THE REPUBLIC OF UGANDA

Ministry of Education and Sports

HOME-STUDY LEARNING

SENIOR 1

PHYSICS

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This material has been developed as a home-study intervention for schools during the lockdown caused by the COVID-19 pandemic to support continuity of learning.

National Curriculum Development Centre
P.O. Box 7002,
Kampala- Uganda
www.ncdc.go.ug

FOREWORD

Following the outbreak of the COVID-19 pandemic, government of Uganda closed all schools and other educational institutions to minimize the spread of the coronavirus. This has affected more than 36,314 primary schools, 3129 secondary schools, 430,778 teachers and 12,777,390 learners.

The COVID-19 outbreak and subsequent closure of all has had drastically impacted on learning especially curriculum coverage, loss of interest in education and learner readiness in case schools open. This could result in massive rates of learner dropouts due to unwanted pregnancies and lack of school fees among others.

To mitigate the impact of the pandemic on the education system in Uganda, the Ministry of Education and Sports (MoES) constituted a Sector Response Taskforce (SRT) to strengthen the sector's preparedness and response measures. The SRT and National Curriculum Development Centre developed print home-study materials, radio and television scripts for some selected subjects for all learners from Pre-Primary to Advanced Level. The materials will enhance continued learning and learning for progression during this period of the lockdown, and will still be relevant when schools resume.

The materials focused on critical competences in all subjects in the curricula to enable the learners to achieve without the teachers' guidance. Therefore effort should be made for all learners to access and use these materials during the lockdown. Similarly, teachers are advised to get these materials in order to plan appropriately for further learning when schools resume, while parents/guardians need to ensure that their children access copies of these materials and use them appropriately.
I recognise the effort of National Curriculum Development Centre in responding to this emergency through appropriate guidance and the timely development of these home study materials. I recommend them for use by all learners during the lockdown.

Alex Kakooza
Permanent Secretary
Ministry of Education and Sports

ACKNOWLEDGEMENTS

National Curriculum Development Centre (NCDC) would like to express its appreciation to all those who worked tirelessly towards the production of home–study materials for Pre-Primary, Primary and Secondary Levels of Education during the COVID-19 lockdown in Uganda.

The Centre appreciates the contribution from all those who guided the development of these materials to make sure they are of quality; Development partners - SESIL, Save the Children and UNICEF; all the Panel members of the various subjects; sister institutions - UNEB and DES for their valuable contributions.

NCDC takes the responsibility for any shortcomings that might be identified in this publication and welcomes suggestions for improvement. The comments and suggestions may be communicated to NCDC through P.O. Box 7002 Kampala or email admin@ncdc.go.ug or by visiting our website at http://ncdc.go.ug/node/13.

Grace K. Baguma
Director,
National Curriculum Development Centre

ABOUT THIS BOOKLET

Dear learner, you are welcome to this home-study package. This content focuses on critical competences in the syllabus.

The content is organised into lesson units. Each unit has lesson activities, summary notes and assessment activities. Some lessons have projects that you need to carry out at home during this period. You are free to use other reference materials to get more information for specific topics.

Seek guidance from people at home who are knowledgeable to clarify in case of a challenge. The knowledge you can acquire from this content can be supplemented with other learning options that may be offered on radio, television, newspaper learning programmes. More learning materials can also be accessed by visiting our website at www.ncdc.go.ug or ncdc-go-ug.digital/. You can access the website using an internet enabled computer or mobile phone.

We encourage you to present your work to your class teacher when schools resume so that your teacher is able to know what you learned during the time you have been away from school. This will form part of your assessment. Your teacher will also assess the assignments you will have done and do corrections where you might not have done it right.

The content has been developed with full awareness of the home learning environment without direct supervision of the teacher. The methods, examples and activities used in the materials have been carefully selected to facilitate continuity of learning.

You are therefore in charge of your own learning. You need to give yourself favourable time for learning. This material can as well be used beyond the home-study situation. Keep it for reference anytime.

Develop your learning timetable to ca ter for continuity of learning and other responsibilities given to you at home.

Enjoy learning

SENIOR ONE

These home study materials have been developed to help you continue with learning despite the closure of schools that was necessitated by the Covid-19 pandemic. They are a continuation of the first home study materials that were previously developed. They will help you understand the major concepts in different topics in Physics for your level.

A variety of activities and exercises have been provided. Please try out all the activities and exercises to improve your understanding of the topics. Where possible, consult with other learners in your area. You can also consult from other sources like textbooks and use internet to further your knowledge. However, ensure that you are following the standard operating procedures (SOPs) so as to avoid Covid-19. You should ensure that you regularly wash your hand with soap and water and avoid crowded places. In case you are to be in public, always put on your mask.

All the best as you continue to study using these materials.

CHAPTER: STATES OF MATTER

LESSON 1: MEANING OF MATTER

Competences

You should be able to:

- understand the meaning of matter.
- understand that atoms are the building blocks from which all matter is made.
- appreciate that the states of matter have different properties.

Learning Resources /Materials

Sand, match box, dried grass, plastic cup, water in a Jerry can, source of heat,and candles,

Introduction

When you look around your house, you see many things. When you are at the lake or river shores or the beach, you see heaps of sand (Fig 1), water and even feel the air breeze. All these things are different but made up of tiny particles. The study of matter and its states will help you understand this.

Figure 1: Heaps of sand at the lake shores

The heaps of sand and any other substances around us are made up of tiny particles called **atoms.**

What is matter?

All the things around us are called Matter. Matter takes up space. It also has weight. Matter exists in many shapes, colours, textures, and forms. Water, rocks, living things, and stars are all made of matter. The study of matter is important because it guides us to classify things.

You can do the following:

Study Figure 2. List at least **five** different things in the figure which are forms of matter.

Exercise 1

Look at the items in Figure 2. Make a table with three columns labelled 'solid', 'liquid' and 'gas', and classify the items in the figure.

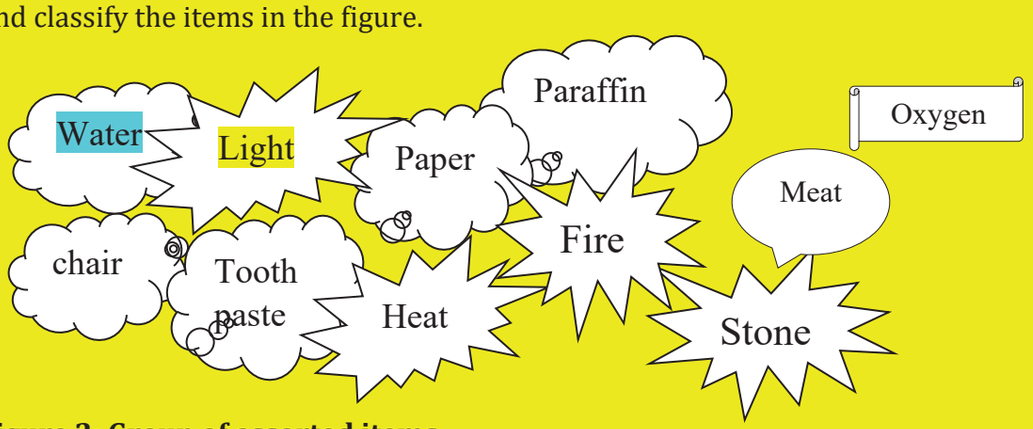


Figure 2: Group of assorted items

In the above items, are there items which are not matter? If so, what are they? They could be energy (heat and light) or ideas.

States of matter

At Primary School, you learnt that matter exists in different states, namely solids, liquids, gases. There is another state of matter called plasma.

What are properties of solid, liquid and gas?

Activity 1: Categorising materials according to their properties

Identify and list substances in your environment that:

- Can be held and kept in the hand.
- Change shape (have no definite shape)
- Flow (pours) into a heap
- Flow (pours) but not in a heap

Now let us examine the properties of the states of matter

A solid

- It cannot move unless something or someone moves it.

- It keeps its shape unless it is broken or burned.
- Its volume stays the same (unless it is heated or cooled).

A liquid

- It can flow.
- It takes the shape of the container.
- Its volume stays the same (unless it is heated or cooled).

A gas

Have you ever smelt the flavour of the food when it is being prepared in the kitchen? What if one opens a bottle of perfume from one corner of the room, can a person in another corner smell the perfume? This is what happens. If someone is cooking in the kitchen, it doesn't take long for the smell to travel around the house to other rooms. Gas particles from car exhaust fumes, perfumes or flowers move through the atmosphere. The particles in gaseous form move through air from food or any other thing that has a smell and this movement is called **diffusion**. Gas has the following properties:

- It can flow.
- It will spread out as far as it can.
- It will change its shape.
- Its volume will change when it spreads out.

*Did you know that liquids and gases are referred to as **fluids** because they can both flow?*

LESSON 2: PARTICLE NATURE OF MATTER

Competences

You should be able to:

- apply the particle theory to explain diffusion and Brownian motion and their applications.
- understand how the particle theory of matter explains the properties of solids, liquids and gases, changes of state, and diffusion.

Materials

- Match box, grass (dry), water, salt sauce pan, transparent mineral water bottles, chlorophyll squeezed out of leaves.

Introduction

When someone smokes from the compound in the evening, you can easily smell the cigarette and tell your brother or sister that someone is smoking.

Have you ever smelt the flavour/aroma of the food when it is being prepared in the kitchen? What if one opens a bottle of perfume from one corner of the room, can a learner in another corner smell the perfume? This is what happens. If someone is cooking in the kitchen, it doesn't

take long for the smell to travel around the house to other rooms. Gas particles from car exhaust fumes, perfumes or flowers move through the atmosphere. The particles in gaseous form move through air from food or any other thing that has a smell and this movement is called **diffusion**.

What causes the smell to move, is because of the particles (molecules/atoms) are in a state of random continuous motion. The smell moves from where it is much to the areas where it is less. The movement of molecules/atomsfrom a region of high concentration to a region of low concentrationis called diffusion. Note that diffusion is faster in gases than solids or liquids.***Can you suggest why?***

Activity 1: Investigating evidence of particles using a liquid

Key question
How do we know that solids and liquids are made of particles which are in a state of random motion?

What to do

1. Fill two containers (transparent mineral water bottles) with water and allow the water to settle.
2. Carefully place a coloured pigment (chlorophyll) in the water on one side of one of the containers.
3. Using a straw place some crystals of potassium permanganate at bottom of the other container with water.
4. Do not move the containers. Look at what happens to all of them during the rest of the time. Leave them overnight and look again. What is the difference between them?

What happened to the coloured pigment(chlorophyll)? Did you see that the pigment changed the colour of the water? This can be explained by the idea of particles in motion.

Each particle leaves the pigment(chlorophyll) in between the particles of water and spreads. You cannot see each particle because the particles are very, very small. When particles of a substance spread from one region to another, the process is called **diffusion**. After some time all the particles from the potassium permanganate crystal have spread evenly throughout the water to form a **purple solution**.

Think of coloured liquid like ink. What would happen to the colour of water if a drop of ink is put into a glass of water?

The particles in the ink will also diffuse (spread) throughout the water until the colour becomes the same throughout the solution.

Activity

i) Now that you know what diffusion is all about, identify two cases/processes that explain diffusion.
ii) Explain two ways in which diffusion is important in your family or community.
iii) Can you explain the properties of solids, liquids and gases using diffusion of particles?

LESSON 3: PLASMA AS A STATE OF MATTER

Competences

You should be able to understand the meaning and importance of Plasma in Physics.

What you may need:

Television screens, fluorescent tube, looking at stars, recalling lightning happening

Introduction

Lately, another state of matter has been discovered. This state of matter is called **plasma.**

Plasmas are a lot more like **gases**, but the atoms are different because they are made up of free **electrons** and ions of an element such as **neon**. You don't find naturally occurring plasmas too often when you walk around. They are not t things that happen regularly on earth. While natural plasmas arenot found around you that often, human-made plasmas are everywhere. You encounter it every day, but may not recognize it.

Figure 1 shows some examples of the forms of plasma: stars (including the Sun) and lightning.

Figure Plasma

Plasma has these properties:

- Plasma is ionized gas.
- Plasma is a very good conductor of electricity and is affected by magnetic fields.
- Plasmas, like gases, have an indefinite shape and an indefinite volume.
- Plasmas are less dense than solids or liquids.

Activity

a) Now that you know what plasma is and what it involves, why do you think we need to study plasma in Physics?
b) Why is plasma physics important to you, family and the community?

CHAPTER: THE EFFECTS OF FORCES

LESSON 1: MEANING OF FORCE

Competences:

You should be able to:

- know the meaning of a force as a push or a pull and that the unit of force is the Newton.
- categorise forces as contact and non-contact.

What you need:

Jerrycan full of water, wooden blocks or bricks,ropes, rubber band

Introduction

Have you ever carried a Jerrycan full of water or any luggage? How do you feel when you try to lift that same Jerrycan full of water? Secondly consider a case where you have ever pulled a goat by the rope. What do you feel when you pull a goat? Take another example when people are pushing a vehicle which is stuck in the mud on ditch.

What you may have experienced is a force in some way. Forces play a role in everything that we do. It may be kicking a ball, turning a tap, or even taking a bite! What shows that there is a force? In this lesson, you will learn different kinds of forces and how they affect objects.

Look at the picture below:

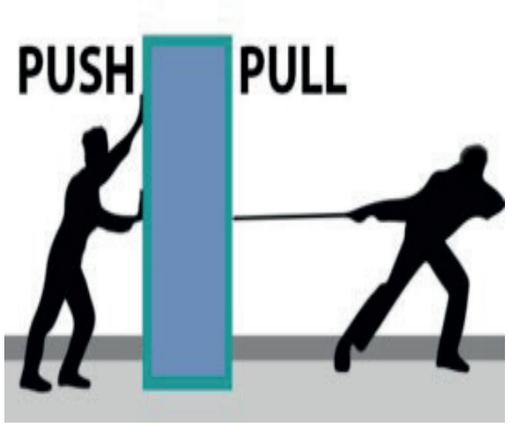


Figure 1: Observing a Push or Pull

In all the cases, you feel something is pushing or pulling you. This push or pull called a **force**.

A force is a push or pull upon an object resulting from the object's interaction with another object.

Meaning and Measurement of Force

Look at the pictures in **Fig 2** below. Can you identify what is being done in each case? What does it involve?

Figure 2: Some uses of forces

Force is measured using a spring balance and the unit for measuring force is the **Newton, N**.

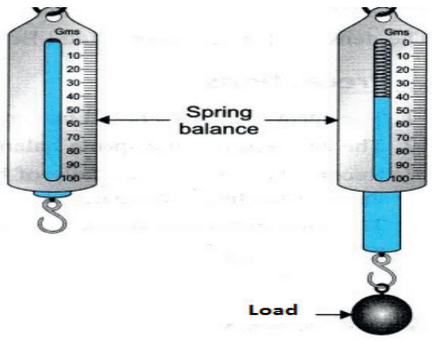


Figure 3: Picture of a spring balance

Types of forces

There are different types of forces e.g. gravity, electrostatic, magnetic, friction etc. But all forces can be classified into two groups according to whether there is contact between the bodies or not.

Contact forces

A contact force is one that acts at the point of contact between two objects. Examples of contact forces include pushing or pulling objects with different parts of your body. Friction is a contact force between one object moving over another.

Figure 4: A person exerts a contact force when they push or pull an object

Non-contact forces

A non-contact force is a force applied to an object by another body that is not in contact with it.

Fig 6: Gravity is a non-contact force exerted between the planets and the sun

Other non-contact forces include electrostatic and magnetic forces

Assignment: Can you identify various forces and instances in which they occur?

LESSON 2: EFFECTS OF FORCES ON OBJECTS

Competences:

In this lesson, you will:

- identify the effects of forces.
- understand the meaning of balanced and unbalanced forces.

Materials:sticks, ropes, football, wires, tennis, balloons

Introduction

At home and at school, we experience forces of different forms and they affect objects. If your mother has told you to split fire wood, how would you handle it? Or take an example of you breaking a piece of wood while gathering firewood. Or think about playing with a football which we like so much!!! There you need a type of force to help you do the task given to you. The force will cause an effect on the material you are dealing with.

Forces affect bodies in different ways.

Activity 1: Investigating the effects of forces

The pictures in Figure 1 below show some of the effects of forces on different bodies. Look at each picture carefully and describe the effect of the forces being shown.

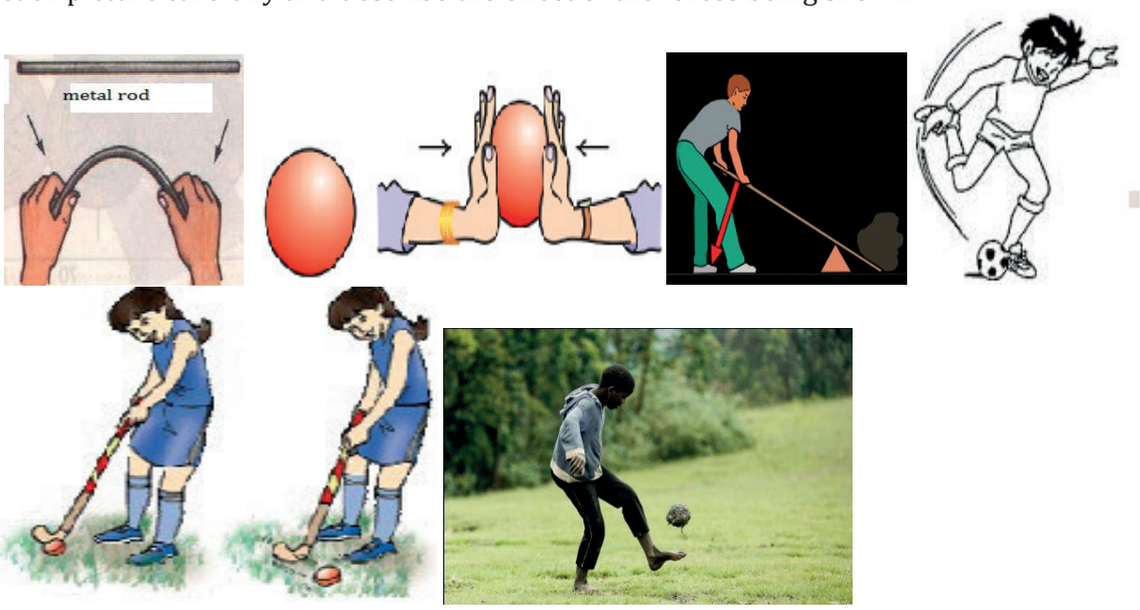


Figure 1: Effects of forces

Can you think of other effects of forces with examples?

Balanced and Unbalanced Forces

When two forces act on an object the net effect will depend on the size and direction of each of the forces.

Figure 2: The forces acting on the stationary book are balanced

When we place a book on the table, the weight of the book acts down due to gravity, and an equal force acts upwards. The upward force is due to a push by the table. The forces are equal in size and act in opposite directions. These forces are said to be balanced. The shape or position of the book does not change.

***Did you know**? The difference between unbalanced forces is called the resultant or net force.*

Figure 3: The forces acting on the moving container are unbalanced

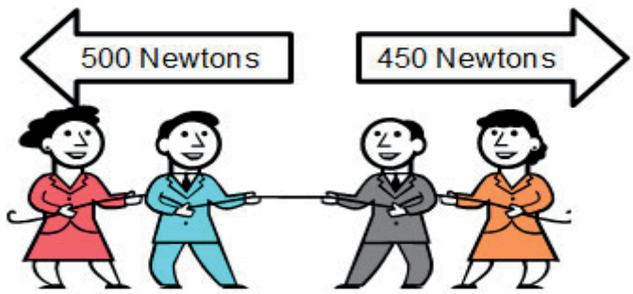
When a crane raises a container, it must exert an upward force greater than the weight of the container. The forces act in opposite directions but they are not equal in size. These forces are

said to be unbalanced. Unbalanced forces cause changes in the shape, position or speed of an object.

Effects of balanced and unbalanced forces on motion

When balanced forces are exerted on a stationary object, it does not move. If balanced forces are exerted on a moving object, its speed will remain unchanged.
When unbalanced forces are exerted on a moving object, it will either move more quickly (accelerates) or less quickly (decelerates) depending on the magnitudes of the resultant force.

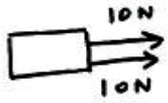
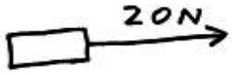
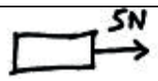
Suppose there is a tug-of-war and there are two teams pulling each other as shown below. What do you say about the teams? Which team will move? In which direction will it move? You can try this activity using a rope.

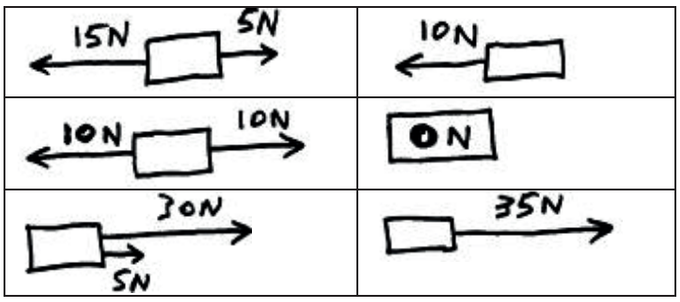


The effect of the above forces is called resultant force.

- If the forces are acting in the same direction, the resultant is obtained by adding the forces.
- If the forces are acting in opposite direction, the resultant force is obtained by subtraction
- If the forces are acting on a body at right angles, then the resultant is obtained using Pythagoras theorem. Do you remember Pythagoras theorem?

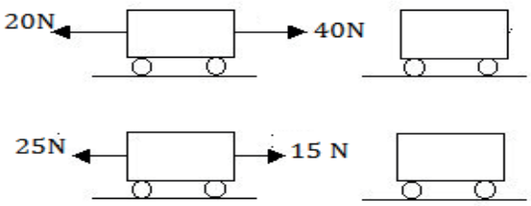
These rules are partly illustrated below:

Original forces	Resultant forces
	
	



Now using the above illustration, can you obtain the resultant of the forces below and indicate their direction?

Original force **Resultant force**



LESSON 3:WEIGHT AND MASS

Competences

You should be able to:

- understand the existence of the force of gravity and distinguish between mass and weight.
- appreciate that the weight of a body depends on the size of the force of gravity acting upon it.
- appreciate the importance of the force of gravity to life on earth.

Materials

Ball, heavy stone or other heavy object that does not break,

Introduction

In your home environment, you have ever seen boys and girls playing football either kicking the ball or throwing the ball upwards. Now what happens to the ball after being thrown vertically upwards? Or what happens when you release your pen from a point above the ground?

You think of throwing a stone upwards while chasing some birds. What happens to the stone?

The body (stone) is able to fall back because of pull of the earth or force of gravity which is called **Weight** of a body. Weight of a body depends on the position of the body from the Centre of the earth.

Did you know?
The weight of body varies from place to place on the surface of the earth. This is because different parts of the earth surface are at different distances from the earth center. It is also different on different planets.
Weight is very important because it keeps air surrounding the earth. Air is important to life.

Force of gravity and weight

Throw up small pieces of chalk or small stones or jump upwards. What happens? You notice that there is falling back in each case. Falling back to the ground is a result of a body's weight.

The weight of an object is the gravitational force between the object and the earth. The direction of the weight of a body is always towards the centre of the earth. Weight is a force related to the mass of an object. Like other forces, weight is measured using a **spring balance** and expressed in *Newton's*.

Now try out this:

Lift a large object such as a stone from the ground. What do you feel when you lift a heavy stone upwards from the ground?

A heavy stone is in a state of matter called solids. These solids are made up of matter and the quantity of matter in the stone is called its **Mass**.

Weight and mass are related by the equation **weight (W) = mass (m) x acceleration due to gravity (g)**

W= m x g

The value of g=10 ms^{-2} near the Centre of the earth. It is different at other positions and at other planets. That's why weight varies at different positions.

Note: Acceleration due to gravity (g) *is also known as the* ***gravitational field strength*** *and is the force that acts on a mass of one kilogram at a point in the gravitational field. So for points near and on the earth's surface,* ***g = 10Nkg^{-1}***

To use the above equation, mass must be expressed in kilograms.

Now try out this exercise:

1. What is the weight of a body whose mass is 250 g?
2. What is the weight of a bull of mass 180kg?

3. The gravitation field strength on the surface of the moon is one sixth that on the earth's surface. What is the weight of an astronaut of mass 100kg on the surface of the moon?

Activity

State the differences between mass and weight.

LESSON 4: FRICTION

Competences

You should be to understand the concept of friction in everyday life contexts.

Materials

Your shoes, car tyres, threads

Introduction:

In your area, you have ever walked on a slippery road. What was your experience? What causes someone to slide over? Take another a case where you walked on a road with shoes without threads.

Friction is a force that acts in the opposite direction to the movement between two surfaces which are in contact. Friction only exists when the two surfaces are moving relative to each other. It also existswhen the surfaces in contact and stationary.

Look at the pictures below:

Some applications of friction are indicated in these pictures. Can you identify these applications?

Can you state other applications of friction not indicated in the pictures?

Although friction has a number of applications, it has disadvantages also. For example, our shoes wear out because of the friction between the shoes and the ground. Parts of our machines can also wear away. Can you identify other disadvantages of friction?

Due to the disadvantages of friction listed above, there is need to reduce friction especially in our machines. Some of the methods of reducing friction are indicated in **Figure 1** below. Can you explain how the friction is being reduced?

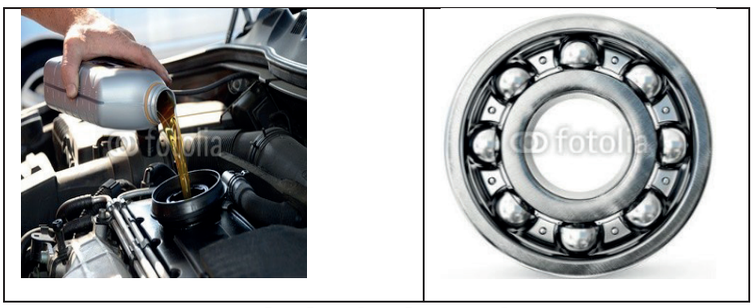


Figure 1: Some methods of reducing friction

LESSON 5: INTERMOLECULAR FORCES

Competence

You should be able to:

- understand the meaning of adhesion and cohesion as forms of molecular forces.
- understand the effects of these forces.

What you need:

Vaseline, plastic cups, drinking straws, empty plate, glasses, wick

Introduction

Have you ever noticed that while washing glass utensils water remains attached to the utensils or**S**mall insects can walk on water because their weight is not enough to penetrate the surface? These and other phenomena result from the forces within substances. These forces are called intermolecular forces and have effects and applications.

Intermolecular forces are forces that exist between molecules. The molecules may be of the same substance or of different substances.

Inter molecular forces are **cohesion force** and **adhesion force**.

In the home environment, if you splash water on a plate which hasfats,
What is observed? or when you have smeared yourself with Vaseline (Movit, Tip Top, Samonaetc.) on your legs or arms. What do you observe when water is poured on the smeared skin?

(a) Cohesive force

Cohesion is the force of attraction between the molecules of the same kind. Cohesive forces cause a tendency in liquids to resist separation of its particles.
An example is rain which falls in droplets rather than a fine mist. This is because water has strong cohesion which pulls its molecules tightly together, forming droplets.

(b) Adhesion

Adhesion is the force of attraction between molecules of different substances. Adhesion causes the liquid to cling to the surface on which it rests.

An example is water climbing up a paper or paper towel that has been dipped into a glass of water. This is because the adhesive forces between water and paper are strong enough to pull the water molecules out of their spherical formation and move them up the paper.

Look at **Figure 1** below.

(a) (b) (c)

Figure 1: Cohesion and Adhesion: Which pictures show cohesive forces?

When liquid is placed on a smooth surface, the shape that the liquid takes depends on which of cohesive and adhesive forces acting on that liquid is stronger.

Example:

Explain why water in a narrow glass tube has a concave meniscus while mercury, in the same tube, has a convex meniscus.

What is observed when water or mercury is poured a glass

Solution:

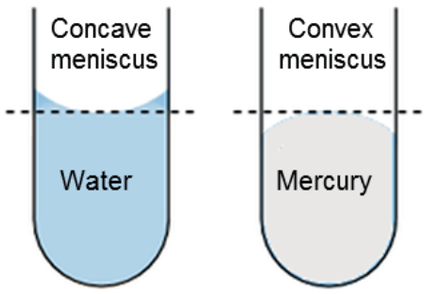


Figure 2: Shapes of meniscus

For water in the glass tube, the force of adhesion between the water and glass molecules is greater than the force of cohesion among the water molecules; so water clings to glass forming a concave meniscus.

On the other hand, the force of cohesion among mercury molecules is greater than that of adhesion between mercury molecules and glass molecules, so, mercury molecules cling to each other forming a convex meniscus.

Note that, a situation where a liquid has formed a thin film means adhesion is greater than cohesion. A case where a liquid forms spherical drops on the glass surface is an indication that cohesion is greater than adhesion.

Activity:

Make an investigation on what happens when water is poured on your hands smeared with vaseline.

LESSON 6: CAPILLARITY AND SURFACE TENSION

Competence

You should be able to explain surface tension and capillarity in terms of adhesion, cohesion and their application.

What you need:

Piece cotton cloth, paraffin, plastic container, match box, drinking straws a basin of water, needle

Introduction

Capillarity is the tendency of a liquid in a capillary tube (small tube) or absorbent material to rise or fall. Capillary action is the result of surface tension and adhesive forces. There are two cases:

Activity 1: Studying Capillarity in liquids

What you need
paraffin (or kerosene), a dry wick, beaker

What to do:

- Put kerosene in a clean dry beaker.
- Deep one end of a wick in the beaker containing kerosene.

What do you observe? Explain your observation.

Capillary rise and fall is due to the intermolecular forces in the liquid.

(a) Liquids that rise in a capillary tube (attraction)

Activity 2: Studying capillary rise in liquids

What you need:
two drinking straws(of different sizes if possible) and a beaker of water

What to do:

1. Place water in a beaker till it is half- full.
2. Place a drinking straw in the water vertically. Leave it for some time until the water is no longer rising in the tube.
3. Note and mark the level of water in the capillary tube.
4. Replace the first straw with another one of a different size.

5. Note and mark the water level.
6. Alternatively, you can dip the two straws into a beaker of water to the same depth at the same time.

What do you observe? Explain your observations.
You may have seen that the levels of the water in the two tubes appear like Fig. 1 below.

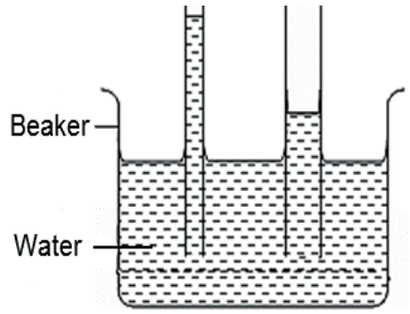


Figure 1: Capillarity in water

(b) Liquids that fall in a Capillary tube (repulsion)

Here, the cohesive forces are greater than the adhesive forces. The level of the fluid in the tube will be below the surface of the surrounding fluid. This is because the force of cohesion between mercury molecules is greater than the force of adhesion between them and the glass, and the liquid clings to itself.

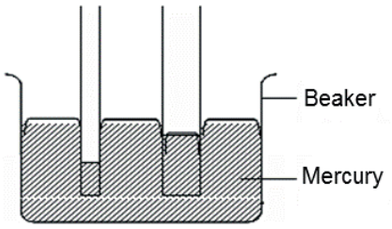


Figure 2: Capillarity in mercury

Please Note	The amount of elevation, or depression of a liquid in a capillary tube depends on the internal diameter or size of the tube.The liquid rises higher or sinks lower when the diameter is smaller.

Examples of capillarity

i) Water moving up a straw or glass tube
ii) Water being absorbed by a paper or cloth towel
iii) Movement of water through a plant
iv) Blotting paper to absorb liquids
v) Paraffin rise in wicks of stoves and lamps.
vi) Towels and soft tissues rinsing water

***Wetting* is the ability of a liquid to maintain contact with a solid surface, resulting from strong adhesive forces when the two are brought together, like water in a test tube, ink spreading on a paper or paint on a wall.**

Surface tension

The cohesive forces among liquid molecules at the surface hold them together and it acts as if it were a stretched elastic layer.

Surface tension is the force on a liquid surface that makes the liquid surface behave as if it is covered with thin elastic membrane/skin. Examples that show surface tension include:

a) When water drops slowly, it breaks into a continuous stream and forms drops. This shape of the drops is caused by the surface tension of the water.

b) Several insects are able to walk on water, for example, the water strider.

c) A pin or sewing needle, when gently put on the surface of water in a container, it floats due to surface tension.

Figure 3: Effect of surface tension

Activity3: Studying surface tension in liquids

	***What you need:***	• Dish or beaker with cold water, a piece of paper • A sewing needle or metallic paper clip
	Caution:	Needles are sharp. Handle them with care!
What to do		

a) Take a sewing needle and set it down on top of the water in the bowl. Observe what happens.
b) Cut a small piece of paper (larger than the needle) and set it to float on the water.
c) Gently set the needle on top of the floating paper.
d) Carefully press down on the sides of the paper so that they get water logged and the paper sinks (or you can just wait until the paper sinks on its own). Observe what happens.

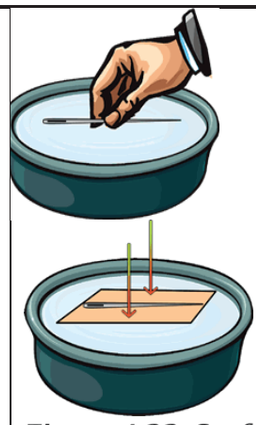


Figure 4.23: Surface tension in liquids

Questions:

1. What happened on putting the needle or paper clip on water
   a) directly?
   b) using a paper?
2. Explain your answer in each of the cases above.

Add soap solution or oil on the surface of the water and repeat the above procedures. What do you notice?

Surface tension in water can be reduced. Can you suggest ways of doing this?

CHAPTER: TEMPERATURE MEASUREMENT

LESSON 1: TEMPERATURE AND HEAT

Competences

You should be able to:

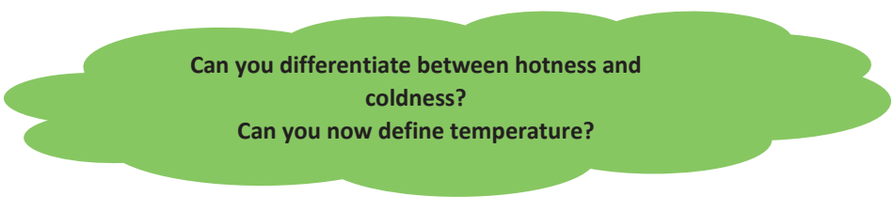
- understand the difference between heat and temperature.
- understand the meaning of temperature.
- understand how temperature is measured.

Introduction

In the introduction to Physics, you learnt that physics deals with the study of matter and its relation with energy. One of the forms of energy is heat. Heat has different effects on matter. One of the effects is the change in temperature. In this chapter, you will learn how temperature is measured and how the environmental temperature changes with time.

Heat and Temperature

As you learnt earlier, **heat** is a form of energy. When a body absorbs heat, it becomes hotter; and when an object loses heat, it becomes colder. A measure of the degree of hotness or coldness of a body is called the **temperature** of the body. Therefore, the amount of heat in a body influences the body's temperature.



Have you heard statements like 'it is very cold today' or 'It is hot'? Do such statements make sense? How hot is hot, and how cold is cold?

Measuring temperature

Explain how mothers at home were able to measure temperature of a sick child.

This was a crude method that involved feeling. But with feeling, you can estimate the temperature of some objects.

How good are you estimating temperature? Can you estimate the temperature of:

1. a hot day?
2. a cup of hot tea?
3. warm bathwater?
4. normal human body temperature?

The following are some common temperature estimates:

- A comfortable temperature for working is 25°C.
- A cold morning is about 19°C to 21°C.
- A hot day is about 29°C.

Temperature is measured using a thermometer. The unit for measurement of temperature is either degrees Celsius (^{0}C) or degrees Fahrenheit (^{o}F) or Kelvin (K).
For example, a temperature of 100^{o}C is equivalent to 212^{o}F or 373 K. From this illustration, it can be seen that the temperature of a body depends on the scale used. Hence, temperature is the **degree of hotness on a chosen scale**.

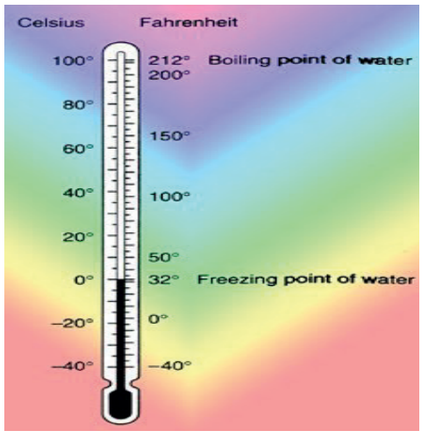


Figure 1: Temperature scales

Types of thermometers

The thermometer makes use of a physical property of a substance which changes continuously and uniformly with temperature. The physical property is referred to as thermometric property.

Examples of thermometric properties

Thermometric property	*Type of thermometer*
Volume expansion of a liquid	Liquid-in-glass thermometer
Volume expansion of a gas	Gas thermometer
Electrical resistance	Resistance thermometer

How a liquid-in-glass thermometer works

This is the commonest thermometer. A liquid thermometer consists of a tube with a bulb and a narrow capillary or bore.When the thermometer is put in a warm or hot substance, the liquid in the bulb expands forcing its way in the bore to a length that corresponds with the temperature of the substance.

Fig. 5.2: A laboratory thermometer

Bulb:	It stores the liquid
Bore:	It gives the liquid a route of travel as it expands and contracts. It is very narrow to make the thermometer more sensitive and accurate.
Stem:	This surrounds the bore in the thermometer. It is also a magnifying glass to enable easy reading of temperature.
Expansion Chamber:	This provides space where gases and air inside the capillarycollect as liquid rises.

A thermometer is said to be sensitive if it can record very small temperature changes.The sensitivity of the thermometer can be increased by using a large bulb and a narrow capillary tube.

Clinical thermometer

This is the thermometer doctors and nurses normally use in the hospitals to measure the temperature of the human body. It is a liquid-in-glass type of thermometer.

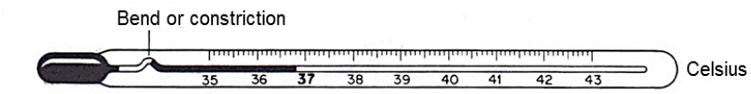


Figure 5.3: Clinical thermometer

These thermometers are suitable for measuring body temperature because:

a) Mercury which is used as the liquid is very sensitive to temperature changes.
b) The scale is limited between 35^0C to 43^0C, the only range needed for medical purposes.
c) There is a constriction or bend which breaks the mercury column and prevents its backflow. Thisallows enough time for a reading to be taken.

For your study: Based on the features of the clinical thermometer, suggest best practices of the proper handling of a clinical thermometer.

Did you know? The gun thermometers used in measuring temperature for Covid-19 patients is a digital thermometer and not a liquid in glass thermometer.

Thermometric liquids

Liquids whose volumes vary continuously with temperature are called thermometric liquids and they are used to make good liquid thermometers.Examples of thermometric liquids include mercury and alcohol.

The table below compares the characteristics of mercury and alcohol when used in thermometers.

Comparing thermometric liquids

Mercury	Alcohol
• It is opaque and makes reading easy.	• It is colourless and makes reading difficult. It needs colouring.
• It expands regularly.	• It has a somewhat irregular expansion
• It has a high boiling point, 357^0C.	• It boils at 78^0C.
• It freezes at -39^0C.	• It freezes at -115^0C.
• It has a lower expansivity than alcohol.	• It has a higher expansivity than that of mercury.

State the reasons why water is not used as a thermometric liquid, despite its relatively high abundance.

CHAPTER: HEAT TRANSFER

LESSON: MODES OF HEAT TRANSFER

Competences

You should be able toidentify the different modes of heat transfer in the different states of matter.

What you need:

source pan, firewood, match box

Introduction

Have you noticed that when you put a cold metal teaspoon into your hot cup of tea, the teaspoon handle warms up after a while? Have you ever wondered how this warmth "moved" from the hot tea to the cold teaspoon handle? Why do we feel warm when we are cooking or ironing, or when we sit or stand near a fire or in sunshine? Think of a metal put in a fire source, after few minutes, it is hot.

When two bodies or places are at different temperatures, heat energy flows from the hotter body or place to the colder one. In this chapter you will learn how heat is transferred from one place/body to another and how heat transfer is useful in everyday life.

Methods of heat transfer

Activity 1: Identifying methods of heat transfer

Figure 1: Methods of heat transfer

Look at figure 1 above and answer the following questions.

i) How does heat from fire reach our bodies?
ii) How does heat from the fire reach the water in the saucepan?
iii) Why does a lit candle melt?

There are three methods by which heat is transferred, namely:
(a) Conduction
(b) Convection
(c) Radiation

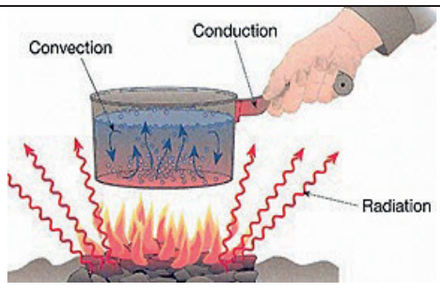


Figure 2: Processes of heat transfer

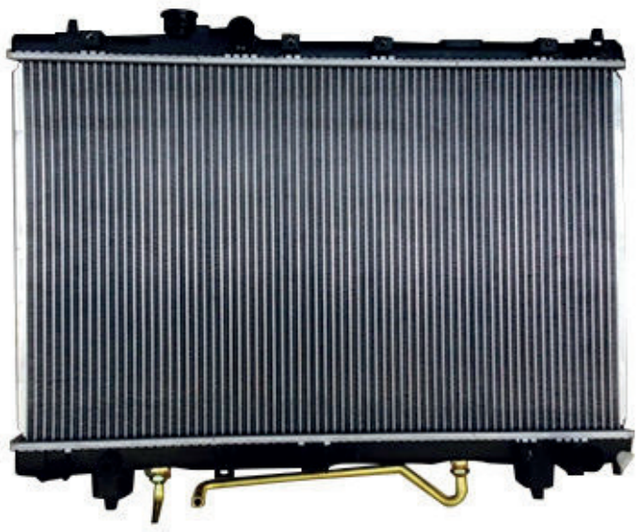
Activity

Study the figure below of the man roasting some meat and answer the questions that follow.

i) What caused the man to feel heat through the metal and removes his hand after some time?
ii) If the man were boiling the meat instead of roasting it, what methods of heat transfer would be involved and where?
iii) Name the process by which heat is able to reach the man who is roasting meat.

The methods of heat transfer depend on the state of matter involved. In solids, the method of heat transfer is mainly conduction. Best conductors of heat are the metals. In liquids and gases, heat transfer occurs by convection. Convection helps in rain formation. In spaces without matter, heat transfer is by radiation. Heat from the sun reaches the earth by radiation.

Some of the other uses of modes of heat transfer are illustrated in the pictures below. Try to identify each of the applications.



Why do we put on heavy woollen sweaters on a very cold day and very light and preferably brightly coloured clothes in hot sunny weather conditions?

CHAPTER: EXPANSION OF SOLIDS, LIQUIDS AND GASES

LESSON 1: SOLID EXPANSION

Competences

You should be able to:

- understand that substances expand on heating.
- recognize some implications of solid expansion.

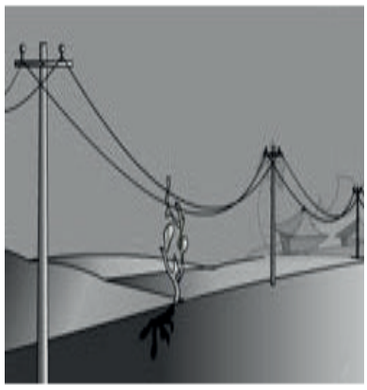
Materials

balloons, Source pan, firewood, ball, ring, sauce of heat,

Introduction

In the previous chapter, you learnt some of the effects of heat. When we heat any substance, the particles get more energy and begin to move faster. This movement causes the particles to move further apart so the substance **expands.** If we cool down a hot substance, we take energy away from the particles. The particles start to move more slowly and get closer together so the substance **contracts. All states of matter expand when heated and contract when cooled. Gases expand most** when heated compared to solids and liquids. Can you suggest a reason for this?

Look at the picture below: Why do the wires appear like that?



Activity 1: To find out what happens when solids are heated

Key question
What happens to solids when they are heated?

Materials needed:

- metal ball and ring
- spirit burner

What to do:

1. Suggest the procedure for the experimental arrangement shown below.
2. Do the experiment, observe what happens and describe it in your own words.

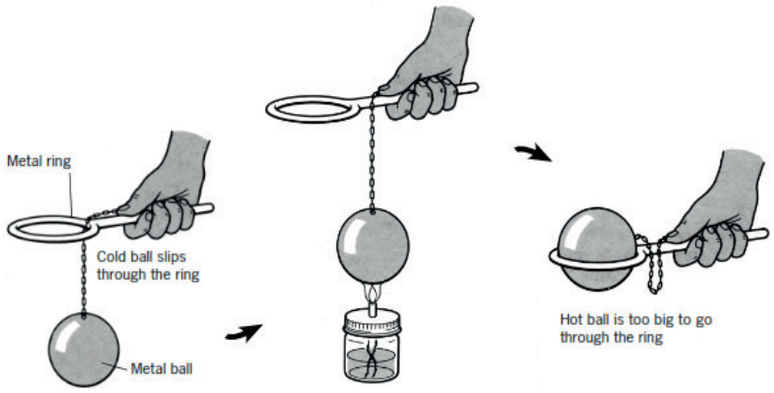


Figure 1: Ball and ring experiment

What happens when a solid is heated?

You cannot see a solid expand in some instances. The ball and ring experiment shows that solids expand when you heat them, but to make a solid expand even by a small amount you have to heat it strongly.

Implications of expansion of solids

Engineers need to know about expansion when designing things such as bridges and railway lines. Bridges and railway lines expand on a hot day. Engineers must know how large a gap to leave for expansion. What would happen if there were no gap? Look at Figure 7.4 and suggest reasons why the railway line is buckled.

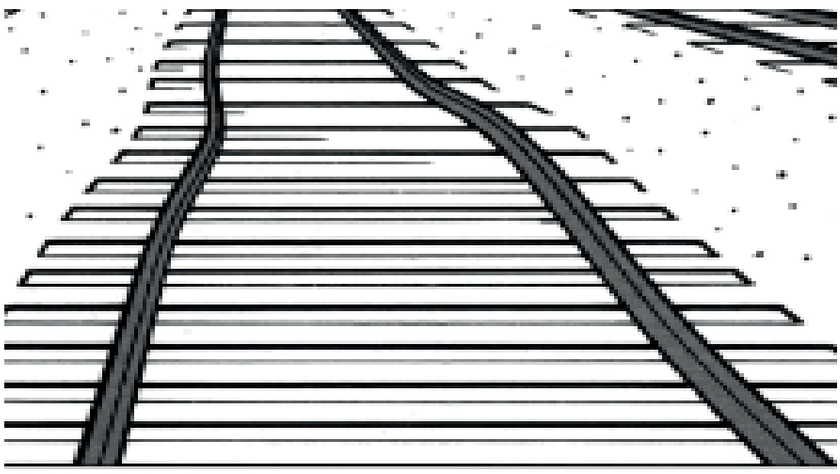


Figure 2: A buckled railway line

LESSON 2: EXPANSION OF LIQUIDS

You should be able to:
- understand that liquids expand when heated.
- appreciate the anomalous expansion of water.

Do liquids expand when we heat them?

Activity 1: Observing liquid expansion

What you need:

- test tubes
- beakers
- stoppers
- glass tubes
- water
- coloured water

What to do:
1. Set up the apparatus in the experiment as shown below.
2. Do the experiment, observe what happens and describe it in your own words.

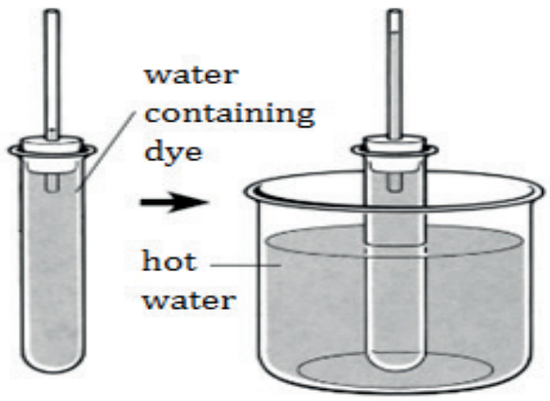


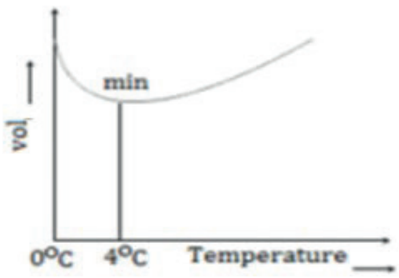
Figure 2: Liquid expansion

Liquids expand more than solids. Heating a liquid with hot water caused quite observable expansion in the above Activity. Can you suggest why?
In which measuring instrument is this arrangement applied?

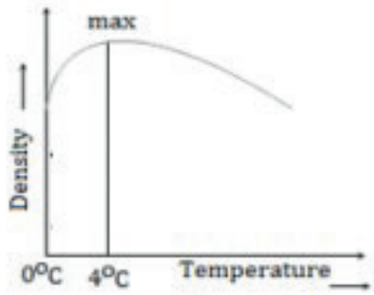
Anomalous expansion of water

The **anomalous expansion of water** is an abnormal property of water whereby it first contracts when heated from 0^oC to 4^oC instead of expanding. However, heating from 4^0C upwards results in expansion. Therefore, at 4^oC, the volume of water is least. This suggests that for a constant mass of water at 4^0C, the density is maximum.

This can be illustrated by the graphs below.



Variation of volume of water with temperature



Variation of density of water with temperature

How do we try to explain this?

When water cools, it contracts like other liquids and its density increases. But below 4^0C, just before it freezes, it expands. It does not continue to contract like other liquids. This is because the molecules of water begin to rearrange themselves into a different structure.
In the new structure, they are further apart than they were in the warmer liquid—this is the structure of the particles in the ice crystals. Ice is less dense than water because the particles are further apart in ice than they are in water just above freezing. So ice forms on the top of water, not at the bottom

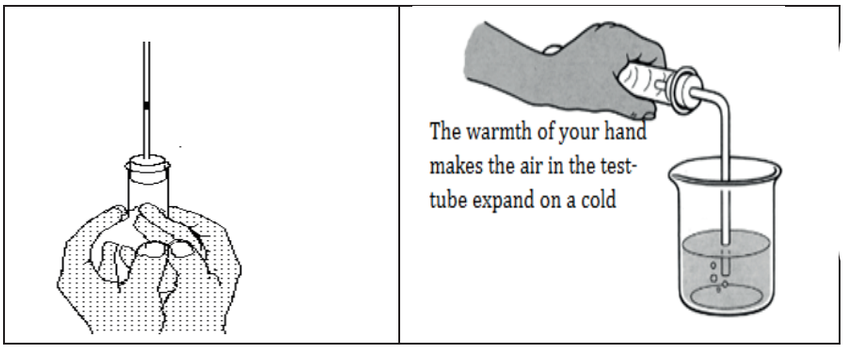
The density becomes less and less as water freezes because molecules of water normally form open crystal structures of ice in solid form. For this reason, ice floats on water.
This behaviour is important for aquatic life because during winter, the water surface is covered by ice while underneath fish can easily move.
Have you ever wondered why a glass bottle filled with water to the brim and tightly corked when left in a freezer or fridge for a long period of time may get broken?

LESSON 3: EXPANSION OF GASES

You should be able to appreciate that gases expand when heated and its implications.

Activity 1: Demonstrating gas expansion

What you need:



- A bent capillary tube
- A capillary tube
- A test tube
- A beaker of water
- A stopper

Figure 3: Gas expansion

What to do:

1. Set up the apparatus in the experiments as shown above.
2. Do the experiment, observe what happens and describe it in your own words.

What causes the observations in the activity?

You will have found in **Activity 3** that gases expand a lot when you heat them. You can cause quite a lot of expansion with the heat just from your hand.

Did you know?
Gases expand almost 3,000 times more than solids when they are heated over the same amount of temperature.

Gas expansion is manifested in many ways in everyday life. During functions, balloons used for decoration normally burst in hot weather. Can you suggest why? In what other instance is gas expansion not desirable.

Activity

You have been given a balloon to be inflatedand used for decoration during a party at your home. What happens to it (balloon)

i) after 2 hours in the morning.
ii) at mid-day when sunshine has increased.

Explain the observations above.

Why do you think it is not advisable to leave a car, motor-cycle or even a bicycle parked in direct sunlight for a long time during very hot weather conditions?

CHAPTER: NATURE OF LIGHT; REFLECTION AT PLANE SURFACES

Lesson 1: Sources of Light

Competences

You should be able to:

- know illuminated and light source objects in everyday life.
- understand how shadows are formed and that eclipses are natural forms of shadows.

What you need:

firewood, match box, candle, bulbs, pieces of boards, card boards, balls

Introduction

We all need light every day to see objects around us and to see ourselves. We get most of our light from the sun. Imagine what life would be like if there was only darkness for a full week! In our environment there are different sources of light.

Where does light come from?

Where does light come from? Why are we able to see different objects?To answer these questions, try this activity.

Activity 1: Identifying sources of light

In the table below, write down the natural and artificial sources of light which you are familiar with. You may use the word grid inthe table below.

Natural source	Artificial source

There are many sources of light. Some of them are natural while others are artificial. At night, the moon and stars light up the sky. Some of the stars are sources of light while others just reflect light from other sources. The moon is not a source of light. It only reflects light from the sun.

Activity 2

At night in the house do the following experiments:

a) Place a bulb or lantern/ candle in front of a piece of a box (card board) and state what is observed on the other side of the wall.
b) Make a small hole in a piece of a box (or card board) and place it in front of the bulb/ lantern, candle with flame. State what is seen on the wall.
c) Make conclusions for observations in (a) and (b).

Shadows

What do you see when light shines on you from one side and you observe the other side? What you see is a shadow. Shadows form because light has met an obstacle along its path and yet light travels in straight lines.***The travelling of light in straight lines is called rectilinear propagation of light.***Shadows have two regions. The darkest inner region is called **umbra** while the less dark outer region is called **penumbra**.

Try to block light from a torch or other source and observe umbra and penumbra in the shadow formed.

Eclipses

How does an eclipse occur? Eclipse is a natural occurrence of shadows. Eclipse of the sun or **solar eclipse** occurs when the moon passes between the **sun** and the earth. The moon may fully or partially block the Sun from an observer on Earth. A **total eclipse** occurs when the dark shadow of the moon completely obscures the sun. A **partial eclipse** occurs when the moon partially obscures the sun.

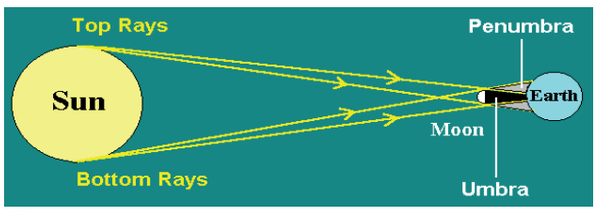


Figure 1: The solar eclipse

The **lunar eclipse** also called **eclipse of the moon**. It occurs when the earth stops light from the sun reaching the moon.

Did you know?
It is dangerous to view a solar eclipse using a naked eye.
You may become blind.

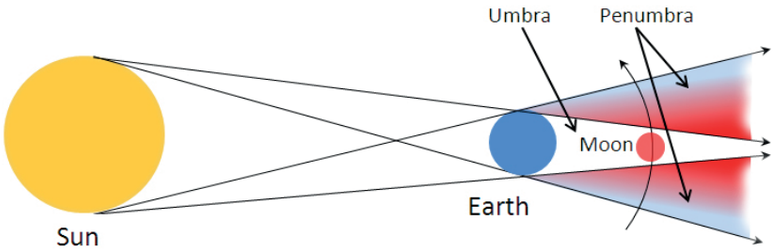
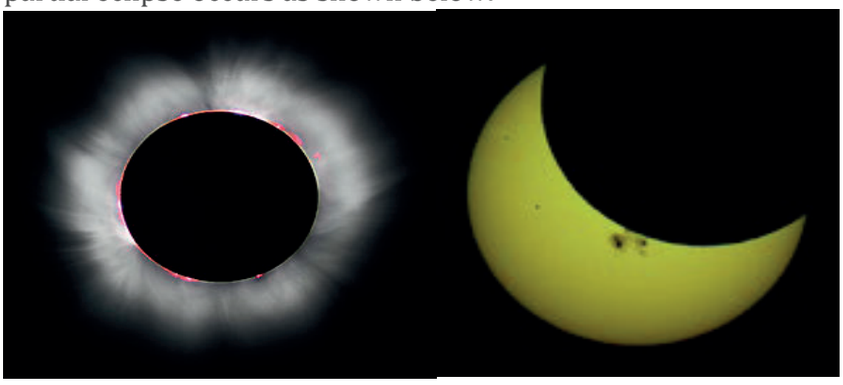


Figure 2: Lunar eclipse

When the whole moon is obscured, total eclipse occurs, but when part of the moon is obscured, partial eclipse occurs as shown below.



(a) Total eclipse **(b)Partial eclipse**

Figure 3: Total and partial eclipse of the moon

Activity 3: Make a model of an eclipse at home bear in mind that the way shadows are formed is the same way as eclipses are formed.

What you need:

- Bulb or use a torch
- Bulb holder
- Switch
- Cardboard with a small hole
- Large cardboard or large ball
- A small ball

Note: You can use the internet to view images of the eclipses

LESSON 2: THE PINHOLE CAMERA

By the end of this lesson, you should be able to describe how a pinhole camera works.

Introduction

The rectilinear propagation of light can be used in a pinhole camera. A simple pinhole camera looks like this.

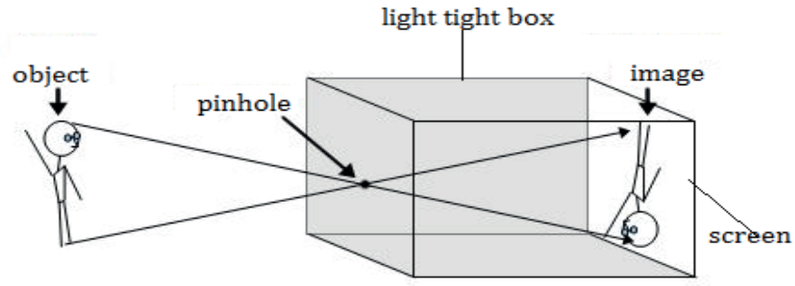


Figure 1: A pinhole camera

A **pinhole camera** is a simple camera without a lens but with a tiny **aperture**, a **pinhole,** through which light from the object enters a light-proof (light-tight) box. Light from an object passes through the aperture and projects an image on the opposite side of the box. The face where the image is formed is called **screen** (a light sensitive material).

Activity 1: Describing images formed by a pinhole camera

1. Look at the **Figure 1** above.
2. Identify some of the characteristics of images formed by a pinhole camera.

The relation between the size of the image and the size of the object is called **magnification.** It is also the ratio of image distance to object distance.

Hence: Magnification $= \frac{height\,of\,image}{height\,of\,object} = \frac{image\,distance}{object\,distance}$

Test yourself: An object 2 m tall is observed using a pinhole camera and height of the image is found to be 2 cm. If the distance of the object from the pinhole is 10 m, find the distance between the pinhole and the image.

Note: Sometimes the pinhole is made so large such that much light enters the camera. In this case the image formed is bright but not clear at the end. Such image is referred to as **blurred.**

LESSON 3: REFLECTION AT PLANE SURFACES

Competences

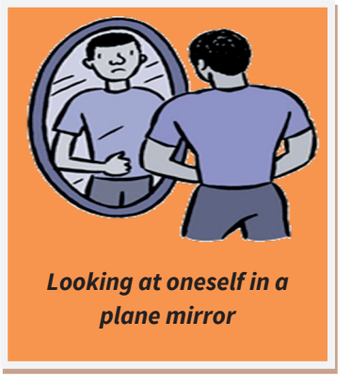
You should be able to:

- understand how the reflection of light from plane surfaces occurs.
- understand how reflection is useful to us.

What you need:
plane mirrors, glasses

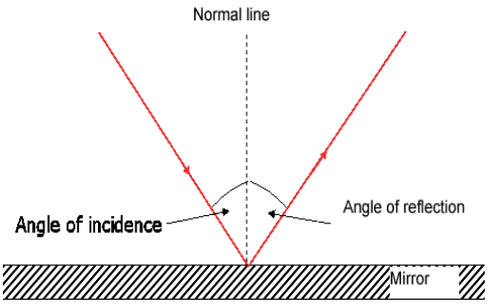
Introduction

How do we see objects? We are able to see objects because when light falls on them, they (objects) send or bounce it to our eyes. This is called **reflection.** More smooth surfaces reflect more light than rough surfaces.Imagine objects that cannot reflect light. **They appear dark**.
A plane mirror is a very smooth surface and reflects all the light falling on it from the other objects. That is why we are able to look at ourselves through the mirror.



Looking at oneself in a plane mirror

Light rays falling on the mirror form the incident rays, while those leaving the plane mirror form the reflected rays as shown in the Figure below.



Reflection at plane surfaces

A line perpendicular to the plane mirror is called the normal. Incident ray makes angle of incidence with the normal while the reflected ray makes angle of reflection with the normal.
Reflection in the plane mirror follows two basic laws. The laws are demonstrated in the following activity.

Images formed in plane mirror

Consider a situation when you enter a saloon room and you want to shave or you are at home and get a plane and start checking on your face. What do you see in the mirror?
The situation described above diagrammatically may be like the one in the figure 3
Plane mirrors form images according to the figures below.

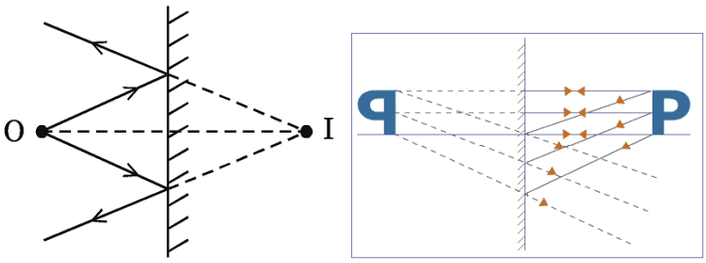


Figure 1: Image formation in a plane mirror

What do you notice about the images in **Figure 1**?

Activity 1: Investigating the properties of images in plane mirrors

What you need

- some white paint or chalk or ash or a small piece of paper
- aplane mirror (Puller or a comb)

What to do

1. Put some little paint or chalk or white Ash or fix a small piece of paper on your left cheek
2. Observe yourself through the plane mirror. On which cheek does the paint or paper appear to be?
3. Now remove the paint or paper and move the mirror away from your face. What do you observe?
4. From the above activity, summarise the properties of images formed by plane mirrors.

Activity 1
In your home environment and elsewhere, list all the applications of plane mirrors.

Now test yourself
An object is placed 16 cm away from a plane mirror. If the object is moved 4 cm towards the mirror, what will be the distance between the object and its image?

END

Please stay safe. Covid-19 is real.

National Curriculum
Development Centre,
P.O. Box 7002,
Kampala.

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