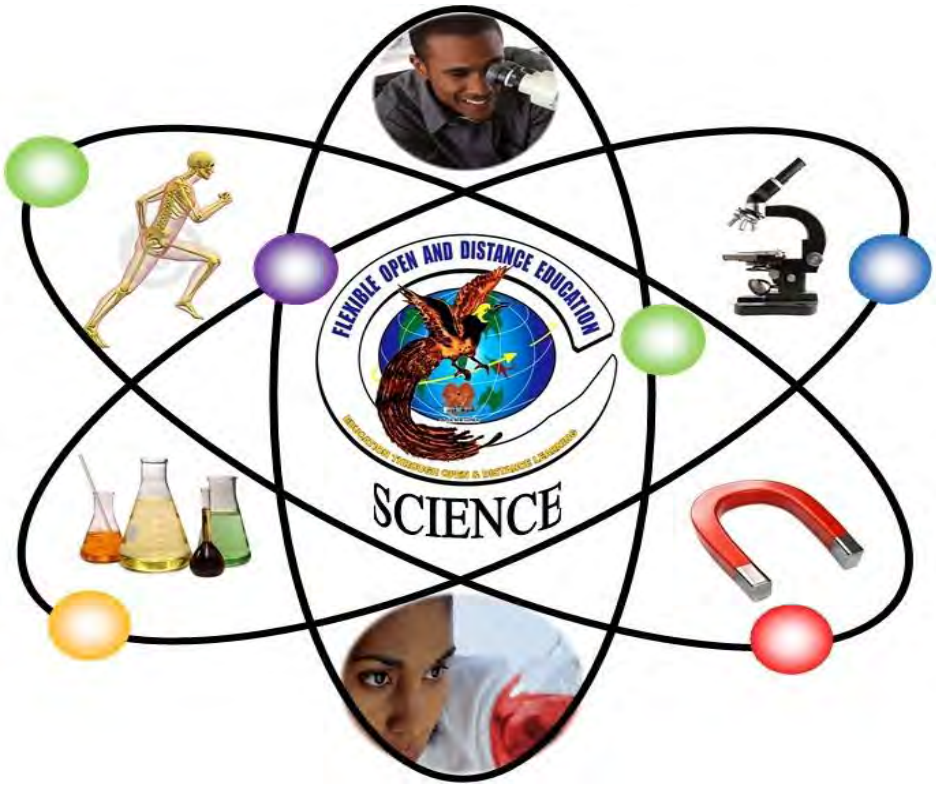
DEPARTMENT OF EDUCATION

GRADE 8

SCIENCE

STRAND 4



EARTH AND BEYOND

FLEXIBLE OPEN AND DISTANCE EDUCATION
PRIVATE MAIL BAG, P.O. WAIGANI, NCD
FOR DEPARTMENT OF EDUCATION
PAPUA NEW GUINEA
2017

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GRADE 8

SCIENCE

STRAND 4

EARTH AND BEYOND

SUB STRAND 1:	**ROCK FORMATION AND CLASSIFICATION**
SUB STRAND 2:	**METALS FROM MINERAL**
SUB STRAND 3:	**SPACE INVENTIONS**
SUB STRAND 4:	**COMMUNICATION AND INFORMATION**

Acknowledgement

We acknowledge the contributions of all secondary teachers who in one way or another have helped to develop this Course.

Our profound gratitude goes to the former Principal of FODE, Mr. Demas Tongogo for leading FODE team towards this great achievement.

Special thanks to the staff of the Science Department of FODE who played active roles in coordinating writing workshops, outsourcing lesson writing and the editing processes involving selected teachers of Central Province and NCD.

We also acknowledge the professional guidance provided by Curriculum and Development Assessment Division throughout the processes of writing and the services given by members of the Science Review and Academic Committees.

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DIANA TEIT AKIS

PRINCIPAL

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TABLE OF CONTENTS

SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is part and parcel of the new reformed curriculum. The learning outcomes are student-centred with demonstrations and activities that can be assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution and Government Policies. It is developed in line with the National Education Plans and addresses an increase in the number of school leavers as a result of lack of access to secondary and higher educational institutions.

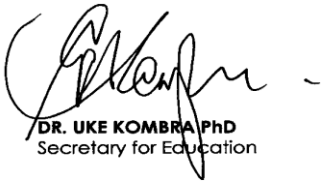
Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

- To facilitate and promote the integral development of every individual
- To develop and encourage an education system that satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced through this course to provide alternative and comparable pathways for students and adults to complete their education through a one system, two pathways and same outcomes.

It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all the teachers, curriculum writers and instructional designers who have contributed towards the development of this course.



DR. UKE KOMBRA PhD
Secretary for Education

STRAND 4: INTRODUCTION

Dear Student,

Welcome to Strand 4 of your Grade 8 Science Course! I hope you enjoyed studying the three earlier Strands. You should also enjoy this Strand, Earth and Beyond. It is an interesting topic and I hope you enjoy this strand as well.

In this Strand, there are four Sub-strands with 20 Lessons. The four Sub-strands are:

- **Rock Formation and Classification**
- **Metals from Minerals**
- **Space Inventions**
- **Communication and Information**

There are five lessons in all four Sub-strands.

In Sub-strand 1, the lessons will discuss about the types of tools made out of rocks in prehistoric times and the different types of rocks formed on Earth. You will also learn from this Sub-strand the mineral composition of rocks.

In the second Sub-strand, the lessons will discuss the sources of metals and the extraction processes. You will also look at minerals and metals found in Papua New Guinea. The mining activities and environmental issues relating to mining in Papua New Guinea will also be discussed.

In the third Sub-strand, you will learn about satellites, space shuttles, space stations and their uses. Telescopes and people who travelled in space will also be discussed in these lessons.

The last Sub-strand will discuss some forms of medium of communication, their importance and how they are transmitted. You will also discuss the advantages of using computers to communicate.

Remember, you have to do all the Activities and the Practice Exercises after each lesson. Answers to activities are at the end of the activity but the answers to the Practice Exercises are at the end of each Sub-strand.

If you have any problems in understanding any of the lessons in this Strand, please do not hesitate to inform the Science Department at FODE Headquarters. This will help the distance teacher to revise the lessons for the next edition.

You may study this Strand now following the Study Guide on the next page.

All the Best!

STUDY GUIDE

Follow the steps given below and work through the lessons.

Step 1 Start with Sub-strand 1 and work through it in order.

Step 2 When you complete Lesson 1, do Practice Exercise 1.

Step 3 After you have completed the Practice Exercise, correct your work. The answers are given at the end of each Sub-strand.

Step 4 Then, revise well and correct your mistakes if any.

Step 5 When you have completed all these steps, tick the check box for Lesson 1 on the contents page, like this:

√

Lesson 1: Rock Formation and Classification

Then, go on to the next lesson. Repeat this process until you complete all the lessons in this Sub-strand. When this is done, revise using the Sub-strand Review.

Remember, as you complete each lesson; tick the box for that lesson on the Contents Page. This will help you check your progress.

Assignments: Sub-strand Tests and Strand Tests

When you have completed all the lessons in a Sub-strand, do the Sub-strand test for that Sub-strand in your Assignment Book. The Course Book tells you when to do this.

When you have completed the entire Sub-strand tests for the Strand, revise well and do the Strand Test. The Assignment Book tells you when to do the Strand test.

When you have completed the entire Assignment Book, check and revise well before sending it to the Provincial Centre.

If you have any questions, write them on the Student‘s Page. Your teacher will advise you when he/she returns your marked Assignment.

Your Distance Teacher will mark the Sub-strand Tests and Strand Test in each Assignment. The marks you score in each Assignment will count towards your final result. If you score less than 50%, you will repeat that Assignment.

Remember, if you score less than 50% in three Assignments, your enrolment will be cancelled. So work carefully and ensure that you pass all Assignment.

SUB-STRAND 1

ROCK FORMATION AND CLASSIFICATION

In this sub-strand you will learn about:

- **stone tools used before the discovery of metals**
- **the three types of rocks and how they are formed**
- **the classification of igneous rocks**
- **the three categories of sedimentary rocks**
- **the formation and characteristics of metamorphic rocks**
- **the rock cycle**

SUB-STRAND 1: ROCK FORMATION AND CLASSIFICATION

Introduction

Rocks are found almost everywhere. There are rocks in deserts, on mountains, and in fields. There are also rocks at the bottom of the ocean. You might also find rocks in your own backyard. Even soil is made partly of ground-up rock. Most of Earth‘s crust, or outer layer, is made of rock. If you dig down deep enough in the ground, you will find a layer of solid rock. This layer is called bedrock.

Rocks are chunks of solid minerals. Rocks can be red, brown, black, tan, grey, or other colours. Some rocks are plain looking, some rocks are very beautiful. Some rocks even have stripes or speckles.

To know what rocks and how they are formed, you should ask yourself these questions:

- What is a rock?
- How are they formed?
- Why are they so important to human beings?
- Why are rocks so diversified with different colours and shapes?

In this Sub-strand, you will find the answers to these questions and all other questions relating to rocks.

Lesson 1: Stone Tools

Welcome to Lesson 1 of Strand 4. Different kinds of tools and metals are obtained from rocks and were important to human beings in many different parts of the world for thousands of years. When we try to find out about people in the past, we can see many of the things they made came from materials found in the ground. Different rocks were used for tools in many ways but the most common tools will be discussed in this lesson.

Your Aims:

- identify the primitive stone tools used before the discovery of metals
- describe and give the importance of each of the primitive stone tools used

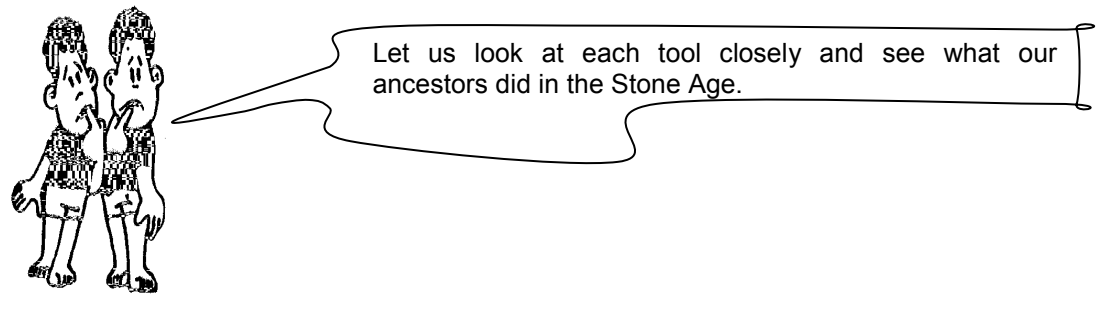
The Three Ages

Scientists think that people in different parts of the world were developed through three stages, learning first to make tools from stone and then metals. The three stages are described in the table below.

Age	How many years ago?	Materials used	Tools made	What else did they do?
Primitive stone age	About 2 000 000 to 3500 BC	Primitive stone tools	Axe	Hunting and gathering
Bronze age	About 3500 BC to 500 BC	Primitive stone tools	Axe	Hunting and gathering
Iron age	About 500 BC to 500 AD	Metal ore to make iron and steel	Iron tools, spears and swords, tools for agriculture	First cities begin

Stone Tools

Stone tools are simply tools that are made of stones in the Stone Age. Human beings have been making tools for nearly 2.5 million years. Prehistoric humans made a great variety of stone tools, many of which were designed for particular tasks.



Primitive Stone tools used in the Stone Age

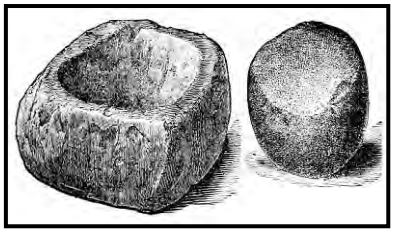
Some of the tools used in the Stone Age are listed below. Larger tools, such as axes were used to cut wood

Larger tools, such as axes were used to cut wood

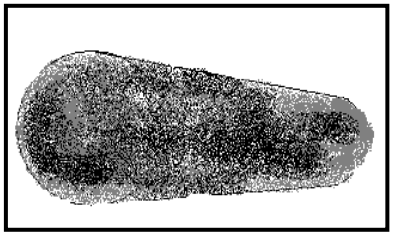
Some just held the stone and cut the wood

Flake-edged adze was used for woodworking especially for dugout canoes. Knifelike blades were used to butcher animals for food. Small arrowheads of variety of shapes and sizes were used for weapons for hunting

Pestle (used for putting seeds in)



Pestle and mortar were used for smashing and grinding seeds and other food to dust. Spoons or scoops were also made from stones



Mortar (used for smashing seeds in the pestle)

Spoon or scoop

Activity: Now test yourself by doing this activity.

Part A. Short Answer Questions

1. Describe the type of people who lived in the Stone Age.

_____

_____

2. Name and describe any other type of stone tools used in the Stone Age.

_____

_____

3. In PNG, did any of our ancestors use stone tools? _____

4. Give an example of a type of tool used in PNG. What was it used for?

_____

5. Why do you think rocks are important to human beings?

_____

_____

_____

Part B. True or False

6. Rocks are still used in some of our tools today. _____

7. Flint stone is one common rock used for arrowheads and cutting tools.

_____

8. People used stone tools to build big cities in their countries in the Stone Age.

_____

9. Stones are no longer used in the modern era. _____

10. The use of stones as tools was discovered by experimentation and observation. _____

Part C. Long Answer Questions

11. Explain briefly, what is mean by Stone Age.

_____

_____

12. What are rocks made up of?

_____

13. Briefly, explain why people in the Stone Age needed tools?

_____

_____

14. What were some of the tools used for?

_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 1.

Summary

You have come to the end of lesson 1. In this lesson you have learned that:

- different kinds of rocks are important to people in many parts of the world.
- many of the things people made in the past came from materials they found in the ground.
- people in different parts of the world developed through three different stages or ages.
- the three ages are; Stone Age, Bronze Age and Iron Age.
- in the Stone Age, people used materials like stones, clay and wood to make tools.
- the most common stone tools made during the Stone Age ere; axe, scrapers, mortar and pestle, scoops and arrowheads, cutting tools for butchering animals and skin for clothing.

NOW DO PRACTICE EXERCISE 1 ON THE NEXT PAGE.

Practice Exercise 1

1. In the table below, list as many tools as you can think of which people in the Stone Age used to survive and describe their uses.

Tools used	Purpose

2. Briefly describe how people lived in the Stone Age.

_____
_____
_____
_____
_____
_____
_____
_____

3. Briefly explain how you think Stone Age people clothed themselves. Where and how they got the clothes.

_____
_____
_____
_____
_____
_____
_____

4. Name and describe at least one stone tool, which was used in PNG and is still used today.

_____
_____
_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Answers to Activity

Part A. Short Answer Questions

1. Stone Age people were people who lived in caves and huts near water and survived by hunting and gathering. Their tools were made out of stones and wood.
2. Scraper for scraping and pestle and mortar for smashing nuts
3. Yes
4. Stone axes were used in the highlands for chopping wood. Mumu stones were and are still being used in the New Britain Island and many other parts of PNG.
5. Rocks are important to human beings because they are easily accessible and hard enough to be used as tools in meeting their needs to survive.

Part B. True or False

6. True

7. True

8. False

9. False

10. True

Part C. Long Answer Questions

11. Stone Age is the era or time in which people lived in caves and used stones as tools for survival.

12. Rocks are made up of minerals.

13. People in the Stone Age needed tools for survival such as helping them in hunting for food and cutting wood for things like canoe or building huts.

14. Some tools were used for hunting, cutting wood, and for smashing and grinding food such as nuts, seeds and bones. Some were used as weapons against other animals.

Lesson 2: Igneous Rocks

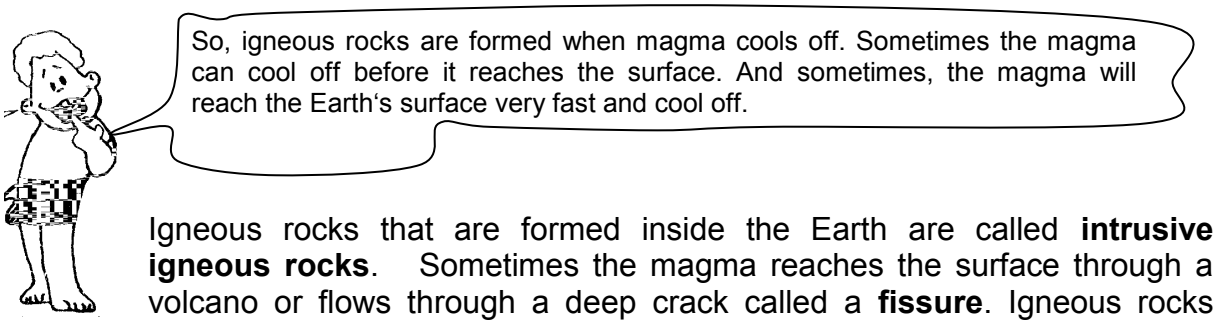
Welcome to Lesson 2 of Strand 4. In Lesson 1, we looked at Primitive Stone Age tools and how important rocks were to human beings. You should appreciate the fact that, rocks were so part to the evolution of humankind. Rocks are now used in many ways but the important use of rocks now is in the building and mining industries. There are different types of rocks but in this lesson, we will discuss one type of rock called igneous rocks.

Your Aims:

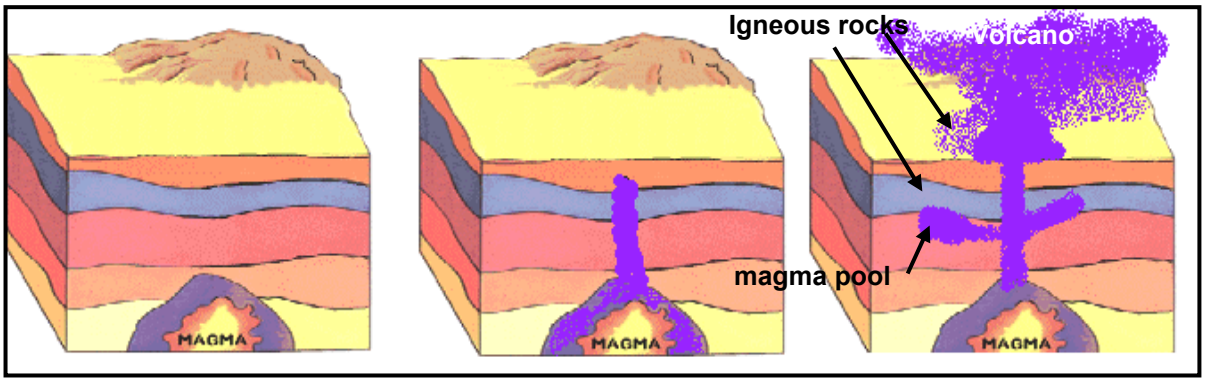
- define igneous rocks
- explain the formation of igneous rocks
- describe the classification of igneous rocks

Igneous Rocks

Deep inside the Earth, the heat and temperature is very high and the rocks melt. These molten rocks are called **magma**. When magma cools and solidifies, the rock that is formed is called an **igneous rock**.



Igneous rocks that are formed inside the Earth are called **intrusive igneous rocks**. Sometimes the magma reaches the surface through a volcano or flows through a deep crack called a **fissure**. Igneous rocks formed in this way are called **extrusive igneous rocks**.



The diagram above illustrates where igneous rocks are formed.

Igneous rocks found in different parts of the world come from different places inside the Earth and so contain different minerals. This means that igneous rocks can be classified by the type of minerals they contain and by the size of the crystals of the minerals.

Examples of Extrusive Igneous Rocks

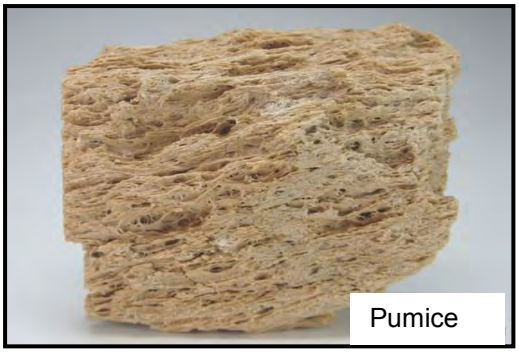
When magma cools quickly, it forms crystals, which are very small. If the cooling is very fast, then an igneous rock called **obsidian** is formed. Obsidian looks like black glass and can be made into tools with a sharp edge.

Obsidian

The igneous rock called **basalt** is formed when lava cools quickly on the surface of the Earth. Basalt rocks can be seen near Sogeri, Lae, and Mt. Hagen and in many other places in Papua New Guinea.

Basalt

A special igneous rock called **pumice** is sometimes found washed up on beaches. Pumice is formed when the gases that dissolve in the rock are released when the lava erupts at the surface through a volcano. The lava hardens very quickly and bubbles of gas form many small holes in the rock when released, which make the pumice light enough to float on water.



Pumice

Example of Intrusive Igneous Rocks

Magma below the surface of the Earth cools slowly and forms large crystals that can be seen with the naked eye. **Granite** is one example of an intrusive rock.

Granite

Classification of Igneous Rocks

Igneous rocks vary in colour from almost white to black. The colour indicates the minerals the rock may contain.

Light coloured rocks such as granite and pumice contain light coloured minerals such as quartz, while dark coloured igneous rocks contain dark coloured minerals and are usually heavy.

The minerals that are found in a rock are described as the **mineral composition**, which is important in helping to classify rocks.

- Igneous rocks can be classified according to the minerals they contain and their crystal size.
- Igneous rocks with small crystals have cooled quickly and are said to be fine-grained.
- Igneous rocks with large crystals have cooled slowly and are said to be large-grained.

The table below can be used to classify igneous rocks.

Crystal Size	**Chemical classification of Igneous rocks** **Light coloured → dark coloured**		
Small crystals Fine grain	rhyolite	andesite	basalt
Large crystals Course grain	granite	diorite	gabbro

Activity: Now test yourself by doing this activity.

Part A. Short Answer Questions

1. Where do igneous rocks come from?

   _____

2. What do you call an igneous rock that is formed when gases dissolved in the rock are released during eruption of a volcano?

   _____

3. How is an obsidian formed?

   _____

4. An example of an igneous rock with large crystals would be _____

5. What does the colour of rocks indicate? _____

Part B. Write True or False.

_____ 1. Igneous rocks are formed when broken materials are cemented together.
_____ 2. Igneous rocks cool off slowly at the surface.
_____ 3. Rhyolite is an igneous rock with light colour and fine grain.
_____ 4. Gabbro has large crystals and is dark in colour.
_____ 5. Igneous rocks with small crystals cool off slowly.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 2.

Summary

You have come to the end of lesson 2. In this lesson you have learnt that:

- all rocks are made of minerals. The way a rock looks and its properties depend on the minerals that make up the rock.
- the cooling of molten rock called magma forms igneous rocks.
- slow cooling produces large crystals while fast cooling produces small crystals.
- igneous rocks can be classified according to crystal size, minerals and colour.
- igneous rocks with small crystals have cooled quickly and are said to be fine-grained.
- igneous rocks with large crystals have cooled slowly and are said to be course-grained.

NOW DO PRACTICE EXERCISE 2 ON THE NEXT PAGE

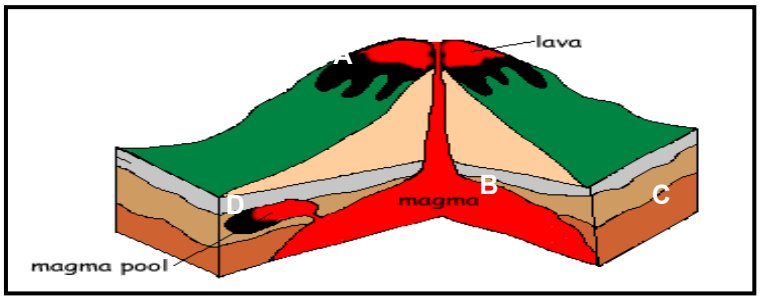
Practice Exercise 2

1. What is an igneous rock?

_____

2. From the diagram given, indicate where igneous rocks are formed by writing the letters **A**, **B**, **C** or **D**.

Answer: _____



(For Questions 3 and 4, write the correct word in the space provided)

3. When magma cools off before it reaches the surface, _____ igneous rock are formed.

4. When magma reaches the surface and quickly cools off very fast, _____ igneous rocks are formed.

5. Igneous rocks with fine grain and small crystals is an example of what type of igneous rock? _____

6. The cooling of what substance forms igneous rocks? _____

7. How are igneous rocks classified?

_____

8. Igneous rocks with large crystals are said to be what type of igneous rocks?

_____

9. Study the igneous rock given. Is the rock intrusive or extrusive? Give your reasons why you think so.

_____

_____

_____

10. The rock given in the diagram in Q9. Is dark coloured, has large crystals and is large grained. What do you think the name of the rock? _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1

Answers to Activity

Part A. Short Answer Questions

1. Igneous rocks are formed around volcanic areas

2. Pumice

3. Obsidian is formed when magma cools quickly and forms crystals, which are very small.

4. Granite

5. The colour of rocks indicates the minerals they contain.

Part B. True or False

1. false

2. false

3. true

4. true

5. false

Lesson 3: Sedimentary Rocks

Welcome to Lesson 3 of Strand 4. We learnt in our last lesson that rocks are formed in many different ways. The cooling of molten rocks called magma forms igneous rocks. What about sedimentary rocks? A sedimentary rock is another type of rock and you will learn more about it in this lesson.

Your Aims:

- define sedimentary rocks
- discuss the formation of sedimentary rocks

Sedimentary Rocks

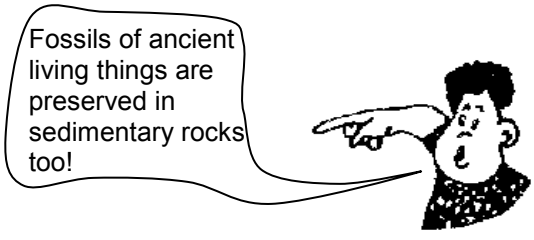
Have you ever been to the beach or near rivers where there are a lot of sand? Have you tried to put your toes in the sand? Over thousands of years, that sand might become part of a **sedimentary rock.**

Ripples in beach sand and river sand, such as those in photograph (A) may someday become a rock like the sandstone in photograph (B). This sandstone was part of a beach over 200 million years ago.

Sedimentary rocks are rocks that are formed from layers of sediments deposited by the sea rivers, wind or moving ice.

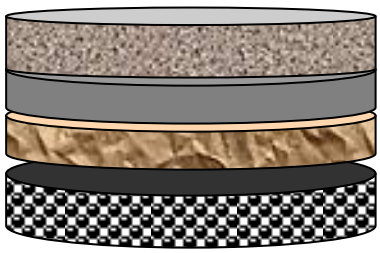
Sedimentary rocks make up about three-quarters of the rocks on the Earth‘s surface. They form at the surface in environments such as beaches, rivers, the ocean and anywhere that sand, mud and other types of sediments collect.

Sedimentary rocks preserve a record of the environments that once existed. By looking at sedimentary rocks of different ages, scientists can figure out how climate and environments have changed through Earth‘s history.

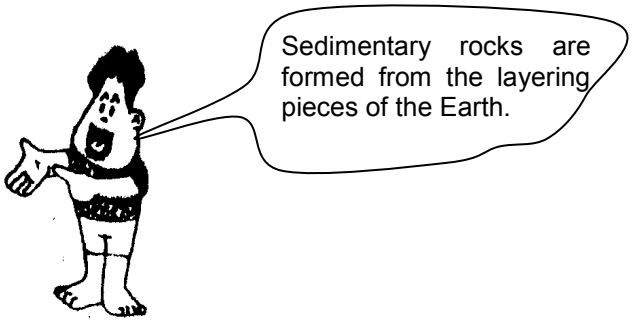


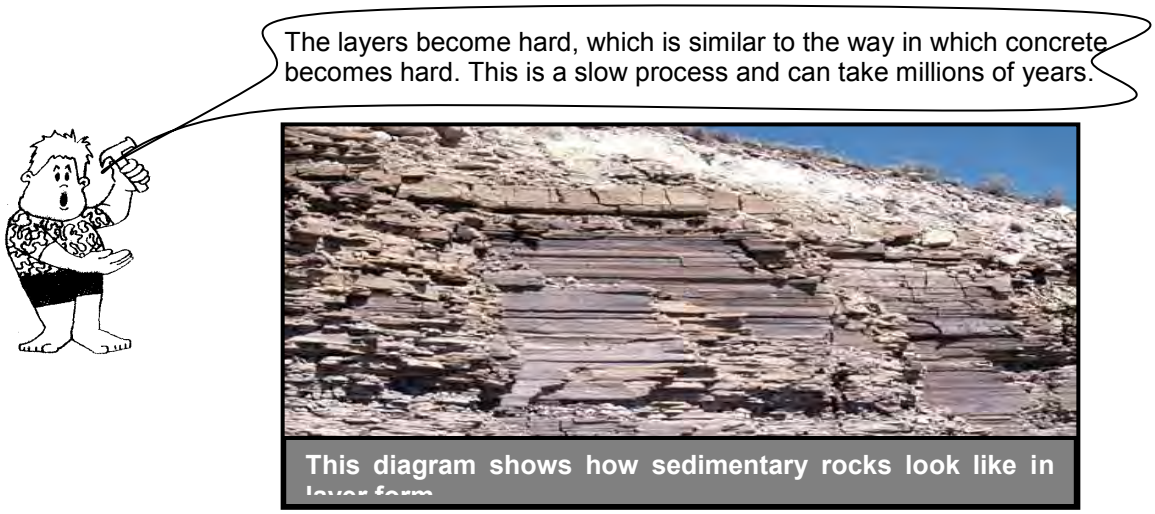
Formation of Sedimentary Rocks

For thousands, even millions of years, little pieces of our Earth have been eroded, broken down and worn away by wind, water and ice. These little bits of our earth are washed downstream where they settle to the bottom of the rivers, lakes, and oceans. Layer after layer of eroded earth is deposited on top of each other. These layers are pressed down or squashed as more and more material collects above them through time, until the bottom layers slowly turn into rock.



The layers of rocks are called Strata.





This diagram shows how sedimentary rocks look like in layer form

Types of Sedimentary Rocks

The broken bits of rocks are called **sediment**. Sediment is the sand you find at the beach, the mud at the bottom of the lake, the pebbles in a river, and even the dust on furniture. The sediment may, in time, form a rock if the little pieces become cemented together. Many sedimentary rocks are made from the broken bits of other rocks. People who study about rocks are called Geologists.

Geologists place sedimentary rocks into three broad categories:

(1) **Clastic rocks** form from clasts, or broken fragments, of pre-existing rocks and minerals.
(2) **Chemical rocks** form when minerals precipitate, or solidify, from a solution, usually seawater or lake water.
(3) **Organic rocks** form from an accumulation of animal and plant remains.

It is common for sedimentary rocks to contain all three types of sediment.

The table below summarizes the three categories of sedimentary rocks.

Category	Formation	Examples	Diagram
Clastic Sedimentary Rocks	Made from broken bits of other rocks	Sandstone Shale	 **Sandstone**
Chemical Sedimentary Rocks	Made from minerals in the water. Water or sea dries up leaving layers of minerals	Halite Gypsum	 **Gypsum**
Organic Sedimentary Rocks	Made from the remains of living things such as clamshells, plankton, skeletons, dinosaur bones, and plants.	Limestone Coal	 **Coal**

Activity: Now test yourself by doing this activity.

Part A. Short Answer Questions

1. What is a sedimentary rock?
   _____

2. The broken bits of rocks are called _____.

3. Chemical rocks form when minerals _____ or _____ from a solution.

4. Can sedimentary rocks contain all three types of sediments? _____

Part B. Write True or False.

1. Sandstone is a sedimentary rock. _____

2. Organic sedimentary rock is made from minerals in the water. _____

3. When remains of living things are solidified, we obtain organic sedimentary rocks. _____

4. Sedimentary rocks are made over millions of years. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 3.

Summary

You have come to the end of lesson 3. In this lesson you have learnt that:

- sedimentary rocks form from layers of sediments deposited by the sea, rivers, wind or moving ice.
- sedimentary rocks form in layers just like layers of a cake. The layers of rocks are called strata.
- sediment is the sand you find at the beach, mud in the lake bottom, the pebbles in a river, and even the dust on furniture.
- many sedimentary rocks are made from the broken bits of other rocks.
- it is common for sedimentary rocks to contain all three types of sediments.
- geologists place sedimentary rocks into three broad categories:
    a. **Clastic rocks** form from *clasts*, or broken fragments, of pre-existing rocks and minerals.
    b. **Chemical rocks** form when minerals precipitate, or solidify, from a solution, usually seawater or lake water.
    c. **Organic rocks** form from the build- up of animal and plant remains.

NOW DO PRACTICE EXERCISE 3 ON THE NEXT PAGE

Practice Exercise 3

1. Briefly describe how sedimentary rocks are formed.
   _____
   _____

2. What are the three main categories of sedimentary rocks?

   (a) _____

   (b) _____

   (c) _____

3. What type of sedimentary rock is Halite? _____

4. What is a sediment?
   _____

5. Describe how sandstone is formed.
   _____
   _____

6. The layers of rock seen in sedimentary rocks are called _____

7. Name some materials (sediments) that make up an organic sedimentary rock.
   _____
   _____

8. What type of sedimentary rock is shale? _____

9. What is shale made up of?_____

10. What is sandstone made up of? _____

11. Where are the most likely places for sedimentary rocks to be formed?
    _____

12. Name some physical factors that move sediments to these places for the rocks to be formed.
    _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Answers to Activity

Part A.

2. Rocks that are formed from layers of sediments deposited by rivers, sea, wind or moving ice.

2. Sediments

3. precipitate, solidify

4. Yes

Part B.

1. True

2. False

3. True

4. True

Lesson 4: Metamorphic Rocks

Welcome to Lesson 4 of Strand 4. Remember rocks are formed in many different ways. Igneous rocks are formed from the cooling of molten rocks. And sedimentary rocks, are formed from layers of sediments being deposited by the sea, rivers, wind or moving ice. Metamorphic rocks however, are another type of rocks that are formed which you will learn more in this lesson.

Your Aims:

- define what metamorphic rocks are
- discuss how they are formed

Metamorphic Rocks

A metamorphic (met uh MOR fik) rock is a type of rock formed when an igneous rock or sedimentary rock feels intense heat and pressure in the crust of the earth. Metamorphic comes from the Greek words meaning "change" and "form".

Many things change their form. For example, a tadpole changes into a frog, and a caterpillar changes into a butterfly. The process where things change from one form to another is called ‗**metamorphosis**'.

Rocks also change from one stage to another through the metamorphic process. Therefore, through this process, both igneous and sedimentary rocks change into metamorphic rocks, and a metamorphic rock can change into another type of metamorphic rock.

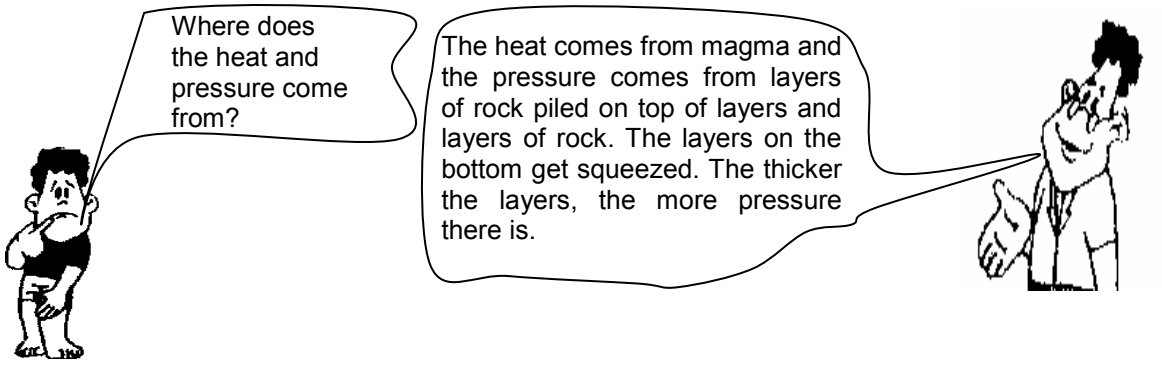
Formation of Metamorphic Rocks

Rocks can change many times over millions of years. Wind and water can wear away igneous and metamorphic rocks. Tiny grains of these rocks can build up in layers to become sedimentary rocks. Sedimentary rock buried beneath the Earth can —cook" and change into a metamorphic rock. Metamorphic or sedimentary rock can melt, become lava, and turn into an igneous rock.

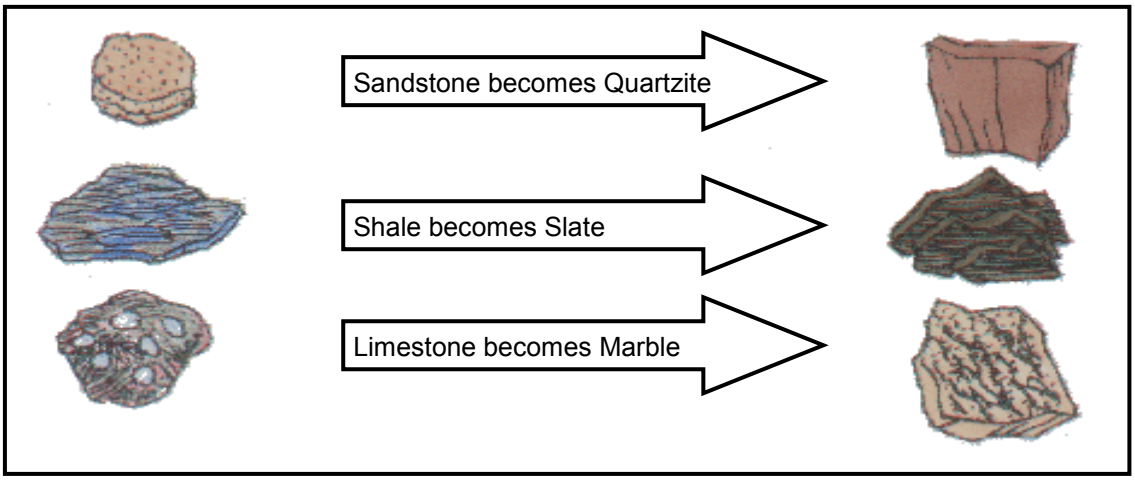
Heat and pressure can change many things. They can even change rocks. Metamorphic rocks form deep in the earth where high temperature, great pressure, and chemical reactions cause one type of rock to change into another type of rock. Metamorphic rocks begin to form at 12-16 kilometres beneath the Earth's surface. They begin changing at temperatures of 100^0C to 800^0C. If you squeeze and heat a rock for a few million years, it can turn into a new kind of rock.

Fascinating Fact

The oldest known rock lies in Canada. The Acasta gneiss, a metamorphic rock, and it is 3.96 billion years old.



Examples of what rocks become after metamorphosis takes place.



Here is a checklist of some common metamorphic rocks and their characteristics.

Some Common Metamorphic Rocks			
Name	**Image**	**Colour**	**Texture**
Gneiss		Pink/Gray	Foliated
Marble		Light Coloured	Unfoliated
Quartzite		Light Coloured	Unfoliated

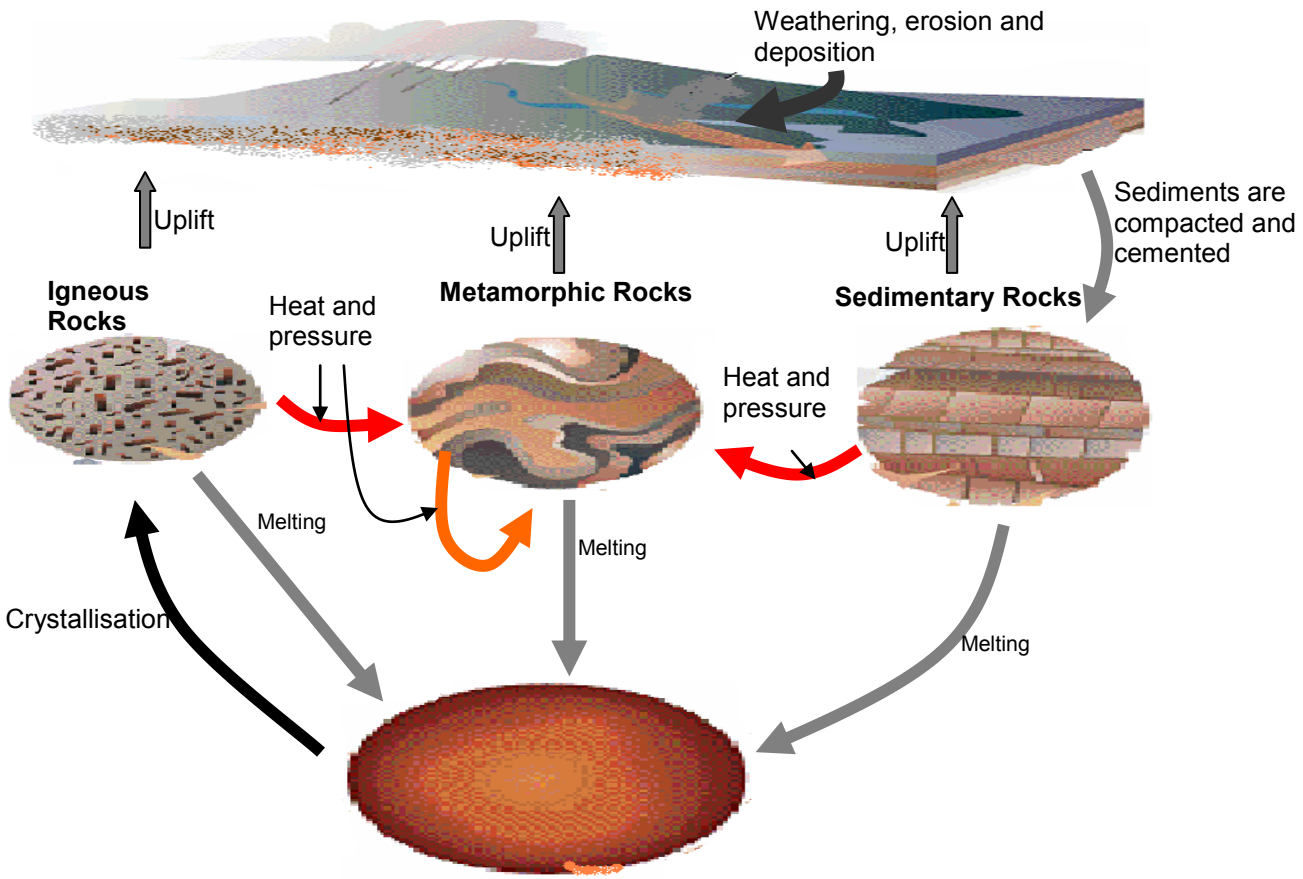
Below is a summary of the major characteristics of metamorphic rocks.

- Classified by texture and composition
- Rarely has fossils
- May react with acid
- May have alternate bands of light and dark minerals
- May be composed of only one mineral, for example, marble & quartzite
- May have layers of visible crystals
- Usually made of mineral crystals of different sizes
- Rarely has pores or openings
- May have bent or curved foliation

The Rock Cycle

The rock cycle below shows how each of the three principal types of rocks (sedimentary, metamorphic, and igneous) can evolve into either of the two other types of rock, or even into other rocks of its own type.

Sediments that are compacted and cemented form sedimentary rocks, rocks that are subjected to heat and pressure form metamorphic rocks, and rocks that are melted and then cooled form igneous rocks.



Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. Metamorphic rocks do have

   A. fossils.
   B. large grains.
   C. curved foliation.
   D. pores or openings.

2. In metamorphosis, a shale becomes _____.

   A. slate B. quartzite
   C. limestone D. sandstone

3. The three things needed in the metamorphosis of rocks are

   A. wind, water and time.
   B. pressure, heat and time.
   C. pressure, time and wind.
   D. wind, pressure and force.

4. The three types of rocks formed beneath the surface is brought to the surface by a force called _____.

   A. pull B. push
   C. uplift D. thrust

5. The characteristics of a marble stone are

   A. dark coloured and foliated.
   B. light coloured and foliated.
   C. dark coloured and unfoliated.
   D. light coloured and unfoliated.

6. A pinkish-grey foliated metamorphic rock is called _____.

   A. slate B. gneiss
   C. marble D. quartzite

7. What is the name of the oldest rock on Earth?

A. Marble B. Gabbro

C. Granite D. Acasta gneiss

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 4.

Summary

You have come to the end of lesson 4. In this lesson you have learnt that:

- a metamorphic rock is a type of rock formed when an igneous rock or a sedimentary rock experiences intense heat and pressure in the crust of the earth.
- the process where things change from one form to another is called '**metamorphosis**'.
- rocks can change many times over millions of years.
- the heat comes from magma and the pressure comes from layers of rock piled on top of more layers of rock to form metamorphic rocks.
- metamorphic rocks begin to form at 12-16 kilometres beneath the Earth's surface.
- the rock cycle shows how each of the three principal types of rocks can evolve into either of the two other types of rock, or even into another rock of its own type.

NOW DO PRACTICE EXERCISE 4 ON THE NEXT PAGE.

Practice Exercise 4

1. What is a metamorphic rock
   _____
   _____

2. How is a metamorphic rock formed?
   _____

3. What is metamorphosis?
   _____

4. Where does the heat come from beneath the Earth‘s surface?
   _____

5. Where does the pressure come from in forming metamorphic rocks?
   _____
   _____

6. A pink-grey foliated metamorphic rock is called _____.

7. What does limestone become when it is changed to a metamorphic rock?
   _____

8. When magma crystallises, what type of rock does it form? _____

9. When sediments are compacted and cemented, what rock does it form?
   _____

10. When heat and pressure are applied to an igneous, sedimentary, what type of rock does it form? _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1

Answers to Activity

1.	C	5.	D
2.	A	6.	B
3.	B	7.	D
4.	C		

Lesson 5: Minerals

Welcome to Lesson 5 of Strand 4. So far, we have discussed the three basic types of rocks that are formed beneath the Earth's surface and their characteristics. You must understand that rocks and everything else in the world are made of chemical elements. You will learn more about the chemical elements that make up a rock in this lesson.

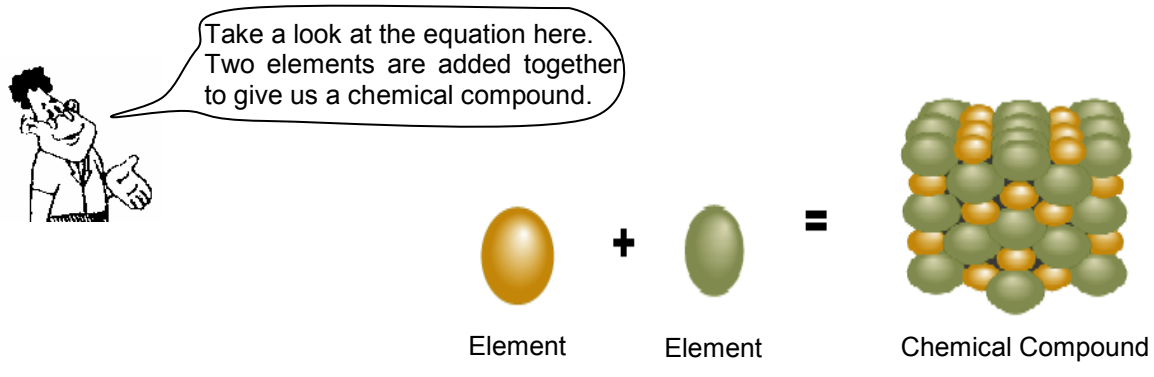
Your Aims:

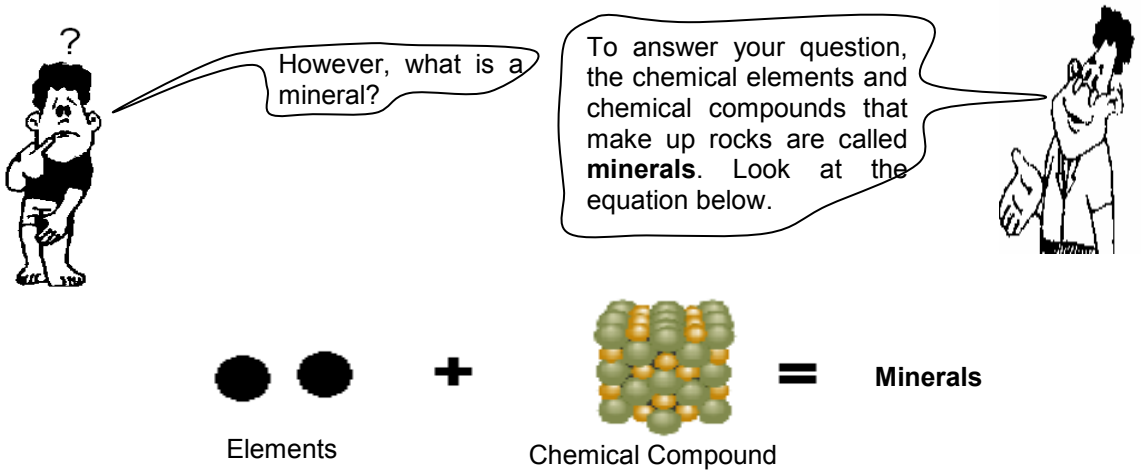
- define minerals
- identify some minerals
- explain some minerals and their related metals

What Is A Mineral?

Rocks are made up of chemical **elements**. Elements are substances that cannot be broken down into a simpler substance by ordinary chemical means.

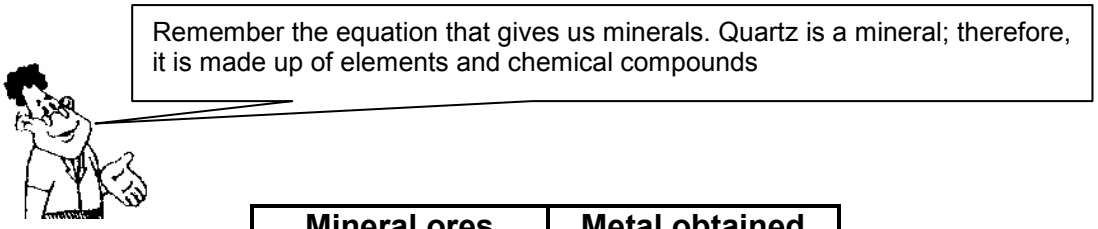
Chemical elements are known as metals and non-metals. Gold, silver and copper are examples of chemical elements found as metals in nature. However, not many elements are found in a natural state in the environment. This means we cannot just dig them out of the ground. Most substances in the Earth's crust are formed from elements that are joined together. These substances are called **chemical compounds**.





Minerals are made up of chemical elements and compounds.

There are many different minerals but only a few are common in the Earth‘s crust. All rocks are made of minerals. A rock‘s appearance and properties depend on the minerals that make up the rock. Most rocks are a mixture of a few minerals. For example, the igneous rock called **granite** contains the minerals quartz, feldspar and mica.



Mineral ores	Metal obtained
Haematite	Iron
Limonite	Iron
Bauxite	Aluminium
Chalcopyrite	Copper
Azurite	Copper
Galena	Lead
Cinnabar	Mercury
Cassiterite	Tin
Carnonite	Uranium

Mineral ores and metals

Some rocks contain minerals that are very useful to the community. For example, the minerals may contain metals such as iron, gold, silver and copper. Rocks that contain metals are called **mineral ores**. One of these is *chalcopyrite*, which is a copper ore that is common in Papua New Guinea and is usually yellow in colour.

Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. Elements are substances that

   A. are created by mechanical means.
   B. cannot be found on the Earth‘s surface.
   C. can be broken into smaller substances.
   D. cannot be broken into smaller substances.

2. When elements combine, what is formed?

   A. Mixture B. Solution

   C. Minerals D. Compounds

3. What do you get when elements and compounds are combined?

A. Gold B. Mixture

C. Solution D. Minerals

4. Minerals that make up the rock, give the rocks their

A. origin and time.
B. name and origin.
C. name and identity.
D. appearance and property.

5. A rock that contains the minerals quartz, feldspar and mica is called

A. slate. B. gabbro.

C. marble. D. granite.

6. Rocks that contain metals are called

A. ore body.
B. mineral ore.
C. ore deposit.
D. mineral deposit.

7. What metal is obtained from the mineral galena?

A. Gold B. Lead

C. Silver D. Copper

8. Uranium is obtained from the mineral ore called

A. cinnabar. B. carnonite.

C. cassiterite. D. chalcopyrite.

9. Chemical elements are classified into two groups. They are

A. metals and ores.
B. gases and solids.
C. metals and non-metals.
D. elements and compounds.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 5.

Summary

You have come to the end of lesson 5. In this lesson you have learnt that:

- rocks are made up of chemical **elements**.
- metals are chemical elements and they are substances that cannot be broken into substances that are more elementary by ordinary chemical means.
- chemical elements make up chemical compounds
- minerals are made up of chemical elements and compounds.
- there are many different minerals but only a few are common in the Earth‘s crust.
- a rock‘s appearance and properties depend on the minerals that make up the rock.
- Rocks that contain metals are called **mineral ores**.

NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE

Practice Exercise 5

Answer the following questions:

1. What is a chemical element?
   _____
2. Chemical elements are classified into two categories. What are they?
   _____
   _____
3. What is a chemical compound?
   _____
4. What is a mineral?
   _____
5. What is a metal?
   _____
6. What is a mineral ore?
   _____
7. Name the mineral ore that contains the metal lead. _____
8. Name two mineral ores that contain copper._____
9. All rocks are made up of _____.
10. What metal does the mineral ore bauxite contain?_____
11. What mineral ore is the metal tin extracted from?_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1

Answers to Activity

1.	D	6.	B
2.	D	7.	B
3.	D	8.	B
4.	D	9.	B
5.	D		

REVIEW OF SUB STRAND 1: ROCK FORMATION AND CLASSIFICATION

Revise all the lessons in this Sub-strand and then do **ASSIGNMENT 4.**
Here are the main points to help you revise.

Lesson 1: Stone Tools

- Rocks are important to people in many parts of the world.
- Things people made in the past came from materials they found in the ground.
- People in different parts of the world developed through the three different stages or ages. The three ages are; Stone Age, Bronze Age and Iron Age.
- In the Stone Age, people used materials like stones, clay and wood to make tools.
- The most common stone tools made during the Stone Age were; axes, scrapers, mortar and pestle, spears and arrowheads and cutting tools.

Lesson 2: Igneous Rocks

- The cooling of molten rock called magma forms igneous rocks.
- Slow cooling produces large crystals while fast cooling produces small crystals.
- Classification of igneous rocks can be done according to crystal size, minerals and colour.
- Igneous rocks with small crystals have cooled quickly and are fine-grained.
- Igneous rocks with large crystals have cooled slowly and are course-grained.

Lesson 3: Sedimentary Rocks

- Sedimentary rocks are rocks that are formed from layers of sediments deposited by the sea, rivers, wind or moving ice.
- Sediments can be the sand you find at the beach, mud in the lake bottom, the pebbles in a river, and even the dust on furniture.
- Sedimentary rocks can be formed from the broken bits of other rocks.
- Sedimentary rocks are classified into three broad categories:

  (a) **Clastic rocks** form from clasts, or broken fragments, of pre-existing rocks and minerals.
  (b) **Chemical rocks** form when minerals precipitate, or solidify, from a solution, usually seawater or lake water.
  (c) **Organic rocks** form from the accumulation of animal and plant remains.

Lesson 4: Metamorphic Rocks

- A metamorphic rock is a rock formed when an igneous rock or a sedimentary rock experiences intense heat and pressure.
- The process where things change from one form to another is called **metamorphosis**‘.
- The heat comes from magma and the pressure comes from layers of rocks forming metamorphic rocks.
- Metamorphic rocks form at 12-16 kilometres beneath the Earth's surface.
- The rock cycle shows how each of the three principal types of rocks can evolve into either of the two other types of rock, or even into another rocks of its own type.

Lesson 5: Minerals

- Rocks are made up of elements.
- Elements are grouped as metals and non-metals.
- Elements are substances that cannot be broken into substances that are more elementary by ordinary chemical means.
- Chemical elements make up chemical compounds.
- Chemical elements and compounds make up minerals.
- There are many different minerals but only a few are common in the Earth‘s crust.
- A rock‘s appearance and properties depend on the minerals that make up the rock.
- Rocks that contain metals are called **mineral ores**.

REVISE WELL AND THEN DO SUB STRAND TEST 1 IN YOUR ASSIGNMENT 4.

Answers to Practice Exercises 1- 5

Practice Exercise 1

1.

Tools used	Purpose
Ground-Edge axe	used for chopping firewood
Flake –Edge adze	used for woodworking
Blade knife	used for slicing meat
Arrowhead	used for spears to hunt
Pestle	used for putting seeds or food in
Mortar	used for smashing seeds in the pestle
Spoons or scoops	for eating or serving

2. People in the Stone Age lived in caves and huts built near water and survived by hunting and gathering with tools made out of stones.

3. Stone Age people were not fully clothed as we do in the modern era. They were partly clothed and the material came from animal skin. The animal was killed and skinned. The skin was then dried and sewn.

4. Stone axe from the highlands of PNG was used for cutting firewood. It is still seen today especially for artifacts as a form of tourist attraction.

Practice Exercise 2

1. Igneous rock is a rock that is formed when magma cools off and solidifies.

2. A and D

3. Intrusive

4. Extrusive

5. Extrusive

6. magma

7. According to the minerals they contain and their crystal size.

8. intrusive

9. Intrusive because the rock has large crystals and is course grained.

10. gabbro

Practice Exercise 3

1. Sedimentary rocks are formed from layers of sediments deposited by sea, rivers, wind or moving ice.

2. (a) Clastic Sedimentary rock
   (b) Chemical Sedimentary rock
   (c) Organic Sedimentary rock

3. Chemical Sedimentary rock

4. Broken bits of other rocks or it can be sand, mud, pebble or even dust. Sandstone is formed from broken bits of other rocks.

5. strata

6. Remains of living things such as clamshells, plankton, skeletons, dinosaur bones and plants

7. Clastic sedimentary

8. Broken bits of other rocks

9. Broken bits of other rocks

10. Beaches, rivers, the ocean and anywhere that sand, mud and other sediments collect.

11. Wind, water, sea or moving ice.

P**ractice Exercise 4**

1. A type of rock formed when igneous or sedimentary rock experiences intense heat and pressure in the crust of the Earth.

2. They are formed in the Earth where high temperature, great pressure and chemical reactions cause one type of rock to change into another type of rock.

3. When something changes from one form to another

4. Heat from beneath the Earth‘s surface comes from the molten rocks or magma.

5. The pressure from beneath the earth‘s surface comes from the layers of rocks piled on top of more layers of rocks.

6. Gneiss

7. Marble

8. Igneous rock

9. Sedimentary rock

10. Metamorphic rock

Practice Exercise 5

1. A chemical element is a substance that cannot be broken into more elementary substances by ordinary chemical means.

2. Chemical elements are classified as metals and non-metals.

3. A chemical compound is a substance formed when two or more elements are added together.

4. A mineral is a substance which consists of a chemical element and chemical compounds.

5. A metal is a chemical element.

6. Mineral ores are rocks that contain metals.

7. Galena

8. Chalcopyrite and Azurite

9. minerals.

10. Aluminium

11. Cassiterite

SUB-STRAND 2

METALS FROM MINERALS

In this sub-strand you will learn about

- **metals and where they are obtained from**
- **processes of extracting metals from minerals**
- **identify the metals and minerals found in PNG**
- **discuss the mining activities in PNG**
- **discuss the environmental issues relating to mining**

SUB STRAND 2: METALS FROM MINERALS

Introduction

Metals are found naturally in rock. Papua New Guinea has many valuable mineral deposits from which we obtain metals, especially of copper, gold and silver. Metals are used for many purposes in the world and it is so demanding. Where there is demand, there has to be supply, and countries having abundance of minerals have to supply the world with metals for their use.
Several processes have to be carried out to obtain metals from the rocks.

You will learn from this topic what metal is, and how metals are obtained from rocks. You will learn that to obtain the metals from the mineral, mining has to take place.

All these stages do come at a cost and the effects on the environment. We will discuss further certain environmental issues in this Sub-strand.

To know about metals and how they are extracted, you should ask yourself these questions:

- What is a metal?
- How are they extracted?
- Why are they so important to human beings?
- What are the effects of extracting minerals?

In this Sub-strand, you will find the answers to these questions and all other questions relating to metals.

Lesson 6: Sources of Metals

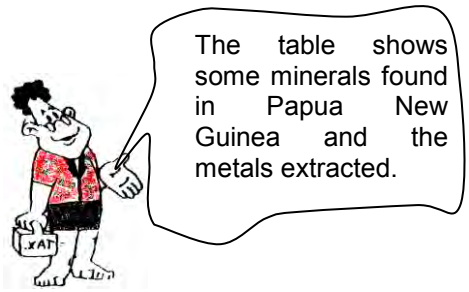
Welcome to Lesson 6 of Strand 4. In Lesson 5, we talked about minerals. You should now know that chemical elements are classified as metals and non-metals. We will discuss metals in this lesson.

Your Aims:

- revise metals
- identify the sources of metals
- discuss the methods used in searching for metals

Metals From Minerals

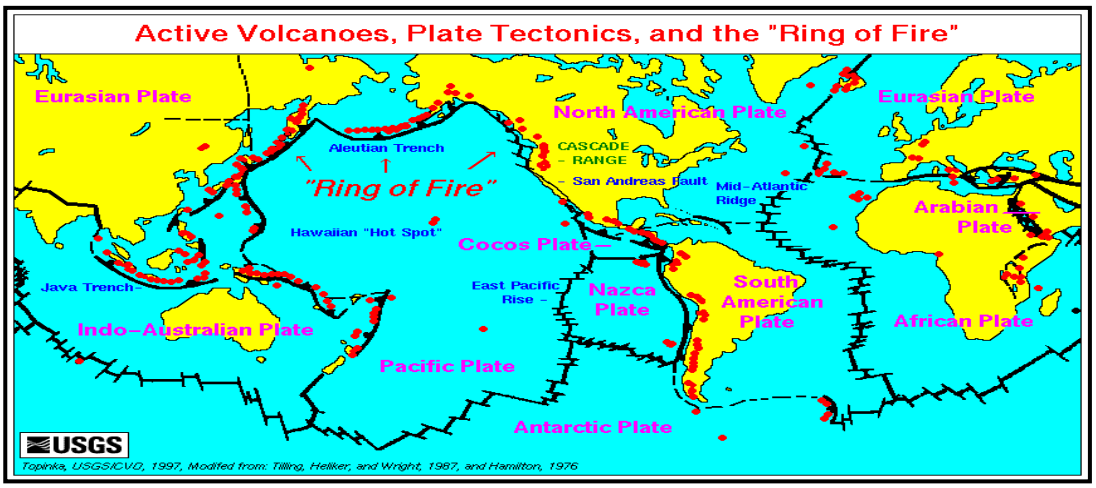
Metals are chemical elements and they are substances that cannot be further broken down using any chemical means. Metals are found in the minerals that occur naturally in rocks. Papua New Guinea has many valuable mineral deposits, especially of copper, silver and gold.



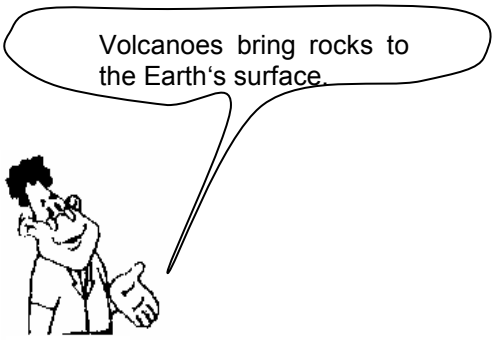
Mineral	Formula	Metal	Formula
niccolite	NiAS	nickel	Ni
linnaerite	Co_3S_4	cobalt	Co
pyrolusite	MnO_2	manganese	Mn
argentite	Ag_2S	silver	Ag
molybdenite	MoS_2	molybdenum	Mo
gibbsite	$Al(OH)_3$	aluminium	Al
silver	Ag	silver	Ag
gold	Au	gold	Au
chalcopyrite	$CuFeS_2$	copper	Cu

Metal Ores

The rocks we get from metals are called **ores** and a large amount is known as an **ore body**. In Pacific Island Countries, there are many volcanoes and earthquakes known as the –ring of fire".



The changes occurring inside the Earth that causes earthquakes and volcanoes bring rocks containing metal ores close to the surface.



Some rocks contain large amounts of metal compound or metal so it is worth digging up and extracting the metal. For example, gold has been mined in the Pacific since 400 AD when Chinese miners worked in Indonesia. Gold was found in Fiji in 1868 and was observed in local pottery in Redscar Bay, Central Province, in 1852. By the 1890s, there were hundreds of gold miners in the islands of Milne Bay. There are thirty large mineral deposits of gold in the Pacific.

Some examples of metal ores that are mined in Papua New Guinea are shown below.

Manganese Ore

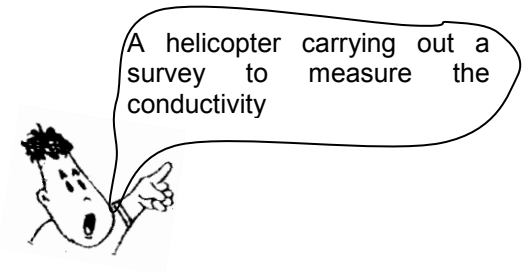
Lead Ore

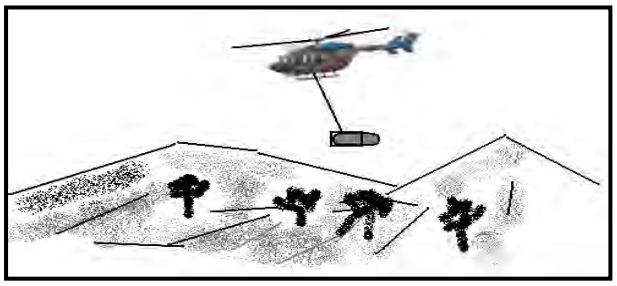
Iron Ore

Gold Ore

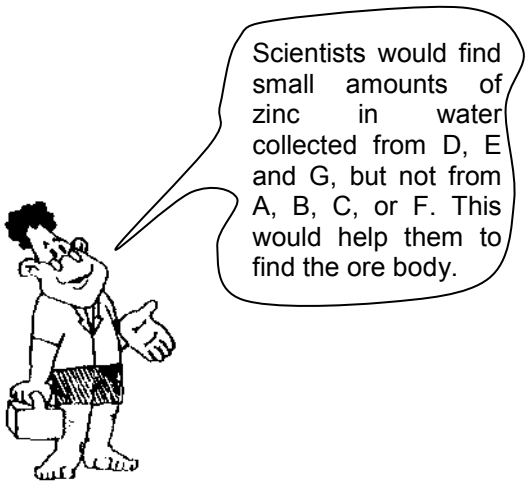
Searching for Metals
Scientists use two methods to explore ore bodies:

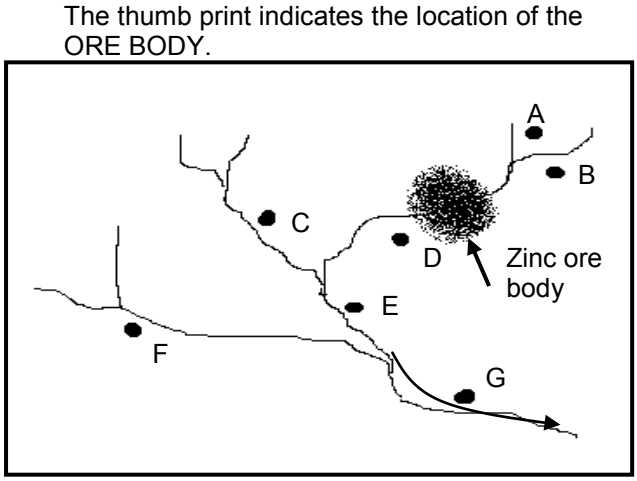
- **Ariel surveys** – looking at geological maps to find rock types and taking photographs from airplanes. Helicopters can also be used to carry equipment to measure the magnetism and conductivity of the ore body as they fly over.





- **Surface exploration** – small amounts of metal ores will dissolve in water and can be found in rivers. By testing the water at different places scientists can find the ore body, as shown in the diagram. The copper ore bodies at Panguna and Ok Tedi were found in this way.





Once scientists find an area where they think may contain an ore body, they take samples of rock and carry out tests to identify the minerals and the amount of metal present in the ore. This will help decide whether to build a mine and take out the ore from the ore body.

Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. Where are metals obtained?

   A. In the air
   B. In the water
   C. In the minerals
   D. In animals‘ bodies

2. What is the metal that is obtained from pyrolusite?

   A. Gold B. Copper
   C. Aluminium D. Manganese

3. Rocks containing metals are called _____.

   A. ores B. samples
   C. minerals D. compounds

4. One of the ways in which rocks containing metals come to the Earth‘s surface is by _____.

   A. wind B. erosion
   C. volcano D. weathering

5. Large amount of rocks containing metals is known as a/an _____ body.

   A. ore B. sample
   C. mineral D. compound

6. Places where volcanoes and earthquakes occur the most is known as

   A. ring of volcano.
   B. Lord of the ring.
   C. the ring of fire.
   D. ring of earthquake.

7. Geologists use maps and take photographs to find ore bodies. This method is called

   A. mapping.

   B. land survey.

   C. ariel survey.

   D. surface exploration.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 6.

Summary

You have come to the end of lesson 6. In this lesson you have learnt that:

- metals are chemical elements and they are substances that cannot be further broken down using any chemical means.
- metals are found in the minerals that occur naturally in rock.
- the rocks from which we obtain metals are called **ores** and a large amount is known as an **ore body**.
- in the countries around the Pacific Ocean, there are many volcanoes and earthquakes and this is sometimes known as the –ring of fire".
- volcanoes bring rocks to the Earth's surface.
- scientists use two methods to explore and find ore bodies:
  a. Ariel surveys
  b. Surface exploration

NOW DO PRACTICE EXERCISE 6 ON THE NEXT PAGE.

Practice Exercise 6

Answer the following questions:

1. What is a metal?

   _____

2. Where are metals obtained? _____

3. What is the "ring of fire"?

   _____

4. What do we call the rocks from which we obtain metals? _____

5. What do we call a large amount of rocks from which we obtain metals?

   _____

6. How do the rocks containing mineral ores come close to the surface?

   _____

7. What is the metal obtained from the mineral gibbsite? _____

8. Is PNG located along the ring of fire? _____

9. What are the two ways in which scientists explore to find ore bodies?

   (a) _____

   (b) _____

10. What method was used to find the copper ore bodies at Panguna and Ok Tedi? _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2.

Answers to Activity

1.	C	5.	A
2.	D	6.	C
3.	A	7.	C
4.	C		

Lesson 7: Extracting Metals

Welcome to Lesson 7 of Strand 4. In Lesson 6, we talked about sources of metals and discussed the two methods in which scientists use to search for metals. In this lesson you will learn about how metals are taken out from minerals.

Your Aims:

- define extraction
- discuss the process in extracting metals

The Process Of Extracting Metals

Metals are very useful. Ores are naturally occurring rocks that contain metals or metal compounds in sufficient amounts. For example, iron ore is used to make iron and steel. Copper is easily extracted, but rich ores in copper are becoming more difficult to find. Aluminium and titanium are metals with useful properties, but they are expensive to extract. Most everyday metals are mixtures called alloys.

Extraction simply means, taking out or separating minerals from rocks or separating out metals from ores.

Methods of extracting metals

The Earth's crust contains metals and metal compounds such as gold, iron oxide and aluminium oxide, but are often mixed with other substances. A metal ore is a rock containing a metal, or a metal compound, to make it economical for world demand.

The method used to extract metals from the ore depends on their reactivity. For example, reactive metals such as aluminium are extracted by **electrolysis**, while a less-reactive metal such as iron may be extracted by **reduction** with carbon or carbon monoxide.

For instance, iron is extracted from iron ore in a huge container called a blast furnace. Iron ores such as haematite contain iron oxide. The oxygen must be removed from the iron oxide to leave the iron behind. Reactions in which oxygen is removed are called **reduction reactions**.

Electrolysis – this is a method of extracting metals by passing electric current. through molten ore in order to cause the decomposition of the ore into its components.

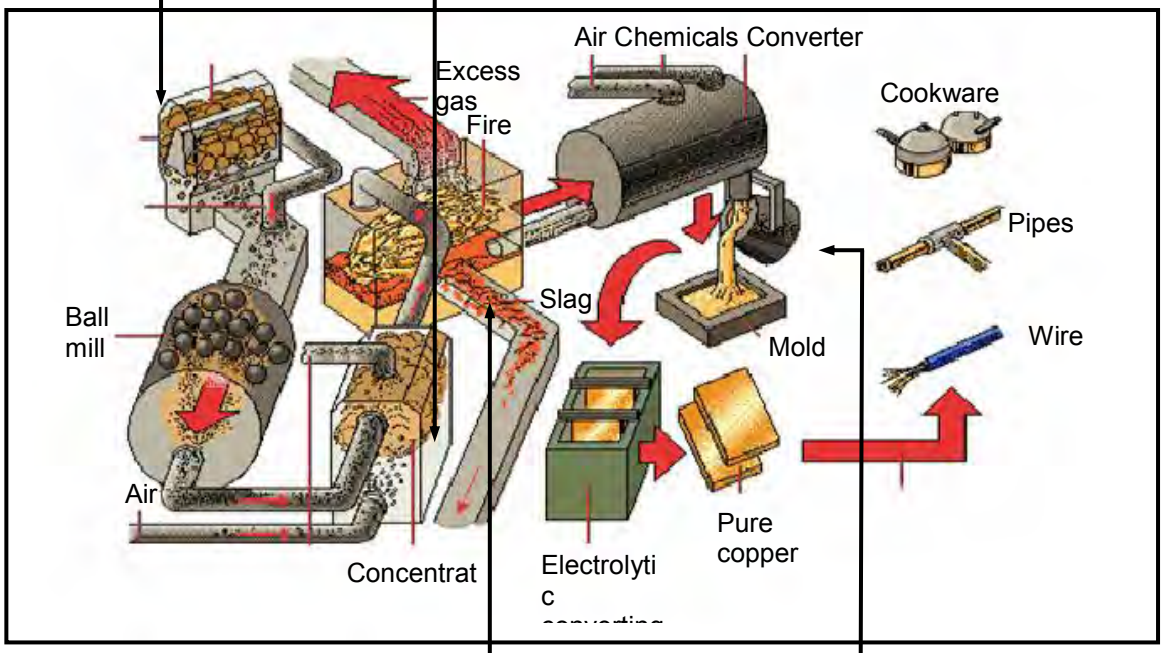
Reduction – this is a method of extracting metals by decreasing or removing oxygen from mineral ores by passing the ore through reducing agents such as carbon or carbon monoxide.

Extraction of Copper

Let us look at how copper is extracted from its ore.

1. The ore is crushed and milled before entering a flotation chamber, in which copper will concentrate at the top while unwanted fragments sink.

2. Next, the concentrate, now called charge, will enter a reverberatory furnace, where more impurities are removed.



3. During smelting, waste gases are removed, and the material forms a molten pool of copper and iron, called the matte, at the bottom of the furnace. The orange layer of impure metal on top of the matte is slag, which is drained off while the copper matte continues on to a converter.

4. Molten copper from the converter is cast and must be refined once more by electrolysis before it is ready for use in the manufacture of products such as electrical wire and utensils.

Simple Ways of Extracting Metals

A few metals are found naturally occurring in the environment. For example, gold is usually found in veins in rocks containing quartz. When the rock is weathered and eroded the sand and gravel formed is mixed with small pieces of gold and carried by rivers where it settles at the bottom.

This is called **alluvial gold**. Gold found in this way is known as a **placer deposit** and is usually the first to be discovered. We can separate the gold by a process called **panning**. There are about 4000 small-scale miners in Papua New Guinea earning their living by panning for gold.

Mining Safety

Mining is a dangerous job, and the safety of mineworkers is an important aspect of the industry. Surface mining is less dangerous than underground mining and metal mining is less dangerous than coal mining. A study shows that the dangers come from the nature of the operation.

Dust produced during mining operations is generally harmful to health and causes diseases of the lungs. Some fumes generated by incomplete dynamite explosions are extremely poisonous.

A tight and active safety program is usually in operation in every mine, where special care is taken to educate the miners in safety precautions and practices.

In March of 2013, Ok Tedi Mining Limited hosted a safety expo during the National Mining Safety Week in Tabubil where the managing director of the mine Mr Nigel Parker urged his employees to go out to Tabubil communities and let them know about safety and how the mine sees safety as a priority in its line of work.

Mining operations are considered one of the main sources of environmental degradation. Social awareness of this problem is of a global nature requiring government actions. The damage to the natural environment have led to numerous international agreements and laws directed toward the prevention of activities and events that may widely affect the environment.

Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. What is extraction?

   A. Degrading
   B. Separation
   C. Producing more
   D. Bringing together

2. What are the two methods of extracting metals from their ores?

   A. Crushing and mixing
   B. Electricity and mixtures
   C. Reduction and deduction
   D. Electrolysis and reduction

3. Extraction method in which oxygen is removed is called _____.

A. crushing B. reduction

C. deduction D. electrolysis

4. What is the name of the orange layer of impure metal found in one of the stages of extracting copper?

A. slag B. matte

C. matter D. slugger

5. The process called _____ can separate alluvial gold.

A. panning B. crushing

C. reduction D. electrolysis

6. Which type of mining is more dangerous?

A. Metal mining
B. Surface mining
C. Alluvial mining
D. Underground mining

7. _____ is usually found in veins in rocks containing quartz. What is the missing word?

A. gold B. silver

C. copper D. aluminium

8. One problem related to mining would be

A. low GDP.
B. poverty.
C. unemployment.
D. environment degradation.

9. Before any metal is extracted from its ore, the ore has to be _____

A. melted. B. cooled.

C. heated. D. crushed.

10. The dangerous gas that is given off in mines is called the _____ gas.

A. ethane
B. methane
C. carbon dioxide
D. carbon monoxide

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 7.

Summary

You have come to the end of lesson 7. In this lesson you have learnt that:

- ores are naturally occurring rocks that contain metal or metal compounds in sufficient amounts to make it worth extracting them.
- extraction simply means, taking out or separating minerals from rocks or separating out metals from minerals.
- reactive metals such as aluminium are extracted by electrolysis, while a less-reactive metal such as iron may be extracted by reduction with carbon or carbon monoxide.
- **electrolysis** – this is a method of extracting metals by passing electric current through molten ore in order to cause the decomposition of the ore into its components.
- **reduction** – this is a method of extracting metals by decreasing or removing oxygen from mineral ores by passing the ore through reducing agents such as carbon or carbon monoxide.

NOW DO PRACTICE EXERCISE 7 ON THE NEXT PAGE

Practice Exercise 7

Answer the following questions:

Part A – Short Answer Questions

1. What is extraction?
   _____

2. What are the two methods of extracting metals from mineral ores?

   (a) _____
   (b) _____

3. Which method is used when oxygen is removed from the mineral ore?
   _____

4. Which method uses electric current? _____

5. Which method is used when highly reactive metals are to be extracted?
   _____

6. What is alluvial gold? _____

7. How can alluvial gold be separated from sand and gravel? _____

8. Where was the first place deposit found in Papua New Guinea? _____

9. What problems are encountered in underground mines?
   _____

10. What problems are faced in metal mining? _____
    _____

Part B – True or False

11. Mining operations are considered one of the main sources of environmental problems. _____

12. The method used for extracting metals depends on the content of the metals.
    _____

13. A placer deposit is gold that is found in sand and gravel and is carried by rivers. _____

14. The molten copper and iron is called slag. _____

15. The rocks from which we obtain metals are called **ores**. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2

Answers to Activity

1. B
2. D
3. B
4. A
5. A
6. D
7. A
8. D
9. D
10. B

Lesson 8: Metals and Minerals in Papua New Guinea

Welcome to Lesson 8 of Strand 4. In Lesson 7, we talked about extracting metals and discussed the methods in which scientists use to extract metals from mineral ores. Metals extracted from mineral ores are important to us. Apart from other resources, mineral resources contribute a significant amount of income for our country's economic and social development. Mineral deposits are abundant in Papua New Guinea and exploration of minerals is still on going.

Your Aims:

- identify the metals and minerals found in Papua New Guinea
- discuss the minerals and metals found in PNG

The Importance Of Minerals In Papua New Guinea

Money earned from the mining of minerals is important to the economy of Papua New Guinea and minerals exploration and mining is controlled by the Department of Mining and Petroleum. The government is able to do this because although the people own the land, the minerals that are found twenty metres or more below the surface belong to the government or state.

Papua New Guinea is so fortunate to have a vast amount of mineral deposits, some of which are being mined and others are expected to be in operation in the near future. The government is able to earn a lot of money from the minerals that are sold overseas. In 2005 about half the money, which the government earned came from the mining of minerals. For this reason, the mining of minerals has become very important to the people of Papua New Guinea. The people who live on the land where the mines are situated are also paid some money called **royalties** but mines can also cause problems like pollution.

Minerals and Metals Found in Papua New Guinea

The identified land-based minerals in Papua New Guinea are gold, copper, silver cobalt, and nickel. These minerals including others such as lead and zinc are also found on the sea floor in the Bismarck sea. Off shore mining is the first of its kind in the world and Papua New Guinea is very fortunate to start a mine, which will involve extracting minerals under the sea.

Minerals and the metals extracted from the minerals in Papua New Guinea.

Mineral	Metal
niccolite	nickel
linnaerite	cobalt
pyrolusite	manganese
argentite	silver
molybdenite	molybdenum
gibbsite	aluminium
silver	silver
gold	gold
chalcopyrite	copper
galena	lead
smithsonite	zinc
chromite	chromium

Metals found in certain Provinces of PNG

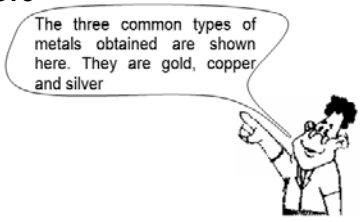
Province	Gold	Copper	Silver	Nickel / Cobalt	Platinum	Chromium	Iron
Western	√	√	√				
Morobe	√		√			√	
Madang				√		√	
Enga	√						
New Ireland	√	√	√				
Milne Bay	√					√	
Oro	√			√		√	
Central	√	√	√	√	√		√
Eastern Highlands	√						
Autonomous Region	√	√	√				
West Sepik	√					√	

The table above shows the main metals found in Papua New Guinea. From the information given in the table, you should notice that gold, copper and silver are the main types of metals found in PNG.

Gold Nugget

Copper Ore

Silver Ore



The introduction of nickel and cobalt has further diversified the mineral base of the country. Other minerals such as molybdenite, pyrolusite, smithsonite and chromite are being discovered lately and consequently, new mines are expected to be developed to extract these minerals. Finally, minerals are non-renewable resources and each mine has only a fixed lifetime.

Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. Minerals are important to PNG because

   A. they are the symbol of our origin.
   B. our ancestors brought them to our land.
   C. our economy depends very much on them.
   D. they are the only natural resources we have.

2. People own the land but the government owns the mineral resources which are _____ metres or more below the surface.

   A. 10 B. 20
   C. 30 D. 100

3. What do you call the money that is paid to the landowners when mining takes place?

   A. Royalty payment
   B. Loyalty payment
   C. Interest payment
   D. Dividend payment

4. Some of the metals found in PNG are

   A. gold, uranium and zinc.
   B. gold, silver and copper.
   C. gold, silver and uranium.
   D. gold, diamond and uranium.

5. The metal nickel is obtained from the mineral _____

   A. argentite. B. niccolite.
   C. linnaerite. D. pyrolusite.

6. The metal zinc is obtained from the mineral _____

A. galena. B. gibbsite.

C. smithsonite. D. chalcopyrite

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 8.

Summary

You have come to the end of lesson 8. In this lesson you have learnt that:

- money earned from the mining of minerals is important to the economy of Papua New Guinea.
- although the people own the land, the minerals that are found twenty metres or more below the surface belong to the government or state.
- Papua New Guinea is so fortunate to have a vast amount of mineral deposits, some of which are being mined and others are expected to be in operation in the near future.
- the people who live on the land where the mines are situated are also paid some money called **royalties** but mines can also cause problems like pollution.
- the identified land-based minerals in Papua New Guinea are gold, copper, silver cobalt and nickel.
- gold, copper, silver cobalt and nickel including others such as lead and zinc have also been identified in the sea floor in the Bismarck sea.
- off shore mining is a kind of mine, which will involve extracting minerals under the sea.

NOW DO PRACTICE EXERCISE 8 ON THE NEXT PAGE.

Practice Exercise 8

Answer the following questions:

1. Why are minerals so important to PNG?

   _____

   _____

2. Name three common minerals found in PNG.

   (a) _____

   (b) _____

   (c) _____

3. Name the metals extracted from the minerals gibbsite, chalcopyrite and argentite.

   (a) _____

   (b) _____

   (c) _____

4. Beside the metals given , write their chemical symbols:

   (a) gold : _____

   (b) silver : _____

   (c) copper : _____

   (d) molybdenum : _____

   (e) cobalt : _____

5. What are the minerals commonly found in the Morobe Province?

   _____

   _____

6. Which metal is extracted the most in PNG? _____

7. Which metal is extracted the least in PNG? _____

8. Name two metals, which will be mined in the sea floor in PNG waters.

   (a) _____

   (b) _____

9. Why is deep sea mining so important to PNG?

_____

_____

10. The people own most of the land in PNG. Why do you think the government owns all the minerals?

_____

_____

11. What do you call the money that is paid by the government to the landowners for mining on their land?

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2

Answers to Activity

1. C
2. B
3. A
4. B
5. B
6. C

Lesson 9: Mining Resources in Papua New Guinea

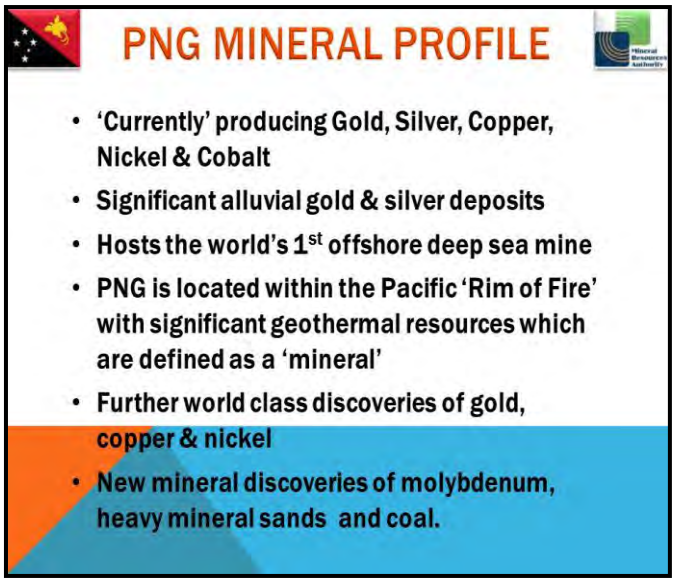
Welcome to Lesson 9 of Strand 4. In Lesson 8, we talked about metals and minerals found in Papua New Guinea. Mineral resources are very important to our country's economy as the money earned from minerals can be used to develop our country. For our country to extract and sell these minerals, we need mining companies to dig out mineral ores and process them to extract metals.

Your Aims:

- identify and describe the mines in Papua New Guinea
- explain the importance of mining in Papua New Guinea

Operating Mines In Papua New Guinea

PNG has eight (8) producing mines: Ok Tedi producing copper, gold and silver; Porgera, Simberi and Tolukuma producing gold and silver; and Lihir and Sinivit producing gold and silver. The Kainantu mine is under construction and maintenance while exploration continues. Hidden Valley (a gold-silver project owned by a Harmony Gold Ltd and Newcrest Mining Ltd joint venture); and the Ramu nickel cobalt project by Metallurgy Co of China (MCC) Ltd.



A summary of some of the operating mines is listed below.

Ok Tedi (gold-copper):
Ok Tedi is the largest of the mines in PNG. Ok Tedi started producing gold in 1984 and copper in 1987. Under the current mining programme, it is expected to close operations by 2013. However, mining may continue after 2013 thanks to a proposed new programme that might involve underground mining.

In 2008, Ok Tedi brought in a tunnel-boring machine to build a tunnel with the main objective of draining open-pit water. The other objective was to facilitate further exploration underground with a possibility of underground mining.

Porgera (gold):
Porgera mine is owned and operated by Barrick Gold Corp, the world's largest gold producer. The mine is located in the Porgera Valley, Enga Province. The mine started as an underground mine (operating between 1990 and 1997). It is now into stage five, involving both open pit and underground mining.

Porgera Mine Pit

Lihir (gold):
Lihir Gold Ltd. owns the Lihir gold mine, one of the largest in PNG. The mine is located on Lihir Island in New Ireland Province. The company employs more than 2,000 employees, and the facilities are being upgraded. The company uses geothermal power for 30% of its requirements, and the efforts to control tailings disposal into the sea, by using a curtain around the run off points, is proving successful.

Hidden Valley (gold):
The Morobe Mining joint venture (MMJV) is the new company that owns the Hidden Valley and Wafi project because of Newcrest Ltd joint venturing with Harmony Gold Ltd. Their operations are at Hidden Valley and Hamata, near Wau, in Morobe Province. The Hidden Valley project had completed all its construction work as of 2008 and 2009, and commenced production.

Ramu Nickel (cobalt):
The Ramu nickel/cobalt mine, owned and managed by Metallurgy Co of China (MCC), is set to diversify PNG's mineral exports, which traditionally have been gold, silver and copper. The mine's life span is around 20 years based on a projected annual production of 33,000 tonne of nickel and 3,280 tonne of cobalt. The project will also benefit from a chromite by-product, which the company plans to develop.

The Ramu nickel-cobalt project is operating. General access infrastructure, roads, bridges and wharves have been completed. Buildings and plants, for example processing plants, are currently under construction. The mine is designed to operate for twenty years after its first production

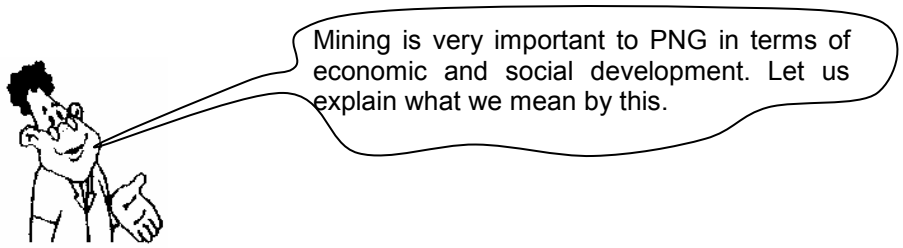
ALLUVIAL MINING

Alluvial mining is the oldest form of mining in Papua New Guinea. Before the Second World War, alluvial mining was a booming industry in the Wau and Bulolo areas of the Morobe Province. This part of the country still supports alluvial mining, with more than 6,000 miners employed.

Alluvial mining is now present in almost all of the 19 Provinces. The country has the potential to earn almost K600 million annually from alluvial mining, if this is invested in and managed properly. This activity also has the potential to improve the way of life for rural people.

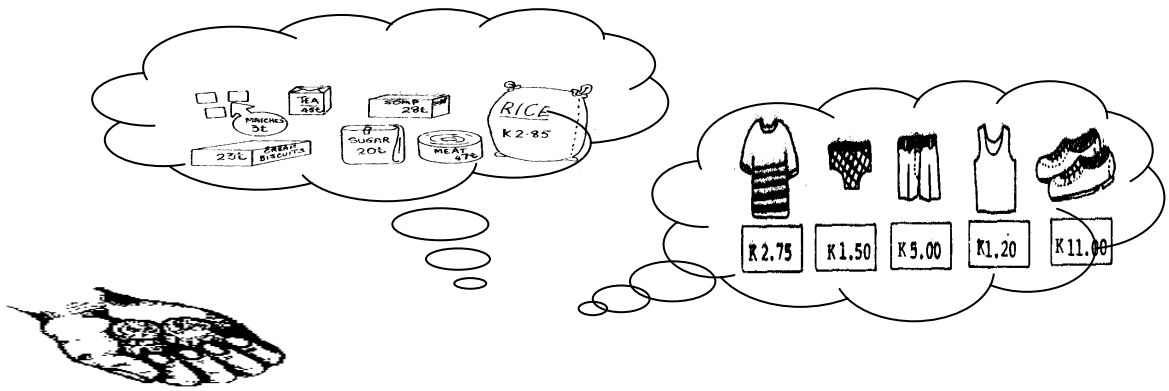
A small-scale mining branch is tasked to properly manage this industry. It is educating and co-ordinating training on good and effective practices on alluvial mining. This will create good commercial and environmental practices, and minimise or stop illegal gold exports.

The Importance of Mining in Papua New Guinea



Metals such as gold, copper, silver and others are very important to people all over the world. The need for these metals makes them become so valuable throughout the world and Papua New Guinea is so fortunate to have these mineral resources.

Mining operations are important to our country‘s development. Mining companies employ many people and they are paid very well. Landowners are also paid money in terms of royalties. The government also earns money by selling the minerals to other countries. From the income earned by the government, roads, bridges, schools, hospitals and other basic services can be built.



With the money we earn from mining, we can be able to purchase the basic needs and services to live. Money can be earned directly by being employed or indirectly from royalties.

Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. Which is the biggest mine in PNG?

   A. Ok Tedi
   B. Lihir Gold
   C. Porgera Gold
   D. Tolukuma Gold

2. The minerals that are mined at the largest mine in PNG are gold and _____.

   A. copper B. uranium
   C. diamond D. manganese

3. Which mine is yet to start operations?

   A. Lihir B. Sinivit
   C. Tolukuma D. Hidden valley

4. What type of mine is Lihir Gold mine?

   A. Alluvial
   B. Open pit
   C. Deep sea
   D. Underground

5. Which mine is involved in both open pit and underground mining?

   A. Ok Tedi
   B. Lihir Gold
   C. Porgera Gold
   D. Tolukuma Gold

6. In which mine do they use geothermal power?

   A. Ok Tedi
   B. Lihir Gold
   C. Misima Gold
   D. Porgera Gold

7. In which province is Hidden Valley?

   A. Enga
   B. Madang
   C. Morobe
   D. Milne Bay

8. Mining operations are important for our country because

   A. they help contribute to the greenhouse effect.
   B. it is our only symbol of wealth and cultural heritage.
   C. mining companies are very rich companies in the world.
   D. they help develop our country economically and socially.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 9.

Summary

You have come to the end of lesson 9. In this lesson you have learnt that:

- PNG has eight (8) producing mines: Ok Tedi producing copper, gold and silver; Porgera, Simberi and Tolukuma producing gold and silver; and Lihir and Sinivit producing gold and silver. Hidden Valley and the Ramu nickel cobalt project.
- Ok Tedi is the largest of the mines in PNG.
- Porgera mine started as an underground mine (operating between 1990 and 1997). It is now into stage five, involving both open pit and underground mining.
- alluvial mining is the oldest form of mining in Papua New Guinea. Before the Second World War, alluvial mining was a booming industry in the Wau and Bulolo areas of the Morobe Province.
- metals such as gold, copper, silver and others are very important to people all over the world.
- mining operations are important to our country‘s development.
- with the money we earn from mining, we can be able to purchase the basic needs and services to live. Money can be earned directly by being employed or indirectly from royalties.

NOW DO PRACTICE EXERCISE 9 ON THE NEXT PAGE

Practice Exercise 9

Answer the following questions:

1. Name the six operating mines in PNG.

   (a) _____

   (b) _____

   (c) _____

   (d) _____

   (e) _____

   (f) _____

2. (a) Which is the biggest mine in PNG? _____

   (b) Where is the biggest mine located? _____

   (c) Name the minerals that are mined. _____

3. What type of mine is the Porgera gold mine? _____

4. Where was alluvial mining a booming industry before the Second World War?
   _____

5. Which two mines started their operations just recently?
   _____

6. Why is mining important to Papua New Guinea?
   _____
   _____

7. Mining operations will exist for a long time. True or false? _____

8. Alluvial mining is present in all the provinces of PNG. True or false?
   _____

9. In which type of mining can you find Illegal and bad mining practices?
   _____

10. Money earned by the government can be used to provide services. Name at least five basic services that can be provided by the government.

    i. _____

    ii. _____

iii. _____

iv. _____

v. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2

Answers to Activity

1. A
2. A
3. D
4. B
5. C
6. B
7. C
8. D

Lesson 10: Mining and the Environment

Welcome to Lesson 10 of Strand 4. In your last lesson you learnt that money earned from mineral resources can be used to develop our country. Where there is development, there are always good and bad results. We cannot always expect to get good results from development. However, we want to get good results from it, so for bad results, we just need to minimise them.

Your Aims:

- enumerate the environmental problems associated with mining
- explain renewable and non-renewable resources

Environment Problems With Mining

There are a number of environmental issues associated with mining.

Environmental issues can include

- erosion
- formation of sinkholes
- loss of biodiversity
- contamination of soil, groundwater and surface water by chemicals from mining processes.
- in some cases, additional forest logging is done near mines to increase the available room for the storage of the created debris and soil.

Let us discuss some of the major problems associated with mining in detail.

Besides creating environmental damage, the contamination resulting from the leakage of chemicals also affect the health of the local population. Mining companies in some countries are required to follow environmental and rehabilitation codes, ensuring the area mined is returned to close to its original state. Some mining methods may have significant environmental and public health effects.

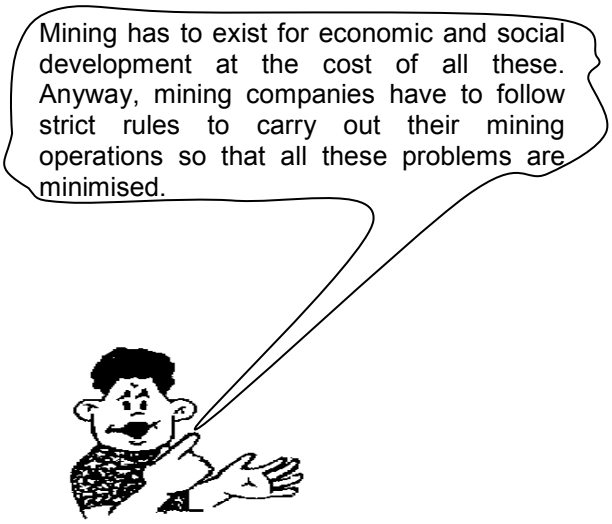
See picture of contaminated river system.

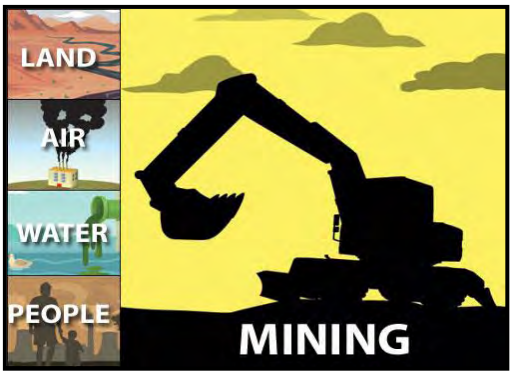
Erosion of exposed hillsides, mine dumps, tailings dams and resultant siltation of drainages, creeks and rivers can significantly affect the surrounding areas. A prime example being the giant Ok Tedi Mine in Papua New Guinea. For 16 years, the Ok Tedi copper mine, one of the world's largest, has discharged a steady flow of waste rock and mill tailings into the Ok Tedi River.

See picture of Ok Tedi River.

In areas of farming, it may disturb or destroy productive grazing and croplands.

In areas of wilderness, mining may cause the destruction and disturbance of ecosystems and habitats.





In urbanised environments, mining may produce noise pollution, air pollution, dust pollution and visual pollution.

Renewable and Non-renewable Resources

A natural resource is a renewable resource if natural processes replace it whereas for a non-renewable resource, natural processes cannot replace it.

Examples of Renewable Resources	Examples of Non-renewable Resources
• Solar radiation • Tides • Wind • Rivers • Water • Oxygen • Geothermal power • hydropower • Timber • Bio Energy	• Fossil fuels - coal - oil - natural gas • Minerals - copper - gold - Silver - nickel

Some renewable resources such as timber must be carefully managed to avoid exceeding the world's capacity to replenish them.

Below are pictures of some renewable resources:

Geothermal power is the power extracted from the heat stored in the earth. Geothermal power is cost effective, reliable, sustainable, and environmentally friendly but has been limited to areas near tectonic plate boundaries.

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, wind mills for mechanical power, wind pumps for pumping water or drainage, or sails to propel ships.

A typical example of a non-renewable resource

Minerals are non-renewable resources and cannot be replaced once they are mined.

Activity: Now test yourself by doing this activity.

Multiple Choice Questions

Circle the correct letter.

1. One of the main environmental problems caused by mining is

   A. diseases.
   B. pest problems.
   C. water pollution.
   C. over-planting trees.

2. Contamination of soil, surface water and ground water comes from

   A. dust and erosion.
   B. exposed hillsides.
   C. siltation of drainages.
   D. chemicals from mines.

3. How can farm areas be affected by mining?

   A. More cattle are bought by farmers
   B. Destroy productive grazing and croplands.
   C. Produces dust and noise disturbing the farm animals.
   D. Trees are cut down preventing shade for farm animals.

4. How can the forest be affected by mining?

   A. Ecosystems and habitats are destroyed.
   B. More trees and other plants are planted.
   C. Contributes to the logging industry by cutting trees.
   D. Soil fertility is destroyed preventing plants from growing again.

5. A renewable resource is

   A. a resource that is new.
   B. a resource that looks new all the time.
   C. a resource that can be renewed or replaced.
   D. resource that needs to be renewed all the time.

6. An example of a renewable resource would be _____

   A. coal. B. copper.
   C. timber. D. natural gas.

7. In urban areas, mining can produce

   A. poverty.
   B. dust pollution.
   C. lack of employment.
   D. lack of infrastructure.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 10.

Summary

You have come to the end of lesson 10. In this lesson you have learnt that:

- environmental issues can include erosion, formation of sinkholes, loss of biodiversity, contamination of soil, groundwater and surface water by chemicals from mining processes and in some cases, additional forest logging is done in the vicinity of mines to increase the available room for the storage of the created debris and soil.
- the contaminations resulting from leakage of chemicals also affect the health of the local population.
- erosion of exposed hillsides, mine dumps, tailings dams and resultant siltation of drainages, creeks and rivers can significantly affect the surrounding areas.
- in areas of farming, it may disturb or destroy productive grazing and croplands.
- a natural resource is a renewable resource if natural processes replace it whereas for a non-renewable resource, natural processes cannot replace them.

NOW DO PRACTICE EXERCISE 10 ON THE NEXT PAGE.

Practice Exercise 10

Answer the following questions:

1. Name five environmental problems caused by mining.

   (a) _____

   (b) _____

   (c) _____

   (d) _____

   (e) _____

2. What was the environmental issue that affected Ok Tedi mine?

   _____

   _____

3. How are the rivers affected by mining?

   _____

4. How are the forests affected by mining?

   _____

5. How are the people affected by mining?

   _____

6. If a mine was close to a town, what would be some of the problems faced by the community?

   _____

   _____

7. Define the following:

   (a) Renewable resources

   _____

   (b) Non-renewable resources

   _____

8. Give two examples of a renewable resource.

   (a) _____

   (b) _____

9. Give two examples of a non-renewable resource

   (a) _____

   (b) _____

10. Give an example of a renewable resource that could run out if we are not careful with how we harvest it. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2.

Answers to Activity

1. C
2. D
3. B
4. A
5. C
6. C
7. B

REVIEW OF SUB STRAND 2: METALS FROM MINERALS

Revise all the lessons in this Sub-strand and then do **ASSIGNMENT4.**
Here are the main points to help you revise.

Lesson 6: Sources of Metals

- Metals are chemical elements and they are substances that cannot be broken into simpler substances that are more elementary by ordinary chemical means.
- Metals are found in the minerals that occur naturally in rocks.
- The rocks from which we obtain metals are called **ores** and a large amount is known as an **ore body**.
- In the countries around the Pacific Ocean, there are many volcanoes and earthquakes and this is sometimes known as the –ring of fire".
- Volcanoes and Earthquakes bring rocks to the Earth's surface.
- Scientists use two methods to explore and find ore bodies:
  (a) Ariel surveys
  (b) Surface exploration

Lesson 7: Extracting Metals

- Extraction is the process of separating minerals from rocks or separating out metals from minerals.
- **Electrolysis –** this is a method of extracting metals by passing electric current through a molten ore in order to induce decomposition of the ore into its components.
- **Reduction** – this is a method of extracting metals by decreasing or removing oxygen from mineral ores by passing the ore through reducing agents such as carbon or carbon monoxide.
- Sometimes gold can be extracted from sand and gravel by the panning method. Gold extracted using panning is called **alluvial gold**.
- Mining is dangerous and the safety of mine workers is very important.
- The dangers of extracting metals come from the nature of the operation.
- Safety programs are usually in operation in every mine; where special care is taken to educate the miners in safety precautions and practices.

Lesson 8: Metals and Minerals in Papua New Guinea

- The mining of minerals is very important to the economy of Papua New Guinea.
- Although the people own the land, the minerals that are found twenty metres or more below the surface belong to the government or state.
- Papua New Guinea is rich with a vast amount of mineral deposits, some of which are being mined and others are expected to be in operation in the near future.
- The people who live on the land where the mines are situated are also paid some money called **royalties**.
- The identified land-based minerals in Papua New Guinea are gold, copper, silver cobalt and nickel.

- Gold, copper, silver cobalt and nickel including others such as lead and zinc are also identified in the sea floor in the Bismarck sea.
- Off shore mining is the first of its kind in the world and Papua New Guinea is very fortunate to start a mine, which will involve extracting minerals under the sea.

Lesson 9: Mining Resources in Papua New Guinea

- There are eight (8) mines in PNG which are in full operation. Ok Tedi producing copper, gold and silver; Porgera, Simberi and Tolukuma producing gold and silver; and Lihir and Sinivit producing gold and silver. Hidden Valley and the Ramu nickel cobalt project.
- The largest of the mines in PNG is the Ok Tedi Copper Mine.
- The Porgera mine started as an underground mine. It is now involving both open pit and underground mining.
- Alluvial mining is the oldest form of mining in Papua New Guinea. Alluvial mining was a booming industry in the Wau and Bulolo areas of the Morobe Province.
- Metals such as gold, copper, silver and others are very important to people all over the world.
- Mining operations are important to our country‘s economic and social development.

Lesson 10: Mining and the Environment

- Environmental issues can include erosion, formation of sinkholes, loss of biodiversity, contamination of soil, groundwater and surface water by chemicals from mining processes and in some cases, additional forest logging is done in the areas near the mines to increase the available room for the storage of the created debris and soil.
- The contaminations resulting from leakage of chemicals also affect the health of the local population.
- Erosion of exposed hillsides, mine dumps, tailings dams and resultant siltation of drainages, creeks and rivers can significantly affect the surrounding areas.
- In areas of farming, it may disturb or destroy productive grazing and croplands.
- A natural resource is a renewable resource if natural processes can replace it whereas a non-renewable resource, natural processes cannot replace it.

REVISE WELL AND THEN DO SUB STRAND TEST 2 IN YOUR ASSIGNMENT 4.

Answers to Practice Exercises 6- 10

Practice Exercise 6

1. **A metal is a chemical element and they are substances that cannot be broken into simpler substances th by ordinary chemical means.**
2. **Metals are obtained from minerals that occur naturally in rocks.**
3. **The "Ring of fire" is the region where there are many volcanoes and earthquakes.**
4. **The rocks from which we obtain metals are called ores.**
5. **A large amount of rocks from which we obtain metals are called ore body.**
6. **Rocks containing mineral ores come close to the surface through cracks called fissures, earthquakes and volcanoes.**
7. **Aluminium**
8. **PNG is definitely located along the ring of fire.**
9. **(a) Ariel survey**

   (b) Surface exploration
10. **Surface exploration was used to find copper bodies at Panguna and Ok Tedi.**

Practice Exercise 7

1. **Extraction is the process of separating minerals from rocks or separating out metals from minerals.**
2. **(a) Electrolysis**

   (b) Reduction
3. **Reduction**
4. **Electrolysis**
5. **Electrolysis**
6. **Alluvial gold is gold that is mixed with sand and gravel.**
7. **By panning**
8. **Wau and Bulolo**

9. Problems in underground mines are usually rock and roof falls, flooding, and inadequate ventilation.

10. The use of explosives

Part B True or False

11. True

12. False

13. True

14. False

15. True

Practice Exercise 8

1. Minerals are important to PNG because it generates income and employment for the country.

2. (a) Gold

(b) Silver

(c) Copper

3. (a) Aluminium

(b) Copper

(c) Silver

4. (a) gold: Au

(b) silver: Ag

(c) copper: Cu

(d) molybdenum: Mo

(e) cobalt: Co

5. Gold, silver and chromite

6. Gold

7. Iron

8. (a) Lead

(b) Zinc

9. Sea mining is important to PNG because it is the first of its kind in the world and PNG will start such a mine.

10. The minerals that are found 20 metres or more below the surface belong to the government.

11. Royalty

Practice Exercise 9

1. (a) Ok Tedi Mine

(b) Porgera Gold Mine

(c) Simberi

(d) Tolukuma

(e) Lihir

(f) Sinivit

2. (a) Ok Tedi Mine

(b) Western Province

(c) Gold and Copper

3. Open pit and underground mine

4. Wau and Bulolo in the Morobe Province

5. Hidden Valley and Ramu Nickel/Cobalt mines

6. Mining is important to PNG because the industry generates income and employment to the country.

7. False

8. True

9. Alluvial mining is where you find illegal and bad mining practices.

10. (a) Hospitals

(b) Schools

(c) Roads

(d) Bridges

(e) Airstrips

Practice Exercise 10

1. (a) Erosion

(b) Formation of sinkholes

(c) Loss of biodiversity

(d) Contamination of soil, groundwater and surface water by chemicals

(e) Forest logging to increase available space for storage of debris and soil

2. The environmental issue that affected Ok Tedi was the erosion of exposed hillsides and resultant siltation of drainages, creeks and rivers.

3. Rivers are affected by the leakage of chemicals into the river system.

4. In some cases, forest is cut down to create additional storage spaces for debris or soil.

5. People can be affected by mining if their hunting grounds and gardens are used for mining purposes.

6. If a mine is close to a town, some of the problems that the community would face are; noise pollution, air pollution, dust pollution and visual pollution.

7. a. Renewable resources: Natural resources that can be replaced by natural processes.

b. Non-renewable resources: Natural resources that cannot be replaced by natural processes.

8. (a) Wind

(b) Solar radiation

9. (a) Fossil fuel such as oil

(b) Minerals such as gold

10. An example of a renewable resource that can run out if we are not careful is timber.

SUB-STRAND 3

SPACE INVENTIONS

In this sub-strand you will learn about:

- **satellites and their uses**
- **space shuttles**
- **space station**
- **the function of a telescope**
- **the first people who ventured into space**

SUB-STRAND 3: SPACE INVENTIONS

Introduction

When you look up to the sky at night, do you often wonder how many stars there are? Do you try to count them? Do you even try to see where certain stars are located? Our forefathers used to use the sky and the stars to tell the time for fishing or hunting or even tell the location of favourite fishing spots. This practice is fading away quickly and in many villages it is no longer practiced.

Today, scientists have invented many ways to study the heavenly bodies and doing search so people can go, live and work in space. And the reasons for people to invent such equipment and why they venture into space also.

You now know that scientist in developed countries have been sending people into space. Why?

Early Telescopes

In this lesson you will look at

- Telescopes
- Satellites
- Space shuttles
- Space stations
- The first human being in space

Lesson 11: Satellites

Welcome to Lesson 11 of Strand 4. In this lesson, you will study and learn about satellites in detail. A better understanding of satellites has been useful to people and also the discovery that the heavenly bodies have been widely used to measure time while the other man-made satellites have greatly helped man-kind with an important and valuable components of development, communication.

Your Aims:

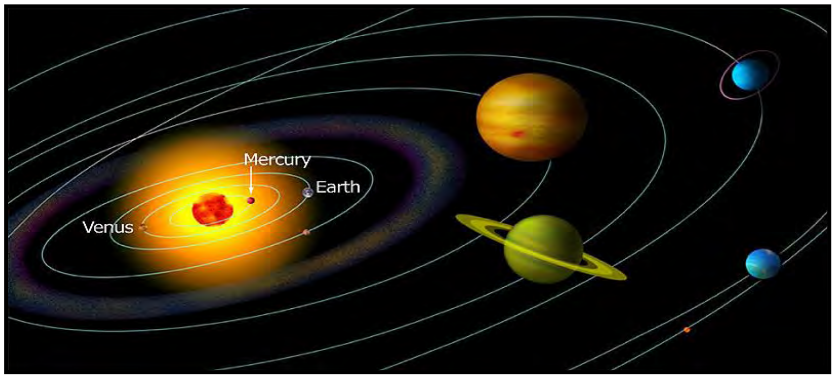
- define satellites
- identify satellites
- discuss the uses of satellites

What Is A Satellite?

A satellite is an object that orbits or revolves around another object.

There are two types of satellites and they are;

1. **Natural Satellites** – these are heavenly bodies that include the planets, asteroids, comets, moons and meteors. Our planet, the Earth is a member of a family of satellites, which orbit our star, the Sun. Natural satellites can be, moons of different planets too.



Planet Earth and the other planets orbiting the Sun

Pluto is the furthest satellite that orbits the sun but now it is not considered to be a planet due to its tiny size. The Moon is the Earth‘s natural satellite.

2. **Artificial Satellites** – more than 4000 artificial (man-made) satellites have been launched into orbit around the Earth. About two-thirds of these have been for military purposes. Artificial satellites behave in the same way as natural satellites. The further they are away from the Earth‘s surface, the longer they take to make one complete orbit.

Both types of satellites are held in orbit around the Earth by gravitational forces. Because their orbits are smaller, satellites close to the Earth take less time to go around it than those further away.

Artificial satellites can be further divided into two general types: Geostationary Satellites and Other satellites.

(a) **Geostationary Satellites** are the ones which orbit the equator of the Earth at the height of 36 000 kilometres, making one complete orbit every twenty-four hours. This type of satellites can see about one-third of the Earth's surface.

At a height of 160 km, one orbit takes about one and a half (1½) hours

(b) **Other satellites** – there are a variety of satellites in orbit nearer the Earth, in less than twenty-four hours. At about 1000 kilometres above the Earth, there are many satellites. Some look away from the Earth, using telescopes to study the universe. Unmanned lunar, solar and interplanetary satellites and probes have been sent to the moon.

Other satellites are put into orbit for other special purposes:

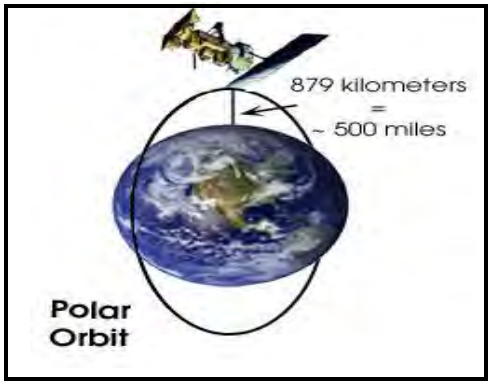
(i) **Weather Satellites** – Some weather satellites are positioned far above the Earth's surface to give an overall view of cloud formation and movements. Others orbit closer to the Earth to give more detailed information on clouds and temperatures.

(ii) **Land Satellites** – It is in close orbit around the Earth and has an orbit time of one and three-quarter hours. As it passes overhead, this satellite views the strip of the Earth's surface. The information collected is used to study such things as water pollution, the effect of industry on the environment and to distinguish different types of crops. Land sort images are also used for making maps.

(iii) **Communication Satellites** – These satellites are used to transmit telephone calls, television broadcasts and other electronic information from one country to another. Global positioning satellites transmit data so that ships and aircraft can locate their positions to within One hundred (100) metres. Both are in geostationary orbits.

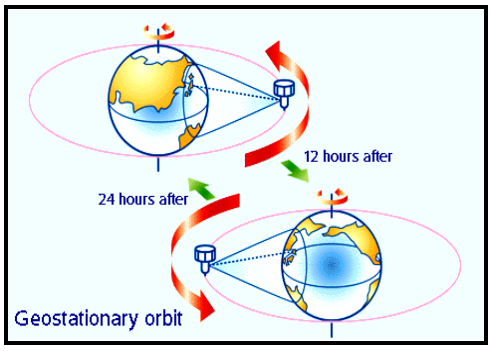
Two types of satellite orbits are particularly useful and they are:

1. **Polar Orbits**

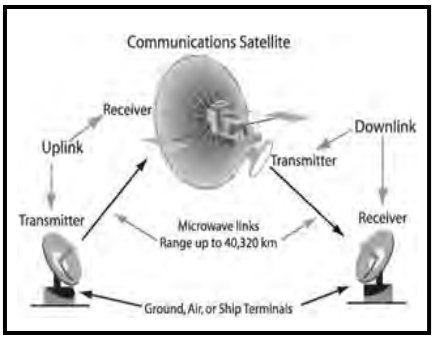


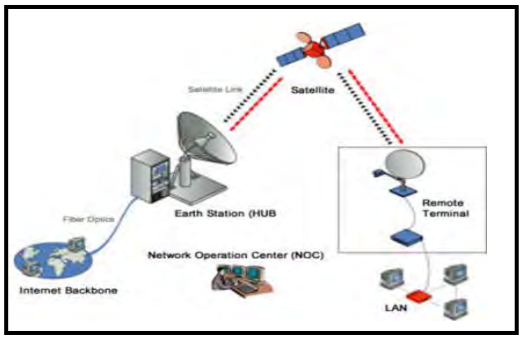
Polar Orbits
The satellite is in orbit over the Earth's poles. It travels from north to south around one side of the Earth, and then back north round the other side. However, while this is happening, the Earth is spinning beneath the satellite. The result is that the satellite appears to travel a spiral track over the Earth's surface.

2. Geostationary Orbits



Geostationary orbit
The satellite travels eastwards in an orbit directly above the equator. Launched to a height of 36 000 km, it takes one day to make one complete orbit. However, the Earth is spinning beneath the satellite in the same direction. The result is that each satellite appears to remain stationery above a point on the equator.





Communication Satellites

Activity: **Now test yourself by doing this activity.**

1. Define these terms.
   a) Communication: _____
   b) Satellite: _____
   c) Equator: _____
   d) Polar Orbits: _____

2. Complete these statements
   a) Geostationary satellites are used for _____ and _____.
   b) Navigation Satellites provide _____ and _____ with an _____ means of locating their _____.

3. The _____ consists of _____ planets, together with their moons, the _____, meteors and _____.

REMEMBER: The further away a satellite is from its parent, the longer it takes to orbit it.

CHECK YOUR ANSWERS. ANSWERS ARE AT THE END OF LESSON 11.

Summary

You have come to the end of lesson 11. In this lesson you have learnt that:

- a satellite is an object that orbits or revolves around another object.
- most satellites are put into orbit for special purposes for transmitting information on weather patterns, radio signals and other electronic information from one country to another.
- there are two types of satellites and they are natural and artificial satellites.
- artificial satellites can be further divided into two general types: Geostationary satellites and other satellites.

NOW DO PRACTICE EXERCISE 11 ON THE NEXT PAGE.

Practice Exercise 11

Answer the following questions:

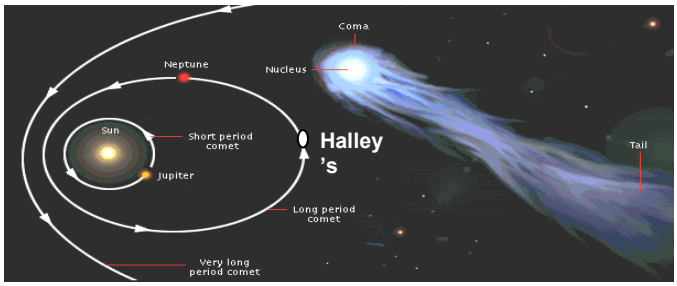
PART A. Multiple Choice

Circle the correct letter.

1. The Solar System has only _____ Sun.

   A. 1 B. 2 C. 3

   The diagram shows the orbit of Halley's Comet.



2. From the diagram, we can say that

   A. Halley's Comet orbits the Sun and all the planets.
   B. Halley's Comet only orbits Neptune, Saturn and Jupiter.
   C. Halley's Comet orbits Neptune, Uranus, Saturn and the Sun.

3. Geostationary Satellites are only used for _____ purposes.

   A. Spying and destruction
   B. Space probes and other
   C. communications, weather predictions and military

4. The instrument used to study star and other objects in the Universe is called

   A. Microscope B. Telescope C. Horoscope

PART B. True or False

Write True or False for these statements.

1. The study of Heavenly bodies is called astronomy. _____
2. Our planet Earth is a member of different stars. _____
3. The Moon is an artificial satellite. _____

Part C. Short Answer

1. How are satellites held in orbit around the Earth?

   _____
   _____

2. Why does a satellite light fade after travelling across the sky for a few minutes?

   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Answers to Activity

1. (a) Communication - **using of language or other signals to exchange information or ideas.**
   (b) Satellite - **an object which orbits another object.**
   (c) Equator - **an imaginary line running across at the centre of the Earth.**
   (d) Polar Orbit - **the orbit that is taking place over the Earth's poles.**

2. a) Geostationary satellites are used for **communication**, **weather predictions** and **military purposes**.
   b) Navigation satellites provide **shipping** and **aircraft** with an **accurate** means of locating their **positions**.

3. The **Solar** system consists of **nine** planets together with their moons, the **asteroids**, meteors and **comets**.

Lesson 12: Space Shuttles

Welcome to Lesson 12 of Strand 4. In the previous lesson, you learnt about satellites. You also learnt that the development of satellites has contributed greatly towards communication and discoveries of other heavenly bodies in the solar system and the universe as a whole. In this lesson, you will look at Space Shuttles. The basic principles of satellites were widely used when the space shuttle program began.

Your Aims:

- define and discuss space shuttle
- explain the uses of space shuttle

What Is A Space Shuttle?

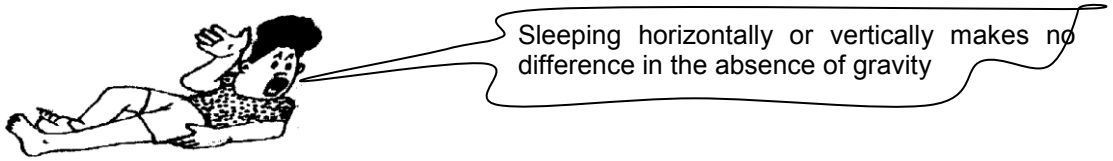
Space shuttle is a space transport system designed to go into orbit around the Earth.

The shuttle is launched into space by its own giant engines and two booster rockets. The shuttle can then remain in orbit around the Earth for up to thirty days and return to the Earth. Both the shuttle and its booster rockets can be used repeatedly. The shuttle can be used to carry up to 30 tonnes of cargo into low Earth orbit. After orbiting Earth, the space shuttle returns to Earth and lands like an aeroplane.

What does the space shuttle consists of?

A space shuttle consists of three major parts. The orbiter is the large, white space plane. It is the only part of the shuttle that goes into orbit. The orbitor is where the crew members live and work. It also has a payload bay for taking cargo into orbit. The second part of the shuttle is the external tank. This large, orange fuel tank connects to the bottom of the orbiter for launch. The third part is really two pieces. Two white solid rocket boosters send out most of the thrust (force) for the first two minutes of a shuttle launch. The solid rocket boosters are long and thin.

Anything used before to the late 70‘s and beyond would be considered a rocket and anything since would be categorised as a —space shuttle”.



What goes on inside the shuttle?

- Astronauts can wear ordinary clothing.
- The temperature, pressure and oxygen levels are regulated to a comfortable level.
- Fans circulate the cabin air, which passes through charcoal and lithium hydroxide to remove odour and carbon dioxide.
- Excess moisture is removed and humidity regulated.
- Food and beverage is preserved by dehydration.
- Clothes are sealed in plastic bags after being used
- Garbage and food containers are sealed in plastic bags.
- In the toilet, air moves through the unit carrying wastes into a container or plastic bag.
- Astronauts take sponge baths.
- Shaving cream and a razor is used to shave instead of electric razor.

Uses of Space Shuttles

The space shuttle is used for many purposes. Their tasks may include any of the following:

1. Checking and repairing unmanned satellites in low Earth orbit.
2. Carrying spacecraft into the Earth‘s orbit. These could then use their own power to put themselves in higher orbit around the Earth or to take off on interplanetary voyages.
3. Carry unmanned satellites into space, install, repair and even return them to Earth, such as the space telescopes.
4. Carry a complete laboratory, such as Spacelab, into the Earth‘s orbit. Spacelab provides the opportunity for scientists and non-scientists to work in space.
5. Carry the building materials for power stations, factories and space settlements into the Earth‘s orbit.

From April 1981 to January 1986, there have been twenty-four successful flights involving four different shuttles. During these flights, satellites have been put into orbit, and some have been repaired and others brought back to the Earth.

Unfortunately, in January 1986 the space shuttle, Challenger, exploded as it was taking off, killing all seven people on board.

Challenger

taking off

exploding in air

Activity: **Now test yourself by doing this activity.**

Follow given instructions to do the given activity.

1. Complete the blank spaces using correct words and phrases.

   a) Space shuttles are designed to go into _____ around the Earth.
   b) A space shuttle has a _____ and two _____ rockets.
   c) A (i) _____ shuttle can carry (ii) _____ and (iii) _____ for power stations. (iv) _____ and space settlements into the Earth's (v) _____.

2. Define the following terms:

   (a) Space Shuttle : _____
   (b) Launch : _____
   (c) Unmanned : _____
   (d) Laboratory : _____
   (e) Astronaut : _____

3. Lunar module is a part of a spacecraft circling the moon that can be detached to make a journey to the moon's surface and back. Why are they sent to the moon's surface?

   _____
   _____

4. Explain why astronauts wear over-sized clothes to walk in space.

_____
_____
_____
_____

REMEMBER: Space shuttle disasters have shown that there are many problems still to be solved before space travel can be safe and reliable.

CHECK YOUR ANSWER. ANSWERS ARE AT THE END OF LESSON 12.

Summary

You have come to the end of lesson 12. In this lesson you have learnt that:

- when men travelled to the moon, rockets were used. Today space shuttles carry people into space.
- a space shuttle is made of a reusable white space plane called an orbiter, two rockets and an external fuel tank.
- space shuttle is a space transport system designed to go into orbit around the Earth.
- the space shuttle is used for many purposes.
- from April 1981 to January 1986, there have been twenty-four successful flights involving four different shuttles.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE.

Practice Exercise 12

Answer the following questions:

PART A Multiple Choice.

Circle the correct letter.

Refer to the table to answer Question 1- 6.

LANDMARK SHUTTLE MISSIONS			
DATE	**MISSION**	**ORBITER**	**EVENT**
1981	STS – 1	Columbia	First shuttle mission
1995	STS – 71	Atlantis	First link-up with Russia‘s space station Mir
1998	STS - 88	Endeavour	First International Space Station mission

1. What is the name of the orbiter that linked-up with Russian‘s space Station?

   A. Orbitor B. Columbia

   C. Atlantis D. Endeavour

2. What is the year mentioned?

   A. 1981 B. 1995

   C. 1996 D. 1998

3. What is the name of the mission of 1995?

   A. STS – 88 B. STS – 71

   C. STS – 61 D. STS – 1

4. The country that sent the space shuttle into space is

   A. Russia
   B. Australia
   C. South America
   D. North America

5. A space shuttle lands like a/ an _____.

A. orbitor B. rocket

C. satellite D. aeroplane

6. What happened to the space shuttle challenger?

A. landed as it was taking off
B. expired as it was taking off
C. crashed as it was taking off
D. exploded as it was taking off

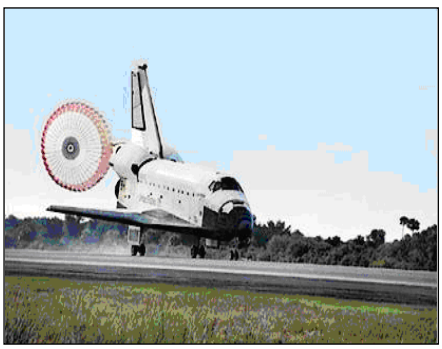
PART B Use your comprehension skills to do these tasks.

Read the passage about the Space Shuttle and then answer the given questions. (Question 7 – 10).

The Space Shuttle

When men travelled to the Moon for the Apollo missions, rockets were used. Today space shuttles carry people into space. A space shuttle is made of a reusable space plane called an orbiter, two rockets and an external fuel tank. The fuel in the external tank and the rockets is burnt to produce 3000 tonnes of thrust for lift-off.

After two minutes, the shuttle reaches an altitude of 48 kilometres and the rockets are burnt out. They detach from the orbiter, parachute back to Earth and are collected for reuse. When the orbiter reaches its correct orbit, the external tank is jettisoned, and burns up in the atmosphere. The orbiter continues to orbit the Earth for the duration of the mission (usually four to seven days).



When rockets were used for the Apollo missions, the re-entry into the Earth's atmosphere was hazardous. The module carrying the astronauts fell through the atmosphere like a meteorite, protected from burning up by heat shields. It was slowed down by parachutes and then landed in the ocean, where the astronauts were then collected by boat.

The space shuttle lands on one of the world's longest runways at the Kennedy Space Centre. The shuttle orbiter relies on a high-speed glide to bring it in to landing. It must be a perfect landing because, unlike aeroplanes, it cannot circle and try again. All the propulsion equipment has been lost. The runway is covered with grooves to provide a more skid-resistant surface and is slightly sloped to get rid of water. The orbiter is protected from heat on re-entry by tiles, gap fillers and insulation blankets. This insulation also protects the orbiter and its occupants from the cold in space.

7. What are the three important parts of a space shuttle?

a) _____
b) _____
c) _____

8. Before the invention of space shuttles, what were used?
_____

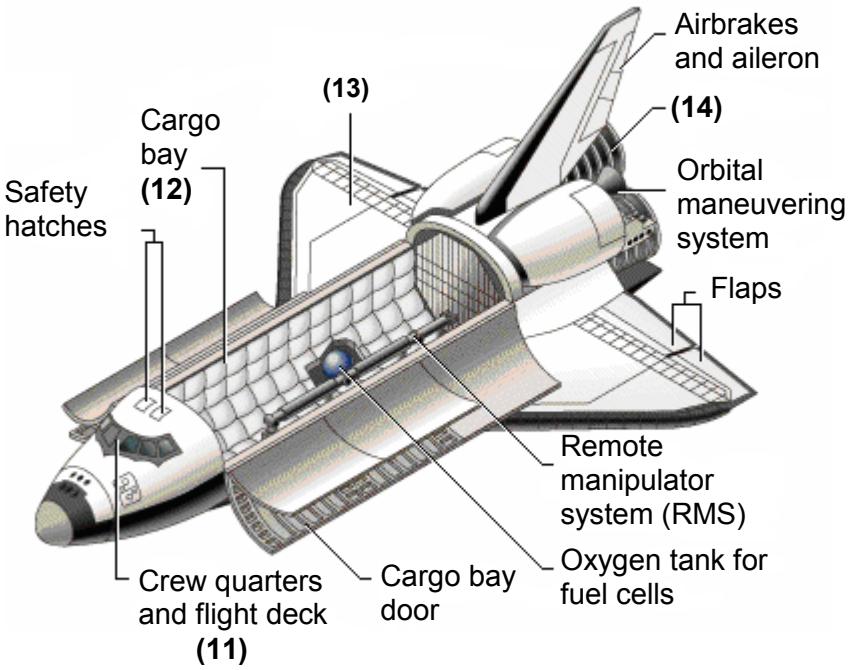
9. For how long and how high do all the rockets burn out?
For _____ minutes and _____ kilometres high.

10. What are the two tasks of an insulation blanket?

a) _____
b) _____

COMPREHENSION

Study the picture of this space shuttle orbiter and complete the table that follows



NO.	PART	FUNCTION
a	Crew Compartment	(11)
b	Payload Bay	(12)
c	(13)	Glide through the Earth's Atmosphere
d	(14)	For lift off and burning liquid hydrogen and liquid oxygen.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Answers to Activity

1. (a) orbit

   (b) giant and rockets

   (c) (i) space

   (ii) building

   (iii) blocks

   (iv) factories

   (v) orbit

2. (a) space shuttle - spacecraft designed for repeated use between the Earth and the space stations.

   (b) Launch - the process of putting together and into motion a spacecraft.

   (c) Unmanned - operated automatically or without a crew.

   (d) Laboratory - room or building used for scientific research, experiment and testing.

   (e) Astronaut - a person who travels to outer space.

3. (a) To collect more information from the surface of the moon.

   (b) To protect themselves from radiation and other harmful materials from outer space.

Lesson 13: Space Stations

Welcome to Lesson 13 of Strand 4. Previously, you learnt that, space shuttles carry scientists into space. The space shuttle is called an Orbiter, which has an external fuel tank that burns to produce three thousand tonnes of thrusts to reach an altitude of 48 kilometres. In this lesson you will learn about space stations.

Your Aims:

- define space stations
- discuss the first station and the International Space Stations (ISS)

What Is A Space Station?

A space station is a large spacecraft that is built on Earth and launched into orbit as a complete unit. They are used to carry out research. Astronauts have examined the behaviour of materials and living things in a micro gravity environment and how space flight affects the human body.

Conditions inside a space station must be carefully controlled. The important conditions are:

- Solar panels supplying power.
- Maintaining a comfortable environment.
- Recycling air and water.

Skylab in Orbit

The United States launched its first space station, Skylab, in 1973. One of its solar panels was ripped off at launch, damaging the heat shield over the crew‘s quarters. The first crew managed to repair the damage and stayed in orbit for 28 days. Later crews spent 56 and then 84 days on board.

First Space Stations

How are Space Stations built? Early space stations such as the Soviet‘s Salyut 1 (1971) and the United States‘ Skylab (1973) were built on Earth and launched into orbit as complete units. Europe‘s Spacelab was launched in 1983. It was carried in a shuttle into space.

The Soviet Union launched the world's first space station, Salyut 1, in 1971 - a decade after launching the first human into space. The United States sent its first space station, the larger Skylab, into orbit in 1973 and it hosted three crews before it was abandoned in 1974. Russia continued to focus on long-duration space missions and in 1986 launched the first modules of the Mir space station.

In 1998, the first two modules of the International Space Station were launched and joined together in orbit. Other modules soon followed and the first crew arrived in 2000.

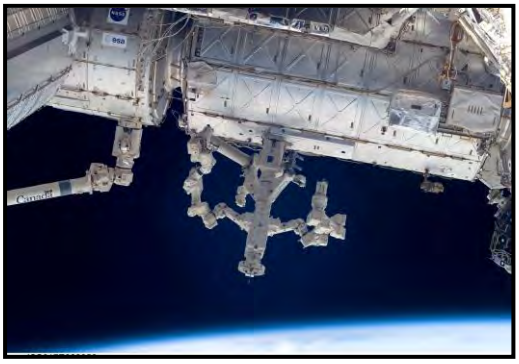
Larger space stations, such as MIR (was launched in 1986) were assembled in orbit from modules or sections ferried up from Earth when they were ready.

Mission to MIR, 1995

In February 1996, Russia launched the first module of a space station that would remain in orbit for 15 years. It was named Mir (Peace). Five more modules were added over the years, carried into orbit by unmanned rockets. In 2001, Mir descended from orbit and broke up

International Space Station (ISS)
Circling in orbit 390 kilometres (240 miles) above Earth is the biggest structure ever built in space, the International Space Station. The nations involved include:

- the United States
- the 14 countries of the European Space Agency (ESA)
- Japan
- Canada



The ISS has been built by assembling its separate parts in orbit and is currently the only space station that is built from more than 100 separate main parts.

What is it like inside the ISS?

The living and workspace on the International Space Station is the same size as the passenger space on a 747 aircraft.

- There are four laboratory modules where astronauts carryout scientific research.
- The main living accommodation, for a crew of seven, is in the US habitation module.
- It has two decks and contains sleep stations, a kitchen (galley), medical facility, gym, toilet and shower room in a space of about 8 metres long and 4 metres wide (26 feet x 13 feet)

Sleeping Quarters inside the ISS

Inside view of the ISS

The lab inside the ISS

Activity: **Now test yourself by doing this activity.**

Answer the following questions.

1. Define the following terms.

(a) Research _____
(b) Microgravity _____
(c) Modules _____
(d) Structure _____
(e) Facility _____

3. Name the six important parts of the ISS.

a) _____ b) _____
c) _____ d) _____
e) _____ f) _____

4. Answer these Questions.

(a) List one of the main functions of the orbiter?

_____

(b) What is the area in square metre (m^2) of the ISS?

_____

(c) What is the weight in (tonnes) of the ISS?

_____

REMEMBER: A space station is a spacecraft that is designed to stay in orbit for many years. Its parts are carefully controlled

CHECK YOUR ANSWER. ANSWERS ARE AT THE END OF LESSON 13.

Summary

You have come to the end of lesson 13. In this lesson you have learnt that:

- a space station is a large spacecraft that is built on Earth and launched into orbit as a complete unit.
- space stations are built on Earth and then launched into space.
- the International Space Station is built by USA and other countries and it is the biggest and most complex space station ever built.
- the Soviet Union launched the world's first space station, Salyut 1, in 1971 - a decade after launching the first human into space.
- the United States sent its first space station, the larger Skylab, into orbit in 1973 and it hosted three crews before it was abandoned in 1974.
- the living and workspace on the International Space Station is the same size as the passenger space on a 747 aircraft.
- conditions inside a space station are carefully controlled such as:
  - Solar panels to supply power.
  - Maintaining a comfortable environment.
  - Recycling air and water.

NOW DO PRACTICE EXERCISE 13 ON THE NEXT PAGE.

Practice Exercise 13

Answer the following questions:

PART A MULTIPLE CHOICE

1. Which statement is true about the research platform on the International Space Station? This section

   A. helps to control spaceships.
   B. is for carrying research materials.
   C. is for carrying researchers to space.
   D. is for carrying out experiments in space.

2. The laboratories of the ISS is unique because

   A. 14 countries work in one space.
   B. The size of the laboratories is like 747 aircraft.
   C. experiments are carried out in conditions of microgravity.
   D. Japan has dominated all researches done on ISS laboratory.

3. In 1973, the Skylab was

   A. carried in a shuttle.
   B. launched into space.
   C. destroyed from orbit.
   D. brought back for maintenance.

4. The crew of the orbiter are surrounded on all sides by _____ and _____.

   A. stars, planets
   B. radiators, panels
   C. instruments, controls
   D. oxygen, carbon dioxide

5. The space _____ is piloted by two crews.

   A. deck B. probe
   C. shuttle D. station

PART B COMPREHENSION

Answer these questions:

6. What are the three methods in which spacecrafts study their targets?

   a) _____

   b) _____

   c) _____

7. Which nation is the leader in space research? Why?

   _____
   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Answers to Activity

1. (a) Careful study or investigation in order to discover new facts or information.

   (b) Near weightlessness

   (c) Independent self-contained unit of a spacecraft. (service module) (others – command module – for the astronaut in common. – lunar module – used to land on the moon).

   (d) Way in which something is put together, organized or built

   (e) Equipment that make it possible or easier to do something.

2. (a) Solar panels (b) thermal panels (c) Truss

   (d) Research laboratories (e) Resupply orbiter

   (f) External equipment platform

3. (a) Supply and Resupply needed materials to the International Space Station (ISS)

   (b) 8800 m^2 (square metres)

   (c) 500 tonnes

Lesson 14: Telescopes

Welcome to Lesson 14 of Strand 4. In the previous Lessons, you learnt that human beings have discovered new planets and studied other amazing and interesting things from outer space with the use of modern technology, especially with the invention of satellites, space shuttles and recently, the International Space Station (ISS). In this lesson you will learn about telescopes.

Your Aims:

- define space stations
- discuss the first station and the International Space

Simple And Modern Telescopes

What is a Telescope?

Telescope consists of a tube with lenses at each end, which you can see distant things more clearly. A simple telescope uses glass lenses to magnify the light from the stars. Astronomers use telescopes to study the sky.

A simple telescope

Astronomy is the scientific study of stars and other objects in space. A telescope focuses light from distant objects and makes them clearer. Different types of telescopes reveal rays of light that are invisible to human eye.

- Radio Telescope capture radio waves
- Space telescopes can study rays that cannot pass the Earth‘s atmosphere.

Modern Telescopes
There are two different types of modern telescopes.

1. Reflecting Telescopes - They capture light with a mirror

2. Refracting Telescopes - These telescopes use lenses.

All modern and professional telescopes are reflectors. They capture light with a mirror.

Observatories
Optical observatories study the visible radiation (light) from objects in space. There are also observatories with telescopes that can detect invisible forms of radiation. High above the Earth‘s atmosphere, space observatories like the HUBBLE SPACE TELESCOPE (HST) can view the universe much more clearly.

What is an electromagnetic wave?
There are energy (waves) that travel at the speed of light. Electromagnetic radiation can be thought of as either a wave of energy or as a stream of energy particles. Some of these are described below:

Some of the electromagnetic waves from the space telescope HST are shown here:

Gamma Rays
This gamma rays image shows M1, the Crab Nebula. Gamma rays have the shortest wavelengths and the most energy. They are produced by some of the most violent events in the Universe, such as colliding galaxies.

X-Rays
High energy X-rays are also emitted when violent events occur in the Universe. They carry more energy than visible light and have longer wavelengths than gamma rays. Here the scattered debris from a supernova explosion it is emitted them.

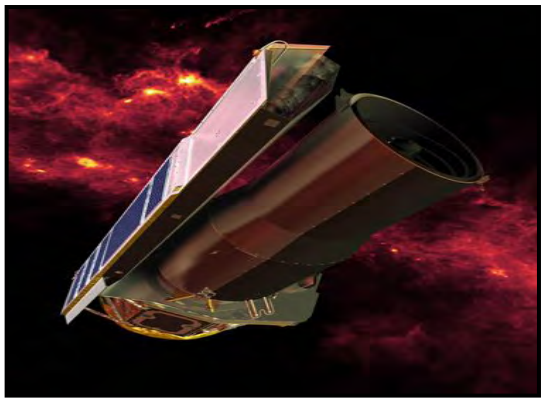
Infrared Rays
M16, the Eagle Nebula, is seen here as an infrared image. Infrared rays have longer wavelengths than visible light. On Earth, they are felt as heat, and are also known as heat rays. In space, they penetrate interstellar dust and reveal what is behind it.

Ultraviolet Rays
This ultraviolet image of the Sun reveals different temperatures in the corona. Ultraviolet rays also have more energy than visible light, but less than X-rays. They come from very hot objects, such as the Sun. These rays can burn the sky.

Radio Waves
M51, the Whirlpool Galaxy, is seen here as a radio image. Radio waves have the longest wavelengths and the lowest energy. In space, they are emitted from stars, galaxies, and gas clouds. Ground – based radio telescopes can pick up most.

Spitzer Observatory

Launched in 2003, the Spitzer Space Telescope is the largest infrared telescope in space. It observes the Universe at invisible, infrared wavelengths. The Spitzer looks at the cooler objects in space, such as small, dim stars, extra solar planets (planets round other stars), and giant clouds between the stars. To make it ultra-sensitive, its instruments are cooled by liquid helium to around – 273°C (-459°F).



The Spitzer Space Telescope

Some images taken by the Spitzer Telescope

REMEMBER:
Astronomers observe the universe using telescopes, which focus light from distant objects and make them clearer.

Activity: **Now test yourself by doing this activity.**

1. List at least three different, invisible forms of radiation that the atmosphere absorbs.

   a) _____
   b) _____
   c) _____

2. Explain why each one is different from the other.

   a) _____
   b) _____
   c) _____

3. Explain why the old telescope is different from the modern telescope.
   _____

4. Explain:

   a) visible radiation _____
   b) invisible radiation _____

5. Answer the Questions on the Very Large Array (VLA) after considering these facts!

Radio signals are collected by the dish and reflected into a central antenna
The signals are then fed to a receiver and are processed to produce pictures, called radio images.

a) Where is the VLA located?

_____

b) What does the dish reflector collect?

_____

c) How long are the radio waves?

_____

d) What are radio waves?

_____

CHECK YOUR ANSWERS. ANSWERS ARE AT THE END OF LESSON 14

Summary

You have come to the end of lesson 14. In this lesson you have learnt that:

- people used the movement of heavenly bodies for navigation, farming and hunting.
- telescopes are instruments used to magnify images of the stars.
- there are two different types of modern telescopes.
  (1) Reflecting Telescopes - They capture light with a mirror.
  (2) Refracting Telescopes - These telescopes use lenses.

NOW DO PRACTICE EXERCISE 14 ON THE NEXT PAGE.

Practice Exercise 14

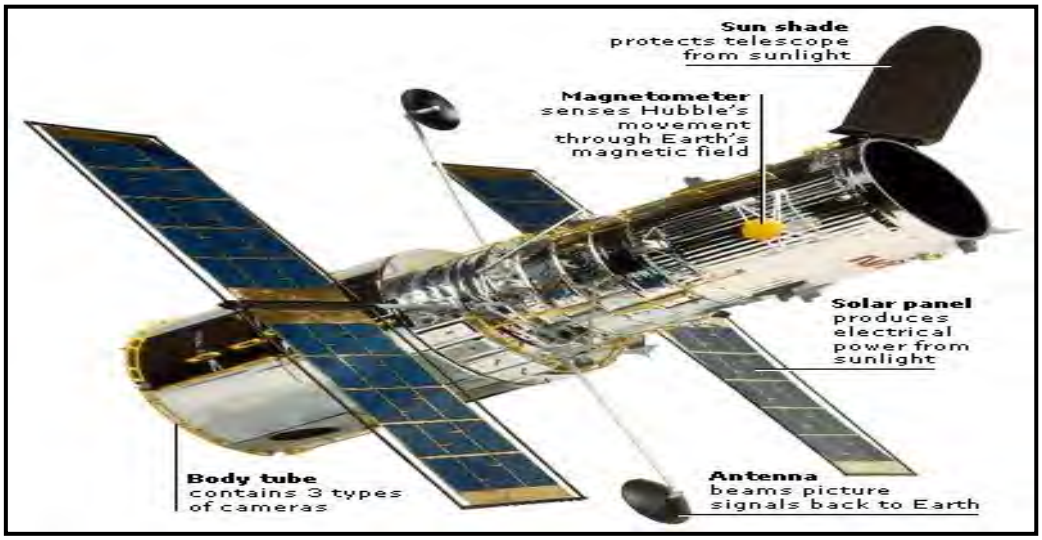
Answer the following questions:

PART A. MULTIPLE CHOICE

Read the passage title: —SPACE OBSERVATORIES" and complete the exercises that follows.

SPACE OBSERVATORIES

A spacecraft launched to observe the Sun, Stars and remote galaxies is called a space observatory. Why are observatories launched into space? Earth's moving atmosphere bands and distorts the light from distant stars and galaxies. In space, the observatories can see far more clearly. They can also pick up radiation, such as, X-rays, that we cannot detect on Earth because it is absorbed by molecules in the atmosphere.



The Hubble Space Telescope (above) was the first important space observatory. Launched from a space shuttle in 1990, the Hubble Space Telescope (HST) orbits about 600 km above Earth. It sends back some of the most detailed images of the Universe ever seen. The HST is a reflecting telescope – it uses mirrors to gather and focus light. The focused light is fed to electronic cameras and infrared detectors to create images.

1. The job of Sunshade is to protect the

   A. protect the telescope from sunlight
   B. protect the atmosphere from bending
   C. protect the observatory from radiation
   D. protect the sunlight from the telescope

2. A space Observatory is launched to observe the

   A. Sun and stars only
   B. galaxies, sun and stars
   C. Stars and galaxies only
   D. Sun, Stars, galaxies and space only

3. The _____ is generated from the solar panel.

   A. solar B. light
   C. radiation D. electricity

4. The HST is a _____ telescope

   A. reflecting B. refracting
   C. retracting D. recreating

5. The body tube contains _____ types of camera

   A. 1 B. 2
   C. 3 D. 4

6. Electronic cameras are operated

   A. manually
   B. using a switch
   C. at its own wish
   D. using a computer

Part B

Solve the following

7. An unmanned space observatory gathers information at a speed rate of 300 pictures every 6 hours.

   (a) How many pictures would be taken in one day?
   _____

   (b) How many pictures in 1 hour?
   _____

8. The pictures are transmitted back to Earth at the rate of four pictures per minute.

   How many pictures would be transmitted in 12 hours?
   _____

9. The rate at which the electronic cameras and infrared detectors create images is half an image a10 seconds.

   (a) How many images would be created in 4 minutes?
   _____

   (b) How many images would be created in 120 seconds?
   _____

   (c) How many minutes would be needed to create 30 images?
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Answers to Activity

1. Any three from this list.

   - Gamma Rays
   - X-rays
   - Ultraviolet Rays
   - Infrared Rays
   - Radio Waves

2. Any three from this list

a)	Gamma Rays	-	have the shortest wavelengths and most energy
b)	X-rays	-	carry more energy than visible light and have long wavelengths than gamma rays
c)	Ultraviolet Rays	-	have more energy than visible light but less than X-Rays
d)	Infrared Rays	-	longer wavelengths than visible light
e)	Radio waves	-	longest wavelengths and lowest energy

3. Old telescopes use glass lenses to magnify light while modern telescopes use mirrors to detect invisible forms of radiation.

4. Visible radiation is light energy in the form of rays and can be seen with the naked eye and invisible radiations are electromagnetic waves that can only be detected from reflection.

5. a) They are located on the land (New Mexico – USA)
   b) Reflect Radio Signals
   c) Longest wavelengths
   d) Invisible Radiation.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Lesson 15: Man in Space

Welcome to Lesson 15 of Strand 4. You have learnt a great deal of ideas about scientific instruments and astronauts exploring the outer space doing researches to gain skills and knowledge. In this lesson you will learn about man in space.

Your Aims:

- define astronomy
- explain problem associated with living in space
- discuss men who travelled to space

What Is Astronomy?

It is the scientific study of stars and other objects in the outer space. People began stargazing and recording their observations over 5000 years ago.

In 1609, Galileo built a telescope and was the first to look at the heavenly bodies. Also there would be no space explorations without rockets, the propellants burn and produce a stream of gases that propels the rocket forward.

Man in Space

WOW! On August 19, 1960, the Soviet spacecraft Korabyl-Sputnik 2 carried two dogs (named Belka (Squirrel) and Strelka (Little Arrow)) into space and returned them safely to Earth.

Let‘s discuss briefly about some of the first men and women who ventured into space and when.

These are few of the first people who went into space.

Yuri Gagarin
On April 12, 1961, the Russian cosmonaut Yuri Gagarin blasted into orbit. He was the first person in space and completed an orbit of the Earth before landing.

Alan Shepard
Astronaut Alan B. Shepard was the first United States astronaut in space. After the flight on May 5, 1961, his space capsule splashed down into the Atlantic Ocean and he was picked up by a Navy helicopter.

Valentina Tereshkova
Russian cosmonaut Valentina Tereshkova was the first woman to enter space. She piloted the Vostok 6 in orbit around the Earth for four days in 1963.

Neil Armstrong
Neil Armstrong, commander of the Apollo 11 lunar mission, was the first person to walk on the Moon.

There were three astronauts in each Apollo crew. Two of them explored the Moon while the third stayed aboard the main spacecraft.

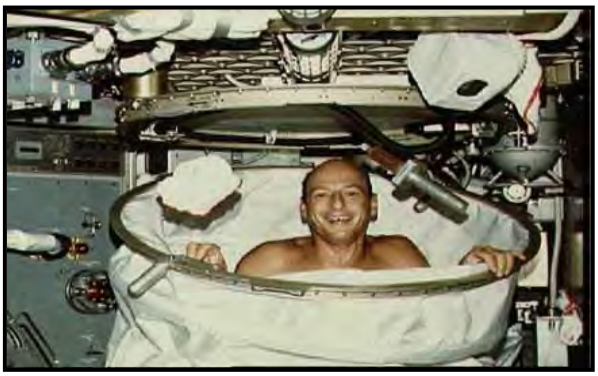
Neil Armstrong, Buzz Aldrin, and Michael Collins were the crew of Apollo 11. This was the first mission to land on the Moon.

Working in Space
In 1993, astronauts aboard the space shuttle Endeavour carried out five space walks to repair the Hubble Space Telescope. An astronaut attached to the remote manipulator arm prepares to perform a repair. When outside the space shuttle, astronauts need the following: red stripes, help observers to identify the space walker; the backpack provides oxygen; water, for costing the space suit; electrical power and a metal arm to secure tools that an astronaut needs in to work.

The human body in Space
Space travel is hard on people‘s bodies. Space flight affects the human body in a number of ways because of the weightless environment. Muscles begin to waste away and bones tend to lose mass and become more brittle. Spending long amounts of time in space makes bones and muscles weak. It is hard to eat in space. It is hard to sleep and take showers.

By monitoring astronauts' bodies during their time in space, scientists have been able to observe some definite changes that occur. These changes occur mostly during the first three months of long space flights. The astronauts are able to regain their muscle strength when they return to Earth, though it may take them months to do so. For flights of more than six months the changes may be irreversible, so extensive testing continues to determine the best ways to overcome these effects.

Scientist use space stations to study how people can live and work in space. The most famous space station was Mir. This space station was used by scientist to perform experiments. The aim of these experiments was to have people living and working in space one day.



This picture shows astronauts having a shower and sleeping in space

An astronaut working in space

Astronauts taking a break relaxing and playing cards in space

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Activity: **Now test yourself by doing this activity.**

Define the following terms:

1. What is astronomy?

   _____

2. What do the astronauts wear before space walking?

   _____

3. Who was the first American to walk on the moon?

_____

_____

4. How do space flights affect the human body?

_____

REMEMBER
Astronomy is the study of stars and other objects and there are problems associated with space travel.

CHECK YOUR ANSWERS. ANSWERS ARE AT THE END OF LESSON 15

Summary

You have come to the end of lesson 15. In this lesson you have learnt that:

- astronomy is the scientific study of stars and other objects in the outer space.
- spending long amounts of time in space makes bones and muscles weak. It is hard to eat in space. It is also hard to sleep and take showers.
- there are two types of satellites and they are natural and artificial satellites.
- because of the weightless environment, space flight affects the human body in a number of ways. Muscles begin to waste away and bones tend to lose mass and become more brittle.

NOW DO PRACTICE EXERCISE 15 ON THE NEXT PAGE.

Practice Exercise 15

Answer the following questions:

1. Who was the first person to go into space?
   _____

2. Who was the first female to go into space and in what year?
   _____

3. Why do you think these astronauts are happy in the image below?
   _____
   _____

4. Name the 3 important parts of the space suit that the astronauts wear.

   a) _____
   b) _____
   c) _____

5. Name some problems that may arise when astronauts are in space

   a) _____

   b) _____

   c) _____

CHECK YOUR ANSWERS. ANSWERS ARE AT THE END OF SUBSTRAND 3.

Answers to Activity

1. Study of stars and other objects.
2. They wear space suits
3. Niel Armstrong
4. Because of the weightless environment

REVIEW OF SUB STRAND 3: SPACE INVENTIONS

Revise all the lessons in this Sub-strand and then do **ASSIGNMENT 4.**
Here are the main points to help you revise.

Lesson 11: Satellites

- A satellite is an object that orbits or revolves around another object.
- Most satellites are put into orbit for special purposes for transmitting information on weather patterns, radio signals and other electronic information from one country to another.
- There are two types of satellites and they are natural and artificial satellites.
- Artificial satellites can be further divided into two general types: Geostationary satellites and other satellites.

Lesson 12: Space Shuttles

- When men travelled to the moon, rockets were used. Today space shuttles carry people into space.
- A space shuttle is made of a reusable space plane called an orbiter, two rockets and an external fuel tank.
- A space shuttle is a space transport system designed to go into orbit around the Earth.
- The space shuttle is used for many purposes.
- From April 1981 to January 1986, there have been twenty-four successful flights involving four different shuttles.

Lesson 13: Space Stations

- A space station is a large spacecraft that is built on Earth and launched into orbit as a complete unit.
- Space stations are built on Earth and then launched into space.
- The International Space Station is built by USA and other countries and it is the biggest and complex space station ever built.
- The Soviet Union launched the world's first space station, Salyut 1, in 1971 - a decade after launching the first human into space.
- The United States sent its first space station, the larger Skylab, into orbit in 1973 and it hosted three crews before it was abandoned in 1974.
- The living and workspace on the International Space Station is the same size as the passenger space on a 747 aircraft.
- Conditions inside a space station are carefully controlled such as;
  - Solar panels supplying power.
  - Maintaining a comfortable environment.
  - Recycling air and water.

Lesson 14: Telescopes

- People used the movement of heavenly bodies for navigation, farming and hunting.
- Telescopes are instruments used to magnify the images of the stars.
- There are two different types of modern telescopes.
  (1) Reflecting Telescopes - They capture light with a mirror

(2) Refracting Telescopes - These telescopes use lenses.

Lesson 15: Man in Space

- Astronomy is the scientific study of stars and other objects in the outer space.
- Spending long amounts of time in space makes bones and muscles weak. It is hard to eat in space. It is also hard to sleep and take showers.
- Because of the weightless environment, space flight affects the human body in the number of ways. Muscles begin to waste away and bones tend to lose mass and become more brittle

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REVISE WELL AND THEN DO SUB STRAND TEST 3 IN YOUR ASSIGNMENT 4

Answers to Practice Exercises 11 - 15

Practice Exercise 11

PART A Multiple Choice

1. **A**
2. **A**
3. **C**
4. **B**

PART B True or False

1. **True**
2. **False**
3. **False**

Part C Short Answer

1. **They are held in orbit around the Earth by Gravitational force.**
2. **The light fades in brightness because the satellite is passing into the Earth's shadow.**

Practice Exercise 12

Part A Multiple Choice

1. **C**
2. **B**
3. **D**
4. **A**
5. **D**
6. **D**

Part B Use your comprehension skills to do these tasks.

7. a) **Orbiter**
   b) **Rockets**
   c) **External fuel tanks**

8. **Rockets**

9. **2 minutes** and **48 kilometres**

10. a) **Protects orbiter from heat on re-entry.**
    b) **Protects the orbiter and its occupants from cold in space.**

Part C Comprehension

NO.	PART	FUNCTION
a	Crew Compartment	(11) **Provides living spaces for crews**
b	Payload Bay	(12) **Contains payloads/ cargoes**
c	(13) Delta Wings	Glide through the Earth's Atmosphere
d	(14) **3 shuttle main engines**	For lift off and burning liquid hydrogen and liquid oxygen.

Practice Exercise 13

PART A MULTIPLE CHOICE

1. D
2. C
3. B
4. C
5. C

PART B COMPREHENSION

6. a) Fly by
b) Orbit their targets
c) Land on their targets

7. America

Practice Exercise 14

PART A MULTIPLE CHOICE

1. A
2. B
3. D
4. A
5. B
6. D

PART B

7. (a) 900 pictures
(b) 50 pictures

8. 48 pictures

9. (a) 12 images
(b) 6 images
(c) 10 minutes

Practice Exercise 15

1. **Yuri Gagarin**

2. Valentina Tereshkova in 1963

3. Because they have travelled to space and explored the moon.

4. a) Red stripes help observers to identify the space walker

b) The backpack provides oxygen, water for costing the space suit and electrical power.

c) A metal arm is used to secure tools that astronauts need in their work.

5. a) Muscles begin to waste away and bones tend to lose mass and become more brittle.

b) Spending long amounts of time in space makes bones and muscles weak.

c) It is hard to eat in space. It is also hard to sleep and take showers.

SUB-STRAND 4

COMMUNICATION AND INFORMATION

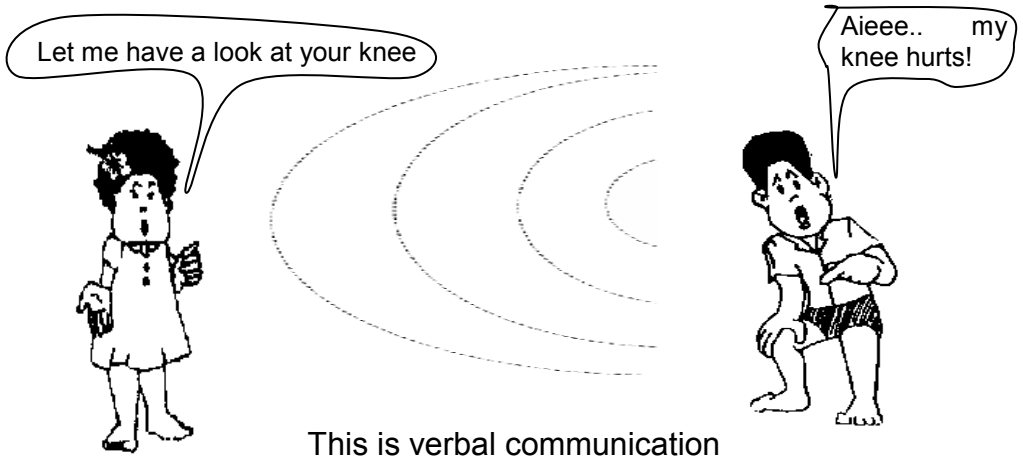
In this sub-strand you will

- **describe how sound is produced**
- **describe the importance of radio**
- **describe how television transmits messages and its importance**
- **describe how telephone transmits messages and its importance**
- **describe computers and its importance**

SUB-STRAND 4: COMMUNICATION AND INFORMATION

Introduction

Communication is a very important part of our lives. When we talk to each other we communicate. The message we are trying to bring across to whomever that we want to talk to reaches that person directly. But what if you want to talk right now to a friend who lives far away? The answer is simple. You pick up your telephone or mobile phone and press some buttons. Next, you hear a ringing sound—one, two, three rings. Then you hear your friend's voice say, —Hello." Making a phone call seems so easy. Or you send a message through the radio and they hear that message you are trying to pass. Or nowadays, you use computers to get your message or information across. But did you ever think about what makes it possible?



This is verbal communication

What about the other means of communicating?
You have seen a telephone, a radio, a mobile phone, a computer and equipment that you could use to pass your message to another person. Ask yourself how this is possible.

Well, we will look at some of this equipment and how messages are transmitted and their importance too.

We will look at:

- How we form word when speaking
- Radios , telephones, television, computers
- How important they are to people

In this Sub-strand, you will find the answers to these questions and other questions relating to communication.

Lesson 16: Speaking and Listening

Welcome to Lesson 16 of Strand 4. In the previous lesson, you studied man in space and looked at problems about living in space. In this sub-strand, Communication and Information you will look at sound. We hear different types of sound everyday around us.

Your Aims:

- describe how sound is produced in our throat
- explain how sound travels
- describe how sound waves affect the ears

Sound

Imagine if you talked to a friend without any sound coming out of the mouth. Can your friend know what is been said? Will they respond to what has been said? No, he or she would not hear what has been said and will not respond. There is no information received between you and your friend so there is no communication. Sound is produced when we speak and this enables us to communicate with each other.
Even animals and insects use sound to communicate with each other, search for food, find a mate or warn others of danger.

How is sound produced?

Sound is produced by something moving backwards and forwards. When you speak the vocal cords in your throat vibrates. The vocal chords are flaps in the windpipe that vibrate when air is blown over them from our lungs.

Fact: Sound is a form of energy

How does sound travel

Sound travels like ripples when you drop a pebble into a dish of water. This is called sound waves. It can travel through air. The particles squash up and move fast passing on the vibration. Sound can travel through solid, liquid and gases.

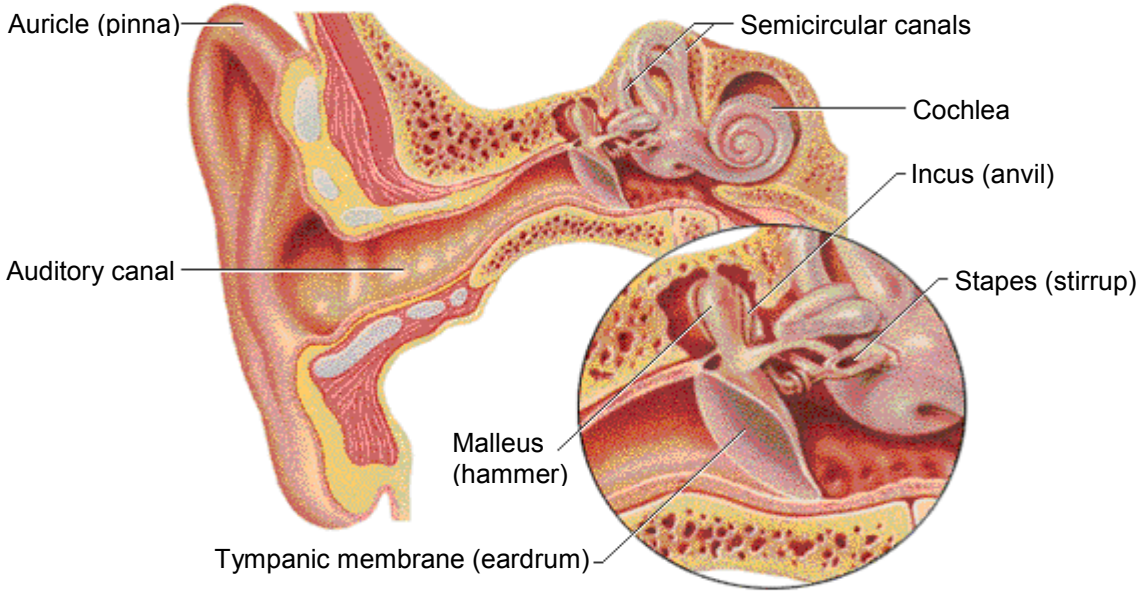
Fact:

- Sound travels through vibrating air particles.
- Sound travels through air at a speed of 330 metres per second.

Try this! Activity!

Put your ear against the desktop and cover the other ear. Now then, tap gently on the far end of the desk. Can you hear the tapping? Yes, you can hear it.

How is sound received?
The sound waves travel through the air canal and vibrate the eardrum. This makes the ear bone vibrate and makes the cochlea. These vibrations are changed into electrical liquid called impulse that travels to the brain and we hear the sound.



Structure of the Ear
The human ear consists of three sections: the outer ear, the middle ear, and the inner ear.

The outer ear includes the auricle (pinna), the visible part of the ear that is attached to the side of the head, and the waxy, dirt-trapping auditory canal. The tympanic membrane (eardrum) separates the external ear from the middle ear, an air-filled cavity. Bridging this cavity are three small bones—the malleus (hammer), the incus (anvil), and the stapes (stirrup). The cochlea and semicircular canals make up the inner ear.

Sound cannot travel through vacuum because there are no particles to pass on the vibration.

Activity: **Now test yourself by doing this activity.**

Part A: **Complete the following sentences.**

1. Sound is made by something that _____.

2. Sound can travel through _____.

3. The air travels through the ear canal and makes the _____ vibrate.

4. The vibrations in the ear changes into _____ _____ called _____.

Part B: Answer the following question.

1. How does sound travel through the air?
_____

2. Explain how sound is made in our throat.
_____

3. What happens to the vibration when it reaches the cochlea?
_____

4. Why is that sound cannot travel through vacuum?
_____

Part C: Write the functions of the parts of the ear listed below.

1. Ear canal _____

2. Ear drum _____

3. Ear bones _____

4. Cochlea _____

Summary

You have come to the end of lesson 16. In this lesson you have learnt that:

- sounds are produced by vibration of something, which causes the particles to vibrate and move apart.
- sounds travel by waves. This is called sound waves. These sound waves are passed on by vibrating particles until it reaches the other side.
- the vocal cords produce sound in the throat as it is being pushed out from our lungs.
- sound is a form of energy like light. It travels through the air at a speed of 330 metre per second.
- the vibrations of ear bones are changed into electrical signals in the cochlea. These signals are impulses and are sent to the brain.

NOW DO PRACTICE EXERCISE 16 ON THE NEXT PAGE

Practice Exercise 16

Answer the following questions:

Part A:

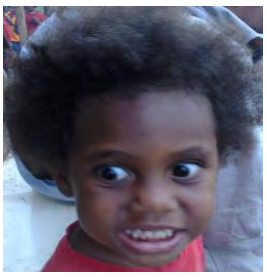
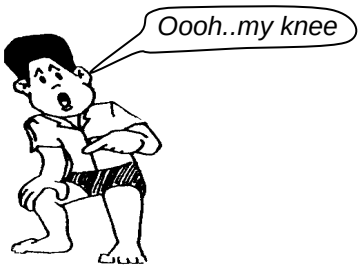
Fill in the blanks.

There are some words connected with sounds.

Vacuum, liquids, vibrations, ear bone

1. Sound can travel through this. _____
2. Sound is made by these. _____
3. Receive vibrations passed from the eardrum. _____
4. Sound cannot travel though this. _____

Part B: Below are some pictures that describe how each would communicate.

1) What does a baby do when she is hungry?	
2) How does the dog tell you that it does not allow you to enter its master home?	
3) What tells you that the boy is hurt and in pain after tripping and falling.	
4) During mating season what sound does the toad make?	

CHECK YOUR ANSWERS. ANSWERS ARE AT THE END OF SUBSTRAND 4.

Answers to Activity.

Part A

1. vibrates

2. solids, liquid and gas

3. ear drum

4. electrical signals, impulse

Part B

1. Sound travels through air as waves. The particles of air move back and forth, passing on the vibrations.

2. Sound is made by air blowing over the flaps in the windpipe from the lungs. This causes it to vibrate to produce sound.

3. The vibrations are changed into electrical signals called impulse that are sent to the brain.

4. Sound cannot travel through vacuum because there are no particles to pass on the vibration to be heard.

Part C

1. Ear canal : allows sound waves through to the eardrum.

2. Ear drum : passes the vibration to the ear bone inside the ear.

3. Ear bones : passes these vibrations to the cochlea.

4. Cochle : turns the vibrations to impulse (electrical signal) and is sent to the brain.

Lesson 17: Radio

Welcome to Lesson 17 of Strand 4. In the previous lesson, you learnt how sounds are made in the throat, how it travels and is received by the ears. One device used for communication is the radio. What is a radio, and how does it transmit messages and why is it an important means of communication?

Your Aims:

- describe the way radio transmits messages
- discuss the importance of radios as a means of communication

What Is A Radio?

Before the radio was invented, the telegraph and telephone were the fastest means of communication. These two devices could only send and receive messages through wires that were hung on poles. However, when radio was invented, long distance communication became possible without connecting wires to places around the world.
Radio simply means sending and receiving messages by electromagnetic waves. Devices like the transistor radio or the pocket size digital FM/AM radio receive broadcasted programs through electromagnetic waves. Ships, planes and even rockets have radio devices to make communication over long distance easier and faster.

How does radio transmit messages?
A radio works by changing sounds into electrical signals.
The electrical signals are then amplified and transmitted through electromagnetic waves known as radio waves.
An Aerial or antenna connected to the receiver detects the radio wave and changes this radio waves back into its original sound.

Radio waves can be transmitted through air and space. They can also pass through some solid objects such the wall of a building or even your homes.

Who uses radios?
If you have a radio or transistor radio then you are using the radio. Why do you listen to the radio? Well there are other reasons why you use a radio, however, here is a few.
- listen to the news of the day
- use radio to listen to educational programs; the papa Mai broadcast for Grade 6,
- listen to music
- listen for weather and disaster information; so listening to the radio is collecting information for one self.

The other type of radio is the two-way radio. This is used by ships to send messages to other ships or seaports along the coast. Captains of planes use this to report to the control towers or to other planes. Even the astronauts working and living space station up in space use this.

So you see, the transistor radio and the two- way radio are very important. These devices help to make communication quicker and easier. Imagine if you were to send a letter to a friend in Samoa to warn him/her of a storm. How long would it take? It would take days or weeks. By then the storm would hit Samoa. Therefore, this is why the radio is a very important means of communication. Your radios are important devices for communication. You are the receiver who listens and collects information.

More than 300 million battery-powered radios are sold every year.

Activity: Now test yourself by doing this activity.

Part: A: Short answers

1. How is a radio message transmitted and received?

   _____

2. Why is it important to have radio on a ship?

   _____

3. What is the important point of using either the transistor radio or the two-way radio?

   _____

4. What is the name of the part that detects radio waves for the receiver?

   _____

Part B: Flow chart

Read carefully and write the correct stages in the transmission of the message in the blank flow chart.

1. Radio waves change into original sound.

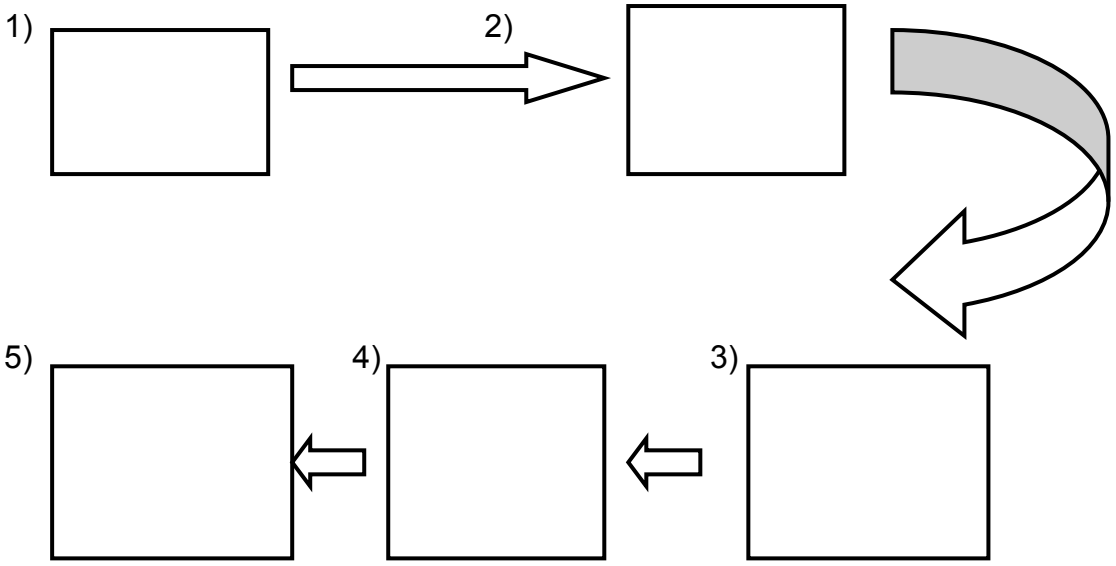
2. Electrical signals simplified.

3. Sound changes to electrical signals.

4. Radio waves detected by antenna.

5. Electrical signals transmitted via radio wave.

Flow of transmission



Part C: True or false

Read carefully and write only true or false.

1. Radio waves can pass through all solid objects. _____
2. Messages are transmitted by sound waves. _____
3. Electromagnetic waves are radio waves. _____
4. Two-way radio is used in planes and even in space by astronauts. _____
5. A transistor radio is a device that receives information. _____

Summary

You have come to the end of lesson 17. In this lesson you have learnt that:

- radio simply means sending and receiving messages by electromagnetic waves.
- a radio works by changing sounds into electrical signals.
- the electrical signals are then amplified and transmitted through electromagnetic waves known as radio waves.
- A radio is a means of communication.

NOW DO PRACTICE EXERCISE 17 ON THE NEXT PAGE

Practice Exercise 17

Answer the following questions:

Part A: Choose the appropriate mode of communication for each situation.

Mode of communication- A) transistor radio

B) two-way radio

No.	Situation	Mode
1	A call for help from a small boat.	
2	Students listen to the news.	
3	Pilot ready to land, waits for advice from the control tower.	
4	A person plays music for people to listen.	
5	A medical officer in the mountains calls to a health centre for an ambulance.	
6	A service program for grade 6 students.	

Part B: Which of the following uses the radio as a means of communication in their jobs?

Teacher, pilot, gardener, doctor, typist, ship captain, carpenter, a navy officer, ambulance officer.

No.	Jobs	Give short description of how they use a radio

CHECK YOUR ANSWER. ANSWERS ARE AT THE END OF SUBSTRAND 4

Answers to Activity

Part A: Short answers

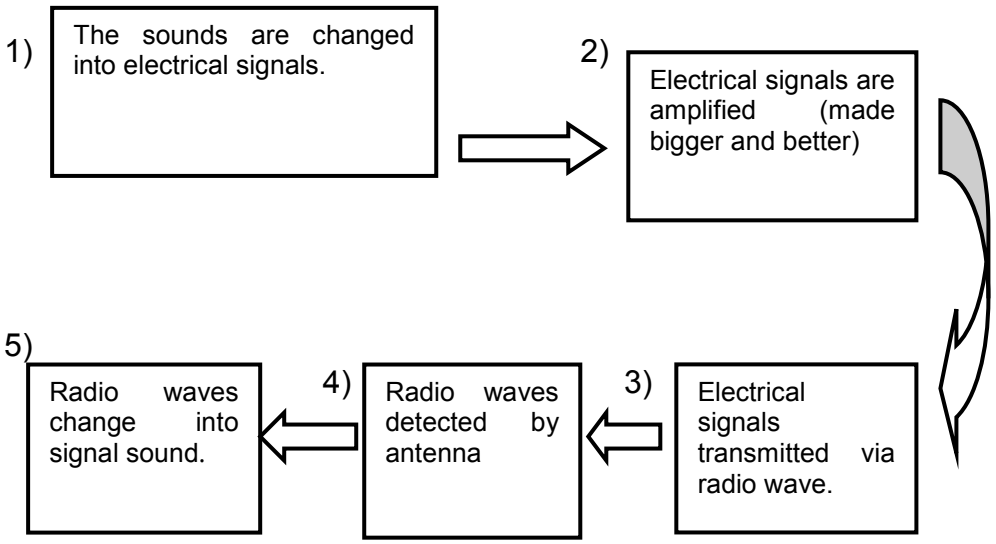
1. Radio message is transmitted via electromagnetic wave or radio wave.

2. To communicate with other ships and parts.

3. The important point is communication.

4. It is the aerial or antenna.

Part B: Flow of transmission



Part C: True or False

1) False

2) False

3) True

4) True

5) True

Lesson 18: Television

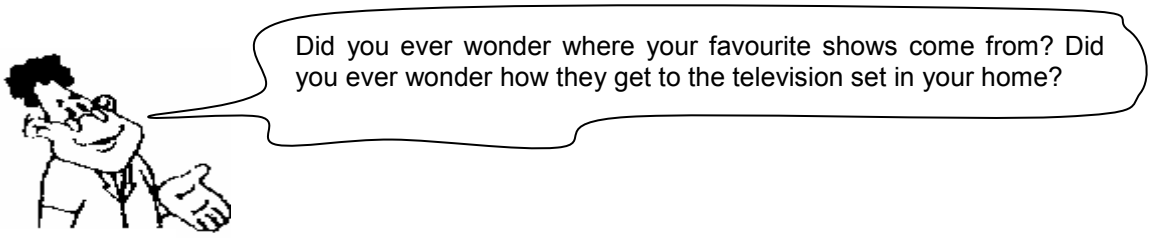
Welcome to Lesson 18 of Strand 4. In our previous lesson, we discussed how radio transmits messages. We also discussed the importance of radio as a means of communication. In this lesson we will discuss television as another means of communication.

Your Aims:

- explain how television transmits messages
- explain the importance of television as a means of communication

Television

It is a system of sending and receiving pictures and sound by means of electronic signals sent through wires and optical fibers. The television is one of the most common household appliances. Although television was invented in the 1920s, regular broadcasts of television shows did not begin until the 1940s.



Where do Television Shows come from?

Some television shows are made in television studios. Some of these shows are broadcast live—that is, as they are being made. Some shows are recorded in the studio. The tape is played on television later on.

Other TV shows are made outside of studios. Some parts of news programs are broadcast —on the scene." For example, TV reporters go to the scenes of accidents, floods, and fires and describe what is happening.

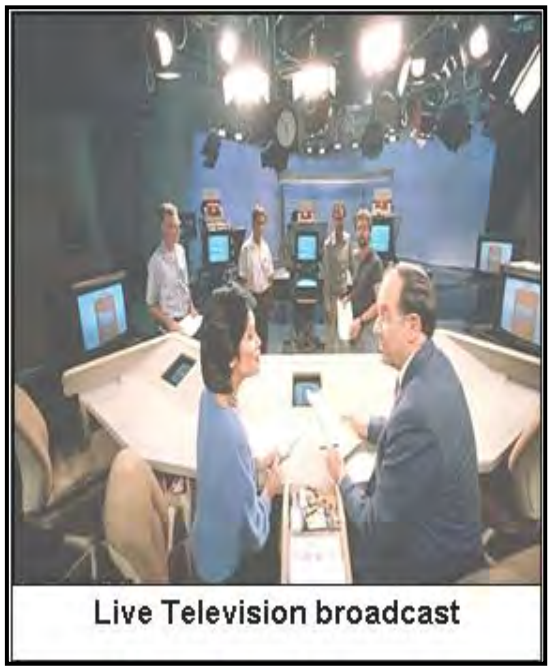
Shows in studios are made on sets. Sets for plays can look like living rooms or kitchens.

How are Television Pictures made?

A TV picture starts with a TV camera. Some TV cameras are big and some are small. The cameras in TV studios are big. Camera operators roll the big cameras around on wheels. There are usually several big cameras in a TV studio. Cameras used outside a TV studio are smaller. TV camera crews take the smaller cameras to news and sports events.

Some cameras send out live pictures to your TV set. Some cameras make videotapes that are played later on a television program.
A camera operator points the camera at a scene. The camera picks up light from the scene. It changes this light into an electric signal called the video signal. A microphone changes the sound of people talking or music playing into an electric signal called the audio signal.

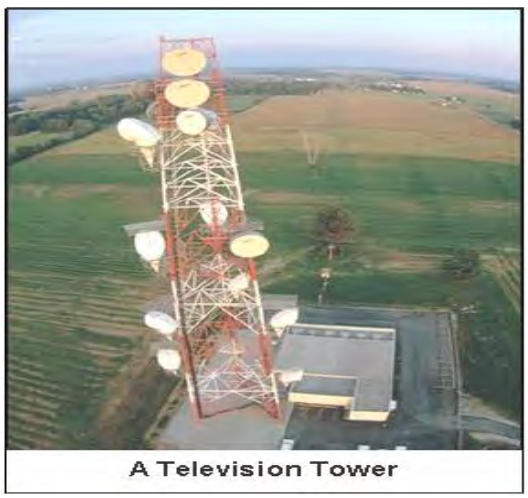
TV cameras do not snap pictures the way an ordinary camera does. Parts inside a TV camera scan, or sweep over, the scene and trace a series of thin, horizontal lines, one below the other. A TV camera scans a whole scene much faster than you can blink. Lines from the scans go together to make a picture.


Live Television broadcast

The Television Control Room
The pictures and sound from the TV cameras and microphones go to a control room. Every television station has one or more control rooms. TV cameras in a studio can send live pictures to the control room. The control room is full of dials, switches, and small TV screens. There are screens that show pictures from each TV camera in the studio.
Producers and directors work in the control room. They make sure that the best pictures with the best views go to your TV screen at home.
People who work in control rooms also use taped pictures to make programs. They use computers to put together the best-taped scenes.

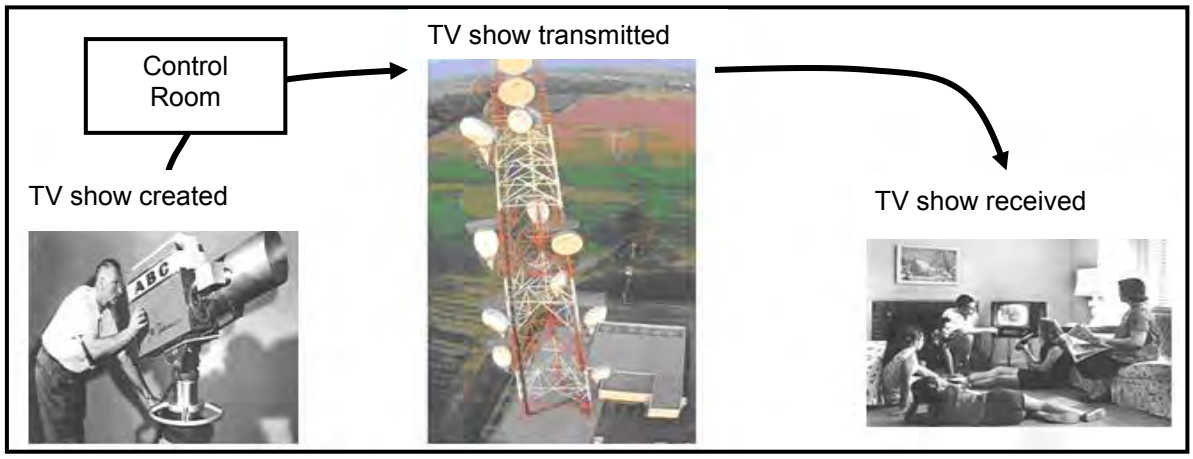
How does the show get to your home?
The picture and sound signals go from the control room to a transmitter. The transmitter makes the signals stronger and sends them to a transmitting antenna. This antenna is very tall. It changes the electric signals into invisible television signals that go through the air. The television signals go out from the antenna in all directions.

TV signals can get to the TV set at your home in several ways. They can go through the air to an antenna on your roof. The antenna picks up the signals and sends them through wires to your TV set. The signals could go to a cable TV company. The company sends the signals through a cable to your home. The TV signals could come right to your house from a satellite circling high above Earth. A satellite dish outside your home can pick up the TV signals and send them through wires to your TV set indoors.


A Television Tower

How does your television set work?
Your TV set changes the television signals back into pictures and sound. Your TV set picks up the thin lines that the TV camera scanned. Your set uses parts called electron guns to —paint" a picture on the TV screen one thin line at a time. The lines are painted from top to bottom. A colour TV set uses three electron guns to beam out three colours—red, green, and blue. These three colours make all the colours you see on your TV screen.

The following diagram illustrates the process involved in transmitting a message from television.



The Importance of Television
Television is the most widespread form of communication in the world. Though most people will never meet the leader of a country, travel to the moon, or participate in a war, they can observe these experiences through the images on their television.
Television can do many things. TV cameras can be sent to places that are difficult or dangerous for people.

Television has a wide range of applications in society, business, and science. The most common use of television is as a source of information and entertainment for viewers in their homes. Security personnel also use televisions to monitor buildings, manufacturing plants, and numerous public facilities. Public utility employees use television to monitor the condition of an underground sewer line, using a camera attached to a robot arm or remote-control vehicle.

Doctors can probe the inside of a human body with a microscopic television camera without having to conduct major surgery on the patient. Educators use television to reach students throughout the world.

Activity: Now test yourself by doing this activity.

Part A: Multiple Choice Questions

Circle the correct letter.

1. A television is a system of sending

   A. pictures and sound.
   B. and receiving sound.
   C. and receiving pictures.
   D. and receiving pictures and sound.

2. Where are television shows made?

   A. From the offices
   B. On the mountain tops
   C. From the control room
   D. From television studios

3. What do you need to make a television show?

   A. Radio B. Computer
   C. TV camera D. Mobile phone

4. What is a Television Control Room?

   A. It is place where actors are making the movie scenes
   B. A place where best scenes and pictures are selected
   C. A room where TV cameras are stored and maintained
   D. It is a place where all the TV producers have their meetings.

5. What does a transmitter do?

   A. It makes the picture and sound signals weaker
   B. It makes the picture and sound signals stronger
   C. It makes the sound signals stronger and pictures weaker
   D. It makes the pictures stronger and sound signals weaker.

6. TV signals can get to the TV set at your home in several ways. One way is

   A. signals come straight from the control room to your TV set.
   B. an antenna picks up the signals and sends them to a transmitter.
   C. a satellite dish picks up the signals and sends them to your TV set.
   D. an antenna picks up the signals and sends them to a TV Cable company.

Part B: Write True or False

1. Producers and directors work in a control room. _____
2. TV cameras can NOT be sent to dangerous places. _____
3. It is hard for educators to use television to educate students. _____
4. TV set changes the television signals back into pictures and sounds. _____
5. A colour TV set uses three electron guns to beam out three colours—red, green, and blue. _____
6. Cameras can NOT send out live pictures to your TV set. _____
7. TV cameras do not snap pictures the way an ordinary camera does. _____
8. A camera operator points the camera away from a scene. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 18

Summary

You have come to the end of lesson 18. In this lesson you have learnt that:

- a television is a system of sending and receiving pictures and sound by means of electronic signals.
- a TV picture starts with a TV camera.
- television shows are made in television studios, some are broadcasted live, taped in the studio, made outside of studios, broadcasted —on scene" and some are made on sets.
- producers and Directors make sure that the best pictures with the best views go to your TV screen at home.
- picture and sound signals go from the control room to a transmitter.
- TV signals can get to the TV set at your home in several ways.
- TV set changes the television signals back into pictures and sound.

NOW DO PRACTICE EXERCISE 18 ON THE NEXT PAGE

Practice Exercise 18

Answer the following questions:

Part A: Write True or False

1. Some parts of news programs are broadcasted—on the scene." _____
2. Security personnel use televisions to monitor buildings. _____
3. Cameras make videotapes that are played live on a television. _____
4. Parts inside a TV camera scan or sweep over the scene. _____
   Television has a no applications in society. _____
5. TV signals can go through wires to an antenna on your roof. _____
6. The television signals go out from the antenna in all directions. _____
7. A TV camera scans a whole scene very slowly. _____
8. Television is not a useful form of communication. _____
9. Television in the old days was very colourful. _____

Part B: Short Answers

1. What are the three steps involved in transmitting a message from a television?

   (a) _____

   (b) _____

   (c) _____

2. Television is a system of _____ and _____ pictures and sound by means of electronic signals.
3. In order to create a television show, you need a _____.
4. Parts inside a TV camera _____ over, the scene and trace a series of thin, horizontal lines.
5. A colour TV set uses _____ electron guns to beam out _____ colours.

6. What are the colours? _____

7. Name one way in which television signals can get to your home.
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Answers to Activity

Part A:

1. D
2. D
3. C
4. B
5. B
6. C

Part B:

7. True
8. False
9. False
10. True
11. True
12. False
13. True
14. False

Lesson 19: Telephone

Welcome to Lesson 19 of Strand 4. In our previous lesson, we discussed how television transmits messages. We also discussed the importance of television as a means of communication. We will discuss telephone as another means of communication in this lesson.

Your Aims:

- explain how telephone transmits messages
- explain the importance of telephone as a means of communication

Telephones

What will happen if you want to talk to a friend right now who lives far away?

The answer is simple. You pick up your telephone and press some buttons. Next, you hear a ringing sound—one, two, three rings. Then you hear your friend's voice say, "Hello." Making a phone call seems so easy!

But did you ever think about what makes it possible?

The **telephone** often referred to as a **phone**, is a communication device that transmits and receives sound, most commonly the human voice.

Telephones are a point-to-point communication system whose most basic function is to allow two people separated by long distances to talk to each other. It is one of the most common appliances in the developed world, and has long been considered indispensable to businesses, households and governments.

When you pick up your phone, it instantly hooks up with a vast, worldwide telephone network. The network has millions of miles of wire. It has cables that run under the oceans. It also has glass fibres as thin as a hair and it has satellites that orbit high above the Earth. It has powerful computers that keep track of everything on the network, including the call to your friend.

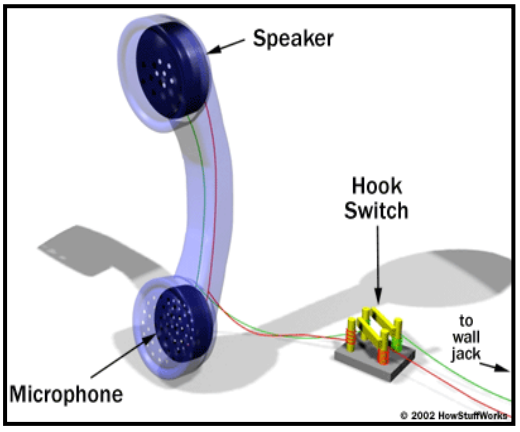
The word "hello" might must have gone through wires, shot up to a satellite, or through a cable under the sea before it got to my ear.

Early Telephones

While working on sound transmission for the deaf, Alexander Graham Bell discovered that steady electric current can be changed to sound like the vibrations made by the human voice. In 1876, he proved that device could sent speech along wires and he called it, the telephone. Early models of the telephone include Edison's 1879, wall-mounted phone, the candlestick design common in the 1920s and 1930s, and a 1937 "cradle" telephone, a style popular since 1890.

How does your telephone work?

Take a close look at your telephone. It has several parts. The part that you speak into is called the microphone or transmitter. The part that you put to your ear for listening is called the speaker or receiver. The buttons you press are called the dial.



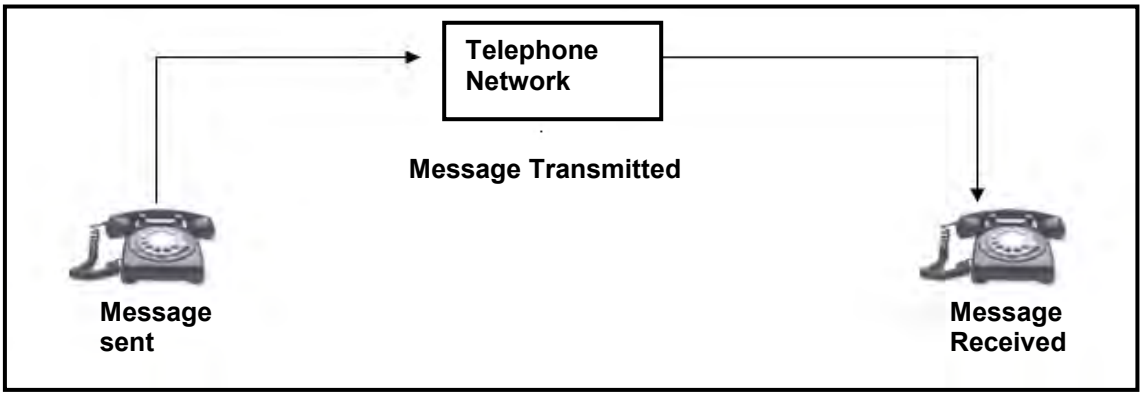
Most phones have a handset and a base. The handset contains the transmitter and receiver and sometimes the dial. We often call the entire handset the receiver, even though only the part we place to our ear receives sound. Many phones have a wire that connects the handset to the base. Wires connect the base to the telephone network. Some phones use radio signals instead of wires to send messages.

Radio signals connect the handset of a cordless phone to the base. Cordless phones let you walk around while talking, but you cannot go too far. Radio signals from a cordless phone only work over a short distance.

Radio signals from a cell phone or a mobile phone go much further. A mobile phone does not need a base to connect to the telephone network. You can take your mobile phone almost anywhere. Radio signals from a mobile phone go to an antenna, a tower that picks up radio signals. The area around an antenna is called a cell. The antenna in one cell can send signals to an antenna in another cell. An antenna can also send radio signals to wires in the telephone network, enabling you to call anyone you want.

How does your voice travel?
Your voice does not really go through the telephone wires. Instead, a copy of your voice goes to the telephone network. The copy can travel through wires. It can also go through the air as a radio signal.
The telephone's transmitter makes the copy of your voice. When you say —hello," sound waves go into the transmitter. The sound waves hit a thin sheet of metal or plastic inside the transmitter which makes the sheet vibrate. Some vibrations are big and some are small. The transmitter turns the vibrations into electric signals. These signals are a copy of your voice saying —hello."

The copy of your voice goes through the telephone network and into the receiver in your friend's telephone. The way the receiver works is the opposite of the way the transmitter works. The receiver turns the electric signals into sound waves. Your friend hears the copy of your voice say —hello." It sounds just like you!



The process involved in transmitting a message from a telephone is illustrated in the diagram above.

The method of transmission can be done in several ways. It can be through wires to a telephone network, or it can use radio signals. Over longer distances, the transmission can be done by a satellite. You have already discussed satellites in Lesson 11.

The Importance of Telephones
Telephones are very important in our lives today. In urban areas people cannot do business without the use of telephones. In rural areas, where there is a telephone, relatives can communicate their needs to each other directly, or on the same day through telephones.

Today our huge telephone network does many things besides carrying telephone calls. It sends copies of letters and pictures from one machine to another, called a fax machine. It connects computers all over the world into another vast network called the Internet. This network lets you send e-mail messages from your computer to your friends' computers'. It is hard to imagine what life would be like without the telephone.

Activity: Now test yourself by doing this activity.

Answer the following:

Fill in the blanks

1. _____ signals connect the handset of a cordless phone to the base.

2. _____ a communication device that transmits and receives sounds, most commonly the human voice.

3. _____ discovered that steady electric current can be changed to sound like the vibrations made by the human voice.

4. _____ can send radio signals to wires in the telephone network, enabling you to call anyone you want.

5. _____ is the area around an antenna.

Summary

You have come to the end of lesson 19. In this lesson you have learnt that:

- the telephone often referred to as a phone, is a communication device that transmits and receives sound, most commonly the human voice.
- telephones are a point-to-point communication system whose most basic function is to allow two people separated by large distances to talk to each other.
- telephones are very important in our lives as they allow people to communicate with each other directly.

NOW DO PRACTICE EXERCISE 19 ON THE NEXT PAGE.

Practice Exercise 19

Answer the following questions:

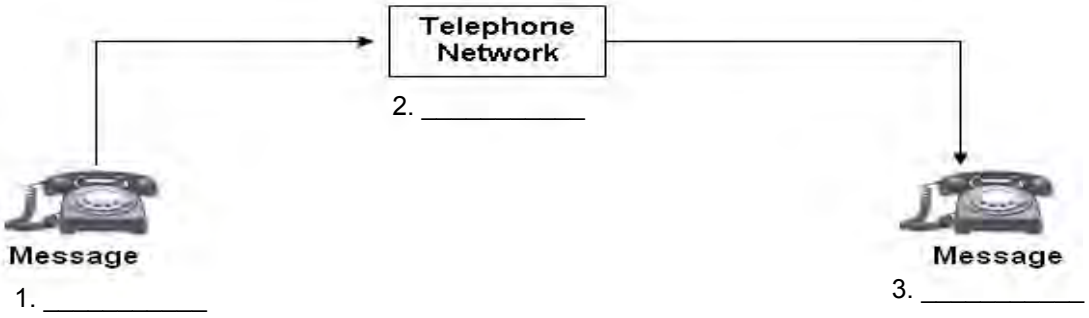
1. What do you call the part of the telephone that you talk into?

   _____

2. What is the function of the receiver?

   _____

3. Fill in the missing part of the diagram correctly



4. Describe what a telephone is.

   _____

   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

Answer to Activity

1. radio
2. telephone
3. Alexander Graham Bell
4. antenna
5. cell

Lesson 20: Computers

Welcome to Lesson 20 of Strand 4. In our previous lesson, we discussed how telephones transmit messages. We also discussed the importance of telephones as a means of communication. In this lesson, we will discuss computers as another means of communication.

Your Aims:

- explain how computer transmits messages
- list the uses of computer
- describe the importance of computer as a means of communication

You've probably known about computers your whole life. But computers have not really been around for very long. Computers started to become popular with big companies in the 1960s. Computers did not become widespread in homes and schools until the 1980s. In Papua New Guinea schools, computers were introduced in 1990s.

What Is A Computer?

A computer is a machine that performs tasks, such as calculations or electronic communication, under the control of a set of instructions called a program. Programs usually exist within the computer and are taken and processed by the computer's electronics. The program's results are stored or sent to output devices, such as video display monitors or printers. Computers perform a wide variety of activities reliably, accurately, and quickly.

Computers are not just desktops and laptops. Computers are everywhere around your home. Have you ever been in towns before? Have you ever used a TV set or watched a video? There are tiny computers inside microwave ovens, television sets, and videocassette recorders (VCRs) or digital video disc (DVD) players. There are even tiny computers in cars to help them run better. Cell phones and watches contain tiny computers that can store information such as telephone numbers, addresses, and appointments. These devices allow you to surf the Web and play games.

Uses of Computers

There are so many uses of computers today and it is used in many ways. Big stores use computers to keep track of products and check you out at the cash register. All our banks use computers to send money all over the world. In Papua New Guinea schools in urban areas, they used computers to keep track of the student's marks and grades. Students use computers to do research and learn also. Computers let you hook up to *networks* (many computers hooked together). They let you hook up to a worldwide network called the Internet. Scientists use computers to solve research problems. Engineers use computers to make cars, trucks, and airplanes. Architects use computers to design houses and other buildings. The police use computers to track down criminals. The military uses computers to make and read coded messages.

How does a Computer Work?
Computers can be quite complicated if we are to look at it in detail, so, we are just going to talk about it briefly. The computers that we use need what is known as hardware and software in order to work.

Your desktop or laptop and all the parts inside are called **hardware**. The central processing unit (CPU) makes the computer work. The keyboard, mouse, printer, and monitor are also pieces of computer hardware. Memory chips are hardware that stores information and instructions. Information also gets stored on the hard disk drive.

The programs that run the computer are called **software**. The computer operating system is a software that tells the computer how to run. Applications or programs are softwares that do certain tasks. For example, Word-processing programs is a software programme, that lets you write letters or do your written assignments or reports. There are many other software programs also that we can be able to use also.

Summary

You have come to the end of lesson 20. In this lesson you have learnt that:

- the computers that we use need what is known as a hardware and software in order to work.
- the keyboard, mouse, printer, and monitor are also pieces of computer Hardware.
- the programs that run the computer are called software.
- the computer operating system is a software that tells the computer how to run.
- applications or programs are software that do certain tasks. For example, a word processing program.

NOW DO PRACTICE EXERCISE 20 ON THE NEXT PAGE

Practice Exercise 20

Answer the following questions:

1. What does CPU stand for?

   _____

2. What is the function of the CPU?

   _____

3. Describe what a software does.

   _____

4. List at least two uses of a computer.

   _____

   _____

5. Name a device that contains computer in them.

   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF THE STRAND.

REVIEW OF SUB STRAND 4: COMMUNICATION AND INFORMATION

Revise all the lessons in this Sub-strand and then do **ASSIGNMENT 4.**
Here are the main points to help you revise.

Lesson 16: Speaking and Listening

- Sounds are produced by vibration of something, which causes the particles to vibrate and move apart.
- Sound travels by waves. This is called sound waves. These sound waves are passed on by vibrating particles until it reaches the other side.
- The vocal cords produce sound in the throat as is being pushed out from our lungs.
- Sound is a form of energy like light. It travels through the air at a speed of.330 metre per second.
- The vibrations of ear bones are changed into electrical signals in the cochlea. These signals are impulses and are sent to the brain.

Lesson 17: Radio

- Radio simply means sending and receiving messages by electromagnetic waves
- A radio works by changing sounds into electrical signals.
- The electrical signals are then amplified and transmitted through electromagnetic waves known as radio waves.
- A radio is a means of communication

Lesson 18: Metals and Minerals in Papua New Guinea

- Television is a system of sending and receiving pictures and sound by means of electronic signals.
- A TV picture starts with a TV camera.
- Television shows are made in television studios, some are broadcast live, taped in the studio, made outside of studios, broadcasted —onthe scene," and some are made on sets.
- Producers and Directors make sure that the best pictures with the best views go to your TV screen at home.
- Picture and sound signals go from the control room to a transmitter.
- TV signals can get to the TV set at your home in several ways.
- TV set changes the television signals back into pictures and sound.
- Colour TV set uses three electron guns to beam out three colours—red, green, and blue.
- Television is the most widespread form of communication in the world.
- The most common use of television is as a source of information and entertainment for viewers in their homes.

Lesson 19: Telephone

- The **telephone** often referred to as a **phone**, is a communication device that transmits and receives sound, most commonly the human voice.
- Telephones are a point-to-point communication system whose most basic function is to allow two people separated by large distances to talk to each other.
- Telephones are very important in our lives as they allow a person to communicate with each other directly.

Lesson 20: Computers

- The computers that we use need what is known as hardware and software in order to work
- The keyboard, mouse, printer, and monitor are also pieces of computer Hardware
- The programs that run the computer are called softwares.
- The computer operating system is a software that tells the computer how to run.
- Applications or programs are softwares that do certain tasks. For example, a word processing program.

REVISE WELL AND THEN DO SUB STRAND TEST 4 IN YOUR ASSIGNMENT 4

Answers to Practice Exercises 16- 20

Practice Exercise 16

Part A

1) Liquids
2) Vibrations
3) Ear bone
4) Vacuums

Part B

1. They cry when they are hungry.

2. The dog growls then barks at you.

3. He moans when in pain.

4. The toad croaks during the mating season.

Practice Exercise 17

1. Two-way radio
2. Transistor radio
3. Two-way radio
4. Transistor radio
5. Two-way radio
6. Transistor radio

Part B:

No.	Job	Description of how they use radio.
1	pilot	- communicates with the control tower
2	Ship captain	- communicates with other ship. - communicates with people on the wharf when entering and leaving the wharves.
3	Navy officer	- reports and communicates to navy headquarters of their patrols.
4	Ambulance officer	- communicates with emergency medical officer at the hospital about a patient's condition.

Practice Exercise 18

Part A: Write True or False

10. **True**

11. **True**

12. **True**

13. **True**

14. **False**

15. **False**

16. **True**

17. **False**

18. **False**

19. **False**

Part B: Short Answers

1. (a) TV show created

(b) TV show transmitted

(c) TV show received

2. sending and receiving

3. TV camera.

4. sweep

5. three , three

6. Red, green and blue

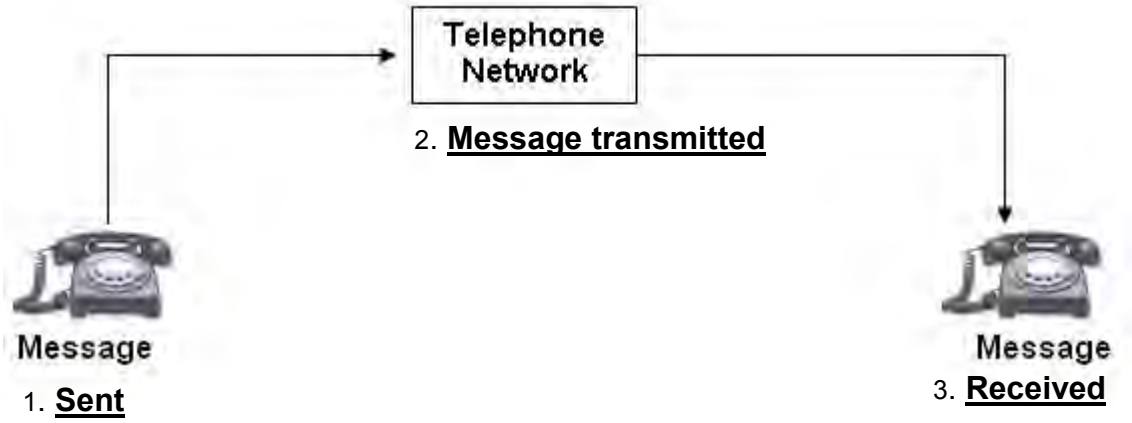
7. They can go through the air to an antenna on your roof or they could come right to your house from a satellite circling high above the Earth.

Practice Exercise 19

1. Microphone

2. The receiver turns the electrical signals into sound waves that can be heard by the person receiving the message.

3.



4. The telephone is a communication device that transmits and receives sound, most commonly the human voice.

Practice Exercise 20

1. **Central Processing Unit**

2. **The CPU makes the computer work.**

3. **A software is a program that runs the computer. The computer operating system is a software that tells the computer how to run.**

4.

- **Big stores use computers to keep track of their products and check you at the cashier.**
- **All our banks use computers to send money all over the world.**
  (all answers relating to use of computers is accepted)

5. **Cell phones or mobile phones**

GLOSSARY

Astronauts	somebody trained to travel and perform tasks in space
Astronomy	the scientific study of the universe, especially of the motions, positions, sizes, composition, and behaviour of astronomical objects
Cosmonauts	an astronaut in the space programs of Russia and the former Soviet Union
Satellites	are satellite which orbit the equator of the Earth
Magma	molten rocks
Satellite	is an object that orbits or revolves around another object.

References

1. Anderton, John, and the Papua New Guinea Department of Education. Fundamental Science For Melanesia Book 1, South Melbourne, Addison Wesley Longman Australia Pte Limited, 1988

2. Anderton, John, and the Papua New Guinea Department of Education. Fundamental Science For Melanesia Book 4, South Melbourne, Addison Wesley Longman Australia Pte Limited, 1988

3. Watson, Geoff. Science Works 2. New York: Oxford University Press, 2001.

FODE PROVINCIAL CENTRES CONTACTS

PC NO.	FODE PROVINCIAL CENTRE	ADDRESS	PHONE/FAX	CUG PHONE (COORDINATOR)	CUG PHONE (SENIOR CLERK)
1	ALOTAU	P. O. Box 822, Alotau	6411343/6419195	72228130	72229051
2	BUKA	P. O. Box 154, Buka	9739838	72228108	72229073
3	CENTRAL	C/- FODE HQ	3419228	72228110	72229050
4	DARU	P. O. Box 68, Daru	6459033	72228146	72229047
5	GOROKA	P. O. Box 990, Goroka	5322085/5322321	72228116	72229054
6	HELA	P. O. Box 63, Tari	73197115	72228141	72229083
7	JIWAKA	c/- FODE Hagen		72228143	72229085
8	KAVIENG	P. O. Box 284, Kavieng	9842183	72228136	72229069
9	KEREMA	P. O. Box 86, Kerema	6481303	72228124	72229049
10	KIMBE	P. O. Box 328, Kimbe	9835110	72228150	72229065
11	KUNDIAWA	P. O. Box 95, Kundiawa	5351612	72228144	72229056
12	LAE	P. O. Box 4969, Lae	4725508/4721162	72228132	72229064
13	MADANG	P. O. Box 2071, Madang	4222418	72228126	72229063
14	MANUS	P. O. Box 41, Lorengau	9709251	72228128	72229080
15	MENDI	P. O. Box 237, Mendi	5491264/72895095	72228142	72229053
16	MT HAGEN	P. O. Box 418, Mt. Hagen	5421194/5423332	72228148	72229057
17	NCD	C/- FODE HQ	3230299 ext 26	72228134	72229081
18	POPONDETTA	P. O. Box 71, Popondetta	6297160/6297678	72228138	72229052
19	RABAUL	P. O. Box 83, Kokopo	9400314	72228118	72229067
20	VANIMO	P. O. Box 38, Vanimo	4571175/4571438	72228140	72229060
21	WABAG	P. O. Box 259, Wabag	5471114	72228120	72229082
22	WEWAK	P. O. Box 583, Wewak	4562231/4561114	72228122	72229062

FODE SUBJECTS AND COURSE PROGRAMMES

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language& Literature
	2. Mathematics - Mathematics A / Mathematics B
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) subjects.
- For Grades 9 and 10, you must complete five (5) subjects and one (1) optional to be certified. Business Studies and Design & Technology – Computing are optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) subjects to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject and course.

Notes: You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

GRADES 11 & 12 COURSE PROGRAMMES			
No	**Science**	**Humanities**	**Business**
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics A/B	Mathematics A/B	Mathematics A/B
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

CERTIFICATE IN MATRICULATION STUDIES		
No	**Compulsory Courses**	**Optional Courses**
1	English 1	**Science Stream:** Biology, Chemistry and Physics
2	English 2	**Social Science Stream:** Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.