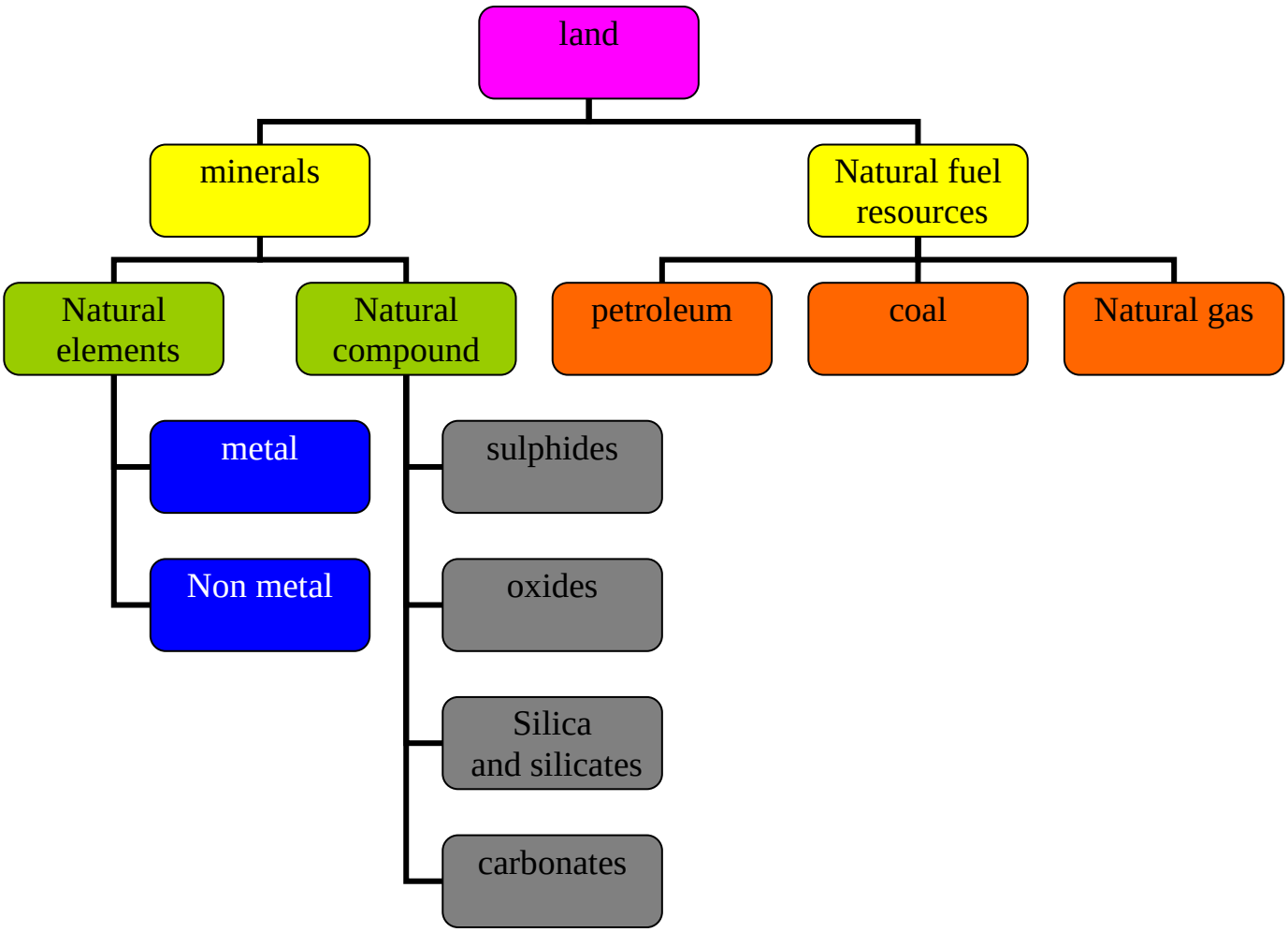
CHAPTER 6: LAND AND ITS RESOURCES



6.1 The Various Minerals Found in the Earth's Crust.

1.. Mineral is natural element or compound found in the Earth's crust.

2. A mineral has a composition and a specific crystalline structure. Examples of minerals are calcite, feldspar, quartz, mica, marble and silicate.

3.. Only inactive elements can exist freely in the Earth's crust. Meanwhile, active elements will react with other elements to form particular compounds.

4.. Natural elements commonly found in the Earth's crust are gold, silver, platinum, mercury and arsenic.

5.. Table below shows the percentage of elements in minerals found in the Earth's crust.

elements	% by weight
oxygen	46.6
silicon	27.7
aluminium	8.1
iron/ferrum	5.0
calcium	3.6
sodium	2.8
potassium	2.6
magnesium	2.1
titanium	0.4
hydrogen/carbon	0.14

6. Almost 75% of the weight of a mineral in the Earth's Crust is made up of oxygen and silicon elements. Thus, silicate minerals which contain oxygen and silicon elements make up the largest amount. Examples of silicate minerals include quartz, feldspar, mica and clay.
7. Minerals that do not contain silicon element are known as non-silicate minerals. Examples of non silicate minerals are calcite, dolomite, magnetite and hematite.
8. Other non metallic elements such as oxygen, sulphur and carbon usually exist in the form of compounds such as oxides, sulphides and carbonates.
9. Less active elements combine with oxygen and sulphur to form oxides and sulphides such as iron oxide, aluminium oxide, lead sulphide and iron sulphide.

Element in Natural Compounds

Types of compounds	Elements present
Oxides	metal and oxygen
Carbonates	metal, carbon and oxygen
Sulphides	metal and sulphur
Silicates	metal, silicon and oxygen
Silica	silicon and oxygen

10. Sulphides react with oxygen to form sulphates. On the other hand, oxides will convert into carbonates when reacting with water and carbon dioxide.

11. Table below shows a few examples of minerals compounds found in the Earth's Crust.

Types of minerals	Examples Of Natural Minerals	Chemical name (Mineral Content)	Elements in the mineral
oxides	bauxite	aluminium oxide	Aluminium and oxygen
	hematite	iron oxide	iron and oxygen
	magnetite	magnesium oxide	Magnesium and oxygen
	cassitetite	tin oxide	tin and oxygen
sulphide	galena	lead sulphide	lead and sulphur
	pyrite	iron sulphide	iron and sulphur
	chalcocite	copper sulphide	copper and sulphur
	blende	zinc sulphide	zinc and sulphur
carbonate	calcite (marble)	calcium carbonate	calcium, carbon and oxygen
	magnesite	magnesium carbonate	Magnesium, carbon and oxygen
	dolomite	magnesium carbonate	Magnesium, carbon and oxygen
	malachite	copper carbonate	copper, carbon and oxygen

Lime stone	calcium carbonate	calcium, carbon, oxygen
Clay	aluminium silicate	aluminium, silicon, oxygen
Mica	potassium aluminium silicate	potassium, aluminium, silicon, oxygen
lime water	Calcium chloride	calcium chloride oxygen

12. Different minerals have different characteristics. Minerals posses different characteristic in terms of:
    i. hardness
    ii. solubility in water
    iii. reaction to heat and its effects.

I. Hardness of Minerals

1. Hardness of mineral refers to the resistance offered by the mineral on being scratched. The hardness of a mineral is measured in Moths unit.
2. Most minerals are hard. These minerals can only be scratched by hard objects such as knives. Nevertheless, hard minerals can scratch softer minerals.
3. All minerals made up of carbonate, oxide and sulphide compounds are hard.
4. Diamond is the hardest mineral while talc is the softest mineral.
5. The Moths Scale of hardness (in 1824, an Austrian scientist Friedrich Mohs) shown below.

Moths' scale	hardness value	Clue
Talc (softest)	1	Tarzan
Gypsum	2	George
Calcite	3	Can
Fluorite	4	Force
Apatite	5	A
Feldspar	6	Fat
Quartz	7	Queen
Topaz	8	To
Corundum	9	Carry
Diamond (hardnest)	10	Diamond

II. Solubility of Minerals in Water

1. All minerals of metal oxides, sulphides and carbonates are insoluble in water, except minerals of metallic potassium and sodium compounds.
2. The following experiment shows the solubility of various mineral in water. Conclusion: metals such as potassium and sodium are very active their compounds are soluble in water.

iv. The Effect of Heat on Some Metal Carbonates, Oxides and Sulphides.

i. Action of Heat on Metal Carbonates

1. All metal carbonates decompose when heated, except potassium carbonate and sodium carbonate because both the metal carbonates are very stable.
2. The heating of metal carbonates form metal oxides and carbon dioxide gas.

Metal carbonates $\xrightarrow{\text{Heat}}$ metal oxide (solid) + carbon dioxide (gas)

3. examples;

a. calcium carbonates $\xrightarrow{\text{heat}}$ calcium oxide + carbon dioxide

b. zinc carbonates $\xrightarrow{\text{heat}}$ zinc oxide + carbon dioxide

c. iron carbonates $\xrightarrow{\text{heat}}$ iron oxide + carbon dioxide

d. Copper carbonate $\xrightarrow{\text{heat}}$ ..... + ...

e. lad carbonate $\xrightarrow{\text{heat}}$ ..... + ...

4. Carbon dioxide gas released can be tested with:
   i. turn lime water milky
   ii. extinguished burning splinter
   iii. changes red bicarbonate indicator to yellow

lukis rajah 6.2 m/s 102

ii. Action of Heat on Metal oxides

1. Most metal oxides are stable and do not decompose when heated.
2. Nevertheless, mercury oxide and argentums oxide are exceptions. Both these metal oxides will decompose into oxygen gas and their original metal when heated.

Mercury oxides $\xrightarrow{\text{Heat}}$ solid mercury + gas oxygen

3. examples;

argentums oxides $\xrightarrow{\text{heat}}$ argentum + oxygen

4. Oxygen gas released can be tested with;
   i. the glowing splinter will burn brightly

lukis rajah 6.3 m/s 102

iii. Action of Heat on Metal Sulphides

1. Most metal sulphides will decompose when heated strongly to form metal oxides and produce sulphur dioxide gas.

Metal sulphides $\xrightarrow{\text{Heat}}$ solid metal oxide + gas sulphur dioxide

2. examples (when heated);

iron sulphides $\xrightarrow{\text{heat}}$ iron oxide + sulphur dioxide

zinc sulphides $\xrightarrow{\text{heat}}$ zinc oxide + sulphur dioxide

lead sulphides $\xrightarrow{\text{heat}}$ lead oxide + sulphur dioxide

3. Sulphur dioxide gas released is acidic, has a pungent smell and;
   i. bleaches acidic purple potassium manganate (VII) colourless
   ii. converts orange acidic potassium dichromate (VI) to green.

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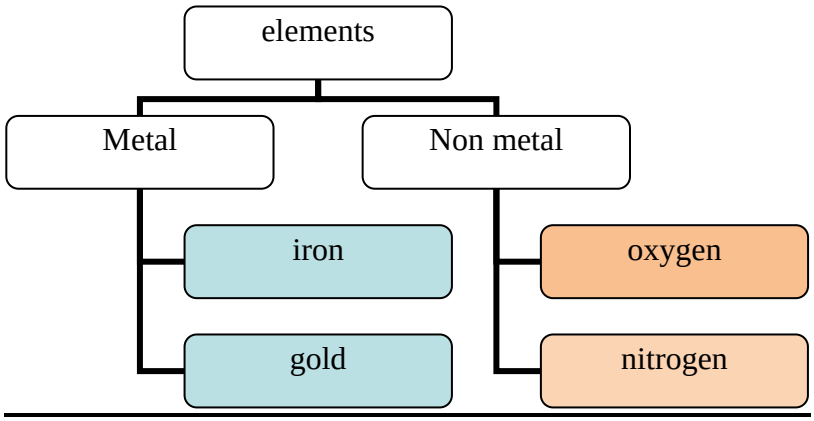
<u>Conclusion</u>

The effect of heat on some mineral		
The effect of heat on carbonates (carbon dioxide is released)	The effect of heat on oxides (oxygen is released)	The effect of heat on sulphides (sulphur dioxide is released)
Turn lime water milky Extinguished burning splinter Changes red bicarbonate indicator to yellow	The glowing splinter will burn brightly	Bleaches acidic purple potassium manganate (VII) colourless Converts orange acidic potassium dichromate (VI) to green.

6.2 Reactions between Metals and Non-Metals



6.2.1 Metals

1. Metals are elements that have the following properties:
   a. have shiny surfaces and can be polished.
   b. Metal are good conductors of electricity.
   c. Metal are elastic, that is can be beaten into specific shapes.
   d. Metal have very high melting points.
2. Examples of metals are magnesium, aluminium, zinc, iron, silver, mercury, copper, lead and platinum.

6.2.2 Non-Metals

1. Non metal are elements that have the following properties:
   a. have dull surfaces (do not shine)
   b. non metals are poor heat conductors
   c. non metals are poor electrical conductors
   d. non metals have low densities
   e. non metal are brittle, easily broken up when beaten
   f. non metal have low melting points.
2. Examples of non metals are oxygen, carbon, sulphur, bromine, iodine, chlorine and hydrogen.

3. Examples of non-metal and metal are shown below:

METAL	NON-METAL
Magnesium	oxygen
Aluminium	sulphur
Zinc	chlorine
Iron	fluorine
Tin	phosphorus
Lead	carbon
Copper	silicon
Calcium	hydrogen

6.2.3 Reaction between Metals and Oxygen PMR 04

1. Most metal will react with oxygen to form more stable compounds.
2. Metals can react with oxygen to form metal oxides.

Metal + oxygen $\xrightarrow{\text{react}}$ metal oxide

Examples:

a. iron + oxygen $\xrightarrow{\text{react}}$ iron oxide (rusty red)
b. zinc + oxygen $\rightarrow$ zinc oxide (white)
c. lead + oxygen $\rightarrow$ lead oxide (yellow)
d. copper + oxygen $\rightarrow$ copper oxide (black)
e. aluminium + oxygen $\rightarrow$ .....
f. magnesium + oxygen $\rightarrow$ .....

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3. less reactive metals such as silver, gold and platinum do not react with oxygen.

4. The degree of reactivity of metal with oxygen differs depending on the reactivity of the metal.

type of metal	degree of reactivity with oxygen
potassium (most reactive)	very vigorous
Sodium	
Calcium	
Magnesium	
Aluminium	
Zinc	
Iron	
Tin	
copper (less reactive)	least vigorous

PSC MAZI TC

6.2.4 Reaction between Metals and Sulphur PMR 06

1.. Most metal react with sulphur to form more metal sulphides.

Metal + sulphur $\xrightarrow{\text{heat}}$ metal sulphide

Examples:

a. iron + sulphur $\xrightarrow{\text{heat}}$ iron sulphide

b. zinc + sulphur $\xrightarrow{\text{heat}}$ zinc sulphide

c. lead + sulphur $\xrightarrow{\text{heat}}$ lead sulphide

d. magnesium + sulphur $\xrightarrow{\text{heat}}$ .....

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2.. Reactive metals reach more vigorously with sulphur than less reactive metals.

type of metal	degree of reactivity with sulphur
potassium (most reactive)	very vigorous
Sodium	
Magnesium	
Aluminium	
Zinc	
Iron	
Tin	
Lead	
copper (less reactive)	least vigorous

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6.3 Silicon Compound

1. Silicon is non-metallic element that is the second most abundant element after the element oxygen in the Earth's crust.
2. Silicon does not exist as a free element in its natural states but combines with other elements to form compounds. Examples of silicon compounds are silica and silicate.
3. Characteristic of silicon:
   a. Do not dissolve in water
   b. Do not react with acid
   c. Do not decomposed when heated

6.3.1 Silica

a. When silicon is heated with oxygen, a new compound known as silicon dioxide or silicate is formed. Silica is also a silicon compound.

Silicon + oxygen $\xrightarrow{\text{heat}}$ silicon dioxide (silica)

b. Examples of silica include sand, sandstone, quartz, jasper and opal.

c. Silica is a stable compound and is not decomposed by action of heat. Silica also does not react with dilute hydrochloric acid.
d. Silica is not soluble in water, is acidic and can neutralise alkaline solution.

6.3.2 Silicate

a. Silicate is silicon compound made up of metal element that combines with silicon element and oxygen.
b. Silicate can also be produced from neutralisation reaction between silica and alkali.

$$\text{Silica + alkali} \xrightarrow{\text{neutralisation reaction}} \text{silicate salt and water}$$

c. Silicate is not decomposed by heat and cannot react with dilute hydrochloric acid. Silicate is also insoluble in water except sodium silicate. Examples of silicate are asbestos, mica, feldspar and clay.

The characteristic of silica and silicate

CHARACTERISTICS	SILICA	SILICATE
solubility in water	insoluble	insoluble (except sodium silicate)
action by heat	do not decomposed	do not decompose
react with dilute acid	no reaction	no reaction

6.3.3 Uses of silica and silicate in life

1. Silicon compounds (silica and silicate) have many uses.
2. The uses of these silicon compounds are shown in table below.

silicon compound	Uses
Silica	to manufacture glasses, bricks, mortar, concrete and cement.
Clay	to make ceramic product (earthenware, porcelain, tiles, vases)
sodium silicate	to preserve eggs, furniture polish and silica gel.
Mica	as electrical insulators in electric irons.
coloured silicate (topaz, jade, ruby)	to make jewellery.
Asbestos	as heat insulator, to make protective clothing of firefighters.
Talcum	to make powder.

6.4 Calcium Compounds

1. Calcium is a metallic element that is very reactive and exists freely in natural form.
2. Calcium compound is commonly found in the Earth's crust as calcium carbonate.
3. Calcium carbonate is the chemical name for lime element that is formed from 3 types of elements, which are calcium, carbon and oxygen.
4. Examples of calcium compounds are:
   a. lime
   b. Lime stone
   c. marble
   d. calcite
   e. gypsum
   f. shell of sea animals
   g. bones and teeth
   h. egg shells.

5. The characteristics of calcium carbonate are: PMR 03, 04
   a. insoluble in water
   b. soluble in water containing dissolved carbon dioxide gas to form calcium hydrogen carbonate.
   c. It reacts with dilute acid to produce calcium salt water and carbon dioxide.

d. It decomposes into calcium oxide quicklime and carbon dioxide when heated. PMR 07, 08
e. Calcium oxide dissolves a little in water to form calcium hydroxide slaked lime and heat energy is released.

7 The properties of calcium carbonate

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8 Calcium oxide and calcium hydroxide
9 The uses of calcium compounds.

10 Natural fuel resources and their importance.

a. Formation of natural fuel resources.
   i. Natural fuel resources include fossil fuels such as petroleum, natural gas and coal.
   ii. Coal is formed from plants that grew in swamps millions of years ago.
   iii. Petroleum and natural gas are formed from plants and animals that lived in the sea or on the land millions of years ago.
      1. When these animals and plants died, their remains became buried under mud and sand at the bottom of the sea.
      2. High pressure and heat slowly changed the mud and sand into rocks and the remains of the animals and plants into petroleum and natural gas. PMR 08

b. Characteristics and uses of petroleum fractions
   i. Fossil fuel are hydrocarbons (hydrogen and carbon)
   ii. Petroleum is a mixture of many types of hydrocarbons which need to be separated before can be used.
   iii. The hydrocarbons in the petroleum have different boiling points.

iv. Therefore, the petroleum can be separated into various components by fractional distillation.
v. The components which are separated are called fractions or distillates.

6. The higher the boiling point of a fraction of petroleum, PMR 03, 05, 08
   1. the darker its colour
   2. the higher the viscosity
   3. the colour of the flame become more yellowish
   4. more soot produced when burnt
   5. more difficult to burn in air

figure fractionating column

7. The uses of the products of distillation of petroleum. PMR 07

Petroleum fraction	Uses	Clue
Petroleum gas	Fuel to make plastic and cooking oil	Girl
Petrol (gasoline)	Fuel for motor vehicles and machine	Pondan
Naphtha	Fuel making plastic and PVC	Nak
Kerosene	Fuel for jet aircraft and rocket	Kahwin
Diesel oil	Fuel for diesel engine	Dengan
Lubricating oil	Fuel for engine and machine	Lelaki
Fuel oil	Fuel for ship and electric generators	Fantasi
Wax	Fuel to make polish, candle	
Bitumen	Fuel to seal road surface	beb

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8. Fractional distillation of petroleum

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9. Importance of the petroleum and natural gas industry.
10. Using natural resources efficiency

.....Tammat the end

CALCIUM CARBONATE (LIME STONE/MARBLE)

HEATED

CALCIUM OXIDE (QUICK LIME)

ADD A LITTLE WATER

SOLID CALCIUM HYDROXIDE (SLAKED LIME)

DISSOLVES IN WATER

CALCIUM HYDROXIDE SOLUTION (LIME WATER)