SCIENCE BOOK 1

LOWER SECONDARY

i-DISCOVER

i-OBSERVE

doing SCIENCE

i-THINK

i-TRY

i-RECORD

MINISTRY OF EDUCATION

CURRICULUM DEVELOPMENT UNIT

Quality Education for Change, Peace and Progress

BASIC SCIENCE

SCIENCE BOOK 1

LOWER SECONDARY

CURRICULUM DEVELOPMENT UNIT
MINISTRY OF EDUCATION, NATIONAL HERITAGE, CULTURE & ARTS
SUVA, FIJI 2011

Acknowledgements

Science Book 1 - Lower Secondary has been produced for use at the Form 3 level and as reference at the Form 4 level by the Basic Science Section at the Curriculum Development Unit of the Ministry of Education.

The following teachers and officers are acknowledged for their contribution to the development of this textbook: Ms Olive Rayawa, Mrs.Premila Kumar, Miss Salanieta Lalagavesi, Mrs. Malikesa Malo, Mrs. Prabha Nair, Mrs. Kelera Taloga, Mrs.Iva Teilai, Mrs. Serenia Rawalai, Mrs. Elena Seninawanawa, Mrs. Luisa Sigawale and the 2011 Basic Science Moderation Panel, Lautoka.

A special thanks goes to the CDU Secondary Officers and family members of writers for their cooperation and support, and also to Stan Sigawale for the cover design and photographs taken.

Table of Contents

Introduction

This book provides science information and places emphasis on the basic learning of the three sciences, Biology, Chemistry and Physics. It is based on five major areas of Skills, Processes and Procedures; Matter; Living Things and the Environment; Energy; Earth and Beyond.

The first chapter introduces you to the skills you have to acquire and the processes and procedures you need to follow as a student in science.

In the study on matter, you will learn how matter is made up and how it behaves, the different materials we use, how they react and how they can impact the environment in which we live. This involves you conducting experiments and investigating on these different reactions using chemical principles.

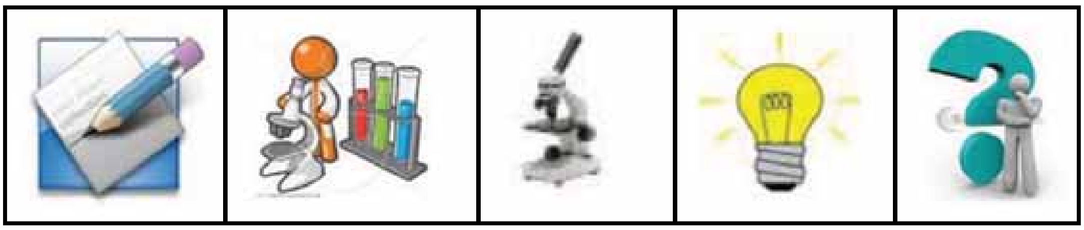
In the study of Living Things and the Environment, you will look at the structure of plants and study the processes that enable living organisms to survive, the use of microscopes to examine the world of organisms invisible to the naked eye, the study of the ecosystem and its biodiversity, you will establish the impact of man's activity on the ecosystem and find ways of sustainably using the present resources.

The study of energy is about the physical world and about light and how it behaves. It investigates forces and how they behave and affect our everyday life.

The study of earth and beyond is about the planets of the solar system, the earth's atmosphere and the changing earth and its impact on our lives.

Using this Book

Each chapter of this book has units with certain sections of text, written exercises, practical activities/experiments and research investigations or group activities. The icons used, would show you what to do:



Exercise / Activity ← Experiments → Think About

CHAPTER 1: SKILLS, PROCESSES AND PROCEDURES

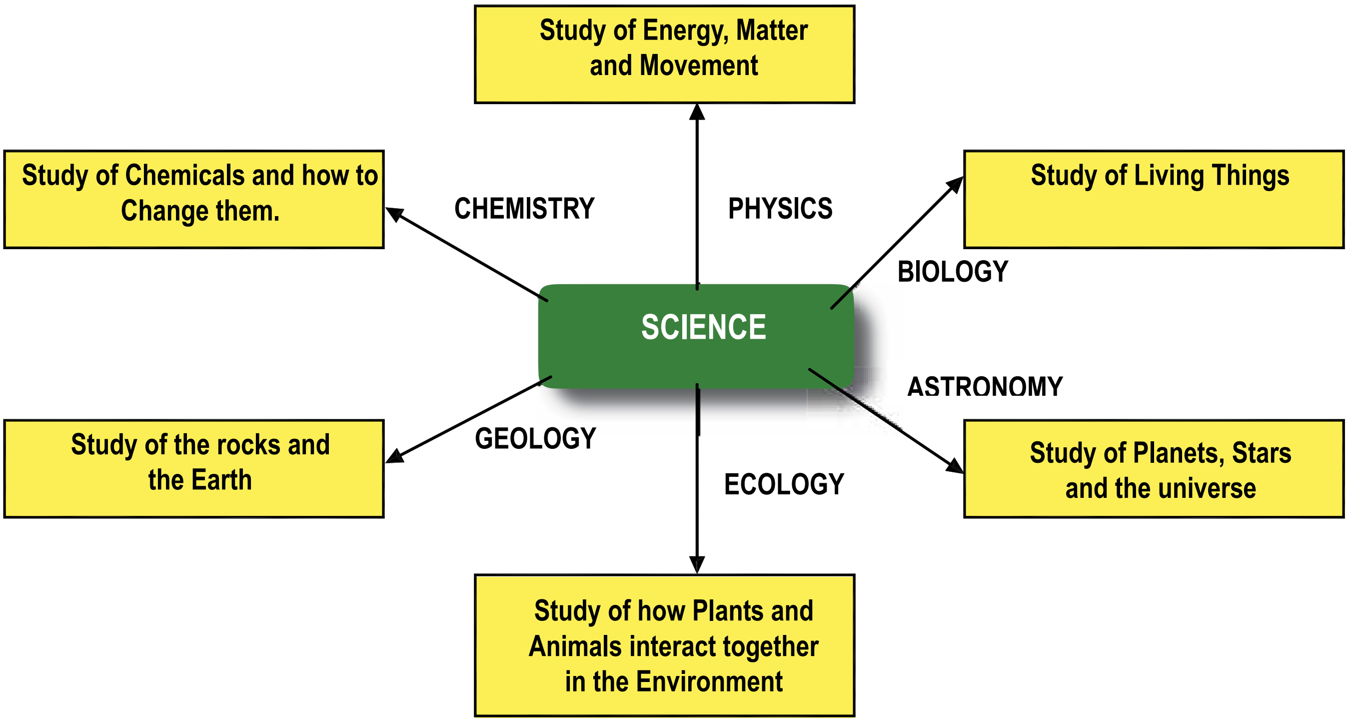
1. STARTING SCIENCE
2. INVESTIGATING

UNIT 1: STARTING SCIENCE

1.1.1 What is Science

Science is an exciting subject, where you can do experiments and work in a laboratory. But what is science?

- Science is doing experiments. Experiments are a way of finding answers to problems.
- Science is knowledge



1.1.2 Safety in the Science Room

In the laboratory there are gas taps and burners, glass beakers and flasks, water taps, and electrical power points. The laboratory could be a dangerous place if there were no safety rules. There are safety rules that apply to everyone in all laboratories and it is important that everyone remembers these rules and obeys them.

General Safety rules

1. Do not enter the science room unless you are with your teacher. Always wear a lab coat and proper footwear (closed shoes flat shoes) in the laboratory.
2. No running or pushing. The floor is slippery and hard.
3. Keep your notebook neat and tidy, and away from where you are doing your experiment.
4. Never eat food or lollies or chew gum in the laboratory, or drink from laboratory glassware.
5. Do not taste or inhale any chemicals or lick anything in the laboratory. Always wash your hands after working in the laboratory, and especially before eating food.
6. Pour waste liquids into sinks or waste bottles. Place waste solids into rubbish bins. Broken glass should be placed in special bins.
7. Clean all equipment after use and put it back where you got it from. Clean your work bench after doing experiments.

Safety rules when heating or mixing chemicals

8. When heating or mixing substances, never look inside the flask or beaker .Do not point the open end of test tubes or beakers towards you or others. Wear safety goggles while heating.
9. Follow the correct method for lighting a Bunsen burner.
10. After heating equipment, let it cool down before picking it up. This will avoid burns.
11. If you have long hair, keep it tied back and away from flames and chemicals.
12. Do not place flammable substances near naked flames.

When accidents occur

13. Report all breakages and damage to your teacher.
14. If you spill acid or other chemical on your hands, wash with a lot of running tap water or ask your teacher for help.
15. If your clothing should catch fire, smother it with a blanket or coat. Never run.

Create: Choose one of the laboratory safety rules that you have learned and draw a poster that will illustrate the rule clearly.

Safety Labels

Hazardous chemicals must be labeled to alert people to their dangerous properties. These chemicals have a symbol representation to show their properties.

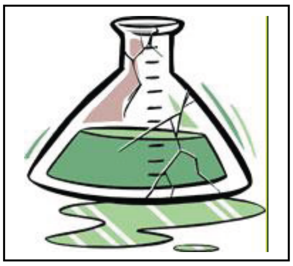
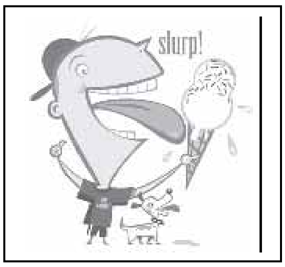
Symbol					
Meaning	Poison	Flammable	Corrosive	Explosive/ Explosion hazard	Combustible material
Examples	Chloroform	Methylated spirit	Caustic soda Hydrochloric acid (concentrated)	Sodium in Water	Hydrogen

Mini -exercise: Select the words from the list on the left to complete the sentences below.

bump
chemicals
teacher
water
eat food
fire
taste
blanket
instructions

(a) Never ………….. any chemicals in the laboratory.
(b) ……….. all breakages to your teacher.
(c) If you spill ……… on your skin, wash immediately with plenty of………, then tell your …………
(d) Take care not to ……….. anyone who is using chemicals.
(e) Do not ………. in the laboratory.
(f) Never point a ………… towards your own face or anyone else's.
(g) A ……….. can be wrapped quickly around someone to smother flames.
(h) Know what you are doing in the laboratory. Read the ……… carefully.

Assessment

LAB STATION	SCENARIO	LAB STATION	SCENARIO
1: Lab Directions 	Suppose you are going to begin a scientific investigation. What should be one of the first things everyone in your group should do?	**2: Lab Area Safety** 	1. Imagine this is your group's lab area. What is wrong here? 2. What might happen if your lab group had such a cluttered lab area? 3. Write a lab safety rule for this station.
3: Lab Dress Code  	1. What do you think is the proper clothing to wear when we conduct laboratory investigations? (include hair, shirts, jewellery, and shoes)	**4: Lab Dress Code**  	1. Which picture accurately shows proper lab safety in the lab? 2. Write a lab safety rule for this station.
5: Glassware and Sharp Object Safety 	1. What should you do if you break any of the glassware? 2. Should you use the flask above? Why or Why not? 3. What special precautions should you take if you are using sharp objects like scalpels (knives) from the dissecting kit?	**6: Animal Safety** 	1. If we are conducting an investigation using live animals, how should you treat the animal and why? 2. What should you do when you are finished handling the animal?
7: Chemical Safety 	1. Take a whiff of this unknown substance, what do you think the substance is? 2. If this substance had been poisonous, what might have happened if you sniffed it? 3. What is the proper way to smell a substance in the lab? 4. Write a safety rule for this lab station.	**8: Chemical Safety** 	1. Taste this unknown substance, what do you think this substance is? 2. If the substance had been poisonous, what might have happened if you tasted it? 3. Write a safety rule for this station

LAB STATION	SCENARIO	LAB STATION	SCENARIO
9: Chemical Safety 	1. If you spilled a chemical, what would you do?	**10: Chemical Safety** 	1. What is the name of this safety equipment? 2. When would you use it?
11: Chemical Safety 	1. If you did not use all of the substances given to you for the investigation, what would you do with it? 2. How would you dispose of substances used in the lab?	**12: Fire Safety** 	1. Where is the nearest fire extinguisher? 2. Where is the nearest fire alarm? 3. Where is the nearest fire blanket? 4. What 3 words do you remember about fire safety if your clothing to catch on fire?
13: Clean up 	1. What should you always remember to do before leaving the Lab?	**14: Clean up** 	1. Class is about to end, what should happen here? 2. Write a lab safety rule for this situation.

1.1.3 Working in the Laboratory

When working in the laboratory, you will be expected to use a number of equipment when conducting your experiments. The two equipment you will often use at this level are the Microscope and the Bunsen burner.

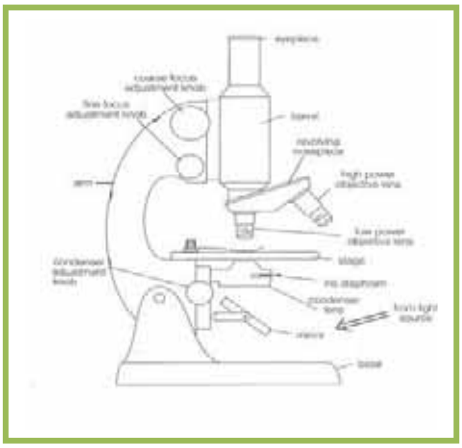
Microscope

A microscope is an instrument that magnifies very small objects that cannot be readily studied using the naked eye.

Types of Microscope:

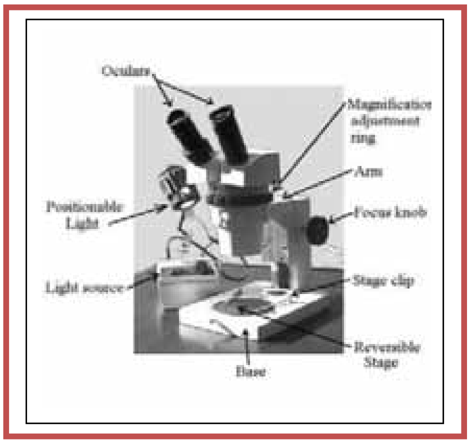
Simple Microscope - A microscope that uses only one magnifying glass called a lens in a tube.

Compound Microscope:



A compound microscope is one that uses two lenses and is commonly used in schools. Each lens is at the end of the tube that can be moved up and down. The lens at the top of the tube, where you put your eye, is called the eyepiece. The lens at the bottom of the tube is called the objectives. Compound microscope use glass lenses that focus light passing through an object.

Stereo or dissecting microscope



A dissecting microscope is used to look at objects that are thicker than objects looked at under a compound microscope. As its name indicates, the dissection microscope is used to observe tissues and organs as a specimen is being dissected. Biologists use it to study the structure of insects and other invertebrates. Botanists also use dissection microscopes to observe parts of plants and fungi.

Using the Microscope

To get really good results it is important to go through these steps. **They are jumbled here. Write them down in the correct order but check with your teacher first.**

- use the clips to hold the slide
- when finished reset to low power and put the microscope back in its box
- use fine focus for medium power and readjust the light if it helps
- position the lamp and mirror to get good light
- use the course focus to move the objective AWAY from the stage
- always start with low power
- turn to medium power if you need more detail
- looking from the side bring the objective close to the stage

There are two important things you need to know before you start looking at things:

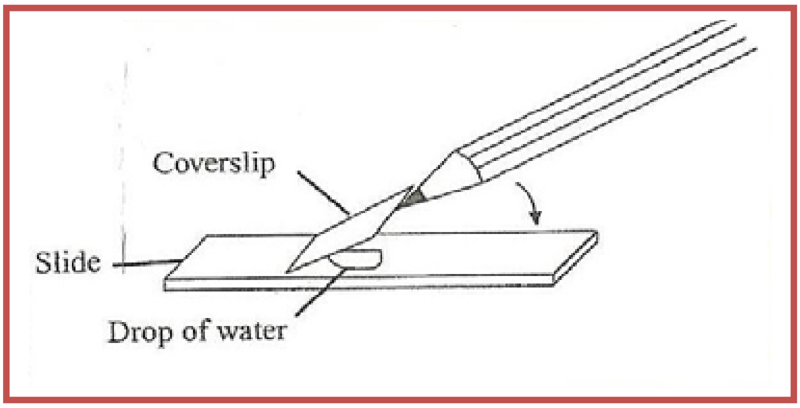
1. how to put the sample on the microscope slide
3. how to find the size of the object

Some extra tips:
- **If looking at a thick specimen, ask for a cavity slide**
- **Some objects, particularly thick ones may look better if you place a piece of black paper under the slide and shine your light down from the side.**

Observing specimens using a microscope

Specimens need to be thin and transparent so that light can get through. Most specimens are mounted between two pieces of glass: the thick **microscope slide** below and a thinner **coverslip** above. The coverslip is placed on top as in the diagram below. It keeps the specimen flat, giving a better picture and protects the (microscope) objective from the specimen. Water prevents the specimen from drying out. Stains enable us to see organelles more clearly.

Preparing a wet mount



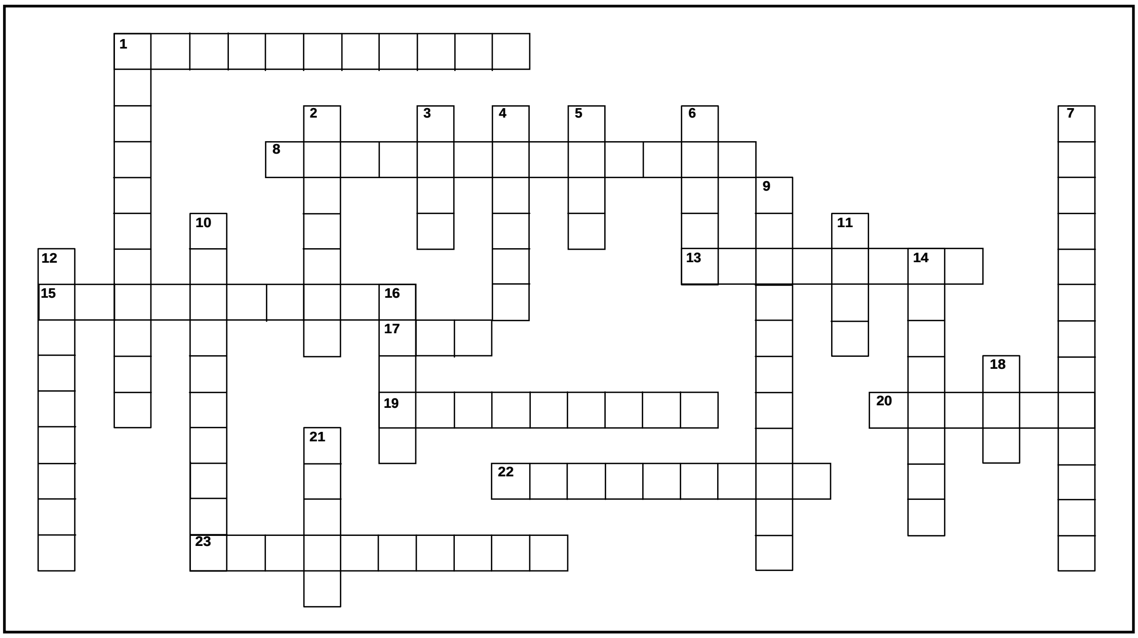
Preparing the Slide for viewing

1. Wash and dry the slide.
2. Place the specimen to be observed in the center of the glass slide. If the sample is already in a liquid suspension, skip Step 3. If not, you will need to add a liquid medium to suspend the sample for viewing.
3. Add a drop of water over the top of the specimen.
4. Add a stain if necessary (iodine for animal cells and methylene blue for plant cells).
5. Place the coverslip on.

Caring for the microscope

1. Carry the microscope with two hands: one hand under it (base) and one hand holding it using the arm.
2. Store the microscope in its box or under a dustproof cover.
3. Do not try to clean the microscope. Wiping the lenses need only special tissue paper.
4. Check that the microscope is working and has all its pieces attached.

Activity : Microscope Mania



Puzzle Clues

Across:

1. Known as the "Father of Microscopy"
8. Refers to the power of a microscope calculated by multiplying the power on the objective by the power on the eyepiece
13. Part of the microscope that contains the ocular lens Type of lens found in the eyepiece
17. When viewing objects under ___-power, you are able to see a larger field of view, but not as much detail.
19. Small disk found under the stage that regulates the amount of light that reaches the specimen.
20. Large knob on the side of a microscope that should be used first when viewing a slide
22. Small glass or plastic piece that is used to cover a water drop on a slide.
23. Refers to the type of microscope Leeuwenhoek created with one lens.

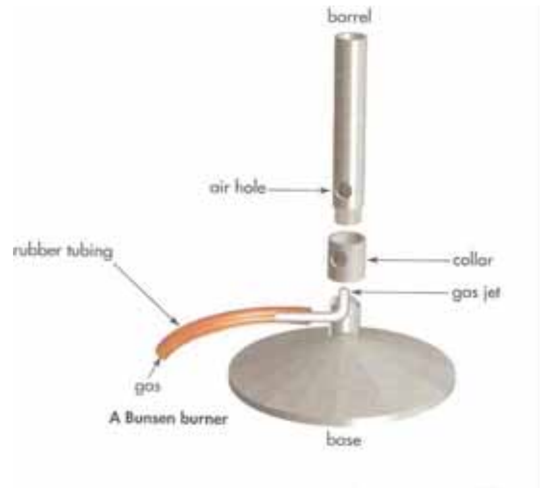
Down:

1. Provides light to allow you to view materials on a glass slide
2. Developed one of the first compound microscopes by placing several lenses in a tube
3. When viewing objects under ___-power, the field of view is smaller, but you are able to see more details.
4. Type of light source that reflects light rays
5. Bottom portion of the microscope
6. Used a compound microscope to discover that living things are composed of cells
7. Found on the nosepiece; range from low to high power
9. Refers to the amount of a specimen we are able to see; decreases as the power of magnification increases
10. Used to hold a slide in place on the stage
11. Small knob on the side of a microscope that helps you focus the microscope
12. Part of the microscope that holds the objective lenses and is able to rotate to change magnification
14. Type of microscope made up of two or more lenses
16. Rectangular glass plate used to view samples of water or other materials.
18. Part of the microscope that should be used when it is carried
21. Part of the microscope that supports the slide being viewed

Adapted from: T. Trimpe 2004 http://sciencespot.net/

Lighting of Bunsen burner

Bunsen burners were invented by a German chemist, Robert Bunsen, in 1855.They are still pieces of laboratory equipment that we need today.



Rules for lighting a Bunsen burner:

1. Push the rubber tube on to the gas outlet.
2. Close the air hole. You do this by turning the collar.
3. Light the match and hold it over the top of the barrel (refer to diagram above).
4. Turn on the gas. Always turn on the gas last. (Note: When the air hole is closed, no air gets in and the colour of the flame is bright yellow. This flame is called the safety flame. It is not very hot and not good for heating).
5. Open the air hole, so that air mixes with gas to produce a hotter, pale blue flame. This flame is used for heating.
6. When the Bunsen burner is not being used for heating, the yellow safety should be used.

Rules for Heating in Test tubes:

1. Never have the test -tube more than one third full.
2. Always use a test- tube holder.
3. Point the test-tube away from yourself and others.
4. Heat the side of the test-tube, not the bottom.
5. Move the test-tube in the flame as you heat it.

Rules for using Thermometers

1. Always keep the thermometer in its case unless it is being used. Make sure the cap of the case is attached tightly as it is made of glass and can break easily.
2. Do not shake the thermometer because it is long and can snap easily.
3. Do not drop it into any container you are using as it could break the bottom of the container.
4. Do not leave it at the edge of the bench, it could roll off and break.
5. Hold it in the middle-never by the bluib as you do not want to measure the temperature of your hand.
6. Do not use it for stirring liquids.

Mini-exercise

1. Given below is a list of five steps (not in the correct order):
   - A. Hold the test tube in the flame and move it to and fro.
   - B. Light the burner.
   - C. Open the air hole on the burner and turn down the gas.
   - D. Pick up the test tube using a test tube holder.
   - E. Rotate the collar on the burner so that it is closed

   Tick √ the alternative below which shows the correct sequence of steps for this activity.

   ☐ B → E → D → A → C   ☐ D → E → B → C → A

   ☐ C → B → E → D → A   ☐ E → B → C → D → A

2 Why is it necessary to:

(a) Use a small flame?
(b) Move the test tube to and fro?

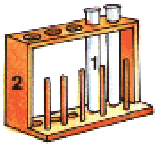
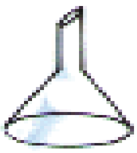
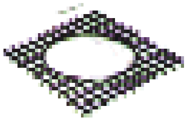
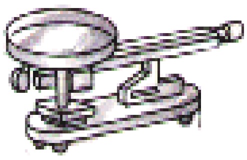
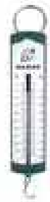
Mini -exercise

The ____ can be rotated, which changes the size of the_______ hole. When the air hole is ______, air gets in and mixes with the _________.This makes the gas burn________, and the colour of the flame is pale_________. When the air hole is _____, no ______ gets in, and the colour of the flame is bright________.This flame is called the _________ flame. It is not as hot as the __________ flame, and it is very sooty. This means that it is not good for__________. But it can still burn you.

1.1.4 Laboratory Equipment

In a science laboratory you will be using different equipment. Equipment is the name given to the beakers, burners, flasks and stands you use in the laboratory to do experiments. The diagrams below show the names of commonly used equipment. When you put together equipment for an experiment, it is called an apparatus.

Common Laboratory Apparatus

Equipment/Name	Use	Equipment/Name	Use
 1. Test tube 2. Test tube Rack	1. Used for holding and mixing small volumes of liquids. 2. Used to hold test tubes while reactions happen in them or while they are not used.	 Test tube Holder	Used to hold test tubes when they are hot and untouchable
 **Beaker**	Used for holding and heating large volumes of water. Multipurpose and useful in the lab.	 Tripod Stand	Used for holding objects above the Bunsen burner.
 Filter Funnel	Used in the lab but not confined to the lab. Used to target liquids into any container so they will not be lost or spilled.	 Measuring Cylinder	Used for measuring large volumes of liquids.
 Gauze Wire	Used for holding objects above the tripod stand	 Bunsen burner	Used for heating and exposing items to flame.
 Triple Beam Balance	Used for finding the mass of chemicals	 Conical Flask	Used to heat and store liquids. The bottom is wider than the top so it will heat quicker because of the great surface area exposed to the heat.
 Thermometer	Used to take temperature of solids, liquids and gases. They are usually in °C but can also be in °F.	 Spring Balance	Used to measure the weight of an object by opposing the force of gravity with the force of an extended spring

 Spatula	Used for moving small amounts of solids from place to place.	 Stirring Rods	Usually made of glass and used to stir things.
 Hand lens	Used to magnify an object or make things appear closer	 Watch Glass	It is a circular concave glass used generally for evaporating liquids or for holding small samples.

Activity

Identify as many pieces of equipment as you can from the table above. List them in your book.

1. **Alongside each write what you can use it for.**
2. **You want to measure exactly 55 mL of water for an experiment. Which piece of equipment would you use?**

1.1.5 Keeping Records

Everyone keeps records. At school you keep records of your lessons in note books for each subject. There are two parts to keeping records in science experiments. One is a record of the equipment you have used in an experiment. This is drawn in a **diagram**. The other part is a written story of what you did. This is called the **report**.

Rules for drawing in Science

1. Always use a pencil (HB or B pencils are good because they rub out easily)
2. Always use a ruler for straight lines
3. Draw outline diagrams – no sketches or perspectives
4. Draw the diagram big enough so that it can be seen clearly (a quarter to a whole page depending on the object)
5. Label the object clearly. Sometimes you need to label parts of the object. Point to these with lines.
6. Do not colour the diagrams

Writing Practical Reports

Your report should include the following information under the correct headings. Not all of these areas will necessarily be needed for every report. Your teacher will inform you if a shorter format is required for a particular place of work.

Title
The name of the experiment, e.g. Making Soap in the Laboratory.

1. **INTRODUCTION**
General background to the topic being investigated.

2. **AIM**
A statement about the purpose of the experiment

3. **HYPOTHESIS**
Your best educated guess of what you thought you would discover.

4. **MATERIALS**
List of the equipment and chemicals that were used.

5. **METHOD**
An account of what was done; usually include a diagram showing how equipment was set up. Provide enough details to allow the reader to repeat your experiment.

6. **RESULTS &OBSERVATIONS**
A presentation of your data. This might include a list of observations and calculations or tables and graphs

7. **DISCUSSION**
An explanation of your results and a description of any difficulties that you had with the experiment and suggestions for improvement.

Conclusion
This section should be short and to the point. The conclusion should relate directly to the aim. Has the hypothesis been supported or disproved?

Bibliography
If you used books or other written sources, eg. Journals, encyclopedia, internet, etc. to obtain information, it should be referenced. A list of these sources, if used, must be included in a bibliography.
Example: Begon, M., & Harper, J. &. (1996). Ecology Individuals, Populations and Communities. London: Blackwell Science Ltd.

Acknowledgements
Any other assistance obtained from people should be acknowledged here.

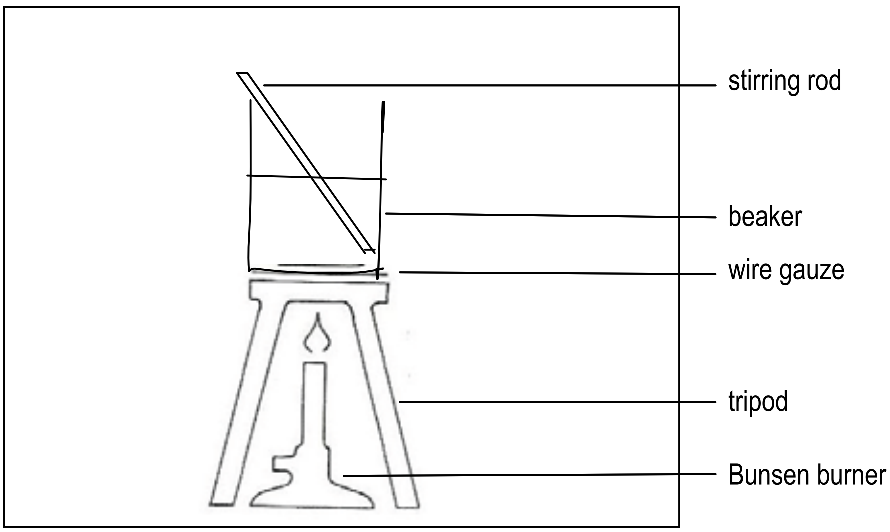
SAMPLE REPORT **Dissolving Salt**

Aim:
To compare how much salt will dissolve in hot water compared to cold water.

Hypothesis:
A lot more salt will dissolve in hot water compared to cold water.

Materials:
Beaker, heatproof mat, Bunsen burner, tripod, wire gauze, matches, spatula, stirring rod, salt, water.

Method:
1. A spatula was used to add salt to 100 mL of cold water in a beaker. The salt was stirred and more added until no more would dissolve. The amount of salt dissolved was recorded.
2. The mixture of salt and water was heated in a Bunsen burner for 4 minutes and the salt added one spatula at time until no more would dissolve.



Results and observations:
Amount of salt dissolved in cold water = 2 spatulas
Extra amount of salt dissolved in hot water = 4 spatulas
Total amount of salt dissolved in hot water = 6 spatulas

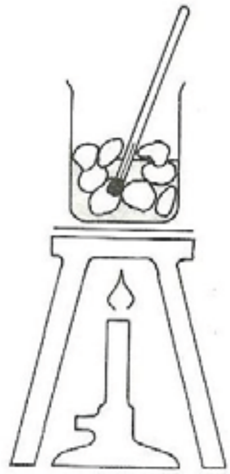
Discussion:
I was able to dissolve more salt in the hot water than in the cold water. A thermometer could have been used to measure the temperature of the water. The amount of salt that could have dissolved could have been found more accurately by adding small amounts at a time.

Conclusion:
Three times as much salt dissolves in hot water as in cold water.

Experiment: Heating of ice/water mixture

The sentences below are not in the right order. Work with a friend to sort them into the correct order. Sort them into:
AIM sentence(s)
METHOD sentence(s)
RESULT sentence(s)
Now do the experiment. The **figure** given will help you. Make sure you read the "Rules for drawing graphs' before plotting the graph.

- We half-filled the beaker with ice
- We continue measuring until the water started boiling.
- We plotted a graph of the temperature against time on a line graph. We joined the points with a smooth curve or straight line to show what was happening.
- We added tap water and left the ice/water mixture to stand for 5 minutes.
- We measured the temperature of the ice/water mixture.
- We wanted to fine out what happened when ice was turned into steam.
- We heated the ice/water mixture, recorded its temperature every two minutes (or longer if we had a slow Bunsen.
- We took a 250mL glass beaker, crushed ice, a Bunsen burner, tripod, gauze and a thermometer



Heating Ice

1.1.6 Measurements

We use measurements every day. To make sure measurements are consistent, we use standards measuring amounts, called units of measurement. The system of measurement we use in Fiji is called the **metric system**. Another system used in some other countries is called **imperial system**.

Writing measurements

Every measurement has two parts: the number and the unit. 3 metres is written as 3 m. Writing 3 ms is wrong, because **s** means seconds, and 3 ms means three milliseconds.

Prefixes are added to the units when very large or small things are being measured. A large mass would be measured in kilograms, or a very short length in millimetres. The prefixes that are used in measurements are shown in the table below.

Prefix	Symbol	Multiply by
mega	M	1 000 000
kilo	k	1000
hecto	h	100
deca	da	10
deci	d	1/10
centi	c	1/100
milli	m	1/1000
micro	μ	1/1 000 000

Volume

- Volume is how much space something takes up.
- It is measured in the units called **litres** (L) and millimetres (mL).
- Beakers and measuring cylinders are used to measure the volume of liquids.
- In a glass container, water is pulled up where it touches the glass. This is called the meniscus. When you measure volume, always read the scale from the bottom of the meniscus.

Length

- Length is measured in the unit called **metres** (m)
- For long distances, kilometers (km) are used.
- For short distances, centimeters (cm) or millimetres (mm) are used.
- Trundle wheel, metre rule and tape measure are used to measure length.

Mass

- Mass is how much matter is in an object.
- It is measured in the units called **grams** (g) or **kilograms** (kg)
- Tiny masses are measured in milligrams (mg)
- Beam balances, spring balances and electronic scales are used to measure mass.

Time

- Time is measured in the unit called seconds (s)
- Other units of time are minutes and hours.
- It is measured with a watch or a clock.
- A stopwatch measures time in seconds.

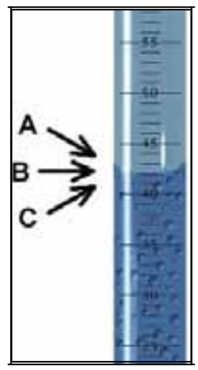
Temperature

- Temperature is measured in the unit called **degrees Celsius** (°C).
- It is measured with a thermometer or a thermistor.

Activity: Reading from a meniscus

Water pulls up at the sides of a glass tube due to “adhesion”. We call this curving a “meniscus”. In order to correctly read the volume of the water you should look from which of the three angles?

A. ?
B. ?
C. ?



UNIT 2: INVESTIGATING

1.2.1 Making Observations, Inferences and Hypothesis

An **observation** is something that you notice using any of your senses. Being observant means using all your senses to notice things around you. It is important to be accurate in your observations. Some observations are:

- Smelling onions in the kitchen
- Finding that a fabric feels like satin
- Seeing a man running down a street
- Hearing an electronic alarm
- Finding that lemon juice tastes sour.

An **inference** is a likely explanation of what you observed. It is how you explain the observation. The explanation may or may not be true. Here are some inferences you might have made about the observations above:

- You will have onions with your dinner
- Mum bought the fabric for the concert
- The man is scared of dogs
- A cat caused the alarm to sound
- Lemons contain acid

A **hypothesis** is a guess at an answer, which you can test by doing an experiment. Some things cannot be tested by experiment such as personal likes and dislikes. Some hypotheses you might make about the observations above:

- Onions smell more on a hot day than on a cold day.
- The fabric feels smooth because the fibres are close together
- The man running from the dog was bitten last year.
- Cats climb onto cars, and the movement activates the car alarm.
- Lemons are sour because they contain citric acids.

A **control** is the part of a science experiment that acts as a standard by which to compare experimental observations.

Before starting an experiment, it is important that you plan what you are going to do. Write it in your notebook. It is important to check with the teacher so that time taken and materials used is not wasted.

1.2.2 Displaying Data

Data is information that has been collected. It can be represented in the form of a table or a graph so any trend shown is easily seen. Sometimes the information we have needs to be sorted.

Tables
A table is a grid of rows and columns into which data (information) is placed. It is used whenever at least two sets of data are collected. Tables are suitable for data that involve both words and numbers. Tables are used as it is often easier to read information when it is organized in a table, rather than described in lines of text. Tables make it easier to:

- study relationships between pieces of data
- make conclusions
- use the data for other activities, such as graphing.

Creating tables

A table should have:

- a clear and simple title
- a set of rows and columns
- heading for the columns with unit if data have been measured in units.

Graphs

Values or measurements obtained from an investigation are called data. After collecting a set of data, it is important to present them clearly so that other people reading or studying them can understand or make some meaning out of them. Organizing data as a graph makes the information easier to read, interpret, show trends and make conclusions. A graph is a diagram that shows the connection between two or more things using dots, lines or bars. The four different types of graph are histogram, bar graph, line graph and pie chart.

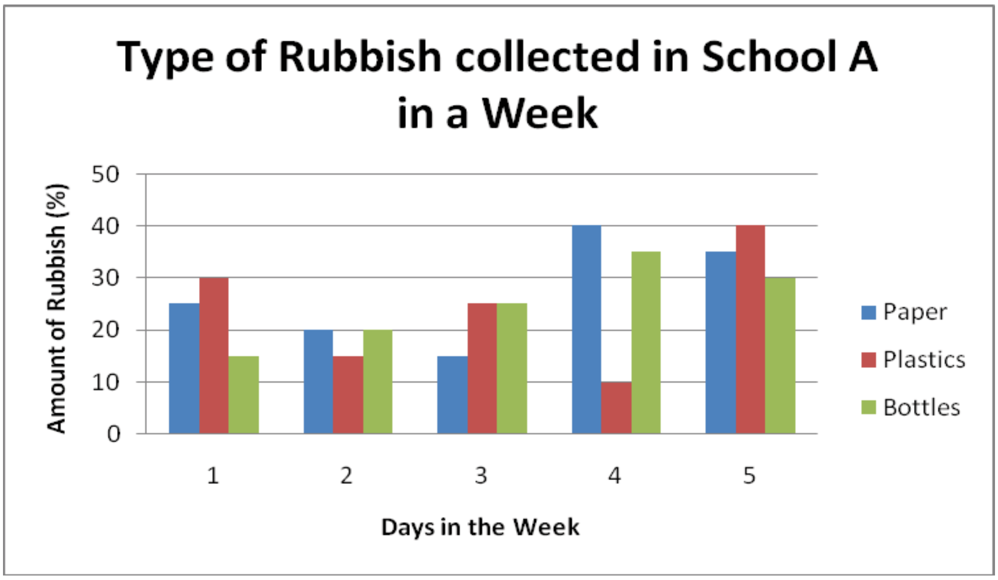
When drawing graphs:

- Each graph must have a **title** – what the graph shows
- The graph should fill most of the graph paper
- Start graph at 0 on vertical axis (horizontal axis as well if it is part of data)
- Scale should be regular – each increase should be the same
- Plot the data points clearly, and join with a ruler
- Label the x-axis and y-axis with their appropriate name and their units within brackets.

Bar graphs

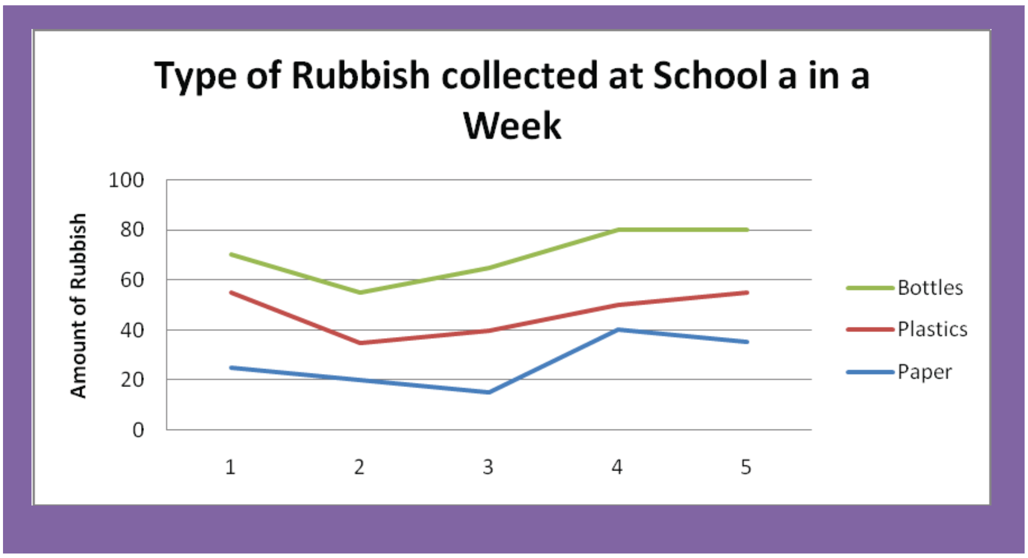
A **bar graph** is used to display and compare data.

- Bar graphs have a horizontal X-axis and vertical Y-axis. The X-axis represents the group of data being graphed. The Y-axis represents the value or number of each group.
- The height of each bar represents a certain amount of data of each group. The higher the bar, the bigger the value or number of each group.



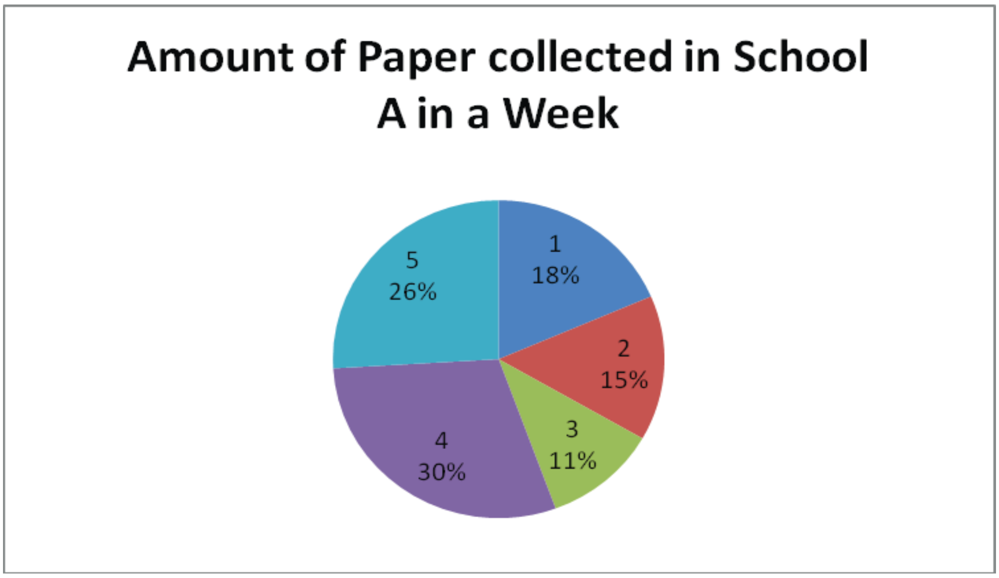
Line graphs

- Line graphs are used to show how data changes over a period of time.
- Line graphs, like bar graphs have an X-axis and a Y-axis. The X-axis usually represents time. The Y-axis represents quantity.
- Line graphs are made of points on the graph that are connected by a single line.
- Most graphs used in science are line graphs.



Pie graphs /charts

- Pie charts are used to represent data as portions of a whole.
- All segments of a pie chart added together equal 100%.
- Segments are organized by size from smallest to largest in a clockwise direction.
- Use the following formula to convert a percentage (X) into a degree (Y): 3.6º x X% = Yº.



USING DATA

Liti and Leilani performed an experiment to find out how effectively two plastic cups maintain the temperature of near boiling water. Their measurements are shown below:

COMPARING PLASTIC CUPS

Time (mins)	Temperature (⁰C) Liti's cup	Temperature (⁰C) Leilani's cup
0	90	90
10	47	58
20	29	39
30	22	31
40	20	26
50	20	23

1. Draw a graph to display the data in the table above.
2. Which cup maintained the temperature of the water more effectively?
3. Estimate the temperature of the water in Liti's cup 15 minutes after timing commenced.
4. Use your graph to estimate how long it would have taken the water in Leilani's cup to drop to a temperature of 20⁰C.

1.2.3 Fair Testing

All experiments have to **fair** and **valid**, so that someone else can repeat them and get the same answer. In some experiments you must use a control. A control experiment is a comparison that is used to make sure a fair test is carried out.

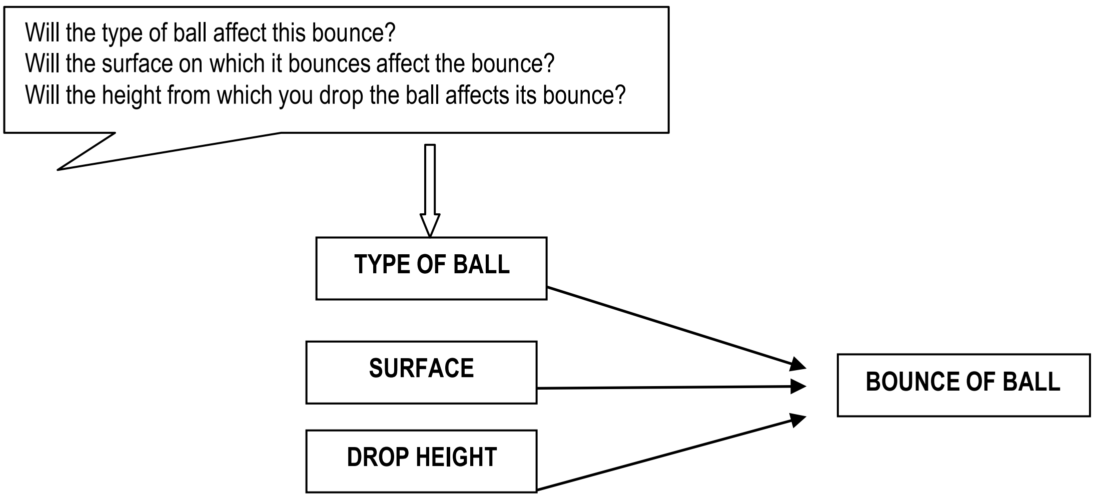
Each experiment must have two parts. One part is what you test is called the **variable** and the other is the control that you will compare it with. A series of steps that have to be followed is called the scientific method. The steps are:

- Observing – note as much as you can about a situation.
- Inferring – think of an explanation of what you observed.
- Hypothesis – make a guess at the answer that you can test by an experiment.
- Design a fair experiment, with a control to test the hypothesis.
- Do the experiment, and study the results.
- Form a conclusion – say if your results agree with (prove) or disagree with (disprove) your hypothesis. A good conclusion must answer the hypothesis.

How to conduct a fair test

Planning a Fair Test

Science investigations usually involve predictions about how one thing affects another thing. For example, students might be interested in things that affect the bounce of a ball.



Things that can be changed or measured in an experiment are called variables. In fair science investigations we:

- change one variable at a time
- measure another variable
- keep all other variables the same.

Example: If students predict that a solid rubber ball will bounce higher than a tennis ball, their investigation would test whether ball type affects bounce.

So the investigation would: ⇒

CHANGE : Type of Ball

MEASURE : Bounce height

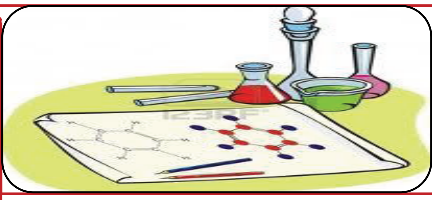
KEEP THE SAME: Surface

Think About this:
If the tennis ball was dropped on concrete and the rubber ball on grass, would it be a fair test? Discuss.

ACTIVITY: **Outline the procedure that you would use to investigate the following questions.**

1. Do snails prefer light or dark conditions?
2. Do thicker candles burn longer than thin ones?
3. Does a soccer ball bounce higher than a basketball?
4. Is new paper better than recycled paper?

CHAPTER 2: MATTER



1. **INVESTIGATING MATTER**
2. **MATERIALS**
3. **REACTIONS**

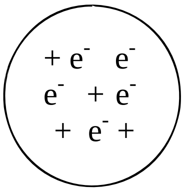
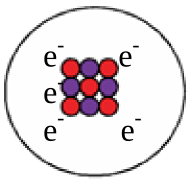
Introduction

- Matter is everything around you! Anything that takes up space, and has mass.
- Matter can be living such as trees, insects, and humans. It can also be non-living like wood, rocks, metal, air, water.
- Matter is made up of tiny particles called atoms.
- Everything on our Earth is in one of three states – solid, liquid or gas. We can explain the properties of these states by looking at what is happening to the particles making up the materials.

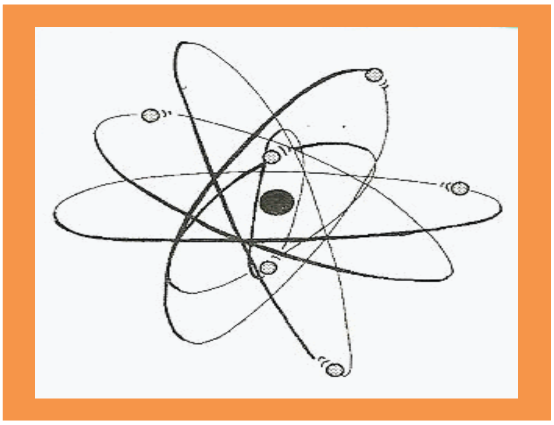
UNIT 1: INVESTIGATING MATTER

2.1.1 Structure and Properties of Atoms

Since the early 1800's, scientists have been coming up with different models of the atom based on experimental evidence. Shown below are some of these models.

Model	Structure
Dalton's model (1807): Model shows the atom as a hard dense sphere.	
Thomson's model (1903): Model shows the electrons scattered throughout the atom.	
Rutherford's model (1911):Model shows the atom with a dense nucleus, made up of protons and neutrons and surrounded by negatively charged electrons.	

- Atoms are building blocks of all matter.
- An atom consists of a central nucleus that contains two main particles: protons and neutrons.
- Protons are positively charged.
- Neutrons have no electrical charge.
- Electrons, have a negative charge and are arranged in shells (orbits) of different energy levels around the nucleus.
- Number of protons in an atom is equal to its number of electrons to make them (atoms) electrically neutral.



The structure of an atom

Two numbers tell us important things about an atom:

- The **atomic number (Z)** of an element gives the **number of protons** in the atom and determines which element the atom is. For example, atoms of hydrogen always have one proton, those of helium always have two, those of carbon have six and those of oxygen have eight.
- The **mass number** of an element is the number of protons plus the number of neutrons in an atom of that element. For example: Magnesium has 12 protons and 12 neutrons in the nucleus of its atoms. It would have a mass number of 12 + 12 = 24.(Since the electrons have insignificant mass, they are never counted but must always be equal in number to the protons)

Mini exercise: Make at least seven true sentences by choosing an entry from each column.(Note the order cannot be changed.

All	atom	is	not	a	and	atom (s)
An	matter	is not	found	many	charged	nucleus
The	electron shell		composed of	protons	in	particle (s)
A	electron		made up of	in	a/an	neutron (s)
	atomic			orbiting	the	orbit
	nucleus			electrons	small	
	neutron			two kinds of	electrons	

2.1.2 Structure and Properties of Matter

Matter comes in three forms, or state: solids, liquids and gases. Each kind of matter can, under certain condition exists as a solid, a liquid or a gas. The **particle theory of matter** states that everything is made up of particles which are in constant motion. These particles vibrate, or move. How much they move depends on how much energy they have. The theory can be used to explain different the **properties of matter**. We probably all know what to expect from a solid, a liquid and a gas. But how do we quantify (discover) the differences in a scientific way?

- The easiest way to understand the properties of solids, liquids and gases is to imagine what is happening to the particles they are made up of.

Solids

- The particles in a solid are arranged in a fixed pattern and held very closely together. They do not have enough energy to break out of this structure, so only vibrate. They have a fixed volume and retain their shape unless you do something to change them. In a solid the particles are packed relatively close together and do not move very much- just a gentle vibration.

Uses of Solids: Complete the table

Solid	Property	Use
Plastic		
Iron		
Glass		
Aluminium		

Liquids

- The particles in a liquid possess more energy than the particles of solids. Therefore, the particles have some space between them and so can move easily or flow. Liquids have no definite shape. They have no fixed volume, but their shape depends on the shape of their container. In a liquid the particles have more energy- they move around more, but still linked together. This explains how a liquid flows and fits, but does not necessarily fill the shape of any container you put it in.

EXPERIMENT:COMPARING DENSITIES OF DIFFERENT LIQUIDS.

1. Measure equal volumes of vegetable oil, water and syrup.
2. Mix them in a tall cylinder.
3. Let the mixture stand for some time and observe.
4. Record observation
5. List the liquids in order of their density.

Surface Tension and Effect of Water Pollution by Detergent.

1. Pour some clean water into a basin.
2. Slowly lower a clean razor blade on the surface of the water.
3. Place a few drops of detergent in the water.
4. Record your observation and explain what must have happened.

RESEARCH

Investigate how to make Virgin Coconut Oil

Gases

The particles in gases are very loosely held together. Unlike solids and liquids, gases have no fixed volume and no fixed shape. Gases have these properties because their particles have so much energy that they move around freely. In a gas the particles are moving freely with so much energy that they break free of one another and move anywhere. This explains how a gas will fill any container it is put in.

Properties of Matter

Matter is recognized by their properties. An object can be identified and classified according to its properties. Common physical properties of matter which are clearly observed include colour, size and shape. Other physical properties include elasticity, strength, hardness, solubility, density, melting point, electrical conductivity and heat conductivity.

Physical Properties	Explanation
Elasticity	The ability of a material to return to its original shape and size after being stretched or compressed.
Strength	The ability of a material to support a mass or heavy load without breaking or collapsing.
Hardness	The ability of a material to withstand scratches and wear.
Solubility	Is the maximum quantity of a substance that can dissolve in a given quantity of the solvent (e.g 10g/100g water).
Melting point	The temperature at which a substance changes from solid to liquid.
Electrical conductivity	A measure of how readily electric current flows through a substance. Substances that allow electricity to pass through them are called conductors. Those that do not allow electric current to pass through them are called insulators.
Heat conductivity	A measure of how readily heat flows through a substance.

Property of Matter

Identify the physical properties you should look for in materials to make the following products:

(a) Furniture (b) airplane body (c) electric plug cover (d) pajamas

2.1.3 Expansion and Contraction of Matter

In the world around us materials are constantly getting bigger and shrinking again in response to changes in temperature. The particle model can be used to explain changes in the size of substances as well as changes in state. When substances are heated, the particles gain energy, move faster and moving further apart, taking up more space. This makes the substance expand. Gases usually expand much more than solids or liquids because their particles are not strongly attracted to each other and are far apart or spread out.
When solids, liquids and gases are cooled, their particles lose energy, slow down, move less and become more strongly attracted to each other.

Effects of Expansion and Contraction in Everyday Life:

The expansion and contraction of objects have caused a variety of problems in our everyday life. In solids, this expansion and contraction may be small, but the forces experienced can be tremendous.

Engineers and architects allow for expansion and contraction of materials when designing bridges and buildings.

(a) Bridges have gaps at each end of large sections to allow the metal and concrete to expand in hot weather so they will not buckle. Rollers and sliding joints allow for the movements of the bridge as it expands and contracts.

(b) Railway lines also have gaps to allow for expansion in hot weather. A continuous track of metal rail if used, will expand in hot weather and buckle. To prevent this, there are gaps laid in between sections to allow for expansion.

(c) Electrical wires or overhead power lines are hung loosely from poles so that when the weather cools, they will not become too tight and break as they contract. Overhead cables expand and sag on hot days, but contract and tighten in cold weather. Allowance has to be made for thermal expansion and contraction of the overhead wires during their installation.

The amount by which each structure will expand will depend on the material it is made from.

Bridge

Railway line

Electrical Wires

Source: primary

Liquids expand more than solids. This property makes them useful in thermometers. Most thermometers that we use in the lab are made up of thin tubes and a bulb containing a liquid. As the temperature increases, the liquid expands and moves up the tube. The two common liquids used in thermometers are mercury and alcohol. A clinical thermometer is specially designed to measure human body temperature.

Exercise

1. Explain what happens to the particles in:
   - (a) ice-cream as it melts
   - (b) the air bubbles trapped in dough as it is cooked to make bread.
2. Why does sugar dissolve more quickly in hot than in cold tea? Explain what happens to the sugar particles.

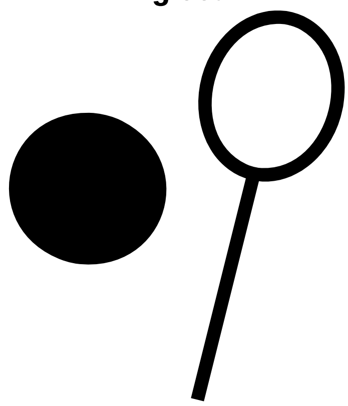
Expansion in solids investigation

Aim: To observe the effect of heat on the volume of a solid.
Materials: metal ball and ring set, Bunsen burner, pair of tongs (heat proof).

- Try to put the ball through the ring.
- Use the Bunsen burner to heat the ring and use tong to try to put the ball through it. Take care not to touch the hot metal.
- Let the ring cool and try to put the ball through the ring again.

1. What has happened to change the size of the ring?
2. Use the particle model to explain the change that took place in the ring.

Metal Ball and Ring Set

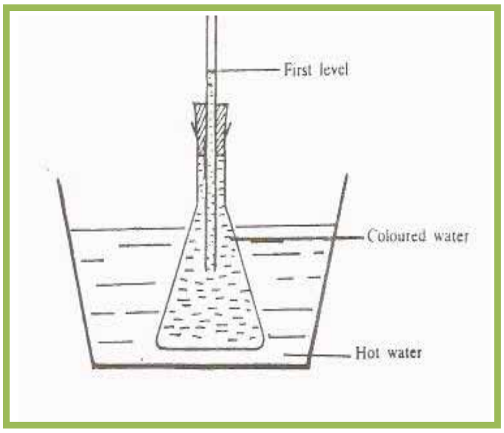


Expansion in Liquids investigation

Aim: To observe the effect of heat on the volume of a liquid.
Materials: 500ml conical flask, narrow glass tube, rubber stopper with one hole, Bunsen burner, tripod and wire gauze, eye dropper, food colouring, marking pen.

- Place 2 or 3 drops of food colouring in the flask and fill it with water up till the top.
- Place the stopper in the flask with the tube fitted .Some coloured Water should rise up into the tube. Mark the level of the liquid in the tube using the marking pen.
- Place the flask on the tripod and gauze mat, light the burner and gently heat the liquid.
- After about 5 minutes of heating, turn off the burner and watch what happens to the level of the liquid.

1. What happens to the level of the liquid while it is being heated?
2. What happens to the level of the liquid while it is cooling down?
3. Use the particle model to explain why liquids expand



Expansion in Gases investigation

- Cut across the centre of three rounded balloons.
- Stretch these smoothly over the top of three wide-mouthed jars.
- Hold them in place with rubber bands.
- Place one jar in iced cold water and another in hot water for a few minutes. Leave the third jar at room temperature.

1. What happens in the two set-ups when compared to the one just left at room temperature?
2. Use the particle model to explain your results.

Exercise

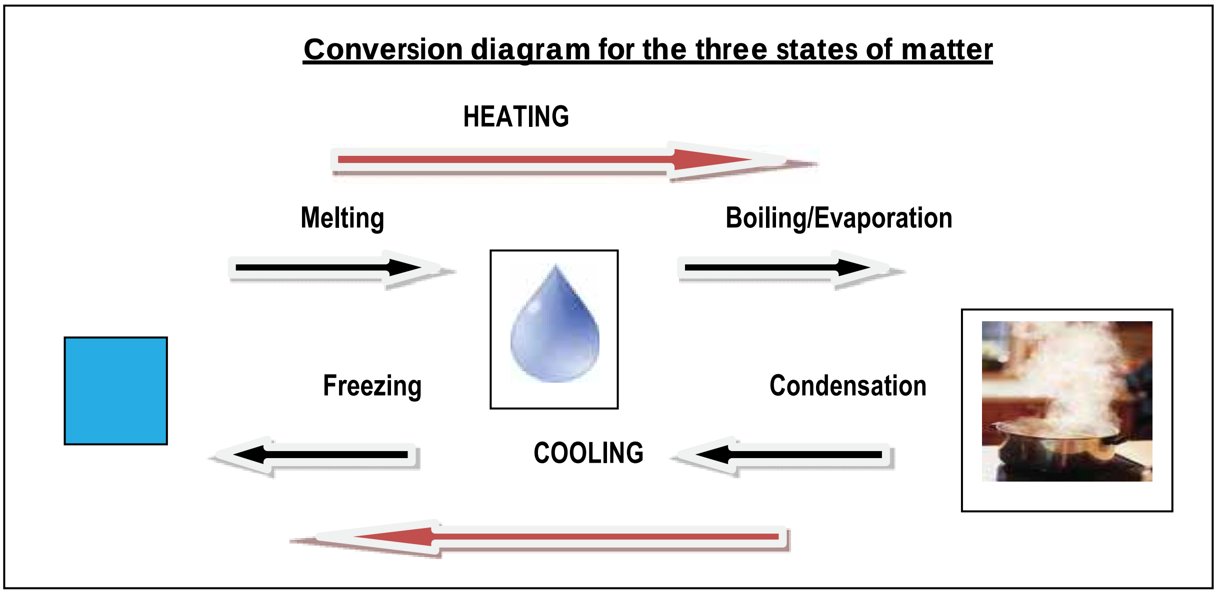
Based on your knowledge of expansion in solids, liquids and gases, investigate why some eggs crack when they are placed in boiling water.

Source: Primary

2.1.4 Effect of Heating and Cooling on Matter

Changes of State

Substances can exist in more than one physical state. They change from one state to another due to the behavior their particles. This change happens with a change in temperature. If a solid is heated, its particles have more energy and can move around more freely. Finally they break of their fixed positions, and the solid turns into a liquid.



Exercise time!

1. Boiling and evaporation are not quite the same. Can you explain the difference?

2. What change of state do diagrams (**a) – (d)** show? (Use the correct scientific word, eg solid melting to a liquid.) Some pictures may show more than one change of state. Where is the energy coming from or going to?

3. Create a concept map (spider diagram) around the phrase CHANGES OF STATE using the terms: *freezing, condensation, reverse sublimation, melting (fusion).*

(a) Water boiling

(b) Candle burning

(c) Clothes hanging in the sun

(d) Dew on windscreens

UNIT 2: MATERIALS

A material is a substance that is used for making objects. Some objects are made from naturally occurring materials and are used as they are found or processed in some way. For example, the cotton in your school uniform is processed more than the wood used in furniture. Other objects are made from synthetic or manufactured materials, for example, the plastic containers. Synthetic materials are made from raw materials by changing them chemically. This is done by heating them together or reacting them with other substances.

Materials from naturally occurring substances

These can be from non-living sources and from living sources.

Non-living sources	Living sources
• Building materials from rocks, such as slate ,marble ,stone, gravel • Metals from ores, eg. Iron, copper	• Wood from trees for buildings and furniture and for making paper and cardboard • Canvas and ropes from plants • Silk, wool and cotton fibers for clothing from silk worms , sheep and cotton plants • Rubber from latex of rubber trees • Leather from animal skins

Classes of Materials: synthetic or manufactured materials

Material	Manufactured from	Examples
Ceramics	Clay, Sand and other minerals	chinaware, concrete, bricks, tiles
Plastics	Crude oil and other substances	polythene, polystyrene, formica
Glass	Sand, limestone and other minerals	soft soda glass, glass fibres, pyrex glass
Alloys	Mixtures of metals and other substances	steel, brass, bronze
Synthetic fibers	Crude oil and other substances	Nylon, terylene, polyester
Composite materials	Two or more materials such as plastic reinforced with glass fibre	Plastic reinforced with glass fiber for canoes, baths and plastic reinforced with carbon fibers for tennis rackets

2.2.1 Properties and interactions of materials

Properties of Materials

How a material is used depends on its properties. The properties of a material describe how it behaves and what it is like. Given below are properties of the main group of materials.

Group of Materials	Properties
Glass	• Transparent,brittle,unreactive,high melting point, non-conductor of heat and electricity
Metals and Alloys	• Usually hard,strong,dense,malleable, ductile, have high melting point, conduct heat and electricity
Plastics	• Flexible, low density,moulded when warm, many melt easily and some burn on heating, good insulator of heat and electricity
Ceramics	• Brittle, hard, high melting point, unreactive, non-conductors of heat and electricity
Fibres	• Flexible, low density, many burn on heating, long strands
Composites	• Have the properties of the materials making them

When describing the properties of materials, the following words are used:

Property	Meaning
Transparent	Clear, can see through it, for example, glass and some plastics
Strong	Resists the effect of forces, for example, steel.
Brittle	Hard but breaks easily for example, glass
Dense	A large mass compared with its volume, for example, lead.
Flexible	Can be bent or twisted without breaking for example, some plastics and fibres.
Malleable	Can be hammered into shape, for example, copper.
Ductile	Can be drawn out into wires, for example, copper.
Conductor of heat (or electricity)	Lets heat (or electricity) pass through it easily, for example, copper
Non- conductor (insulator of heat (or electricity)	Difficult for heat (or electricity) to pass through it, for example, P.V.C

Plastics

Plastics are man-made raw materials. They are made from chemical compounds obtained from plants, coal and petroleum. They are soft or liquid-like when first made and can be moulded into different shapes under heat or pressure before they harden. Plastics have been replacing many materials in the making of useful products as they can be shaped into almost any form and has a wide range of hardness and colour.

Plastics	Products		
PVC (polyvinyl chloride) Strong, flexible, easily coloured, resistance to chemicals and weather.	**Pipes** 	**Raincoats** 	**Toys** 
Polystyrene Lightweight, odourless, cheap	**Cups, bowls** 	**Computer disks** 	**Packaging material** 
Polythene Lightweight, flexible, feels waxy.	**Bags** 	**Pails** 	**Food Wrapper** 
Bakelite Tough, withstands heat, resists wear.	**Radio** 	**Camera** 	**Plugs** 

<u>Source</u>: primary

Activity

1. Name the raw materials used to manufacture the following: bricks, nylon, glass, paper.
2. Give the properties of the following materials which make them suitable for the use given:
   (a) Glass in windows
   (b) Wooden or plastic handle on a saucepan
   (c) Metal used for making airplanes.

Properties of Materials

Do you think nylon or cotton thread is stronger?

Plan an experiment to test your idea. Remember to make it a fair test. What results do you expect from the experiment?

PLASTICS

1. **List and describe the two major types of plastics** 2. **Differentiate between the four common plastics.**
3. **What is wrong with society using plastics? What can be done to solve (or reduce) the negative points or impacts associated with using plastics?**
4. **Compare the advantage and disadvantages of plastics.** 5. **Using examples, discuss how important plastics are to humans**
6. **It has been estimated that, worldwide, there are between 500 billion and 1 trillion plastic bags discarded each year. That's about 1 million bags per minute. Many businesses encourage to use reusable shopping bags to help reduce the amount of plastic in the environment. Should we put a ban on the use of plastic shopping bags? Why or why not? Defend your position by considering both sides of the argument.**

2.2.2 Effect of Soap and Detergents on Water Types.

Sources of Water

Wells, Lakes, Springs, Streams, Swamps, Rivers, Sea.

Types of Water

Water is the basic necessity of life. But how well do we know it? Not many people out there are familiar with terms like hard water and soft water. These are basically two classifications of water based on its chemical content.

Hard Water

This type of water contains mineral salts of calcium and magnesium, mainly bicarbonates, chlorides, sulphates and sometimes irons. Temporary hardness is caused by calcium bicarbonate. This is removed by boiling as it converts bicarbonates to the insoluble carbonate. In homes, the hardness of water is often indicated by non-formation of lather when soap is shaken in a water sample. Generally, hard water is not harmful to one's health but can pose serious problems in industrial settings, where water hardness is monitored to avoid costly breakdown in boilers, cooling towers and other equipment that handles water.

Soft Water

This type of water contains very few or absolutely no traces of minerals such as calcium and magnesium. Among the ground water sources, soft water is derived from igneous rocks such as granite or sedimentary rocks such as sandstone which have low mineral content.

Differences between hard and soft water.

Hard Water	Soft Water
• Does not lather with soap • Ions dissolved in water react with chemicals present in soap and produces an insoluble residue (scum) making the clothes look dirty. • Important source of minerals such as magnesium and calcium.	• Lathers well with soap • Reacts well with soap making the skin smooth and glowing. • Saves money by increasing the efficiency of cleaning by more than 200 percent.

Exercise: Choose the best word(s) to complete the statement.

Hard water is water which **does/does not** lather easily with soap .Soft water is water which **does/ does not** lather easily with soap. Hard water is caused by **soluble/insoluble** substances which get into the water when it passes over **rock/sand**. Hard water is a nuisance because it **saves/wastes** soap and forms a **soluble/insoluble** "scum" which can make clothes look dirty. It also forms a layer of solid on the inside of containers in which it is **frozen/ boiled**. This is called **pot scrub/kettle fur** .Hard water can be softened by **boiling/warming** or **adding baking/ washing soda**.

Soaps and detergents have different effect on water. To decide if a substance is soap or a detergent, we shake it up with some hard water and if lather forms, we know it is a detergent. This gives detergent a bigger advantage over soaps where we can use them in any type of water.

Soap when swallowed, reacts with stomach acids to form harmless substances as soap completely loses its soapiness. However, detergents do not react with stomach acids and our bodies cannot digest or change it. If swallowed,it remains as detergent to form foam and froth inside our bodies. This can interfere with our intestines make us sick as detergents are poisonous. It some cases, it may even cause death.

When soapy water is thrown away it finds its way into streams, creeks, ponds, lagoons, rivers, or the ocean. On the way, natural processes particularly the work of bacteria, quickly destroy it. Soap is not likely to poison fish or spoil our water supply. Unfortunately, this is not true for detergents. Most of them are not easily destroyed by bacteria. They stay as detergent and water containing them stays frothy and bubbly. This may be harmful to living things in the water, and may spoil drinking water. When many people in a village or town use too much detergent, the water supply and the rivers and lagoons may become dirty or "polluted."

Detergents and soaps are different because of the way they are made. Soap is made from vegetable oils and caustic soda while detergents are usually made from petroleum or mineral oils from under the sea. They are made from a different process to soap and this gives them their different properties.

Some detergents have "Biodegradable" written on their labels. This means that when they go into the rivers or into the ground, bacteria can break them up into harmless substances. These detergents are made by a different process, and do not pollute water.

Exercise

Draw 2 columns in your book. Head one of them **Soap** and one **Detergent.** Write the following statements in the correct column.

(a) Lathers with hard water
(b) Does not lather with hard water
(c) Is destroyed in the stomach
(d) Is not destroyed in the stomach
(e) Is poisonous
(f) Is harmless
(g) Is destroyed in the stomach
(h) Is not destroyed by bacteria
(i) Pollutes water supplies
(j) Does not pollute water supplies

Exercise

1. Imagine you are living on an island where the only water you can use for washing is sea water. What would you use in the water, detergent or soap? Give reasons for your answer.

2. Eroni went to stay with his aunt in Sigatoka. When he came back to school, he told his teacher that there is hard water in Sigatoka. What observation would he have made to make him think that.

2.2.3 Effect of materials on the environment

Every material we use effects the environment. All the materials we use were originally extracted from, or grown on the earth's surface. Wherever materials originate, they have an effect on the environment. Sometimes the effect on the environment is positive but often it is negative. Often the environmental effect is obvious but sometimes it is hidden.

From cell phones and computers to bicycle helmets and hospital bags, plastic has moulded society in many ways that make life both easier and safer. But the synthetic material also has left harmful imprints on the environment and perhaps human health. Plastics are very long-lived products that could potentially have service over decades, and yet our main use of these lightweight, inexpensive materials are as single-use items that will go to the garbage dump within a year, where they'll persist for centuries.

Evidence is mounting that the chemical building blocks that make plastics so versatile are the same that might harm people and the environment. Its production and disposal also contribute to a number of environmental problems like:

- Chemicals added to plastics are absorbed by human bodies. Some of these compounds have been found to alter hormones or have other potential human health effects.
- Plastic debris, laced with chemicals and often ingested by marine animals, can injure or poison wildlife.
- Floating plastic waste, which can survive for thousands of years in water, serves as mini transportation devices for invasive species, disrupting habitats.
- Plastic buried deep in landfills can leach harmful chemicals that spread into groundwater.

People are exposed to chemicals from plastic a number of times each day through the air, dust, water, food and use of consumer products. It is therefore important to find ways to minimize the use of plastics or recycle and use biodegradable plastics.

Activity

Study the photographs below and identify the types of materials pictured. In groups, suggest ways of how these materials may be disposed of properly. This suggestion may be through posters, flyers etc that the group decides.



Source: primary

Activity

1. Choose one of the materials used to make the outside seating. Choose steel**, softwood, hardwood**, **plastic** or **concrete**.
2. Find out from the internet or books:
   a) where the raw materials to make the seat comes from;
   b) what processes occur to change the raw material into the chair.
   c) if there have been any environmental problems in obtaining and processing the raw material.
3. From your research try and identify the occasions when energy derived from fossil fuels has to be used to make the finished product. List the occasions.

UNIT 3: REACTIONS

2.3.1 Elements, Ions and Compounds

Elements

An element is a pure substance made up of only one type of a particle or atom. The element iron is made up of iron atoms which are all alike .Sulphur is made of sulphur atoms which are all alike. But iron atoms are not like sulphur atoms.

Scientists use symbols to represent elements. Most of the symbols are the first letters of the element's name.

Element	Symbol	Element	Symbol
Carbon	C	Iron	Fe
Oxygen	O	Zinc	Zn
Nitrogen	N	Copper	Cu
Hydrogen	H	Aluminium	Al
Sulphur	S	Sodium	Na
Chlorine	Cl	Calcium	Ca

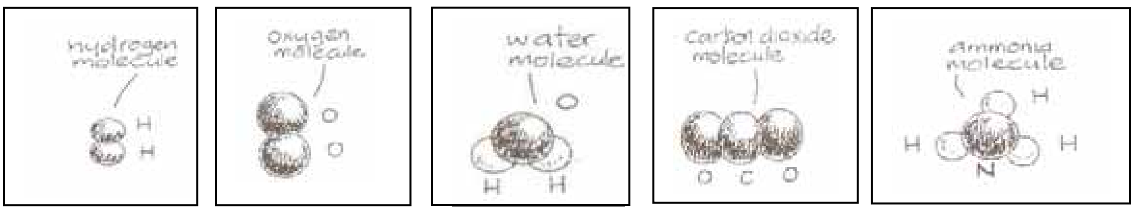
Ions

When an element reacts during a chemical reaction, it can either lose or gain electrons. When it loses or gains an electron, what results or forms is an ion. All elements have equal number of protons which are positively charged and electrons which are negatively charged. Therefore if an element loses its electron(s) in a chemical reaction, its ion has more positive charge on it, thus called **cation**. If the element gains electron(s), its ion has more negative charge on it, and is called an **anion**. Most metal elements lose electrons when they react while non- metal elements gain electrons.

Molecules

Not all atoms move around by themselves. Many especially gases, join up to make pairs. A molecule is made up of two or more atoms of the same kind or of different kinds chemically combined together. Molecules exist in both elements and compounds. We write an oxygen molecule as O_2.Hydrogen usually exists as H_2 molecules, nitrogen forms N_2 and ammonia exist as NH_3.

Models of some molecules



Hydrogen oxygen water carbon dioxide ammonia

Exercise:

What do you notice about the water, carbon dioxide and ammonia molecules? Are these substances elements? What type of atoms is found in water, in carbon dioxide and in ammonia?

Compounds

Compounds are substances which are made of more than one type of atom joined together. A compound may be made by chemically combining two or more elements. Compounds may be decomposed (broken up) by the use of heat, electricity or by the action of other chemicals.

A compound is represented using a chemical formula. The formula of a compound shows the type of atoms present in the compound and how many of each atom.

Exercise:

The formula of the simple sugar, glucose is $C_6H_{12}O_6$. Which elements are present? How many atoms of each one? How many atoms altogether make up one molecule of glucose?

Acids and Bases

Acids and bases are very important compounds in everyday life. Acids and bases are defined by what they do. This is referred to as operational definition and specifically based on their properties. Acids can be divided into two groups: mineral acids and organic acids. Organic acids are found in plants or animals. Mineral acids are the ones used commonly in the laboratory and in industries. They are known for their corrosive nature and must be handled with care.

Properties of Acids

- Most acids are corrosive ('burns' your skin) and react with many materials.
- All acids have a sour taste (e.g. lemons, vinegar).Do not detect acids by tasting them.
- Acids contain hydrogen ions (H^+) when dissolved in water and have pH less than 7.
- Acids turn blue litmus paper to a red colour.
- Aqueous solutions of acids are good electrical conductors.
- Acids react with alkalis to form salt and water.
- Dilute acid reacts with metals to produce hydrogen gas.
- Dilute acid reacts with carbonates to produce carbon dioxide gas.

Common Acids and their Uses

Acid	Formula	Uses
Acetic acid or ethanoic acid	CH_3COOH	Preserving food and for cooking. Found in vinegar and used to be made by the souring of wine
Citric acid Ascorbic acid	$C_6H_8O_7$ $C_6H_8O_6$	Making health food. Found in many fruit and vegetables, particularly citrus and source of vitamin C.
Hydrochloric acid	HCl	Cleaning metallic surfaces before they are coated. Found in the stomach and called spirits of salts. A mixture of hydrochloric and nitric acids is known as "aqua regia'- literally 'royal water' because the mixture is the only substance that will dissolve gold.
Sulphuric acid	H_2SO_4	Function as electrolyte in batteries, electroplating, making plastics and fertilizers.
Nitric acid	HNO_3	Manufacture of nitrogen-based fertilizers and explosives.
Carbonic acid	H_2CO_3	Very weak acid formed when carbon dioxide dissolves in water. When carbon dioxide in the air dissolves in rain, it dissolves in limestone (calcium carbonate)
Phosphoric acid	H_3PO_4	Making fertilizers and inhibiting the rusting of iron.

Test for Hydrogen Gas

Introduce a burning splint into a tube containing the gas.
Hydrogen gas is identifies by a 'pop' sound.

Test for Carbon dioxide Gas

Pass some carbon dioxide gas through clear Limewater. Carbon dioxide is identified by the limewater turning 'milky' or by the formation of a white precipitate.

Bases

Bases are commonly considered as the opposite of acids. When an acid and a base mix they cancel out each other and this is known as neutralization. Bases come in two forms:

- Soluble bases are called alkalis. These dissolve in water.
- Insoluble bases do not dissolve in water.
- Both soluble and insoluble bases react the same way with acids.

Properties of Bases and Alkalis

- Concentrated alkalis are corrosive ('burns' your skin). They must be handled with care.(example- caustic soda)
- All alkalis have a bitter taste and a soapy feel.
- When heated, alkalis react with ammonia salts to form ammonia gas.
- Alkalis turn red litmus paper to a blue colour
- Alkalis are good electrical conductors.
- Many alkalis (soluble bases) contain hydroxyl ions (OH^-) and have a pH more than 7.
- Alkalis react with acids to form salt and water only.

Common Alkalis and their Uses

Alkali	Formula	Uses
Sodium hydroxide	$NaOH$	Making soap, washing powders and drain cleaners.
Calcium hydroxide	$Ca(OH)_2$	Making mortar and reducing the acidity of soil.
Ammonium hydroxide (ammonia solution)	NH_4OH	Making fertilizer and cleaning liquid (agent).
Potassium hydroxide	KOH	Making paint removers and dyes for fabrics
Magnesium hydroxide	$Mg(OH)_2$	Making indigestion tablets and 'milk of magnesia'

Activity

1. Make a list of five elements which are found in your home. Describe each one and give its use.
2. Give the name and symbols of two liquids, four solids and three gaseous elements.

Mini exercise

Arrange the following in a table to show which are elements and which are compounds: copper, water, salt, magnesium, oxygen, carbon dioxide, zinc chloride

2.3.2 Chemical Reactions: Word and Chemical equations

Chemicals react together to form new substances or break up to form new ones. The evidence that a chemical reaction has taken place can be:

- a gas given off
- heat or light given out
- a new substance forms

The chemicals or substances used to start a reaction are called **reactants** and the substance that is formed or we finish up with are called **products**. In the equation, the reactants are on the left-hand side (LHS) and the products are on the right-hand side (RHS) of the arrow.

The process can be written as: Reactant 1 + Reactant 2 $\longrightarrow$ Product

A verbal description of what happens in the reaction is called a **word equation**. In a word equation, a **plus (+) sign** is used to show that two things (reactants) are joining together, or there are two or more products. An **arrow** is used to show that a chemical reaction takes place. For example, when iron rusts, iron oxide is formed.

The word equation for the reaction is: Iron + Oxygen $\longrightarrow$ Iron oxide

Chemical Equation

A chemical equation is a brief way of summarizing what has happened in a chemical reaction. In a chemical equation, symbols and formulae are used. They do not only show which atoms and ions are involved in the reaction but how many as well. Chemical equations are always balanced. This means that there must be the same number of each kind of atom on LHS and RHS of the equation. To balance an equation, whole numbers are place in front of the various symbols and formulae in the equation and not anywhere else.

Steps in writing Balanced Chemical Equations.

1. Identify the reactants and products by looking at the information given or by observing the reaction carefully.
2. Write a word equation. In a word equation, the reactants and products are named.
3. Decide on the symbols and formulae for the reactants and products and write a chemical equation using the symbols and formulae.
4. Balance the equation if necessary.

Poster Design
Make a poster about kitchen chemistry. Include pictures of drawings of at least 5 common kitchen procedures that depend on acid-base reactions. Write captions explaining what the reaction is and what it does. (Write the reaction using word and chemical equation)

Exercise time!
Write word and chemical equations for the following:

(a) Sodium reacts with chlorine to form sodium chloride.
(b) Carbon burns with oxygen to form carbon dioxide.
(c) Iron reacts with sulphur to form iron sulphide.
(d) Calcium carbonate decomposes to form calcium oxide.

Exercise time! Instruction: Copy the chart below. Fill in the answers. Then discuss it with the class. You may change your answers if you want to.

What happens when the following activity occur?	Is it a chemical reaction? Y/N	My reasons	What I think after class discussion
• Removing the top off a soft drink bottle • Frying an egg • Brewing tea in a teapot • Water freezing • Compost being made • Bread covered with mould • Fireworks exploding • Stirring sugar into water • Cassava rotting • Curtains fading			

2.3.3 Effect of Chemical Reactions on the Environment

A large number of chemical substances from different sources have been introduced into the environment by humans over the century. Some are wastes from industrial and agricultural processes. Some were used as structural materials and others have been designed to perform various functions such as healing the sick or killing pests and weeds.

Some chemicals are useful but many are toxic and their harm to the environment far outweighs their benefit to society. To manage the risks better, we need to only use chemicals which are safe.

Chemicals enter the waterway as effluent and air as emissions .Motor vehicle and industrial emissions of nitrogen and sulphur oxides cause acid rain, which poisons fish and other aquatic organisms in rivers and lakes and affects the ability of soil to support plants.

Carbon dioxide causes the greenhouse effect and climate change. Chlorofluorocarbons (CFC's) cause the destruction of ozone in the stratosphere and create the possibility of serious environmental damage from ultraviolet radiation.

Chemical fertilizers and nutrients run-off from farms and gardens cause the build up of toxic algae in rivers, making them uninhabitable to aquatic organisms and unpleasant for humans. Some toxic chemicals find their way from landfill waste sites into our ground water, rivers and oceans and induce genetic changes that compromise the ability of life to reproduce and survive.

ACTIVITY: GROUP RESEARCH

1. Find out ways in which harmful chemicals in the environment enter our bodies.
2. Discuss what you can do to minimize the effects of such chemicals in our bodies and environment

CHAPTER 3: LIVING THINGS AND THE ENVIRONMENT

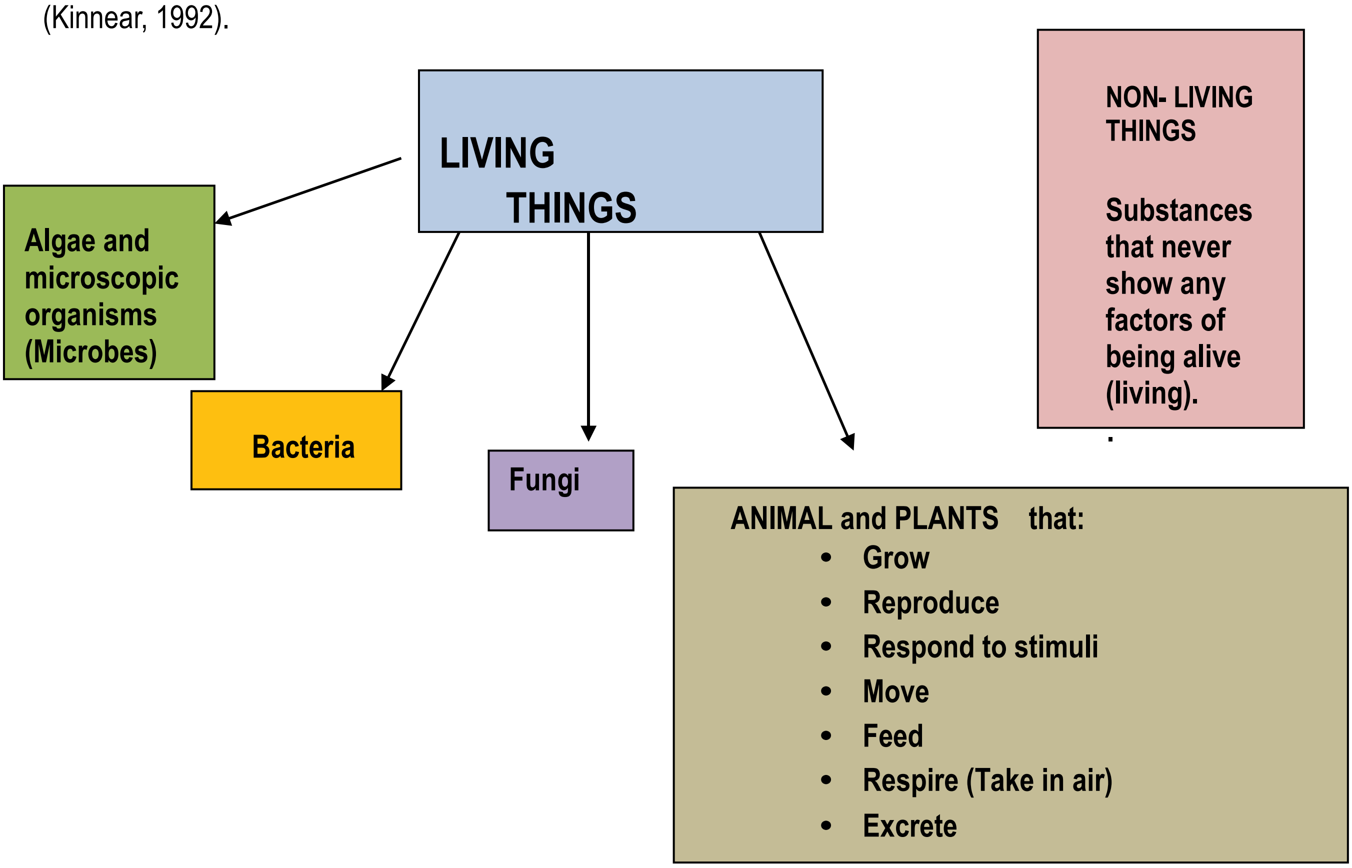
1. LIVING TOGETHER
2. BIODIVERSITY, CHANGE AND SUSTAINABILITY
3. STRUCTURE AND LIFE PROCESSES

Introduction

Biology is the study of living things. To decide if something is living or non-living, we can use the phrase **MRS GREN.** **M** is for movement, **R** is for respiration, **S** is for sensitivity, **G** is for growth, **R** is for reproduction, **E** is for excretion and **N** is for nutrition.

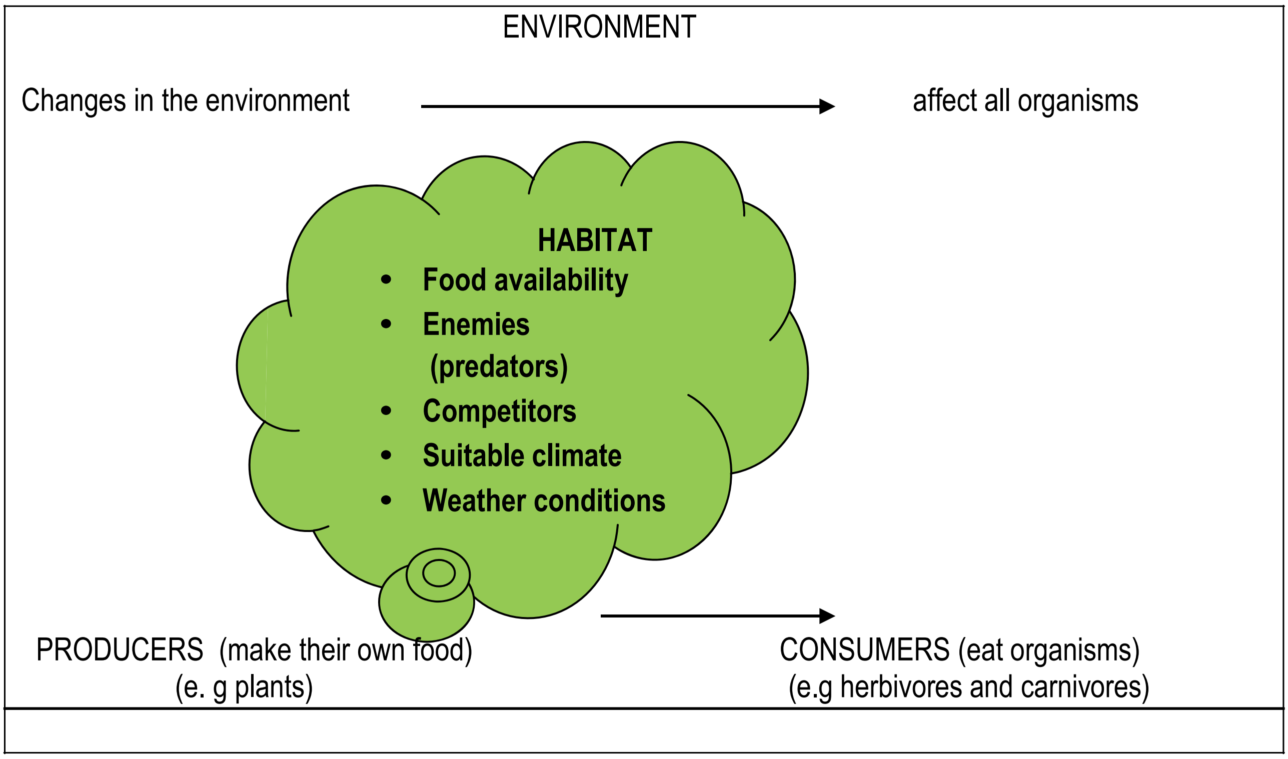
What are living things?

- Are made up of organic matter (carbohydrates, lipids, proteins, nucleic acids)
- Trap energy from their surroundings, store energy, release energy in a controlled manner and use the released energy to maintain their living state.
- Exchange matter with their surroundings including supplies of carbon, hydrogen, oxygen, nitrogen and sulphur (Kinnear, 1992).



What is the Environment (of the living thing)?

- The conditions in which the organisms live in.
- The environment is everything around us including both the living and non-living parts. (Wilkinson, 1992)
- The external surroundings in which an organism lives and are influenced by abiotic (non-living) and biotic (living) factors. (Kinnear, 1992)
- Some abiotic factors include soil, water, air ,light intensity, temperature humidity (climatic conditions) and some biotic factors or the influences of other organisms (Begon & Harper, 1996) are competition for food /space/mates, density and population to name a few.
- The environment in a habitat (a place where an organism lives) is produced by the action and interaction of the biotic and abiotic factors and it affects the organisms that live there. (Kinnear, 1992)



In general the study of living things and the environment basically involves the study of the relationship between living things themselves and also with their environment. This is shown by how they interact, how they depend one another for survival and how they influence one another.

UNIT 1 LIVING TOGETHER

Introduction

This unit will help us understand, recognize and appreciate the nature in which living things and their environment are interdependent and how each contributes to the survival of the other, especially organisms.

3.1.1 Ecosystems

Ecosystems are living systems which link together these five components, three of which are alive: energy, chemicals, producers, consumers, consumers. A natural forest is an ecosystem, so is a mangrove forest or your garden at home. An ecosystem is more than just a collection of plants. It is sort of a 'mega life', made up of many kinds of plants, animals, decomposers, together with water, soil chemicals and all these energized by sunlight. The chemicals move from one life- form to another and are continuously recycled.

A community consists of all the finds of living things which naturally live in a particular place, like a fish pond or a forest. All plants and animals living in one place are normally linked in a food web. The exact place where it lives is called a habitat. If it is very small, like a damp area under some leaves, then it is called a micro-habitat.

Terrestrial Ecosystems

Grassland

Forest

Garden

Aquatic ecosystems

Reef

creek

Coastal

CORAL

Corals are colonial animals which mean that each "head" is made of thousands of individual interconnected polyps. They survive where temperature is between 20 0 C – 300C. There are several kinds of corals but only those with zooxanthellae build reefs. Zooxanthellae is a type of algae that live in corals.

Diagram of a Coral Polyp

As the coral colony grows, new individuals build on top of old skeletons. The old skeleton consists of the evident massive structure. Only a little living tissue is present on the top. As a result of this, corals are so easily damaged if they are touched by divers, anchors or other rough things. Coral grow in shapes that reduce the impact of water movement.

CORAL REEFS

Coral reefs are unique as the geological structures are built by living communities. They are formed by the combined effort of billions of tiny marine organisms ranging from algae, protozoa through to coral animals.

Types of Coral Reefs

1. Fringing Reef - border the shores, surrounding the islands.(Commonly found in Fiji).
2. Lagoon - enclosed flat-topped reefs
3. Barrier Reef - Found at some distance off-shore
4. Platform Reef - accumulated small patches found inshore of the barrier reef.

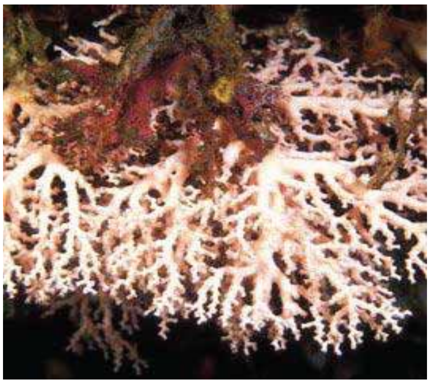
IMPORTANCE OF CORAL REEFS

- Homes/Habitats to a variety of marine organisms eg. Fish, worms, clams, starfish, crustaceans
- Protect island shorelines from strong waves
- Important part of the ocean food web
- Income Earner (Families/Country – revenue)
- Source of employment
- Tourist Attraction
- Contributes to the formation of islands
- Has an Impact on Climate Change
- Contributes to the rate of climate changing taking place today

COMMON CORALS FOUND IN FIJI

Hard coral

Hard corals have calcium carbonate; they feed on algae and are found in clear waters.

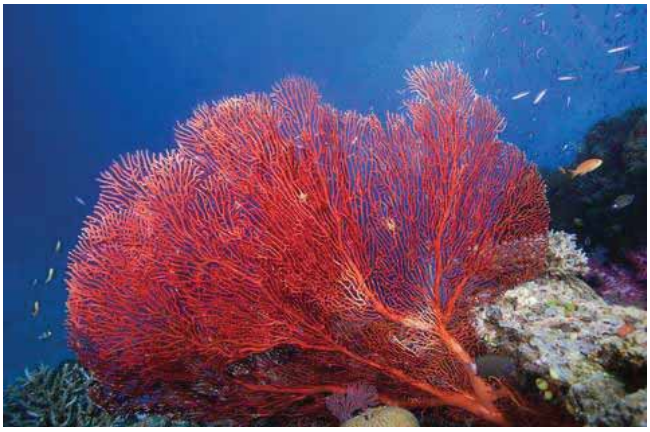
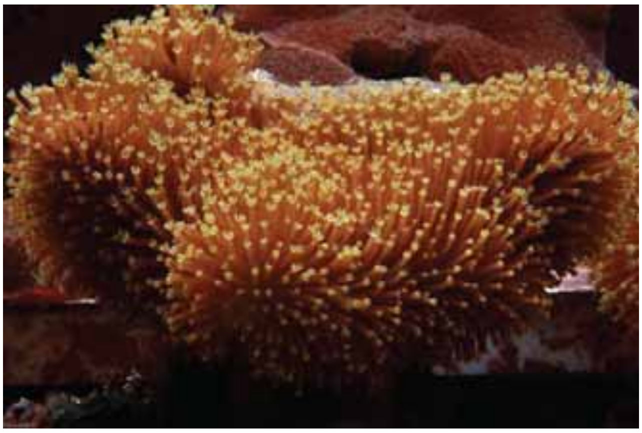
Type	Diagram	Features
Fragile Coral		- Needle coral - The fragile branches interlock to produce a very dense thicket. - Colours include pink, brown, green and grey, often with whitish tips. - Home to small fish - Common on reef flats and in the lagoon.
Staghorn Coral *(Lasetagane)*		- The commonest corals on the reef - Grows quite tall and form branches as well as cup- shaped and plate-like structures.
Mushroom Coral *(Coroga)*		- Each coral is a solitary polyp of large size - The skeleton it produces resembles an upturned mushroom.

Brain Coral *(Vatubuso)*		- Coral looks smooth and the growth form large rounded heads or brain-like shape. - Colours include pink, purple, grey and brown - Widespread over the reef
Vase Coral / Scroll Coral		- Usually light grey, brown or green - Like coral, can be about 20cm in diameter - They grow into thin curving sheets which look like scrolls.
Fire Coral *(Lasekata)*		- Can deliver a nasty burn on humans

Source [Pictures of Types of Hard Corals]   : Internet

Soft Coral

The following corals are classified as soft corals. Soft corals lack calcium carbonate skeletons so they do not contribute to the growth of a reef.

Type	Diagram	Features
Horny Corals		- Named not because of their sex drive but because their skeleton is made of a horny substance called gorgonin. - Often very colourful – orange and red.
Stinging Corals		- Consist of a series of flattened branches - Usually yellow-brown or orange - If you get stung by one of these, the best treatment is to cover infected area with vinegar or any diluted acid.

Source [Pictures of Soft Corals]: Internet

Activity 1: Observing Organisms Living Together

In manageable groups, select a freshwater ecosystem (e.g stream or nearby creek) and a terrestrial ecosystem (land). Observe the organisms (plants and animals) in each ecosystem. Predict possible interactions and relationships that may be present and record observations on the recording sheet.

1. How many types of organisms are present?
2. Are the organisms living together or have their separate habitats?
3. Are there any special features, relationships in the ecosystem e.g walai /wabosucu (mile a minute) growing on other plants.
4. Are there any visitors to the habitat e.g a man, mongoose or manulevu who might eat organisms living there.
5. What special features are present in the freshwater ecosystem that is present or absent in the land/marine ecosystem?

Activity 2: Comparison of an Aquatic and a Terrestrial Ecosystem

In groups, discuss the similarities and differences between a fresh water/marine and land ecosystem. Findings of Activity 1 can be used as reference examples.

1. How are the ecosystems similar?
2. How are the ecosystems different?
3. Are the organisms present in each ecosystem the same/different?
4. Are there any special relationships/interactions in this habitat that enable organisms to survive?
5. Give examples of how the environmental conditions in the habitats (water & land) affect the organisms.
6. Does the organism affect its environment or does the environment affect the organism?

3.1.2 Features of the Environment

The environment is everything that is external to the organism. Both nonliving and living factors interact to make up the total environment of organisms. Abiotic features of the environment vary greatly from place to place. The greatest diversity exists between the abiotic features of an aquatic (water) environment and a terrestrial (land) environment. The distribution, diversity and numbers of plants and animals found in ecosystems are determined by the biotic and abiotic factors.

Abiotic Factors

Abiotic factors are the non-living features of the environment. These factors rarely threaten the survival of a species but will greatly affect their populations. They affect the type of ecosystem and therefore the distribution and abundance of organisms within that ecosystem.

- Physical factors include temperature, light, landform, tides, and shelter
- Chemical factors include amount of water, salinity, soil nutrients

Biotic factors

Biotic factors are the living organisms that occur in the environment. The distribution and abundance of organisms in an ecosystem is greatly affected by the organisms that live in the ecosystem. An organism may be affected by:

- Activities of members of the same species: competing for resources/A mate for reproduction.
- Activities of members of different species.
  - A source of food
  - A predator or a parasite
  - A disease causing organism

Activity 3: Carrying out Tests on the Abiotic factors of the environment
Conduct tests and carry out observations and tabulate your results to determine the differences in the following abiotic features of an aquatic and a terrestrial environment: Light, water, buoyancy, oxygen availability, nutrients, and temperature variation

TESTS OUTLINE

Temperature
Measure temperature using a thermometer.

Humidity
Place a strip of Cobalt chloride paper on leaf and record time taken for paper to turn pink

Turbidity
Use a secchi disk to measure the turbidity of the water.

Salinity
Weigh empty beaker. Heat 100mL of seawater in weighed beaker until all water has evaporated. Work out salinity by using the formula below:

$$\text{Salinity} = \frac{\text{mass of salt}}{\text{100mL of seawater}}$$

3.1.3 Interactions between Living Things

Living things (organisms) are not isolated in their environment. Organisms must interact with other individuals of their own species, with other species, and with their physical environment. The study of the interactions between organisms and their environment is called ecology. Ecology encompasses all aspects of biology; from physiology to behavior, because any change within an organism has the potential to affect its relationship with the environment. Likewise, ecological interactions can be studied at many different levels; between an organism and its environment, between an organism and a group of organisms, or between two groups. The survival of an organism depends on its relationship and how it adapts to its environment.

Organisms interact with each other all the time, whether we know it or not. Many of the interactions between species involve food: competing for the same food supply, eating or avoiding being eaten.

Types of Interactions

The three main types of interactions are competition, predation and symbiosis.

TYPE OF INTERACTION	DESCRIPTION	EFFECT
Competition	In competition, organisms struggle to survive as they attempt to use the limited resources of the environment such as food, water or shelter.	Competition limits the populations of the organisms involved because the resources for which they compete are limiting factors.
Predation	One organism, called the predator kills another organism called the prey for food.	At first the prey population decreases but the number of predators will also decline, as the predator's food supply is reduced. Predator-prey population go through related cycles of increase and decrease.
Symbiosis • Mutualism • Commensalism • Parasitism	In symbiosis, there is a close relationship between two species that benefits one of them. There are three types of symbiotic relationships, mutualism, commensalism and parasitism.	Mutualism – both species benefit. Commensalism – one benefits and the other is neither helped nor harmed. Parasitism – one organism (parasite) lives in or on another organism (the host) and it harms it.

Food Chains

Within an ecosystem, animals eat organisms and are in turn being eaten. The food relationship among organisms in an ecosystem is called a **food chain**. Every plant and animal in a food chain is called a link. The number of links may vary from one food chain to another. Most food chains start with green plants. Green plants are called **producers** because they make their own food. They provide food in the form of energy for the rest of the organisms in the food chain.

Food Chain example: **CABBAGE LEAF ⟶ CATERPILLAR ⟶ BIRD**

Animals get their food by eating plants or other animals because they cannot make their own food. They are called consumers since they consume other living things. A herbivore is a primary consumer because it feeds directly on plants. A carnivore is a secondary consumer because it feeds on other animals which are primary consumers.

The further away a consumer is from the producers in the food chain, the less energy is obtained from the sun. Animals that eat both animals and plants are called **omnivores**. The **decomposers** (bacteria and fungi) feed on decaying matter. This speeds up the decaying process that releases mineral salts back into the food chain for absorption by plants as nutrients. In reality, many food chains are connected to each other to form **'food webs'**. In any ecosystem, the webs are so complex. Energy move through food webs from the sun to chemicals in plants and animals. When anything is eaten, about 90% of the energy is lost and about 10% is carried on. This causes a pyramid effect so top carnivores are always rare.

Food Webs

Every food chain in an ecosystem will end up with a lot of interconnected food chains. This is because many animals eat more than one type of food. Likewise, each animal or plant can be eaten by different animals. This results in the formation of a network of interconnected food chains which is called a food web.

Food Chains &Food Webs

Instruction: Survey organisms (plants and animals) around your school/home.

1. Construct food chains for the ecosystem in your school or home locality
2. Describe what would happen if food chains and food webs are broken.
3. How can food chains and food webs be protected?
4. Perform a **role play** as organisms in a food chain or a food web. Act out what will happen when one of the links of the food chain or food web is affected by changes such as poisoning or drought.

Activity: Decomposers

Bury some rubbish in a hole in the soil, e.g. disposable plastic and paper plates, fruit peelings etc. One month later, dig up the rubbish and observe what has happened to it. Which type of rubbish has been broken down? Which has not been broken down? What broke the rubbish down?

Discuss effects of improper rubbish disposal in a group.

3.1.4 Responses of Plants to External Stimuli

The response or growth movement of plants towards external stimuli is called tropism. Plants generally use environmental stimuli for orientation in growth and movement. The response of plants may be toward (positive) or away (negative) from the external stimuli. The different external environmental stimuli that plants respond to are light, water, gravity and touch.

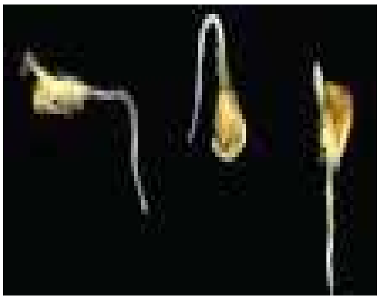
This plant growth process is caused by a plant growth hormone called **auxin** which not only regulates the growth of the plant but also control the movements towards or away from the external stimulus.

Phototropism

Source: http://images.the scientist.com/content/ images/articles/phototropism

Phototropism is a plant's growth response to light. Plants need light to grow. With more light, the plant is able to photosynthesize and produce more organic compounds that plants need to grow. The stems and shoots of most plants grow towards light and their roots away from light. When a plant is exposed to light, auxin is released into the cells on the plant's shady side. This lets the plant bend and grow towards the light source.

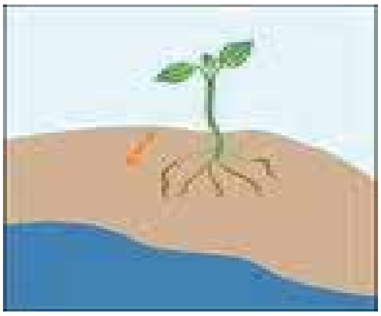
Source: http://images.the scientist.com/content/ images/articles/phototropism



Geotropism

Source: http://www.desktoclass.com/wp-content/uploads/2011/05/geotropism

Geotropism is also called gravitropism because plants use the gravitational pull for orientation. The roots grow downwards into the soil (positive geotropism) while the shoots grow into the opposite direction towards the light (negative geotropism).



Hydrotropism

Source: http://virtualastronaut.tietronix.com/text only /act25/images/hydrotropism

Hydrotropism is a plant's response to water concentrations. Roots for example grow towards moist soil to avoid drought stress. On a root cap has sensed water, it beds and the root grows towards it. This ability is essential because plants need water to grow. Water and soluble mineral nutrients are taken up by the root hairs. Then, in vascular plants, the water is transported through the xylem vessels.

Thigmotropism

Source: primary

Thigmotropism is a plant's response to physical contact. Climbing plants with coil- like structures (tendrils), first bend and turn until they touch a suitable supporting object. Once a tendril touches this support, it releases the hormone auxin into the tendrils growing to the other side.Auxin makes the cells in these tendrils longer and stronger thus helping the tendril to find support to grow around. The part of the tendril that is in contact with the object do not have auxin and so are weaker, allowing them to coil around the supporting object.

Types of Climbing Plants

- Twining stem around a support
- Clinging root
- Twining petioles
- Tendrils (shoots, leaves)
- Hooked structures (thorns, hooked branches

Activity: Identify the type of climbing plant shown in the pictures below. Discuss the advantage of this response for the plant.



Source: primary

UNIT 2: BIODIVERSITY,CHANGE AND SUSTAINABILITY

3.2.1 Biodiversity and its Importance

The varieties of living things in different ecosystem like the rainforest, reef etc. Refers to the diversity of life in area. Biodiversity can be described in terms of its genetic composition, species diversity and ecosystem. Genetic diversity refers to the variety of genetic information contained in all individual plants, animals and micro-organisms. Species diversity refers to the variety of living species and ecosystem diversity relates to the variety of habitats, communities and ecological processes and the diversity that is found within them.

Research: Medicines from Plants

Over a quarter of modern medicines are from plants or were first discovered in plants. Most of the knowledge comes from indigenous people who have their own traditional plant remedies. A lot of this old knowledge is in danger of being lost. Also one of the tragedies of rainforest destruction is that many plants and animals are becoming extinct before we discover anything about them- or even know that they exist.

Importance of biodiversity in an ecosystem

- Provide humans and organisms with food, medicine and shelter
- Helps to keep our water clean – Natural vegetation around water catchment areas, help maintain healthy water systems, regulate and stabilise water runoff, and help to prevent extreme events such as flood and drought.
- Helps to form and maintain soil structure and helps to keep the soil moil moist and rich in nutrients. Dead and decaying organic matter breakdown with the help of fungi and bacteria leaving nutrients in the soil.
- Nutrient storage and recycling
- Breaking down and absorption of pollutants created by human activities such as oil spills, rubbish and waste water. All parts of the ecosystem from decomposers to higher life forms are involved in the breakdown and absorption of these pollutants.
- Contribute to stability in climate. Studies have shown that undisturbed forest helps to maintain rainfall in an area by recycling water vapour in the atmosphere as well as locking away some of the harmful greenhouse gases released through burning of fossil fuels, intensive agriculture and clearing of land which cause climate change.

3.2.2 Changes in the ecosystem:

The changes in an ecosystem cause threats to the biodiversity of that ecosystem. This result in:

- Using up of natural resources before they can be renewed e.g. overfishing in oceans, over-harvesting of trees on land.
- Habitat destruction like clearing forest or draining wetlands for new developments or agricultural purposes.
- Releasing invasive species into foreign ecosystems like African tulip in forest, tilapia in Rewa river etc.

How can you help Biodiversity?

- ✓ Do not use pesticides- they kill plants and animals
- ✓ Use cloth napkins
- ✓ Recycle old newspapers and buy recycled paper products
- ✓ Always use eco-friendly cleaning products

- Any kind of pollution
- Failure of food chains

Habitat destruction

Clearing of Forest for development

Source: primary

Invasive Species: African Tulip

Source: primary

Mini –exercise: Short term and Long Term Effects of Change in Biodiversity

A. **Instruction:** Work in pairs and complete a similar table in your science exercise book.

	Short Term Effects	Long Term Effects
1		
2		
3		
4		

B. **Imagine you are an organism that has been affected by the destruction of the ecosystem in which you live. Write your story using cartoon illustration of the challenges you faced.**

Exercise 2: Compare and Contrast

Use diagrams or words to distinguish between the meanings of the following terms:

1.. Exotic species and native species
2. Overharvesting and sustainable yields
3. Degrading and Restoration Activities
4. Biodegradable and non-biodegradable
5. Conservation and destruction

Effects of changes on Organisms

- decrease in number of species: endangered
- decrease in food supply
- loss and degradation of habitat

3.2.3 Human Activities that contribute to these changes in the ecosystem

- Improper waste disposal and polluting of environment
- Reclamation of land for use through development
- Burning and deforestation/Logging

The Work of Biosecurity Authority of Fiji

Biosecurity Authority of Fiji is mandated to:

- protect Fiji's agricultural sector from the introduction and spread of animal and plant pests and diseases.
- manage quarantine controls at our borders to minimise the risk of exotic pests and diseases entering the country. It also
- provide import and export inspection and certification to help retain Fiji's favourable animal, plant and human health status and wide access to overseas export markets.

Foreign pests and disease pose a huge danger to Fiji's plants, animals and environment. The American iguana is a declared pest in Fiji. It is said to have been brought illegally into the country and released in Qamea Island. Now almost 10 years later, it has spread to Laucala, Taveuni and Matagi Island as well. If the American iguanas are not controlled and eradicated it could have disastrous effect on our environment, biodiversity, food security and the economy.

They pose an immediate threat to food security in villages and islands where they are present as they eat plants such as dalo leaves and cassava tops, bele, tomatoes, cabbage, beans and yam vines. If American iguana numbers are left unchecked, food sustainability in Fijian villages will be a great risk in the near future. These iguanas could also affect Fiji's biodiversity having a serious impact on endemic plants and bird eggs and nestlings. American iguanas post risk to our endangered native iguanas through possible transmission of iguana-specific diseases, parasites and pathogens from American iguanas to the endemic Fijian iguanas.

The eradication of these iguanas is a challenge as they are arboreal (tree dwelling), well camouflaged and have excellent eyesight thus they able to avoid detection. They are also excellent swimmers and usually climb a tree and drop into water where they can stay submerged for an hour or more. A good way of eradication would be locating all American iguana nesting areas and controlling the breeding by destroying the eggs.

Natural Solution on Biodiversity Conservation and Protected Areas

- Fencing
- Marine Protected areas
- Community involvement

EXERCISE: BIODIVERSITY

1. Identify human activities that lead to the destruction of loss of habitat.
2. Explain how loss of habitat affects plant and animal species.
3. Define and use the terms endangered, threatened and extinct and give examples of endangered, threatened and extinct species.
4. Investigate some species of plants and animals whose populations have been reduced because of human activities.
5. Identify ways in which humans pollute the environment and explain the effects of pollutants on biodiversity.
6. Define the term invasive and give examples of invasive species and discuss the impact they have on biodiversity.
7. Investigate the causes of climate change and its impact on biodiversity.

Exercise : Appreciating different sustainable uses of plants and animals

How are you today Dogo?

"I am a bit better but my shoulders are still bleeding from the attack. I hope it will heal soon."

What attack? Did someone attack you? With what? And what did you do? How many people?

Oh Tiri! A group came and cut all our arms off and put it in trucks. They just came with a chain saw and starting cutting, didn't even stop to check if they were cutting the small children's arms too. There was a lot of noise and

Write your story or dramatize this!!

1. Which two organisms are talking?
2. What are they talking about?
3. Are they happy or sad about what happen?
4. What possible uses could the 'arms 'be for?
5. Were the organisms given a choice to be cut or not? As a member of the ecosystem where the organisms live in ,do you ever take time to think or realise or imagine how hurting it is for the organism when parts of their 'bodies' are used for human consumption?
6. Imagine if a group of people came to your home or village and cut off all the arms of those present, young and old ...HOW WOULD YOU FEEL?

Source: primary

3.2.4 Sustainability and the Need for Conservation

Sustainability

Sustainable means taking no more from nature than is naturally replaced in the long run. Sustainable use can keep going for a long time. It simply means keeping things in a state of balance, but is not the same as leaving nature untouched..

Conservation

Conservation is the protection of valuable resources and management of forests, oceans, swamps and many more. It is the protection of our planet's biodiversity and the protection of many of the things we consider very useful.

Kinds of conservation

- Wildlife conservation
- Soil conservation
- Energy conservation

Conservation is needed because it is important for the entire planet, especially for biodiversity, and it protects endangered species from becoming extinct. Some ways that may contribute to helping in conservation include donating to organizations that promote conservation, planting a tree, picking up rubbish and encouraging people to help with conservation and many more.

WildLife Conservation

This is where people try to protect various endangered species from becoming extinct. This includes both plants and animals that have been identified as being at risk. Wildlife conservation includes protecting not only the particular species but their habitats as well. Several factors could lead to the extinction of such species. These include deforestation, overhunting and even various types of pollution. These animals and plants therefore need to be protected, and therefore a large number of government and non-government organizations have taken up this important cause.

Conservation Groups in Fiji

There are a number of conservation groups both government and non-government organizations which play a role in the conservation of biodiversity of plants (flora) and animals (fauna) in Fiji.

1. World Wildlife Fund (WWF)

This organization is one of the world top organizations when it comes to preserving wildlife. It works in several countries all over the world and uses the best scientific knowledge available to protect ecosystems and to come up with various development options with regard to preservation, efficient use of natural resources and also to deal with other environmental issues that have a great impact on the lives of endangered species. The WWF also work with governments, providing them with advice, policy alternatives, etc.

2. BirdLife Fiji

Since 2005, the forest of the Natewa Peninsula, part of the island of Vanua Levu was identified as a site of National Significance in the National Biodiversity Action Plan and the area was also designated as an Important Bird Area (IBA) by BirdLife International. It was also assigned as a Key Biodiversity Area (KBA) by Conservation International in 2005. Since then, BirdLife Fiji has been working with the communities of the Natewa Tunuloa Peninsula to promote conservation of avifauna and biodiversity. The High biodiversity of gobids and birds and the presence of the seven of the nine subspecies endemic to Vanua Levu island, such as the Silktail (Lamprolia victoriae), make this an important area to conserve.

3. Mareqeti Viti (NatureFiji)

NatureFiji – MareqetiViti was Fiji's first NGO, established in 2006 for terrestrial conservation. It works solely for the conservation and sustainable management of Fiji's unique natural heritage. Its role is to:

- Raising the level of conservation and environmental awareness and education in all aspects of wildlife conservation and management.
- Providing opportunities for children to learn of the remarkable natural heritage of our islands and seas.
- Recognize the key role of Fiji's indigenous landowners and promote to them a better understanding and awareness of Fiji's wildlife.
- Assist in conservation projects, wildlife management and island restoration projects.

Exercise : School Compound Survey

1. Identify an area in your school that you think is an environmental problem.
2. Make a list of the factors that your group thinks is causing the problem.
3. For each factor come up with possible solutions or ways to improve the current state of the area in order to make it environmentally friendly.
4. Draw up an action plan on how your group can help improve the area.
5. Put the plan into action and help beautify your school.

Exercise: Demonstrating Care for the Environment

In groups, collect recent newspaper articles (of Fiji) that describe how the environment is or ecosystems are being damaged or managed or protected.
Scan through the article to summarise what is being explained and then fill in a table similar to the one below.

HEAD LINE	Brief description of what the article is about
1.Polluters face fines (The Fiji Times ,10th September,2010)	Eg. Suvavou people are complaining to the Department of Environment to fine ship owners whose ships are berthed on their beachfront as they pose a threat to the marine life. etc.

Exercise 3: Waste management

In groups, make a model based on the themes shown below.

- REFUSE (what you do not need)
- REDUCE (what you do need)
- REUSE (what you cannot reduce)
- RECYCLE (what you cannot reuse)
- RECOVER (what you cannot recycle)

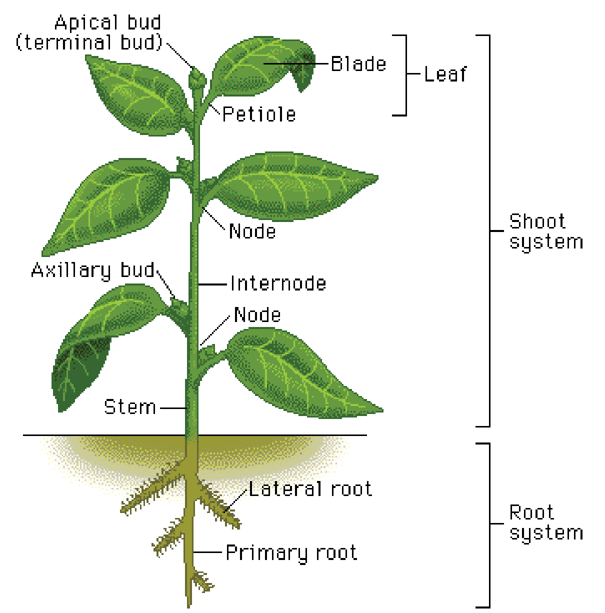
Note:

1. The Model should be made of materials that are regarded as rubbish around your classroom or school. e.g paper, pencil shavings etc
2. The Model should be able to be used in the School science lab for at least two (2) years.
3. If models are well done, it can be modified to be a source of income for the student.

UNIT 3: STRUCTURE AND LIFE PROCESSES

Structure of Plants

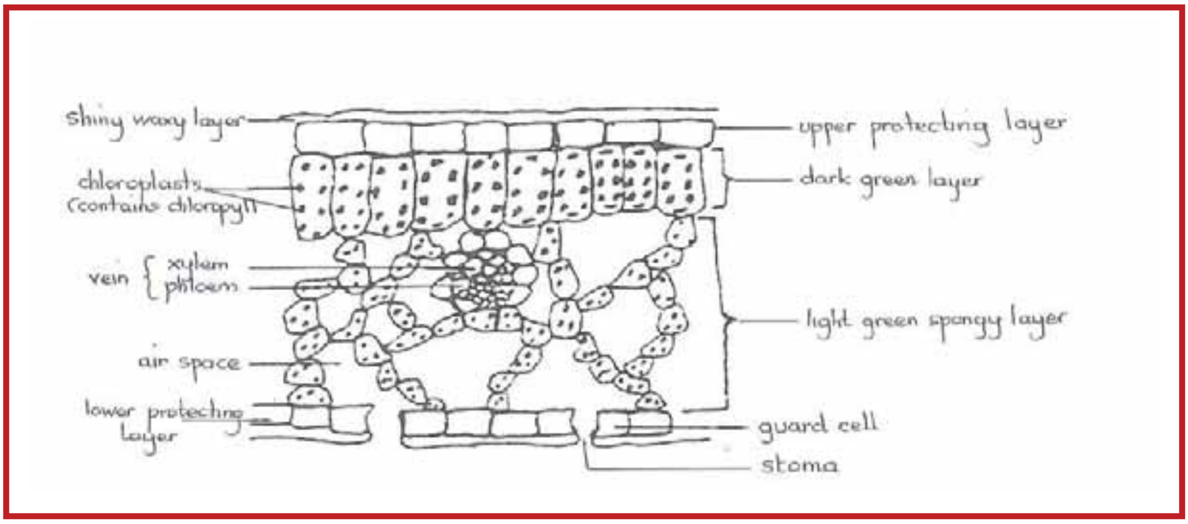
Anatomy is the study of the internal structure of plants.
Morphology is the study of the external structure of plants.



PLANT STRUCTURE (External)	Part of Plant	How does it help the Plant Function
	Root	• Provides anchorage in the soil • Absorb and conduct/transport water and minerals/nutrients
	Root Hairs	• Increase the absorption of water
	Stem	• Support the leaves, flowers and fruit • Carry water, minerals and
	Leaf	• A plant's food factory • Main site of photosynthesis where sugars are made from water, carbon dioxide using sunlight energy.
	Flower	• Reproductive part of the plant
	Fruit/Seeds	• Dispersal and continuation of species

Source(picture):http://www.phschool.com/science/biology_place/biocoach/plants/basic

Internal Structure of a Leaf



Activity:

Fold a thick leaf such as *viavia* or purple wandering jew and cut a thin slice using the slicing method. Use a hand lens to look carefully inside the leaf. If the thin slice is placed under the microscope, the parts could be seen in much more detail.

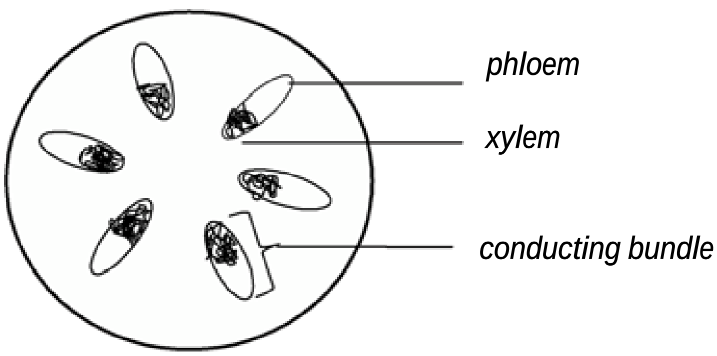
Research

Find out!

Functions of these parts of a leaf:
Upper layer, Dark green layer, Spongy Layer, vein, stomata. Lower layer

Internal structure of a Stem

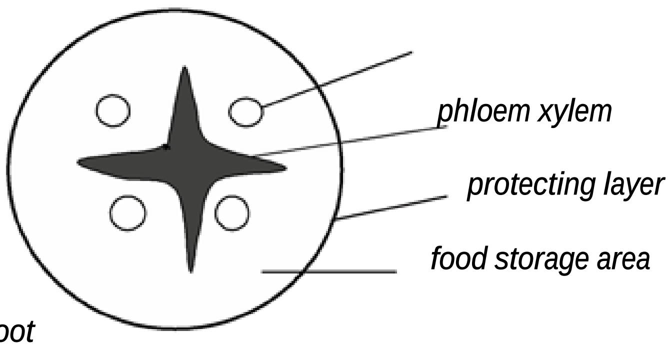
The internal structure of the stem reflects its function. There are conducting and supporting tissues.



A section across a stem

Source: primary

Internal structure of a Root



A section across a root

Exercise : Internal Structures of Plants

(a) Using the same kind of plants (aquatic and terrestrial), examine internal structures of the plants using a microscope. Examine and draw the following cross-sections of the plant : stem, root, and leaf.

(b) Also examine stomata on lower and upper surface of leaf and compare the abundance of stomata on both surfaces. Tabulate your findings.

3.3.2 Functions and Adaptive Features of parts of Plants

Leaves: The primary function of leaves is to obtain light and make food for the plant. A leaf's shape, colour, size and surface texture all play a part in transpiration and photosynthesis. Leaves have adaptations or features that enable them to perform this role effectively. These features include:

(a) A waxy cuticle on the upper surface of the leaf to prevent water loss.

(b) Plants have tiny openings or pores, especially on the lower surfaces of their leaves. These openings are called stomata (one pore is called a stoma).A stoma is a hole surrounded by two special cells, called guard cells. These cells can change their shape to open or close the stoma. Stomata let water vapour leave the plant in transpiration. They also let carbon dioxide and oxygen enter or leave the plant as they are needed.

Stems: The primary function of the stem is to hold the rest of the plant by supporting the leaves, flowers and fruit. The stem lifts the leaves up where they can obtain enough sunlight, moves food and water from place to place in the plant.

Roots: The primary function of the root is to provide anchorage in the soil, absorption of water and minerals and transport these upwards for the plant.

Some leaves, stems and roots are special because they carry out other functions in addition to their primary basic function. Study the photographs given and identify if they show leaves, stem or roots, and explain their special functions.





Source: primary

Exercise time!

1. A lot of words in science are borrowed from other languages especially Greek and Latin. Write out these six words: *photo-synthesis, chloro-phyll, bio-olgy, sapro-phyte, epi-dermis, stoma.*
   Under the two parts of each word write down what it means in plain English. Use this list: bio=life, phyll= leaf, chloro= green, phyte= plant, dermis= skin, sapro= rotten, epi= on, synth= to make, logos= knowledge, stoma= mouth, photo= light.

Activity : External Structure of Plants

Select an aquatic and terrestrial plant . Examine the external structures of each plant and note how they are similar and how they are different.

. **Exercise**:

Re-write each sentence so that each function correctly matches a design feature.

Structure (design feature)

Most leaves are broad and flat because this……
The outer surface is waxy, because this…..
There are many stomata because they…..
Inner cells have chloroplasts because these…..
There are veins (with xylem cells) going to leaves because they….
There are also sieve tubes in the veins because they…

Function (task which does it)

cuts down water loss in dry conditions.
carry water to leaves.
carries sugar away to the rest of the plant.
helps the plant collect more light.
help CO_2 get into the leaf.
are where sugars are actually made.

3.3.3 Types of Plants

Green plants are put into groups depending on certain features they possess.

Algae are the simplest plants. They grow in water. You may know them as seaweeds like lumi, nama or as slimes that grow in drains and ditches around your school. Algae do not have proper stems and leaves and do not reproduce by seeds. Sometimes they are made up of a lot of fine threads, like green hair. In the ocean there are many different algae. Some of them may have a red or brown colour which hides their chlorophyll. Many of them are so tiny that they can only be seen with a microscope. These algae float on top of the sea and are called **plankton**. All of these seaweeds are very important as the producers in food chains which are taken up by fish or man.

"Nama"

Source: primary

Mosses live in moist, shady places. You may find them on rotting logs in the forest. They are very small plants and grow very close together. Sometimes they make a soft green mat on the forest floor. Mosses reproduce by spores which are found in a small container called a **capsule**. This is at the end of a hair-like stalk. When the capsule dries, the spores are scattered and grow into new moss plants.

Source: primary

Ferns

Ferns come in many shapes and sizes ranging from tiny delicate "filmy ferns growing on tree trunks to the tall tree ferns or balabala. Ferns mainly live in moist, shady places. Some even live on water. Most ferns have underground stems which grow horizontally. From this, roots grow down and leaves grow upwards. The new leaves of a fern uncurl as they grow. This is sometimes called a 'fiddle head' or "shepherd's crook" and is easy to find in the forest. The leaf or frond may be very large, over 3metres in some tree ferns. It is usually divided into leaflets. The back of the leaflets contain spores. Different types of ferns have different shaped spot of spores. The spores are scattered and grow into new plants.

Source: primary

Conifers

Conifers are plants which reproduce by seeds. However their seeds are not formed by flowers, but are found in cones. Dakua, nokonoko and pine are some of the conifers that grow in Fiji. Many conifers have needle-shaped leaves and all of them have two types of cones. The small ones make pollen, and the larger ones are where the seeds are formed. The seeds are protected by woody scales. When the scales open, the seeds are scattered. Conifers are important trees in our industrial world. Some of them are used for timber, others for making paper, and others produce turpentine, charcoal and tar.

Source: primary

Flowering plants (Angiosperms)

Source: primary

Flowering plants are the most common of all plants. They have roots, stems, leaves and flowers. They reproduce by seeds which are formed from flowers. The seeds are found inside a fruit. There are many different types of flowering plants of all shapes, sizes and colours. All of the fruit and vegetables we use for food, most of our timber trees; and most of the plants that makes environment and compounds so attractive are flowering plants.

3.3.4 Transpiration

Transpiration is the evaporation of water into the atmosphere from the leaves and stems of plants. Plants absorb soil water through their roots and this water can originate from deep in the soil. Plants pump the water up from the soil to deliver nutrients to their leaves. This pumping is driven by the evaporation of water through small pores called "stomata", which are found on the undersides of leaves. Transpiration accounts for approximately 10% of all evaporating water.

Source: primary

Importance of Transpiration

1. It helps to keep the plant cool when temperature and sunlight cause the rapid evaporation of moisture.
2. Helps to draw more water and minerals upwards from the soil.
3. Allows for photosynthesis to occur by helping the plant obtain the carbon dioxide it needs from the atmosphere as it releases oxygen contained in water vapour.

Environmental factors that affect the rate of transpiration

1. **Light**
   Plants transpire more rapidly in the light than in the dark. This is largely because light stimulates the opening of the stomata. Light also speeds up transpiration by warming the leaf.

2. **Temperature**
   Plants transpire more rapidly at higher temperatures because water evaporates more rapidly as the temperature rises. At 30°C, a leaf may transpire three times as fast as it does at 20°C.

3. **Humidity**
   The rate of diffusion of any substance increases as the difference in concentration of the substances in the two regions increases. When the surrounding air is dry, diffusion of water out of the leaf goes on more rapidly.

4. **Wind**
   When there is no breeze, the air surrounding a leaf becomes increasingly humid thus reducing the rate of transpiration. When a breeze is present, the humid air is carried away and replaced by drier air.

5. Soil water

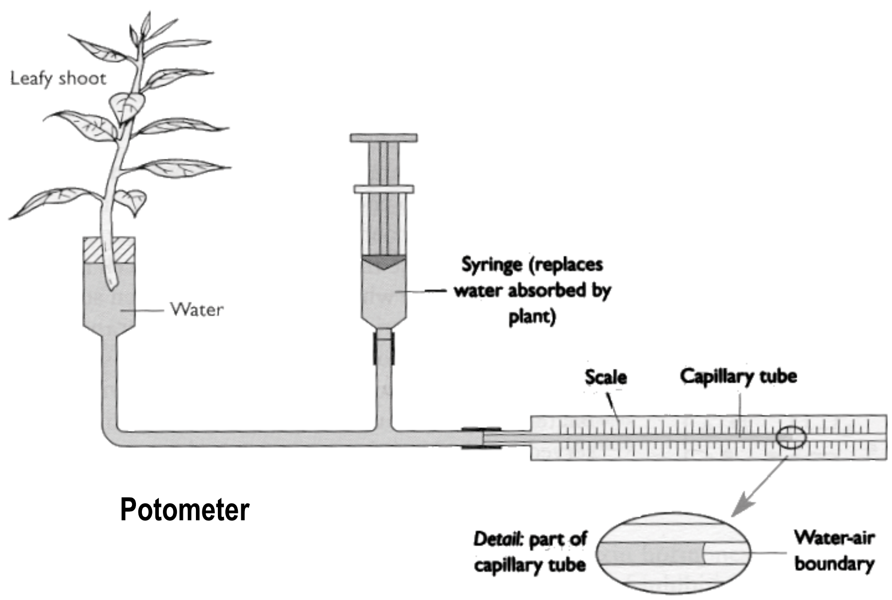
A plant cannot continue to transpire rapidly if its water loss is not made up by replacement from the soil. When absorption of water by the roots fails to keep up with the rate of transpiration, loss of turgor occurs, and the stomata close. This immediately reduces the rate of transpiration (as well as of photosynthesis). If the loss of turgor extends to the rest of the leaf and stem, the plant wilts.

Exercise 1 Transpiration
Complete the following sentences by choosing the correct words from the box:

Transpiration is the evaporation of ___________ from leaves. The water escapes through tiny pores called ___________. These are mainly found on the __________ of the leaf. It is cooler under the leaf and there is less air movement. This means that the plant doesn't lose too much water though its stomata. If the plant is short of water the stomata will ____________ to reduce water loss.

close	bottom	stomata	water

Activity 1: The rate of transpiration can be measured using a potometer.



Potometer

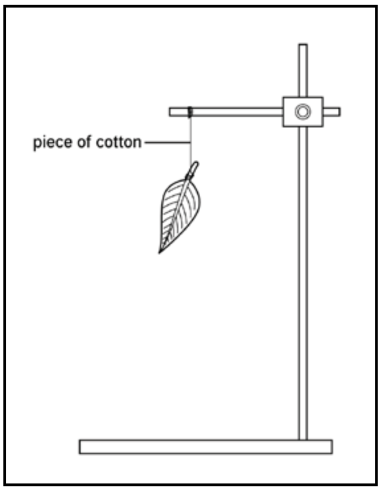
The rate of water loss from the plant through transpiration is found by measuring how far the water travels along the scale in a given time. Simon set up an experiment to compare the amount of water lost by the plant when it was light and when it was dark. These are his results.

	Distance water travelled along tube (mm)	
	In light	In dark
0	0	0
5	10	2
10	20	4
15	28	5
20	38	8
25	50	10
30	60	12

1. Plot the results for the light on a line graph. Then add the results for the dark onto the same graph.
2. What happens to the stomata of a leaf during the day? Why does this happen? How would this affect the rate of transpiration (would it increase or decrease)?

Activity 2: Leaves & Transpiration

You are going to investigate how much water a leaf loses in different conditions. You need to plan your investigation carefully.



Apparatus

- some leaves of similar size
- hairdryer
- fan
- 4 clamp stands
- balance
- cotton ties
- marker pen

Method

1. Take your leaves and mark each one with a number using a marker pen.
2. Measure the mass of each leaf. Record the masses in a table like the one below.
3. Using a piece of cotton, tie each leaf to a clamp stand.
4. Place each leaf in different conditions. Record the conditions you are using and how you made them in your table.
5. Measure the mass of each leaf after 45 minutes.

Prediction

1. Write down what you think will happen.
2. Why do you think this?

Results

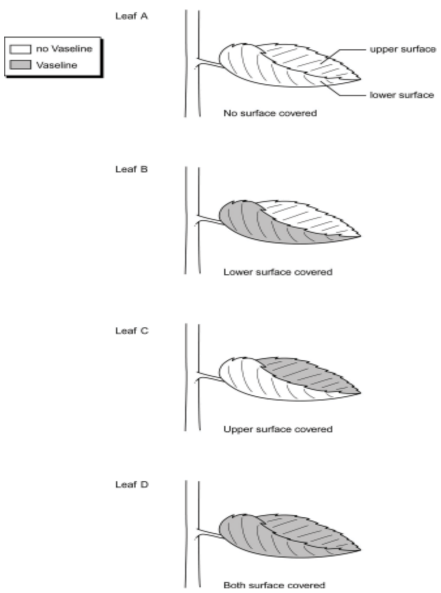
1. Make a table like this one.

Leaf number	Conditions	How you made the conditions	Mass of leaf before you started the experiment (g)	Mass of leaf at the end of the experiment (g)

2. Why do the leaves lose mass?
3. Which leaf lost the most mass? Why do you think this is?
4. Do your results agree with your predictions? If not, say why.
5. How precise do you think your results were? Were your leaves the same size?
6. How do you think the experiment could be improved?

Activity 3

An experiment was set up using four identical leaves. Different parts of each leaf were covered with grease, which is waterproof and blocks the stomata. The leaves were hung on a line and left for a week.



4 Which leaf do you think would lose the most water? (Hint: Think about where most of the stomata are in a leaf) Explain why this would happen.

5 Which leaf do you think would lose the least water? Explain why this would happen.

6 Look at leaves B and C. Which of these two leaves do you think would lose the most water? Explain why this would happen.

3.3.5 Photosynthesis

The word photosynthesis is formed from the words 'Photo' which means light and 'synthesis' which means 'joining together. Therefore photosynthesis in plants means 'using light to join molecules together to make food'. Photosynthesis is a very important process to all living things for a number of reasons: First, it is a way in which all animals get their food and energy through food chains. Secondly, it provides us with all the oxygen which we need for breathing and burning and thirdly, it uses up the carbon dioxide which is released into the air when animals breath and fire burns.

Photosynthesis can be summed up like this:

carbon dioxide	**+**	**water +**	**light**	⟶	**sugars**	**+**	**oxygen**
(from the air)		(from the soil)	(energy source)		(for many purposes)		(goes in the air)

Factors That Affect Photosynthesis

Photosynthesis is the chemical reaction that takes place inside green plants in the presence of chlorophyll and sunlight. Caron dioxide and water are converted into plant food and oxygen with the help of chlorophyll and sunlight. Besides these two factors, there are other factors such as carbon dioxide, pH levels, light intensity, and temperature that affect photosynthesis.

Light Intensity

The intensity of light affects the rate of photosynthesis. A low light intensity would mean low rate of photosynthesis. Increased intensity of light leads to a high rate of photosynthesis. Once the intensity has reached 10,000 lux, it does not affect the photosynthesis rate. A very high intensity of light can bring down the photosynthesis rate as it can bleach chlorophyll.

The Concentration of Carbon Dioxide

High concentrations of carbon dioxide lead to efficient photosynthesis. The atmosphere normally has a carbon dioxide concentration of 0.03 to 0.04 percent. This concentration is sufficient for photosynthesis. It has been observed that plants grow faster and better in a greenhouse where the carbon dioxide concentration is nearer 0.1 percent. The crops grown in greenhouses are bigger and yield more by comparison with field grown crops.

Temperature

Very high or low temperatures are not suitable for the photosynthesis process. Enzyme activity is essential for the two stages of photosynthesis. Temperatures ranging near 0 degrees C deactivate the enzymes affecting photosynthesis. Similarly, very high temperatures denature the essential enzymes prohibiting photosynthesis. The ideal temperature range is 25 to 35 C.

Chlorophyll

Chlorophyll absorbs light, without which photosynthesis cannot take place. An absence of chlorophyll will mean that photosynthesis will not take place at all. Certain diseases, mineral deficiency, and aging may lead to chlorophyll deficiency.

Water

Water is the life source for plants; plants cannot survive without it. Lack of water leads to lack of carbon dioxide as the leaves refuse to open their stomata to keep water they have stored logged inside.

Polluted Atmosphere

A polluted atmosphere can lead to a 15 percent decrease in the rate of photosynthesis. Industrial gases are the major culprit. Soot, which settles down on leaves, blocks the stomata, making it difficult to take in carbon dioxide. Polluted water affects aquatic plants and their photosynthesis process. For photosynthesis to occur at a constant rate the presence and levels of various factors are essential. Photosynthesis needs all of them at optimum levels to produce the best results.

Exercise time!

PLANNING YOUR METHOD

To find out if a plant has been making new chemicals, you simply have to test a few leaves for starch. Here are four simple steps which are used to find if a leaf has starch in it – but the order A to D has been scrammbled. Decide what the correct order is, then write these steps down unscrammbled as a proper plan. Add your own drawing of what is done at each stage. Check your plan for correctness and safety before you actually do the practical.

A. Pour some iodine solution over the leaf, and let it soak for 2 or 3 minutes. Any starch in it will turn bluish black. Gently rinse off the iodine.

B. Boil your leaf in methylated spirit for 1 or 2 minutes. (Important!! There must be no flames nearby! For safety sake, use a water-bath).When the leaf is pale looking, place in warm water.

C. Gently spread out the softened leaf in a Petri dish, with a little warm water. Take care- the leaf has just had a hard time.

D. Boil the leaf for 3 or 4 minutes, to burst the cells and soften the leaf before starting.

Experiment

DRAWING WITH LIGHT

Once you have worked out steps ABCD, you can test some leaves for starch. This works best if you use a plant with soft leaves- many types of weeds are good; tough leaves are useless. Make sure that the plant has been in good light for a few days. This experiment is more interesting if you cover parts of the leaves with black paper.

Source: primary

3.3.6 Reproduction in Plants

The two types of reproduction in plants are asexual reproduction and sexual reproduction. A sexual reproduction is also called vegetative reproduction. This form of asexual reproduction involves growth of plant parts which eventually become detached and grow into new plants. A sexual reproduction does not introduce variation in a plant species, however, it is a means of maintaining continuity of a group of plants and is also a quick method of increasing their numbers.

Natural Vegetative reproduction

All plant organs have been used for vegetative reproduction, but stems are the most common. Reproduction from a stem usually involves the buds. Instead of producing a branch, the bud grows into a complete plant which eventually supports itself. Vegetative reproduction can be either natural or artificial (man-made). The main types of natural vegetative reproductive structures that arise from stems are runners, stolons, rhizomes, bulbs and corms.

Runners

These are horizontal stems that grow above the ground from the parent plant. When their terminal buds touch the ground, they form roots and produce new plants.

Source: primary

Stolons

Stolons are modified stems whose purpose is to spread the plant over the surface of the ground. A type of runner in which the main shoot forms the new individual.

When the growing end of a shoot arches over and touches the ground, the terminal bud curves up, reproducing a new shoot which soon develop adventitious roots.

Source:internet

Rhizomes

These stems grow horizontally under the ground. In some cases the underground stems are swollen with food reserves e.g. ginger. The terminal bud turns upwards to produce the flowering shoot and the lateral buds may grow out to form new rhizomes.

Source: primary

Bulbs

Bulbs have very short stems with closely packed leaves arranged in concentric circles around the stem. These leaves are swollen with stored food. e.g. onion. A terminal bud will produce next year's flowering shoot while the lateral or axillary buds will produce new plants.

Source: primary

Corms

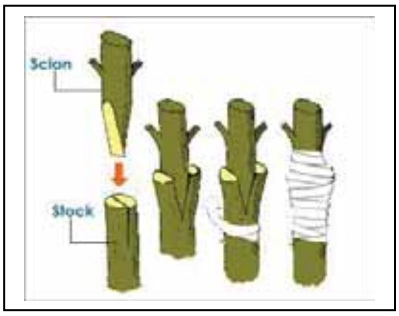
Corms also have short stems which swell and stores food. As with bulbs, the terminal bulb grows into a flowering shoot and the lateral buds produce now plants.

Source: primary

Artificial Vegetative Reproductive Structures.

Grafting

A bud or shoot from one plant is inserted under the bark on the stem of another closely related variety. The rooted portion is called the stock, the bud or shoot being grafted is called the scion.



Source: https://www.google.com/#q=image+of+grafting+of+plants

Cuttings

This method produces new individuals from certain plants by putting the cut end of a shoot into water or moist earth. Roots grow from the base of the stem into the soil while the shoot continues to grow and produce leaves.

Layering

Layering is a means of plant propagation in which a portion of an aerial stem grows roots while still attached to the parent plant and then detaches as an independent plant. Natural layering occurs when a branch touches the ground and it produces adventitious roots. Later the connection with the parent plant is cut and a new plant is produced as a result.

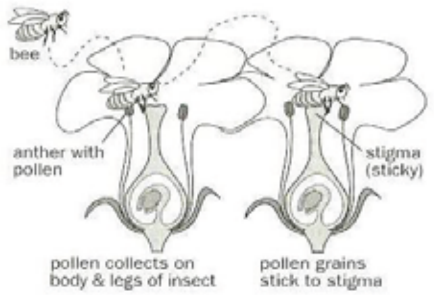
Sexual Reproduction in Plants

The flower is the reproductive part of a plant. Most plants have both the male and female parts on the same flower, some have separate male and female flowers on the same plant while others have separate male and female parts on different plants. A flower
consists of :

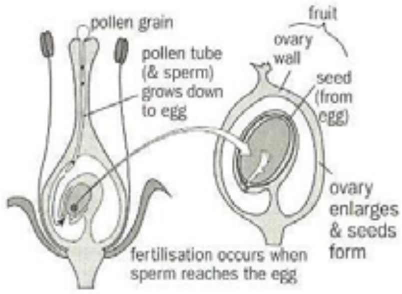
Source: primary

- sepals and petals,
- stamen, the male part that consist of the anther
- which produce pollen and the filament or stalk.
- pistil, the female part that consist of a stigma, a column of tissue or style and ovary (produce eggs or gametes).

The two processes that are involved in reproduction in plants are pollination and fertilization.



Pollination



Fertilization

Pollination

Pollination is the transfer of pollen grains from the anther of one flower to the stigma of another flower or to the same flower. The transfer of these pollen grains may be by insects or wind. Some plants have flowers that are pollinated by insects while others have flower that are pollinated by wind. This depends on the features of the flowers.

Fertilization

Fertilization in plants involves the fusion of the male and female nuclei to form the fruit and seeds.

Steps:
(a) Insects collect pollen from one flower and when they get to another flower of the same type, some of the pollen rubs on to the stigma of the flower.
(b) The pollen grain grows a tube down to the ovary where it can fertilise the egg to form a zygote.
(c) The ovules become the seeds.
(d) The ovary wall swells to become the fruit.

Dispersal of seeds

A seed must get away from its parent plant to be able to germinate and grow into a new healthy plant. This is because the new plant will need space, light, water, minerals and it cannot compete with the well-established parent plant.

Some ways that seeds are dispersed:
1. Wind – this method of dispersal is for seeds that are light of have wings, eg grass seeds, invasive species like African Tulip.
2. Water – The seeds in this mode of dispersal may float away, eg mangrove and coconut.
3. Animals – the seeds may stick to the coat of animals or go through the digestive system.. If it goes through the digestive system, it must provide a food source eg pawpaw, tomatoes.
4. Explosive Mechanism – the seeds are contained in pods and are thrown away at a distance from the parent plant when the pods dry and open. They could also be helped by wind currents in dispersal.

Activity Group work

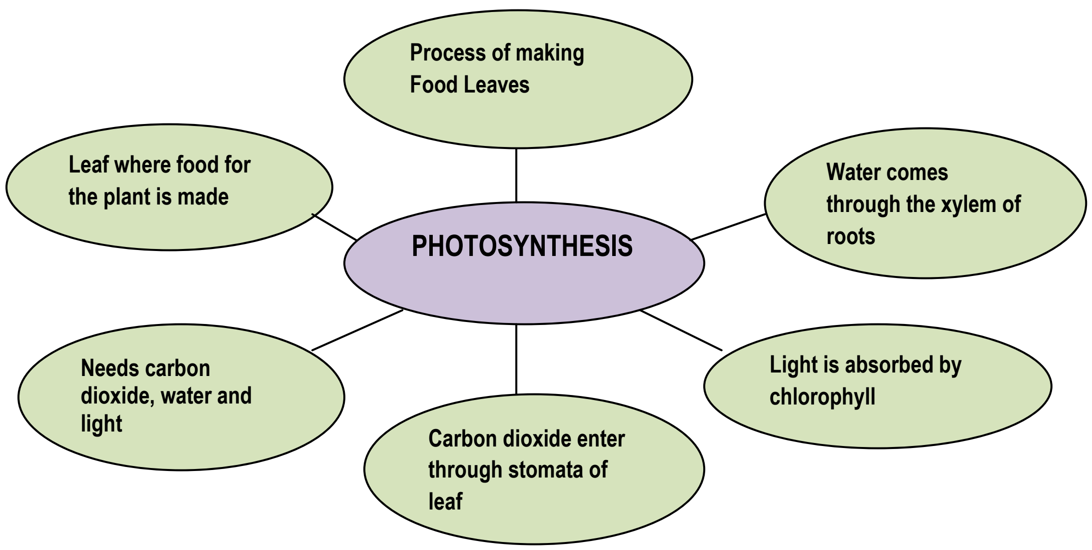
1. Make a collection of different plants seeds showing the ways they are dispersed.
2. What part of the potato plant do we eat? What is the fruit of the potato and can we eat it?
3. Imagine you are a seed. Describe how you were formed and how you came to your particular plot.

Exercice

(a) Research in groups, information of wind- pollinated flowers and insect-pollinated flowers, features and examples.

(b) Present research on a brochure or a book mark.

Concept map for Photosynthesis as a Life process in plants.



Draw Concept Maps for other Life Processes

Exercise
Life Processes

1. Are the processes dependant on each other?
2. Can one process occur without the other?
3. What main structures are included in the processes?
4. Are the structures similar or different aquatic and terrestrial plants?
5. What factors affect the rate of the processes?

Exercise: Setting Up Controlled Experiments

1. Design a controlled experiment to investigate a factor (of your choice) that is needed for the life process (Photosynthesis or Transpiration) to occur.

2. In your design, clearly state the aim, materials needed and write a science report on the results obtained

Exercise: Respect for Plants

A. In your school or home, make a flower garden to beautify your environment. Attend to your garden regularly so that it can beautify your school throughout the year before you go to the next class or form.

B. Invite a member of the community who is talented at flower arranging to teach the class on flower arrangement.

CHAPTER 4: ENERGY

1. ENERGY SOURCE AND TRANSFER
2. ENERGY TRANSFORMATION, USE AND CONSERVATION
3. FORCES

UNIT 1: ENERGY SOURCE AND TRANSFER

Energy is the power to change things. It is the ability to do work. Energy lights our towns and cities, powers our vehicles and runs machinery in factories. It warms and cools our homes, cooks our food, plays our music, and gives us pictures on television. Joule is a unit of energy and is equal to 0.2388 calories.

When man lived in caves and began to hunt, he would make a fire to roast the animal he had hunted. He used the firewood he found in his surroundings for this purpose and thus man began to make use of heat energy. The substance that produces energy on burning is called "fuel".

4.1.1 Sources of Energy

The Sun is our principal source of energy. Other sources of energy are Fossil fuels, Hydro power, plant Biomass, Wind Energy, Solar energy, Geothermal energy, Ocean thermal energy, Tidal energy, Wave energy, Nuclear energy.

Source: primary

Wood firewood is used as fuel in rural areas. One kilogram wood gives about 1700 kilojoules of energy. It is a matter of concern that the use of wood for fuel is causing the destruction of forests and has endangered the environment. Charcoal is formed when wood is burnt in insufficient air. Charcoal burns without producing smoke.

Wind energy is the kinetic energy associated with the movement of atmospheric air. It has been used for hundreds of years for sailing, grinding grain and for irrigation. Wind energy systems convert this kinetic energy to more useful forms of power. Wind turbines transform the energy in the wind into mechanical power which can then be used directly for grinding etc. or further converting to electric power to generate electricity. Wind turbines can be used singly or in clusters called 'wind farms'. Example as in Butoni Wind Farm (on-trial basis)

Source: http://www.eastasia.forum.org

At the Hydro Power Plant, electricity produced from generators driven by water turbines converts the energy in falling or fast-flowing **water** to mechanical energy. Water at a higher elevation flows downward through large pipes or tunnels. The falling water rotates turbines, which drive the generators, which converts the turbines mechanical energy into electricity. The advantages of hydroelectric power over such other sources as fossil fuels and nuclear fission are that it is continually renewable and produces no pollution. Example in Fiji is the Monasavu hydro power.

Source: primary

Solar energy is the radiant light and heat from the Sun that has been harnessed by humans since ancient times using a range of ever evolving technologies. A **solar cell** changes light energy from the sun directly into electricity. Solar cells are found in solar-powered calculators, watches and even satellites. Solar panels are usually found on rooftop of houses or tall buildings. **Solar panels** are painted black to trap the heat energy from the sun. Heat trapped is used for heating the water flowing through the panels. The hot water is either used or stored in insulated tanks for use in the future. A partial list of solar applications includes space heating and cooling through solar cooker, solar cell, solar heater etc.

Source: primary

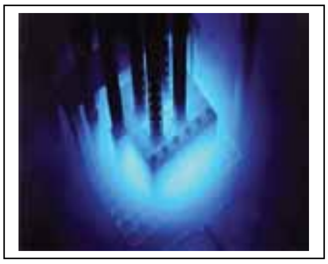
Geothermal energy is heat from within the earth. We can use the steam and hot water produced with the earth to heat buildings or generate electricity. Geothermal energy is a renewable energy source because water is replenished by rainfall and the heat is continuously produced inside the earth. Geothermal energy is generated in the earth's core, about 4 miles below the surface. Temperatures hotter than the sun's surface are continuously produced inside the earth by the slow decay of radioactive particles, a process that happens in all rocks. An example is the Savusavu Hot Spring.

Source: primary

The main objective of Ocean Thermal Energy or **Ocean Thermal Energy Conversion (OTEC)** is to turn the solar energy trapped by the ocean into useable energy. This kind of energy is found in tropical oceans where the water temperature differs from surface to deeper into the sea. On the ocean surface it can be at least 20ºC hotter or cooler than the temperature at a deeper sea level. Ocean thermal is also relatively clean and will not produce more pollutants that contribute to global warming. OTEC plants are most suitable for islands around the tropical region of the East Pacific Ocean. This is because OTEC plants can provide both energy and pure water at the same time with a relatively low cost.

Source: primary

In many areas of the world, the wind blows with enough consistency and force to provide continuous waves. There is tremendous energy in the ocean waves. Wave Power Devices extract energy directly surface motion of ocean waves or from pressure fluctuations below the surface. Wave technologies have been designed to be installed in near shore, offshore, and far offshore locations. While all wave technologies are intended to be installed at or near the water's surface, they differ in their orientation to the waves with which they are interacting and in the manner in which they convert the energy of the waves into other energy forms, usually electricity.


Source: http://www.mathies.com/ blog/nuclear energy

Changes can occur in the structure of the nuclei of atoms. These changes are called nuclear reactions. Energy created in a nuclear reaction is called nuclear energy, or atomic energy. Nuclear is produced naturally and in man-made operations under human control. In nuclear fission, the nuclei of atoms are split, causing energy to be released. The atomic bomb and nuclear reactors work by fission. The element uranium is the main fuel used to undergo nuclear fission to produce energy since it has many favourable properties. Uranium nuclei can be easily split by shooting neutrons at them. Also once a uranium nucleus is split, multiple neutrons are released which are used to split other uranium nuclei.

This phenomenon is known as chain reaction. In nuclear fusion, the nuclei of atoms are joined together or fused. This happens only under very hot conditions. The Sun like all other stars, creates heat and light through nuclear fusion. In the Sun, hydrogen nuclei fuse to make helium. The hydrogen bomb, humanity's most powerful and destructive weapon, also works by fusion. The heat required to start the fusion reaction is so great that an atomic bomb is used to provide it. Hydrogen nuclei fused to form helium and in the process release huge amounts of energy thus producing a huge explosion.

Advantages and Dis-advantages of Energy Sources: Copy and complete the Table

Source	Advantage(s)	Disadvantage(s)
Firewood		
Wind Energy		
Hydro Power		
Solar Energy		
Geothermal		
OTEC		

Classification of Energy Sources

CLASSIFICATION OF ENERGY SOURCES

- **Limited**: Coal, Oil, Natural Gas, Uranium
- **Unlimited**: Solar, Wind, Gravitational, Tidal, Geothermal
- **Renewable**: Wood, Biomass Gasification, Biomass fermentation, Animal Power

4.1.2 Renewable and Non-renewable energy

Renewable energy sources

A renewable energy source is energy that comes from natural resources such as sunlight, wind, falling water, tides and geothermal heat and biofuel. An advantage of using renewable energy is that:

- It is renewable, therefore sustainable and energy supply will never run out.
- Facilities used generally require less maintenance that the generators.
- As fuel is derived from natural and available resources, the cost of operation is reduced.
- Renewable energy produces little or no waste products such as carbon dioxide or other chemical pollutants, so has minimum impact on the environment.

Some disadvantage with renewable energy is that:

- it is difficult to generate the quantities of electricity that are as large as those produced by traditional fossil fuel generators therefore we need to reduce the amount of energy we use or simply build more energy facilities. It also indicates that the best solution to our energy problems may be to have a balance of many different power sources.
- the reliability of supply. Renewable energy often relies on the weather for its source of power. For example, hydro generators need rain to fill dams to supply flowing water, wind turbines need wind to turn the blades, and solar collectors need clear skies and sunshine to collect heat and make electricity. When these resources are unavailable so is the capacity to make energy from them. This can be unpredictable and inconsistent

Non-renewable energy sources

Coal, **oil** and **gas** are called **"fossil fuels"** because they have been formed from the organic remains of prehistoric plants and animals. Crude oil (called "petroleum") is easier to get out of the ground than coal, as it can flow along pipes. This also makes it cheaper to transport. Natural gas provides around 20% of the world's consumption of energy, and as well as being burnt in power stations, is used by many people to heat their homes in countries that have very cold nights during winter. It is easy to transport along pipes, and gas power stations produce comparatively little pollution.

Fossil fuels are not a renewable energy resource. Once we've burnt them all, there isn't anymore, and our consumption of fossil fuels has nearly doubled every 20 years since 1900.This a particular problem for oil, because we also use it to make plastics and many other products.

Coal

The formation of coal needs anaerobic environment. A swampy, heavily vegetated environment is therefore ideal for forming coal. Trees and other plant matter that fall into pools are quickly covered with mud. This mud prevents air and fresh water from attacking the chemical structure of the sugar chains. Much of the coal we are using today were formed between 300 - 400years ago, a period referred to as the Carboniferous period as conditions then were ideal for coal formation.

Over time the plant matter is compressed as more and more mud is deposited on top of it. The weight of all this extra mud eventually squeezes the water, sap and other liquids out of the plant matter, leaving just the sugar chains squashed together.

Environments on earth are constantly changing. When the wet swamp eventually changes into a different environment, like grassland, the old plant matter is now well buried. It can no longer be reached by the oxygen in the air. With more time and more compression, this plant matter goes through a series of transformations.

Coal Formation

The following diagrams show the stages on the formation of coal and their fuel content.

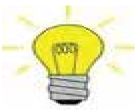
Stage	Diagram	Descript
Peat		• Low value fuel
Brown Coal		• Peat turns to Lignite • Fuel is drier and higher in energy content than peat • Can contain up to 70% moisture
Black Coal		• Further compression and aging of the brown coal results in black coal, a denser and drier fuel than brown coal. • Black coal, also called bituminous coal, is valued as a household fuel source and is also used to manufacture coke for the steel industry. • It is however a far rarer resource than brown coal.

Anthracite		• Anthracite forms by further compression and heating of black coal. • Glossy and almost metallic in appearance. • Has very high fuel content than black coal due to more C-C bonds. • Used primarily in homes and other heating • Purer source of carbon than other types of coal.
Graphite		• Graphite is the final stage of this forming fossil fuels process of compression and heating. • All impurities are driven off leaving hexagonal rings of carbon bonded to each other in two dimensional sheets. • This type of bonding is incomplete and results in one free electron per carbon atom. These free electrons form "seas" between the sheets of carbon atoms, allowing graphite to conduct electricity. • These electrons also give graphite its shine and slippery feel. • Graphite is not generally used as a fuel as it is very difficult to ignite since it has a high activation energy. Instead it is used as an industrial lubricant and also a major component in pencil

Source: Pictures adapted from Forming Fossil Fuels: Coal

Formation of Oil

Oil was formed in a similar way to coal. Millions of years ago , small plants and animals that lived in the seas sank down to the sea-bed when they died. They were crushed under layers of mud , and gradually turned into **oil**. As oil formed it gave off **natural gas**. The oil and gas flowed upwards until they reached layers of hard rock and became trapped under the rock.



Activity 1: Identification of Components of Oil
Collect pictures/samples of different components of oil and find out their different boiling points.

Activity 2: Making Crude Oil
Collect all the components of oil and mix them (proportion?) to obtain crude oil.

Activity 3: Research Work
Find out more about “Fractional Distillation”

4.1.3 Behavior of Light on Materials

Behaviour of light

- Light is a form of useful energy that supports life.
- It can be detected by our eyes and transferred from one place to another.
- Light does not need a medium to travel in, therefore can travel in a vacuum.
- Light travels in different speeds in different medium. In the same medium, light travels in straight lines.

Investigate a property of Light

Materials: Candle or Lighted bulb, plasticine, 3 square cardboards (25cmx25cm) .

Instruction: Demonstrate by setting up an experiment that Light travels in straight Lines

Light and Materials

Without light, nothing is visible. When you look at the reef animals, what you are really seeing is light. You can see a reef through the water because light passes through the water between the reef and your eyes. But you can't see the reef through the bottom of a boat because light doesn't pass through the boat.

A **transparent** material transmits light, which means it allows almost all the light that strikes it to pass through it. This property of light allows us to see through transparent objects. No shadow is formed when light is shown through a transparent object. For example, the water where the fish and coral live is transparent. While riding on a bus, you can see buildings and trees outside because the bus windows are transparent.

A **translucent** material allows some light to pass through it and scatters the rest. If you can see through a material, but the objects you see through it do not look clear or distinct, then the material is translucent. Looking into a room through a frosted glass door, you can make out shapes, but they are fuzzy and lack detail.

An opaque object does not allow any light to pass through it. Most materials around us are opaque Wood and metal are examples of opaque materials. An **opaque** material either absorbs or reflects all of the light that strikes it. When light is shone on an opaque object/material, a shadow is formed behind it.

Transparent	Translucent	Opaque
		

Source: primary

4.1.4 Reflection

Interactions of Light

When light strikes a new medium, the light can be reflected, absorbed, or transmitted. When light is transmitted, it can be refracted, polarized, or scattered. When light encounters matter, some or all of the energy in the light can be transferred to the matter. Just as light can affect matter, matter can affect light. The path along which light travels is called a ray. Light rays are indicated by straight lines with arrows showing the direction of motion. A beam of light is made up of a bundle of rays. It can be parallel, divergent or convergent.

Reflection

There are many types of reflection. **Regular reflection** occurs when parallel light waves strike a surface and reflect all in the same direction. **Diffused (scattered) reflection** occurs when parallel light rays of light strike a rough, uneven surface and reflect in many different directions. An **image** is a copy of an object formed by reflected (or refracted) waves of light.

Scattering

In **scattering**, light is redirected as it passes through a medium.

- Most of the particles in the atmosphere are very small. Small particles scatter shorter-wavelength blue light more than light of longer wavelengths.
- Blue light is scattered in all directions more than other blue colours of light, which makes the sky appear

A scattering effect reddens the Sun at sunset and sunrise

4.1.5 Mirrors – Plane, Concave, Convex

Mirrors are made of plate glass, one side of which is coated with a metal or some special preparation to serve as a reflecting surface. The junction of this reflecting surface and the plate glass is called the mirror line. Highly polished metals and other materials serve also as mirrors. Three common types of mirrors are the plane mirror which has a flat or plane surface; the concave mirror and the convex mirror. Convex and concave mirrors are known collectively as curved or spherical mirrors, since their curved reflecting surfaces are usually part of the surface of a sphere.

The Plane Mirror

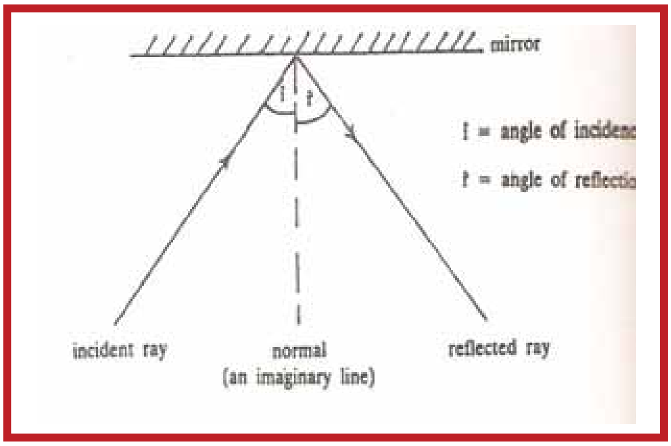
In a plane mirror the rays of light falling on it are reflected with little change in their original character and their relationship to one another in space. The apparent position of the image is the same distance behind the mirror as the actual object is in front of the mirror. The image is the same size as the object and is called a virtual image which means that the rays of light from the object do not actually go to the image, but extensions of the reflected light rays appear to intersect behind the mirror.

Light Reflection

When light strikes a smooth surface at a right angle, it will be reflected along the same path. This line is called the normal. However, if light strikes at an angle (angle of incidence) to the normal, it will be reflected at the same angle (angle of reflection) to the normal, but on the opposite side of the normal. Below is a picture of such a situation. Here a single ray of light strikes a surface and is reflected from it.

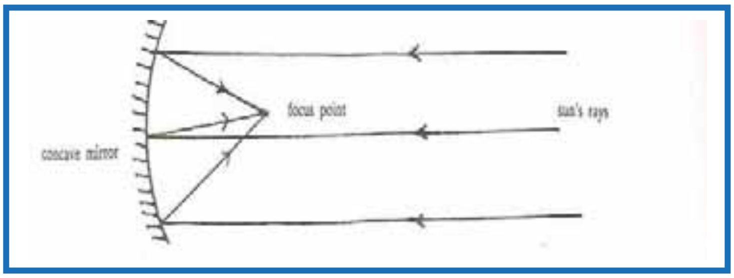
Here are descriptions for the terms in this diagram:

- The ray of light that strikes the surface is called the incident ray
- The ray of light that leaves the surface is called the reflected ray.
- A line perpendicular to the surface is imaged at the point of reflection is called the normal which means perpendicular.
- The angle between the incident ray and the normal is called the angle of incidence or incident ray.
- The angle between the reflected ray and the normal is called the angle of reflection or reflected angle.
- The angle of incidence and the angle of reflection.



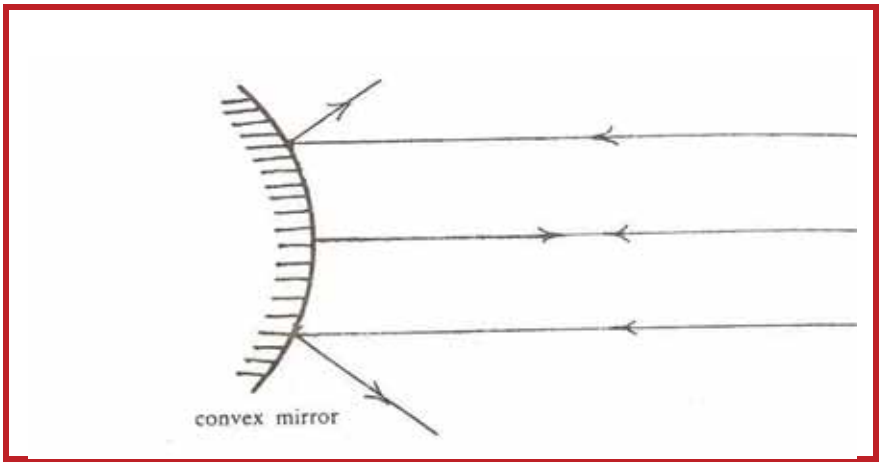
Concave mirrors

The concave mirror type is one in which the midpoint of vertex of the reflecting surface is further away from the object than are the edges. A line extending through the center of curvature and the vertex of the mirror is the principal axis, and the rays parallel to it are all reflected in such a way that they meet at a point on it lying half-way between the center of curvature and the vertex. This point is called the principal focus. Concave mirrors produce virtual images which are magnified if the object is near the mirror. This property of concave mirrors allows them to be used as cosmetic mirrors, microscopes, dentist's mirrors. Concave reflectors are use in car headlights and search lights.



Convex mirrors

In a convex spherical mirror the vertex of the mirror is nearer to the object than the edges—the mirror bulges toward the object. The image formed by it is always smaller than the object and always erect or upright and gives a wider scope of view. It is never real because the reflected rays diverge outward from the face of the mirror and are not brought to a focus. This property of convex mirrors allows them to be used as security mirrors in shop and also in car rear vision mirrors.



UNIT 2: ENERGY TRANSFORMATION, USE AND CONSERVATION

4.2.1 Types (Kinds) of Energy

There are two types of movement energy: kinetic energy and potential energy.

- KE (kinetic energy)
  Kinetic energy is energy in use. Anything that is moving or changing has kinetic energy.
  Examples: Blowing wind has kinetic energy. Flowing water has kinetic energy. A boy on roller blades has kinetic energy.
- **PE (potential energy)**
  Potential energy is stored energy. Something has potential energy when it is not moving, but is in a position to move. If you hold a marble in the air, it has potential energy. If you drop the marble, it has kinetic energy as it falls.

Group Activity

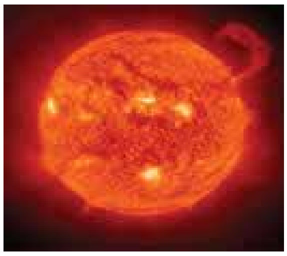
Collect pictures of things that have potential or kinetic energy and display these on charts for your class.

4.2.2 Forms of Energy

There are many forms of energy and these include mechanical, electrical, chemical, thermal, electromagnetic and nuclear energy.

Form of Energy	Description	Diagram-Example
Mechanical Energy	• Energy due to an object's motion (kinetic) or position (potential). • Sound, wind, waterfall, compressed spring • KE or PE • Not 100% efficient much of the energy is lost as heat.	 **Source**: http://www1.curriculum.edu.au/sciencepd/energy/mech.htm

Electrical Energy	• Energy caused by the movement of electrons or moving electrical charges. • Easily transported through power lines and converted into other forms of energy. • Kinetic energy. • Electricity from batteries, power lines and lightning.	 **Source: primary**
Thermal Energy	• Heat energy • The heat energy of an object determines how active its atoms are. - A hot object is one whose atoms and molecules are excited and show rapid movement. - A cooler object's molecules and atoms will show less movement. • The internal motion of an objects atoms and molecules. • Measured by temperature. • The faster particles move, the more thermal energy they have. • KE only	 Source: http://www.inmagine.com/alamy/bw4paf-photo
Chemical Energy	• Energy that is available for release from chemical reactions. • The chemical bonds in a matchstick store energy that is transformed into thermal energy when the match is struck. • Energy stored by chemical bonds in an object. • When bonds are broken energy is released. • PE only • gasoline, food, coal, wood	 Source: http://www1.curriculum.edu.au/sciencepd/energy/chem.htm.
Electromagnetic Energy	• Energy that travels in waves and have electrical and magnetic properties. • Light, Magnetism, X-Rays, Radio waves, microwaves, ultraviolent and infrared radiation • Kinetic Energy	 **Source :primary**

Nuclear Energy	• Energy stored in center(nucleus) of an atom • Fission (breaking apart) • Fusion (forming) • The sun • Most powerful • PE only	

Picture Source: Internet

Exercise

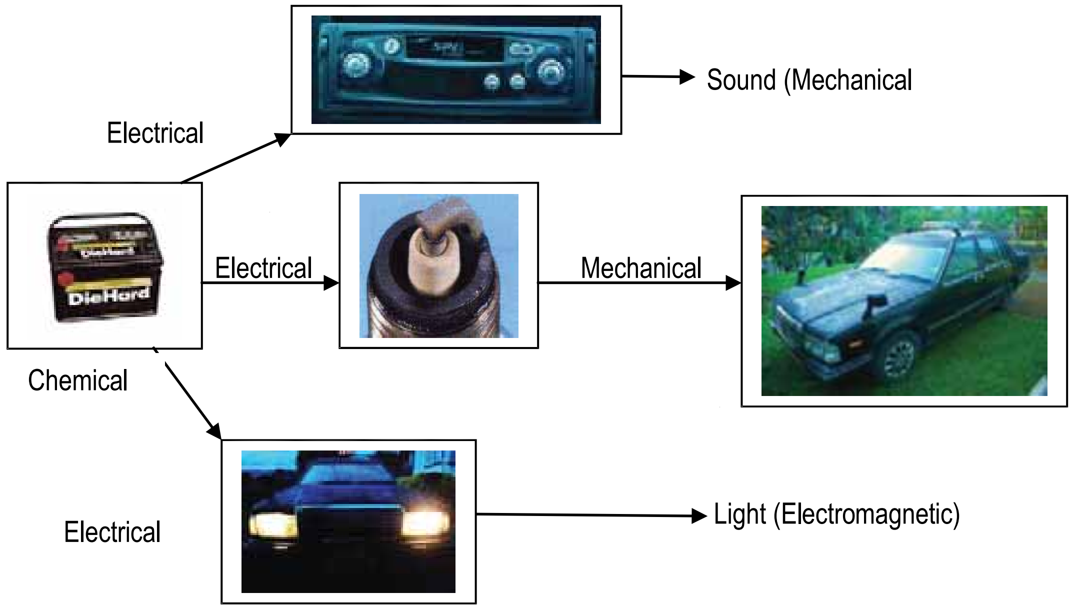
1. **What form of energy cooks food in a microwave oven?**
2. **What form of energy is the spinning plate inside of a microwave oven?**
3. **Electrical energy is transported to your house through power lines. When you plug an electric fan to a power outlet, electrical energy is transform into what type of energy?**
4. **What energy transformation occurs when an electric lamp is turned on?**

ELECTRICAL ENERGY → X

5. **What forms of energy are shown in the pictures below?**

6. **What form of energy is shown for each of the diagrams below?**

Energy Transfer



4.2.3 Uses of Energy

There are many of uses of energy. Energy is used in homes, schools, factories, transportation and in machines. In homes energy is used in cooking, heating and washing to name a few. Solar energy is also used as solar heaters, solar cookers and solar stills.

<u>Investigation</u>: Energy Use Audit - Potential Individual and Group Activity

(a) Conduct an energy audit at home or in your school, to establish in what ways you use energy and record for example: ironing (number of minutes); washing clothes in hours; rice cooker in hours, electric kettle in minutes; number of bulbs (hours of light); TV (number of hours).

(b) Identify and discuss what steps you can take to help conserve energy.

4.2.4 Conservation of Energy

In a world that is changing so rapidly, because of climate change and also because of a fast growing population, there is a need to conserve energy. There are a number of ways by which we can conserve energy.

EC- 1

Use efficient cooking methods like putting on lids on pots while cooking, simmering gently instead of boiling vigorously as this can save half of the greenhouse gas generated during cooking.

EC- 2

When buying electrical appliances, look for the energy rating label. The energy rating label has from one to six stars marked on it. The more stars an appliance has, the less energy it will use.

EC- 3

Televisions, DVDs and stereos can generate between 20 – 85 kilograms of greenhouse gas per year when in 'standby' mode. Turn them off from the power source when not in use.

EC- 4

Use lights, fans and air conditioning efficiently. Turn them off when not in use or when you leave the room

EC- 5

When out walking, collect littered containers like bottles and aluminium cans and recycle them.

EC- 6

Ensure the door of the refrigerator and washing machine seals are clean and the doors also close properly.

UNIT 3: FORCES

Introduction

We live in a world of motion or movement. The way that all objects move depends on what forces are acting on them. Forces are acting around you all the time and they can cause changes to occur. A force is a push or a pull exerted by one object on another. Types of forces objects experience include frictional force, electrostatic force, magnetic force and gravitational force. Sometimes the effects are obvious and sometimes they are not.

4.3.1 Types of Forces

Frictional force

Friction is the force acting on an object when it moves against the surface of another object. Both surfaces do not have to be moving. Friction acts where the surfaces touch. Friction can slow down an object or stop it from moving. Friction can be between any two things and it doesn't matter if they are solids, liquids or gases. Rough surfaces produce more friction than smooth surfaces. If there was no friction, you would not even be able to start moving forward as your feet would slip backwards. However, if there was too much friction, it would take too much effort to keep moving.

Negative Effects of Friction

Friction also causes problems in cars or in any device where parts rub against each other. In the moving parts of machines a minimum of friction is desired. An excess of friction produces heat, which in turn causes expansion, the locking of moving parts, and a consequent breakdown of the machinery.

Reducing undesirable Effects of Friction

There are several ways used to minimise the undesirable effects of friction. These include:

- Lubricating surfaces in contact with oil or grease as in a door hinge
- Streamlining the bodies of objects which move through liquids or air as in the hull of a speedboat.
- Smoothening surface in contact as in polishing a bowling ball
- Place ball bearing between sliding surfaces as in a swing
- Putting wheels or rollers between surfaces or use air cushion between surfaces as in a hovercraft.

Uses of friction: used when holding a pen, used in writing, eating, walking.

Exercise time !

For each of the situations described below, write down what the friction is between (eg solid and liquid etc)

- A boy walking to school
- A girl riding a bicycle
- A child sitting and moving down a slide
- A student diving into the swimming pool

Activity time ! Imagine

Frictionless Friday!

Write a science fiction story about a day without friction .What would it be like? First look at the marking criteria (how your story will be marked) that your teacher will provide for you.

Exercise time!! Friction in Nature

1. Based on the effects of friction, explain:
   - how do pieces of rocks turn into pebbles in streams and rivers.
   - the formation of sand from corals.
2. Some ways in which man uses friction to help him include sandblasting, filling of teeth, smoothing wood or metal. Discuss how the three ways mentioned work or operate.

Practical : Friction in Air

Instruction: (a) Take two sheets of paper. Keep one sheet flat and crumple the other into a small tight ball. Let both fall from the same height.

1. Which one touches the ground first?
2. What do you think might be causing one sheet to fall more slowly than the other.(explain)

(b) Make a parachute from a square piece of light cloth, 4 pieces of string with equal length and a small heavy object like a stone. Compare its fall to the sheet of paper and the ball of paper.

Experiment: Friction in Liquids

Materials: measuring cylinders (or scaled length of wide glass tubing, water, coconut oil or thick glue.

Instruction: 1. Measure the height of the liquid in the cylinders.
2. Drop a pea or ball bearing or similar small object into each liquid.
3. Measure the time it takes to reach the bottom.
4. Repeat and find the average. Record results in a table.
5. Comment on the result/observation. What do you conclude?

Magnetic force

Magnetic force is the force of attraction (pull) or repulsion (push) produced by magnets on magnetic materials like iron, steel etc. Magnetic force is a non-contact force. This is because magnets need not be in contact with the magnetic material to exert a force on them. The magnetic force becomes weaker as the object move further away from the magnet. Magnetic force is very useful in our everyday life. Examples of situations that make use of magnetic forces are magnetic chess game, magnetic needle in a compass for giving directions.

Gravitational force

Gravity is the pulling force that attracts objects to the centre of the earth. Without the force of gravity, even the Earth's atmosphere would float off into space. The force of gravity is not the same on all objects. The greater the mass of the object, the greater the force of gravity on it. Mass is related to the amount of material (matter) in an object or substance. The standard unit of mass is kilogram (kg). The force of gravity on an object or substance causes its weight. The standard unit of force is the newton (N).Since weight is a force it is measured in newtons.

Exercise time!

1. What two forces act on all falling objects in the Earth's atmosphere?
2. When you drop a nail and a feather from the same height, they reach the ground at different times. Explain with aid of a diagram why this is the case.

4.3.2 Effects of Forces

A force is a push, a pull and a twist. A force experienced in this manner can:

- Change the shape of an object
- Change the size of an object
- Change the speed of a moving object, either speeding it up or slowing it down.
- Change the direction in which an object is moving
- Stop a moving object
- Moving a stationary object.
- Have no visible effect at all.

Task 1: Investigating Force

Make a container that will stop an egg from breaking when it is dropped from the top of a building. To make the container you will get some paper, empty milk packet, one metre string and 30cm of sticky tape.

In you book:

- Draw your container
- Write a few sentences saying what will happen when you

drop your container and egg using as many of the key words as you can.

KEY WORDS: gravity, friction, reaction, force, weight, acceleration, buoyancy, momentum, speed

Exercise: Identify what type of force is shown in the following pictures and explain the effect of the force applied.

Source: primary

4.3.3 Strength of Force of Gravity at different places

Gravity is a force that attracts objects. It is also the force that makes objects fall down when you drop them. Because of gravity things on earth have a certain weight. Gravity on Earth pulls objects to the centre of the planet. Every time you throw a ball up into the air it is pulled back to Earth. This occurs in nature all the time. In the 17th century, the English scientist and mathematician Isaac Newton found out that every body or object has a force of gravity, and that every body pulls other bodies towards it. He also explained that gravity depends on the mass of an object or the amount of material that it has. Therefore the sun, which has a very large mass, has a greater force of gravity than the Earth, so the Earth moves around the sun. The moon goes around the Earth because the Earth's gravity is larger than the moon's. The force of gravity also depends on the distance between two objects. If they are close together gravity between them is greater.

Mass and Weight

Mass and weight are not the same. The mass of a body, its volume, always stays the same. Weight is the pull of gravity on an object. On Earth, an astronaut may weigh 70 kg. However when the same astronaut walks on the moon he weighs only a sixth – about 12 kg because the moon has less mass than the Earth and therefore its gravitational pull is smaller. If you stand on scales you can see how much your body is pulled towards the centre of the Earth. This is your weight.

The Earth's Gravity

The force of gravity is not the same everywhere on Earth. It depends on:

- the distance from the centre of the Earth
- the spin or rotation of the Earth

A house at the seaside, for example, is closer to the Earth's centre. Gravity is stronger here than at a house up in the mountains. The Earth's spin also reduces the strength of gravity. The centrifugal force causes a body or an object to move in a straight line unless something tries to change its path. At the equator the centrifugal effect is greater than anywhere else on our planet. An object must travel 40,000 km during one rotation of the planet. The distance and the centrifugal force decrease when you move towards the poles. Therefore you would weigh more at the poles than at the equator. For this reason spacecraft are launched from places that are as near to the equator as possible. In this way it takes less fuel and power to escape the Earth's gravitational force and get into orbit. Gravity also holds our atmosphere together. We wouldn't see any clouds or rain if there were no gravity.

4.3.4 Effect of force on Different Surfaces and Weight

There are a number of factors that influence the force of friction. Two such factors are the nature of surfaces in contact or types of surfaces and the other factor is the weight of the object. On the nature of the surfaces in contact, there are ways of varying and altering surfaces and one is by applying lubricants. With the weight of the object, the greater the weight, the greater is the force of friction. The area of contact of sliding surface does not influence force of friction if all other factors are kept constant.

Investigating Friction

<u>Instruction:</u> You will need some smooth pieces of wood, sticky tape, sand paper, powder, plastic, carpet, a protractor and a smooth wooden block.

1. Stick the sand paper onto one piece of wood using sticky tape at the top. Stick plastic and the carpet onto two others and sprinkle powder onto the last one and rub it smoothly over the surface.
2. Tilt each piece of wood to make a ramp.
3. Test the object to see how much friction it experiences on the ramp:
   a. Put the object at the top of the ramp without the ramp being tilted.
   b. Gradually tilt the ramp more and more steeply until the object just begins to slide.
   c. Use your protractor to measure the angle of the ramp which makes the objects just begin to slide
   d. Record your results in a table and comment.
4. It is the force of friction that stops the object from sliding when the ramp is tilted. Which surface makes the most friction? List the surfaces in order from one that causes the most friction to the one that causes the least.

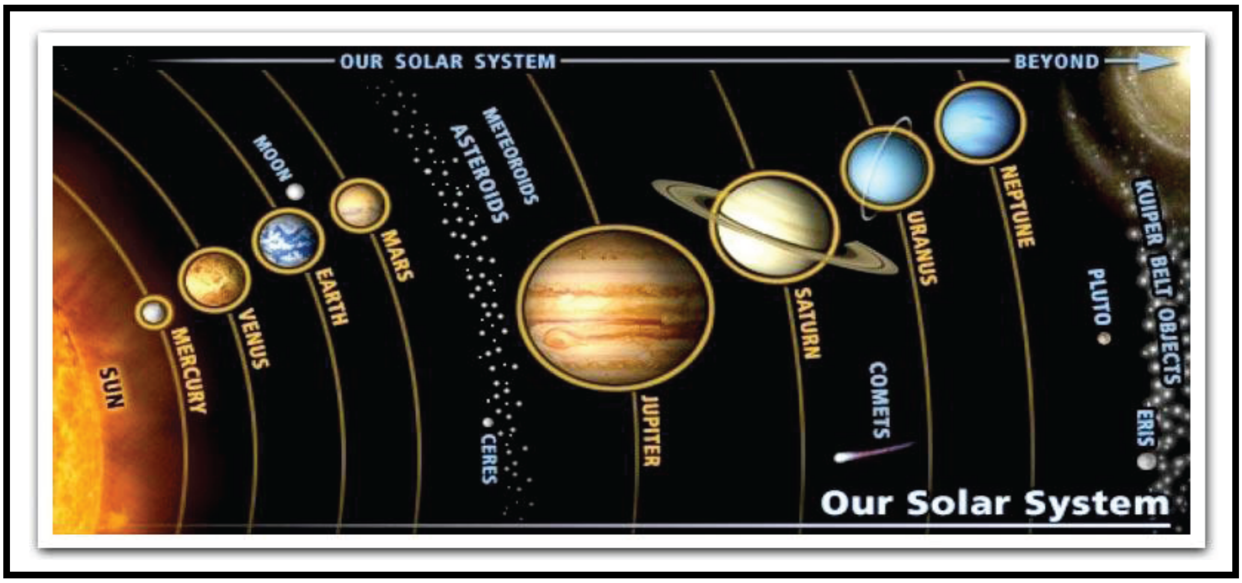
CHAPTER 5: EARTH AND BEYOND

1. OUR SOLAR SYSTEM
2. OUR CHANGING EARTH

UNIT 1: OUR SOLAR SYSTEM

Solar system

Our solar system consists of the Sun, eight planets and their moons, and millions of other objects such as asteroids, comets, meteors and meteorites. Our solar system lies in a spiral arm of the Milky Way galaxy extending from the centre like a pinwheel .The diameter of our solar system is 12 billion km. The Sun is at the center of our solar system and has enormous gravitational pull.



Source: http://www.vtaide.com/png/solar-system.htm[Solar System Diagram modified from National Aeronautics and Space Administration]

5.1.1 Planets of the Solar System

The Sun

The Sun is a star (the closest star to earth) and lies at the centre of the solar system. The Sun contains 99.8% of the total mass of the solar system. The more mass in an object, the greater the pull it has on other objects. Therefore all other objects in our solar system, including the Earth orbit around the Sun. The Sun has a surface temperature of around 6000°C. The temperature at its core is 14million°C- so hot that nuclear explosions occur continuously, producing enormous amounts of energy. Without this energy, life could not exist on Earth.

What are planets?

A planet is a body that orbits the Sun (or another star) and produces no light of its own. It reflects the light of the Sun or star. There are eight major planets and one dwarf planet in our solar system: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto (dwarf planet).

None of the planets are perfect spheres- they all bulge at their equators, and are flattened at their north and south poles. Except for Earth, the planets are named after ancient Greek and Roman gods. The planets are classified into two groups: the inner terrestrial planets and the outer gaseous planets.

On August 24, 2006, the International Astronomical Union (IAU) formally downgraded Pluto from an official planet to a **“dwarf planet”**. According to the new rules, a planet must:

1. orbit around the Sun
2. have sufficient mass for its self-gravity to overcome rigid body forces to take on a nearly round shape
3. have cleared other objects in its orbital path around the Sun. (ie. so there are no similar objects at roughly the same distance from the Sun. Pluto failed the third criteria - it orbits among the icy wrecks of the Kuiper Belt and is really “just” one of many Kuiper Belt Objects (KBOs). Eris and Ceres (in the asteroid belt) are the other two members of this dwarf planet classification.

Terrestrial planets or inner planets

The four small rocky planets closest to the Sun-Mercury, Venus, Earth and Mars- are the terrestrial planets. ‘Terrestrial’ means Earth-like. They orbit the Sun in almost circular orbits.

Mercury

- Distance from the Sun: 58 million km. It is the closest planet to the sun.
- Size: its diameter is 4880km and it is 40% smaller than the Earth. It is the second smallest planet.
- One day: it takes 59 earth days to rotate.
- One year: it takes 88 earth days to orbit the Sun.
- Surface temperature: from 450ºC on the side facing the Sun to -200ºC on the night side.
- Its surface is covered with mountains, craters, ridges and valleys.
- Meteorites do not burn up before they hit the surface because there is no atmosphere.
- It is made mostly of iron and has a rocky layer.
- It has no atmosphere
- Moons and rings: it has none.

Source: NASA website

Venus

Source: NASA website

- Distance from the Sun: 108 million km. It is the second planet from the Sun, and Earth's closest neighbours.
- Size: its diameter is 12 104 km and it is slightly smaller than Earth.
- One day: 243 earth days. It rotates in the opposite direction to that of Earth – the Sun rises in the west and sets in the east.
- One year: 225 Earth days (its year is shorter than its day1).
- Surface temperature: average is 482ºC – the hottest planet.
- Its surface is covered with volcanoes, large plains, mountains and craters.
- Its closeness to the Sun means that water vapour is prevented from condensing into oceans.
- It is the brightest object seen in the sky from Earth after the Sun and the Moon, and it is referred to as morning star or the evening star. The bright white light that can be seen is the reflection of the sunlight off the clouds that cover the planet.
- Its atmosphere is composed mostly of carbon dioxide- producing an enormous greenhouse effect.
- Its air pressure is enough to crush many objects including spacecraft.
- Moons and rings: it has none.

Earth

Source:NASA website

- Distance from the Sun: 150 million km. It is the third planet from the Sun.
- Size: its diameter is 12 756 km wide and it is the fifth largest planet.
- One day: 24 hours
- One year 365 days
- Surface temperature: from -86ºC to 60ºC.
- 70% of its surface is covered with water.
- Its atmosphere extends 80km above its surface and consists of 78% nitrogen, 21% oxygen, 1% carbon dioxide and other gases- it has a stable greenhouse effect.
- It is the only planet currently known to support life.
- Moons: one Rings: none.

Mars

Source: NASA website

- Distance from the Sun: 228 million km. It is the fourth planet from the Sun.
- Size: its diameter is 6794 km and it is half the size of the Earth.
- One day: 24 Earth hours and 40 minutes.
- One year: 687 Earth days.
- Surface temperature: from -73ºC to 27ºC.
- It is commonly referred to as the 'red planet' because of iron in the soil forming a rusty dust.
- It has the largest volcano in the solar system. It is called Olympus Mons. It is three times higher than Mt Everest. It is thought to be extinct.
- It has weather with thin clouds, occasional dust storms and its polar ice caps consist of frozen carbon dioxide (dry ice).
- It has a very thin atmosphere composed of around 95% carbon dioxide, and small traces of nitrogen, argon, oxygen and water.
- Moons: two, called Phobos and Deimos. Rings: none.

The asteroid belt

Orbiting between Mars and Jupiter is the asteroid belt, composed mainly of asteroids that are rocky or metallic objects. The largest asteroid is **Ceres**, a diameter of 914 km.

Outer planets

Jupiter, Saturn, Uranus and Neptune are the outer planets and are composed of gases such as hydrogen and helium with solids (usually ice and rocks) at their core. These planets are referred to as the gas giants.
All of the gas giants have rings. Pluto is the outermost planet and is composed of rocks and ice.

Jupiter

Source: NASA website

- Distance from the Sun: 778 million km. It is the fifth planet form the Sun.
- Size : its diameter is 142 984 km and it is 11 times the size of Earth – the largest planet in the solar system.
- One day: 10 Earth hours.
- One year: 12 Earth years.
- Cloud temperature: about - 150ºC.
- Its surface is covered in violent storms with wind speeds of up to 600 km/hr (because it rotates so fast).The **Great Red Spot** is a gigantic swirling, windy storm, over 40 000 km wide (3 times wider than Earth).
- It has light and dark bands called the **zones** and **belts**. These bands are caused by high velocity winds that blow in opposite directions.
- Its atmosphere is composed of 90% hydrogen and about 10% helium with traces of methane, water and ammonia.
- Rings: has 3, measuring 29 km thick and 6400 km wide.
- Moons: 28 discovered so far (6 are named plus 12 discovered recently but not yet named). Te largest is Ganymede.

Saturn

Source: NASA website

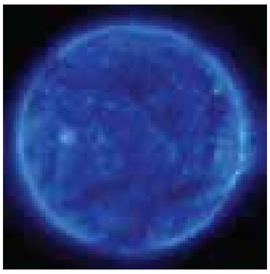
- Distance from the Sun: 1430 million km. It is the sixth planet from the Sun.
- Size: its diameter is 120 536 km and is the second largest planet in the solar system.
- One day: 10 Earth hours and 40 minutes
- One year: 29.5 earth years.
- Cloud temperature: about -170ºC.
- About every 30 Earth years, following Saturn's summer, a massive storm occurs. It is known as the **Great White Spot**.
- Its atmosphere consists of 97% hydrogen with helium, water, methane and ammonia making up the rest.
- Rings: about 1.5 km thick and are divided into 3 main parts – the bright A and B rings and the dimmer C ring. The rings contain dust and large quantities of water frozen in various forms.
- Moons: 21 (18 named, 13 discovered recently but not yet named).Titan is Saturn's largest moon (it is larger than Mercury).

Uranus


Source: NASA website

- Distance from the Sun: 2871 million km. It is the seventh planet from the Sun.
- Size: its diameter is 51 800 km and is the third largest planet in the solar system.
- One day: 15 Earth hours and 40 minutes.
- One year: 84 Earth years
- Cloud temperature: on average -210ºC.
- Its pale blue-green in colour due to absorption of red light by methane in the upper atmosphere.
- Its cloudy atmosphere is made up of 83% hydrogen, 15%helium and small amounts of methane and hydrocarbons.
- Rings: 11 known - they are very dark and composed of large particles of ice and dust. The brightest is known as the Epsilon ring.
- Moons : 21

Neptune


Source: NASA website

- Distance from the Sun: 4504 million km. It is the eighth planet from the Sun.
- Size: its diameter is 49 532 km and is the fourth largest planet in the solar system.
- One day: 16 Earth hours.
- One year: 164 Earth years.
- Cloud temperature: on average -212ºC.
- It's blue in colour due to methane gas in the atmosphere.
- It has several dark spots – the largest is known as the Great Dark Spot, which is about the size of the Earth. It is the result of some of the fiercest winds in the solar system. Winds can reach 2000 km/h, more than 4 times faster than the fastest tornado on Earth.
- Rings: has a set of 5 rings, which are narrow and very faint. They are composed of particles of dust and rock.
- Moons: has 8 – Triton is the largest.

Pluto


Source: NASA website

- Distance from the Sun: 5914 million km – the furthest planet from the Sun.
- Size: its diameter is 2274 km and is the smallest (dwarf) planet in the solar system.
- One day: 6 Earth days. It rotates in the opposite direction to that of Earth.
- One year: 250 earth years.
- Surface temperature: varies between -235ºC and -210ºC – the coldest planet.
- Its composition is unknown, but its density indicates that it is probably a mixture of 70% rock and 30% water ice – similar comets.
- Its very thin atmosphere consists of nitrogen, carbon monoxide and methane.
- It revolves around the Sun on a different plane to all other planets.
- Moons: one, called Charon. Rings: none.

There are a number of mnemonic phrases that are easily memorized for remembering the names of the planets, including “My Very Energetic Mother Just Served Us Noodles.

EXERCISE: SOLAR SYSTEM

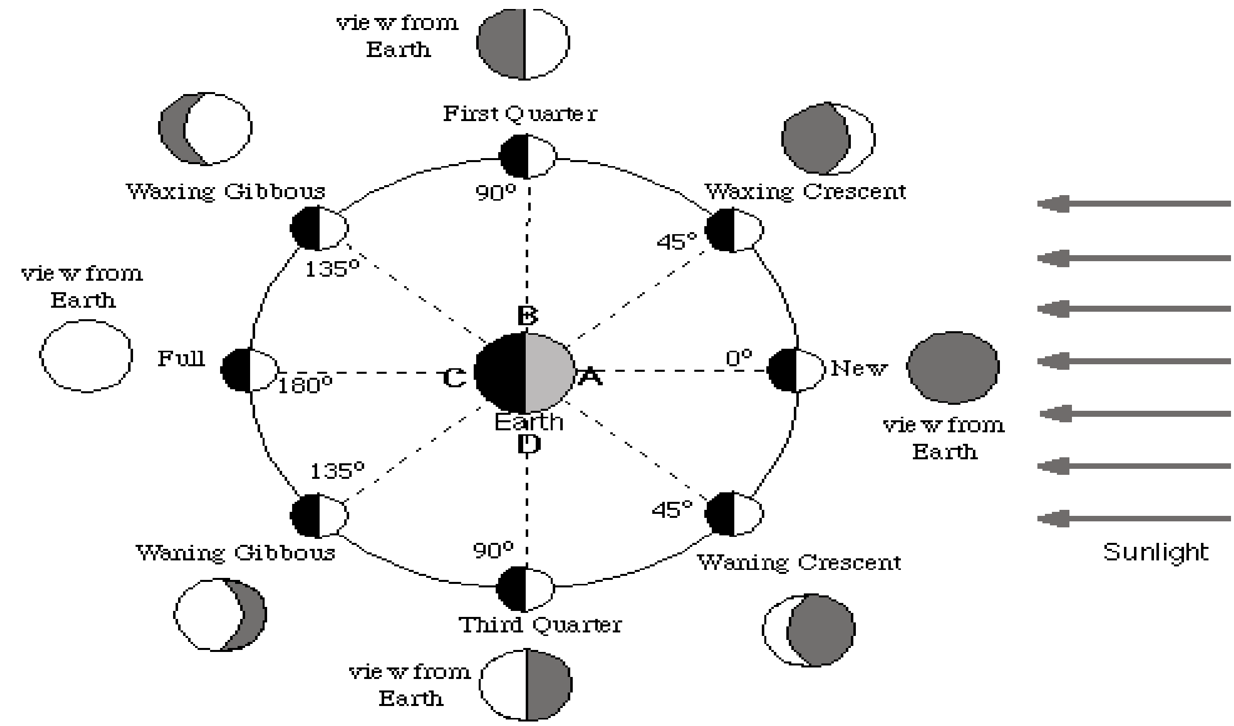
1. Compile a list of similar features of the planets Mercury, Venus and Mars.
2. What are the major differences between the features of Venus and Earth?
3. The atmospheres of Mercury and Mars are very thin. What effect does the thin atmosphere have on the temperature on the surface of these planets?
4. List the features common to all four gas giants that make them different to Earth.
5. Why are the planets Jupiter, Saturn, Uranus and Neptune called the gas giants?
6. Why is it unlikely that a spacecraft will ever actually land on any of the gas giants?

5.1.2 The Moon and Phases of the Moon

Earth’s moon

- The Moon is the earth’s only natural satellite. A satellite is any object that moves in an orbit around a planet.
- It is 384 000 km from earth and its diameter is 3476 km. It is one- quarter the width of Earth.
- The Moon spins (rotates) once in exactly the time it takes to orbit the Earth (approximately 28 days), which means the same side of the Moon is always seen from the Earth. This side is called the **‘near side’** and the opposite side is the **‘far side’**.
- The Moon rises and sets, just like the Sun. It rises about 50 minutes later each day. The Moon is in the sky during the day as well as at night, but it is harder to see then.
- The Moon has a weak gravity – one-sixth as strong as Earth’s gravity. **Gravity** is the force of attraction an object has on another object.
- Its mean temperature varies from -170ºC to 130ºC. The Moon has no atmosphere or weather, but may have some ice in craters near its north and south poles.
- The Moon has been severely bombarded by meteorites, and its surface is scarred by about half a million craters.
- The so- called **‘Man in the Moon’** is an illusion created by the appearance of the Moon’s largest crater.
- The Moon is covered with rocks, boulders and a layer of charcoal-coloured soil. Its crust is about 68 km thick. Below the crust is a mantle and a small core, about 340 km in radius.

Phases of the Moon



The Sun-Moon angle is the angle defined by Sun->Earth->Moon with Earth (where *you* are) as the angle vertex. As the Sun-Moon angle increases we see more of the sunlit part of the Moon. Note that if this drawing were to scale, then the Moon would be half this size and its orbit would be about 22 **times** larger in diameter and the Sun would be about 389 **times** farther away than the Moon!

<u>Source</u>: http://mrsstahlheber.com/science/moon-phases-diagram

The changes in the appearance of the moon's shape are called the **phases of the Moon**. The Moon is always round and does not change its shape. What changes is the amount of sunlit part of the Moon that we can see from the Earth. This depends on the position of the Earth, Moon and Sun.

Tides

Tides occur because of the gravitational pull of the Sun and the Moon on the oceans. While the Sun has a greater gravitational pull than the moon because it is larger, the Moon is much closer to the Earth so it has a stronger pull. The oceans rise up and fall back again twice every day, due to the Moon's gravitational pull. These water movements are called the **tides**. As the earth rotates it experiences two cycles of high and low tides, roughly thirteen hours apart.

- **High tides** – the Moon's gravity causes a bulge of water on the side of the Earth closest to the Moon and another on the opposite side of the Earth.
- **Low tides** – in between the bulges there is a lot less water and the tides are low.
- **Spring tides** – are extra large tides that occur twice a month when the Sun, Moon and Earth are in a straight line. The pull on the oceans due to gravity is stronger then, where the high tides are highest and the low tides are lowest, so the high tides are not so high and the low tides are not so low.

- Neap tides – are small, weak tides that occur twice a month when the Sun, Moon and Earth are at right angles to one another. The Sun and Moon's gravity cancel each other out so the pull on the oceans is weaker.

EXERCISE: **TIDES**

1. What is the major cause of tides on Earth?
2. Why are there two high tides and the two low tides in a 24-hour period?
3. Even though the sun is much larger than the moon, it has much less effect on the tides. Why?

5.1.3 Artificial satellites

An artificial satellite is a manufactured object that continuously orbits earth or some other body in space. Most artificial satellites orbit Earth. People use them to study the universe, help forecast the weather, transfer telephone calls over the oceans, assist in the navigation of ships and aircraft, monitor crops and other resources, and support military activities. Artificial satellites also have orbited the Moon, the Sun, asteroids and the planets Venus, Mars, and Jupiter. Such satellites mainly gather information about the bodies hey orbit. Artificial satellites differ from natural satellites or natural objects that orbit a planet. Earth's moon is a natural satellite.

Types of artificial satellites

Artificial satellites are classified according to their mission. There are six main types of artificial satellites namely scientific research, weather, communications, and navigation, Earth observing and military.

Weather satellite

Weather satellite help scientists study weather patterns and forecast the weather. Weather satellites observe the atmospheric conditions over large areas. Some weather satellites travel in a sun-synchronous, polar orbit from which they make close, detailed observations of weather over the entire earth. Their instruments measure cloud cover, temperature, air pressure, precipitation, and the chemical composition of the atmosphere. Because these satellites always observe Earth, at the same local time of day, scientists can easily compare weather data collected under constant sunlight conditions. The network of weather satellites in these orbits also functions as a search and rescue system. They are equipped to detect distress signals from all commercial and many private planes and ships.

Photo taken by NASA
A weather satellite called the Geostationary Operational Environmental Satellite observes atmospheric conditions over a large area to help scientists study and forecast the weather.

Other weather satellites are placed in high altitude, geosynchronous orbits. From these orbits, they can always observe weather activity over nearly half the surface of Earth at the same time. These satellites photograph changing cloud formation. They also produce infrared images, which show the amount of heat coming from earth and clouds.

Communication satellite

Communication satellites serve as relay stations, receiving radio signals from one location and transmitting them to another. A communication satellite can relay several television programs or many thousands of telephone calls at once. Communication satellites are usually put in a high altitude, geosynchronous orbit over a ground station. A ground station has a large dish antenna for transmitting and receiving radio signals.

Photo taken by NASA
A communication satellite, such as the Tracking and Data Relay Satellite (TDRS), shown above, relays radio, television and other signals between different points in space and on Earth.

Sometimes, a group of low orbit communication satellites arranged in a network, called a constellation, work together by relaying information to each other and to users on the ground. Countries and commercial organizations, such as television broadcasters and telephone companies use these satellites continuously.

Navigation satellites

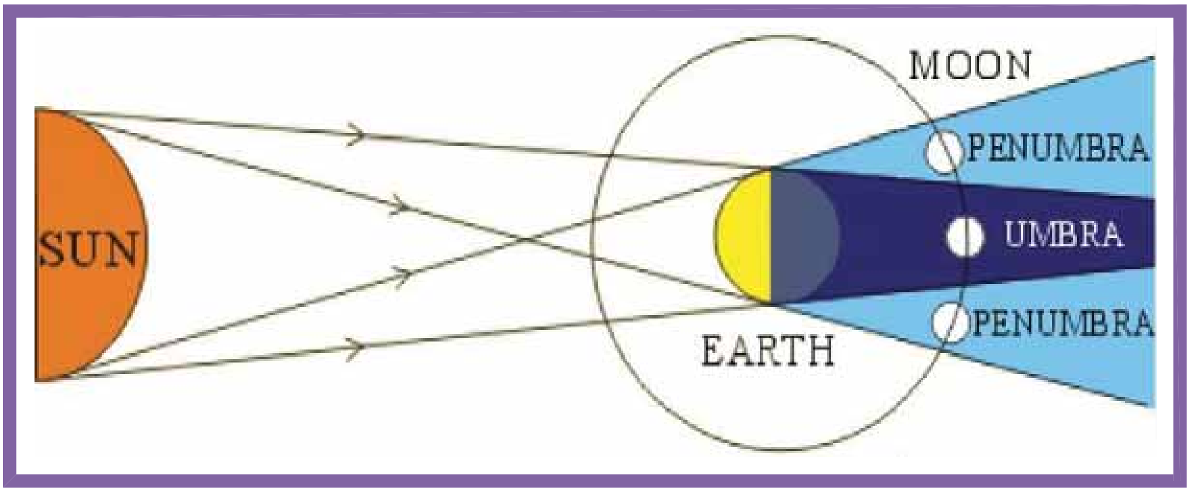
Navigation satellites enable operators of aircraft, ships and land vehicles anywhere on Earth to determine their locations with great accuracy. Hikers and other people on foot can also use the satellites for this purpose. The satellites send out radio signals that are picked up by a computerized receiver carried on a vehicle or carried in the hand.

Photo taken by NASA
A navigation satellite, like this Global Positioning System (GPS) satellite sends signals that operate aircraft, ships and land vehicles and people on foot can use to determine their location.

Navigation satellites operate in networks, and signals from a network can reach receivers anywhere on Earth. The receiver calculates its distance from at least three satellites whose signals it has received. It uses this information to determine its location.

5.1.4 Eclipses

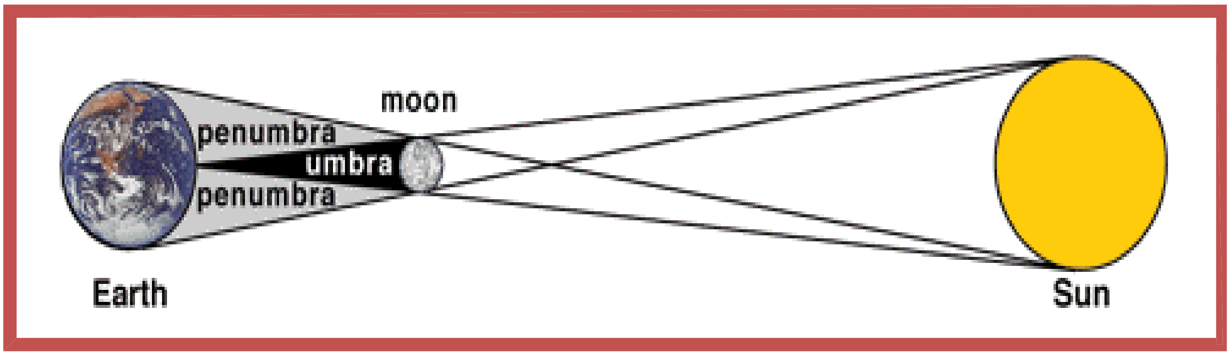
An eclipse occurs when the Earth or Moon moves into a shadow and appears dark instead of being lit by the Sun. The shadow could be an umbra or a penumbra. When you are out in the sun, your body casts a shadow on the ground. When there are two lights, there will be two shadows. Where the shadows overlap and it is darkest it is called the umbra. Where there is a pale shadow it is called the penumbra, which is only a partial shadow.



Source: http://www.hko.gov.hk/gts/astron2011/lunar_eclipse_e.htm

Solar eclipse

A solar eclipse is an eclipse of the Sun. This happens when the Sun is blocked by the Moon. A solar eclipse can only be seen in the daytime. Solar eclipses occur when a new moon passes directly between Earth and the sun. These eclipses are observable only within or near the path where the moon's shadow falls on Earth. The type of eclipse—total, partial, or annular - depends on the alignment and distances between the sun, moon, and Earth. The sun's outer atmosphere, or corona, is visible only during total solar eclipses. Eclipse sequences such as these can last nearly three hours, with totality lasting a maximum of 7.5 minutes



Source: http://www.exploratorium.edu/eclipse/why.html

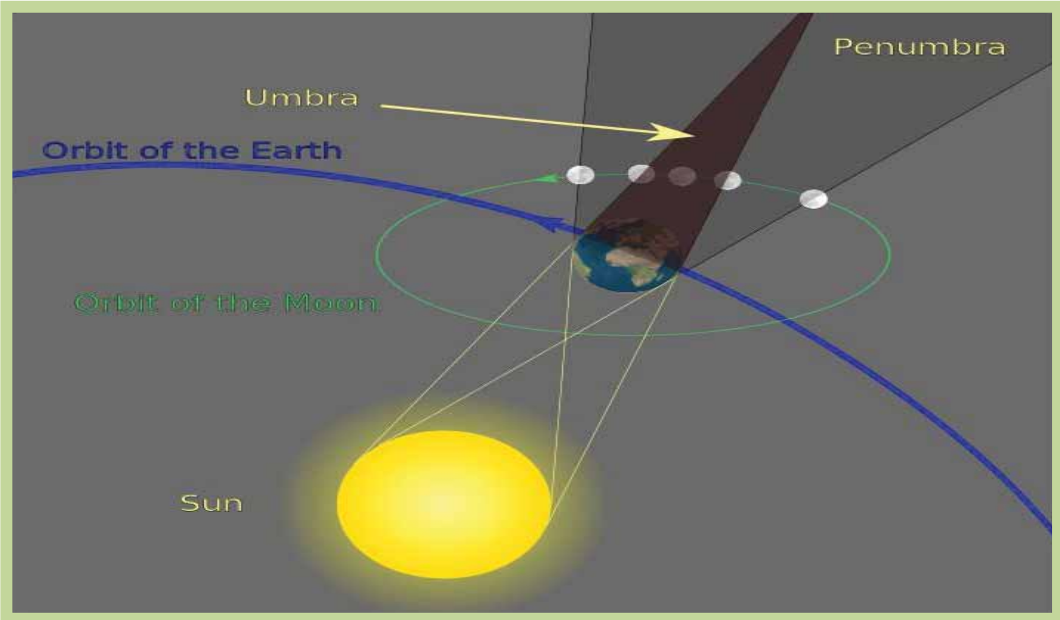
A **total solar** eclipse happens when a section of the Earth is in the umbra and the sky becomes totally dark. This can be seen only from a small part of the earth, in a band 250 km wide. Outside this band, a partial solar eclipse is seen, where only part of the Sun is covered. The sky does not become completely dark, because that part of the Earth is only in penumbra.

Caution: *Do not look at the Sun directly even when it is blocked during solar eclipse, because it will seriously damage your eyes.*

Lunar eclipse

A **lunar eclipse** is an eclipse of the Moon. Lunar eclipses occur when a full moon passes through Earth's shadow. Earth's shadow has two parts - the inner full shadow, or umbra, and the outer partial shadow, or penumbra. The moon darkens as it passes through the penumbra, and then turns reddish-orange while within the umbra.

Though the moon is totally within Earth's umbra in the middle of this sequence, the moon is dimly lit by sunlight bending through Earth's atmosphere. The atmosphere filters out most of the blue light, making the moon appear a reddish color. The moon lightens again as it passes through the other side of the penumbra, and then returns to normal brightness as it exits Earth's shadow. Lunar eclipses can be total or partial and can last a maximum of 104 minutes.



Lunar Eclipse

Source: http://en.wikipedia.org/wiki.File:Geometry of a lunar eclipse. srg

EXERCISE : ECLIPSE

1. During a solar eclipse, what casts a shadow on the Earth?
2. What is the difference between a total solar eclipse and a partial solar eclipse.
3. What is in shadow during a lunar eclipse? What casts the shadow?
4. Which type of eclipse occurs more often- solar or lunar?
5. Why do solar eclipses take place only whether is a new moon?
6. Why do lunar eclipses occur only when there is a full moon?

5.1.5 What causes Day and Night

Day and night is the result of the rotation of the Earth on its own axis. The axis of the Earth is an imaginary line that passes through the North and the South poles. The Earth takes approximately twenty-four hours to complete one rotation. The Sun is the source of light.

At the time of the rotation, it is day on the side of Earth that faces the Sun; while it is night on the other side of Earth not facing the Sun. The position of the Sun is fixed and it does not change.

The Sun rises in the east because the Earth is moving towards the east. Later, in the mid noon the Sun is in the south because Earth is moving towards the south and gradually towards the west and the Sun sets.

The length of the day is measured from the time the Sun rises to the time the Sun sets. Another interesting fact about Earth is that because Earth tilts on its axis, it is day in the southern hemisphere and night in the northern hemisphere and vice versa.

5.1.6 Seasons of the Year

The axis of the Earth is always tilted at an angle of 23.5 degrees. The rotation of the Earth on its own axis not only results in day and night but also creates the four seasons (summer, winter, autumn and spring). The summers and winters are the result of the tilt of the axis of the Earth. When the southern hemisphere is tilted towards the Sun, the sunlight is stronger because the Sun is overhead, so it is warmer and experiences summer. At this time it is winter at the Northern hemisphere, because the sunlight is at an angle and is weaker. When the Northern hemisphere has summer, the Southern hemisphere has winter.

The length of the day and night varies in each season. For instance, the daylight is longer in summer and the night is shorter. In winter, the nights are longer and the days are short. It is the length of the day and night that determine the temperature of the seasons and not the revolution of the Earth.

Activity: Complete the table below by identifying the missing causes or effects. The first one is done for you.

CAUSE	EFFECT
(a) Rotation of the Earth on its axis	Day and night
(b) …………………………………………………………	Seasons
(c) Gravitational force of attraction between the Earth and the Sun	……………………………
(d) The Moon revolves around the Sun in 29.5 days and it rotates on its axis every 29.5 days.	……………………………
(e) The same area of the Moon's surface is lit by the Sun, but different amounts of its surface can actually be seen from Earth.	……………………………
(f) Earth's spinning on its axis and the gravitational pull of the Moon (and to a lesser extent, the Sun)	……………………………
(g) …………………………………………………………	Lunar eclipse

Traditional Planting and Fishing Season

Months of the Year in relation to Planting and Fishing in Fiji		
Month	**Traditionally known in Fiji as:**	**Planting/Fishing activity**
January	*Vula I Nuqa Levu*	x Abundance of *Nuqa* (Rabbit Fish) and edible sea snails x Land crabs spawn x Mango,*Dawa* and Breadfruit trees bear fruit
February	*Vula I Sevu*	x First crop of the year are witnessed- *Dalo, Uvi, Tavioka.* x *Wi,* Orange and *Ivi* tree bear fruits x Crop nurseries are built x Dakua Salusalu trees flower
March	Vula I *Kelikeli*	x Uvi is dug for use x Crabs mature x *Yaka,Gasau*(Reeds), t*okatolu* plants flower and fruit
April	*Vula I Gasau*	x Abundance of *gasau (*eg. *Duruka*) x Breadfruit in abundance x *Tugadra* fish abound x *Kaudamau* and *Mako* trees flower
May	*Vula I Doi*	x Doi trees flower and bear fruits x Uvi leka,a variety of yam mature x Abundance of Salala (Mackerel) fish x Yasiyasi and Vesileka flower and bear fruit
June	*Vula I Werewere*	x Uvi (Yam) is planted x Daniva (Sardine), Matu(Gerridae) fish abound. x Dilo,Dakua trees flower and bear fruit
July	*Vula I Cukicuki*	x Octopus season starts x Drala,moivi and vaivai ni vavalagi begin to flower x Breeding season for kerakera fish
August	*Vula I Seni drala or Vula I Kawakawa*	x Drala,Damanu,Kauceuti trees flower x Tiri (Mangrove) and Vaivai ni Vavalagi(raintree) bear fruit x Octopus becomes plentiful x Vaya (Sardine) abound.
September	*Vula I Vakada*	x Yam plants are wound around a supporting pole for growth purposes. x Kawakawa (Cod) fish spawn x Kaunigai,Mango trees flower and bear fruit x Veitqa(spear throwing game);after yearly planting is completed.
October	*Vulai Balolo Lailai*	x Breadfruit matures x Damabi,Makosoi trees flower, Vesi trees bear fruit x Balolo is harvested in some places
November	*Vula I BaloloLevu*	x Crabs well filled with spawn x Walu fish abound x Kavika, Pineapples ripen x Tomanu,Toivi trees flower x Balololevu is harvested
December	*Vula I Nuqa Lailai*	x Abundance of small Nuqa fish x Saqa (Trevally)fish spawn x Sekoula, Kuasi and Buabua trees flower

Source: adopted from government official diary 2012.

UNIT 2: OUR CHANGING EARTH

5.2.1 Climate Change

Our climate is changing and its impact on all of us is evident from the changing weather patterns we experience. Some parts and time of the year that in the past used to experience rain, have now seen to have dry weather spells. All these are signs of accelerating climate change or global warming and therefore there is a need to take action to try and minimize this as climate change is expected to increase.

The terms 'global warming' and 'climate change' are often used interchangeably, but there is a difference.

- Global warming is the gradual increase of the Earth's average surface temperature, due to greenhouse gases in the atmosphere.
- Climate change is a broader term which refers to long-term changes in climate, including average temperature and rainfall.

Effects of Climate Change

Climate change will have far reaching impacts in Fiji and many other Pacific Islands nations. This will be experienced in many aspects of our lives like freshwater availability, agriculture, forests, biodiversity, coastal and marine resources, human health and the economy.

Impact of Climate change on Freshwater

Fiji, like other Pacific Islands are quite vulnerable to the effect of climate change on our water supply. It is therefore important to have proper water management for drinking, agriculture, fisheries and tourism.

(a) *Flooding* – Climate change will lead to changes in rainfall patterns resulting in flooding. This reduces the soil's ability to absorb water.

(b) *Salt intrusion* – For areas along the coasts, the rise in sea level will cause sea water to seep into the thin wedge of ground water and so affect the quality and quantity of drinking water and also damage agriculture.

(c) *Drought* – Change in weather patterns may result in some areas receiving less rainfall and so experience more frequent drought.

Impact of Climate Changes on Forests

The forests and their resources are vital to the environment in the Pacific, particularly the high volcanic islands. The forests are natural regulators of the amount of carbon dioxide in the Earth's atmosphere. They act as sinks, where trees absorb the carbon dioxide from the air and store it. The burning or cutting down of trees is responsible for the release of stored carbon dioxide back into the atmosphere. Therefore conserving forests and practicing sustainable forestry is vital for the balance of greenhouse gases in the atmosphere and limiting the impacts of climate change.

Impact of Climate Changes on Biodiversity

The islands of Fiji are associated with rich biodiversity due to the unique habitats provided by coral reefs, forests, mangroves and wetlands. It is expected that the impact of climate change will affect plants and animals by modifying and destroying their habitats.

(a) *Habitat modification and destruction* – Forests are destroyed by fires and cyclones which lead to loss of habitat and food. Likewise, ground-nesting birds on islands are affected by storms and sea-level rise.

(b) *Temperature fluctuations and changes in rainfall* lead to changes in habitat. Higher sea temperatures destroy corals and rain from the hills and mountains increase the silt being washed onto reefs which is also damaging to coral growth.

Impact of Climate Changes on Agriculture

The variations in seasons, cyclones, hurricanes, flooding and drought which are brought about as a result of climate change have an impact on agricultural plants.

(a) *Seasonal Variations* – Traditionally, farmers have set planting patterns which take into account the dry and wet seasons. Longer period of droughts and rainfall during off season have now been experienced. This resulted in some fruit bearing out of season. In Fiji, mango trees now bear fruit for a longer period. As climate change cause more variation, the traditional planting calendars may need to be altered to accommodate these changes.

(b) *Cyclones and hurricanes* – These ,if more frequent, can have a negative effect on agriculture, giving crops less time to recover. Coconuts for example, have a longer recovery time.

(c) *Floods and drought* - The extended dry seasons caused by rising temperatures, changes to rainfall patterns and the increased effects of El Nino leads to ruined crops.

Impact of Climate Changes on Coastal and Marine Resources

Pacific Islanders depend on marine and coastal resources for their livelihood and traditional practices. These have changed to some extent due to the effect of climate change on coral reefs and mangrove community.

(a) *Coral reefs* – These are important as source of food, sand formation, as building materials and wave breakers along coasts. Climate change increases the bleaching of corals. It also has a negative impact on the growth of coral reefs.

(b) *Mangroves* – they protect the coastal ecosystem against storms, tides and cyclones. Mangroves are very important as they provide protection for young fish and other animals. They also are a source of wood and fuel to coastal dwellers. Sea-level rise may have a negative impact on the growth and survival of mangroves.

(c) *Fisheries* – Reefs and mangroves which provide habitats, nurseries and food sources to marine life are gradually destroyed due to climate change. This results in adverse effects in the fishing industry and also the availability and amount of fish for consumption.

Impact of Climate Change on Health

Flooding and water contamination have a direct impact on the health of people both in the spread of diseases and through their diet.

(a) Spread of diseases – There is an increase in vector-borne diseases like dengue fever and also an increase in water-borne diseases like leptospirosis which are the result of flooding and contaminated water.

(b) Threats to the diet – Destruction of marine resources may reduce the availability of fish and other sea foods. This results in the reduction of protein intake of many that depend on marine resources for their diet, therefore resort to buying imported food.

Impact on health may also include an increase in physical injury and loss of life due cyclones and floods and increase in respiratory problems like asthma due to air pollution.

ACTIVITY : CLIMATE CHANGE

1. Discuss in groups what you can do to reduce the impact of climate change on:

(a) Agriculture (**b)** Biodiversity (c) Water

(d) Forests (e) Coastal & Marine Resources (f) Health

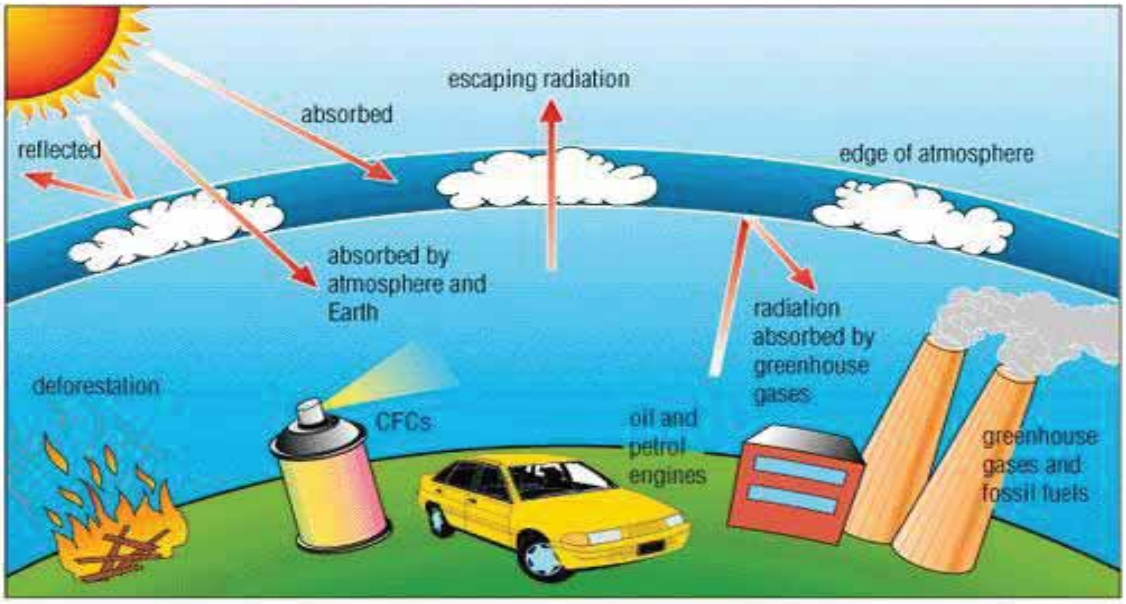
(2) What can you do to help protect Fiji's ecosystem?

5.2.2 The Greenhouse Effect

The atmosphere and surface of the atmosphere is heated by energy from the sun (solar energy).The Earth's atmosphere contains gases which trap some of the energy leaving the Earth's surface. These gases are called **greenhouse gases** and are responsible for maintaining the temperatures on Earth.

Because the atmosphere is warm, it emits heat. While much of the heat is radiated into space, some of it is radiated towards the surface. It is this warming of the Earth's surface by the atmosphere that is called the **greenhouse effect**. The greenhouse effect is necessary to support life on Earth.

Carbon dioxide is a greenhouse gas. Other green house gases include methane, chlorofluorocarbons (CFC's) and nitrogen oxide. Carbon dioxide emissions are now higher than in the 1900s.The increase in burning of coal, oil and gas for energy has caused a thickening of the 'greenhouse blanket' with the result that too much heat is trapped into the earth's atmosphere.



The burning of fossil fuels produces carbon dioxide and other greenhouse gases. The additions of this to the amount of greenhouse gases in the atmosphere results in:

- an increase in the amount of energy trapped in the atmosphere.
- An increase in the temperature of the atmosphere.

Consequently, the temperature of the Earth's surface increases, an effect referred to as **enhanced greenhouse effect or global warming.**

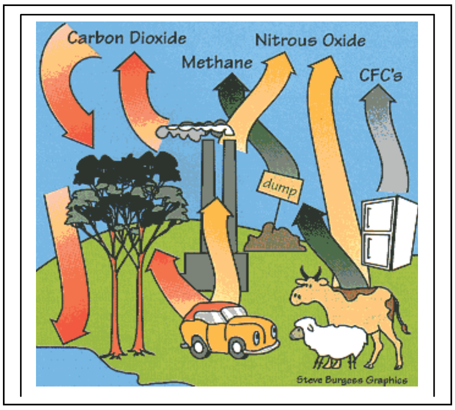
Sources of greenhouse gases

Greenhouse gas	**Main sources**
carbon dioxide	Burning of coal, gas and oil
methane	Livestock such as cows, pigs, rice paddies, mining
CFC's	Aerosols, refrigerants in refrigerators and air- conditioners, dry cleaning, production of plastic foam.
Nitrous oxides	Fertilizers and burning of fossil fuels especially petrol.

Greenhouse gases and human activity

Greenhouse gases produced by human activities have a profound effect on the balance of greenhouse gases in the atmosphere. Such activities include:

- burning of fossil fuels, such as coal, oil or gas
- using energy generated by burning fossil fuels
- some aspects of farming, such as raising cattle and sheep,
- using fertilizers and growing some crops
- clearing land, including logging
- the breakdown of food and plant wastes and sewerage
- some industrial processes, such as making cement and aluminum.



Exercise

1. Explain the difference between greenhouse effect and the enhanced greenhouse effect.
2. The main cause of global warming is the increasing amount of greenhouse gases in the atmosphere. What else contributes to global warming?
3. The burning of fossil fuels increases the amount of carbon dioxide in the atmosphere. What other activities undertaken by humans have contributed to the increase.

Effects of global warming on the earth

Globally, extreme weather is predicted to become more common and to have a negative impact on humans, animals and plants.

(a) Rising temperatures
(b) Changing sea levels and temperatures
(c) Extreme weather- globally, continuing warming means that extreme weather events like severe floods, droughts and tropical storms are likely to become more frequent and dangerous.
(d) Plants and Animals- both plants and animals are affected by climate change.

Our climate is changing, largely due to the observed increases in human produced greenhouse gases which absorb heat from the sun in the atmosphere and reduce the amount of heat escaping into space. This extra heat has been found to be the primary cause of observed changes in the climate system over the 20th century. These changes include increases in global average air and ocean temperature, widespread melting of snow and ice and rising global sea levels.

The extra heat in the climate system has other impacts, such as affecting atmospheric and ocean circulation, which influences rainfall and wind patterns.

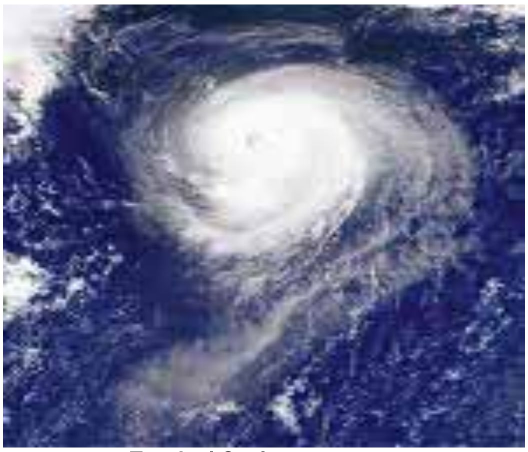
Another serious impact of increases in the greenhouse gas carbon dioxide is ocean acidification. Around a quarter of human-produced carbon dioxide is absorbed by the oceans. As the carbon dioxide dissolves in sea water it forms a weak carbonic acid, making the ocean more acidic. There are early indications that some marine organisms are already being affected by ocean acidification.

These changes experienced at the global level, will impact our lifestyle, agriculture and the survival of other organisms. To reduce the production of greenhouse gases, we need to:

- reduce the burning of fossil fuels by conserving the amount of energy we use.
- use alternative energy sources such as wind, water and solar energy.
- reduce the use of paper, recycle newspaper and other paper as this will also reduce the cutting down of trees to make new paper.

Burning Forest

Source: http://www.saawinterinternational.org/climatechange



Tropical Cyclone

Source: http://www.saawinterinternational.org/climatechange

ACTIVITY: Class Project –POSTER DESIGN

Design a poster to educate your community on:

(a) What Global Warning is
(b) Effects of Global Warning to our livelihood
(c) Things that you can do to reduce global warming.

GLOSSARY

A

abiotic
non- living factors that affect living organisms

acid
A substance that is soluble in water,contains hydrogen and can neutralize a base.Acids turn blue litmus red and have a pH less than 7.

alkali
A substance that is soluble in water and can neutralize an acid.Alkalis are bases that form negatively charged hydroxide ions OH- in a solution in water.

angle of incidence
The angle between the incident ray and the normal.

angle of reflection
The angle between the reflected ray and the normal.

apparatus
Any equipment, instrument or machine used to carry out science experiments.

astronomy
The scientific study of the stars, planets and their movement.

atom
The smallest particle of an element that can take part in a chemical reaction.

B

biology
The scientific study of all living organisms, including plants, animals and microorganisms.

biotic
living factors in an ecosystem like plants, animals, protists and bacteria.

boiling
When many bubbles form a liquid and the temperature of the liquid does not rise further even when heated.

C

carnivore
A meat eating animal.

change of state
The process by which matter changes from one state to another.

chemical equation
The formulae, and number of molecules or atoms of reactants and products, that take part in a chemical reaction.

chemical formulae
is a way of expressing information about the atoms that constitute a particular chemical compound.

chemical reaction
A chemical change in which one or more elements or compounds (the reactants) change to form new elements or compounds (products).

chemistry
The scientific study of matter, its properties and how to change them.

community
A group of organisms living together in a habitat. They have an effect on each other and are linked together in a food web.

compound
A substance that contains two or more elements joined together by chemical bonds in a chemical reaction. Its properties are different from the properties of the original elements and it cannot be separated by physical means.

compound microscope
A light microscope that has one eyepiece lens and one objective lens.

concave mirror
A mirror that is curved inwards. Also known as converging mirror because the reflected rays meet at a focal point.

control
The part of a science experiment that acts as a standard by which to compare experimental observations.

controlled experiment
Experiments where all conditions are kept constant, except the variable being tested.

convex mirror
A mirror that is curved outwards. Also called diverging mirrors because the reflected rays move away from each other.

coverslip
A thin piece of glass used to cover a specimen on a slide.

D

decomposer
An animal or plant that can breakdown dead organisms into simple substances.

digestion
The process of breaking down complex food substances into simple molecules that can be absorbed into the organism.

dispersal
The process that spread seeds away from their parent tree.

dispersal
The process that spread seeds away from their parent tree.

E

eclipse
The total or partial obscuring of light from the sun by either the moon or the earth.

ecology
The study of how living things depend on each other and the natural environment they live in.

ecosystem
A community of organisms including their physical surroundings

energy transformation
When one form of energy changes to another. For example, electrical energy can change into light or heat energy.

environment
The physical, biological and chemical conditions in which an organism lives.

F

force
A push, pull or twist that makes something moves.

friction
The force produced when objects rub together. It is a pushing force that slows or stops everything that is moving.

G

geology
Is the science comprising the study of solid Earth, the rocks of which it is composed, and the processes by which it evolves.

H

Hypothesis
An educated guess taken about the outcome of an experiment before testing it out.

L

laboratory equipment
used to either perform an experiment or to take measurements and gather data.

lunar eclipse
When the Earth comes between the Sun and the Moon, and the shadow of the Earth covers the Moon completely or partially.

M

meniscus
A concave or convex upper surface that forms on a liquid in a tube as a result of surface tension.

microscope slide
A slide that a specimen is placed on for observing with a microscope.

mixture
Made up of two or more elements or compounds mixed together physically and can be separated easily.

molecule
Two or more atoms of the same or different elements combine to form a molecule.

O

opaque
An object that does not allow light rays to pass through it.

organism
Any living thing that carries out respiration, excretion, reproduction and responds to an outside stimulus.

P

particle
The smallest pieces of matter

photosynthesis
the process in which green plants make sugars and starch from carbon dioxide and water, in the presence of sunlight.

physics
The study of how matter and energy are related.

physical change
A change in a substance during which no new chemical substances are formed.

pollination
The movement of pollen from the anther to the stigma in a flower.

pollution
The release of substances into the environment that is harmful to humans, other animals and plants.

potential energy
The energy stored in an object because of its position.

R

refraction
The bending of a light ray as it passes from one medium to another.

renewable
The energy sources that can be replaced naturally.

reproduction
The process by which living things produce offspring.

respiration
The process by which living things break down glucose into simpler substances and release useful energy.

S

soil erosion
The removal of soil by water or wind.

solar cell
A cell that produces an electric current when sunlight falls on it.

solar eclipse
Occurs when the shadow of the Moon falls on the Earth.

solar system
The Sun and everything that moves around it. The solar system includes the nine planets, their moons as well as all the asteroids and comets.

species
A group of organisms that are able to breed with each other to produce fertile offsprings.

spring balance
A simple type of balance used to measure force by stretching a spring.

T

Thermometer
A device used to measure temperature.

transluscent
An object that allows some light rays to pass through it.

transparent
An object that allows all light rays to pass through it.

troposphere
The layer of the atmosphere closest to the surface of the earth.

U

umbra
A shadow with a sharp clear edge. Shadows are areas of darkness created by an opaque object blocking the light. If the light comes from a single point, such as a tiny torch bulb, an umbra is formed.

V

variable
A condition that can be changed, to affect the result of an investigation.

W

weight
The downwards pull on an object, caused by the attraction of the gravitational force on its m

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