- Fair-test
- Ethical rules

1.1 Doing scientific investigation

As you have learnt about the nature of science in your grade 7 general science, science is the process of gaining knowledge by asking questions and seeking answers to these questions. To answer questions, scientists use scientific methods. They include identifying a question, forming and testing a hypothesis, analyzing results, and drawing conclusions.

1.1.1 Scientific methods

Activity 1.1

After a heavy rainy season in an area, the soil turned into mud. Many life creatures such as worms and snails crawl on top of the mud. These creatures were not seen before.

1. Where do these creatures come from?
2. How can you investigate this phenomenon?
3. Briefly outline the steps that you will follow during your investigation.
4. What does the study of fungi have in common with the study of atoms, and motion? How is research in a chemistry laboratory similar to research in a biology or physics laboratory?

Scientific investigation is the way in which scientists use a systematic process to answer questions about the world around us. It is a way of finding the answer to a question using carefully arranged steps. In other words, the scientific method is a process by which observations are questioned, hypotheses are formulated and tested, and the results are analyzed. There are common steps, in which a scientific method can be implemented.

1.1.2 Steps of scientific methods

Step 1: Making an observation

A scientific investigation often starts when someone observes an event in nature, laboratory, or day to day experiences and wonders why or how it occurs. Observation can be qualitative or quantitative. Qualitative observations describe properties or types. For example, consider the statements shown below. All describe the properties or types of substances or events.

1. Outside air temperature varies in seasons.
2. Table salt is a crystal solid.
3. Sugar dissolves in water.
4. A ripen strawberry has red color.

Quantitative observations are measurements, which are described by numbers and units. In other words, quantitative observations describe the amount of something present in the study. For example, consider the following statements which are expressed in numbers and units.

1. The melting point of sulfur crystal is 115.21^0 Celsius.
2. 100 gram of water can dissolve 36 gram of table salt at 20^0 Celsius.

Step 2: Ask a question

A critical observer creates a scientific question from his observation that can be answered with the time and resources available. It is the basic step in a scientific investigation. From your day to day activities, you can raise many questions.

Example:

a. Why does an iron nail rusts?

b. Why is black carbon obtained when sugar is heated?

c. Why do plants change the color of their leaves?

Step 3: Develop a hypothesis

A hypothesis is a tentative explanation that can be tested with a scientific investigation. It uses prior knowledge and observations to predict what will happen and why. A hypothesis may not be correct, but it helps to understand the system being studied into a form that can be tested. Consider the following scientific questions and the hypothesis developed for each question.

1. **Scientific question**: What is the cause of overweight of people?

Hypothesis: Daily intake of sugary drinks leads to overweight.

2. **Scientific question**: What is the cause of lung cancer?

Hypothesis: Smoking cigarettes causes lung cancer.

It is also possible to develop a hypothesis from day to day observation. For example, the observation that we experience alternating periods of light and darkness corresponding to observed movements of the sun, moon, clouds, and shadows is consistent with one of the following hypotheses:

1. Earth rotates on its axis every 24 hours, alternately exposing one side to the sun.
2. The sun revolves around the Earth every 24 hours.

Suitable experiments can be designed to choose between these two alternatives.

Some hypothesis cannot be answered through direct testing. For example, one of the hypothesis for the disappearance or extinction of the dinosaurs is the impact of a large extraterrestrial object. Unfortunately (or perhaps fortunately), this hypothesis does not lend itself to direct testing by any obvious experiment, but scientists can collect additional data that either support or refute it. You will learn about these methods in higher grades.

Step 4: Testing the hypothesis /Design experiment

Since a hypothesis is a tentative explanation, it should be tested whether it is valid or not. To test the hypothesis, you need to design your experiments and collect data from the experiments. After a hypothesis has been formulated, researchers conduct experiments to test its validity. Experiments are systematic observations or measurements to get qualitative or quantitative information or data. Experiments should be conducted preferably under controlled conditions in which a single variable changes.

Step 5: Interpret and analyze the result

The data obtained from the experiment should be analyzed and interpreted. It helps to decide whether the hypothesis is valid (correct) or invalid (wrong). If the result obtained from the experiment shows the hypothesis is invalid (wrong), it must start at step 3 or restate the hypothesis and do all the steps again. If the hypothesis is valid, the researcher can move to the final step. Describe the trends that can be seen from the data and compare it with related studies and finally draw a conclusion.

Additional experimental data are then collected and analyzed, at which point a researcher may begin to think that the results are sufficiently reproducible (i.e., dependable) to merit being summarized in a law, a verbal or mathematical description of a phenomenon that allows for general predictions. A law simply states what happens; it does not address the question of why. Consider the following laws:

1. The law of conservation of energy (energy neither created nor destroyed)
2. The law of conservation of mass (mass neither created nor destroyed)
3. The law of definite proportion of mass (a chemical substance always contains the same of elements by mass)

Another verified explanations or statements about a phenomenon is a theory, it attempts to explain why nature behaves as it does. Laws are unlikely to change greatly over time unless a major experimental error is discovered. In contrast, a theory, by definition, is incomplete and imperfect, evolving with time to explain new facts as they are discovered. Sometimes, a researcher may start with a hypothesis formed by reading about work done by others before in the field, rather than by making direct observations.

Example: Assume you have two plants grown in your garden. One of the plants looks green while the other is turning brown. Both plants were grown on the same type of soil and obtained the same amount of water. From the given information, it is possible to apply the basic steps of scientific methods as follows.

Step-1: Observation

- In this garden, plants have different leaf colors.

Step-2: Asking questions

- Why plants that grow in the same garden have different leaf colors?

Step -3: Develop a hypothesis

- The plant with green leaves might receive more sunlight. Or the plant with brown leaves might receive less sunlight.

Step 4: Design experiments

Grow two plants with controlling sunlight. Place one of the plants in full/direct sunlight and another one in a place where there is limited/little sunlight and carefully observe the difference between the two plants. The result of your experiment may or may not support your hypothesis. If the result of your experiment supports your hypothesis, your hypothesis is valid. If the result of your experiment does not support your hypothesis, it does not mean not a final failure. You can improve the hypothesis and try again.

.Activity 1.2

Classify the following statements as an observation, a hypothesis, an experiment, a law, or a theory

a. Ice always floats on liquid water.

b. Birds evolved from dinosaurs.

c. Hot air is less dense than cold air.

d. When 10 g of ice were added to 100 ml of water at 25°C, the temperature of the water decreased to 15.5°C after the ice melted.

e. The ingredients of Diana /Repi soap were analyzed to see whether it really is 99.44% pure, as advertised.

In scientific investigations, we often want to study the effect of one variable on another variable. A variable is a condition or factor in scientific experiments. Variables are an important part of any scientific investigations. To test the hypothesis, an experiment with a variable is crucial. There are three common types of variables. These are independent variables, dependent variables, and controlled variables.

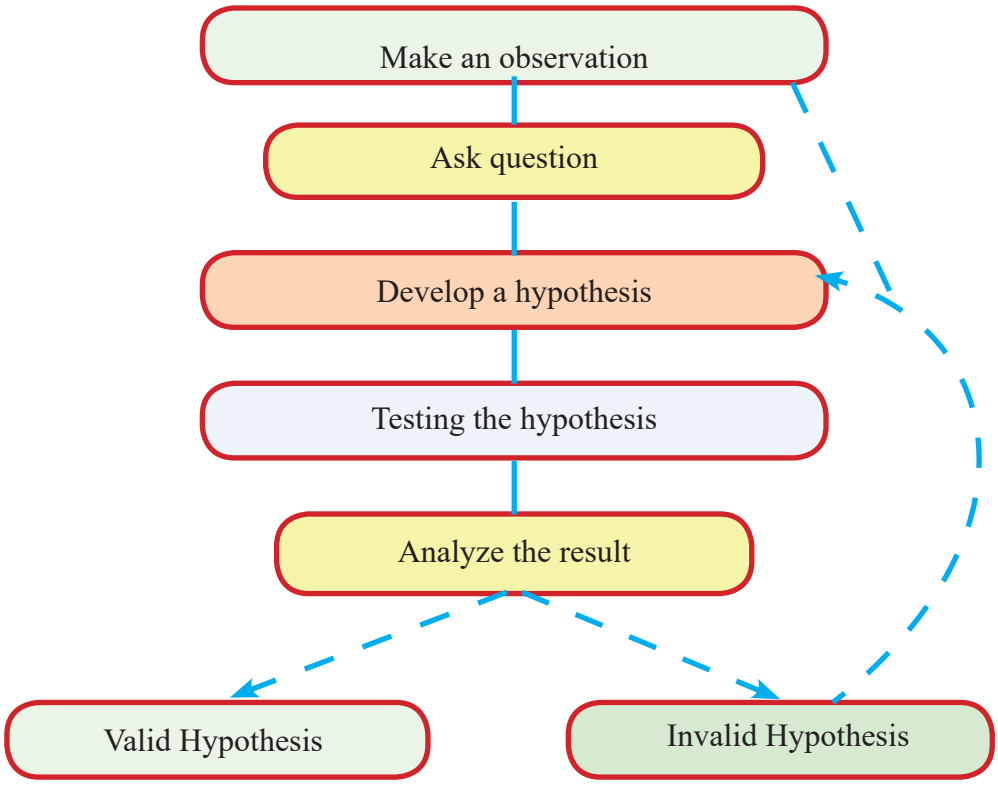


Figure 1.1: Basic steps of scientific methods

I. Independent Variable

The independent variable in an experiment is a condition that is manipulated, or changed, by a scientist. The effects of manipulating an independent variable are measured by changes in a dependent variable. This variable does not rely on any other variables. Being able to modify or manipulate this variable is important to study the effects.

II. Dependent Variable

Dependent variables are observed and measured during an experiment; they are the experimental data. Changes in dependent variables "depend upon" the manipulation of the independent variable. Suppose a scientist is testing medications to treat high blood pressure. The independent variable is the dose of medication. The dependent variable is blood pressure.

III. Control Variable

In scientific investigations, some variables need to remain constant. These are your control variables. By keeping a variable constant, you ensure your results remain accurate. If you have an experiment without control, then you cannot be completely sure of the cause and effect.

Ideally, only one independent variable should be tested in an experiment. Thus, all of the other conditions have to stay the same. The conditions that do not change during an experiment are called constants. To study the effects of an independent variable, a scientist uses a control group or control condition. Subjects in a control group are treated exactly like experimental subjects except for the independent variable being studied. The independent variable is manipulated in experimental groups or experimental conditions.

Activity 1.3

For the following scientific questions, identify the independent and dependent variables

	Scientific questions	Independent variable (s)	Dependent variable (s)
1	Does temperature affect solubility of salt?		
2	Does temperature affect leaf color in plants?		
3	How is enzyme activity affected by different pH values?		
4	What is the effect of soft drink on blood sugar levels?		

In scientific investigations, one of the most common methods is designing a controlled experiment, which has at least two groups (a control group and an experimental group). The experimental group is used to study the effect of a change in the independent variable on the dependent variable. The control group contains the same factors as the experimental group, but the independent variable is not changed. Without a control, it is impossible to know if your experimental

observations result from the variable you are testing or some other factor. It is impossible to control two variables at a time.

Activity 1.4: What do plants need to prepare their food?

1. Formulate testable hypotheses.
2. Design an experiment with experimental and control groups and identify the variables (independent, dependent, and control variables) [Hint: Plants need CO_2 to prepare their own food. What other raw materials do they need? Test one variable at a time].
3. Using bean seeds try out this investigation at home on your own.

Suppose a scientist wants to develop a drug for a human disease. The scientist, then, needs to design an experiment to verify whether an agent can be a cure for a specific disease. Do you think that this experiment could be directly conducted on humans? Are there any other options for conducting an experiment? What should we consider while conducting scientific investigation?

Any scientific investigation should be guided by ethical values. Ethics are moral principles that govern a person's behavior and the things that are considered right or wrong. In other words, ethics can be described as distinguishing between acceptable and unacceptable behaviors. Particularly, scientific investigations, which are conducted on human beings and animals, should be guided by ethical values such as honesty, transparency, objectivity, safety, and harms.

Activity 1.5

1. Why are mice considered model animals to study drugs?

Since, the entire goal of any scientific investigation and science education is to find the truth, and researchers should be honest, transparent and objective about their findings and data they obtained. Throughout the process of investigation, no harm is expected either to the researcher or the subject that the research conducts on it.

1.2 Semi-guided investigations

1.2.1 Does a coiled nail act like a magnet?

Activity 1.6



Materials needed: Copper wire; nail; batteries; tape; paper clips

Procedure:

1. Wrap the wire tightly around the whole length of the nail. Do not overlap the wire. Do not wrap the wire at each end of the nail.
2. Try to pick up the paper clips by touching them with the nail. What happens?
3. Connect the two ends of the wire with the batteries at its two ends.
4. Try again to pick up the paper clips. What happens? Why?
5. Now disconnect the battery and try to pick up the paper clips again. Does the same thing happen as in step 2? What has happened to the nail?
6. How many paper clips can your electromagnet pick up?
7. How could you make it stronger?

1.2.2 How do plants store their food in their leaf?

How do plants store their food in their leaf? Plants make food (glucose) during photosynthesis. When a plant produces glucose in excess, it can be converted into starch, lipids (oils) and proteins and stored. The storage areas are usually plant parts modified as under - ground storage organs, but other plant parts above ground can also act as storage organs. Storage in plants occurs in vegetative organs (roots, stem and leaves) and reproductive structures (fruits and seeds). In this section, you are going to see leaves as storage organs of food in plants.

Experiment 1.1

All plants store food temporarily in their leaves. Most store starch. How do you know that plants store food temporarily in their leaves? Now you are going to conduct a simple experiment to verify this.

Laboratory activity: Test for starch in leaves

Materials required: Iodine solution, plant leaves, ethanol alcohol, heat source (Bunsen burner or sprite lamp), forceps, beakers, and water.

Procedures:

1. Collect freshly detached plant leaves.
2. Closely observe the collected plant leaves' physical features.
3. Boil a plant leaf in water for 30 seconds.
4. Then boil the leaf in ethanol alcohol for a few minutes. Ethanol is flammable, so there should not be a direct heat contact with it!
5. Wash the boiled leaf with tap water.
6. Spread the leaf out on a flat area/container.
7. Add certain drops of iodine solution onto the leaf using a pipette and watch.

Questions:

1. What did you observe? Note the color change.
2. Why boiling the leaf in water is important? Why do you wash it?
3. What is the purpose of ethanol?
4. What can you conclude from this simple experiment? (Hint: formation of dark green color with iodine indicates the presence of starch)

1.2.3. Is air necessary for burning?

Activity 1.7

Take 2 cm of candle, a water glass, and a match. Put the candle under the glass. Take another 2cm candle and put it on a table in the open air. Burn both candles with a match.

1. What did you observe?
2. Why did the candle under the glass turn off but the one in the open air did not?

1.3 Conducting fair test

Any scientific investigation should be fair. In other words, it is important for an experiment to be a fair test. You can conduct a fair test by making sure that you change only one factor (variable) at a time while keeping all other conditions the same (constant).

Activity 1.8: Conducting Fair Tests

1. If you want to study the effect of fertilizers on the growth of a bean plant, what do you do?

Conducting a fair experiment (test) is one of the most important features of scientific investigation and makes the test valuable. To say that your experiment is a fair test, you must change only one variable at a time while keeping all other factors, which can affect your experimental result constant.

Summary

- Science is not simply a collection of facts. Important theories are created with the idea of explaining observations. To be accepted, theories are tested by comparing their predictions with the results of actual experiments. Note that, in general, a theory cannot be "proved" in an absolute sense.
- The steps of scientific method includes making critical observation, asking scientific questions, formulating hypothesis, testing hypothesis through experiments, and analyzing data and interpreting the results.
- A scientific theory is usually deeper and more complex than a scientific law. A scientific law is a concise statement, often expressed in the form of an equation, which quantitatively describes a wide range of phenomena.

Review Questions

I. Fill in the blank space

1. _____is a plan for asking questions and testing possible answers in order to advance scientific knowledge.
2. Conducting a fair test is measuring the effect of _____.

II. Multiple choice questions

1. A person takes a painkiller "Aspirin" whenever he feels headache. The independent variable is

   A. Headache
   C. Pain killer
   B. Aspirin
   D. The person

2. Foods like milk have high calcium content and are good for the bone strength of a child. What is the dependent variable?

   A. Milk
   C. Any food
   B. Bone strength
   D. Child

III. Investigative Questions

1. Describe the main steps of a scientific method.
2. What is the source of any hypothesis?
3. In conducting a fair test, the effect of one variable should be measured keeping other conditions constant, why?



The 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
- Describe that atoms are the building blocks which make up all substances
- Demonstrate the idea that the identity of a substance is determined by its atomic structure
- Differentiate molecules of elements from molecules of compounds.
- Differentiate monatomic, diatomic and polyatomic molecules.
- Demonstrate scientific inquiry skills along this unit: communicating, asking questions, drawing conclusions and applying concepts.

Keywords:

- Matter,
- Atom,
- Nucleus,
- Proton,
- Neutron,
- Electron,
- Molecules, and
- Compounds.

2.1 Early thinking about the composition of matter

Activity 2.1

In your home, so many things are available such as tables, chairs, clothes, books, jewelleries, and stones. The tables and chairs are made of wood. The clothes are made of cotton, wool and other synthetic polymers.

The books are made of paper and an endless array of things is made of plastic The jewelleries are also made of gold, silver, copper and any other precious metals.

1. Where do all these things come from?
2. What do you think about the composition of all these things?
3. Is the composition of all these things similar or different?
4. Is the property of all these things similar or different?
5. How do you classify the above-mentioned things?
6. What is the smallest particle of all these things?
7. Are they all matter? What is matter and what is not?

You are all completely surrounded by matter. You need to get a basic understanding of the types, composition and properties of matter. Democritus (460–370 B.C.) and Aristotle (384-322 B.C.) proposed different theories about the types, composition and properties of matter. Democritus developed a theory of matter known as discontinuous theory. Based on Democritus theory, if you took a stone and cut it in half, each half had the same properties as the original stone. He reasoned that if you continue to cut the stone into smaller and smaller pieces, at some point you would reach a piece so tiny that it could no longer be divided. Democritus called these very small pieces of matter atoms (Greek word which means atomos). Democritus used the word "atomos" meaning "indivisible" or "uncuttable" to describe the ultimate building blocks of matter. He suggested that atoms were eternal and could not be destroyed. Democritus theorized that atoms were specific to the material that they made up meaning that the atoms of stone were unique to stone and different from the atoms of other materials, such as fur. This was a remarkable theory that attempted to explain the whole physical world in terms of a small number of ideas. Democritus's ideas were based on reasoning rather than experiment.

On the other hand, philosophers such as Plato and Aristotle argued for the continuous theory of matter. They believed that matter could be continuously divided without end (the "continuous" idea of matter). According to them, it was proposed that matter was continuous, infinite, present in every form, and always all around us. It

was thought that matter could be divided and subdivided into smaller and smaller pieces without limit. Aristotle strongly argued that all matter is made from four natural elements (earth, water, air, and fire). This concept was called the continuous theory of matter. The continuous theory of matter received widespread support until the 1800's when John Dalton refreshed the atom concept to explain certain aspects of chemical reactions.

Activity 2.2

1. Be in groups and debate on the ideas of Discontinuous and Continuous theory of matter. Which theory do you support and why? Argue for or against each theory?

According to the current understanding, the world we live in is made of matter. Matter is anything that has mass and takes up space. Things we can see, such as tables, chairs, clothes, books, jewelleries, stones and things that we cannot see, such as air, are also matter. Matter is made up of atoms.

2.2. Inside of an atom

Activity 2.3

Around your surroundings there are so many materials. Consider buildings, humans, a fly, pinhead, amoeba, molecules, atoms and atomic nuclei. From the above-mentioned things:

1. Which one is the largest?
2. Which one is the smallest?
3. How can you see small size things such as amoeba, molecules, and atoms?

2.2.1 Observing an atom

Recently, powerful new instruments such as transmission electron microscope (TEM), atomic force microscope (AFM) and Scanning Tunneling Microscope (STM) were invented to see individual atoms of a given matter with higher magnification. To see inside an atom, we need instruments with more magnification power.

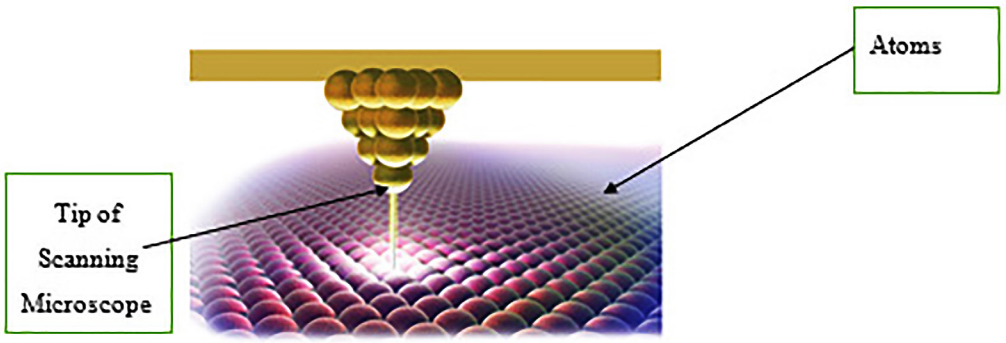


Figure 2.1: Scanning Tunneling Microscope (STM) Image of Gold and Copper atoms.

2.2.2 The subatomic particles

An atom consists of subatomic particles. It can be divided into internal part (nucleus) and external part (electron). Experimental evidence indicated that most parts of the atom are empty space. The rest consists of a positively charged nucleus (protons) surrounded by a cloud of negatively charged electrons. The nucleus is small and dense compared with the electrons, which are the lightest charged particles in nature. Electrons are attracted to any positive charge by their electrostatic force, bind the electrons to the nucleus of an atom. The structure of an atom describes how these particles are arranged

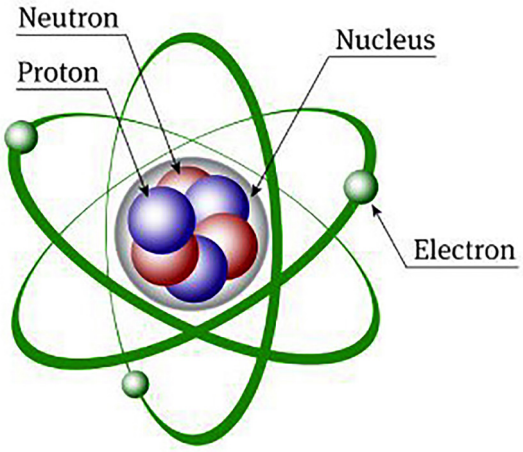


Figure 2.2 Subatomic particles

2.2.3 Relative mass, charge and location of subatomic particles

Activity 2.4

Suppose you have one cup of sugar, add one granule of sugar in a cup, can you notice the added mass of granulate sugar? Relate the granulated sugar with subatomic particle electrons? Think over it and tell your conclusion for your classmate.

Atoms and their subatomic particles (protons, neutrons and electrons) that compose them are extremely small. The subatomic particles have mass and charge. The masses of subatomic particles are also very small. Compared to protons and neutrons, the mass of an electron is negligible.

For example, a carbon atom weighs less than 2×10^{-23} g, and an electron has a charge of less than 2×10^{-19} C (coulomb). The properties of tiny objects are described using small units of measurements such as the atomic mass unit (amu) and the fundamental unit of charge (e). The amu was originally defined based on hydrogen, the lightest element, then later in terms of oxygen. Since 1961, it has been defined with regard to the mass of carbon-12, meaning the mass of Carbon-12 is exactly 12 amu. An atomic mass unit is equal to one twelfth (1/12) of the mass of an atom of carbon-12, 1 amu = 1.66×10^{-24} g. The fundamental unit of charge (also called the elementary charge) equals the magnitude of the charge of an electron (e) with e = 1.602×10^{-19} C.

Table 2.1: Properties of Subatomic Particles

Subatomic Particles	Symbol	Location	Charge (C)	Unit Charge	Actual Mass (g)	Relative mass Mass (amu)
Proton	P+	Nucleus	1.6×10^{-19}	+1	1.673×10^{-24}	1
Neutron	N0	Nucleus	0	0	1.675×10^{-24}	1
Electron	e-	Outside nucleus	1.6×10^{-19}	-1	9.09×10^{-28}	0

Therefore, a proton has a mass of 1.0073 amu and a charge of +1. A neutron is a slightly heavier particle with a mass 1.0087 amu and a charge of zero; as its name

suggests, it is neutral. The electron has a charge of −1 and is a much lighter particle with a mass of about 0.00055 amu (it would take about 1800 electrons to equal the mass of one proton) as summarized in Table 2.1.

2.2.4 Atomic number and mass number

1. Atomic Number (Z)

Atomic number is the number of protons contained in the nucleus of an atom. The identity of an element arises from the number of protons. Each element has a unique atomic number and chemical symbol.

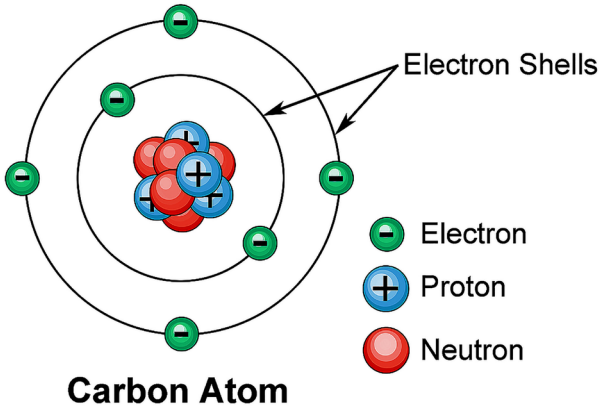


Figure 2.3: The number of electrons, protons, and neutrons of a Carbon atom.

Example:

Carbon (C) has 6 protons = atomic number = 6

Sodium (Na) has 11 protons = atomic number = 11

Copper (Cu) has 29 protons = atomic number = 29

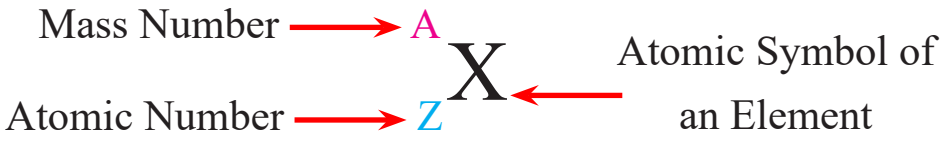
2. Mass Number (A)

The sum of the number of protons and neutrons in an atom. Mathematically it can be expressed as

Mass Number (A) = Number of Protons (Z) + Number of Neutrons (N)

A = Z + N

Symbolic representation of an element (X) with atomic number (Z) and Mass Number (A)



Examples:

$^{23}_{11}Na$ $^{31}_{15}P$ $^{32}_{16}S$ $^{39}_{19}K$

Example: Subatomic Particle

How many protons, electrons, and neutrons are there in an atom of Nitrogen, $^{14}_{7}N$?

1. **Analyze based on the given information**: Numbers of protons, electrons, and neutrons are required.

2. **Plan**: Atomic number = number of protons = number of electrons

   Mass number = Number of neutrons + number of protons

3. **Solve**: The atomic number of Nitrogen is 7; hence, Nitrogen has seven protons and seven electrons. Therefore,

   Number of neutrons = mass number - atomic number = 14 - 7 = 7 neutron

4. **Check your work**: The number of protons in a neutral atom equals the number of electrons. The sum of the protons and neutrons equals the given mass number (7 + 7 = 14)

Practical Problem

1. How many protons, electrons, and neutrons make up an atom of Chlorine, $^{35}_{17}Cl$?

3. Isotope and Atomic Mass

The nucleus of an atom contains protons and neutrons. Unlike protons, the neutrons is not absolutely fixed for most elements. Atoms that have the same number of protons and hence the same atomic number, but different number of neutrons are said to be isotopes. The atomic mass of an element is the average mass of its naturally occurring isotopes. To determine average atomic mass, each exact atomic mass is multiplied by its percent of natural abundance and the sum of the resulting number in appropriate significant figures. The relative masses of atoms are reported in the atomic mass unit (amu). Atomic mass unit (amu) is defined as 1/12 of the mass of one atom of carbon-12, with 6 protons, 6 neutrons and 6 electrons. Carbon

has three isotopes (^{12}C, ^{13}C and ^{14}C). The relative atomic mass of carbon, which is the average masses of the three isotopes of carbon, is 12.01 amu.

Example 1. Magnesium (Mg) has three isotopes (^{24}Mg, ^{25}Mg and ^{26}Mg) with mass and percent of natural abundance of 23.98504 and 78.70 %, 24.98584 and 10.13 %, and 25.98259 and 11.17 % respectively. Calculate the atomic mass of Mg.

Solution: To calculate the atomic mass of Mg from the masses and percent of natural abundance of the three isotopes is :

amu of Mg = (23.98504 x 0.7870) + (24.98584 x 0. 1013) + (25.98259 x 0.1117)

amu of Mg = 24.31 amu

Hydrogen has three isotopes: protium (^{1}H), deuterium (^{2}H) and tritium (^{3}H). Mass number is always greater than atomic number except hydrogen (protium), which has equal number of mass number and atomic number ($^{1}_{1}H$, A=Z).

Activity 2.5

In the following table, elements with atomic number 1 to 10 are given. Write the number of electrons, neutrons, and protons on the space given in the table. Remember you should know every information of elements listed in this table for this grade 8 general science lesson.

Name	Symbol	Atomic Number(Z)	Mass Number (A)	Number of Electron	Number of Proton	Number of Neutron
Hydrogen	H	1	1			
Helium	He	2	4			
Lithium	Li	3	7			
Beryllium	Be	4	9			
Boron	B	5	11			
Carbon	C	6	12			
Nitrogen	N	7	14			
Oxygen	O	8	16			
Fluorine	F	9	19			
Neon	Ne	10	20			

Activity 2.6 (Model Construction)

In most atoms of an element, the number of neutrons in the nucleus is the same as the number of protons. The number of electrons can change, but for now, we are going to make models of neutral atoms. Therefore, there must be the same number of electrons as protons. Choose an element from the first 10 elements (from activity 2.5). Your teacher will guide you to get the information. Build a model of the element you have chosen.

Materials: Glue, paper plate, play dough, dried lentils or peas, and Marker

Procedure:

1. Prepare the paper plate into a circle shape.
2. Using a marker, mark the center of the circular paper.
3. Draw other circles next to the center with equal distance.
4. Take a dried lentil or pea grain and put each grain on the nucleus and around the nucleus.
5 Stick the grains with glue.

Remember the grains represent the protons, electrons, and neutrons. The circular line represents the shells on electrons.

Reflective Activities

1. What is the name of your element?
2. What is the atomic number of your element?
3. How many protons will you need to make your atom?
4. After you have built your model, draw a model of your atom. Provide labels. These are both models of your atom.

N.B: If play dough is available at your school, use it instead of lentils or peas.

2.3 Molecules

Activity 2.7

The air you breathe is a mixture of oxygen, carbon dioxide, nitrogen, neon, etc. Which of the above mentioned substances consist of a single atom?

A molecule is the smallest stable particle of an element or a compound that can exist by itself. Molecules can be classified into molecules of elements and molecules of compounds. Molecules of elements can be further classified into three (Mono atomic, Diatomic and Polyatomic) molecules.

1. Monatomic Molecules – A single atom of an element can exist in stable form. All six noble gases or inert gases are monatomic molecules; Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn).
2. Diatomic Molecules – Two atoms of a given element can exist in stable form. There are seven common Diatomic molecules such as Hydrogen (H_2), Nitrogen (N_2), Oxygen (O_2), Fluorine (F_2), Chlorine (Cl_2), Bromine (Br_2) and Iodine (I_2).
3. Polyatomic Molecules – Three or more atoms of a given element can exist in stable form. Examples of polyatomic molecules are Ozone (O3), Phosphorus (P4) and Sulphur (S8) etc.

Molecules of compounds are formed from two or more atoms of different elements. Examples of molecules of compounds – Hydrogen Chloride (HCl), Carbon Dioxide (CO_2), Ammonia (NH_3), Carbon tetrachloride (CCl_4).



O_2 H_2O N_2 CO_2

Figure 2.4: Model diagram of Diatomic and Polyatomic molecules

Summary

- Matters are made of tiny particles called atoms.
- An atom has two regions: the atomic nucleus and electron shells.
- The nucleus contains neutrons and protons.
- The mass of an atom is concentrated in the nucleus.
- Atomic number is the number of protons in the nucleus of an atom.
- The mass number of an atom (A) is the sum of its number of protons (p) and number of neutrons (n); $A = p + n$.
- In a neutral atom, there are equal number of protons and electrons.
- A molecule is the smallest particle of an element or a compound that can exist in stable form.
- A monatomic molecule contains a single atom in a molecule.
- A diatomic molecule contains two atoms per molecule of the same element.
- A polyatomic molecule contains more than two atoms per molecule of the same element.
- Molecules of compounds formed from two or more atoms of different elements.

Review questions

I. Short answer questions

1. What are the basic building blocks of matter?
2. The simplest particles of iron are _____
3. Fill in the table below to compare the mass and the volume of a proton with the mass and the volume of an electron.

Particle	Mass	Volume
Proton		
Electron		

4. If you were to cut a metal element over and over again, to the point that it is barely visible, would it still be considered as an element? Why?

5. Which is larger? A living cell or an atom of hydrogen? Explain your answer.

II. Multiple choice questions (choose the correct answer)

6. An element is determined by the number of:

   A. Atoms B. Electrons C. Neutrons D. Protons

7. Which part of an atom takes up the most space?

   A. The nuclei B. The electrons C. The neutrons D. The protons

8. The nucleus of an atom consists of:

   A. Electrons
   B. Neutrons
   C. Protons and neutrons
   D. Protons, neutrons, and electrons

9. Which two particles of an atom attracted to each other?

   A. Electrons and neutrons B. electrons and protons
   C. Protons and neutrons D. All particles are attracted to each other

III. Investigative Questions

10. Describe the composition of a matter.

11. If scientists found a new particle that they thought was the smallest part of an atom, how could they be sure that there wasn't anything smaller? Can you think of anything that is not made of atoms?

12. How do you know that the air you breathe is not a single substance?

13. Gallium (Ga) with atomic mass 69.72 amu has two isotopes, ^{69}Ga and ^{71}Ga. ^{69}Ga has atomic mass of 68.9257 amu. What is the mass of ^{71}Ga, if the natural abundance of the two isotopes (^{69}Ga and ^{71}Ga) are 60 % and 40 % respectively?



Classification of Compounds

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

- Explain the classification of compounds into organic and inorganic
- Write the formula and names of the first ten alkanes, alkenes, alkynes
- List the uses of 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

Keywords:

- Compounds
- Organic
- Inorganic
- Oxides
- Acids
- Bases
- Salts and
- Neutralization

Activity 3.1

In our daily life, we use different compounds such as water (H_2O), table salt (NaCl), table sugar ($C_{12}H_{22}O_{11}$). calcium carbonate ($CaCO_3$), sodium hydrogen carbonate ($NaHCO_3$), methane (CH_4) and sodium hypochlorite (NaOCl).

1. What do we mean by a compound?
2. Which compounds are found in foods we eat?
3. Which one is found in common drinks?
4. Which one is found in chalk, baking powder, soap, marsh gas, vinegar and bleaching powder?
5. Would you describe the use of those compounds in your daily life?
6. Would you classify these compounds as organic and inorganic compounds? And what is the main difference between them?

There are more than 100 known elements that combine in a multitude of ways to produce compounds. Compounds are pure substances that are formed by the chemical combination of two or more atoms. Compounds can be classified into two main groups called organic compounds and inorganic compounds.

3.1 Organic and inorganic compounds

Organic compounds are compounds that contain carbon and hydrogen, along with other possible elements such as oxygen and nitrogen. But some compounds containing carbon such as carbonates, hydrogen carbonates, carbon monoxide, carbon dioxide, carbides and cyanides are not organic compounds. These are inorganic compounds. Inorganic compounds are commonly known as minerals. Inorganic compounds are typically lack carbon–hydrogen bonds. Most inorganic compounds are minerals, which are found in the earth crust. Inorganic chemistry is the study of gases, rocks, minerals and the compounds that could be made from them.

3.1.1 Organic compounds

Activity 3.2

Compounds which are used as fuel for household activities, vehicles and for making plastics are organic compounds.

1. Mention examples of organic compounds that you know.
2. Why are they used as fuel?

Organic compounds are compounds that contain carbon and hydrogen. Organic molecules of various sizes, shapes, and chemical properties are based on carbon. Except water and salts, most compounds in living cells are organic compounds. The skin, hair, horns, and tissues of the animals are made of organic compounds (proteins). An organic compound is a compound that contains the element carbon. Carbon is a unique element because it can join with itself and other elements. Carbon can form short chains, long chains, branched chains, and ring structures.

A. Hydrocarbons and its source

Hydrocarbons are organic compounds whose molecules are composed of hydrogen and carbon only. Hydrocarbons are organic compounds whose molecules are composed of Alkanes, Alkenes and Alkynes. There are three groups of hydrocarbons such as alkanes, alkenes and alkynes. All members of Alkanes can be represented by a general formula, C_nH_{2n+2}, where n is the number of carbon atoms. Alkenes have the general formulas, C_nH_{2n}, and Alkynes have also the general formula, C_nH_{2n-2}.

The family of alkanes, alkenes and alkynes are called homologous series (homos is a Greek word meaning “the same as”). A homologous series is a family of compounds in which each member differs from the next by one methylene, “CH_2” group. Each member of the homologous series is said to be homologs. For example methane and ethane are homologs of alkane, ethane and propane are also homologs of alkane. Methane and ethane differ one another by one methylene, “CH_2” group.

Nomenclature

The name of a hydrocarbon is derived from the number of carbon atoms present in hydrocarbons which is expressed by prefix, and the ending of the name contains a suffix. The prefixes used for hydrocarbons containing upto 10 carbon atoms are listed below:

Table 3.1: the basic prefix in naming hydrocarbons

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

The suffixes for the three groups of hydrocarbons are

The suffix –ane for alkanes

The suffix – ene for alkenes

The suffix –yne for alkynes

Example: Butane is an alkane containing 4 carbon atoms; the name of an alkene containing 7 carbon atoms is heptene. Since, hept indicates 7 carbon atoms and –ene is for alkene. The molecular formula of a hydrocarbon can be deduced from its name.

Activity 3.3

The numbers of carbon atoms of Alkanes, Alkenes, and Alkynes are given in the following Table. Write the name and molecular formula of the homologous series of hydrocarbons.

Table 3.2: The Homologous Series of Alkanes, Alkenes and Alkynes

Number of Carbon Atoms	Alkanes (C_nH_{2n+2})		Alkenes (C_nH_{2n})		Alkynes(C_nH_{2n-2})	
	Name	Molecular Formula	Name	Molecular Formula	Name	Molecular Formula
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

B. Uses of some hydrocarbons

Activity 3.4 (Project)

Hydrocarbons are good sources of energy. One technology that is used at different zones and woredas in the Amhara region is biogas. Develop a small-scale device that can generate electricity from biogas. Present your work for your class.

1. Have you ever heard about biogas?
2. What are the components of biogas?
3. What can you say about its advantages?
4. What do you suggest to the local people in your area?

Biogas is a renewable fuel produced by the breakdown of organic matter such as food and animal wastes. It can be used in a variety of ways including as vehicle fuel and for heating and electricity generation.

There are useful hydrocarbons for different purposes. The known use of common hydrocarbons is listed below as an example

- Methane used for fuel gas.
- Butane is used in lighter
- Propane and butane are used for bottled gas (buta gas).
- Octane is used as a component of petrol (fuel for engines).
- Decane is one of the components of kerosene (for cooking and lighting)
- Ethene and propene are feedstock for polymers (starting material for plastics).
- Ethyne is used at high temperatures for cutting and welding metals like Aluminium.

Activity 3.5

In our country, Ethiopia, there are known areas of hydrocarbons. In groups, ask your geography teachers or other experts and write your report for the class.

3.1.2 Inorganic compounds

Activity 3.6

In our daily life, we use a large number of substances. Recall tastes of some edible substances listed in the table below. If you have not tasted any of these substances yet, taste it, if they are available around your home and write the result in the table.

Observation and analysis

1. Do these substances have the same taste?
2. Do you think the substances belong to the same category?
3. What do you conclude about their properties?

Substance	Taste (Sour, bitter or other)
Lemon juice	
Orange juice	
Vinegar	
Sugar	
Common salt	
Baking soda	
Grape	
Mango	
Coffee	
Tea	

Based on their properties and compositions, inorganic compounds can be classified into four groups: Oxides, Acids, Bases and Salts.

Oxides

Activity 3.7

The rusting of iron made materials such as bridges, buildings, motor vehicles, tools, fences, and other structures is a major economic problem throughout the world.

1. Have you ever seen a used nail or piece of metal in your surrounding? What kind of color do they have? Is it similar to the original color? Why?
2. You have learned in previous classes about physical and chemical change. Has the above used nail or metal went through chemical or physical change? Why?
3. What is rusting?

Oxygen reacts with most elements to form oxides. Oxides are binary compounds of oxygen. Oxides are loosely classified into metallic and non-metallic oxides. Metallic oxides are formed when a metal reacts with oxygen, whereas non-metallic oxides are formed when a non- metal reacts with oxygen. Common oxides are water (hydrogen oxide), carbon dioxide, rust (Iron (III) oxide), and lime (calcium oxides).

Oxides can be further classified into five classes, these are Basic oxides, Acid oxides, Amphoteric oxides, Neutral oxides and Peroxides. Each group of oxide has its own specific properties. Now you are going to learn about basic oxides and acidic oxides.

1. **Basic oxides** are mostly metallic oxides and can react with acid. Example: Na_2O, MgO, and CaO … etc.
2. **Acidic oxides** are mostly non-metallic oxides and can react with bases. Example: NO_2, N_2O_5, P_2O_5, SO_2, and SO_3 … etc.

Properties of oxides

There are different properties of oxides which can help to differentiate the two main types of oxides such as acidic and basic oxides.

Acidic oxides are oxides of non-metals (acidic anhydride) and give acids in water.

$$SO_3 + H_2O \longrightarrow H_2SO_4 \text{ (Sulfuric acid)}$$

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

Chemicals: sulphur, water.

Procedure:

1. Put some powdered sulphur in a deflagrating spoon and ignite it.
2. When it starts burning, put it into a gas jar.
3. When the burning stops, add 5mL of water into the gas jar and shake.
4. Put blue and red litmus paper, one after the other, in the jar.
5. Record your observations.

Observation and Analysis

1. What is the color of the flame when sulphur burns in air?
2. What is the color change of blue and red litmus paper?
3. Classify the oxide as acidic or basic? Why?

Basic oxides (basic anhydride) are oxides of metals and give bases with water.

$$CaO + H_2O \longrightarrow Ca(OH)_2 \text{ (Calcium hydroxide)}$$

$$MgO + H_2O \longrightarrow Mg(OH)_2 \text{ (Magnesium hydroxide)}$$

$Na_2O + H_2O \longrightarrow 2NaOH$ (Sodium hydroxide)

The term anhydride "without water" refers to compounds that give either an acid or a base upon the addition of water.

Experiment 3.2 Preparation of magnesium oxide

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

Materials: Red and blue litmus paper, Bunsen burner, tongs, crucible.

Chemicals: Magnesium ribbon

Procedure:

1. Cut about 2 cm of magnesium ribbon.
2. Hold the ribbon with a tong and burn it over a flame from Bunsen burner.
3. When it starts burning, put the burning metal into a crucible and collect the product.
4. Add a small amount of water to the resulting powder in the crucible and shake it.
5. Rub the resulting substance between your fingers.
6. Test the solution with blue and red litmus paper.

Observation and Analysis

1. What is the color of the flame produced when magnesium burns in air?
2. What happens to the color of red and litmus papers?
3. Is the resulting solution basic or acidic? Why?

3.2 Acids and bases

Activity 3.8

Suppose you are playing in a field together with your friends; unfortunately, you are stung by a type of insect called wasp and one of your friends is bitten by an ant.

1. Do you feel any pain?
2. What do you think about the cause of the pain?
3. What do you do for you and your friend to get relief from the pain?

Acids cause the sour taste of fruits and other foods; citric acid makes lemons and oranges taste sour and vinegar is sour because it contains acetic acid. Acids are substances that release hydrogen ion or proton (H^+) or hydronium ion (H_3O^+) in water. For example hydrochloric acid (HCl) is an acid, which releases hydronium ion (H_3O^+) in water ($HCl + H_2O \longrightarrow H_3O^+ + Cl^-$).

Acids neutralize bases and basic oxides.

Bases are substances that release hydroxide ions (OH-) in water. Soluble bases are called alkalis. For example sodium hydroxide (NaOH) a base

($NaOH + H_2O \longrightarrow Na^+ + OH^-$)

Bases have a bitter taste. Bases neutralize acids and acidic oxides.

Activity 3.9

From your previous reading and experience, mostly the sour and bitter tastes of food are due to acids and bases present in them. If someone in the family is suffering from a problem of acidity after overeating,

1. Which of the following would you suggest as a remedy?

A. Lemon juice B. vinegar C. Baking soda solution

2. Which property do you look for while choosing the remedy?
3. What do you conclude about the reaction of the remedy?

3.2.1 Naming and writing formula of acids and bases

Names and formula of acids

Since all acids contain hydrogen, the name of an acid is based on the non-metal (negative) ion that goes with it. This negative ion can either be monatomic or polyatomic.

The three different suffixes that are possible for the negative ion lead to the three rules below.

1. When the negative ion ends in –ide, the acid name begins with the prefix hydro-. The root of the negative ion followed by the suffix–ic.

Example: HCl is hydrochloric acid because Cl- is the chloride ion.

2. When the polyatomic ion ends in –ate, the name of the acid is the root name of polyatomic ion followed by the suffix –ic. There is no prefix.

Example: H_2SO_4 is sulfuric acid (not sulfic) because SO_4^{2-} is the sulfate ion.

3. When the anion ends in –ite, the name of the acid is the root of the anion followed by the suffix –ous. Again, there is no prefix.

Example: HNO_2 is nitrous acid because NO_2^- is the nitrite ion.

Activity 3.10

Give the name of the following acids

Formula of Acids	Name
HBr	
HF	
HI	
H_2SO_3	
HNO_3	
H_2CO_3	

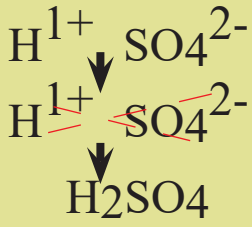
Like other compounds that you have studied, acids are electrically neutral. Therefore, the charge of the negative ion part of the formula must be exactly balanced out by the H^+ ions. Since H^+ ions carry a single positive charge, the number of H^+ ions in the formula is equal to the quantity of the negative charge of monoatomic or

polyatomic ions. From your grade 7 textbook, you have read how to write chemical formulas of compounds using valence numbers. Therefore, use the following steps of writing the formula of acids:

Step1: Write the valance number of negative ions followed by H^+ ion.

Step 2: Crisscross the two opposite charges and put it as a subscript number.

Example: The sulfate ion carries a −2 charge, so two H^+ ions are needed in the formula of the acid (H_2SO_4).



Names and formulas of bases

There is no special system for naming bases. Since they all contain the OH^- ion, names of bases end in hydroxide. The positive ion is simply named first. The number of hydroxides in the formula does not affect the name. The compound must be neutral, so the charges of the ions are balanced just as acids. For example, Sodium ion (Na^+) requires one OH^- ion to balance the charge, so the formula is NaOH. Calcium ion (Ca^{2+}) requires two OH^- ions to balance the charge, so the formula is $Ca(OH)_2$. Hydroxide ion is a polyatomic ion and must be put in parentheses when there are more than one in a formula.

Activity 3.11

Give the formula of the following bases

Name	Formula of bases
Magnesium hydroxide	
Ammonium hydroxide	
Potassium hydroxide	

3.2.2 Acid-base indicators and pH

Activity 3.12

In your home, you may find different substances such as vinegar, baking soda, and lemon; how do you identify the acidity or basicity of the substances?

Special type of substance is used to test whether a substance is acidic or basic. These substances are known as indicators. The indicators change their color when added to a solution containing an acidic, a basic or a neutral substance. Turmeric, litmus plant, and plant petals, etc., are some of the naturally occurring indicators.

The most commonly used natural indicator is litmus. Litmus is a natural dye; it is extracted from lichens. It has a purple color in distilled water. When added to an acidic solution, it turns red and when added to a basic solution, it turns blue. It is available in the form of a solution, or in the form of strips of paper, known as litmus paper. Generally, it is available as red and blue litmus paper.



Figure 3.1: Red and Blue litmus paper

pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH has a numerical scale usually ranges from 0 to 14. A solution with pH equal to 7 (pH = 7) is neutral, pH less than 7 (pH < 7) is acidic and pH greater than 7 (pH > 7) is basic.

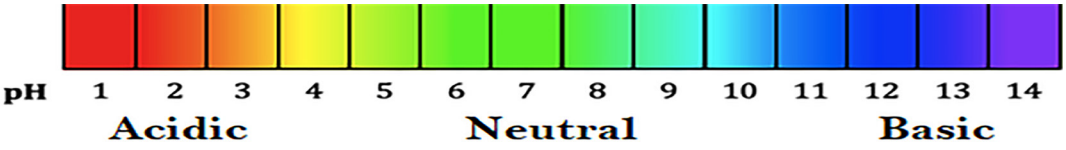


Figure 3.2: The pH scale

Experiment 3.3: Effect of acids on indicators.

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

Materials: blue and red litmus paper, test tube, test tube rack.

Chemicals: phenolphthalein, methyl orange, universal indicator, sulphuric acid and hydrochloric acid.

Procedure:

1. Pour about 5 mL of dilute HCl into four test tubes.
2. Hold the first test tube in an inclined position and put red and blue litmus papers turn by turn into it and see if there is any color change.
3. Add a few drops of phenolphthalein into the second test tube and few drops of methyl orange in to the third, few drops of universal indicator in the fourth and observe if there is color change.
4. Repeat the above procedure using a dilute H_2SO_4 solution.

Observation and conclusion

Record your finding in table1.

Table 3.3: Effect of acids on acid base indicators.

Acid	Colour of the indicators in the acid solution			
	Litmus	Phenolphthalein	Methyl orange	Universal Indicator
Lemon Juice				
Dilute HCl				
Dilute H_2SO_4				

3.2.3 Investigating properties of acids and bases

Properties of acids

Acids are easily recognized by their sour taste, but they can also be identified by using indicators. A common indicator used to test acids is litmus paper. Acids turn blue litmus paper to red. Acid can react with different substances.

1. Acids neutralize bases and basic oxides.
2. Acid can react with some metals such as iron, zinc, aluminum and magnesium to give salt and hydrogen gas.
3. Acids react with carbonates or bicarbonates to give salt, water and carbon dioxide.
4. Aqueous solutions of acids are electrolytes (conduct electrical current).

Experiment 3.4: Reaction of an acid with a metal.

Objective: To investigate the reaction of zinc with hydrochloric acid.

Materials: test tube, test tube rack, rubber stopper, match, steel wool and wooden splint.

Chemistry: Zinc and dilute HCl.

Procedure:

1. Pour about 5mL of dilute HCl into a test tube.
2. Clean a piece of zinc with the steel wool until it is shiny.
3. Add zinc to the test tube containing dilute HCl, close the test tube with a rubber stopper and record your observation.
4. Ignite a wooden splint using a match, remove the rubber stopper and introduce the lighted splint into the mouth of the test tube.

Observation and Analysis:

a. Why do you clean the piece of zinc 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 color of the gas?

e. What happens when the lighted splint is held inside the mouth of the test tube?

Uses of acids

Acids are very important in our life. Our stomach contains an acid that helps break down the food we eat. Amino acids are parts of protein that make up our body tissues. Carbonic acid and phosphoric acid maintain the acidity or basicity balance in our blood. Acids are also important in our diet. For example, vitamin C, which is found in lemon, orange, and other foods, is ascorbic acid. Serious health problems can result from a lack of vitamin C.

Acids are also used in making many products. Manufacturers use sulphuric acid in a wide variety of products, including fertilizers, detergents, plastics, and pesticides. Sulphuric acid is used in car batteries as electrolyte.

Hydrochloric acid, commonly called muriatic acid, is used as a strong cleaner for bricks and concrete. Like sulphuric acid, hydrochloric acid is used in manufacturing products ranging from rubber to medicine.

Properties of bases

Like acids, bases have a common set of properties. In aqueous solutions, they feel slippery on our skin, you experience this when you use soap, which are made from bases. If you have ever forgotten soap in your mouth, it tastes bitter. A bitter taste is another physical property of bases. Solutions of bases cause red litmus paper to turn blue. Like solutions of acids, solutions of bases contain ions, so they can conduct electricity. Bases neutralize acids and acidic oxides by forming salts and water.

Experiment 3.5

Title: The effect of base on an indicator

Objective: To study the effect of a base on an indicator

Materials: red and blue litmus paper, test tubes, test tube holder and test tube rack

Chemicals: ammonia solution, methyl orange and phenolphthalein

Procedure:

Take four clean test tubes.

Add about 5mL of NH3 solution in each of the tubes and level the test tube 1, 2, 3 and 4.

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.

Observe the colour change and record your observation.

Observation and analysis:

a. What is the color of ammonia solution, phenolphthalein and methyl orange before the experiment

b. What happens to the color of red and blue litmus paper, phenolphthalein and methyl orange solution after the addition of ammonia solution.

Uses of bases

Bases are important in life; Magnesium hydroxide is found in milk of magnesia, a medicine used to relieve stomach distress. Another base, baking soda, is used to make biscuits and breads. Gardeners use bases to make acidic soil neutral. Strong bases, such as sodium hydroxide, are used for cleaning because they are able to eliminate grease.

Bases are also used to produce new products. For example, sodium hydroxide is used to manufacture soap, rayon, and paper. Calcium hydroxide is used to make

plaster and mortar.

Investigation using local indicators

Activity 3.13

Take a small amount of baking powder in a spoon and dissolve it with enough water in a beaker or a glass. Then take a sheet of paper and drop a small amount of baking powder solution on the paper and rub the paper with freshly cut beetroot.

Observation and analysis

a. What happens to the paper? Explain your observation?

b. Would you mention any parts of plants such as roots, leaves, flowers or fruits, which can be used as indicators?

Using synthetic indicators have various effects on human beings; mainly chemical hazardous and pollution effects. To overcome the above mentioned negative effects of synthetic indicators, currently people focus on preparing indicators from locally available natural sources or bio-sources. Local indicators are prepared from natural sources (plants). They have an advantage like easily accessible, less toxic, and environmentally friendly (Eco- friendly).

Local indicators can be prepared by extracting from different parts of plants such as roots, leaves, flowers or fruits. Consider the figures shown below, both Petunia flower and Beetroot can be used as a natural indicator.



Petunia Flower



Beetroot

Figure 3.3: Plant beetroot and flowers used as indicators.

3.2.4 Precautions in working with acids and bases

Care must be taken whenever you are working with strong acids and strong bases. Strong acids and strong bases are corrosive in nature. Common acids such as hydrochloric acid, sulfuric acid, nitric acid and common bases such as potassium hydroxide (caustic potash) and sodium hydroxide (caustic soda) are corrosive.

The followings are some of the precautions whenever working with strong acids and bases

1. Wear acid-resistant gloves when handling strong acids and bases.
2. Wash with water during splashing of acids and bases, and
3. Safe handling of strong acids and bases.

3.3 Neutralization reaction and salts

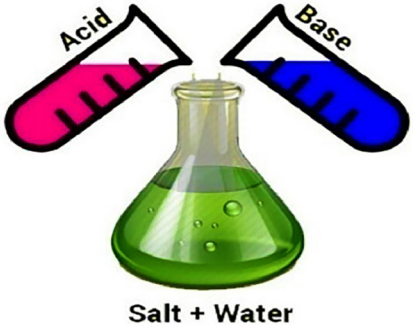


Figure 3.4: Neutralization reaction

3.3.1 Neutralization reaction

Activity 3.14

1. Why is taking too much soft drinks, candy and citrus fruits are unsafe for your teeth?
2. How do anti- acids, such as milk of magnesia, relieve gastritis (excess stomach acid)?

Remember, from your grade 7 chemistry, you have learnt about chemical reactions. Neutralization reaction is a type of chemical reaction between an acid and a base that produces salt and water. Consider the reaction between an acid (HCl) and a base (NaOH),

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Acid Base Salt Water

The products, sodium chloride and water, are neutral. The resulting solution has a pH of 7, and so it is neutral. In other words, a neutral solution (pH = 7) has no effect of acidity or basicity. Neutralization reactions have different practical applications in home, health, waste water treatment and agriculture. Some of the applications of neutralization reactions in our daily life are the following.

1. Waste water treatment

Acidic gases such as sulphur dioxide (SO_2) can be emited from industries form acidic effluents in the waste water. To reuse the waste water after treatment for drinking or any other purpose, the treatment should include neutralization of the acid component.

2. Controlling soil pH

Soil pH is very important for crop cultivation. Plants grow on a soil which has a particular pH value. High acidity of soil affects the yield of crop production. Different crops require different nutrients in different proportions and, as a consequence, each crop grows best in soil within a particular pH range.

Crop	best pH range
Potatoes	5.5 – 6.5
Oats	5.5 – 7.0
Beans	6.0 – 7.5

When organic materials, such as dead leaves, animal wastes etc. decay, organic acids are produced and these lower the pH of the soil so, over the years, soil naturally becomes more acidic. In order to increase the yield of crop production, it is often necessary to control the soil pH by adding alkaline substances such as wood ash, limestone ($CaCO_3$) and quick lime (CaO). They can help to neutralize the acidity of soil and increase the crop yield.

3.3.2 Salts

Activity 3.15

1. What is meant by a salt?
2. Do you think that salt refers to NaCl only?

Salts are compounds formed by the reaction of acids and bases. They contain negative ions of acids and positive ions of bases. Different salts naturally occur as rocks (carbonates, Sulfates, phosphates, etc). Naming of salts has two parts. The first part (positive ion) comes from a base or a metal oxide and the second part (negative ion) comes from an acid or non metal oxide. For example, if we consider the salt Sodium Chloride (NaCl), the sodium ion (Na^+) may come from a base (NaOH) or an oxide (Na_2O) and the chloride ion (Cl^-) from an acid (HCl).

Classification of salts

Based on the number of elements they contain, salts can be classified into two, binary salts and ternary salts.

a. Binary salts contain two elements.

Example: Sodium chloride contains sodium and chlorine.

b. Ternary salts contain three elements.

Example: Sodium carbonate contains sodium, carbon and oxygen.

Preparation of salts

Salts can be prepared by using different methods. Neutralization reaction is the most common and useful method of salt preparation. It is the reaction involving an acid and a base to give salt and water .

(Acid + Base $\longrightarrow$ Salt + Water).

For example: HCl + NaOH $\longrightarrow$ NaCl + H2O.

Reaction of basic oxide and acid also gives salt and water.

Acid + Basic oxide $\longrightarrow$ Salt + Water.

For example: 2HCl + CaO $\longrightarrow$ CaCl2 + H2O

Experiment 3.6: Preparation of salt by the reaction of acid and base

Objective: To prepare sodium chloride by the reaction of sodium hydroxide and hydrochloric acid.

Materials: beaker, dropper, glass rod, evaporating dish, wire gauze, tripod, Bunsen burner, red and blue litmus paper

Chemicals: sodium hydroxide solution and dilute hydrochloric acid

Procedure:

1. Measure 15 mL of sodium hydroxide and pour into a beaker
2. Measure 20 mL of dilute hydrochloric acid solution and pour about 13 mL of it into the beaker containing sodium hydroxide solution
3. Stir the mixed solution with a glass rod and test with red and blue litmus paper
4. Then continue adding the acid solution using a dropper and testing the solution using blue and red litmus paper until the color of the blue and red litmus does not change.
5. When the color of red and blue litmus remains the same pour the solution into an evaporating dish and heat the evaporating dish.

Observation and Analysis

1. Which color of the litmus paper changed?
2. What volume of hydrochloric acid was added till the colors of red and blue litmus paper changes?
3. When do the colors of blue and red litmus paper remain the same?
4. What is left in the evaporating dish after evaporation? Name the compound?

3.3.3 Naming and writing formula of salts

Naming of salts has two parts. The name of the positive ion (cation) comes first followed by the name of the negative ion (anion). Examples of cations are sodium, potassium, ammonium, etc. and anions are chloride, sulfate, nitrate, etc.

For example, if you consider the salt sodium chloride (NaCl); the cation, sodium ion (Na^+) comes first followed by anion, chloride ion (Cl^-).

Activity 3.16

Give names for the following salts

Formula of Salts	Name
$CaCl_2$	
$Mg(NO_3)_2$	
$Al_2(SO_4)_3$	
$BaSO_4$	

Writing formula of salts

In writing the formula of salts, the positive ion comes first followed by the negative ion. For example, in writing the formula of the salt sodium chloride (NaCl), the positive ion (Na+) comes first and then the negative ion (Cl-).

Activity 3.17

Give formula for the following salts

Name	Formula of Salts
Potassium bicarbonate	
Magnesium sulfate	
Sodium nitrate	
Ammonium sulfate	

Uses of salts

Activity 3.18

In your home or local area, people use different salts for different purposes. In groups, mention the salts and discuss the uses of the salts you have mentioned.

Salts have different uses. In ancient times, salts have been used for food preservation and flavouring. In addition to this, salts have also been used in chemical industries such as soap production, tanning, dyeing, etc. Currently, salts have different applications. The applications of some salts are listed in the table below.

Table 3.4: Formula, name and major uses of some salts

Formula of Salts	Name	Main Uses
NaCl	Sodium chloride	In food cooking, preservatives, in production of soap, etc.
$CaCO_3$	Calcium carbonate	An ant-acid, fillers in cosmetics, disinfectant agent and as pH corrector
$NaHCO_3$	Sodium bicarbonate	An antacid and making baking powder
$CaSO_4$	Calcium sulfate	Setting fractured bones, surface smoothing, fire-proofing material
KNO_3	Potassium nitrate	For fertilizer
$(NH_4)_2HPO_4$	Diammonium phosphate	For fertilizer

Activity 3.19 (project)

In group, collect different types of rocks such as limestone, marble, etc. from your local area. Using vinegar or lemon juice test whether the rocks contain carbonate or not. After testing write a report to your teacher with describing the industrial importance of carbonate rocks.

Summary

- Hydrocarbons are organic compounds, which contain mainly two elements carbon and hydrogen.
- There are three groups of hydrocarbons such as alkanes, alkenes and alkynes.
- All members of hydrocarbons such as alkanes, alkenes and alkynes can be represented by a general formula of C_nH_{2n+2}, C_nH_{2n} and C_nH_{2n-2} respectively.
- Oxides are binary compounds which contain elements and oxygen.
- Oxides are mainly metallic and non-metallic oxides; most metallic oxides are basic oxides, whereas most non-metallic oxides are acidic oxides.
- Basic oxides behave like a base and react with acids to form salts.
- An acid is a substance that forms hydrogen (H^+) ions when dissolved in water.
- Base is a substance that forms hydroxide (OH^-) ions when dissolved in water.
- Acid-base indicators are weak organic acids; they change from one colour to another within a particular pH range.
- pH is the measure of acidity or basicity of a substance.
- Salt is a substance formed by the reaction of acid and base by neutralization reaction.

Review Questions

I. Short answer questions

1. What is a compound?
2. What are the two main classes of compounds?
3. Hydrocarbons are organic compounds, which are composed of two chemical elements _____and_____.

4. _____ neutralize acids and acidic oxides.

5. The reaction of acid and base gives _____ and _____. The reaction is called _____.

II. Multiple choice questions (choose the correct answer)

6. Which formula represents the hydrocarbon octene?

A. C_8H_{14} B. C_8H_{12} C. C_8H_{18} D. C_8H_{16}

7. Which organic compound, is an alkyne? .

A. Acetylene B. Urea C. Aspirin D. Ethene

8. Which one of the following is an inorganic compound?

A. Marsh gas B. Water C. Sugar D. Vinegar

9. All metallic oxides are basic oxides. A) True B) False

10. Which one of the following is the chemical formula for Ammonium phosphate?

A. NH_4PO_4 B. $(NH_3)_4PO_4$ C. $(NH_3)_3PO_4$ D. $(NH_4)_3PO_4$

11. Identify the nonmetallic oxide among the followings

A. Al_2O_3 B. MgO C. CO_2 D. BaO

12. A student burned a certain substance in air and put the product into water; the solution turned red litmus paper to blue. The product obtained by the student was _____.

A. A basic oxide C. An acidic oxide

B. An acid D. A neutral oxide

13. One of the following is **not** the products when an acid reacts with carbonates?

A. Carbon dioxide gas C. Salt

B. Oxygen gas D. Water

14. Which one of the following is a binary salt?

A. $MgSO_4$ C. $Al_2(SO_4)$

B.NaH_2PO_4 D. FeS

15. Which reaction differs from the rest?

A. $Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 + 2H_2O$

B. $2HCl + MgCO_3 \longrightarrow MgCl_2 + CO_2 + H_2O$

C. $HCl + NaOH \longrightarrow NaCl + H2O$

D. $2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$

III. Investigative Questions

1. A farmer in your locality is challenged to cultivate a "Teff", due to high soil acidity of his farmland. What do you recommend to him to improve the yield of "Teff" in his farm?

2. In everyday life, souring of "Tella" and "Milk" is a common problem. What do you suggest to extend the age of "Tella" and "Milk" without souring? And what is the common indigenous knowledge used by the people in your locality? Ask your parents, why they tightly pack the containers of the crude mixture (Difidif) of Tella or Teji?

3. Assume you want to test the acidity and basicity of substances in your local area, but you do not have any litmus paper or acid-base indicator, what do you do?

4. In your laboratory, unfortunately, if a strong acid is splashed into the eye of your friend, what will be the substance that should be used for first aid treatment?

5. If you live in a lowland area, you may commonly use freshwater from lakes for drinking. Lake water is often alkaline and its pH is greater than 7, which is not convenient/good for drinking. What will be your remedy?

6. Your Mom often washes her jewellery made from Gold or Silver with lemon juice. Why did she use lemon juice to clean her jewellery instead of soap?

7. Before people become aware of the problem that acidic rain caused, they often used metals, limestone and marble as building materials. What is the effect of acidic rain on buildings? And what are the sources of acidic rain?

8. Why do indicators change their color in acidic and basic solutions?

Unit 4

Human Body Systems and Health

Keywords:

- Integumentary system
- Skin
- Hairs
- Nails
- Epidermis
- Dermis
- Eczema
- Skin Cancer
- Acne
- Athlete's foot
- Akin burn
- Sweat gland
- Sebaceous gland

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
- Understand the integration of different body parts

Activity 4.1

Consider a car and its different body parts. The outer body protects the internal parts and has aesthetic value. The gear system enables the car to move. The electric circuit lights up the car battery. Think of every other body part of the car and consider their functions.

1. What will happen if one of the parts is not working properly?
2. How do you relate the car with that of the human body system?
3. The following are some of your day to day activities: *Sitting down and eating food, sitting down and reading books, sleeping during the night, playing games, taking showers, and watching television*. Do you think that any of your body systems are working under such circumstances? Try to relate the body system with the activities mentioned above, if any.

A body system is a collection of body organs that are able to work together to serve a common purpose. Each part of a system depends on the other to perform tasks that can't be achieved by a single part alone. The body systems covered in this unit include integumentary, muscular, skeletal, digestive, respiratory, circulatory, and reproductive systems.

4.1 Integumentary system

After completing this section, you will be able to:

- Distinguish the major structural components of human integumentary system
- Describe the main functions of human integumentary system
- Identify and discuss the main diseases or disorders and effects of human integumentary system

Activity 4.2

1. What do you think is the largest organ in the human body?
2. Do you think that humans have a body system which is visible to naked eyes? Describe it.
3. Have you ever heard about the integumentary system? If so, which body parts make up this system?

One of the body systems in our body is the integumentary system. It is the body system that surrounds all of our other organ systems. Our integumentary system consists of many tissues that protect our body.

4.1.1 Components of the integumentary system

Recall from grade 7 that a system consists of a group of organs working together to perform specific activities. Our integumentary system is composed of the skin, hair, nails and associated glands of the skin, and sensory receptors.

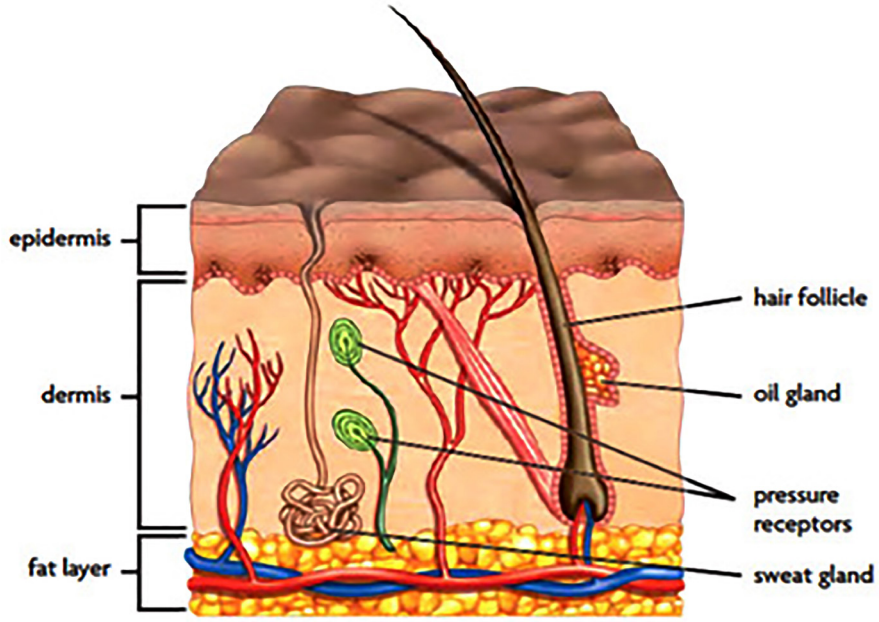
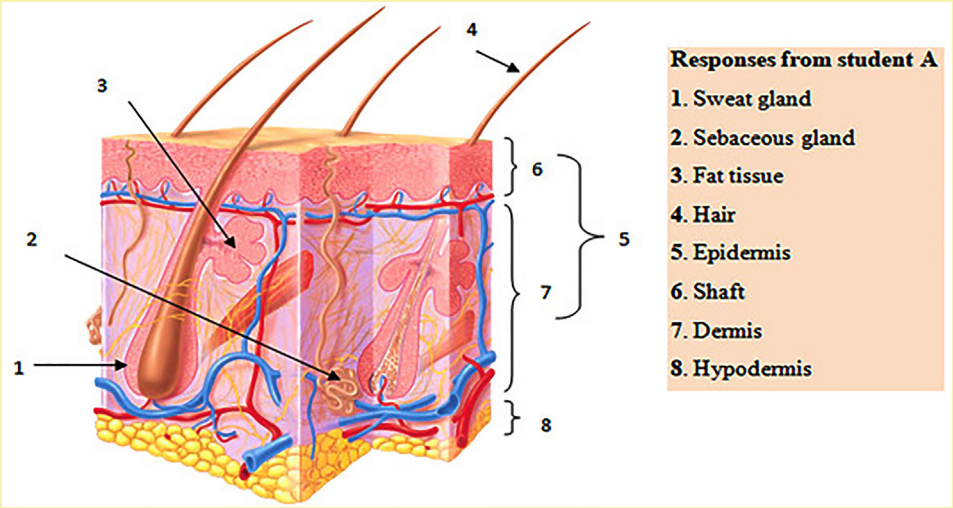


Figure 4.1 Human integumentary system

Activity 4.3

Suppose a student "A" in grade 8 responded to the diagram labeling question as follows.



How do you evaluate the student's response? Present your answers to the class with explanations.

The skin consists of two main parts: epidermis and dermis. The epidermis is the thin, outer layer that we see. The surface of the epidermis consists mostly of dead cells. It also contains pores through which sweat, salts, and oils can leave the body. The dermis lies underneath and is made of connective tissue and protein fibers. It contains several glands and nerve endings. Deep to the skin is the subcutaneous layer, which attaches the dermis to the underlying body part.

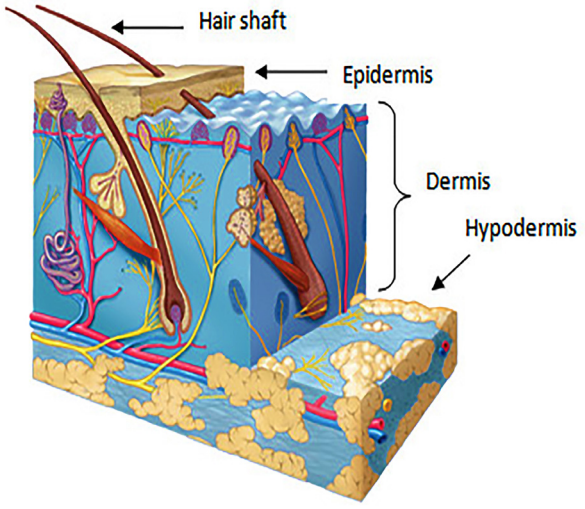


Figure 4.2 Skin layers

Hairs and nails are composed mostly of dead, keratinized cells. Hair follicles produce the hair on our skin. Muscle fibers attached to the hair follicles cause hair to stand up. This action helps regulate temperature. Hair also filters out dust particles from our nose and eyes. Nails protect the sensitive tips of our fingers and toes and help us pick up small objects.

4.1.2 Functions of the integumentary system

Activity 4.4

1. Below are some of the functions of the parts of the integumentary system. Identify the body part that performs each activity. Check if your answers are correct after reading this section.

Part of integu-mentary system	Their functions
	Provides protection against scratch, ultraviolet radiation, and prevent entry of microorganisms
	Guards the skin on the head from injury and sun's rays and decreases heat loss due to sweating
	Can detect heat, cold, touch, pressure, and pain.
	Lubricating and waterproofing of our skin
	Regulate body temperature by controlling blood flow and the activity of sweat glands.
	Excrete metabolic wastes like urea and synthesis vitamin D
	Protects the ends of fingers and toes

2. Most of you might have experienced feeling cold after having your hairs cut especially at earlier ages. Reason out.

The integumentary system has many important functions. The major functions include protection, sensation, temperature regulation, vitamin D production, and excretion. The skin provides protection against ultraviolet light. It also prevents the entry of microorganisms and prevents dehydration by reducing water loss from the body. The integumentary system has sensory receptors that can detect heat, cold, touch, pressure, and pain. Body temperature is regulated by controlling blood flow through the skin and the activity of sweat glands. Sweat glands help to maintain temperature by cooling the body as the sweat evaporates off the skin. When

exposed to ultraviolet light, the skin produces a molecule that can be transformed into vitamin D. Small amounts of waste products are lost through the skin and in gland secretions. Oil glands in the skin release acidic oils that stop fungi and bacteria from growing on the skin, thereby preventing infection

4.1.3 Common skin disorders

Because it is the most exposed of all our organs, skin is the most vulnerable to injury and disease and also the one where we are most likely to notice anything unnatural.

Skin burns

Activity 4.5 (Project work)

If a child in your locality gets skin burn due to spilling of hot water or fire on his/her hand:

1. How do the local people treat the injured part?
2. What health consequences will the child face because of the skin burn?
3. Evaluate the effectiveness of the various treatment methods that are used by the local people in your area.
4. What do you recommend for parents whose child gets skin burn?

A burn is tissue damage caused by excessive heat, electricity, radioactivity, or corrosive chemicals that denature (break down) proteins in the skin. Children are particularly vulnerable to burns. The seriousness of a burn is determined by its depth and extent of area involved, as well as the person's age and general health. Prevention strategies should address the hazards for specific burn injuries, education for vulnerable populations and training of communities in first aid.



Epidermis & part of dermis destroyed

Athlete's foot

Activity 4.6

Have you ever experienced a condition like the one shown in the diagram? What is going on the foot? Describe how we can prevent this disease.



Athlete's foot is caused by a fungal infection that usually involves the skin of the toes and soles. When fungus grows on the feet, it is called athlete's foot. It got this name because it affects people whose feet tend to be damp and sweaty, which is often the case with athletes. But anyone can get this infection.

Skin cancer

Activity 4.7

1. Most parents in Ethiopia prohibit their children from exposing their bare body to full sunlight. Is there any scientific justification for it?
2. Look at the following diagrams. What has happened to these skins? Can you explain the cause and how to avoid such things?



Skin cancer is the most common type of cancer. Most skin cancers result from damage caused by the ultraviolet (UV) radiation in sunlight. The sites of development of most skin cancers are the parts of the body most exposed to sunlight, such as the face, neck, ears, and dorsum of the forearm and hand. Some skin cancers are induced by chemicals, x-rays, depression of the immune system, and inflammation. The best way to prevent skin cancer is to protect your skin from the sun. So, enjoy

the sun in moderation, and protect yourself at the same time. Avoid sitting outside for too long in the middle of the day. Seek shade and use sun protective clothing to make sure your skin doesn't burn or darken.

Acne

Activity 4.8

1. Examine the following diagrams and explain possible causes?





2. Discuss what the local people believe about it. Is it related to puberty? Justify your answers

Acne is a skin condition that occurs when your hair follicles become clogged with oil and dead skin cells. It causes whiteheads, blackheads or pimples. Acne is most common among teenagers, though it affects people of all ages. Acne typically appears on our face, forehead, chest, upper back and shoulders because these areas of skin have the most oil (sebaceous) glands. Treatment consists of gently washing the affected areas once or twice daily with a mild soap and medication.

Eczema

Activity 4.9

Here is also another kind of skin disease (see diagrams). Have you ever experienced this condition? Can you explain the cause and its prevention strategies?





Eczema is an inflammation of the skin characterized by patches of red, blistering, dry, and extremely itchy skin. Symptoms can vary from a mild rash that disappears quite quickly to a more severe condition that is present for a long time. Although eczema can occur at any time of life, it usually develops in children. Most children have a substantial improvement in their eczema by their mid-teens but, in some, severe eczema persists into adulthood. Eczema is related to a gene variation that

affects the skin's ability to provide protection from bacteria, irritants and allergens. In some children, food allergies may play a role in causing eczema. There's no cure, but most people can manage their symptoms by avoiding irritants and getting treatment to heal the affected skin and prevent flares of symptoms.

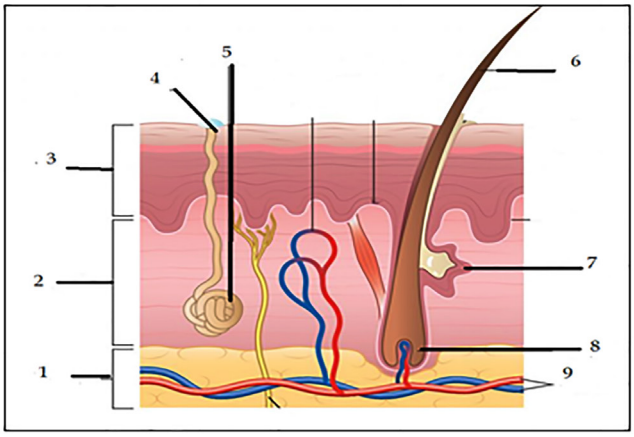
Summary

- The integumentary system is the outermost organ system of the body which consists of the skin, hairs, nails, glands, and nerve endings.
- Skin is composed of two layers; epidermis (outer layer) and the dermis(the inner layer).
- Accessory organs of the skin include hairs, nails, and the associated glands.
- Skin provides physical, chemical, and biological barriers that help protect the body.
- Some common disorders of the skin include skin burn, skin cancer, acne, eczema, athlete's foot.

Review questions

1. What are the components of the integumentary system?
2. How does the skin help us to regulate our body temperature?
3. Explain how the following components of the integumentary system protect our body from external environments? Nail, skin and hair.
4. Label the following diagram which shows the components of the integumentary system.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____



Exercise

1. Going out in the sun stimulates quite a bit of activity in the skin, especially on a hot summer day. Describe what is happening in the skin in response to sunlight.
2. Although the epidermises of plants and humans have different structures, some of these structures have the same function. How are pores in human skin functionally similar to stomata on plants?
3. Why might it be beneficial to have dead skin cells on the outermost layer of the epidermis?
4. Given what you know about the cause of acne, propose some ways to prevent or treat the disorder.
5. How can the function of oil glands be affected if you wash your skin too frequently?
6. What is the difference between epidermis and dermis?

After completing 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 and effects of human muscular system

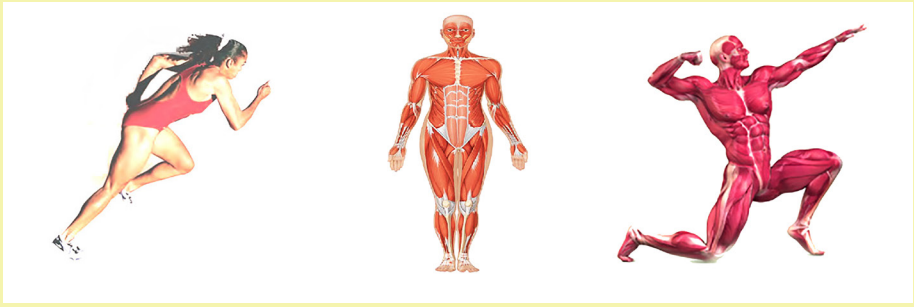
4.2 Muscular system

Keywords:

- Muscular system
- Skeletal muscle
- Smooth muscle
- Cardiac muscle
- Voluntary muscle
- Involuntary muscle
- Muscle fiber
- Muscle strain
- Muscle cramp
- Muscle dystrophy

Activity 4.10

1. What comes to your mind when you see diagrams like the following and why?



2. On a daily basis, you are doing many things such as eating, speaking, walking, running, writing, playing, dancing, and many others. Have you ever considered the body system that enables you to perform these tasks and what elements it contained?

The muscular system is one of the biological systems of humans that produce movement. Muscles are the only tissues in the human body that have the ability to contract and therefore, move the other parts of our body.

4.2.1 Components of the muscular system

Activity 4.11

1. Do you agree or disagree with this concept "Muscles are in the arms. They are not found all over the body".
2. Do you think that muscles of our body are all one kind? Explain your answer.
3. Consider our internal organs such as heart, esophagus, and bones. What kinds of muscles are associated with these organs?

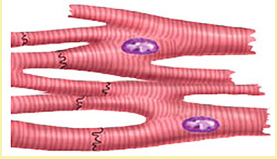
Muscles are made up of fibers. When the fibers contract, the entire muscle becomes shortened and vice versa. Muscle tissue is classified into three types according to structure and function: skeletal, cardiac, and smooth muscles.

Activity 4.12

1. Identify the three types of muscles (skeletal, smooth, or cardiac) and explain how you identified them? why?



A



B



C

2. Complete the table which is about muscle comparison based on structure and their location in the body.

Muscle type	Structural elements	Location
?	?	Attached to bones
?	Short, branched, single central nucleus	Heart
Smooth	Short, spindle-shaped, single nucleus in each fiber	?

The biceps and triceps in our arms are examples of skeletal muscles. Our beating heart is another muscle. We also have smooth (visceral) muscles that line internal organs. Some of the smooth muscles push food through our digestive organs; others change the size of the blood vessels to allow more blood to reach different parts of the body.

4.2.2 Functions of muscular system

Muscles are in charge of all the body's movements. It would be impossible to move any body part without muscles. The primary job of muscle is to move the bones of the skeleton. Muscles also enable the heart to beat, and facilitate bodily processes such as respiration, excretion, and digestion.

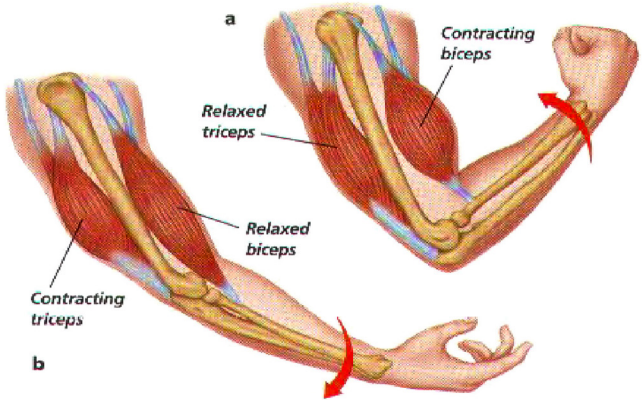


Figure 4.3: Muscle flexor and extensor

Muscles usually work in pairs called flexors and extensors. If a muscle bends part of our body, it is called a flexor. If a muscle straightens part of our body, it is called an extensor. Flexor and extensor pairs are found across many of our joints. These pairs provide almost all the movement of our skeleton.

Activity 4.13

1. You are able to perform the following activities using your body muscles. Identify which muscle types are involved in each activity and determine whether it is voluntary or involuntary.

Activities	Muscle involved (cardiac, visceral, and skeletal)
Pointing fingers	
Holding a pen	
Pumping blood	
Swimming in a river	
Pushing food through the digestive tract	

Blinking eyes	
Giving birth	
Contracting gland ducts	

2. Which of the above activities are under your conscious control?

Most behavior and many physiological actions depend on muscle contraction and relaxation. Skeletal muscles are responsible for all voluntary body movements such as running or playing football. They also play a role in breathing, shivering, and maintaining posture. Smooth muscles create movements in many hollow internal organs such as the gut and bladder. Cardiac muscles are responsible for the beating action of our heart.

4.2.3 Major muscle disorders

Activity 4.14

1. Students! Please ask your parents why older people prohibit children from lifting heavy loads. Come with reasons.
2. Have you ever experienced problems related to muscle while playing football, gymnastics or running? What is wrong with your muscles?
3. Most of you may be familiar with grass peas (Guaya in Amharic). How is grass pea related to leg paralysis? Argue for or against the beliefs about grass pea in relation to leg paralysis.

Most of you might have painful muscles after exercising or working too much. Some discomfort can be a normal part of healthy exercise. But, in other cases, muscles can become strained. Muscle strain resulted from muscle stretched too much or the muscle actually tears. Lifting something that was too heavy and lifting in the wrong way can strain muscles in our back. This can be very painful and can even cause an injury that will last a long time.

Another kind of muscle disorder is muscle sprain. It results when ligaments (which connect bones to bones) are stretched or pulled too much. Most people are familiar with the pain of a sprained ankle. Muscle diseases such as muscular dystrophies are caused by genetic disorders. Over time, muscle weakness decreased mobility,

making everyday tasks difficult. There are many kinds of muscular dystrophy, each affecting specific muscle groups. Another kind of abnormal muscular contraction is a spasm, which is a sudden involuntary contraction of a single muscle in a large group of muscles.

Grass pea (Guaya in Amharic) is a legume that is cultivated in India, Africa, and the Middle East. It is mostly grown in Ethiopia. The local people in Ethiopia believe that the steam or vapor from boiling, the smoke from seeds as well as walking or lying on the straw and the stalks of the grass pea would trigger the onset of leg paralysis. This belief hindered the society from taking action to extract the toxic effect of grass pea. It is the excessive or prolonged consumption of grass pea that can lead to muscle paralysis which is caused by a neutrotoxin in the seeds. Some measures to reduce toxin burden include using metallic cooking utensils rather than traditional clay pots to avoid accumulated toxicity from iron-induced oxidation, addition of antioxidant seasonings, soaking seeds in lemon-water, and avoiding unripe seeds.

Summary

- Muscles are tissues that can contract and relax to enable body movements.
- Humans have three types of muscles: skeletal, smooth, and cardiac muscles.
- Skeletal muscles are voluntary while smooth and cardiac muscles are involuntary.
- Muscles work in pairs but antagonistically.
- Some muscle disorders and diseases include muscle strain, muscle cramp, and muscle dystrophy.

Review questions

1. What is the function (s) of muscles in the human body?
2. List down the three different types of muscles in your body?
3. Which of the following is NOT correct about muscles?

   A. Biceps and triceps work antagonistically.

   B. Skeletal muscles move our bones.

   C. Skeletal muscles work lifelong.

   D. Cardiac muscles contract rhythmically

4. Which of the following best describes smooth muscles? Smooth muscles are

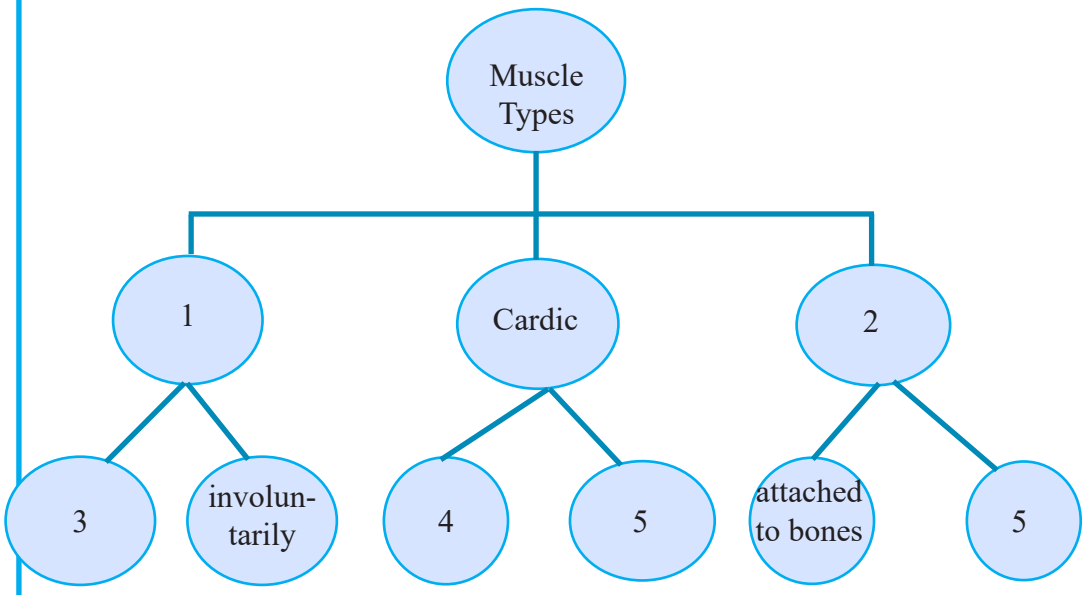
   A. striated and spindle shaped muscles.

   B. striated and long shaped types of muscles.

   C. non striated and branched shaped muscles.

   D. non striated and spindle shaped muscles

5. Fill the following concept map with correct words.



Exercise

1. Explain how smooth muscle is different from both the cardiac and skeletal muscles.
2. Describe how the cardiac muscle is different from both the smooth and skeletal muscles?
3. How do muscles move your body? Give one example of body movement and explain briefly.

After completing 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 and effects of human skeletal system

4.3 Skeletal system

Keywords:

- Skeletal system
- Axial skeleton
- Appendicular skeleton
- Skull
- Girdle bones
- Phalanges
- Limbs
- Osteoporosis
- Bone fracture
- Osteoarthritis

Activity 4.15

In this activity, you are going to sketch the outline of bones in your body. So, first sit in groups and imagine the shape, length, and number of bones in the various regions of your body. Then, draw the structure of the human skeleton by connecting bones end to end. Try to imagine the shape and length of the bones by pressing and feeling your bones. You need to consider the number of bones in different regions of your body.

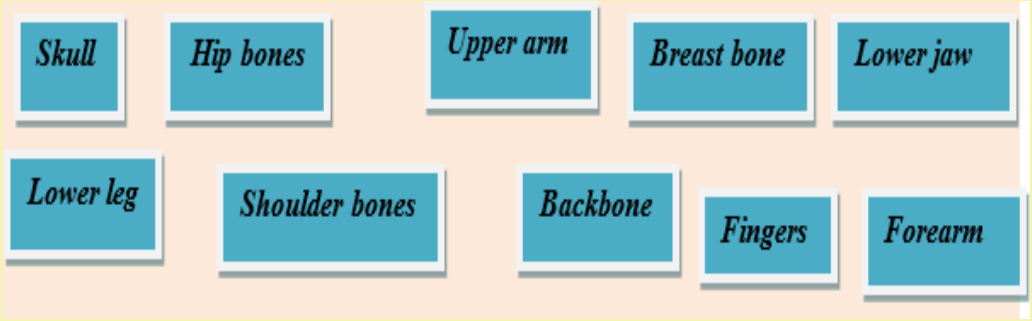
The hard structures within our bodies are part of the skeletal system. Press on your wrist, ankle, knee, or elbow. Do you feel something hard under your skin? You are feeling a bone, a hard tissue made mostly of cells, collagen, and calcium. Despite its hardness, the skeletal system actually consists of dynamic, living tissues that are capable of growth, adapt to stress, and undergo repair after injury.

4.3.1 Structural components of the skeletal system

The skeletal system is an organ system that includes the bones and the connective tissues that hold the bones together. It is made up of the appendicular and axial skeletons. The axial skeleton consists of the bones that lie around the longitudinal axis (imaginary line) of the human body. The appendicular skeleton consists of the bones of the upper and lower limbs plus the bones that connect the limbs to the axial skeleton.

Activity 4.16

1. Suppose you are provided with the following bones. Based on your prior information, classify them into axial and appendicular skeletons.



2. Who has a greater number of bones, children or adults and why?

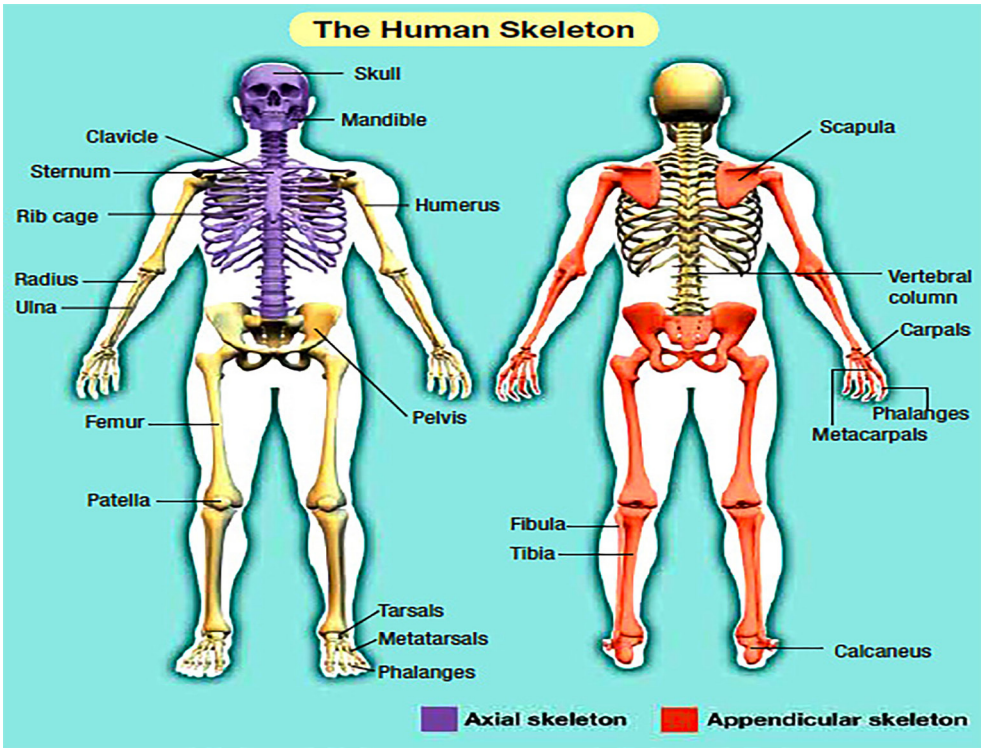
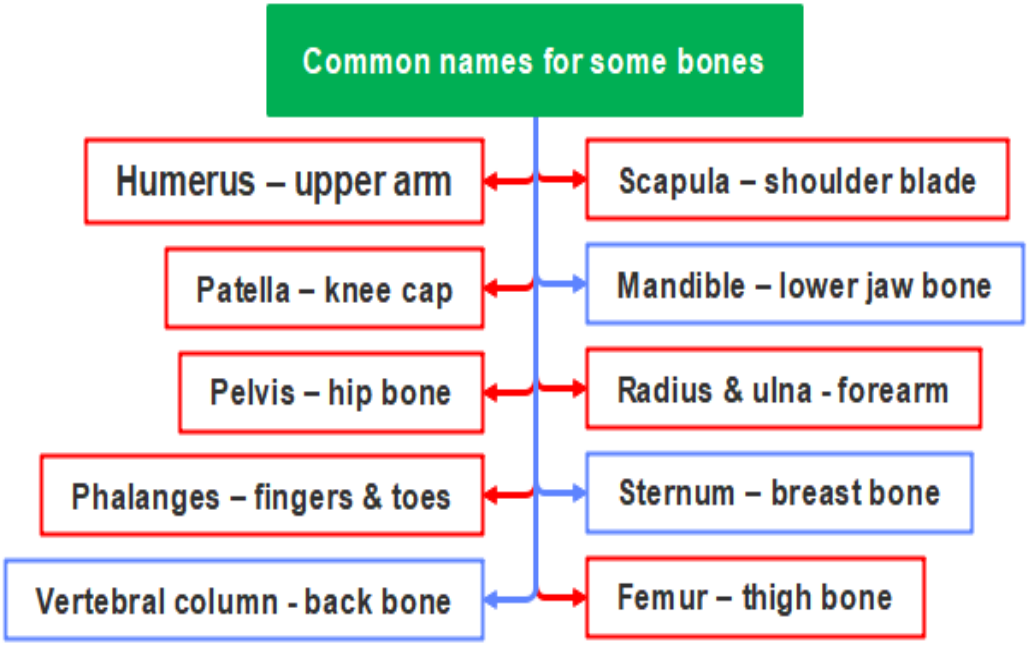
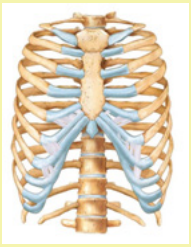


Figure 4.4 Human skeletal system



Try to analyze the diagrams given above, human skeleton, and then a) locate the bones on your own body, b) identify the axial and appendicular skeletons, and c) compare your diagram in Activity 4.15 with the diagram given above in fig 4.4.

Activity 4.17 Name the following bones.

			
a	b	c	d
			
e	f	g	h

4.3.2 Functions of the skeletal system

Activity 4.18

1. What holds up the walls and the roof of a building or a house and protects it from the outside environment? There are beams, braces, and insulation inside the walls and under the roof that you cannot see.
2. In the same fashion, what structures support and protect our internal bodies? Explain.
3. What would happen if we don't have a skeletal system?
4. If our skeletal system is devoid of muscles, what would happen?

You might be wondering how our skeletal system protects our internal body parts. Imagine a tree. The wood fibers support the tree and protect the tree's internal tissues. As wood fibers support a tree, our skeletal system protects our organs and supports our body, allowing our body to keep its shape. Unlike the wood in a tree, however, our skeletal system allows us to move.

Unlike the branches of a tree, which cannot move much, our appendicular skeleton allows for wide ranges of movement. The girdles (shoulder and hip) attach the bones of the arms and legs to the body loosely enough that these limbs have a wide range of motion (e.g. we can rotate our arm and raise our leg). The bones of the axial skeleton support the weight of the body and protect the internal tissues. Vertebrae are the bones that surround the spinal cord. The bones of the skull protect the brain, and the ribs and breastbone protect the heart, and lungs. In addition, the skeletal system stores minerals and fats, and is the site of blood cell production.

Activity 4.19

1. Since bones are hard structures, they cannot bend. So how is movement possible?
2. Bones should not rub directly against each other? Explain why.
3. Discuss the functions of the following bones: femur, tibia, fibula, radius, ulna, pelvis, humerus, ribs, and vertebral column.

Joints

Our bodies are flexible and we can bend, twist, and rotate. This is possible because bones connect at joints. A joint is the place where two or more bones meet. Ligaments help hold bones together at joints and add to our flexibility. Cartilage covers the ends of the bone and prevents the bones from rubbing against each other, thus, reduces friction and increases flexibility.

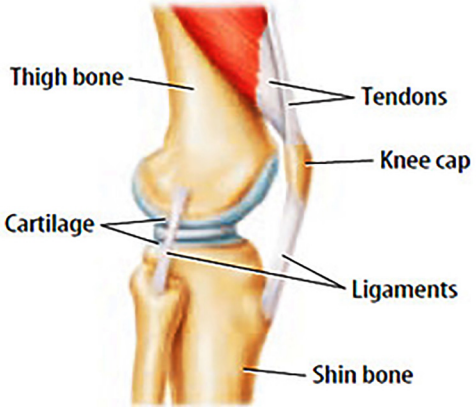
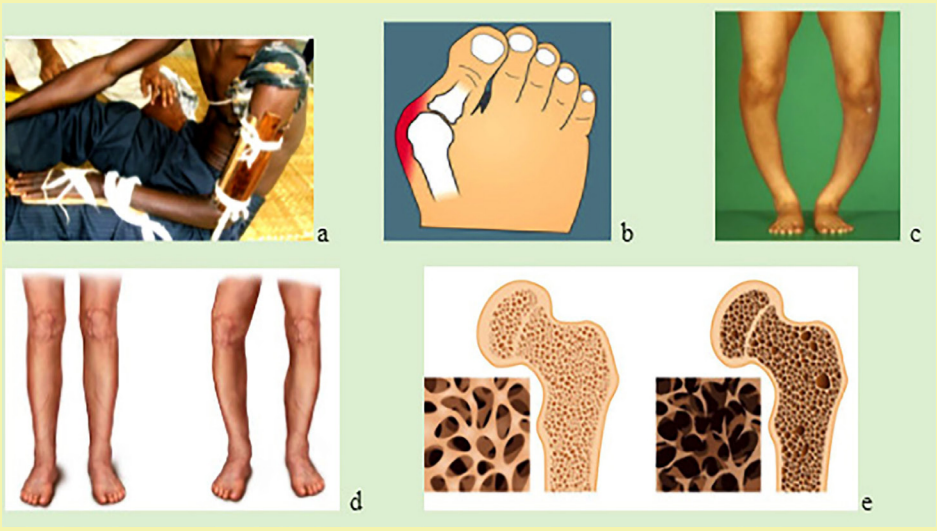


Figure 4.5 Knee joint

4.3.3 Major diseases of the skeletal system

Activity 4.20

Look at the following diagrams and tell what you understood from each.



A number of disorders affect the skeletal system; some of them are discussed below.

Bone fractures

A fracture is a break or a crack in a bone. Most bone fractures are caused by falls and accidents. There are several different ways in which a bone can fracture; for example, a break to the bone that does not damage surrounding tissue (closed fracture) or one that damages surrounding skin and penetrates the skin (open fracture). We can prevent many fractures by avoiding falls, staying in shape and getting the right vitamins and minerals. Treatment includes immobilizing the bone with a plaster cast, or surgically inserting metal rods or plates to hold the bone pieces together.

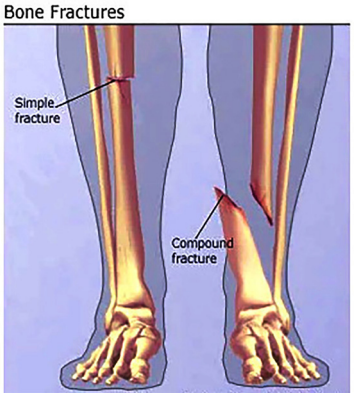


Figure 4.6 Bone fractures

Activity 4.21

How do the local people in your area treat bone fractures? Interview the local bone setters and present your report to the class.

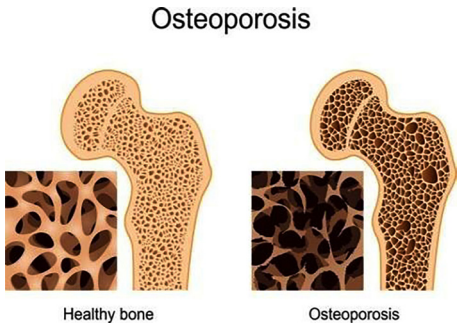


Figure 4.7 Osteoporosis

Osteoporosis is an age-related disorder in which bones lose mass, weaken, and break more easily than normal bones. The bones that break most often include those in the wrist, hip, shoulder, and spine. Osteoporosis is often treated with medications that may slow or even reverse bone loss.

Osteoarthritis is a joint disease that results from the breakdown of joint cartilage and bone. The most common symptoms are joint pain and stiffness. Joints commonly involved in osteoarthritis are those near the ends of the fingers, at the bases of the thumbs, and in the neck, lower back, hips, and knees. Osteoarthritis cannot be cured but treatments include exercise, efforts to decrease stress on joints, pain medications, and surgery.

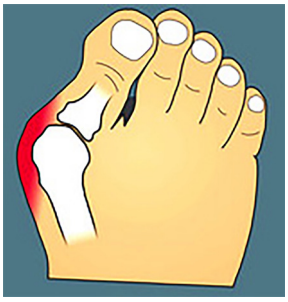


Figure 4.8 Osteoarthritis



Figure 4.9 Rickets

Rickets, a bone disease that affects children, is the weakening of bones caused by a vitamin D deficiency.

Paget's disease

This skeletal disease causes new bone tissue to grow too rapidly, which causes bones to become misshapen or fragile. It frequently occurs in older patients and in patients who have the disease in their family history.



Figure 4.10 Paget's disease

Activity 4.22 (Project work)

Work in groups to construct a model of human skeleton from clay, paper, or other locally available materials and bring the model to the classroom for further comment and discussion.

Summary

- A skeletal system is the flexible inner framework of our body made of bones, cartilage, and ligaments.
- The human skeleton is divided into two distinct parts; axial and appendicular skeletons.
- The axial skeleton includes bones in the skull, ribs, and sternum and forms the central axis of the body.
- The appendicular skeleton is composed of the bones of the upper limbs, lower limbs, and the girdles.
- The skeletal system provides support, protection, and movement.
- Joint is a place where two or more bones meet together.
- Interaction between muscular and skeletal systems allows the bones in the human body to move.
- Some common disorders related to the skeletal system are bone fractures, osteoporosis, osteoarthritis, rickets, and paget's disease.

Review questions

1. Below are some of the functions of the bones of the human skeletal system. Identify the type of bone that performs each activity.

Name of Bone	Function
	A bone that protects the vital organs of the body, such as the heart, the lungs, and the airways
	Lens-shaped “triangular” bone that forms the kneecap
	Movable bone to which most of the shoulder muscles are attached
	Bone of the forearm that extends from the lateral side of the elbow to the thumb side of the wrist
	A bone found in the forelimb that connects to the fibula and provides movement of the legs
	A bone which is an attachment point for muscles, located to the side of the tibia and between the patella and ankle

2. Label the parts of the human skeleton (1 to 13) in the diagram given below.

3. Classify each of the above bones (labeled from 1 to 13) in question 1 as parts of the axial or appendicular skeletal system.

4. Which of the following is not a function of the skeletal system?

   A. Breaking down large food particles

   C. Creating body movement

   B. Producing various body cells

   D. Storing minerals like calcium

5. The pectoral girdle consists of the bones _____.

   A. clavicle and sternum

   B. sternum and scapula

   C. clavicle and scapula

   D. thigh and humerus

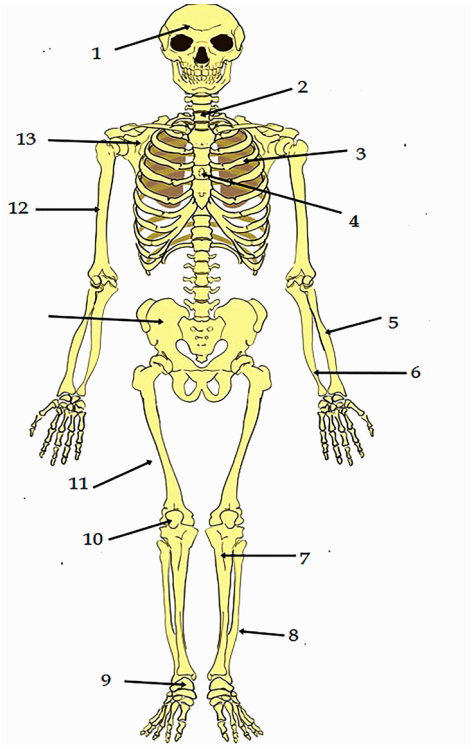
6. The lower limb consists of the bones _____.

   A. femur, tibia, fibula, and patella

   B. radius, ulna, humerus, and ribs

   C. sternum, humerus, scapula, and clavicle

   D. cranium, vertebrae, sternum, and ribs



7. The axial skeleton consists of _____.

   A. Bones of the hands and feet

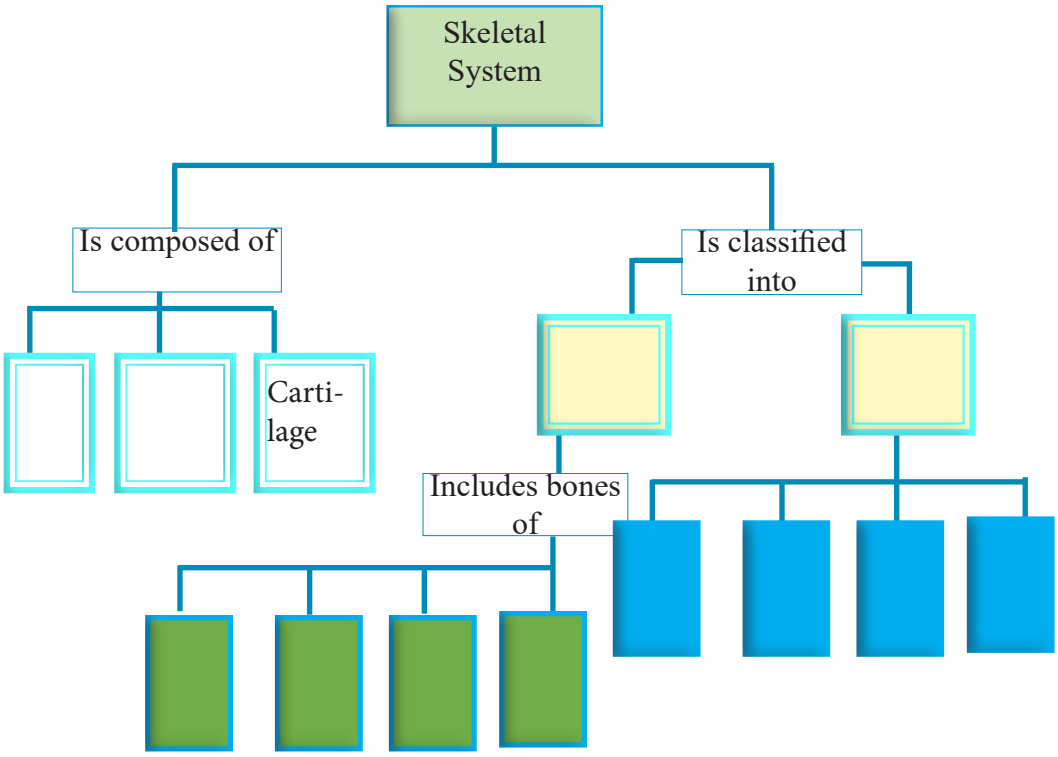
   B. Bones of the upper extremities

   C. Bones of the thoracic cavity

   D. Bones of the lower extremities

Exercise

1. Distinguish between the axial and appendicular skeletons.
2. Why is the human skeletal system important?
3. List the bones that form the pectoral girdle and upper limb; the pelvic girdle and lower limb.
4. How are bones and cartilage important in our body?
5. Give the functions of the following bones: Cranium, femur, scapula, breast bone, and upper hand bone.
6. Complete the following concept map about the human skeletal system.



After completing 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 and effects of human digestive system

4.4 Digestive system

Keywords:

- Digestive system
- Digestion
- Absorption
- Defecation
- Small intestine
- Large intestine
- Mouth
- Esophagus
- Stomach
- Bile
- Pancreas
- Sphincter

Activity 4.23

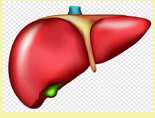
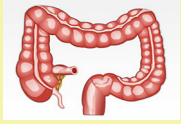
1. Suppose you are eating food and drinking water. What becomes of the food you eat and trace the pathways the food crosses over, does it go into the heart, kidney, or liver? Does the food and water follow the same path?
2. Have you ever experienced something wrong while having food (eating) or water (drinking) in the mouth? Why do elderly people usually advise children not to talk while eating or drinking?

Before our body utilizes the nutrients in the food we consume, the nutrients must be broken down physically and chemically, absorbed into cells, and the wastes must be eliminated. Thus, the digestive system takes the foods we eat and breaks them into smaller components that our bodies can use for energy, cell repair and growth. Digestion is the process by which the large complex molecules in food are broken down into smaller molecules that can be used by the body.

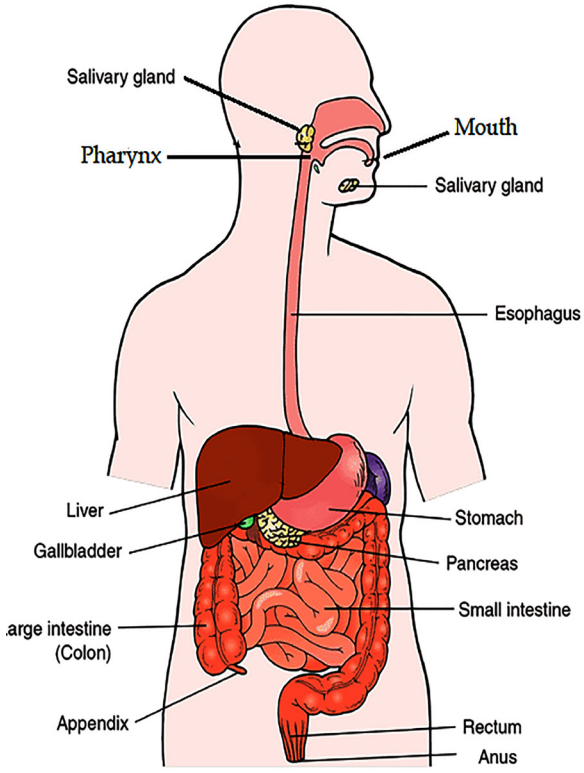
4.4.1 Structural components of digestive system

Activity 4.24

The following structures are organs of the digestive system. Write their name in front of the diagram.

Diagram	Name of the organ	Diagram	Name of the organ
			
			
			

The digestive system is a collection of organs including the mouth, esophagus, stomach, pancreas, liver, gallbladder, large and small intestines, rectum, and anus. Rings of muscles, called sphincters, separate one section from another. The opening and closing of these sphincters and the contractions of smooth muscles in the walls of the organs keep food moving in one direction.



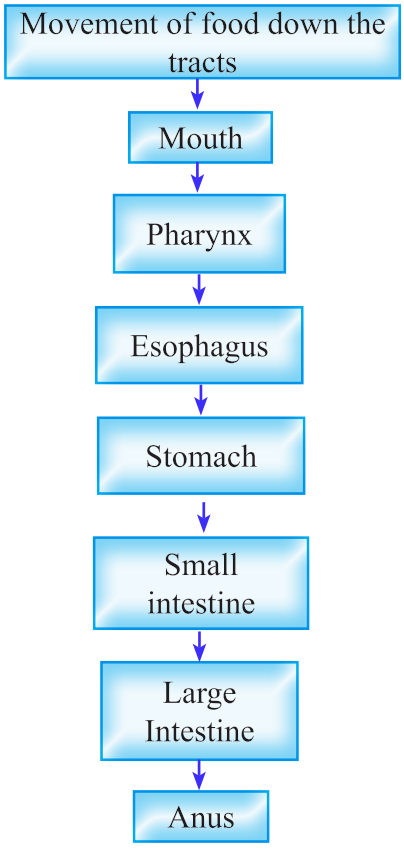


Figure 4.11 Human digestive system

4.4.2 Functions of the digestive system

Activity 4.25

1. You might have heard someone telling their children, “Chew your food - don’t just swallow it” Why do they insist on doing so?
2. Our digestive system is like a factory that breaks down things apart instead of putting them together. Explain why.
3. Food goes from the stomach to the bloodstream. Argue for or against.

We need food to fuel our bodies for energy, growth and repair. The digestive system converts the foods we eat into their simplest forms, like glucose (sugars), amino acids (that make up protein) or fatty acids (that make up fats). The human digestive system uses both mechanical and chemical digestion to break down food into absorbable substances during its journey through the digestive tract. The broken down food is then absorbed into the bloodstream from the small intestine and the nutrients are carried to each cell in the body.

The digestion story: The story of bread and egg

The story is about a long trip with storms and several challenges. It's a difficult journey with long distances and it takes several hours. Everything changes in it.

It starts with that first bite of bread with egg (sandwich). Your teeth take a big bite of your sandwich (mechanical). Your molars chew your sandwich and the salivary glands start working to make it easier to swallow (moisten). It is a big wet ball. As if it was magic, starch in your bread begins to turn into maltose (salivary amylase). Some more chews and your tongue pushes the ball of food (bolus) to the back of your throat (pharynx). A flap of cartilage (epiglottis) located in the throat behind the tongue closes the trachea and pushes the food down your gullet (esophagus).

Next, your muscles (smooth) squeeze the wet food down the esophagus (peristalsis). Then, the sphincter muscle to the stomach opens and the bread mush arrives in your stomach. The stomach produces an enzyme (pepsin) which breaks down the food (proteins) into smaller pieces (short peptides). The walls of the stomach contract (physical) and mix the food and chemicals (HCl) together, so it breaks the food into smaller bits. Then a valve opens and the half-digested food (chyme) is pushed into the small intestine. Inside the small intestine, there are chemicals and liquids. Those from your pancreas neutralize the acid (bicarbonate). Those from your gallbladder (bile salts) break down fats into smaller pieces. The small intestine is wet and filled with things that look like small fingers (villi).

They absorb the nutrients from the food you eat. From the villi, the nutrients (vitamins, minerals, amino acids, glucose and fatty acids) will flow into your bloodstream (absorption), leaving behind the materials that are not nutritious.

But the story's not finished yet. The undigested food that your body can't use is pushed into the large intestine. It gets smaller, harder and drier because the water is removed from it and recycled back into your body. The undigested food that leaves your body is only 1/3 of the size of what first arrived in your intestines. Now the drier undigested food is a solid brown waste (fecal matter). It goes to the end of the large intestine, the rectum, waiting for you to get rid of it, out of your anus (egestion). Of course, you know the rest! What a long trip, don't you think?

Activity 4.26 Digestive system game

Draw a large outline of the digestive system outside the classroom on a flat ground or on the playing field, with string or use stones or other locally available material. Assign students to represent different food items (Carbohydrates, fats, proteins) and tell them to walk through the outline and ask them what happened to them at the different places. Labels may be added before or during the activity. Look at the diagram next. Some of the questions that should be raised include:

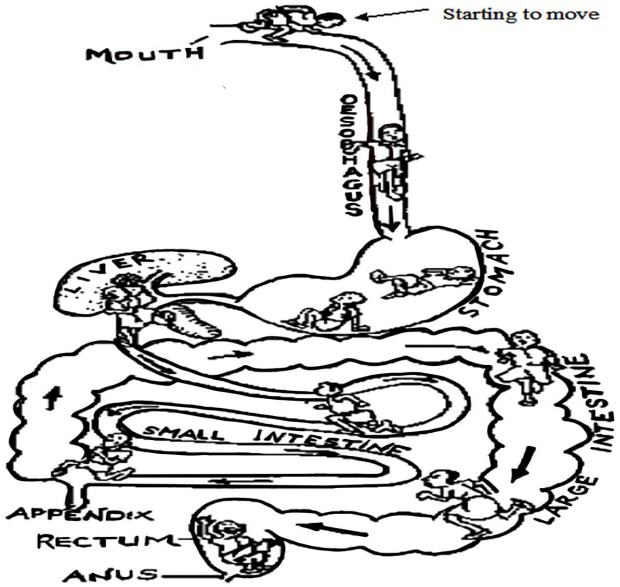


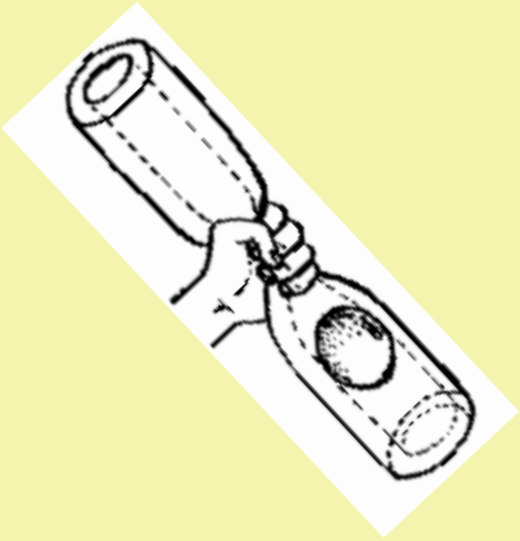
Figure 4.12 Outdoor activity to demonstrate digestive system

1. What type of digestion occurs in the mouth? How?
2. What would happen in the esophagus?
3. What type of digestion occurs in the stomach? How?
4. What would happen in the small intestine?
5. Does the food enter the liver and pancreas? Explain why.
6. What is the role of the large intestine?

Hydrochloric acid (HCl) is so strong that it can dissolve an iron nail in a matter of hours. However, our stomach secretes it for the purpose of facilitating proteins' digestion in the stomach by creating acidic environment for the action of pepsin enzyme on proteins. So, what protects our body from HCl? Once the stomach is empty, the production of gastric juice stops. What keeps the stomach from digesting itself? First, pepsin is active only when it is mixed with hydrochloric. Second, the stomach secretes a layer of mucus to protect itself from its own acidic environment. Even so, cells in the stomach lining are replaced every few days to maintain the protective layer of mucus.

Activity 4.27 Peristalsis Model

Demonstrate peristalsis by pushing a marble or stone down a piece of water hose or a self-prepared tube made from plastic bags or local material as shown in the diagram.



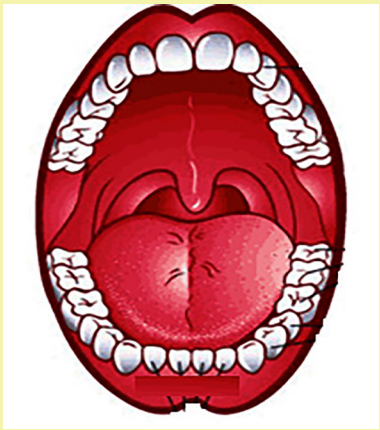
Q1: How does this show peristalsis?

Q2: What does the stone /marble represent?

Q3: What does the constricted tube behind the stone /marble represent?

Activity 4.28 Peristalsis Model

Look at the next human teeth diagram or the human teeth model provided by your teacher and identify the types, numbers, and roles of teeth.



1. How many types of teeth are there?
2. Count the number of teeth in each group.
3. Write their functions
4. What is tooth decay? How can we avoid it?

4.4.3 Major diseases of the digestive system

Activity 4.29

1. Have you ever experienced diarrhea? Discuss its cause and prevention methods.
2. List down any other disorder or disease related to the digestive system and elaborate them.

The secretions of the stomach are highly corrosive to living tissues and can result in ulcers, places where the mucosal lining of the stomach is damaged. Stomach ulcers can lead to problems ranging from indigestion and heartburn to gastric bleeding and stomach cancer. Constipation is another disorder of the digestive system which results due to absorption of too much water from the colon. Dysentery is an inflammation of the intestinal mucosa, characterized by frequent loose stools containing mucus, pus, and blood. The most common dysentery is amoebic dysentery, which is caused by the protozoan Entamoeba histolytica.

Liver cirrhosis is a disease that slowly replaces healthy liver tissue with scar tissue and eventually prevents the liver from functioning properly. Alcohol abuse and fatty liver caused by obesity and diabetes are the most common causes of liver cirrhosis. Hemorrhoids develop when the veins are put under pressure and become engorged with blood. If the pressure continues, the wall of the vein stretches. Such

a distended vessel oozes blood; bleeding or itching is usually the first sign that a hemorrhoid has developed. Stretching of a vein also favors clot formation, further aggravating swelling and pain. Hemorrhoids may be caused by constipation, which may be brought on by low-fiber diets. Also, repeated straining during defecation forces blood down into the rectal veins, increasing pressure in those veins and possibly causing hemorrhoids.

What technology can be developed using the principles of the digestive system?

Summary

- The digestive system is used to breakdown large sized foods into simpler molecules.
- Several digestive organs work together to break down large foods into usable forms.
- The human digestive system consists of the mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum and anus.
- Digestion begins in the mouth and continues in the stomach, and is completed in part of the small intestine.
- The digestive organs use mechanical and chemical digestion to break food down into simple molecules.
- The end products of digestion are glucose, amino acids, fatty acids, and glycerol.
- The liver and pancreas help digest fats, carbohydrates, and proteins in the small intestine.
- Nutrients are absorbed and solid wastes eliminated after digestion.

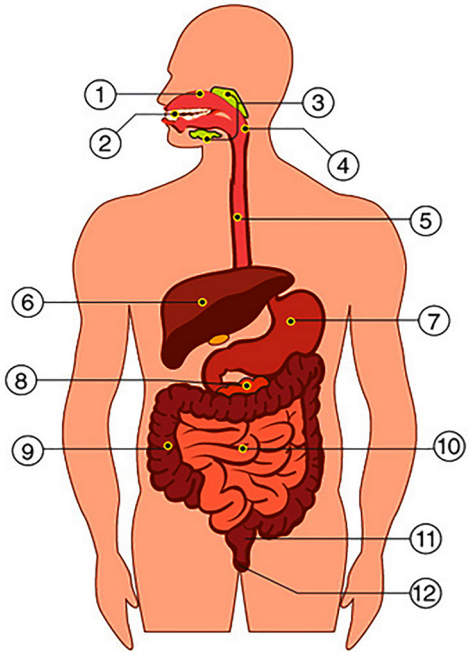
Review questions

1. Trace the pathway of food from mouth to anus.
2. Explain how food is digested mechanically and chemically in the mouth.
3. How do the pancreas and liver help to digest food?
4. What is the main function of the digestive system?

5. Put the following digestion processes in order starting from the initial to the end: Defecation, absorption, ingestion, and digestion
6. Differentiate between mechanical and chemical types of digestion.
7. How can we prevent a stomach ulcer from forming in our stomach?
8. Complete the table below which is about the parts of the digestive system and their respective functions.

Parts of digestive system	Their functions
Mouth	
Salivary glands	
Pharynx	
Esophagus	
Stomach	
Liver	
Pancreas	
Small intestine	
Large intestine	
Gallbladder	

9. Label the following diagram that shows the human digestive system.



Exercise

1. Why is digestion described as both a mechanical and chemical process?
2. If one of your classmates defines the term digestion as the process that involves only the breakdown of larger food into smaller ones. What is your argument?
3. How food moves and what moves it through your alimentary canal?
4. Sphincters are found in organs like the esophagus and stomach. What would happen if there were no sphincters?
5. If you ate a food staff containing bread, meat, and butter: Then:

A. Where do you think that mechanical and chemical digestion of the above listed food items started?

B. What will be the end products of the above foods?

6. If a person has his or her gallbladder removed, what changes in diet should be made? Why?
7. What happens to undigested food after the water is reabsorbed in your digestive system?
8. Explain how your digestive and muscular systems interact and work together?

After completing 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 and effects of human respiratory system

4.5 Respiratory system

Activity 4.30

1. You may already know that we need oxygen to live. We get oxygen from the air we breathe in. We also need to get rid of our bodies of carbon dioxide. So how do we take in oxygen and remove carbon dioxide?
2. Take a deep breath. Think about where you feel the air moving through your body and trace the path you think the air follows.

Keywords:

- Lung,
- Trachea
- Alveoli
- Pharynx
- Larynx
- Bronchus
- Bronchioles
- Diaphragm
- Inhalation
- Exhalation
- Inspiration
- Expiration
- Respiration
- Asthma
- Bronchitis
- Pneumonia
- Tuberculosis

Do you ever notice your breathing? Your breathing happens even when you don't think about it. Take a deep breath. Notice how your chest expands. Every time you breathe, air enters and exits your lungs. You can think of your respiratory system as a major supply depot where the blood can pick up oxygen (O_2) and deposit excess carbon dioxide (CO_2).

The respiratory system is the body system in which gas exchange takes place. It contains tissues and organs specialized for taking in oxygen and removing carbon dioxide from our bodies and for exchanging oxygen and carbon dioxide. The respiratory system is open to the atmosphere, so atmospheric air can move into and out of our body. Breathing is the process of air entering and exiting the lungs. Inhalation is breathing in air, while exhalation is breathing air out.

4.5.1 Structural components of the respiratory system

Activity 4.31

1. The following are organs of our body. Which of them forms our respiratory system?

Lung, heart, liver, kidney, esophagus, trachea, spleen, pharynx, alveoli, capillary, stomach, bronchi, nose, larynx, epidermis, skull, mouth, and bronchioles

2. Using a flow chart put the organs of the respiratory system from outside to inside.

3. Consider the following diagram (a tree which is up down). Relate the tree with that of the human respiratory system.



The respiratory system consists of the nose, pharynx (throat), larynx (voice box), trachea (windpipe), bronchi, and lungs.

The pulmonary system is open to the atmosphere, so atmospheric air can move into and out of your body. Explain how.

The diagram in fig. 4.13 below shows the organs of the respiratory system. Guided with the narrations following the diagram, label the parts of respiratory system indicated by numbers from 1to 8.

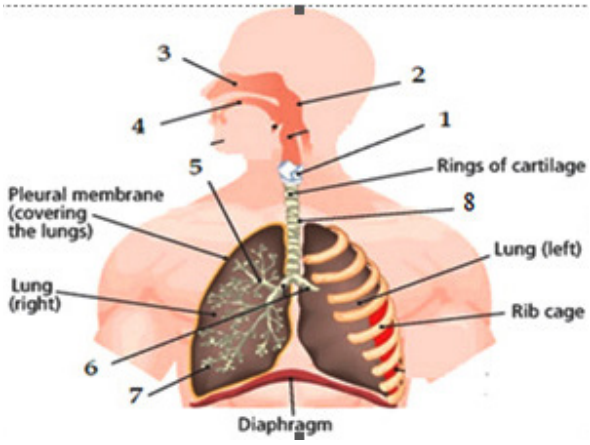


Figure 4.13 Human respiratory system

When we breathe in, air is inhaled through our nose and mouth. From there, it flows through the pharynx, or throat. The pharynx branches into two tubes, the esophagus and larynx. The esophagus leads to our stomach. The larynx leads to our lungs. The larynx also contains our voice box. Next, air flows into the trachea, or windpipe. The trachea splits into two tubes called bronchi. One bronchus (singular) goes to each lung. Each bronchus branches into thousands of tiny tubes called bronchioles. Bronchioles end in tiny sacs called alveoli. Each of our lungs contains thousands of alveoli.

4.5.2 Functions of the respiratory system

Activity 4.32

1. Why do we breathe?
2. Breath is life. Explain how.

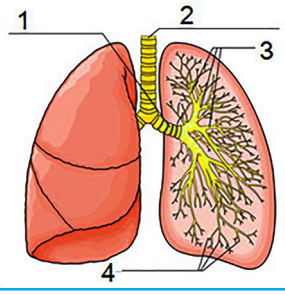
The respiratory system is an organ system that rhythmically takes in air and expels it from the body, thereby supplying the body with oxygen and expelling carbon dioxide. In addition to functioning in gas exchange, the respiratory system also participates in regulating blood pH, contains receptors for the sense of smell, filters inspired air, produces sounds, and rids the body of some water and heat in exhaled air.

Activity 4.33

1. What is the role of mucus and hairs in the nasal cavity?
2. Which one is better for breathing in air, through your mouth or nose and why?
3. Explain the role of epiglottis?
4. Trachea consists of C-shaped cartilage rings. Explain their significance.
5. Several hundreds of alveoli are found in our lungs explain why?
6. Put your hands on each side of your chest. Take a deep breath and sense what is going on. Repeat it several times and explain what is happening.

Breathing (ventilation) refers to the movement of air into and out of the lungs. Gaseous exchange refers to the exchange of oxygen and carbon dioxide, which takes place between the air and the blood vessels in the lungs. The lungs contain no muscle fibers and are made to expand and contract by movements of the ribs and diaphragm. The diaphragm is a sheet of tissue that separates the thorax from the abdomen.

1. Label the following parts of respiratory structures and tell their functions?
2. Match the labels of this diagram with that of a tree diagram in Activity 4.31



Activity 4.34 Lung model (Project work)

In this activity, you are going to construct a lung model using local materials.

Materials required: Plastic bottle, scissor, 3 balloons, 2 tube from local material, and string or plaster.



Procedures:

1. Use a scissor, carefully cut the bottom side of the plastic bottle
2. Take one straw /tube and cut one end so that it is split in half
3. Cut one straw in half. Then, attach one balloon to each straw half. Use string or plaster to seal it off



4. Tie the balloons on either side of the two-way split straw
5. Make a hole in the bottle cap large enough to fit a tube / straw through

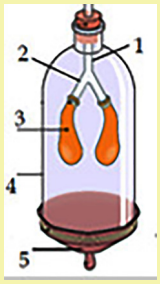




6. Place the balloons inside the bottle, so that the balloons hang towards the bottom
7. Take the last balloon and stretch it over the bottom of the bottle
8. Pull on the bottom balloon to see a simulation of how lungs work?







Questions

1. What do the numbers from 1 to 5 represent?
2. What happened to the balloons when you pull number 5 out and push it in? Why?

One area of technological innovation that relies on breathing is a mechanical ventilator. This machine breathes for a paralyzed person as does natural breathing.

Can you develop your own new technological product?

Activity 4.35

In this activity, you are going to see what happens when you breathe in and breathe out.

Procedures

1. Place your hands on both sides of your rib cage.
2. Take several deep breaths and detect what you feel.
3. Briefly describe what you felt as you breathed in and out.
4. Do you know what the air we inhaled and exhaled contains? Compare the proportions of CO_2, O_2, and N_2 during inhalation and exhalation. Reason out your answer.

4.5.3 Major diseases of the respiratory system

Activity 4.36

1. Have you ever encountered any respiratory disease? If so, try to memorize the symptoms and treatments you received.
2. List down any other diseases that affect the human respiratory system.
3. What conditions or factors affect the human respiratory system?

Respiratory diseases are those that affect the lungs, air sacs, and other organs of the respiratory system. Many conditions can affect the organs and tissues that make up the respiratory system. While the most common causes for respiratory disorders are pollution and smoking tobacco, we might get affected due to some allergies, nutritional deficiency and genetic reasons as well.

The respiratory system is particularly vulnerable to infectious diseases simply because many pathogens are airborne; humans are highly social, and the warm, moistened environment along the respiratory tract allows pathogens to flourish. Nearly all of the structures and regions of the respiratory passageways can become infected and inflamed. Some of the most common respiratory disorders or diseases are asthma, sinusitis, influenza, chronic obstructive pulmonary disease, bronchitis, pneumonia, tuberculosis, and lung cancer.

Activity 4.37 Group work

Visit a health center in your area or ask a health professional in order to gather information about the following diseases. Once done, complete the table with appropriate information.

Disease	Agent	Mode of transmission if communicable	Body Affected	Prevention Strategies
Asthma				
Influenza				
Lung Cancer				
TB				
Bronchitis				
Pneumonia				
Sinusitis				

Summary

- The respiratory system moves air into and out of the body. It is also used to regulate blood pH, contains receptors for the sense of smell, filters inspired air, produces sounds, and rids the body of some water and heat in exhaled air
- The human respiratory system is composed of the nose, pharynx, larynx, trachea, bronchi and lungs.
- The nasal cavities filter, warm, and humidify incoming air.
- Gas exchange takes place in the alveoli.
- Some disorders associated with the human respiratory system are asthma, influenza, lung cancer, tuberculosis, pneumonia, sinusitis, and bronchitis.

Review questions

1. Select the correct sequence of the pathway of air from out to inside of the body.

   A. Larynx, pharynx, trachea, bronchioles, bronchi

   B. Pharynx, larynx, trachea, bronchi, bronchioles

   C. Pharynx, larynx, bronchioles, bronchi, trachea

   D. Pharynx, trachea, larynx, bronchi, bronchioles

2. Air breathed out is different from air breathed in because air breathed out _____.

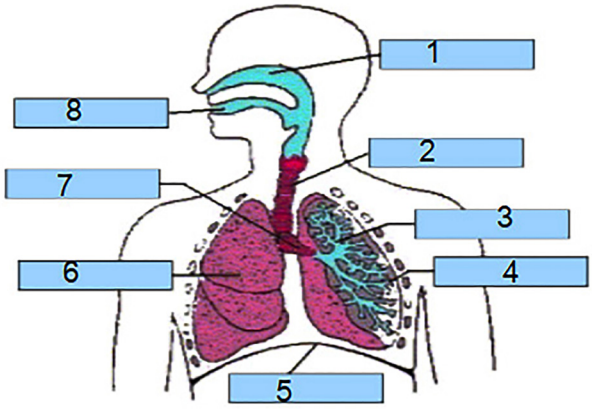
   A. contains less N_2 than inhaled air

   B. is cooler than inhaled air

   C. is drier than inhaled air

   D. contains more O_2 than inhaled air

3. Label the part of the human respiratory tract indicated as in the diagram given below.



4. Below are some of the functions of the parts of the human respiratory system. Identify the body part that performs each activity.

Part of respiratory system	Their functions
	Allows the exchange of oxygen and carbon dioxide between lungs and the blood vessels
	It is associated with the production of sound
	The main respiratory tract that leads air into the bronchi
	It is responsible for warming or cooling, filtering, moistening of air,
	Controls the size of the lung due to its contraction and relaxation nature.
	It is part of both the digestive and respiratory systems
	Air passageway that lead air into alveoli
	It prevents the entry of food or water into the trachea
	It is used for passage of air into the lungs

5. Select the correct term to complete the sentences given below.

Allergies, larynx, nose, respiration, exhalation, pneumonia, respiratory system, asthma, inhalation, diaphragm, alveoli

a. An organism exchanges oxygen, carbon dioxide and water with the environment through the process of _____.

b. The _____ consists of the lungs and their associated passages.

c. Sac-like structures within the lung that allow gas exchange are _____.

d. _____ causes the bronchioles to constrict due to muscle spasms and makes it hard to move air in and out of the lungs.

e. The _____ is a passageway that connects the pharynx with the trachea.

f. Breathing consists of _____ and _____.

g. _____functions in warming, moistening, and filtering air.

h. Muscles that help our lungs pull in air and push it out are the _____.

i. Inhaling particles, such as dust, mold, and pollen, can cause respiratory disorders called ___.

Exercise

1. Trace the flow of air from the alveoli to the nose.
2. Why can't you breathe through the mouth while you are swallowing food? What would happen if you could do this?
3. List the main parts and functions of the respiratory system.
4. People poisoned by CO are often given 100 percent O_2 in a room with two to three times normal atmospheric pressure. Explain why more oxygen would enter their blood under these conditions.
5. Our lungs do not contain muscles and are unable to expand and contract on their own. What controls the size of the lungs?
6. Why do we need to respire continuously throughout our life?
7. Describe how your diaphragm works to make you breathe in and out.
8. Explain how the human respiratory system interacts and works together with the following systems: Digestive, muscular, and integumentary systems.

After completing this section, you will be able to:

- Distinguish the major structural components of the human circulatory system
- Describe the main functions of the human circulatory system
- Identify and discuss the main diseases or disorders and effects of human circulatory system

4.6 Circulatory system



Keywords:

- Cardiovascular system
- Atrium
- Ventricle
- Aorta
- Valve
- Artery
- Vein
- Capillary
- Pulmonary circulation
- Systemic circulation
- Heart
- Blood
- Blood vessel

Activity 4–38

1. Human body is made of trillions of cells. Each cell needs oxygen and nutrients. As our cells carry out their functions, they need to get rid of wastes like CO2. How do substances move to and from our cells?
2. So far you have learnt about the integumentary, muscular, skeletal, digestive, and respiratory systems. How do these body systems meet their requirements for nutrients and air?
3. Consider your home and the school you attend for your education. You went to school on a road keeping the rules and regulations of the road traffic. At school, you exchanged information or knowledge and then came back home but on the opposite side of the road you went before. Some of the roads on your way are major highways and others are sideways. Examine this analogy carefully and think of a body system in your body which is closely related to this analogy. If you got one, identify the body parts that could represent home, school, and the pathways.

Each cell needs oxygen and nutrients. As body cells carry out their functions, they need to get rid of wastes like carbon dioxide. The circulatory system is the organ system that transports materials to and from all the cells of the body.

4.6.1 Components of the circulatory system

Activity 4.39 The water-tower analogy

Consider the water tower system in towns and cities. In towns and cities that use a water tower, fresh water is pumped up into the tower from a river or other sources. The tower serves as a pressure reservoir for providing water to homes through a largely parallel arrangement of distribution pipes. In this analogy, think of the pump (1), pipes (2), and water (3) and relate how they are similar to the human circulatory system?

The circulatory system acts as a transport service for cells to provide necessary materials and get rid of wastes. It consists of the heart, blood vessels, and blood.

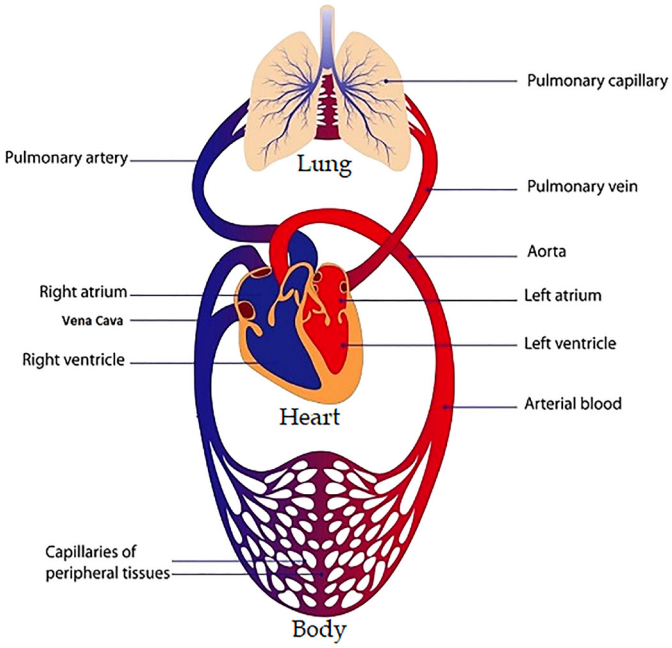


Figure 4.14 Human circulatory system

Activity 4.40

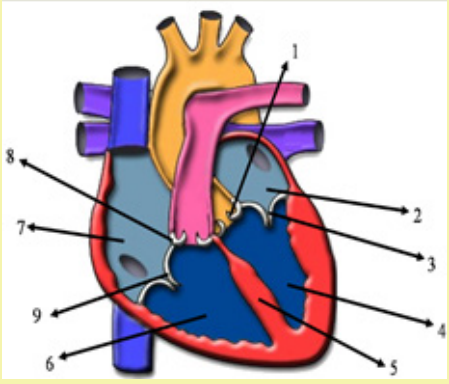
Examine fig.4.14 and answer the following questions.

1. Does the blood flow outside of the heart and blood vessels? Trace the flow of blood in the diagram given above.
2. What does the red and blue color indicate and why?

Heart

Activity 4.41

1. Using the following terms to label the parts of the heart indicated by numbers (1 to 9) in the diagram shown. Mitral valve, left atrium, septum, right atrium, tricuspid valve, left ventricle, aortic valve, right ventricle, pulmonary valve.



2. Why heart is partitioned into four chambers?

The central organ of the cardiovascular system is the heart. It is a hollow and muscular organ, about the size of your fist, and located in the middle of the chest between the lungs. The human heart has four chambers, two atria and two ventricles. When the atrium contracts, the ventricle become relaxed and vice versa. The contraction and relaxation of the heart is called heart beat or pulse rate. The heart pumps blood throughout our body. Each heart chamber has a valve, a flap of tissue that prevents the backflow of blood.

Blood vessels

Activity 4.42

1. The diagrams given below show the structures (lumen) of blood vessels. Identify the arteries, veins, and capillaries.


a.


b


b.

2. Mention as many differences as possible on the basis of the diagrams given above. Describe how the nature of the structure of blood vessels matches with their functions.

There are three principal categories of blood vessels: arteries, veins, and capillaries. Arteries carry oxygenated blood away from our heart to the various body parts except the pulmonary artery that carries deoxygenated blood from the heart to the lungs. Veins carry deoxygenated blood back to the heart except pulmonary veins that carry oxygenated blood from the lungs to heart. Capillaries are microscopic, thin-walled vessels that connect the smallest arteries to the smallest veins. Aside from their general location and direction of blood flow, blood vessels also differ in the structure of their walls (see diagram above).

Blood

Activity 4.43

1. The diagram shown below indicates the kinds of blood cells (formed elements). Identify the kinds of blood cells and list any differences among the cells.
2. Does the cardiovascular system create blood cells? Discuss.
3. What are the functions of those blood cells?



a.



b.



c.

Blood is a fluid tissue composed of fluid called plasma, and solid materials called blood cells. Plasma contains proteins that help blood to clot, transport substances through the blood, and perform other functions. Blood plasma also contains glucose and other dissolved nutrients. There are three types of blood cells in our body: white blood cells (WBCs), red blood cells (RBCs), and platelets.

Blood cells do not originate in the bloodstream itself but in specific blood-forming organs, notably the marrow of certain bones. Blood cells differ from each other in terms of structure, function, and possession of nucleus.

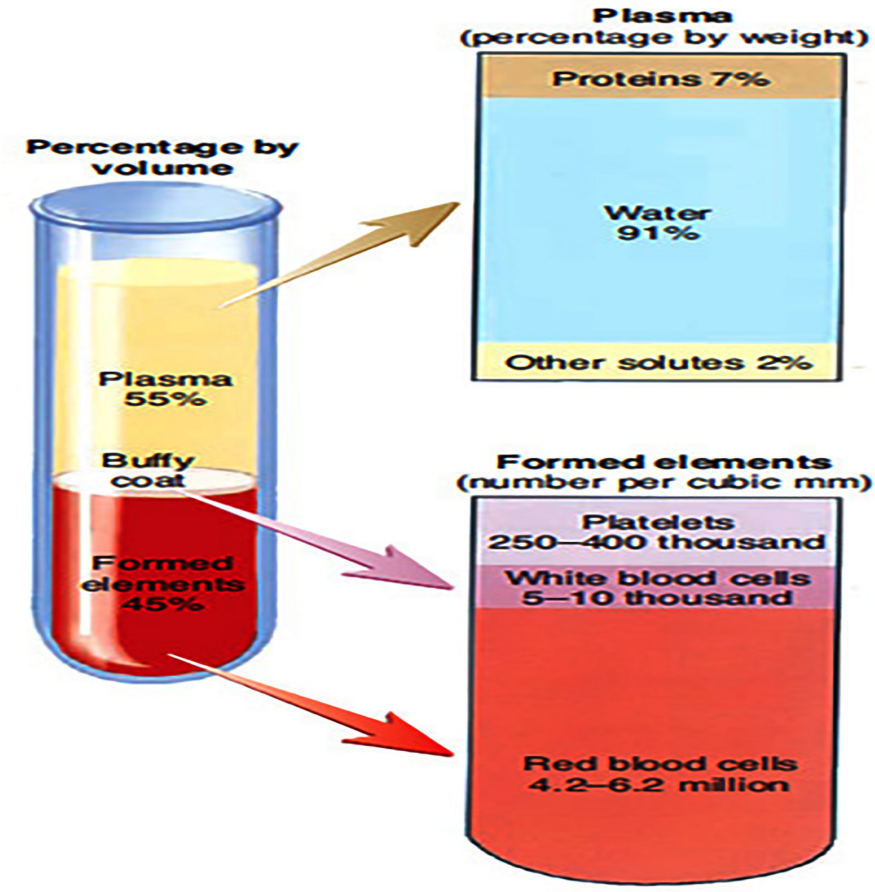


Figure 4.14 Composition of blood (centrifugation)

4.6.2 Functions of the circulatory system

Activity 4.44

1. Recall the muscular system and identify which muscle type never fatigue? What would happen if that muscle got fatigued?
2. Most snake species are non-poisonous, but a few are technically poisonous. How do the local people in your area treat snake bites and why? What do you recommend?

The circulatory system is responsible for carrying oxygen, carbon dioxide, nutrients, hormones and many other substances throughout the body. These materials travel in one direction only, to keep things going where they should. It also helps to fight off disease, helps the body maintain a normal body temperature, and provides the right chemical balance to provide the body's homeostasis, or state of balance among all its systems. The heart is the driving force behind the workings of the circulatory system. The ventricles are the pumping chambers of the heart that push blood out of the heart whereas the atria receive blood returning from the body through superior and inferior vena cava.

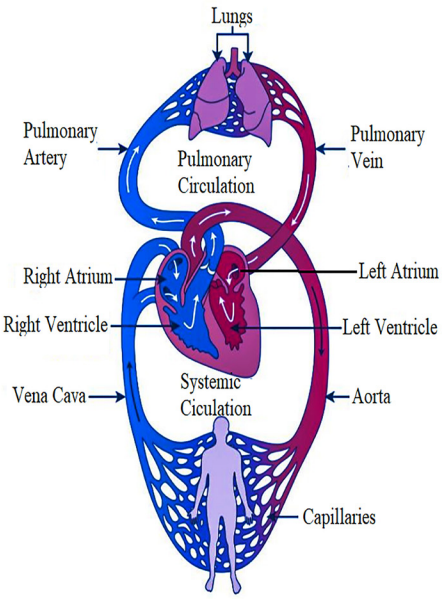


Figure 4.15 Systemic and pulmonary circulations in humans (Double circulation)

Circulating blood follows two separate pathways that meet at the heart. These pathways are called the pulmonary and systemic circulation. All of our blood travels through both of these pathways. Pulmonary circulation occurs only between the heart and the lungs. The main function of this circulation is to carry oxygen - poor blood to the lungs, where it picks up O_2, expels excess CO_2 and water, and carries oxygen - rich blood back to the heart. Each lung is supplied with blood by its own pulmonary artery and pulmonary vein. Systemic circulation occurs between the heart and the rest of the body, except for the lungs. The main function of this circulation is to carry oxygen - rich blood to all cells and transport oxygen - poor blood back to the heart. Systemic circulation begins when blood leaves the left ventricle, the largest chamber of the heart. The blood then circulates through the trunk, arms, legs, and head, and then returns to the heart.

Trace the flow of blood during pulmonary and systemic circulation (include the part of heart and blood vessels involved in each pathway)

4.6.3 Major diseases of the circulatory system

The circulatory system is vital to remain our body functioning. This finely tuned system carries oxygen, nutrients, electrolytes, and hormones throughout our body. Interruptions, blockages, or diseases that affect our heart or blood vessels may end in heart disease or stroke. These complications can arise because of a variety of things, from genetics to lifestyle.

Activity 4.45

Sweet, fatty, and salty foods affect our cardiovascular system the most. Explain how. So to be healthier, what should we eat?

Some of the common cardiovascular disorders are high blood pressure, heart attack, strokes, and heart failure.

High Blood Pressure (hypertension)

It occurs when the force with which the blood pushes against the walls of the blood vessels is too high and can cause damage to the capillaries and several organs.

Heart Attacks

This is a condition that occurs when a narrowing or blood clotting develops in one of the blood vessels that supply the heart muscle with blood. If the narrowing or blood clotting is big enough it can stop the blood flow to the heart muscle and can stop the heart from pumping which is called a heart attack.

Strokes

It occurs when the blood supply to part of the brain is cut off, which can cause brain damage and possibly death.

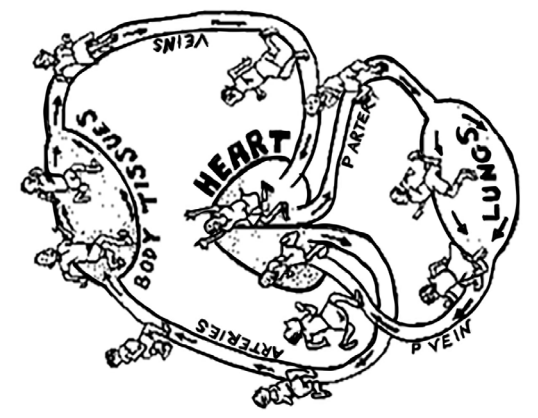
Heart Failure

Heart failure occurs when the heart muscle doesn't pump blood while it should.

When this happens, blood often backs up and fluid can build up in the lungs, causing shortness of breath.

Activity 4.46 Outdoor activity

Instruction: Mark out a model of the circulatory system on the ground using stones, string or chalk. Put pieces of red flowers or paper in the area marked lungs and pieces of blue flowers or paper in the area marked body tissues. To begin the game two or three students pick up blue petals at the body tissues and follow the arrows through to the heart and on to the lungs. At the lungs the students drop the blue flowers and pick up the red and return to the body tissues via the other side of the heart. Any student moving the wrong way or doing something wrong will be disqualified.



Q1: What do the students represent? What about the red and blue colors?

Q2: Describe the structure and function of the body part while you are crossing it.

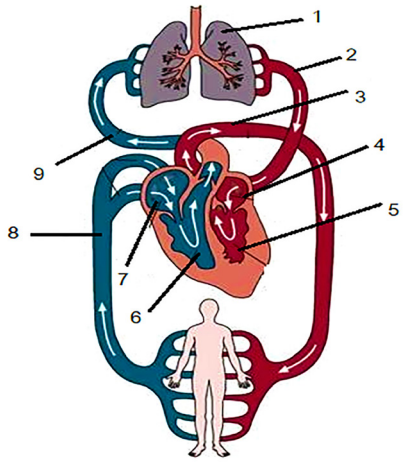
Summary

- The human circulatory system consists of the heart, blood, and blood vessels.
- The heart contracts to pump blood throughout the body.
- Human heart has four chambers, two atria and two ventricles.
- Blood is composed of blood cells (white blood cells, red blood cells, and platelets) and plasma.
- Blood transports hormones, oxygen, and nutrients to the cells and carbon dioxide and other wastes away from the cells.
- There are three types of blood vessels: arteries, capillaries, and veins.

- Arteries carry blood away from the heart and veins return blood back to the heart.
- Capillaries are the smallest blood vessels where the exchange of materials with cells takes place.

Review questions

1. Name the chambers and valves of the heart. Trace the path of blood through the heart.
2. When the left and right ventricles of the heart contract, the atrium becomes _____, and blood flows from _____, and _____ into _____, and _____.
3. Label the indicated parts in the following diagram.



4. Complete the table below which is about blood vessels and their function.

Types of blood vessels	Their functions
	Contain valves to prevent the backflow of blood
	Exchange of materials occurs from these vessels
	The most muscular blood vessels
	These blood vessels carry blood from the heart
	These vessels return blood to the heart
	Vessels in which the pulse is felt

5. Why do you think the wall of the left ventricle is thicker and more muscular than the wall of the right ventricle?

Answer question numbers 6 to 9 based on the human heart diagram given below:

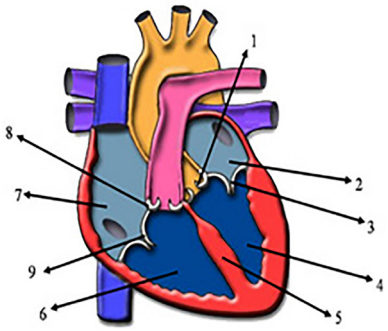
6. Which one of the following statements best describes the blood in chamber G?

   A. It is oxygenated blood coming from lungs after receiving O_2.

   B. It is deoxygenated blood headed to lungs for receiving CO_2.

   C. It is deoxygenated blood headed to the lungs for receiving O_2.

   D. It is oxygenated blood coming from lungs after receiving CO_2.



7. Chamber F receives blood from which blood vessel(s)?

   A. aorta B. pulmonary arteries
   C. venae cavae D. pulmonary veins

8. Which heart chamber pumps blood to the lungs?

   A. E B. F C. G D. H

9. What are the parts represented by B and I in the diagram respectively?

   A. Pulmonary artery and pulmonary vein

   B. Superior and inferior vena cava

   C. Right auricle and right ventricle

   D. Left auricle and left ventricle

10. Which of the following statements about the circulatory system is true? Blood in the

    A. Left ventricle and aorta is deoxygenated.

    B. Left atrium and pulmonary vein is deoxygenated.

    C. Right atrium and vena cava is oxygenated.

    D. Right ventricle and pulmonary artery is deoxygenated.

11. Rewrite the sentences given below in order to create a meaningful understanding of how the human circulatory system works starting from the first to the last action. (Hint: The first sentence starts with "The deoxygenated blood …..")

- The blood goes through the bicuspid valve to the left ventricle.
- The oxygenated blood travels back through the pulmonary veins into the left atrium
- The right ventricle pumps blood through the pulmonary artery directly into the lungs
- The blood goes through the tricuspid valve to the right ventricle
- The blood mixes with oxygen in the lungs
- The deoxygenated blood enters the upper atrium through the superior and inferior vena cava
- Finally the left ventricle pumps blood through the aorta to the rest of the body

Exercise

1. Explain the differences between pulmonary and systemic circulations.
2. Discuss how the human circulatory system interacts and works with the following systems: Digestive and respiratory systems.
3. List the types of blood vessels in the human body and discuss their structure and function.
4. What does human blood carry?

4.7 Reproductive system



After completing this section, you will be able to:

- Distinguish the major structural components of human reproductive system
- Distinguish between the primary and secondary sexual characteristics of humans
- Describe the main functions of the human reproductive system
- Identify and discuss the main diseases or disorders associated with human reproductive system

Keywords:

- Reproductive system
- Puberty
- Ovary
- Uterus
- Estrogen
- Fallopian tube
- Testis
- Hormone
- Scrotum
- Epididymis
- Vas deferens
- Semen
- Follicle
- Ovulation
- Menstrual cycle
- Sexually transmitted diseases

Activity 4.47

1. Every individual person is the results of two different cells. Justify how
2. Think of any body system in humans that differs in structure and performance because of difference in sex. Discuss it.
3. Unlike other life functions, like eating, sleeping, breathing, reproduction has value only for the survival of a species as a whole, not for individual life. Explain.

You have something in common with every person ever born. Like everyone else, you began life as a single cell, produced when one male sex cell joined with one female sex cell. Sexual reproduction is the means by which the human species passes on genetic information to each generation.

Reproduction is the process by which living organisms make more organisms like themselves. Like other living things, human beings reproduce. The reproductive system is a collection of specialized organs, glands, and hormones that help to produce a new human being. Females and males reach sexual maturity, or the ability to produce offspring, only after puberty. Puberty is the time in life when a boy or girl becomes sexually mature. It causes physical changes, and affects boys and girls differently.

Activity 4.48

1. List as many structural and physical changes in human male and female individuals? Categorize these characteristics as those which appear since the time of birth and those that appeared by the time of puberty.
2. Discuss the physical changes in males and females that appeared during puberty stage.

4.7.1 Primary and secondary sexual characteristics of male and females

Sexual characteristics which are present at birth that enable the differentiation of male and female in many species are called primary sexual characteristics. Primary sexual characteristics include internal and external sex organs which are present in babies at the time of their birth.

Secondary sexual characteristics are those features that occur at the time of puberty or adolescence, which show sexual maturity of a human individual and make reproduction possible. Secondary sexual characteristics are displayed at the ages of 11 and 13 in girls and 14 and 16 in boys. The secondary sexual characteristics display distinct changes in males and females. These changes are brought about by sex hormones produced by matured reproductive organs. As a result boys develop into adult men, whereas girls into adult women.

Activity 4.49

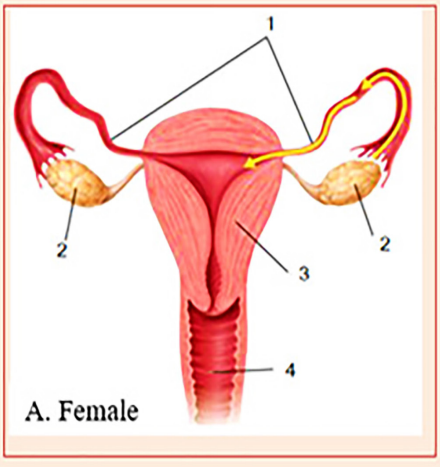
1. What are the primary sexual characteristics of males and females in humans?
2. The table given below shows secondary sexual characteristics of human individuals. Categorize these characteristics as female's and/or male's secondary sexual characteristics.

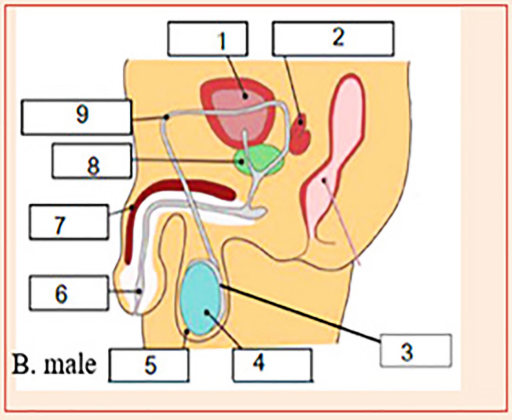
Secondary sexual characteristics	Identify if it occurs in males or females or both
Enlargement of genital organs	
Widening of hips	
Deepening of voice	
The onset of menstruation	
Growing of hairs on armpits	

4.7.2 Components of the reproductive system

Activity 4.50

The diagrams (A) and (B) below show the parts of human female and male reproductive structures. Try to analyze the picture and identify the indicated parts.





Human reproductive system is classified as male and female reproductive systems due to their differences in structural components and functions. A female's reproductive system is used to produce eggs. This system is also the place where a fertilized egg can grow and develop into a baby. Organs of a female reproductive system include vagina, cervix, uterus, fallopian tube, and ovary. The male reproductive system is used to produce sperm and transfer it to the female reproductive system. The male reproductive system includes penis, scrotum, testicles, seminiferous tubules, vas deferens, epididymis, seminal vesicles, prostate gland, and cow per's gland.

4.7.3 Functions of reproductive system

The essential functions of the human reproductive system are production of gametes, fertilization, and maintenance of the unborn child during the period of gestation, birth of the child, and suckling and care of the child.

Activity 4.51

Complete the following tables about parts of reproductive structures and their functions

Female reproductive system

Female part	Function
Cervix	A ring of muscles, separating the vagina from the uterus (Example)
?	Receives the male penis during sexual intercourse, sperms are deposited here
?	The place where the fetus develops
?	Produce oocytes (eggs) and reproductive hormones, estrogen and progesterone
?	transport the ova from the ovary to the uterus each month

Male reproductive system

Male Part	Function
Testicles	for making testosterone, male sex hormone, and for producing sperm cells
Penis	
Vas deferens	
Epididymis	
Scrotum	
Seminiferous tubules	
Prostate gland	
cow per's gland	

4.7.4 Menstruation and menstrual cycle

Activity 4.52

1. Is menstruation a disease?
2. How can I know I am starting the menstruation period? For how many days does a girl menstruate?
3. I am 17 years old but I have not experienced monthly periods. Is something wrong with me?
4. Why do girls feel very bad, emotional, and unhappy when they are menstruating?
5. If you don't have money to buy pads or sanitary towels what can you use when you are menstruating? How can you control your menstruation when you have started while in school?

Each month starting at puberty, the tissue lining the uterus thickens to prepare for pregnancy. If fertilization occurs, the zygote moves down the fallopian tube and embeds in the thickened tissue. If fertilization does not occur, the egg deteriorates. Then, the tissue layer, along with the deteriorated egg, is discharged through the vagina. This process is called menstruation and lasts for about 3 to 5 days on average. After menstruation, the tissue lining the uterus thickens again. Ovulation occurs about two weeks into the cycle. The entire process is called the menstrual

cycle. The length of each menstrual cycle varies from female to female, but the average is 28 days.

4.7.5 Major diseases of reproductive system

Activity 4.53

1. Have you ever heard of any disease that affects the reproductive organs?
2. What does a sexually transmitted disease (STD) mean?
3. Identify which of the following are STDs. (Gonorrhea, syphilis, Influenza, Sinusitis, HIV/AIDS, Tuberculosis, Dysentery, Eczema, Chancroid, Pneumonia, and Hemorrhoids)

Sexually transmitted diseases (STDs) are diseases that pass from one person to another during unprotected or unsafe sexual contact with an infected person. A STD may also be called a sexually transmitted infection (STI) or venereal disease (VD). STDs can be caused by bacteria, viruses, and parasites. STDs don't always cause symptoms or may only cause mild symptoms. So it is possible to have an infection from people who seem perfectly healthy and may not even know they have an infection. If there are symptoms, they could include unusual discharge from the penis or vagina, sores or warts on the genital area, painful or frequent urination, itching and redness in the genital area, sores in or around the mouth, abnormal vaginal odor, anal itching, and soreness or bleeding. Examples of STDs include syphilis, gonorrhea, chancroid, and HIV/AIDS. Antibiotics can treat STDs caused by bacteria or parasites. There is no cure for STDs caused by viruses, but medicines can often help with the symptoms and lower your risk of spreading the infection.

Activity 4.54

Discuss about the causative agent, symptoms, and treatments for the following STDs:

Syphilis, gonorrhea, chancroid, and HIV/AIDS

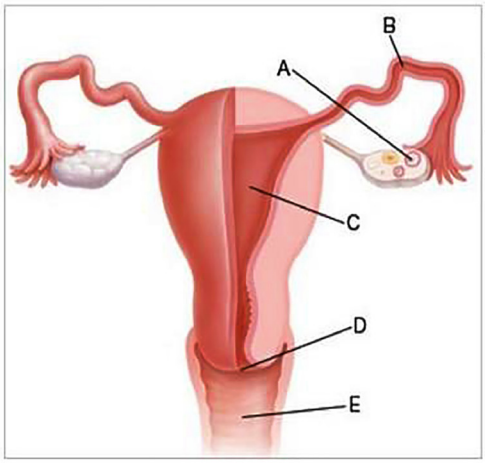
Summary

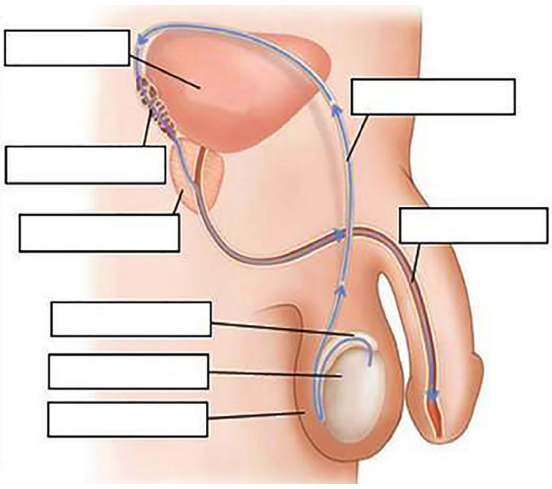
- The reproductive system is a collection of specialized organs, glands, and hormones that help to produce a new human being.
- Females and males reach sexual maturity, or the ability to produce offspring, only after puberty.
- The main functions of the female reproductive system are to produce ova (singular, ovum), or egg cells, and to provide a place where a fertilized egg can develop, and to give birth of child.
- The male reproductive system produces sperm and transfers it to the female reproductive system.
- Gonads, testes in males and ovaries in females, produce gametes and secrete sex hormones.
- Various ducts then store and transport the gametes, and accessory sex glands produce substances that protect the gametes and facilitate their movement.

Review questions

1. Use the following words and label the diagrams given below about the human female and male reproductive systems

Uterus	Testes	Ovary
Vagina	Seminal vesicle	Urethra
Fallopian tube	Vas deferens	Epididymis
Cervix	Scrotum	Urinary bladder





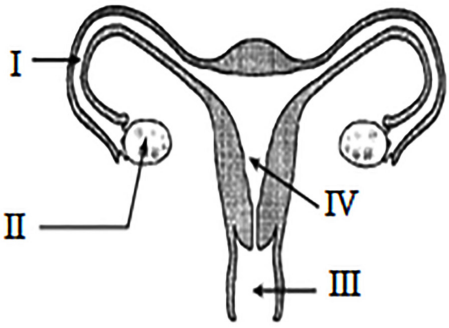
2. Which one of the following is the primary sexual characteristic of a female human?

   A. Beginning of menstruation
   B. Enlargement of breasts
   C. Widening of hips
   D. Having pairs of ovaries

3. Which one of the following secondary sexual characteristics is common for both males and females?

   A. Production of eggs
   B. Widening of hips
   C. Enlargement of genitals
   D. Deepening of voice

Answer question numbers from 4 to 6 based on the diagram given below.



4. Where does fertilization take place?

   A. II
   B. IV
   C. III
   D. I

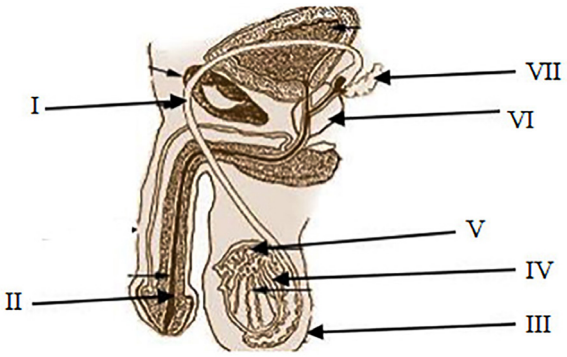
5. At which place does the fetus grow and develop?

A. I	B. III	C. IV	D. II

6. The part of the female reproductive structure that produces egg cells is indicated by ____.

A. IV B. I C. II D. III

Answer question numbers from 7 to 11 based on the diagram given below.



7. Which structure produces sperm cells?

A. III B. I

C. V D. IV

8. Which structures produce fructose used for nourishing sperm cells?

A. VI and VII B. IV and V C. VII D. IV

9. Where do sperm cells stored and matured?

A. I B. V C. III D. IV

10. Which structure secretes alkaline fluid used to neutralize the acidic environment within the male and female reproductive structures for the sperm cells?

A. V B. VII C. VI D. IV

11. Which structures maintain lower temperature which favors sperm cell production?

A. III B. IV C. V D. VII

Exercise

1. Explain the function of the following parts of the female reproductive system: ovary, fallopian tube, uterus.
2. Explain the function of the following parts of the male reproductive system: testes, scrotum, epididymis, vas deferens.
3. In what ways are the effects of testosterone on males and estrogen on females similar?
4. Both males and females have paired organs that produce sex cells. What survival advantage for our species might this pairing of organs provide?
5. In human male, the primary reproductive organs such as scrotum, testicle, and penis are located externally, but in females, ovaries are located internally. Justify your reason why the male reproductive organs mentioned are located externally?



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 in an ecosystem
- Construct simple food chain and explain its components
- Differentiate between food chain and food web
- Describe the role of nutrient recycling in nature
- Explain how energy flows from producers to consumers
- 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
- 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 action
- 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 assoil, forest, etc.

Keywords:

- Ecosystem
- Biotic
- Abiotic
- Mutualism
- Commensalism
- Amensalism
- Predation
- Competition
- Soil
- Air
- Water
- Food chain
- Food web
- Trophic level
- Producer
- Consumer
- Omnivore
- Forest
- Global warming
- Nutrient cycle
- Energy flow
- Conservation

5.1 Ecosystem and interactions

Activity 5.1

Look at the diagram given below and answer the questions that follow.



1. What are the living and nonliving components in the above diagram?
2. Which organism consumes which among the organisms given above?
3. How do the living components interact with the nonliving components in the diagram?

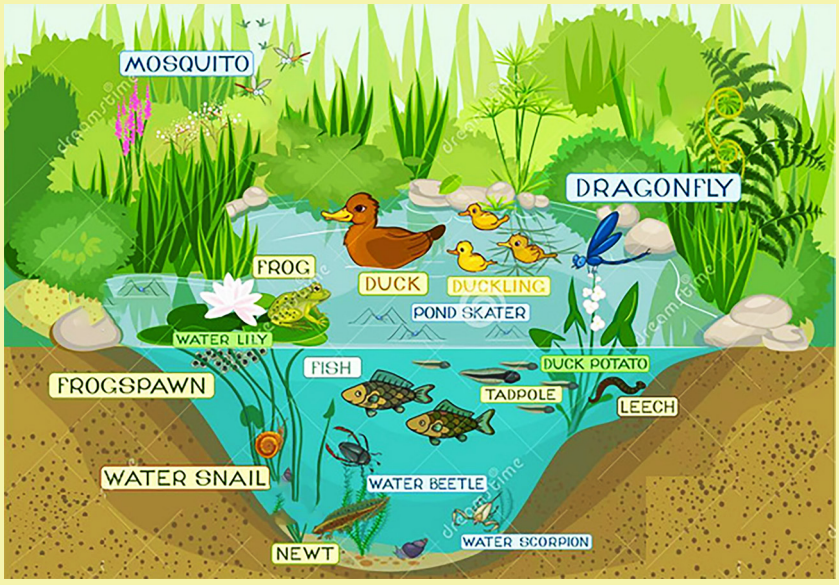
Habitat is the actual place or address where an organism found in a specific time. Population is a group of organisms of the same species that live in an area in a specific time. Community is groups of populations or all the living components found in an area in specific time. Ecosystems are places where organisms, including humans, interact with each other and with their physical environment. The need for energy and nutrients links organisms in many complex ways.

5.1.1 Definition and components of ecosystem

The community of organisms in a habitat and the nonliving part of the environment (air, water, soil, light, etc.) make up an ecosystem. A lake is an ecosystem, which consists of the plant and animal communities, and the water, minerals, dissolved oxygen, soil and sunlight on which they depend. A community is made up of all the plants and animals living in an ecosystem. In the soil there is a community of organisms, which includes earthworms, and other insects, mites, fungi and bacteria. An ecosystem can be categorized into its components, abiotic components including minerals, climate, soil, water, sunlight, and all other non living elements, and its biotic components consisting of all its living members (communities). Linking these components together are two major forces: the flow of energy through the ecosystem, and the cycling of nutrients within the ecosystem.

Activity 5.2

Look at the pond ecosystem in the diagram below and try to identify its components.



1. What are the biotic components of this pond ecosystem? List down the abiotic components.
2. Discuss how these two components interact with each other.

5.1.2 Types of biological interactions

Individual organisms live together in an ecosystem and depend on one another. In fact, they have many different types of interactions with each other, and many of these interactions are critical for their survival.

Activity 5.3

1. What each of the following biological interactions refers to? Parasitism, predation, commensalism, mutualism, competition, and amensalism.
2. Have you ever noticed any of the above listed biological interactions in your local areas? If you say yes, please give examples of the organisms involved in each type of interaction.
3. Study the diagrams and information in the following table. Identify the interdependence in each case and briefly explain each interaction

Diagram	Type of interaction	Explanation
 Lion vs wildebeest		
 Hyenas vs lions		
 Bee vs flower		

 Birds following cattle		
 Cattle vs ticks		

In any ecosystem, all species of the living organisms can interact in different ways with each other for their survival. Some interactions are beneficial and others are harmful. In some interactions, one organism provides food and/or a habitat for another. The major ecosystem interactions among the species in an ecosystem include predation, competition, parasitism, mutualism, and commensalism.

Predation is a type of ecosystem interaction where one organism (predator) kills and eats another (prey). Many organisms, such as the cheetah have become highly adapted to hunting and killing their prey. Competition is an interaction where both organisms suffer as they compete with each other for limited resources (e.g. food, water, or space). Parasitism is where one organism (called parasite) benefits at the expense of the other organism (host). Mutualism is another form of interaction where both organisms benefit from their interactions. Commensalism is an interaction in which one organism is benefited but the other is neither benefited or harmed.

Activity 5.4

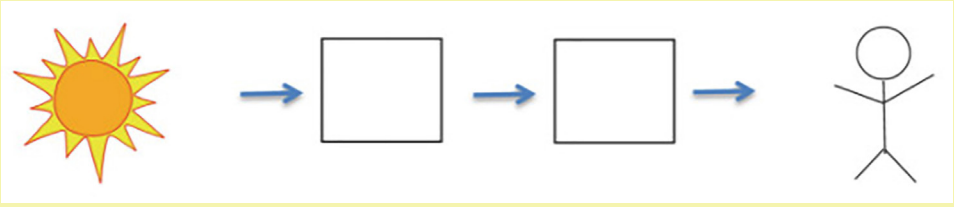
1. Go back to activity 5.3 and identify the types of interactions and which partner derives benefit or get harmed.
2. Humans can get parasites in many ways. What type of relationship is it? Identify who drives harm or benefit.

5.1.3 Tropic (feeding) relationship in an ecosystem

Living organisms need to feed to be able to perform life processes. Some organisms can produce their own food, such as plants, while other organisms cannot do this and need to feed on other organisms to obtain their energy. Therefore, there are different feeding types in an ecosystem. Feeding relationships in an ecosystem can be expressed by food chains and food webs.

Activity 5.5

Think about what you ate for dinner yesterday today. Can you trace the matter and energy in your dinner all the way from the sun to you? Complete the food chain shown below.



Food chain

A food chain is a simple linear feeding relationship among organisms. A food chain is a linear feeding relationship among living organisms in an ecosystem. A food chain shows how each organism in a community gets its food. Some animals eat plants and some animals eat other animals. Plants and some protists are called producers because they store energy from the Sun. Animals that eat plants are called herbivores. Animals that eat other animals are called carnivores. A simple food chain links a producer, a herbivore, and one or more carnivores.

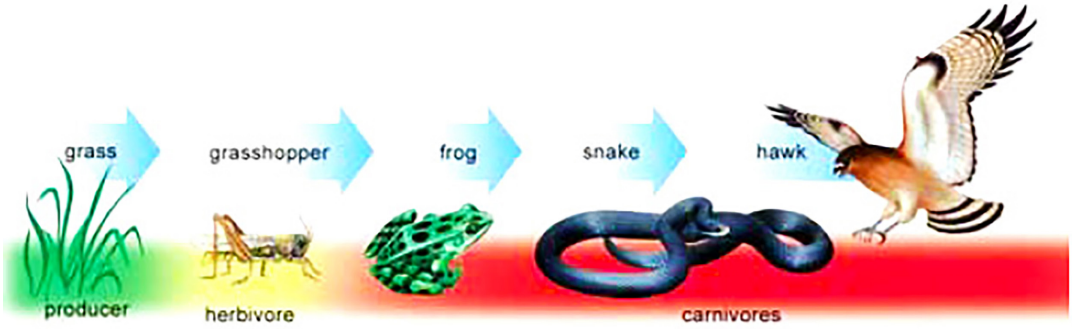


Figure 5.1 Food chain

Food web

Most animals are part of more than one food chain. They eat more than one kind of food to get enough energy and nutrients. You can connect many food chains to form a food web. A food web is a model that shows the complex network of feeding relationships and flow of energy. All energy in food webs comes primarily from the sun. Plants trap sunlight energy during photosynthesis and convert it to chemical potential energy in food compounds, which are available to animals. Herbivores get energy directly from plants, but carnivores and omnivores eat animals for energy. This energy transfer is shown by food chains.

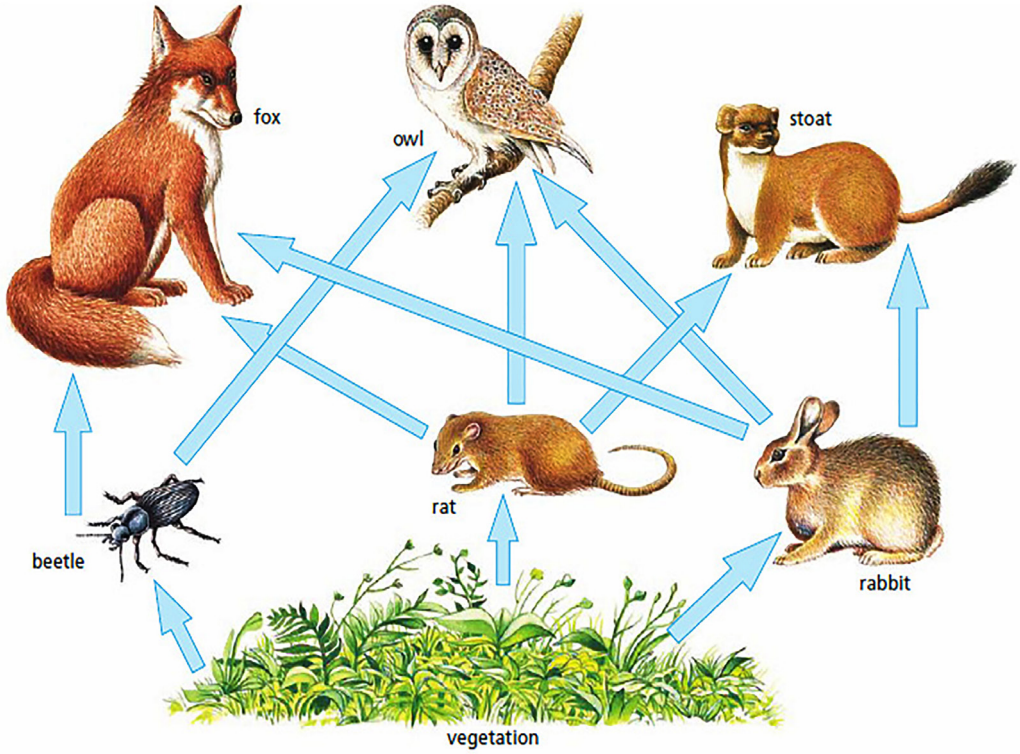


Figure 5.2 Food web

Activity 5.6

1. The following images show a variety of different animals found in Ethiopia.



   a. Which of the animals are herbivores, carnivores, or omnivores?

   b. Construct food chains and a food web using these animals.

2. Write down a list of producers, herbivores, and carnivores that live in your area. Make several food chains using these organisms. Draw arrows to show the direction of energy flow.

Components of food chain

Based on how organisms obtain their food, they can be classified as producers or consumers. Producers are organisms that are able to produce their own organic food. They do not need to eat other organisms to do this. Producers are also called autotrophs. Organisms which cannot produce their own food need to eat other organisms to get food. These organisms are called consumers. All animals are consumers as they cannot produce their own food. Consumers are also called heterotrophs. There are many types of consumers and we can classify them into specific groups depending on the food that they consume. These are herbivores, carnivores, omnivores, and decomposers.

Activity 5.7

1. Are you a consumer or producer? Why? Give examples of producers and consumers in your local area.
2. At which positions in a food chain can we get producers and consumers?
3. Define omnivores and decomposers. Can omnivores and decomposers occupy any specific position in a food chain? Explain why.

5.1.4 Trophic levels and ecological pyramids

Trophic levels are the levels of nourishment of various organisms in a given food chain. The graphic representations of the relationship among organisms at various trophic levels within a food chain are called ecological pyramids.

The bottom of an ecological pyramid, which is represented by the first trophic level, is occupied by the producers. Then, the next levels of the pyramid, which are represented by the second, third and fourth trophic levels respectively, are occupied by the primary consumers also known as the herbivores, the secondary consumers known as primary carnivores, and the tertiary consumers known as secondary carnivores.

There are three types of ecological pyramids. These are pyramid of numbers, biomass, and energy. Pyramid of numbers is the graphic representation of the number of organisms found at each trophic level of a certain food chain. Usually pyramid of numbers is broad at the first trophic level and decreases as we go up in the higher trophic levels within a food chain. However, pyramid of numbers may be inverted in some cases. Can you give an example of inverted pyramid of numbers of organisms what you noticed in your local area?

Pyramid of biomass is the graphic representation that shows the total body mass (dry weight) of organisms found at each trophic level of a food chain. Usually pyramid of biomass is also broad at the first trophic level and decreases as we go up in the higher trophic levels within a food chain. However, pyramid of biomass may be inverted in some cases. Can you give an example of inverted pyramid of biomass of organisms what you noticed in your local area?

Pyramid of energy is the graphic representation energy flow among living organisms within an ecosystem. Pyramid of energy is never inverted at all. It is always broad at the first trophic level and always decreases as we go up in the higher trophic levels within a food chain. In any ecosystem (community), there is always high amount of energy in producers than herbivores (primary consumers). There is always high energy in herbivores than primary carnivores or secondary consumers. Only a fraction (or about 10 %) of energy is transferred from the organisms found at lower trophic level to the organisms found at the next higher trophic level of a food chain. This limits the number of trophic levels in a food chain

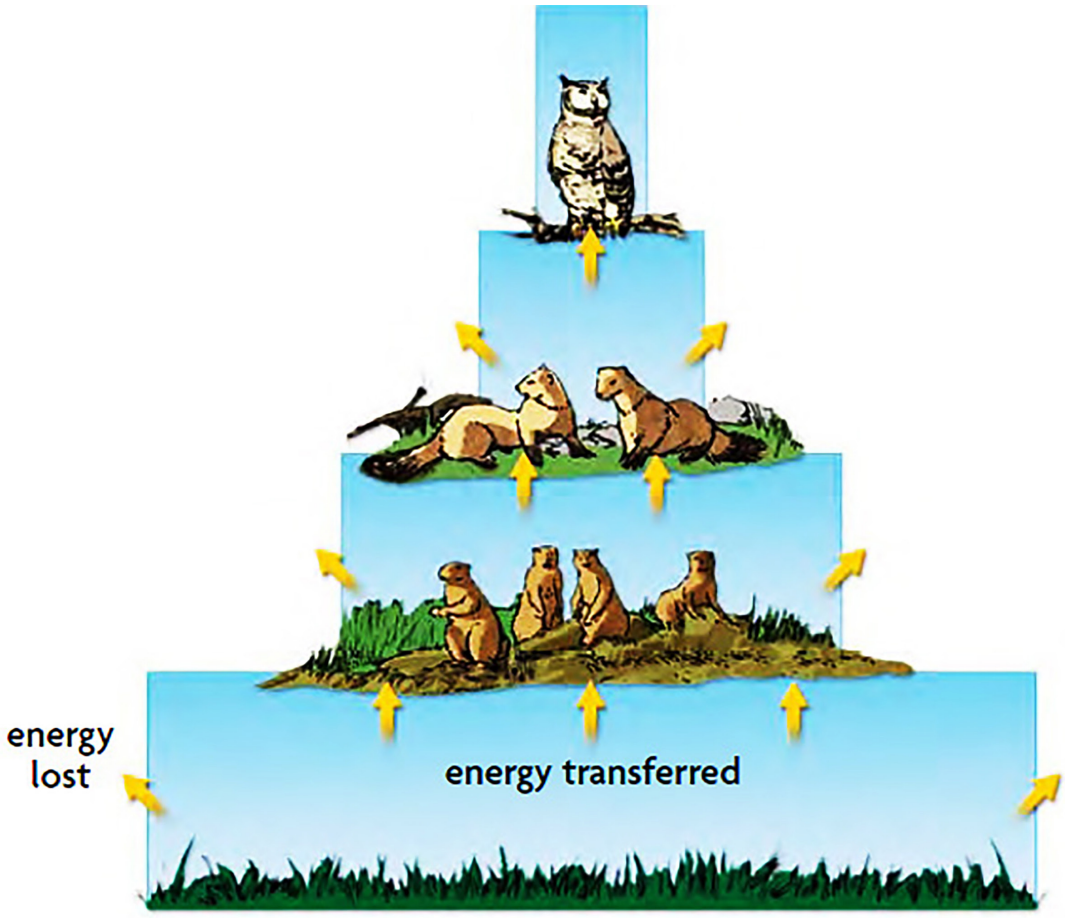


Figure 5.3 Pyramid of Energy

Activity 5.8

1. Analyze the pictures in figure 5.3 and identify the primary, secondary, and tertiary consumers.
2. What would happen to the pyramid in fig.5.3 if there are only a few herbivores?
3. What attributes to the shortness of food chains? Write the food chain that was shown in fig.5.3.
4. Construct a food chain, food web, and ecological pyramid using the following animals.



5. Identify the producers and consumers (herbivores & carnivores) in the diagram given in question 4.

5.1.5 Nutrient cycles and energy flow in an ecosystem

Activity 5.9

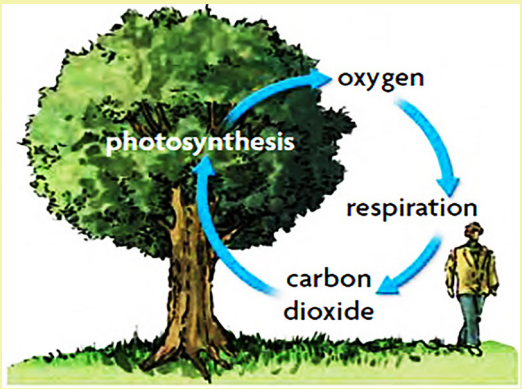
Today's Earth has roughly the same amount of carbon as it had billions of years ago, meaning that the same carbon atoms that make up our body may once have been part of a tree, or gases emitted by a volcano, or even part of a dinosaur. Explain how?

Chemical elements in ecosystems are limited, and those essential for life must be recycled. Organisms absorb and release carbon, oxygen, and nitrogen as gases (CO_2, O_2, and N_2). As a result, these elements move through large-scale global cycles. Solid elements, such as phosphorus (P) and sulfur(S), are less mobile. They do not move far from where they originate. The soil is the main abiotic reservoir for those elements. Nutrient cycle is the process that involves the transformation,

movement, and reuse of nutrients in the ecosystem. Essential elements that are recycled in an ecosystem include carbon, nitrogen, oxygen and water.

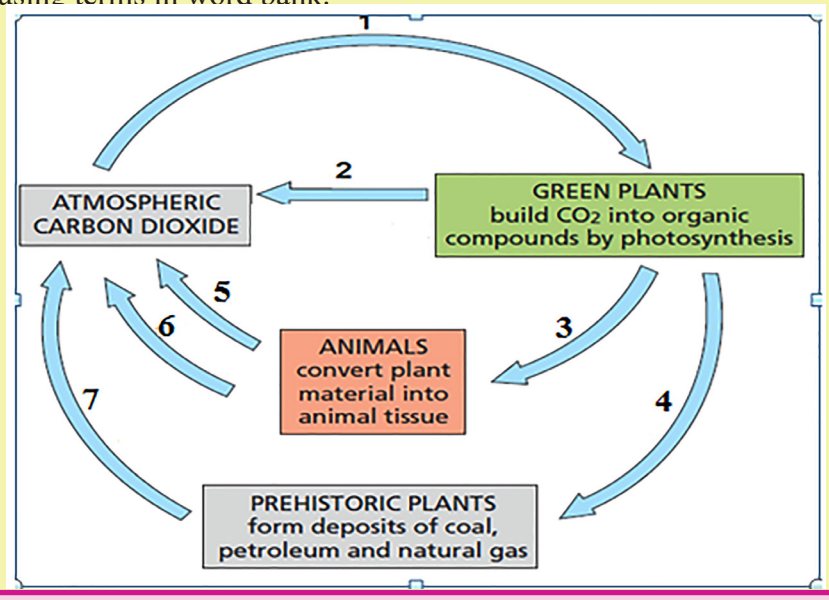
Activity 5.10

1. Oxygen cycle: Look at the oxygen cycle diagram given below and answer the questions that follow



1. What would happen if you cut the tree?
2. Have you ever contributed positively or negatively to this cycle?

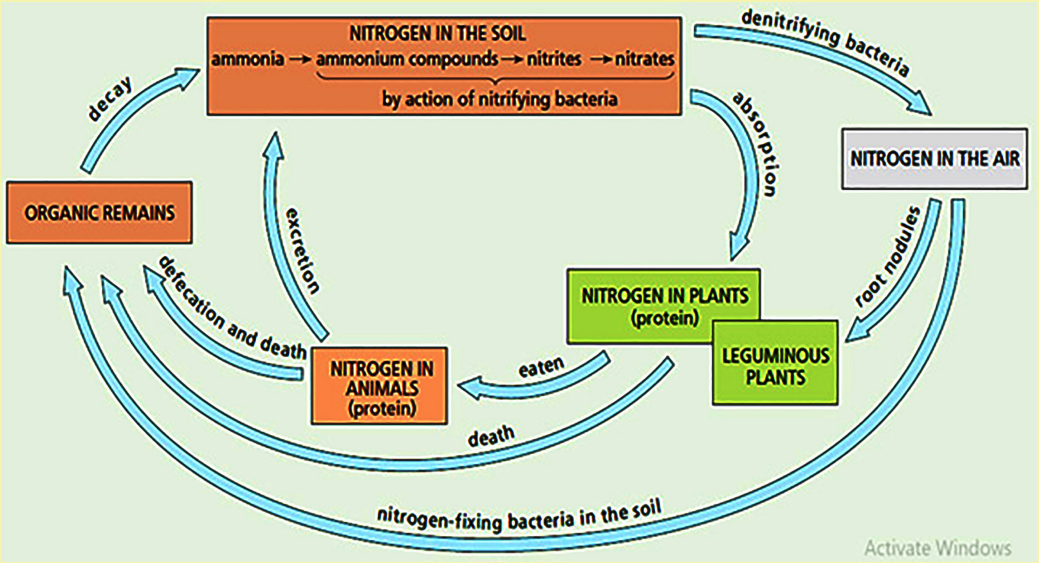
2. Carbon cycle: Complete the following carbon cycle diagram given below using terms in word bank.



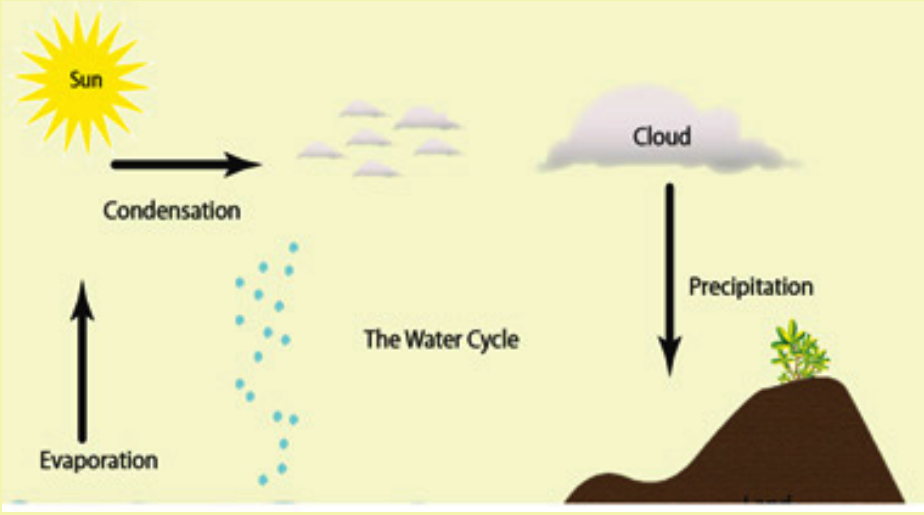
Word bank: Photosynthesis, fossilization, decay, respiration, eaten, combustion

You can use a word twice.

3. Nitrogen cycle: Look at and describe the nitrogen cycle using the diagram shown below.



4. Water cycle: What are the major processes involved in the water cycle diagram given below?



Ecosystems get their energy from sunlight. Sunlight provides the energy for photosynthesis, and that energy flows up the food chain. However, along the way, some of the energy is dissipated, or lost. Fortunately, the Sun pumps new energy into the system and allows life to continue.

5.2 Conservation of natural resources

To ensure that Earth can continue to support, or sustain, a growing human population, it is important to secure the future of the Earth's ecosystems. This way of thinking is known as sustainable development.

Activity 5.11

1. Can you define sustainable development?
2. If you plant trees in your areas, conserve soil, dispose of waste properly, and use resources effectively, what will your environment be after 10 or 15 years?

5.2.1 Soil

Activity 5.12

Study the following soil types and complete the table.

Soil type	Name	The soil type in your area is/are	Characteristics
			
			
			

Soil definition and characteristics

From a general perspective, soil is a very broad term and refers to the loose layer of earth that covers the surface of the planet. The soil is the part of the earth's surface, which includes disintegrated rock, humus, inorganic and organic materials. There are three basic types of soil: Loam, sand, and clay.

Loam is a combination of sand, silt and clay such that the beneficial properties from each are included. For instance, it has the ability to retain moisture and nutrients; hence, it is more suitable for farming. Clay is the smallest particle amongst the other two types of soil (less than 0.002mm particle size). The particles in this soil are tightly packed together with each other with very little or no airspace. This soil has very good water storage qualities and makes it hard for moisture and air to penetrate into it. It is very sticky to touch when wet, but smooth when dried. Clay is the densest and heaviest type of soil which does not drain well or provide space for plant roots to flourish. Sandy soils are one of the poorest types of soil for growing plants because it has very low nutrients and poor water holding capacity, which makes it hard for the plant's roots to absorb water. This type of soil is very good for the drainage system. Its particle size ranging from 0.002 mm to 2.0mm in diameter. In general, Sand soils are often dry, nutrient deficient and fast draining.

Soil formation

All soils initially come from some pre-existing rocks. They are called 'parent materials'. The Parent Material may be directly below the soil, or at great distances away from it. Soil forms continuously, but slowly, from the gradual breakdown of rocks through weathering. The weathering processes involved in the formation of soil can be physical, chemical or biological processes. Soil development is a result of the interactions of climate, vegetation and other organisms on existing geological materials on differing topography over a given period. For the most part, soils are the same wherever all elements of the five formation factors parent materials, climate, topography, biological factors and time are the same. Under similar environments in different places, soils are similar.

Ativity 5.13 Labratory Activity: Study of soils

Materials required: Dry soil samples (sandy, clay, and loam soils), plastic bottles with the top portion cut off to be a funnel, coffee filter, measuring cups or cylinders

Procedures:



1. Place the coffee filter into the funnel part of the bottle.
2. Put some amount of a soil sample into the coffee filter.
3. Pour a certain amount of water using the cup onto the soil sample.
4. Determine the water holding capacity of the soil sample you used in step 2.
5. How do you determine the water holding capacity of a soil sample?
6. Repeat step 1 up to 4 for each of the rest of soil samples.

Based on your findings, answer the followings:

a. Which soil sample absorbed the most water? The least water?

b. Justify your reasons why one soil absorbs more water than another?

Uses of soil

Soil plays a vital role in the Earth's ecosystem. Without soil human life would be very difficult. Soil provides plants anchorage for their roots and holds the necessary nutrients for plants to grow; it filters the rainwater and regulates the discharge of excess rainwater, preventing flooding; it is capable of storing large amounts of organic carbon; it buffers against pollutants, thus protecting groundwater quality; it provides human with some essential construction and manufacturing materials, we build our houses with bricks made from clay, we drink coffee from a cup that is essentially backed soil (clay); it also presents a record of past environmental conditions.

Soil functions are general capabilities of soils that are important for various agricultural, environmental, nature protection, landscape architecture and urban applications. Key soil functions include food and other biomass production, environmental interaction (storage, filtering, and transformation), biological habitat (soil organisms), source of raw materials, physical and cultural heritage, platform for man-made structures (buildings, highways, etc).

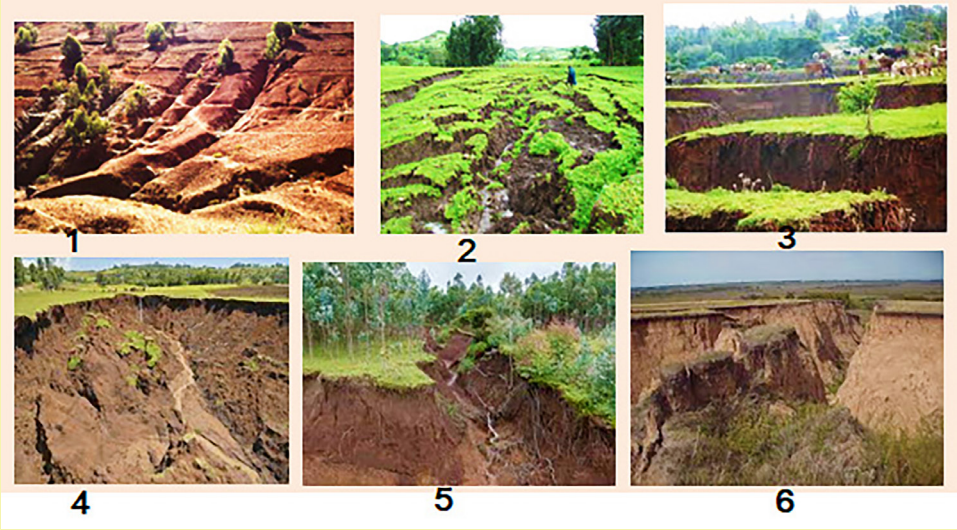
Factors affecting soil fertility and Soil erosions

There are few areas in the world where soil erosion by water or wind hasn't taken its toll, either on the farm or in the surrounding environment. This is especially true in much of the Third World, where harsh climatic conditions, ranging from heavy rainfall to drought and damaging seasonal winds, have combined with unreliable land use practices to accelerate erosion problems. On-farm erosion results in soil loss, yield reduction, and even abandonment of the land. In the surrounding environment, erosion is both a cause and effect of deforestation and desertification.

Soil erosion can be either natural or manmade. Natural factors for soil erosion include flood, wind and landslide. Man-made factors for soil erosion include inappropriate land use: deforestation; overgrazing; faulty farming systems like excessive use of inorganic fertilizers, high crop intensity, and plowing sloppy mountains up and down; housing construction; and mining activities.

Activity 5.14

Study the following pictures and what can you say about them.



1. Look around or think about your local area, which one is similar to your area?
2. What have you done so far?
3. What has to be done next?

Soil conservation strategies

Soil is one of the important abiotic aspects of an ecosystem. Green plants that are the source of food production take up minerals and water from the soil. A plant that grows in a favorable soil texture brings much fruit or production.

Activity 5.15

Study the following pictures and compare them against the pictures in activity 5.14



1. What can you say about these pictures?
2. Which of them are common in your local area?
3. Do you think that these practices reduce soil erosion and improve soil moisture content? Explain how.
4. Have you ever made any contributions towards soil conservation? Discuss.

Soil conservation basically means a way of keeping everything in place. Soil conservation practices involve managing soil erosion and its counterpart process of sedimentation, reducing its negative effects and exploiting the new opportunities it creates. Soil erosion can be improved in several ways. Some of these are afforestation, plant and crop residue cover, terracing, building dams and reservoirs, shelter belting, and contour plowing.

Activity 5.16

1. Is there an environmental protection club in your school? Do you know what they are doing? Are you a member of this club? Why or why not? Look around your school or outside. Is there an area that is eroded by rainfall? Organize your colleagues and try to make some tracing or runoffs and planting trees? What do you expect after a year or two?
2. Have you heard about "Sheger Park" or "Entoto park" in Addis Ababa and "Gorgora project" in the Amhara national regional state? Don't you dream that part of your locality is like them? What can you contribute in making your area look smart?

5.2.2 Water

Activity 5.17

1. When scientists search for life in other parts of our solar system, they begin by looking for water. Why?
2. Earth is also known as the "Blue Planet". Why?

As we know it, water (in its liquid state) is essential to life. Our body is about 60% water. The reactions that sustain life need liquid water to work. Liquid water is also used to transport molecules where they need to go.

Activity 5.18

1. Three-fourth of our planet Earth is water, so why worry about water?
2. There is the same amount of freshwater on earth as there always has been, but in many countries of the world, including Ethiopia, water resources are in crisis. Explain why.
3. Is there water scarcity in your area? Discuss the causes and solutions.

The Earth is a watery place. About 71% of the Earth's surface is covered by water, and the vast majority of water on the Earth's surface, over 96%, is saline water in the oceans. The saline water in the oceans is not palatable for human consumption. The freshwater resources, such as water falling from the sky and moving into streams, rivers, lakes, and groundwater, provide people with the water they need every day to live like for drinking and agriculture.

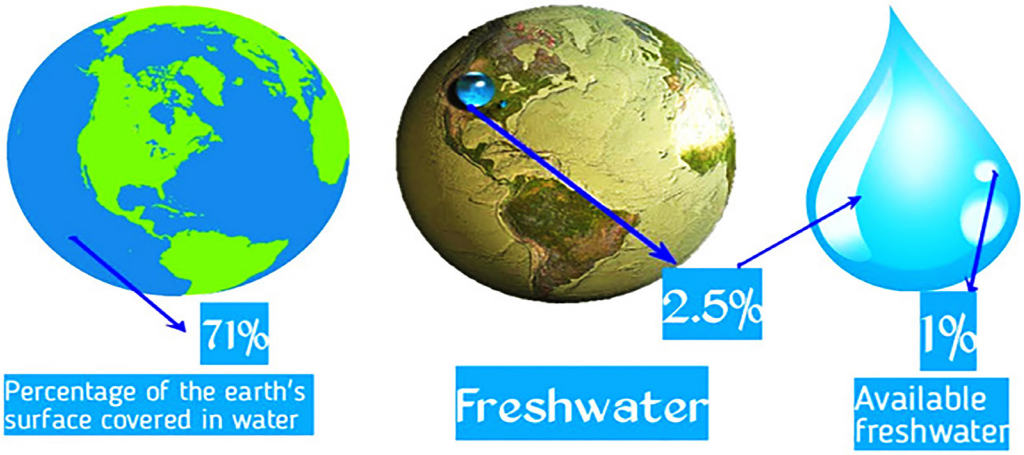


Figure 5.1 Proportion of water

Uses of water

Activity 5.19

Sit in groups and list down the importance of water to you, plants, and other animals as in the table below. Once done, present it to the class. Compare your work with others.

Importance of water to		
Humans	Plants	Animals

When you are thirsty, you need to drink something that is mostly water. Why is the water you drink absolutely necessary? Your cells, and the cells of every other living thing on Earth, are mostly water. Water gives cells structure and transports materials within organisms. All of the processes necessary for life take place in that watery environment. It regulates our internal body temperature by sweating and respiration, transports nutrients through bloodstream, assists in flushing waste mainly through urination, lubricates joints, and acts as a shock absorber for brain, spinal cord, and fetus.

In plants, water is a raw material for photosynthesis, dissolves minerals in the soil taken up by plants through their roots, transport foods and wastes throughout their cells, gives strength to plants tissues and is used to disperse seeds and fruits.

Water conservation strategies

While the amount of freshwater on the planet has remained fairly constant over time, the struggle for a clean, plentiful supply of water for drinking, cooking, bathing, and sustaining life intensifies every year. Water scarcity may be attributed to many environmental, political, economic, and social forces.

Activity 5.20

Study the following pictures and discuss their effects on living things.





1. Are there any water polluting agents in your area?
2. Discuss the various human activities that cause pollution of water and suggest solutions.
3. Mention as many strategies as possible that can be used for conserving water resources.

Saving water can help make sure we have clean water for future use. Preventing water pollution is one way of saving water. Another way to make sure that water is kept clean and conserved is the use of wastewater after cycling. This means that wastewater can be purified at a water treatment plant. Plugging leaks in pipes is also a simple and most effective way of managing water resources. Harvesting rainwater, constructing small dams and reservoirs, adopting more efficient irrigation systems, protection of groundwater, planting trees on hillsides, contour plowing and terracing, planting grasses, and education outreach are also some of the strategies to conserve the water resource.

5.2.3 Air

Composition of air and its uses

Air is mainly composed of the gas's nitrogen, oxygen, and carbon dioxide. It also contains water vapor and dust particles.

Activity 5.21

Discuss the uses of air to humans, animals, and plants and report your discussions using the following table format.

Importance of	To humans	To plants	To animals
Oxygen			
Nitrogen			
Carbon dioxide			

Air pollution and its impacts

Fossile fuels are carbon containing compounds formed underground from the remains of dead plants and animals. Fossil fuels include coal, petroleum and natural gas. Fossil fuels are important parts of the modern society. As we burn these fuels in the form of gas and oil, we are creating compounds that pollute Earth's biosphere.

Activity 5.22

Study the following pictures and describe their effects.



1. Discuss the various human activities that cause air pollution in your home and surrounding.
2. Have you ever contributed to air pollution? Explain your answer.
3. Suggest as many solutions as possible to alleviate air pollution.

Human activities have direct and indirect effects on Earth's natural cycles. Each year humans add synthetic chemicals and materials to the Earth. Many of them cannot be integrated into normal ecosystem functions. The addition of these materials to the environment is called pollution.

Pollution describes any undesirable factor, or pollutant (agents that bring about air pollution), that is added to the air, water, or soil. Pollution can take the form of microscopic air particles, or waste products from factories and sewers, or household chemicals and affect human life in different ways. Smog is a type of air pollution that irritates the eyes and throat and also damages the lungs. Particulates are microscopic bits of dust, metal, and unburned fuel that are produced by many different industrial processes. Once in the air, they may stay in the atmosphere for weeks and can be inhaled and can cause many different types of health problems. The burning of coal or oil that contains sulfur contributes to the acidity of rain. Acid rain forms when sulfur dioxide and nitrogen oxide released by industries and automobiles combine with water vapor in the air. Acid rain has many impacts on both plants and animals. It washes calcium and other nutrients from the soil, making the soil less fertile. Acid rain might also block stomata pores of leaves and degrade plants' chlorophyll. Acid rain also harms fish and other organisms that live in lakes and streams. It can also damage buildings.

The release of CO_2 from various sources such as fuel burning from vehicles and factory smokes can cause global warming.

Activity 5.23

One way to think of global warming is to imagine a car sitting in a parking lot on a sunny day. The car windows let light in and don't let much infrared back out, so the inside gets warm, but we can balance it, so enough heat escapes from the windows to keep the car comfortable. But if we spray windows with a coating that still lets visible light in but prevents heat back out of the car, the balance would be disturbed. The car would hold more energy and heats up.

1. How is this metaphor similar to global warming?
2. What does the coating represent in global warming?

Global warming is an increase in the average temperature of the atmosphere, ocean, and landmass of the earth. It occurs when CO_2 and other air pollutants collect in the atmosphere and absorb solar radiation that has bounced off the earth's surface. Normally this radiation would escape into space, but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter. These heat-trapping pollutants, specifically carbon dioxide, methane, nitrous oxide, water vapor, and synthetic gases, chlorofloro carbons (CFCs), are known as greenhouse gases, and their impact is called greenhouse effect.

Greenhouse gases can be released by factories that burn fossil fuels. Burning fossil fuels has produced about three-quarters of the carbon dioxide from human activity. The rest of the carbon dioxide is caused by deforestation or cutting down trees. Trees absorb carbon dioxide, so when trees are cut down, they cannot remove carbon dioxide from the air. Global warming has many effects. Some of the major effects of global warming include rise of sea levels due to the melting of polar ice caps, uneven distribution of rainfall, food shortage, flooding, drought, water shortage, and extinction of species .



Global warming

What do you suggest to reduce the effects of global warming?

5.2.4. Forests

Forest is a complex ecosystem where trees are the dominant life forms. Forest is one of the largest available renewable resources on the planet earth.

Activity 5.24

1. Is there a forest in your area? What is the dominant tree in that forest, if any?
2. Can you name some forests in the Amhara region? In Ethiopia?
3. What would happen if forest did not exist in your area and /or in the world?
5. Mention some goods and services that forests give to us.

Forests provide us with a wide variety of commodities such as timber, fuel wood, fodder, fiber, fruits, herbal drugs, cosmetics and many types of raw materials used by the industries. Forests provide food sources and shelters for wide varieties of animals. Forests play a great role in soil formation and conservation, water conservation and regenerating of oxygen. Trees fix CO_2 in their biomass and through transpiration (loss of moisture to atmosphere) they moderate the climate. Even forests have medicinal values.

Activity 5.25

1. Discuss the role of forests in reducing global warming.
2. Relate forests with water and soil conservation.

Deforestation and its impacts

Activity 5.26

1. Have you cut a tree for or without a purpose? Don't you think that you never contributed to global warming? Explain why.
2. Why are trees rare in your local area? Who is responsible for the destruction or rehabilitation of an area?
3. Is there any tree plantation program in your area? What have you contributed so far?
4. Think of the world without forests. What would happen?

Deforestation is the temporary or permanent removal of large expanses of forest in an area. Cutting trees for expansion of farming land, mining activities, creation of new and expansion of existing human settlements and development of infrastructure like roads, timber production, firewood, paper and other valuable products are some of the causes of deforestation.

Forests are closely related with climate, biological diversity, wild animals, crops and medicinal plants. Large scale deforestation has many impacts such as increased soil erosion due to reduction of vegetation cover, increase in pollution due to burning of wood and due to reduction in carbon dioxide fixation by plants, increased soil erosion due to reduction of vegetation cover, decrease in availability of forest products, loss of plant, animal and microbial diversity, scarcity of fuel wood, and habitat destruction of wild animals, thus tree-using animals are deprived of food and shelter.

Activity 5.27

1. Look around your school. Evaluate the plant coverage of your school. Have you planted a single tree, even, for your school? Why?
2. Can you tell how many trees you have planted? Are you part and parcel of the "Green Legacy" of your country, Ethiopia? Elaborate.

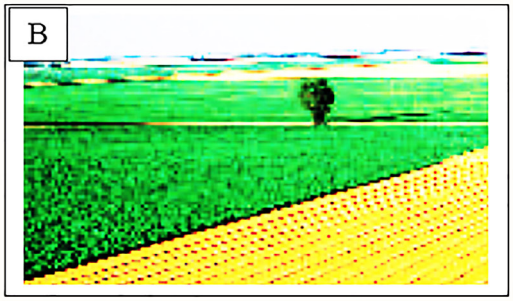
Afforestation (planting trees) is the main forest conservation strategy. Tree plantation can be raised in vacant or unused lands, degraded lands, especially on road side, on contours and on land not suited for agricultural production. Planting trees outside forest areas will reduce pressure on forests for timber, fodder and fuel wood. However, searching alternative fuels as well as raw materials for building constructions, and manufacturing paper is another important strategy for conserving forest.

5.2.5 Biodiversity

Activity 5.28

Imagine you are walking through a forest ecosystem like figure (A) shown below. Trees, shrubs, and small plants are everywhere. You might see animals, birds, and insects. You might also notice a snake or mushrooms. Hundreds of species live in this forest. Now, imagine walking through a wheat field (fig. B). You see only a few species, wheat plants, insects, and weeds.





1. Compare the two ecosystems and which one contains more species?
2. Consider an agricultural field in your area and a reserved forest area. Which one is rich in the diversity of species? Why?
3. What do you think is the importance of keeping biological diversity in an area?

Biodiversity is the variety of life on Earth. It is common practice to describe biodiversity in terms of the number of species among various groups of organisms.

Biodiversity values

Biodiversity has many values to the life of organisms including human beings. The biodiversity values can be categorized as direct and indirect types. The direct values of biodiversity include medicinal and agricultural values. Majorities of the drugs used to treat diseases in humans were originally derived from living organisms including animals and plants. The indirect values of biodiversity include nutrient cycling, waste disposal, and provision of fresh water.

Activity 5.29

1. Discuss more on the values of biodiversity.
2. Are there any plant or animal species that were abundant in your area five or ten years ago but now extinct? Ask your parents, if they have any?

Biodiversity might be lost due to human activities like overexploitation, introduction of new species (exotic species), pollution, and habitat loss. Overexploitation occurs when the number of individuals taken from a wild population is so great that the population becomes severely reduced in numbers. Ecosystems around the globe are characterized by unique assemblages of organisms that have evolved together in one location. Migrating to a new location is not usually possible because of barriers such as oceans, deserts, mountains, and rivers. Humans, however, have introduced exotic species into new ecosystems through colonization, horticulture and agriculture, and accidental transport.

There are several ways of conserving biodiversity. Generally, biodiversity conservation strategies are classified into two: In-situ and ex-situ conservation strategies. In-situ conservation means protecting and keeping the natural resources in their natural habitats. For example national parks, wildlife sanctuaries, and biosphere reserves. Ex-situ means keeping and protecting the natural resources out of their natural habitats or environments. For example, botanical gardens, zoological parks, and seed banks. Some of the measures to prevent loss of biodiversity are habitat restoration, avoid overexploitation of species, landscape preservation, and habitat preservation.

5.2.6 Indigenous knowledge and conservation of natural resources

Activity 5.30

1. In your group, ask local people how they conserve natural resources such as water, forest, and soil? Write your report and present it to your classmates.
2. Evaluate the indigenous practices of conserving natural resources.

Summary

- An ecosystem consists of biotic and abiotic components.
- The biotic components are classified as producers, consumers, and omnivores.
- The abiotic components of an ecosystem include soil, air, water, and other non living components.
- In any ecosystem, the biotic components interact among themselves and with the nonliving components.
- Interaction in ecosystems can be positive or negative.
- Feeding relationships are common among living things in an ecosystem.
- In any ecosystem energy moves only in one direction whereas nutrients such as oxygen, carbon, nitrogen and water are recycled between living and nonliving components.
- Soil is one of the abiotic factors of an ecosystem. Its formation depends on various factors such as parent materials, climate, biotic factors, time and relief. Soil type classified in to three types as Clay, Sandy and Loam soil.
- Water is another abiotic factor that plays important roles in maintaining living things within an ecosystem. It has a cyclical movement within ecosystem and needs caring and conservation as it is becoming one of the scarce resources in different seasons.
- Forests can stabilize the global climate, protect biodiversity and support the global ecological system and processes.

Review questions

1. Look at the diagram given below and answer questions that follow.



   a. What are the producers, primary, and secondary consumers?

   b. Which organisms occupy the first, second, and third trophic levels in this ecosystem?

2. Carefully read each statement below and then, identify the appropriate type of biological association from the parenthesis.

   a. When larger animals like elephants move through a grass field, they stir up the insects found in the grass. During this time, the egret birds follow the elephants and get their food from insects (Parasitism, commensalism, or predation).

   b. In the association between plant flowers and honey bees, the bees get its nectar from the flower whereas the plant undergoes pollination by the help of the honey bee (Competition, mutualism, commensalism).

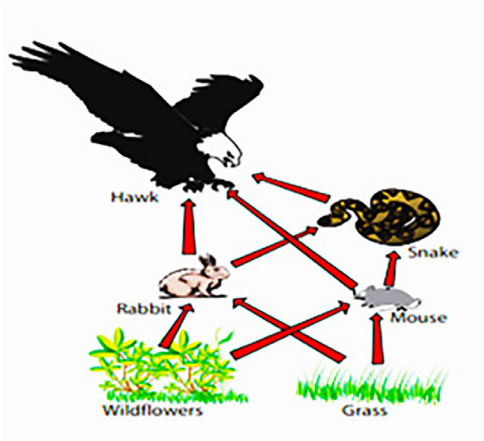
   c. In Nech Sar National Park, lions kill and eat zebras (Mutualism, parasitism, or predation).

   d. Head lice and a human (Competition, mutualism, or parasitism).

   e. All the plants, animals, and microorganisms found in your school compound represent ------ level of organization. (Community, ecosystem, abiotic).

   f. The soil, pond waters, light coming from the sun, Eucalyptus trees, birds, and human beings found in your school compound. (Community, ecosystem, biotic, abiotic).

3. Complete the following paragraph by filling in the missing terms based on the diagram given below.



The above diagram shows a _____. The organisms represented by the wildflowers and grass are known as _____. Rabbit and mouse are the _____. These organisms (rabbit and mouse) are also known as _____ because they eat plants. The snake is _____.

It is also known as _____ because it eats the herbivores. The hawk is _____ consumer. It is also known as _____ as it eats the primary consumers. If a disease killed the rabbit, the snake would survive as the snake can also eat the _____.

4. Fill in the table given below regarding soil types and their characteristics

Soil Characteristics	Soil type		
	Loam	Clay	Sandy
Water draining capacity			
Water holding capacity			
Humus content			
Air content			
Particle size			

Exercise

1. Name an ecosystem that is familiar to you and describe the biotic and abiotic factors that exist there.
2. Assume an ecosystem, which is located near to your school compound, has the following organisms: grass, rabbit, goat, hawk, lion, fox, and mouse. Then answer the following questions based on the provided information.

a. Construct a food web using the organisms listed above.

b. Identify the producers and consumers (primary, secondary, and tertiary consumers).

c. How many possible food chains are there in the food web?



The Solar System

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

- Describe the solar system
- Describe the characteristics and features of different planets
- Compare and contrast planets with each other
- Describe the characteristics of comets, meteoroids, and asteroids
- Differentiate between comets, meteoroids, and asteroids
- Develop the model of the solar system
- Exhibit an interest in science and conducting further activities

Keywords:

- Nebular Clouds
- Solar System

6.1 Formation of the solar system

Activity 6.1:

How do we learn about the stars and planets?

Procedures:

1. Observe the thing your teacher has put on the table and record your observation in detail.

2. After viewing the object at close range, again record your observation in detail. What is the difference from your first observation?
3. Record your observation (a) after removing the newspaper and (b) after opening the thing. Record your observation in detail. What is the difference from your previous observations?

Questions:

1. How do your observations differ as your access to the objects have enhanced? Explain your observations.
2. Do you think that sending space probes or humans to the heavenly bodies lead us to obtain new understanding about stars and planets?

From ancient times, people had looked up at the twinkling lights scattered in the night sky, and wondered "what are these twinkling lights? what is out there? " Before the invention of the telescope, ancient people used observation as their window to understand these lights in the night sky. Through their observation, ancient astronomers noticed that some of these lights changed position relative to other lights. They called these objects planets, a Greek word for *wanderer*.

The Solar System consists of the Sun and everything that orbits the sun, including the planets and their moons, asteroids, and comets, and interplanetary dust and gas.

The solar system is 4.5 billion years old. As there were no humans then, any explanation about its origin are simply theories based on the observations we make now. Scientists hypothesize that the solar system formed from part of a nebula of gas, ice, and dust. Such clouds are common between the stars in our galaxy even today. Astronomers now think all stars have been formed from them. To understand how the solar system is formed, let's discuss the following concepts in detail.

Interstellar clouds are clouds of enormous rotating collection of gas and dust. Interstellar clouds are the raw materials of the solar system. These clouds are found in many shapes and sizes.



Figure 6.1 Nebular Clouds

The interstellar cloud that becomes the sun and the planets was probably a few astronomical units (i.e., one astronomical unit is the distance from Earth to the Sun and roughly equals to about 150 million kms) in diameter and contains twice the present mass of the sun. Interstellar clouds are mainly made from hydrogen and helium and contain a small mixture of silicate, iron compounds, carbon compounds, and frozen water.

The clouds began its transformation into the sun and planets when the gravitational attraction between the particles in the densest part of the cloud caused it to collapse inward as shown in Figure 6.1.The collapse may have been caused by a star exploding nearby or by collision with other clouds.

As the cloud contracted, the nebula likely fragmented into smaller and smaller pieces. The density in the cloud fragments became greater, and the attraction of gravity pulled more gas and dust toward several centers of contraction. This in turn caused them to flatten into disks with dense centers. As the cloud fragments continued to contract, they began to rotate faster and faster.

As each cloud fragment contracted, its temperature increased. Eventually, the temperature in the core of one of these cloud fragments reached about 10 million degrees Celsius. Then nuclear fusion (nuclear fusion is the process that change atoms from one element to another, i.e., four hydrogen nuclei are squeezed or fused together to form a new helium nucleus) began. A star was born – may be the beginning of the sun.

Not all of the nearby gas, ice, and dust was drawn into the core of the cloud fragment. The matter that did not get pulled into the center collided and stuck together to form the planets and asteroids. Close to the sun, the temperature was hot, and the easily vaporized elements could not condense into solids. This is why lighter elements are scarcer in the planets near the sun than in planets farther out in the solar system.

The inner planets of the solar system - Mercury, Venus, Earth, and Mars - are small, rocky planets with iron cores. The outer planets are Jupiter, Saturn, Uranus, and Neptune. The outer planets are much larger and are made mostly of lighter substances such as hydrogen, helium, methane, and ammonia.

Keywords:

- Photosphere
- Chromosphere
- Corona
- Sunspots
- Prominence
- Flares
- Geocentric Model
- Heliocentric Model

6.2 Family of the solar system

Activity 6.2: Motion of the sun, earth and moons

Draw the sun, earth, and moon. After labeling the sun, earth, moon, and their orbits, explain your understanding or thinking about their motions.

People have looked and studied the night sky for thousands of years. Early observers noted the changing positions of the planets and developed ideas about the solar system based on their observations and beliefs. Ancient astronomers saw that the planets moved across the field of stars, but they did not know why. Eventually, two explanations emerged.

One ancient explanation of the planets considered earth to be the center of the universe. According to this model, the sun, the moon, and the stars revolved around earth. Many early Greek scientists thought the planets, the sun, and the moon were fixed in separate spheres that rotated around earth. The stars were thought to be in another sphere that also rotated around earth. This is called the earth-centered (geocentric) model of the solar system.

The other explanation, proposed by Copernicus, stated that the earth, the moon, the stars, and the other planets revolved around the Sun. Copernicus stated that the moon revolved around earth and that the earth and the other planets revolved around the sun. He also stated that the daily movement of the planets and the stars was caused by Earth's rotation. This is the sun-centered (heliocentric) model of the solar system. This idea better explained the motions of the planets. However, it was unpopular when it was introduced. Many people of that time would not accept any idea that did not place Earth at the center of the universe.

Activity 6.3: Compare and contrast the geocentric and heliocentric models:

	Geocentric Model	Heliocentric Model
What it is?		
Evidence or observation that support the model		
Draw the diagram that illustrate the model		

Here is some evidence or observations you can use to support compare and contrast the two models of the solar system.

- All objects in the heavens rise in the east and set in the west.
- The sun travels around the sky in 24 hours.
- Mercury and Venus are seen when sunrise or sunset.
- Sometimes Mars, Jupiter, and Saturn move faster than the stars (retrograde motion).
- Earth was believed to be round.
- Earth rotated, and thus the stars, sun, and planets appeared to move around Earth.
- Mercury and Venus were closer to the sun than Earth and so always appeared near the sun.
- As Earth passed Mars, Jupiter, and Saturn during opposition, the planets would appear to undergo retrograde motion.

6.2.1 The sun

Activity 6.4: Comparing the sun with the earth

Materials: Meter ruler; string (> 60 cm) and a piece of chalk

Procedure

1. Draw a circle in diameter on the floor with the piece of chalk. This represents the earth.
2. Now, move about a few meters away from the circle that represents the earth and give yourself enough space to draw the sun.
3. Draw a circle 108 cm in diameter - this represents the Sun.
4. To draw a circle with a diameter of 108 cm,
   - Tie a string around the chalk.
   - Measure 54 cm of string from the chalk and tie a knot there.
   - Hold the knot and move the chalk around the knot to draw a circle.
   - Questions: If the sun is so much bigger than the earth, why does it look so small to us?

Activity 6.5 Modeling how far the sun is from earth.

Materials: Any grain, a football

Procedures:

1. Let two student (Student A and B) stand side by side at certain location holding the football with one hand and a grain between the thumb and another finger. The football represents the sun, whereas the grain represents the earth.
2. Make the student, who holds a grain (Student B), to make 4 big steps.
3. Make Student B to hold up his/her thump in front of his/her and cover the football with his/her nail. Ask and record how much of the ball he/she can see.

4. Make Student A to hold up his/her thump in front of his/her and cover a grain with his/her nail. Ask and record how much of the ball he/she can see.
5. Do Steps 3 and 4 after 8, 12, 16, 20 and 24 biggest strides he/she can make.

Questions:

1. As one student moves away from the other student, does student B see the ball? Does student A see the grain?
2. Is the ball or the grain as big as your fingernail?
3. Do Students A's fingernails cover a grain? Do Students B's fingernails cover the ball? Justify your answers.

In brief, the sun is by far the largest and most massive object in our solar system making up 98% of the total mass of the solar system. Due to the sun's massive size, its large gravitational pull causes the planets and other objects in the solar system to orbit around it.

The sun is the center of the solar system, and the closest star to Earth. Almost all of the life on Earth depends on energy from the sun.

Notice the different layers of the Sun, shown in Figure 6.2. Like other stars, the Sun is an enormous ball of gas that produces energy by fusing hydrogen into helium in its core.

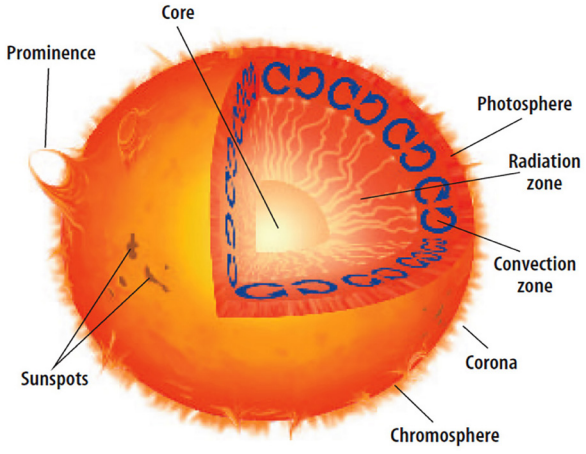


Figure 6.2 Layers of the Sun

The lowest layer of the Sun's atmosphere and the layer from which light is given off is the photosphere. The photosphere often is called the surface of the Sun, although the surface is not a smooth feature. Above the photosphere is the chromosphere. This layer extends upward about 2, 000 km above the photosphere.

A transition zone occurs between 2, 000 km and 10, 000 km above the photosphere. Above the transition zone is the corona. This is the largest layer of the Sun's atmosphere and extends millions of kilometers into space. Charged particles continually escape from the corona and move through space as solar wind.

From the viewpoint that you observe the Sun, its surface appears to be a smooth layer. But the Sun's surface has many features, including sunspots, prominences, and flares.

Areas of the Sun's surface that appear dark because they are cooler than surrounding areas are called sunspots. Because scientists could observe the movement of individual sunspots, they concluded that the Sun rotates. However, the Sun doesn't rotate as a solid body, as Earth does. The sun rotates faster at its equator than at its poles. Sunspots at the equator take about 25 days to complete one rotation. Near the poles, they take about 35 days.

Sunspots aren't permanent features on the Sun. They appear and disappear over a period of several days, weeks, or months. The number of sunspots increases and decreases in a fairly regular pattern called the sunspot, or solar activity, cycle. Times when many large sunspots occur are called sunspot maximums. Sunspot maximums occur about every 10 to 11 years. Periods of sunspot minimum occur in between.

Sunspots are related to several features on the Sun's surface. The intense magnetic fields associated with sunspots might cause prominences, which are huge, arching columns of gas. Notice the huge prominence in Figure 6.3. Some prominences blast material from the Sun into space at speeds ranging from 600 km/s to more than 1, 000 km/s.

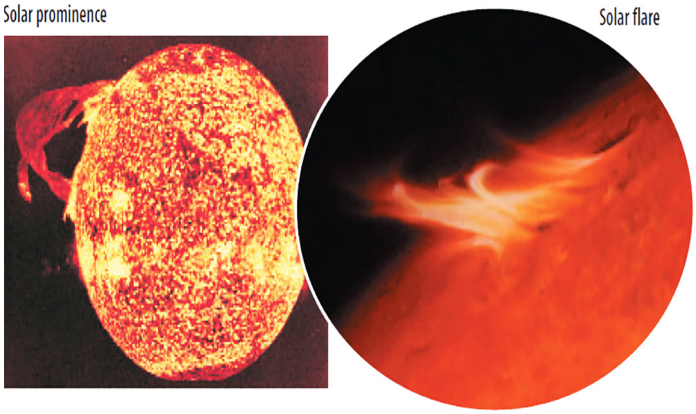


Figure 6.3 Features such as solar prominences and solar flares

Gases near a sunspot sometimes brighten suddenly, shooting outward at high speed. These violent eruptions are called solar flares. You can see a solar flare in Figure 6.3.

6.2.2 Planets of the solar system

The first four planets, Mercury, Venus, Earth and Mars are much nearer to the Sun than the other four planets. They are called the inner planets or teresterial planets. The inner planets have very few moons. They all are made of rock; some of them have a thin layer of gas on the outside. The core is the inner part of these rcoky planet and it is made up of different layers.

The planets outside the orbit of Mars, namely Jupiter, Saturn, Uranus and Neptune are much farther off than the inner planets. They are called the outer planets or gas giants. They have a ring system around them. The outer planets have large number of moons. Gas giants are very far from the Sun. They don't have a hard surface. Outer planets are giant balls of very cold gases. Scientists think that outer planets have hot, solid cores, deep down inside them.

In this section, we look at each of the eight planets of the solar system in detail.

Activity 6.6 Comparing terrestrial planets and gas giants

Compare and contrast the terrestrial planets with gas giants. Use the list in first column as a guideline.

	Inner (Teresterial) Planets	Outer planets (Gas giants)
Distance from the sun	close to the Sun	
Space between Orbits	closely spaced orbits	
Mass	small masses	
Radius	small radii	
Made of	mainly rocky	
Outer surface	solid surface	
Density	high density	
Rotation	slower rotation	
Number of Moons	no or few moons	
Rings	no rings	
Nature of atmosphere	thin atmosphere	
Outer Temperature	warm	

6.2.2.1 Mercury

The closest planet to the sun and the smallest planet in the solar system is Mercury. It can be seen just before sun rise or just after sun set. Mercury is almost a sphere with heavily cratered surfaces, which looks much like Earth's Moon. Mercury has an extremely thin atmosphere. Its magnetic field is also extremely weak. On Mercury's surface, there are cliffs as high as 3 km. These cliffs might have been formed at a time when Mercury shrank in diameter.



Mercury

Why would Mercury have shrunk? Mercury has a weak magnetic field around. This indicates that the planet has an iron core. Some scientists hypothesize that Mercury's crust solidified while the iron core was still hot and molten. As the core started to solidify, it contracted. The cliffs resulted from breaks in the crust caused by this contraction.

Because of Mercury's low gravitational pull and high daytime temperatures, most gases could form an atmosphere escape into space. Traces of hydrogen and helium gas were found.

However, these gases are now known to be temporarily taken from the solar wind. Earth-based observations have found traces of sodium and potassium around Mercury. These atoms probably come from rocks in the planet's crust. Therefore, Mercury has no atmosphere. Mercury's temperature can reach 425°C during the day, and it can drop to -170°C at night.

6.2.2.2 Venus

The second planet from the sun is Venus. Venus is sometimes called Earth's twin because its size and mass are similar to Earth's. Clouds on Venus are so dense that only a small percentage of the sunlight that strikes the top of the clouds reaches the planet's surface. The sunlight that does get through warm Venus's surface gives off heat to the atmosphere. Much of this heat is absorbed by carbon dioxide gas in Venus's atmosphere. This causes a greenhouse effect similar to, but more intense than, Earth's greenhouse effect. Due to this intense greenhouse effect, the temperature on the surface of Venus is between 450°C and 475°C.



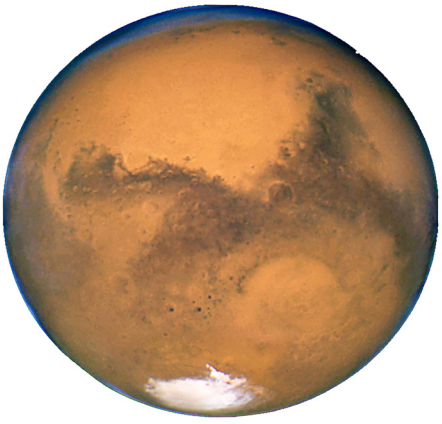
Venus



Earth

6.2.2.3 Earth

Earth is the third planet from the sun. The average distance from Earth to the sun is 150 million km, or one astronomical unit (AU). Unlike other planets, Earth has abundant liquid water and it supports life. Earth's atmosphere causes most meteors to burn up before they reach the surface, and it protects life-forms from the effects of the sun's intense radiation.



Mars

6.2.2.4 Mars

Can you guess why Mars, the fourth planet from the sun, is called the red planet? Iron oxide in soil on its surface gives it a reddish color. Other features visible from Earth are Mars's polar ice caps and changes in the coloring of the planet's surface. The ice caps are made of frozen water covered by a layer of frozen carbon dioxide.

There are long channels on the planet that might have been carved by flowing water. Mars also have the largest volcano in the solar system, Olympus Mons. Olympus Mons is probably extinct. Large rift valleys that formed in the Martian crust also were discovered.

6.2.2.5 Jupiter

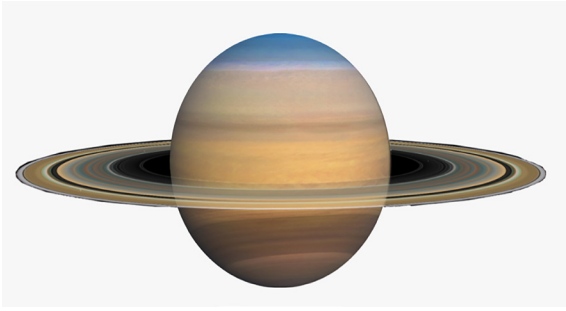
Jupiter, the fifth planet, mostly contains hydrogen and helium. It is the largest planet in the solar system. Jupiter has 16 moons. The well-known four moons are Io, Europa, Ganymede, and Calisto. Io has its own atmosphere of sulfur and sodium and a number of erupting volcanoes. It is a solid rock. Europa is mostly rock and ice. Ganymede is half rock half ice. Calisto is mostly ice with rock center.



Jupiter

6.2.2.6 Saturn

Staurn is the sixth planet in the solar system, and has the lowest density. Similar to Jupiter, Saturn is a large, gaseous planet. It has a thick outer atmosphere composed mostly of hydrogen and helium. Saturn's atmosphere also contains ammonia, methane, and water vapor.



Saturn

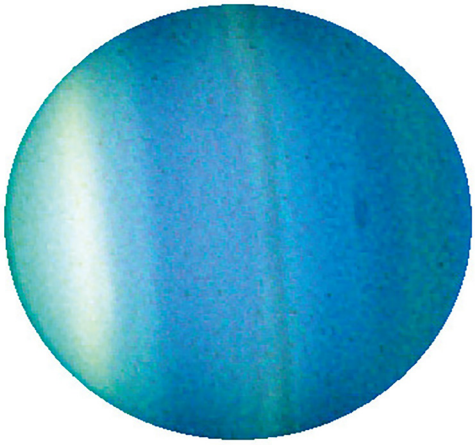
As you go deeper into Saturn's atmosphere, the gases gradually change to liquid hydrogen and helium. Below its atmosphere and liquid layer, Saturn might have a small, rocky core.

Saturn has several broad rings. Each large ring is composed of thousands of thin ringlets. Saturn's rings are composed of countless ice and rock particles. These particles range in size from a speck of dust to tens of meters across. Saturn's ring system is the most complex one in the solar system. At least 31 moons orbit Saturn. Saturn's gravity holds these moons in their orbits around Saturn, just like the Sun's gravity holds the planets in their orbits around the Sun. The largest of Saturn's moons, Titan, is larger than the planet Mercury. It has an atmosphere of nitrogen, argon, and methane. Thick clouds make it difficult for scientists to study the surface of Titan.

6.2.2.7 Uranus

Uranus is the seventh planet from the Sun and was discovered in 1781.
It is a large, gaseous planet with at least 21 moons and a system of thin, dark rings. Uranus's largest moon, Titania, has many craters and deep valleys. The valleys on this moon indicate that some process reshaped its surface after it formed.

Uranus's 11 rings surround the planet's equator. Uranus's Characteristics The atmosphere of Uranus is composed of hydrogen, helium, and some methane.



Uranus

Methane gives the planet the bluish-green color. Methane absorbs the red and yellow light, and the clouds reflect the green and blue. Few cloud bands and storm systems can be seen on Uranus. Evidence suggests that under its atmosphere, Uranus has a mantle of liquid water, methane, and ammonia surrounding a rocky core.

Uranus's axis of rotation is tilted on its side compared with the other planets. The axes of rotation of the other planets, except Pluto, are nearly perpendicular to the planes of their orbits. However, Uranus's axis of rotation is nearly parallel to the

plane of its orbit. Some scientists believe a collision with another object tipped Uranus on its side.

6.2.2.8 Neptune

Passing Uranus, Neptune is the another large, gaseous planet. Discovered in 1846, Neptune is usually the eighth planet from the Sun. Neptune's atmosphere is similar to Uranus's atmosphere. The methane content gives Neptune, its distinctive bluish-green color, just as it does for Uranus.



Neptune

What gives Neptune its bluish-green color? Neptune has dark-colored storms in its atmosphere that are similar to the Great Red Spot on Jupiter. The Great Dark Spot was about the size of Earth. Bright clouds also form and then disappear. This shows that Neptune's atmosphere is active and changes rapidly.

Under its atmosphere, Neptune is thought to have a layer of liquid water, methane, and ammonia that might change to solid ice. Neptune probably has a rocky core. Neptune has at least 11 moons and several rings. Triton is Neptune's largest moon. It has a thin atmosphere composed mostly of nitrogen. Neptune's rings are young and probably won't last very long.

Activity 6.7 Solar System Data

Use the information in the table below to answer the questions that follow.

Planet	Density (kg/m^3)	Diameter (km)	Distance from the Sun (10^6 km)	Day length (hours)	Year length (Earth days)
Mercury	5, 427	4, 879	58	4, 223	88
Venus	5, 243	12, 104	108	2, 802	225
Earth	5, 514	12, 756	150	24	365
Mars	3, 933	6, 792	207	25	687
Jupiter	1, 326	142, 984	741	10	4, 331
Saturn	687	120, 536	1, 353	11	10, 747
Uranus	1, 271	51, 118	2, 741	17	30, 589
Neptune	1, 638	49, 528	4, 445	16	59, 800

Questions:

1. Why do you think the two types of planets (inner and outer planets) are so different?
2. Given that the density of water is 1000 kg/m^3, which of the planets would float on water? Explain your answer.
3. Compare the densities of the rocky planets and the gas giants. Which type of planet tends to be denser? Explain why.
4. Which planet has the shortest day?
5. Compare the day length for the rocky planets and the gas giants. Which type of planet tends to have the shortest day? What does this tell you about how fast the two types of planet rotate on their axis?
6. Which is the fastest planet that orbits the sun? Why is this?
7. Which planet's year is shorter than its day?
8. Plot a graph to show the cubic of distance each planet is from the Sun versus the square of the time each planet takes to orbit the sun. What do you think about the importance of this graph?

6.2.3 Other objects in the solar system

Activity 6.8 Pluto is not a Planet

Pluto was classified as a planet for a third quarter of a century. In 2006, Pluto was categorized as a dwarf planet, not as a full-fledged planet

Diagnostic Questions:

1. Do you think that scientists were wrong initially when categorizing Pluto as a planet?
2. What brought the change in removing the status of Pluto as a planet?
3. Based on your Grade 7 lesson, what nature of science is revealed in this scenario?

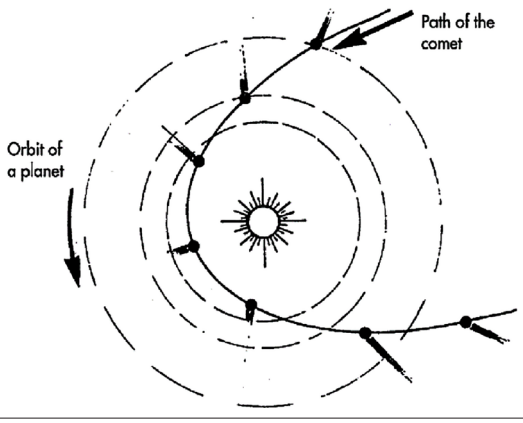
In addition to planets and their moons, comets, meteorids, and asteroids are other objects of the solar system. In this section, you are going to study some aspects of these objects in the solar system.

6.2.3.1 Asteroids

Between the orbits of Mars and Jupiter are asteroids, rocky or metallic objects that orbit the sun. Most asteroids are located in the asteroid belt. The largest object in the asteroid belt is about one fourth the diameter of the Moon. Asteroids orbit the sun just as planets do. Some asteroids travel as far from the sun as Saturn's orbit. Other asteroids have orbits that cross Earth's path.

6.2.3.2 Comets

A comet is a ball of ice and rock that orbits the sun. Comets come from the outer fringes of the solar system. As a comet approaches the sun, the sunlight warms the comet's ice, causing the ice to turn from a solid to a gas and form a cloud of gas and dust.



Near the sun, the solar radiation and sunlight push the cloud away, and this forms a comet tail that points away from the sun.

Most comets are thought to originate in a dense comet cloud beyond Pluto's orbit. One of the famous comet is Halley's comet. It was first recorded in 240 B. C. Halley predicted the comet's return in 1758 based on its previous appearances. It has returned every 75 or 76 years. Is the tail of a comet in front of or behind the comet? Explain your answer.

6.2.3.3 Meteoroids

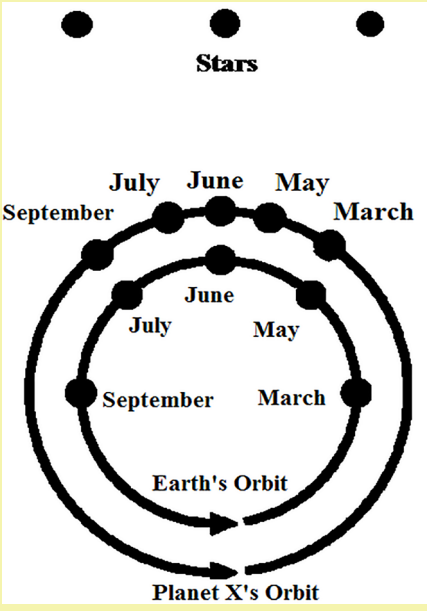
Meteoroids are small, rocky or metallic objects that moves in space. Many meteorids reach earth every year. The craters on the Moon were formed by meteoroid collisions. A meteor is a meteoroid that enters Earth's atmosphere. It appears as a bright streak in the sky. If a meteor fails to break apart and burn up in the atmosphere, it can hit Earth's surface. A meteoroid that strikes Earth's surface is a meteorite. Many places on Earth show evidence of meteorite impacts. How are space objects classified as meteoroids, meteors, and meteorites?

6.2.4 Motion of planets of the solar system

Activity 6.9: Differentiate between planets and stars.

1. In a cloudless night sky, some objects in the sky appear to move. Some others do not appear to move. What do you think about these objects in the night sky? What are they?
2. How can you tell that a particular object in the night sky is a planet or a star?

Materials: three sets of different colored marbles; clay (or mud), compass (to draw), meter ruler; pencil or marker, diagram (shown below)



Procedures:

1. Now, place your drawings on a table.
2. Place three similar marbles on the three positions of the three stars. You can use clay (or mud) to fix the three stars in position.
3. Place two different marbles that represent earth and planet X at the March position.
4. Draw a line from Earth's March position to planet X's March position. Extend the line to the stars.
5. Give a label where planet x appears in relation to the stars.
6. Repeat Steps 3, 4, and 5 for the planets' position in May, June, July, and September. Label these monthly observations respectively.

Questions:

1. Can you describe the motion of planet X with respect to the stars from March to May, from May to July, and from June to September?
2. How can you differentiate a planet from a star?
3. What happens when you increase the distance between earth and planet X?

When Nicholas Copernicus developed his Sun-centered model of the solar system, he thought that the planets orbited the Sun in circles. In the early 1600s, German mathematician Johannes Kepler began studying the orbits of the planets. He discovered that the shapes of the orbits are not circular. They are oval shaped, or elliptical. His calculations further showed that the Sun is not at the center of the orbits but is slightly offset.

Kepler also discovered that planets travel at different speeds in their orbits around the Sun. Planets closer to the Sun orbit faster than planets farther away from the Sun. Because of their slower speeds and the longer distances they must travel, the outer planets take much longer to orbit the Sun than the inner planets do.

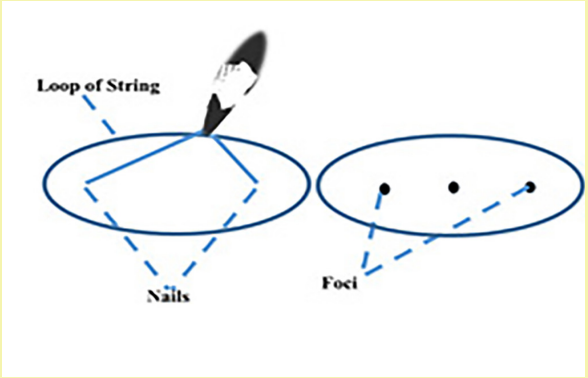
Kepler's laws are summarized as

1. All planets move in elliptical orbits with the sun at one of the focal points.
2. Any planet sweeps out equal areas in equal time intervals.
3. The square of the orbital period of any planet is proportional to the cube of the semi-major axis of the elliptical orbit.

Copernicus's ideas led to the birth of modern astronomy. Early scientists didn't have technology such as space probes to learn about the planets. Nevertheless, they developed theories about the solar system that still are used today.

Activity 6.10 Planetary Motions

Materials: small nails, metric ruler, cardboard, string, papers, and pencil



Procedure:

1. Place a blank sheet of paper on top of the cardboard and insert two nails 3 cm apart.
2. Tie the string into a circle with a circumference of 15 cm to 20 cm.
3. Loop the string around the nails.
4. With someone holding the nails, place your pencil inside the loop and pull it tight.
5. Moving the pencil around the tacks and keeping the string tight, mark a line until you have completed a smooth, closed curve.
6. Repeat steps 1 through 5 several times. (First, vary the distance between the tacks, and then vary the length of the string. However, change only one of these each time. Make a data table to record the changes in the sizes and shapes of the ellipses.)

7. Orbits usually are described in terms of eccentricity, which is determined by dividing the distance, d, between the foci (fixed points—here, the nails) by the length, l, of the major axis. See the diagram above.

Diagnostic Questions:

1. What is the effect of a change in the length of the string on the shape of the ellipse?
2. What is the effect of the distance between the nails on the shape of the ellipse?
3. What must be done to the string or placement of nails to decrease the eccentricity of a constructed ellipse?
4. Where is the Sun located within the orbit?

Summary

- Early Greek scientists thought that Earth was at the center of the solar system. They thought that the planets and stars circled Earth. Today, people know that objects in the solar system revolve around the Sun.
- The inner planets are Mercury, Venus, Earth, and Mars. The inner planets are small, rocky planets.
- The outer planets are Jupiter, Saturn, Uranus, and Neptune. The other outer planets are large, gaseous planets.
- Comets are masses of ice and rock.When a comet approaches the Sun, some ice turns to gas and the comet glows brightly.
- Meteors occur when small pieces of rock enter Earth's atmosphere and burn up.

Review questions

I. Fill in the blank space

1. A large body that orbits a star is a(n)_____, and a large object that orbits a planet is a(n)_____.
2. A star and all the planets, moons, and other bodies that orbit it make up a(n)_____.
3. There will be more pull between a planet and the Sun when the planet has greater_____.
4. When a planet is far away from the Sun, the pulls of gravity between them will be_____.
5. The planets that are closest to the Sun, or the_____, are rocky and are similar in_____.
6. Inner planets have few_____ and no_____.
7. Between the orbits of Mars and Jupiter are orbiting rocky or metallic objects called_____.
8. The planets beyond the asteroid belt are known collectively as the_____.
9. Jupiter, Saturn, Uranus, and _____ are also called the gas giants.
10. Meteoroids that enter Earth's atmosphere are called _____; if they strike Earth, they are called _____.

II. Choose the correct answer

1. Which of the following lists gives the names of the planets in order of their distance from the Sun?

   A) Mercury, Mars, Venus, Earth
   C) Jupiter, Mercury, Venus, Earth
   B) Jupiter, Saturn, Uranus, Neptune
   D) Mars, Jupiter, Uranus, Saturn

2. Which object's name changes based on its location?

A) Planet B) Moon C) Meteoroid D) The sun

3. Which answer shows a pattern from closest object to the Earth to farthest from the Earth?

A) Sun → Saturn → Moon
B) Saturn → Moon → Sun
C) Moon → Sun → Saturn
D) Moon → Saturn → Sun
E) Sun → Moon → Saturn

4. The sun is composed primarily of:

A) water B) hydrogen C) oxygen D) helium E) uranium

5. Our solar system contains:

A) One average star
B) Several stars spread across space
C) Three stars
D) No stars
E) One older, dimmer star and one younger, brighter star

6. As Earth and Mars move they:

A) Exchange positions with one another.
B) Both get farther from the Sun than Jupiter.
C) Move randomly through the solar system.
D) Travel around the Sun with the Earth always closer.
E) This isn't a good question because planets don't move.

7. Objects that can be seen with the unaided eye and appear to move against the background of stars during one month are always:

A) farther away from us than the stars.
B) within the solar system.
C) within the Earth's atmosphere.
D) at the edge of the visible universe.
E) a part of a binary star system.

8. Which statement best describes the movement of the Earth and Sun?

   A) The Earth goes around the Sun once a day.

   B) The Sun goes around the Earth once a day.

   C) The Earth goes around the Sun once a year.

   D) The Sun goes around the Earth once a year.

III. Answer the following questions

9. **Arrange** the following objects in order from the one with the smallest size to the biggest size.

   Moon Saturn Earth Star Sun

10. One of the students said, "It's not possible to tell which is the biggest object!"

    Do you agree, partially agree, or disagree with the student? _____

    Explain how you would rank the size of these objects and why.

    Explain your thinking. Describe the evidence that supports your answer.

11. Compare the distance, the size, and the characteristics of the planets of the solar system with our planet earth.

12. Explain the unique characteristics of the earth.

13. Write an article to a local newspaper that describe why the earth is the suitable for life.

14. Imagine a basketball represents the Sun. A seed, about 100 times smaller than the diameter of the basketball, represents the Earth. About how far away from the basketball should you place the "seed Earth" to show its distance from the Sun in this model?

Circle the answer you think is closest to the relative distance between the "basketball Sun" and the "seed Earth."

A) about 1 meter away

B) about 5 meters away

C) about 15 meters away

D) about 31 meters away

E) about 152 meters away

F) about 305 meters away

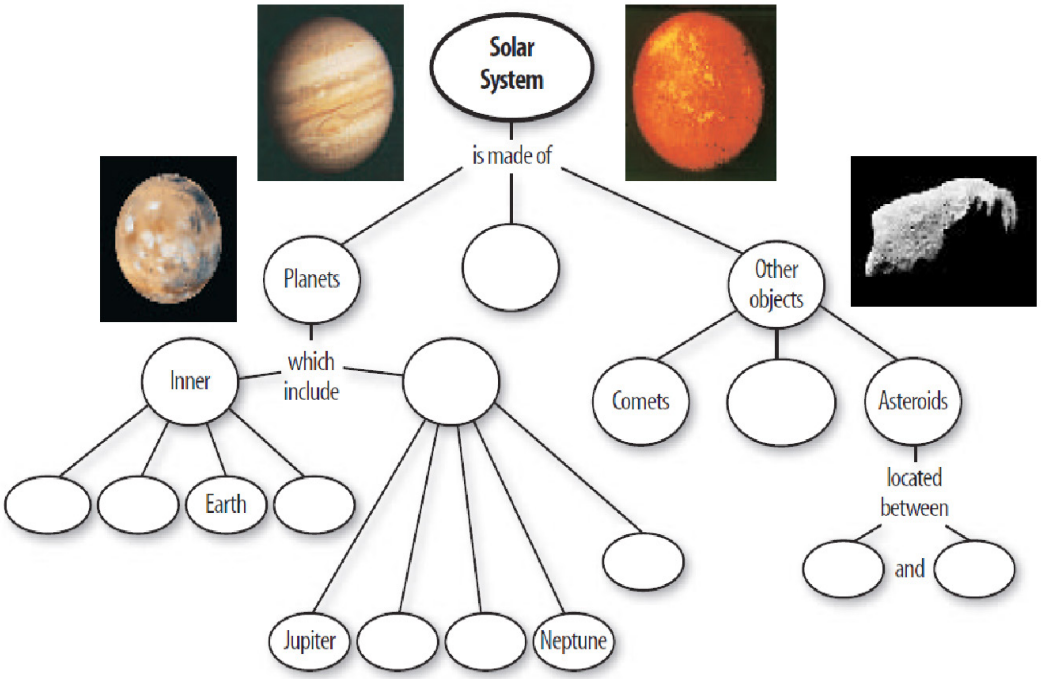
Explain your thinking. Describe how you decided on your answer.

15. Many things are found inside our solar system. Which things you think are found within our solar system.

Clouds	Lake Tana	Asteroids
Galaxies	Moons around other planets	Constellations
The North Star	People	Ethiopia
Earth	Comets	Airplanes
Earth's Moon	Planets	Meteoroids

Explain your thinking. How did you decide which objects are inside our solar system?

IV. Copy and complete the following concept map about the solar system.





Physical Phenomena in the Surrounding

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

- List some sources of light and describe reflection and refraction
- Explain dispersion of light
- Show colors formed on the other side of the prism
- Classify materials as transparent, translucent and opaque
- Demonstrate how image is formed
- Define sound as a form of energy and explain how sound is formed
- Demonstrate the formation of sound and identify material medium for sound propagation
- Prioritize sound propagation in solid, liquid and gases and explain the cause of sound pollution
- List strategies of sound pollution and demonstrate the application
- Define the term heat and explain mechanism of heat transfer
- Classify materials as good conductors of heat and poor conductors of heat (insulators)
- List all material used to construct simple circuit and construct simple circuit
- Define magnetism and do simple experiment and construct magnetic lines of force
- Explain the use of magnet

7.1 Phenomena of light

7.1.1 What is light?

Activity 7.1: How We See Things

Here are two theories about how we see things.

Theory 1: Light rays travel from the man's eyes to the tree and enable him to see it.

Theory 2: Light rays are reflected from the object into the eyes and enable him to see it.

Select the theory you think is right. Use the evidence below to support why you choose that theory and reject the other theory.

Evidence:

- Light travels in straight lines
- We can still see at night when there is no sun.
- Sunglasses are worn to protect the eye.
- If there is no light, we cannot see a thing
- We can look hard at things.
- We can not see objects at night.

We are sometimes afraid to walk in the dark, because we cannot see our surrounding. The greater part of what we know about the world around us is the result of our vision. Light helps us to see things around us by producing a sensation of sight through our eyes and brain. Light also makes plants to grow and produce the food we eat. Plants store energy which is produced from the sunlight.

Light is an electromagnetic wave, which is emitted from a hot body. To produce light, some other forms of energy have to be converted to light energy. For example, in an electric lamp electrical energy is changed to heat and light.

7.1.2 Sources and properties of light

Activity 7.2: Sources of Light



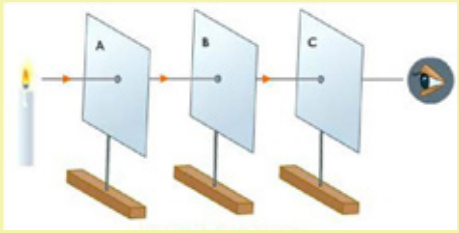
1. What common feature do you observe about these pictures and photos?
2. Look through these pictures or photos and decide whether you think they provide light or not.
3. Identify objects that are the source of light and objects that are not the source of light.
4. When you are done, discuss your choices with your class.

The sources of light are bodies which generate and emit light energy of their own. These bodies are called luminous bodies. For example, the sun, fire, burning lamps and burning candles are luminous bodies. They are sources of light.

Most bodies do not generate light of their own. Such bodies are nonluminous bodies. Nonluminous bodies are visible only when they receive light from some luminous body and reflect it to our eyes. For example a wall, a person, a tree, a book, the moon and mountains are nonluminous bodies. Why is not the moon the source of light?

Activity 7.3: How Light Travels

Materials: 3 cardboards mounted on blocks (see the figure); source of light (candle or lamp). Procedures:



1. The 3 cardboards need to have small holes at their centers exactly at the same level.
2. Arrange the cardboards as shown in figure given.
3. Pass string through the holes and pull it tight to make sure that the holes are in a straight line.
4. Place a lighted candle at one end of the 3 cardboards. Try to look the burning candle flame through the other end as shown in the figure.

Questions:

1. Can you see the flame through the holes?
2. What will happen if you displace one of the cards? Will you still be able to see the light? Write down your prediction and make a drawing of how you think the light will move
3. What do you conclude about the motion of light?
4. Does light travel around a corner?

Let us take other practical examples in our life. If you open a window facing sunlight or walk through trees at sunrise or sunset you will see light streaming through in straight lines as it passes through the window to the opposite wall or between the branches of trees to the ground.

Activity 7.4: Light Investigations

Materials: Colored and colorless drink bottles, cardboard, newspaper, magazine, grease, paper, CD case, wood, thin paper tissue, cement bag, stick of chalk, spoon and stone.

Questions:

1. Which materials let light pass through them? Write you prediction.
2. Prepare your own method of investigation and test whether the material let light pass through it or not?
3. In how many groups do you classify these objects based on your investigation in Step 2?

Some objects like the wall do not allow light to pass through them at all. Such objects are called opaque. Other objects allow light to pass through them partially. Such objects are said to be translucent. Special glasses used in toilet and bathroom windows and water are examples of such material. Materials like air and ordinary window glasses allow light to pass through them. You can see things through them clearly. Such objects are said to be transparent. They serve as media for the propagation of light.

7.1.3 Reflection of light

Light travel in all directions from a source. The direction of light propagation is represented by rays of light. Light travels in straight line in one medium.

When light reaches the boundary of another medium, some changes may happen. Some amount of light is absorbed by the boundary medium. The rest is turned back into the first medium. If the surface is polished and glazed like a mirror, most of the light is turned back from the surface. This phenomenon of light is known as the reflection of light.

Reflection of light is the turning back or bouncing of light when it encounters a different medium. Actually, we see the light because it hits particles in its path and reflect to our eyes.

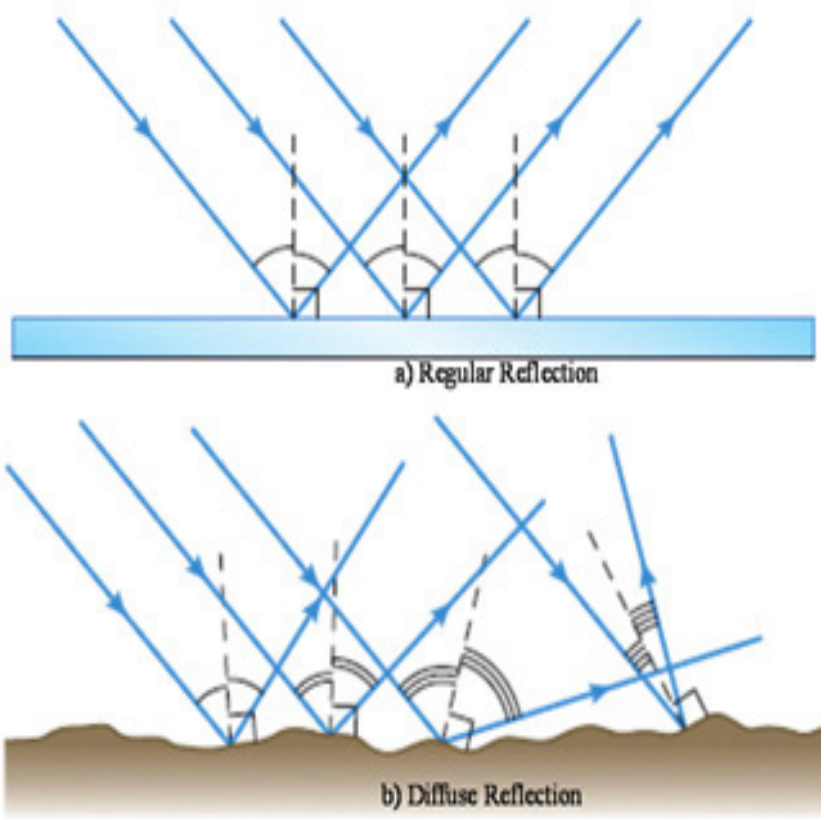


Figure 7.1Schematic representation (a) regular reflection and (b) diffuse reflection,

There are two kinds of reflection: Regular and diffuse reflection.

- Regular or specular reflection: is a reflection where the reflected rays are parallel to one another. Example: reflection from regular, shining, and smooth surface such a mirror. (See Figure 7.1a)
- Diffuse reflection: is a reflection where the reflected rays travel in random direction. Example: reflection from irregular and rough surfaces such as water bodies (See Figure 7.1b)

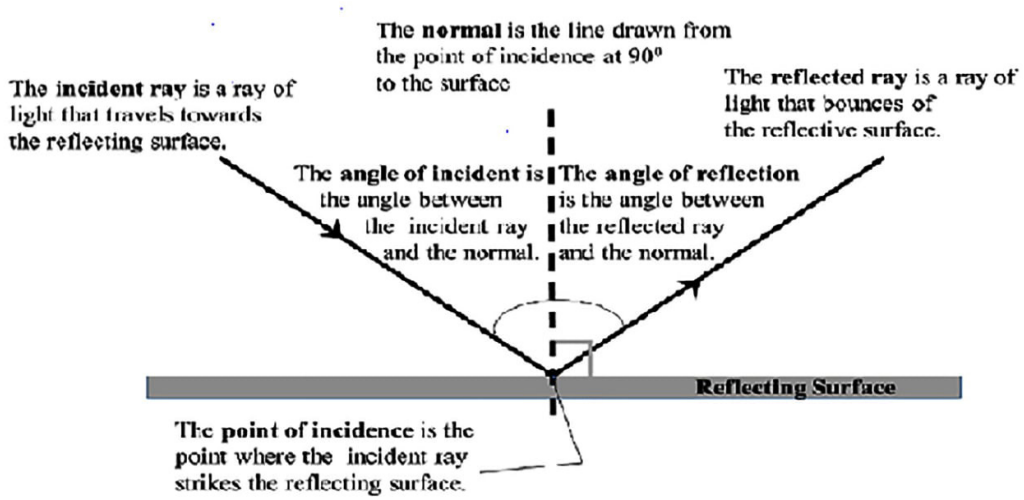


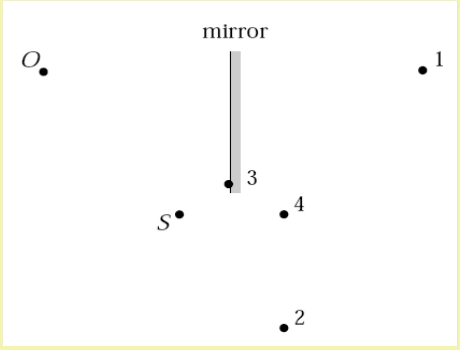
Figure 7.2 Important Terms used in reflection model of light ray

When you look at yourself in the plane mirror, incident rays from your face hit the mirror and return as reflected rays. As these rays enter your eyes, you see the images of yourself that appears to be behind the plane in which the mirror lies. The angle formed by the incident ray and the normal is called the angle of incidence. The angle formed by the reflected ray and the normal is called the angle of reflection. They are represented as θ_i (the angle of incidence) and θ_r (the angle of reflection).

Activity 7.5: Observing Reflection

An observer O, facing a mirror, observes a light source S. Where does O perceive the mirror image of S to be located?

Based on the results obtained from this experiment, what can you infer about the laws of reflection?



Laws of reflection states that:-

1. The angle of incidence is equal to the angle of reflection.
2. The incident ray, the reflected ray, and the normal to the reflecting surface at the point of incidence all lie in same plane.

Do you think that the law of reflection holds for diffuse reflection? The laws of reflection hold for both diffuse and regular reflection. In diffuse reflection, when a beam strikes a rough surface at an angle, all the rays in the beam will be incident at different angles of incidence from the others. So the angles of reflection for the different rays will be different resulting in reflection in all direction.

A plane mirror is a glass plate whose one side is painted black or silver. The reflecting surface is the surface that is not painted. Rays of light falling on a mirror are reflected in a definite direction.

Activity 7.6: Observing Your Image

Materials: Plane mirror.

Questions:

1. Look yourself in the plane mirror.
2. Is your image enlarged, inverted, and sides exchanged in the mirror and how is its position from the mirror?
3. Can you receive your image on a screen (paper) and touch it with your hand?
4. What do you call such images?

Consider a point object O, such as the tip of a candle flame, placed in front of a mirror. Two rays OA and OB, strike the mirror at A and B as shown in Figure 7.3. After reflection, they appear to the eye as if they were originating from I. The eye sees an image at I in such a way that ON is equal to IN and ONI is perpendicular to the mirror. As no rays actually come from I, the image is described as a virtual image.

A virtual image is one through which real rays of light do not pass but which is nevertheless visible to the eye. A virtual up right image is an optical illusion. A real image is formed when actual rays of light meet. If a screen is placed at the position of a real image, the image is seen on the screen.

The image formed in a plane mirror has the following characteristics;

1. It is erect, not upside down.
2. It is of the same size as the object
3. It is laterally inverted. (i.e., sideways reversed)
4. It has the same distance behind the mirror as the object is in front i.e. the image formed in a plane mirror appears to be as far behind the mirror as .

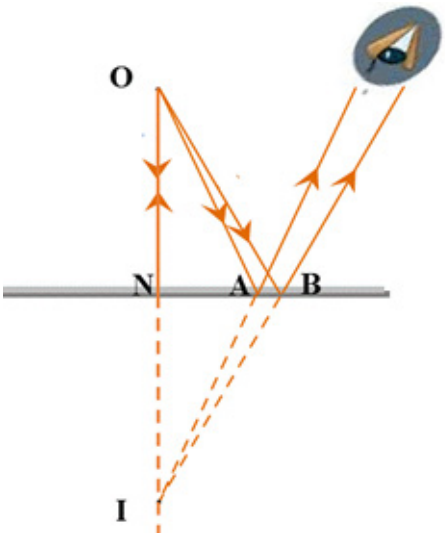
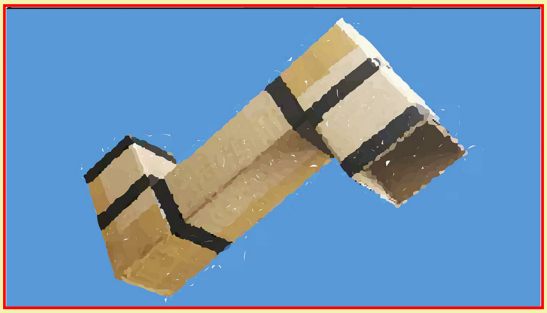


Figure 7.3 Ray Diagram to Construct Image in a Plane Mirror

Activity 7.7: Building a Persicope

1. What are the procedures you followed to build the periscope?
2. Draw the light rays how the light moves through the periscope.
3. Explain how the periscope works.



7.1.4 Refraction of light

Activity 7.8 Observing Refraction

1. Why do you think that the spoon appears as broken?
2. What occurs when a light wave passes from one material to another—from air to water, for example?



In the previous section you learnt that light travels in straight line in a given medium. But this is true only when light travels through one medium.

When a ray of light traveling in one transparent medium enters another different transparent medium, its direction is suddenly changed at the surface separating the two media. This happens only if the light strikes the separating surface obliquely (slantingly). Light travels in a straight line when it enters a new medium perpendicularly. The change in the direction of the light ray is known as refraction of light.

The phenomenon of refraction explains why a pencil appears to bend when part of it is immersed in a glass of water or any other liquid. When the ray enters to a denser medium the refracted ray is bent towards the normal. When the ray enters to a less dense medium, the refracted ray bends away from the normal.

When the light beam moves from air into glass, the light slows down upon entering the glass and its path is bent toward the normal. When the beam moves from glass into air, the light speeds up upon entering the air and its path is bent away from the normal. Therefore refraction of light occurs when light travels from air to glass, from air to a liquid, from glass to air and from a liquid to air.

The incoming ray is called the incident ray. After bending in a new medium it becomes the refracted ray. A line perpendicular to the boundary of the two media at the point where the incident ray entries is called the normal.

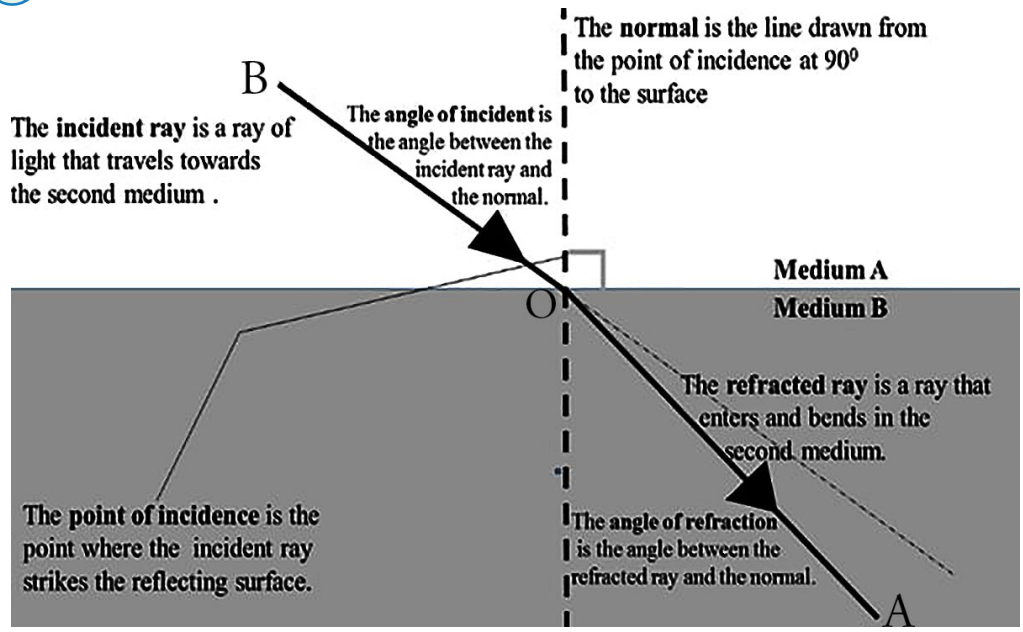


Figure 7.4 Refraction occurs when light travels from one medium to another

That is BO would have been the incident ray and OA the refracted ray. In this case the ray entering the less denser medium would bend away from the normal. In other words a ray traveling from the denser to the lighter medium bends away from the normal as it crosses the surface of the separation of the two media.

These can be summarized as the law of refraction, which are stated as follows:

1. The incident ray, the normal at the point of incidences and the refracted ray lie in the same plane.
2. Light bends towards the normal in denser medium and bends away from the normal in lighter medium.

7.1.5 Dispersion

Have you seen a rainbow in the sky? Rainbow is a large arc in the sky with many colors. Usually, rainbow appears after the rain when the sun is low in the sky. Rainbows can also be observed when you blow a soap bubbles in the sun. Similarly, reflection of light from the surface of a CD produces many colors. Why rainbow happens after the rain?

When such phenomena are observed carefully, there are seven colors in a rainbow. These are violet, indigo, blue, green, yellow, orange, and red (VIBGYOR). Note

that it may be challenging to distinguish all of these seven colors in a rainbow.

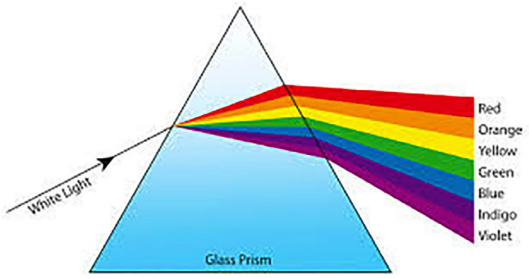


Figure 7.5 A prism splits a beam of sunlight into seven colors

Do all the colors undergo the same amount of refraction? Which color is bent the most?

When a white light passes through the prism, the light splits into many colors. These splitting of light into its colors is known as dispersion of light. Rainbow is a natural phenomenon showing dispersion. Based on these experiences, can we conclude that the sunlight is a mixture of different colors?

White light is a mixture of all the colors of the rainbow. Different colors are refracted by different amounts as they travel through the prism so the white light is split into its different colors.

White light consists of seven colors. Can we mix these colors to get white light?

You can use a circular cardboard disc of about 10 cm diameter to mix these seven colors. First, divide this disc into seven equal segments. Then, paint the seven rainbow colors on these seven segments as shown in the figure below. Make a small hole at the center of the disc and fix the disc on the tip of the pencil (or '*enzirt*'). Now rotate the pencil (or '*enzirt'*). What do you observe? When the disc is rotated fast, the colors get mixed together and the disc appears to be whitish.

7.2 Sound

One of the most commonly observed phenomenon in nature is sound. You hear different sounds throughout the day. The sound of cars, barking of dogs, friends chatting, a teacher talking and music are some examples of sound. Sound is a form of energy which produces hearing sensation in our ears. Sound is produced by vibration of an object. When an object vibrates, it forces the particles of medium

around it to vibrate. In this section you will learn, what sound is, how sound is produced and transmitted, speed of sound in different media, reflection of sound (echo) and some applications of echo.

7.2.1 Sources of sound

Have you ever tried to play a kirar? When you strike each string, it starts to vibrate (moves backward and forwards). The vibrations travel away from the strings of the kirar as a wave called sound wave. You can feel the vibrations if you touch a bell that is ringing or a radio that is playing. The sounds you hear may be different, but they are all alike in one way. All sounds are produced by vibrating matter.

Sound carries energy. It loses its energy as it travels. So, the further the sound travels, the more energy it loses and the weaker the sound becomes. Sound is generated by the series of vibrations of an object. Every sources of sound are in a state of vibration.

Think about the different sounds you hear every day. Some are soft; some are loud. Sounds can have different volumes. Volume is the loudness or softness of a sound. Loud sounds have more volume than soft sounds. Imagine whispering a secret to a friend. Your whisper has a lower volume than your normal talking voice. You change the volume of your voice all the time.

Two sounds can have the same volume but a different pitch. Pitch is how high or low a sound is. Objects that vibrate slowly have a low pitch. Objects that vibrate quickly have a high pitch. Suppose you hit a “Begena” and “kirar”. The “kirar” would have a high pitch because it vibrates quickly. The “Begena” would have a low pitch because it vibrates slowly. Why “Begena” vibrates slowly compared to “Kirar”?

Imagine a day with no sounds happening anywhere. No sounds would mean no matter is vibrating anywhere around you. That is impossible! There are phones ringing, people talking, and shoes squeaking. All these sounds have different volumes and different pitches.

Activity 7.9: Changing Pitches

Materials: Two pencils, any rectangular box; ruler; two rubber bands (different sizes)

Procedures:

1. Make a table like the one shown below. Use your table to record your observations.

Distance between pencils	Prediction	Observations
15 cm apart		
12 cm apart		
9 cm apart		
6 cm apart		
3 cm apart		

2. Cut an opening of at least 15 cm on one side of the rectangular box.
3. Stretch the rubber bands the long way around the rectangular box. Place the pencils under the rubber bands 15 cm apart. (Handle the rubber bands carefully so they don't snap or break.)
4. Tap the rubber bands between the pencils. Listen to the sounds being produced. Notice how high or low the sound of the rubber bands sound.
5. Move the pencils so that they are 12 cm apart. Record your prediction. Tap the rubber bands. Listen to the sounds. How did they change? Record your observations.
6. Repeat step 5 for 9cm, 6cm, and 3cm. Record your prediction. Tap the rubber bands. Listen to the sounds. How did they change? Record your observations.

Question:

1. How will the pitches of the sounds change if you move the pencils closer together?
2. Is there any difference in your predictions and observations? Justify the difference.

7.2.2 Transmission of sound

How did sound travel to our ears? Remember that objects make sound when they vibrate. Sound travels out in all directions from a vibrating object.

A vibrating object makes the air all around it vibrate. For example, the sound from the instrument and the sound from the airplane traveled through the air until it reached the ears of the listeners. You can hear sound only when it travels through matter.

You already know that sound travels through air. Remember that air is a gas. Sound also travels through liquids and solids in the same way.

7.2.3 Speed of sound in different media

Activity 7.10 Speed of Sound

The following scenario was presented to four groups of students in a physics classroom. The four groups came with the answers indicated below.

Alemu and Almaz are standing 50 meters apart and yell "Yo!" at each other at exactly the same time. They yell at each other with the same loudness, but Almaz yells with a higher pitch than Alemu does. Who will hear the other's sound first?

After discussing the scenario, the students gave their answers with reasons:

Group 1: They will hear each other at exactly the same time because the speed of sound waves depends on the properties of air.

Group 2: Alemu will hear the sound first because Almaz yells with a higher pitch and sound with a higher pitch is faster.

Group 3: They will hear each other at exactly the same time because they yell with the same loudness.

Group 4: Alemu will hear the sound first because sound with a higher pitch easily moves through air.

Now examine critically the above scenario and responses and respond to the following questions:

1. Which group's reason or answer do you support? Which group's reason do you reject? Explain why you support or reject each group's answer/ reason.
2. Suppose Alemu yells louder now.
3. Is any of the four groups still has the correct reasoning? Which group do you think is still correct in this case. Justify your answer
4. If you think none of the groups is correct this time, give your own answer with reason.

All materials can transmit sound, but the degree of transmission is not the same for all materials. Solids are better transmitters of sound than liquids and air (gases). Do you know why? Sound needs material medium for its transmission; it cannot travel through a vacuum.

The difference in speeds of sound in different materials can be easily understood from the structure of molecules of a substance. The transmission of sound in different substances depends on the structure of the particles in the substances. Since the particles in solids are close to each other they easily pass the sound to the next particles by collision and the sound moves faster.

But in liquids and in gases, the particles are far apart and the collision between the particles takes place rarely. They pass the sound slower than in solid. Similarly the particles in gases pass the sound much slower than in liquid. Thus, sound travels slower in liquid than in solid and sound travel slower in gases than in liquids. The speed of sound in water is greater than the speed of sound in air and its speed in steel is greater than the speed in water.

Activity 7.11: Sound Propagation

Materials: A flexible plastic tube with a funnel on both ends.

Procedures:

1. Mark the middle of the tube.
2. Attach the funnel on both ends if it were not attached initially.
3. Ask your friend to put the funnels over his or her ears.
4. Tap on the tube in the middle and ask if he or she can hear the sound.
5. While your friend is closing his or her eyes, tab alternatively in the middle, more to the left and more to the right.
6. Ask your friend where exactly the tube was tapped and record the answer.

	The position you exactly tapped	The answer your friend has given
Trial 1		
Trial 2		
Trial 3		
Trial 4		

7. Does your friend hear clearly a sound?
8. Compare the exact position you tapped with your friend's answer.

Questions:

1. When you tap the tube more to the left, which ear will receive the propagated sound first? Why?
2. When you tap the tube in the middle, which ear will receive the propagated sound first?
3. What about the speed of sound in other materials like liquids or solids?
4. Does sound travel faster in warm air than in cold air? Justify your answer.
5. Does sound tend to bend upward or downward when its speed is far from the ground?

7.2.4 Hearing

Activity 7.12: How humans hear sound

Hearing is a process that follows a sequence of steps. These steps are given below. Each step is a process involved in hearing. But they are not in order.

Objects vibrates	Vibrations reach ear
Inner ear vibrates	Air vibrated
Signals reach brain	Sound is heard
Electrical signals are created	

The first step is an object that vibrates. The last step is a sound being heard. The steps in between are provided out of order. What are the steps in between? Put the above phrases that show the processes from 1 to 7 in the correct sequence.

You use your ears to hear what someone is saying to you. You see your ears every time you look in a mirror. You know that they are important in hearing sound. The question is, how do your ears work? Sound travels through the air and goes into them. What happens then? From what you know about sound, you can guess that something is going to vibrate in your ears.

The first part of your body that sound reaches is your outer ear. Your ear also has many other parts that are inside your head. Sound travels through both the outside and the inside parts of your ear before messages about the sound reach your brain. Figure 7.6 shows the path of sound as it travels from the air through your ears.

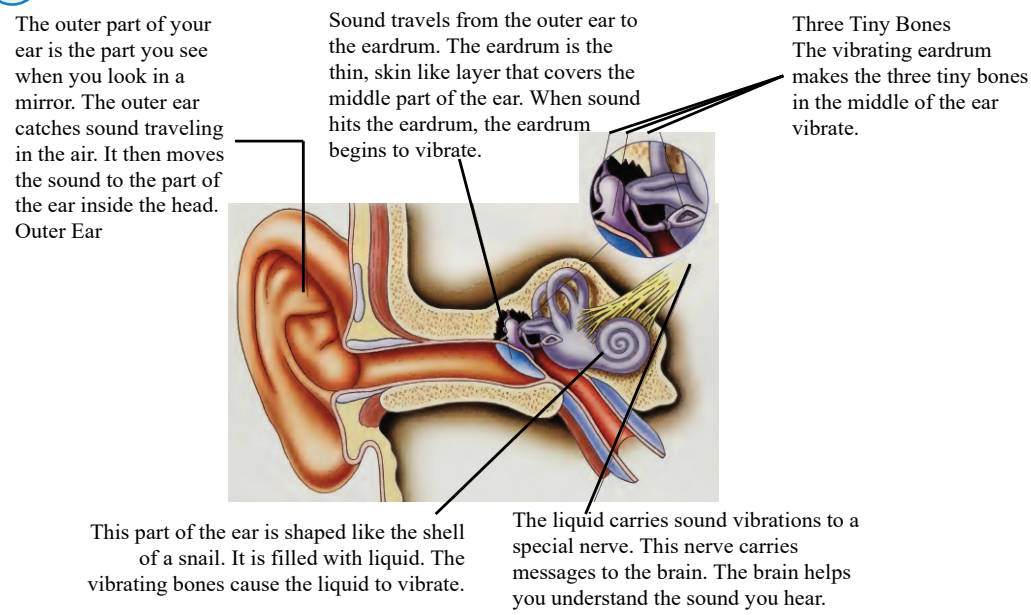


Figure 7.6 Human Ear

7.2.5 Reflection of sound (echo)

Imagine throwing a ball against a wall. The ball hits the wall and bounces back to you. Now imagine shouting in a large, empty room. Like the ball, your voice bounces off of the walls. You hear an echo. An echo is sound bouncing back from an obstacle. Your voice traveled through the air and bounced off of the walls of the room. Whenever sound meets a boundary or an obstacle on its way, some of the sound energy is absorbed and other is reflected. This reflected sound at a boundary is called an echo. Sound does not always bounce back. Do you think that sound reflects back in a room with furniture? Why? Please share your answer with your peers and teacher.

Sound can bounce off from different surfaces. You can hear an echo if you are surrounded by hills, cliffs, or large buildings. However, you can hear an echo best when sound bounces off of a hard, smooth surface. Hard substances such as walls, rocks, hills, metals, wood, buildings, etc. are good reflectors of sound. But when sound strikes soft surfaces such as wool, cloth, etc. most of the sound energy is absorbed.

When you shout or whistle while you are at some distance away from a tall building or a mountain, you may be able to hear the original sound and the reflected sound as two separate sounds. This will be true if the echo /reflected sound reaches you 0.1 sec later than the original sound. This means that your ear is able to distinguish the two sounds as a separate ones only if they reach you at least 0.1 second later.

7.2.6 Application of echo sounding

A. Echolocation

Animals like dolphins and bats make use of sounds waves to find their way. Just like ships on the ocean, bats use sonar to navigate. Waves that are sent out are reflected off the objects around the animal. Bats, or dolphins, then use the reflected sounds to form a "picture" of their surroundings. This is called echolocation.

B. Ultrasound

Ultrasound is sound with a frequency that is higher than 20 kilohertz (kHz). Some animals, such as dogs, dolphins, and bats, have an upper limit that is greater than that of the human ear and can hear ultrasound.

The most common use of ultrasound is to create images, and has industrial and medical applications. The use of ultrasound to create images is based on the reflection and transmission of a wave at a boundary (when the wave goes from one substance to another).

When an ultrasound wave travels inside an object that is made up of different materials such as the human body, each time it encounters a boundary, e.g. between bone and muscle, or muscle and fat, part of the wave is reflected and part of it is transmitted. The reflected waves are detected and used to construct an image of the object. Ultrasound in medicine can visualize muscle and soft tissue, making them useful for scanning the organs, and is commonly used during pregnancy.

Activity 7.13

Discuss the importance of safety equipment such as ear protectors for workers in very loud environments, such as operating heavy machineries and working in factories.

7.2.7 Sound or noise pollution

Activity 7.14: Identifying Noise Pollution

1. List five sounds that are very noisy. Sounds that can hurt your ears. Or just sounds that are difficult to live with.
2. Imagine a learner in a very noisy environment, and identify the possible sources of noise pollution.
3. List some sounds that are sometimes not noisy, but other times can be noisy.
4. Are there any noises at school which distract you during class? Write down some of these, and also some ways which you think could minimize the noise pollution in your class.

Noise pollution is any sound that continues for a long time and is loud, unpleasant, or harmful to our ears. Loud noise can damage your ears. Noise pollution makes the area we live or work in very unpleasant. Noise pollution can be harmful and cause permanent damage to hearing. Even music that is too loud is noise pollution.

Most outdoor noise pollution comes from construction sites and noise from cars and trucks. If you live near an airport, there is a lot of noise pollution from the sounds made by the aeroplanes. Loud sound can hurt our ears and may cause hearing loss.

Activity 7.15: Debate about Noise Pollution

Issues for debates:

1. Any advertising using a Montarbo or big loudspeakers must be prohibited in cities.
2. One person is doing a noise activity (such as watching television, playing music, drilling holes with an electric drill, or any other activity you can think of). The other person, who is nearby, feels that the first person is making too much “noise”. Act out a discussion for the class between the two members of the group. Think about the following: The person who is making the “noise” has rights to make loud sound. The person who is complaining also has rights not to be disturbed. Can you get along? Can you come to an agreement? Can you make a compromise?

7.3 Heat

The universe is made up of matter. Matter is made up of particles that have kinetic energy, and potential energy. This potential energy is present in all matter in the form of thermal or heat energy. Heat transfer occurs when there is a temperature difference between two objects or places. Heat is transferred from the hotter place or object to the cooler place or object. Heat energy transfer continues until both places or objects have the same temperature. Heat energy can be transferred from one place to another by three methods: conduction in solids, convection of fluids (liquids or gases), and radiation through anything that will allow radiation to pass.

When you touch a hot object, such as a hot water, you feel the heat burning you. This is because the hot water transfers heat energy to your hand. Your hand is the cooler object, and therefore the heat energy must be transferred from the water to your hand.

7.3.1 Conduction

Conduction is the transfer of heat between solid objects that have direct physical contact with each other. Heat energy can be transferred between different parts of an object, or between objects that are touching each other.

In conduction, the heat energy travels from the source of heat through the object, or from the warmer object to the cooler object until they have the same temperature.

You experience heat transfer by conduction whenever you touch something that is hotter or colder than your skin, such as when you wash your hands in warm or cold water. When the water is very warm, heat energy is transferred from the warm water to your cold hands until your hands are and warm as the water. When the water you touch is very cold, heat energy from your warm hands gets transferred to the water until your hands are as cold as the water because the heat energy from your hands is not sufficient to warm the water. Even so, the flow of heat energy is always from warm to cool.

Let's look at the example of the cold pot on the hot stove again: These two objects are touching each other. Because of the difference in temperature between the hot stove and the pot, heat energy is transferred from the stove to the pot and eventually

the pot will become as hot as the stove.

Conduction of heat energy can also take place between a solid and a liquid or gas. If you make a hot cup of coffee, heat energy is transferred from the hot coffee to the cup and the spoon. You know this because both the cup and the spoon become warm. This is a good example of conduction from a liquid to a solid.

Activity 7.16: Heat energy transfer by conduction

1. Explain, in your own words, how heat energy is transferred in each of the following situations.

   a) A girl holds a hot cup of tea with her hands.

   b) A man ironing his pair of trousers.

   c) A barefoot boy walking on the asphalt road on a very hot day.

2. Draw a rough sketch of the pictures and use arrows to show the flow of heat energy from the warmer area or object to the cooler area or object.
3. Name three other examples of heat energy transfer in the home.
4. Name three examples of heat energy transfer in industry.

Sometimes, we don't want heat energy to be transferred. People have used their knowledge of heat energy to make items and products that stop or slow down the transfer of heat energy. For example, when it is cold outside, people wear jacket because thick clothing slows down the transfer of heat from our body to the environment. Some types of clothing material are better in keeping the heat of our bodies than others.

People protect their hands or use a piece of old cloths, when removing a hot dish from the oven. The piece of cloth prevents heat from being transferred from the hot pan to their hand.

Activity 7.17: Heat energy transfer in various substances

Materials Needed: Aluminum cup, steel cup, plastic cup, glass cup, wooden cup (or Wancha), warm water, stopwatch or cell phone with a stopwatch function

Question:

1. Touch all the cups with your hands and put them in a row on a table.
2. Half fill each cup with boiled water and wait for 2 minutes.
3. Touch all the cups with your hand: Which cups feel warm?
4. Determine which cup feels the warmest.
5. Order the cups from warmest to coldest.
6. Which material is the best conductor of heat?
7. Which material would be a good insulator?

In the above activity, you would have discovered that some materials transfer heat energy very quickly. We say that these materials are good conductors of heat. For example, all metals are heat conductors, but some metals conduct heat better than others. Copper and aluminum are excellent conductors of heat, that is why they are used to make cooking pots and frying pans.

Some substances, like wood and plastic, are poor conductors of heat. We call these substances insulators. Insulators are used in situations where we do not want heat energy to be lost. For example, pot handles are usually made of wood or plastic, so that you don't burn your fingers when you pick up the pot. Good insulators can also help us to prevent heat energy from being wasted, by being lost to the surroundings. For example, geyser blankets are made from materials that are insulators. Because of this, they keep the geyser from losing heat. This helps to save electricity.

Activity 7.18: Investigate heat conduction of various metals

Materials Needed: Aluminum rod, steel rod, copper rod, iron rod, hot plate, wooden block, candle, stopwatch or cell phone with a stopwatch application

1. Put candle on each rods 12 cm from one end.
2. Place one end of each rod on a hot plate and the other end on a wooden block. Put the wax at the mirror place to the wooden block than the hot plate.
3. Write a testable question for the investigation.
4. Identify the independent, dependent, and controlled variables in the experiment.
5. Write down the aim of the investigation.
6. Make a prediction of the outcome of the investigation.
7. Switch on the hot plate to its maximum heat and start the stopwatch immediately.
8. Record the time at which each rod's wax marking starts to melt. Record your results in the table below:

Metal rod	Aluminum	Steel	Copper	Iron
Time taken for the candle wax to melt				

9. Draw a bar graph to show the results of the experiment.
10. Write a conclusion.

7.3.2 Convection

The particles of a liquid and a gas move around quite freely. This is why liquids and gases are called fluids. When a fluid is warmed up, the particles move around more quickly. The movement of the particles of the fluid makes them take up more space, and so the warm part of the fluid becomes lighter and rises. The cooler part of the fluid is now heavier, and so it sinks. In this way, heat is moved around in a liquid or a gas. Convection is the way heat energy flows through liquids and gases.

Activity 7.19: Investigate convection

Materials Needed: Water, teaspoon of sawdust, 250 ml beaker or glass jar, tripod stand, candle or Bunsen burner

Question:

1. Put water and a small amount of sawdust in the beaker.
2. Stir the water to spread the sawdust.
3. Place your candle or Bunsen burner underneath one side of your beaker and lit it. Do not let the water to boil.
4. Observe carefully what happens to the sawdust.
5. Draw a labeled diagram to show the movement of the sawdust.
6. Use your diagram to explain how convection occurs.

The above activity shows that convection is the transfer of heat from one place to another by the movement of liquid or gas particles. It also shows that water expands when it is heated and that the particles move upwards. The particles in the cooler water at the top sink to the bottom of the beaker. This is called a convection current.

Activity 7.20: Demonstrate convection

Materials Needed: Two 500 ml bottles, hot water, a piece of newspaper, some food coloring (beetroot juice may be used)

Question:

1. Fill up one bottle with hot water.
2. Fill up the other bottle with cold tap water.
3. Cover the mouth of the bottle with cold water with a thin sheet of newspaper and invert it into the mouth of the bottle with hot water. Hold the two mouths of the bottles tightly with your fingers where they meet.

4. Predict what will happen as the cold water meets the hot water.
5. Observe what happens as the water gets through the thin layer of newspaper.
6. Write a conclusion based on your observation.

7.3.3 Radiation

The Sun's heat energy travels across empty space to the Earth mainly through radiation. Radiation is the transfer of heat energy by electromagnetic waves. Electromagnetic waves are special types of waves that can transfer heat energy. There is an important difference between the way convection and conduction transfer heat and the way that radiation does: Conduction and convection transfer heat energy through matter, either a solid, liquid or gas. But, radiation transfers heat energy by waves, not by matter. Radiation does not require physical contact or movement of particles. This means that radiation can transfer heat energy in a vacuum. A vacuum is a space in which there is no matter at all, not even a gas.

The heat energy from the Sun moves across the vacuum of empty space to reach the Earth's atmosphere through radiation. The Sun cannot transfer its energy to the Earth by conduction or convection because of the vast vacuum space between the sun and the earth.

All hot objects radiate electromagnetic waves. When radiation waves come into contact with another object, the heat energy of the waves are passed to that object. The object will absorb the radiation waves and become hot. Hands brought closer to a red hot bar heater get warmed through radiation. A microwave warms food by radiation.

Activity 7.21: Explain how radiation occurs

For many years, people have used fire to keep themselves and their homes warm in winter.

1. Explain what makes it possible for the fire to keep people's homes warm.
2. What does it mean when we say that radiation is a process whereby matter is not required for heat energy to be transferred?
3. Use your own real-life examples to explain how radiation occurs.
4. Why do people and animals sit out in the Sun in winter?

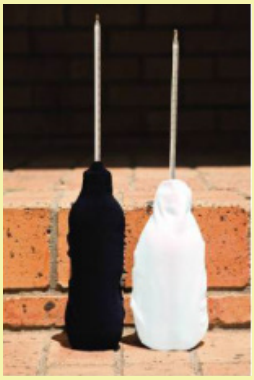
Not all substances absorb radiation waves and take in heat energy equally. Some substances absorb radiation waves easily and therefore become hot very quickly. Absorption is the process in which light strikes a surface and disappears, giving its energy to the surface in the form of heat.

Other substances reflect radiation waves. This means that the waves bounce off the substance. These substances do not heat up quickly. Black objects absorb radiation waves very well, therefore they heat up quickly. White and silver objects reflect radiation waves, so they heat up slowly. This means that on a sunny day, the inside of a white car will be cooler than the inside of a black car parked in same spot.

Activity 7.22: Investigate radiation

Materials Needed: Two 500 ml clear glass or plastic bottles with plastic lids, two thermometers, black and white cloth to wrap around the bottles, (Do this investigation on a bright, sunny day.)

1. Fill the two bottles with tap water.
2. Create holes on the lids to insert the thermometers.
3. Close the bottles and take the readings on the thermometers. Record the readings in the table.



4. Cover the bottles with the cloth: One bottle with the black cloth and the other bottle with the white cloth. Make sure that you can still read the thermometers.
5. Put both wrapped bottles in direct sunlight.
6. Record the reading every 30 minutes.
7. Which bottle recorded the highest temperature after 2 hours?
8. What conclusion can be drawn from this?
9. Draw a line graph to present your findings.
10. Explain why is not advisable to wear a black dress or jersey on a hot day.
11. Explain why you would not buy a black car if you were living in a hot area.

	Temperature			
Time elapsed →	30 min	1 hour	1½ hours	2 hours
Bottle covered with black cloth				
Bottle covered with silver cloth				

7.3.4 Insulation

You have learnt that heat can be transferred by three methods: Convection, conduction and radiation. In this subsection, we focus on the importance of insulation in preventing the loss of energy to the environment. This provides warmth and prevents the wastage of energy.

Activity 7.23: Melting Ice Cubes

Two similar ice cubes are placed next to each other outside in the sun. One is covered with a wool blanket.

Emebet: I think the uncovered ice cube will melt first, because the sun will hit it and the heat energy will change it into water.

Andualem: I think the covered ice cube will melt first, because heat from the sun will be trapped inside the wool blanket and raise the temperature.

Decide to whom you agree with and give an explanation why.

Here is some evidence you can use in your argument:

- Sunlight has both heat and light energy.
- Wool blanket are insulators, which means they stop transfer of heat.
- A dark blanket trap more heat than a light blanket.
- A white ice cube reflects sunlight.
- Heat energy melts ice.

You learnt that heat is a type of energy transfer from an area of high temperature to an area of low temperature. The transfer of heat can only occur if there is a temperature difference between the two locations. Heat is always transferred from the hotter area or object to the cooler one.

Warm-blooded organisms such as humans, other mammals, and birds have the ability to maintain a constant body temperature. When the internal body temperature is much higher than the temperature of the surroundings, heat moves from our bodies to the environment. We experience heat loss. Birds are covered with feathers and mammals with fur or wool to cope with this problem. Humans insulate their bodies with covering such as clothing and blankets.

During winter we must try to prevent heat escaping from the house to the environment through the walls, ceilings, windows, doors and roof. In summer, we must try to prevent heat from entering the house. We can solve these problems by using insulating materials.

People use insulating materials to help minimize heat loss in winter and heat gain in summer. Insulating materials slow down the transfer of heat. They slow down heat loss or heat gain through convection, conduction and radiation. Insulators are used for making things such as ‘cool boxes’ to keep food cold when travelling or going on a picnic and for winter clothing such as coats, jerseys, woolly hats and blankets.

You also learnt that metals are good heat conductors, but non-metals and gases, such as air, are poor conductors of heat. Poor conductors of heat are called insulators.

An insulator is a material that does not easily transfer heat energy. Insulators range from good to poor insulators. Good insulators are the best materials for trapping heat. Materials that are poor conductors can also be described as being good thermal insulators.

7.4 Simple circuit

Activity 7.24 Making a bulb lit.

Materials: Battery, insulated wire, and light bulbs

Explain how you connect a battery, a wire, and a bulb to light the bulb.

Procedures:

1. In your groups, try to use these materials to light the bulb.
2. Draw each setup whenever you make new trials. In addition, record your results.

Questions:

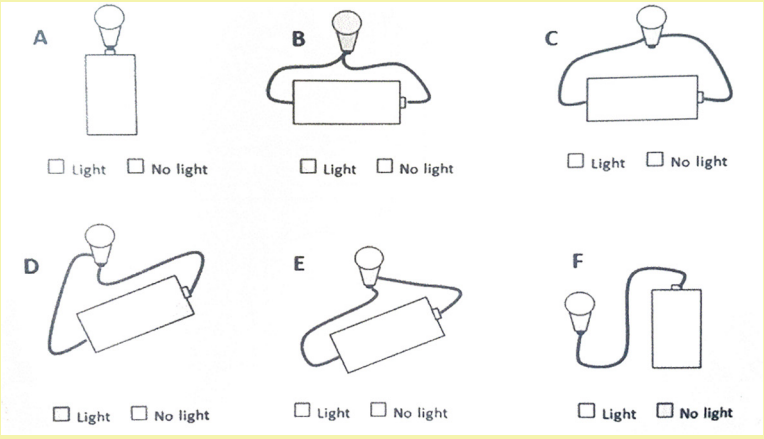
1. After you lit the bulb, compare the setup of your group with that of another group, who also lit the bulb.
2. How many setups were found in the classroom?

In Grade 6, you learned that electrical charges can build up as static electricity and be discharged. Electrical charges can also be made to flow continuously through materials. A flow of electrical charges is known as an electric current. Current electricity is different from static electricity, in which charges build up and stay in one place. Electric current keeps charges moving, like water flowing in a river or stream. In these section, we discuss about circuits.

7.4.1 Circuits

Activity 7.25 Giving Light

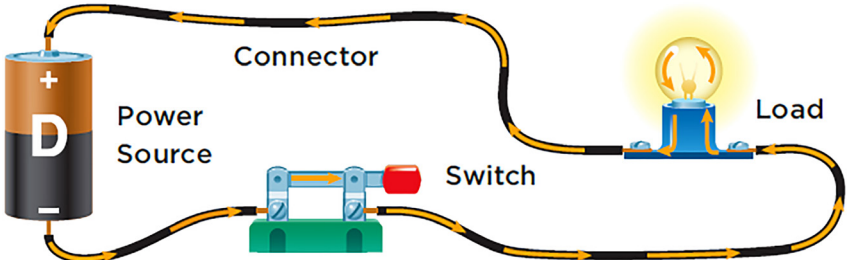
Which of the light bulbs below will give light? Give an explanation to your answers.



Electricity needs a path to carry the current. The path along which electric current flows is called a circuit. A simple circuit has three basic parts: power source, load, and connectors. The power source, such as a battery powers a load, such as a bulb or a computer. The power source and the load are connected by connectors or wires. A simple circuit may have additional parts. Many circuits have a switch. A switch turns electric current on and off. The lights in your classroom are controlled by a switch.

To keep charges moving, the circuit cannot have any breaks. A complete, unbroken circuit is called a closed circuit. Diagram A on Figure 7.7 shows a closed circuit since the switch is closed and electric current can flow through the circuit. If the circuit has any breaks or openings, it is called an open circuit. Diagram B on Figure 7.7 shows an open circuit, hence electric current cannot flow.

A.



B.

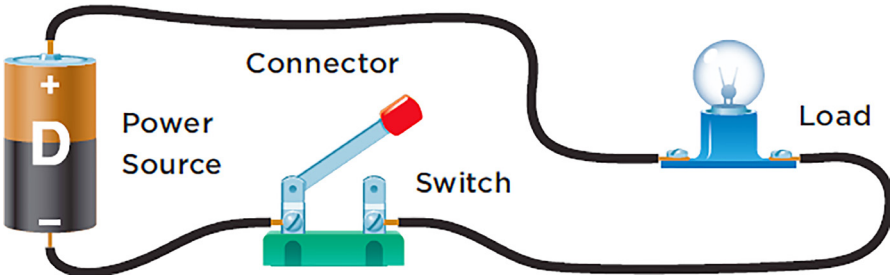
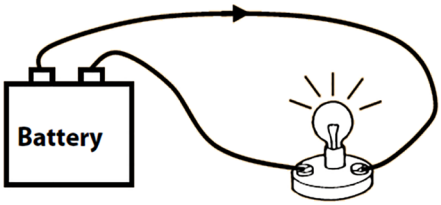


Figure 7.7 Closed Circuit (A) and Open Circuit (B)

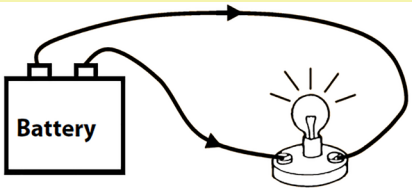
When a light bulb burns out, it makes an open circuit. This happens because a wire inside the bulb breaks in to two. The circuit no longer has a complete path, so electric current cannot flow through it.

Activity 7.26 Electric Current

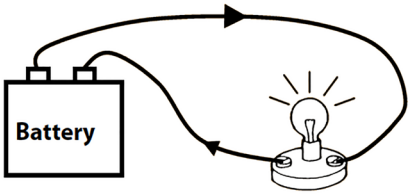
These are four different ideas for how current moves in an electric wire. Which idea do you think is most correct? Why?



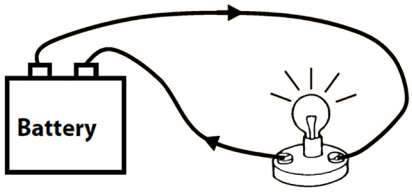
A) The current is in one wire only and moving to the lamp.



B) The current is in both wires and moving towards the lamp.



C) Current is going both ways, but less current is moving is moving back to the lamp.



D) The current is going both ways and is the same in both wires.

A. Series circuit

Picture a one-way circular road. All the cars on this road travel in the same direction in a line. This is how a series circuit works. In a series circuit, all the electrical charges flow in the same direction along a single path.

The parts of a series circuit are connected in one loop. The electric current moves along one path. The current moves from the power source through the wires to one load. It then moves through another load. Finally, the current returns through a wire to the power source. In a series circuit, the parts are connected like links in a chain. The electric current passes through each part one at a time.

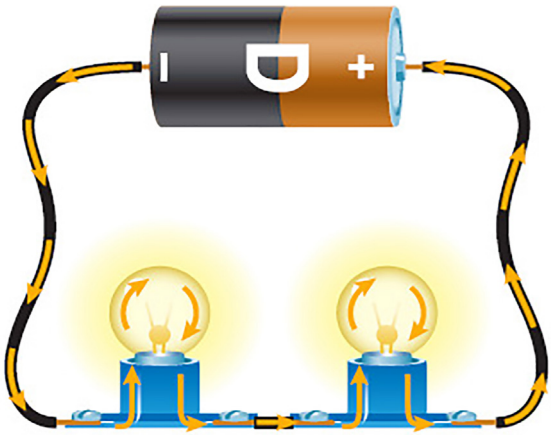


Figure 7.8 A diagram that shows series circuit

If any part of a series circuit is removed or broken, the circuit is open. None of the parts will work because current cannot flow in an open circuit.

Figure 7.8 shows a diagram of series circuit. What are the parts of a series circuit in order of the flow of electric current.

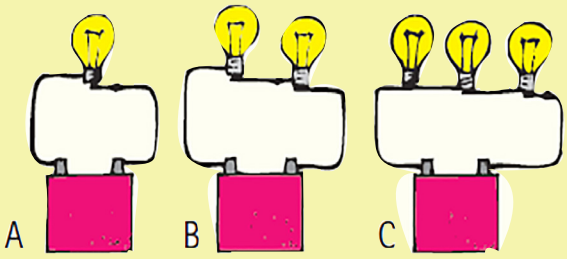
The rate of electrical flow is measured in amperes. An ampere is the rate of flow of 1 coulomb of charge per second.

Activity 7.27 Making a Series Circuit

Materials: Battery, insulated connecting wires, three light bulbs with holder, and ammeter

Procedures: All connections are in series.

1. Connect one battery with one bulb first as shown in diagram A.
2. Note the bulb brightness and record on the prepared table as dim, normal, bright, and very bright.



3. Measure the electric current of the circuit using ammeter and record on the prepared table.
4. Repeat Steps 1 to 3 for diagram B and C.

Diagnostic Questions:

1. What observations you make about the bulb brightness and electric current value for diagram A, B, and C?
2. Write an explanation to account for the bulb brightness and electric current value.
3. What happens if you remove one of the light bulbs?
4. What will happens to the brightness of the bulb and the electric current if you connect 1 battery with 1 bulb; 2 battery with 2 bulb; and 3 battery with 3 bulb?

B. Parallel circuit

A series circuit is like a circular road on which all the cars follow the same path. A parallel circuit is like a group of roads which all lead to the same place but along different paths. A parallel circuit is a circuit in which the electric current flows through more than one path.

These different paths are often called branches. The branches of a parallel circuit divide the electric current between them. Some of the electric current flows through one branch, some flows through another branch. In a parallel circuit, each part, or branch, has its own path for electric current. The electric current passes through all of them at the same time.

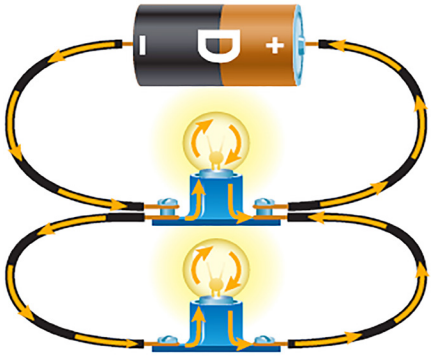


Figure 7.9 A diagram that shows parallel circuit

If a light bulb on one branch burns out, the light bulbs on other branches will still glow. If any branch of a parallel circuit is removed or breaks, current will still flow through the other branches. Figure 7.9 shows diagram of a parallel circuit. What will be the circuit connection if you connected two light bulbs on the bottom branch of the circuit?

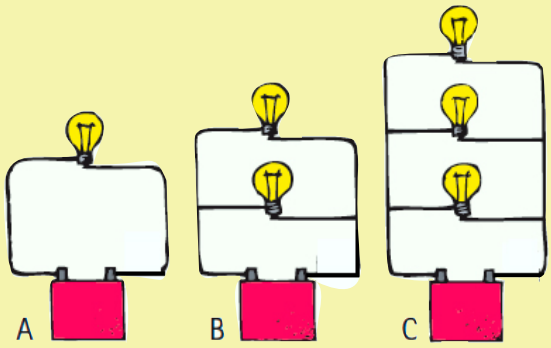
If a light bulb in your home burns out, what happens to the other light bulbs? Are the light bulbs part of a series or a parallel circuit?

Activity 7.28 Making a Parallel Circuit

Materials: Battery, insulated connecting wires, three light bulbs with holder and ammeter.

Procedures: All connections are in parallel.

1. Connect one battery with one bulb first as shown in diagram A.
2. Note the bulb brightness and record on the prepared table as dim, normal, bright, and very bright.



3. Measure the electric current of the circuit using ammeter and record on the prepared table.
4. Redo Steps 1 to 3 for diagram B and C.

Diagnostic Questions:

1. What observations you make about the bulb brightness and electric current value for diagram A, B, and C?
2. Write an explanation to account for the bulb brightness and electric current value.
3. What happens if you remove one of the light bulbs?
4. What will happens to the brightness of the bulb and the electric current if you connect 1 battery with 1 bulb; 2 battery with 2 bulb; and 3 battery with 3 bulb?

7.4.4 What affects electric current?

Activity 7.29 Power Sources and Electric Current

Do you think that all devices use the same number of batteries?

Now write a hypothesis about how adding batteries affect electric current in the circuit.

Questions:

1. To explore the effect of number of batteries on electric current in a circuit, design an experiment to investigate this relationship.
   a. What are the required materials?
   b. What are the steps followed?
   c. Record your results and observations.
2. Did your results support your hypothesis? Why or why not?
3. Repeat the experiment when batteries are connected in parallel, and vice-versa.

The amount of electric current that can flow through a circuit depends on voltage and resistance.

7.4.4.1 Voltage

Voltage is the strength of a power source. A power source with more voltage can produce more electric current. Voltage is measured in units called volts. A dry cell battery has 1.5 volts. Most wall outlets, which get power from a power plant, have 120 volts.

7.4.4.2 Resistance

Resistance is the ability of a substance to oppose or slow down electric current. Increasing the resistance of a circuit decreases the flow of electrical charges through it. Resistance allows electrical energy to be changed into other forms of energy, such as light and heat.

Copper wires are good conductors. They have very little resistance, so they can carry a great deal of electric current. Rubber is an insulator that has a large amount of resistance. It is difficult to make any electric current flow through rubber.

7.4.4.3 Ohm's law

Activity 7.30 Loads and Electric Current

The tables below show how the voltage and current vary in a portable radio and a portable CD player. Use these tables to answer questions 1 through 3.

Questions:

1. Plot the graph of voltage versus current for both devices on your graph paper.
2. Calculate the slope of these two devices and compare the two slopes.
3. What do you think about the relationship between slopes of the V-I graph?

Radio		CD Player	
Voltage (V)	Current (A)	Voltage (V)	Current (A)
2	1	2	0.5
4	2	4	1
6	3	6	1.5

A nineteenth-century German physicist, Georg Simon Ohm, carried out experiments that measured how changing the voltage in a circuit affected the current. He found a simple relationship among voltage, current, and resistance in a circuit that is now known as Ohm's law.

According to Ohm's law, when the voltage in a circuit increases the current increases. However, if the voltage in the circuit doesn't change, then the current in the circuit decreases when the resistance is increased.

In equation form, Ohm's law often is written as follows.

Ohm's Law

Voltage (in volts) = current (in amperes) X resistance (in ohms)

$V = IR$

Now, do question 3 of Activity 7.30

Activity 7.31 Computing V, I, and R using Ohm's Law

1. A light bulb is plugged into a wall outlet. If the light bulb has a resistance of 220 Ω and the current in the light bulb is 0.5 A, what is the voltage provided by the outlet?
2. What is the current in a flashlight bulb with a resistance of 30 Ω if the voltage provided by the flashlight batteries is 3.0 V?
3. What is the resistance of a light bulb connected to a 110-V wall outlet if the current in the light bulb is 1.0 A?

7.5 Magnetism

7.5.1 Magnets

Activity 7.32 Magnets and their Interaction

Materials Needed: 2 bar magnets with the poles marked

Predict:

1. What happens when one magnet is near another magnet?
2. How do different parts of magnets interact?

Procedures:

1. Bring the north pole of one magnet close to the north pole of another magnet. Record what happens. Then try it again.
2. What do you think will happen if you bring the south poles of the magnets near each other? Make prediction first
3. Bring the south poles of the magnets near each other and record the result.
4. Bring the north pole of one magnet close to the south pole of the other magnet. Record what happens. Try it again.

Questions:

1. What happens when like poles (south-south or north-north) of two magnets are brought together?
2. What happens when unlike poles (south - north) are brought together?
3. Based on your responses to Question 1 and 2, draw your conclusions.
4. Explore which part of the magnet is stronger.
5. What procedures will you follow to find the strongest parts of a horseshoe or disc magnet?

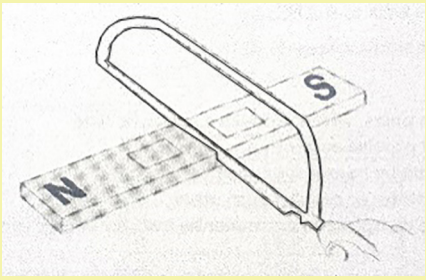
You may have played with magnets and watched them pull or push each other. Magnets can also attract other objects. A magnet can affect an object without even touching it. When you bring two magnets close together, they will either repel or attract each other. The force that pushes magnets apart or pulls them together is called magnetic force. A magnet is any object with magnetic force.

The parts of a magnet where the magnetic force is strongest are called the magnetic poles. All known magnets have two poles—a north pole and a south pole. When two magnets are brought together, a north pole and a south pole attract each other. Like poles (north - north or south-south) repel each other.

Magnets that are far apart do not pull or push enough to move each other. The magnetic force between two magnets is weak when magnets are far apart. The magnetic force gets stronger as the magnets are brought closer together.

Activity 7.33 Cutting a Magnet

A bar magnet is cut into two with a hacksaw. Write "N" or "S" in each box on the diagram to show the polarity of the cut ends. Explain your answer.



Certain materials have strong magnetic fields around them. These are called magnets. All magnets have two poles, a north and a south pole. Other materials are strongly attracted to magnets. These materials are said to magnetic. Magnets exert forces on other magnets and magnetic materials. Which materials are magnetic? Let's investigate.

Activity 7.34 Magnetic or non-magnetic materials

Which materials are magnetic and which are not? Write a hypothesis for this investigation.

Materials Needed: Bar magnets, paper, wood, plastic, iron, aluminum, steel

Material	Magnetic (Yes / No)
Aluminum	
Copper	
Iron	
Paper	
Plastic	
Steel	
Wood	

Procedure:

1. Hold the different items close to the bar magnet (not touching) to see if they are attracted to the magnet.
2. Complete the table indicating whether the items are attracted to the magnet or not.
3. What can you conclude from your results?

Based on Activity 7.34, you had observed that not all metals are attracted to magnets. Those that are attracted to magnets are known as magnetic materials. There are very few magnetic materials. They are iron, nickel and cobalt. Alloys which include any of the magnetic materials can also be attracted to magnets. Steel is an alloy which contains iron so steel can be attracted to a magnet.

So now we know that magnetic forces can act over a distance, but can they still act if there is something in the way? Let's find out.

Activity 7.35 Magnetic force through substances

Can a magnetic force act through substances? Write a hypothesis for this investigation

Materials Needed: Bar magnets, paper, thin piece of wood, thick piece of wood, foil, paper clips

Procedure:

1. Put the paper clips on the desk.
2. Try to pick up the paper clips with the magnet but put one of the other materials between the magnet and the paper clips. Are the paper clips still attracted to the magnet?
3. Try each of the different materials between the magnet and the paper clip.

Questions:

1. Were there any materials, which prevented the magnet from picking up the paper clips?
2. What does this activity tell us about the nature of the magnetic force?

7.5.2 Magnetic fields

In Activity 7.35, we saw that like poles repel each other but opposite poles attract each other. We have also seen that the magnetic force acts over a distance. The magnet does not need to touch something in order to exert a force on it. So a magnetic force is a non-contact or a field force. What is a force field? Can we see it? Let's investigate if it is possible to see a magnetic field.

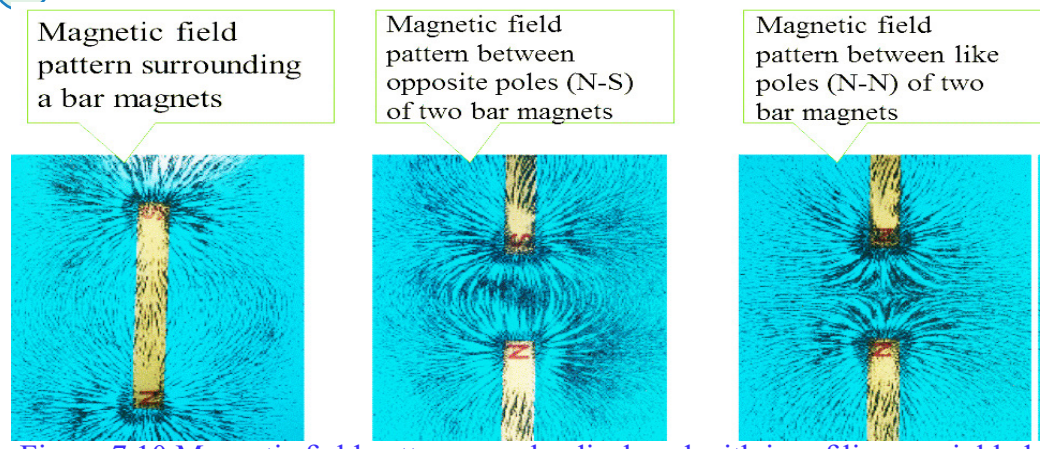


Figure 7.10 Magnetic field patterns can be displayed with iron filings sprinkled on paper near magnets.

Activity 7.36 Visualizing Magnetic Fields

Materials Needed: Iron filings, two bar magnets, paper

Procedure:

1. Put the bar magnet on the table.
2. Put the paper over the magnet.
3. Shake the iron filings onto the paper.
4. Use your finger to slowly push the filings around the magnet.
5. Take note of the pattern and draw it.
6. Lift the paper away from the magnet.
7. Place a second magnet next to the first so that different poles are facing each other.
8. Put the paper back over the magnets.
9. Move the iron filings around the two magnets, especially between the magnets.
10. Draw and show the pattern you have observed.
11. Lift the paper away from the magnet.
12. Move the second magnet so that the same poles are facing each other.
13. Put the paper back over the magnets.

14. Move the iron filings around the two magnets, especially between the magnets.
15. Draw and show the pattern you have observed.

As we have seen, it is possible to visualize the magnetic force field around a magnet. We know from our previous activities that the magnetic force acts over a distance. The field is the space around a magnet in which it can attract or repel another magnet.

How do we draw a force field? Field lines can represent the pattern you saw with your magnets. Field lines are used to show something we can't actually see.

The properties of field lines are:

a) Magnetic field lines forms closed loops.

b) Magnetic field lines do not cross or intersect each other.

c) The field lines go from the north pole to the south pole.

d) The closer the field lines are drawn together, the stronger the field being described.

e) The more field lines that are drawn, the stronger the field.

Figure 7.9 shows the field lines between bar magnets which are attracting and those which are repelling. Opposite poles attract. Like poles repel. A field is strongest next to the magnet and gets weaker further away from the magnet.

Did you know that the Earth is like a bar magnet with a North and a South Pole?

The Earth has a magnetic field. You can imagine Earth's magnetic field as though there is a bar magnet running through the core with the magnet's south pole under Earth's North Pole. No one knows for sure, but the theory is that the super hot liquid iron in the Earth's core moves in a rotational pattern, and these rotational forces lead to the weak magnetic forces around the Earth's rotational axis.

The Earth's magnetic field is the reason why we can use compasses to tell direction. A plotting compass has a needle with a small magnet. The needle points to magnetic north because the small magnet is attracted to the opposite magnetic field and can be used to determine direction.

Charged particles escape from the surface of the Sun and move outwards in all directions. When the charged particles reach Earth, some are trapped by Earth's magnetic field in areas in space around Earth's atmosphere, called belts.

Sometimes the charged particles escape the belts and spiral along the magnetic field lines towards the magnetic poles where they enter Earth's atmosphere. They then interact with atmospheric gas particles, causing beautiful light shows.

Activity 7.37 Making a Compass

Materials Needed: Dish or cup with water, needle, bar magnet.

Procedures:

1. Fill a dish or cup with water.
2. Magnetize a craft needle by rubbing it many times with a permanent magnet.
3. Drag the magnet from the eye of the needle to the point. Then put the magnet away.
4. Push the magnetized needle through a piece of foam.
5. Place the needle and foam into the dish. They should float on the surface of the water.
6. Predict Which direction will the needle point?
7. If you move it, does it turn back to this position?
8. If you held the south pole of a magnet next to a compass, what would happen?
9. Would an astronaut need a compass in space? Why or why not?

A compass is an instrument that uses Earth's magnetic field to help people find directions. A compass needle is actually a thin magnet. The needle points north because it lines up with Earth's magnetic field. Since a compass needle points north, the compass can be used to tell north, east, south, and west, and other directions in between.

7.5.3 Electromagnets

Activity 7.38 Electric Current and Magnets

Can electric current move a magnet? Write a hypothesis for this investigation

Materials Needed: Wire, compass, battery, battery-holder whenever available

Procedures:

1. Wrap fine wire around a compass in several loops.
2. Turn the compass so its needle stays lined up with the coils of wire.
3. Connect the wire ends to the battery to make a circuit. What change do you notice in the compass?
4. What does the compass needle do when you connect and disconnect the battery?

Questions:

1. What happened to the compass needle when electric current was flowing?
2. Why did this happen?
3. Did you detect a magnetic field around the wire when there was no current?
4. What will happen if you reverse the wires on the battery?

In the 1820s and 1830s, scientists such as Michael Faraday and Joseph Henry made some amazing discoveries about electric currents and magnets. They found that electric currents make magnetic fields and that magnets could generate, or make, an electric current.

When an electric current flows through a wire, it creates a magnetic field around the wire. Increasing the current makes the magnetic field stronger. You can also make the magnetic field stronger by winding the wire into a long coil. Each loop of wire is like a little magnet that has its own magnetic force. The loops all push and pull in the same direction. Electromagnets can make even stronger magnetic fields.

An electromagnet is a coil of wire wrapped around a metal core, such as an iron bar. When an electric current flows through the coil, it creates a magnetic field.

This magnetic field causes particles inside the metal core to line up. The metal core becomes magnetic. When the current stops, the metal core is no longer magnetic.

7.5.4 Motors and generators

Activity 7.39. Can magnets create motion?

Materials Needed: Paper clips, wire, battery, adhesive tape, waterproof marker, battery holder, strong magnet wire, bar magnet.

Procedures:

1. Straighten one turn of each paper clip, making one long end. Insert the long ends into the terminals of the battery holder.
2. Make a coil by wrapping the wire around the battery many times. A few centimeters of wire should stick out from each side. Slide the coil off the end of the battery.
3. Tape the loops together so that they hold their shape. Bend the ends of the wire out.
4. Then use a marker to color the top half of one of the wire ends.
5. Fit the battery into the battery holder.



6. Place the coil ends inside the paper clips.
7. Put a magnet under the coil.
8. Push the coil to start the motion.

Questions:

1. What is making the wire loop turn?
2. Where is the energy to turn the loop coming from?
3. How can you make your motor go faster?

7.5.4.1 Electric motors

Electric motors are used in everyday devices such as refrigerators, air conditioners, and electric trains. An electric motor is a device that changes electrical energy into mechanical energy, or motion. Electric motors power tools, toys, and other machines.

A simple electric motor has a power source, a permanent magnet, a rotating loop of wire, and a motor shaft. The shaft is a rod that can spin and move. An electric current runs through the wire loop, making a magnetic field. The permanent magnet pushes and pulls on the wire loop. This causes the wire loop to spin. The wire loop then turns the motor shaft, which might turn a wheel or a gear.

In larger motors, the loop of wire is made into a coil that is wound hundreds of times around an iron cylinder. This makes a strong electromagnet. It has a much stronger magnetic field than a single wire loop. The electromagnet feels more push and pull from the permanent magnets. The motor might use this stronger force to move something heavy or spin faster.

How does a simple electric motor work? How might an electric train use the spinning motion produced by the motor?

7.5.4.2 Generators

An electric generator converts motion into electrical energy. The opposite of a motor, it changes mechanical energy into electrical energy. We depend on electric generators to produce nearly all of our electrical energy.

A simple generator has many of the same parts as a motor. Mechanical energy turns the wire loop between two magnetic poles. The magnetic field produces an electric current in the wire. As the wire gets closer to the magnetic poles, electrical charges are pushed through the wire. The moving electrical charges make an electric current.

How does a simple generator work? What do simple generators and simple electric motors have in common?

Electrical energy can also be generated by spinning a magnet inside a coil of wire. The more loops of wire in the coil, the more electrical energy is produced.

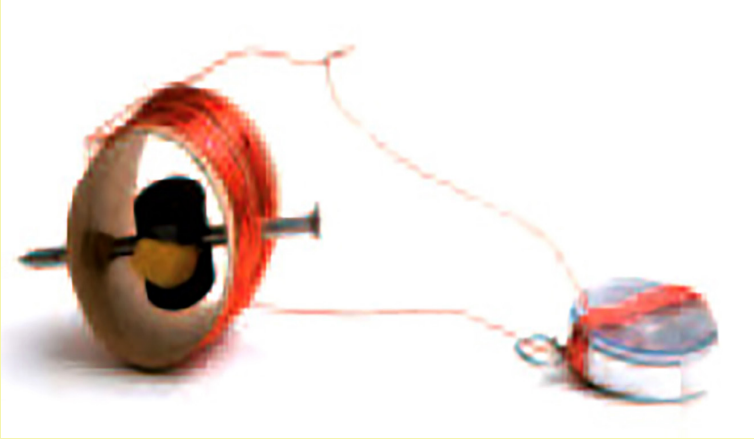
The mechanical energy for a generator is provided by a turbine. A simple turbine looks like an electric fan. Steam, water, or air is used to turn the fan blades. The spinning blades are attached to a shaft which spins the wire loop or magnet inside the generator.

Activity 7.40 Making a Generator

Materials Needed: Paper clips, wire, battery, adhesive tape, waterproof marker, battery holder, strong magnet wire, bar magnet.

Procedures:

1. Push a nail through a cardboard tube.
2. Place a lump of clay on the nail inside the tube.
3. Stick a disc magnet on each side of the clay.
4. Wrap wire 50 times around the tube near the nail.



5. Wrap the extra wire around a compass several times.
6. Twist the ends of the wire together.
7. Turn the compass so that the needle lines up with the wire.
8. Spin the nail so that the magnets spin inside the tube.

Questions:

1. What does the compass needle do?
2. Is electric current flowing?

Most generators that make electrical energy produce an alternating current (AC). Alternating current flows in one direction and then flows in the opposite direction. The electrical charges continuously flow back and forth. Electrical wall outlets, such as those in your home and school, use alternating current.

When the flow of a current is always in one direction, it is called a direct current (DC). In a DC circuit, electric current flows continuously without stopping or reversing direction. A battery is an example of a DC power source. Some electrical devices, such as computers, change alternating current from the wall outlet into direct current. The box on the train's power cord changes alternating current into direct current.

What is the difference between alternating current and direct current? What devices have you used today that use direct current?

Summary

- Light travels from a light source in straight lines. We see things because light hits an object and is then reflected from the object's surface to our eyes. We cannot see anything without light.
- Regular reflection takes place when light is incident on smooth, polished and regular surfaces.
- Diffused or irregular reflection takes place from rough surfaces.
- Two laws of reflection are:
- The angle of incidence is equal to the angle of reflection. Incident ray, reflected ray and the normal drawn at the point of incidence to the reflecting surface, lie in the same plane.
- Image formed in a plane mirror undergoes lateral inversion.
- White light, consists of seven colours: violet, indigo, blue, green, yellow, orange, and red.
- Splitting of light into its constituent colours is known as dispersion
- Sound is produced by vibrating objects.
- In human beings, the vibration of the vocal cords produces sound. The eardrum senses the vibrations of sound, It sends the signals to the

brain. This process is called hearing.

- Sound travels through a medium (gas, liquid or solid). It cannot travel in vacuum.
- Unpleasant sounds are called noise.
- Excessive or unwanted sounds lead to noise pollution. Noise pollution may pose health problems for human beings.
- Attempts should be made to minimize noise pollution.
- The heat flows from a body at a higher temperature to a body at a lower temperature. There are three ways in which heat can flow from one object to another. These are conduction, convection and radiation.
- In solids, generally, the heat is transferred by conduction. In liquids and gases the heat is transferred by convection. No medium is required for transfer of heat by radiation.
- The materials which allow heat to pass through them easily are conductors of heat. The materials which do not allow heat to pass through them easily are called insulators.
- Dark-coloured objects absorb more heat than the light-coloured objects. That is the reason we feel more comfortable in light-coloured clothes in the summer.
- An electric circuit is a complete path for the flow of electric current. It may consist of different items like a source of potential difference, switches connecting wires, and a lamp.
- Electron current is the flow of electrons from negative terminal to positive terminal of the source.
- Voltage is the strength of a power source.
- Ohm's law states the relationship between current and voltage. It states that: "The current flowing through a metallic conductor is directly proportional to the voltage between the two ends."
- An electric current passing through a conductor produces a magnetic field in the surrounding.

- A current carrying wire in an external magnetic field experiences a force.
- An electric motor is a device that converts electrical energy into mechanical energy (kinetic energy.)
- A electric generator is a device used to convert mechanical energy into electrical energy. It makes use of the principle of electromagnetic induction.

Review questions

I. Fill in the blank space

1. Copper is a good _____ of electrical charges.
2. The amount of electric current in a circuit depends on voltage and _____.
3. A complete path in which electric current can flow is a _____
4. If one light bulb in a _____burns out, none of the other bulbs in the circuit will shine.
5. If one bulb in a _____burns out, the other bulbs in the circuit will still shine.
6. A flow of electrical charges through a circuit is called _____.
7. Electric current produces a magnetic field in an _____
8. The area of magnetic force around a magnet is called its _____
9. Electrical energy is converted into mechanical energy or motion by a _____
10. Every magnet has a north and a south _____

II. Multiple choice: Choose the correct answer

11. Why is the heating coil placed at the bottom of an electric kettle?

A) It will save space.
C) Hot air rises.
B) Conduction occurs in metals.
D) Hot water rises.

12. Why does the air conditioner unit in a room have to be placed close to the ceiling?

A) It will allow a convection current to form.

B) Hot air is trapped against the ceiling.

C) Cold air sinks.

D) Air that is less dense sinks.

13. Why do shiny teapots keep tea warmer for longer than black teapots?

A) They radiate heat inwards and outwards

B) They reflect heat back into the tea.

C) They attract air which is a good insulator.

D) They absorb heat far more efficiently than black tea pots.

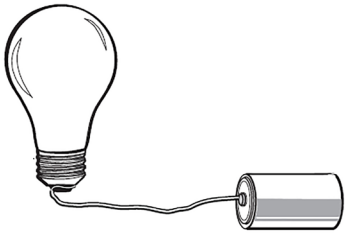
14. A student made the circuit in the drawing below. What does the student need to add to the circuit to make it work?

A) another bulb

B) another batter

C) a switch

D) another wire



15. Which of the following best describes an electric current?

A) a series of electrical wires

B) a flow of electrical charges

C) a surge of electrical power

D) a chain of electrical batteries

III. Answer the following questions

8. Arrange the following objects in order from the one with the smallest size to the biggest size.

   Moon Saturn Earth Star Sun

9. One of the students said, "It's not possible to tell which is the biggest object!"

   Do you agree, partially agree, or disagree with the student? _____

   Explain how you would rank the size of these objects and why.

10. Which statement best describes the movement of the Earth and Sun?

    A) The Earth goes around the Sun once a day.

    B) The Sun goes around the Earth once a day.

    C) The Earth goes around the Sun once a year.

    D) The Sun goes around the Earth once a year.

    Explain your thinking. Describe the evidence that supports your answer.

    A) a series of electrical wires C) a surge of electrical power

    B) a flow of electrical charges D) a chain of electrical batteries

16. Five light bulbs are connected to one battery. When one bulb burns out, the others continue to shine. The bulbs are part of _____

    A) a parallel circuit. C) an open circuit.

    B) a series circuits. D) a circuit breaker

17. Earth can be thought of as a giant magnet because it _____

    A) orbits around the Sun. C) rotates on its axis.

    B) has a magnetic field D) has a moon.

18. Magnetic force becomes stronger when magnets are _____

    A) both metal. C) different sizes.

    B) farther apart. D) closer together

19. What does an electric motor do?

A) changes magnetic fields
B) changes the voltage of electric current
C) produces electric current
D) changes electrical energy into motion

20. What causes the wires in a generator to spin?

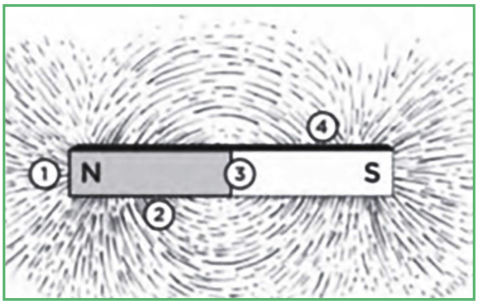
A) heat energy
B) electrical energy
C) light energy
D) mechanical energy

21. What happens when a magnet is brought near an iron nail?

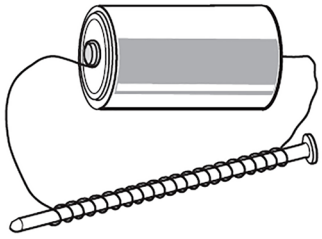
A) The magnet attracts the nail.
B) The nail attracts the magnet.
C) The nail becomes magnetic.
D) Nothing will happen.

22. Iron filings were sprinkled around a magnet, as shown in the figure. Where the magnetic is force strongest?

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



23. Look at the simple electromagnet below. How can you make the electromagnet's magnetic field stronger?



A) Remove the iron nail.
B) Use a wooden nail instead of an iron nail.
C) Wrap more coils of wire around the nail.
D) Wrap fewer coils of wire around the nail.

III. Answer the following questions.

1. Assume you are in a dark room. Can you see objects in the room? Can you see objects outside the room. Explain.
2. Differentiate between regular and diffused reflection. Does diffused reflection mean the failure of the laws of reflection?