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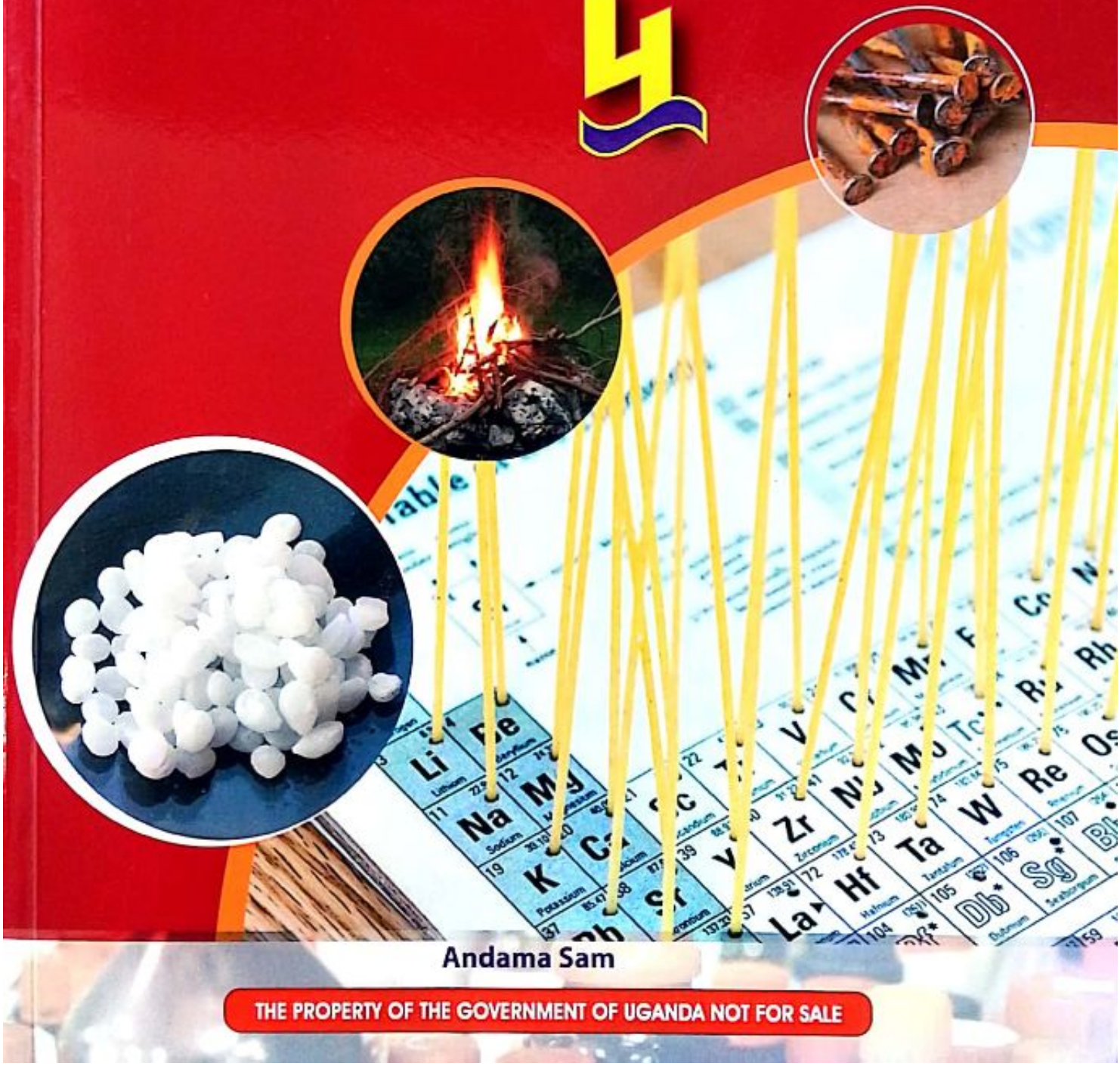
LOWER SECONDARY

CHEMISTRY

LEARNER'S BOOK

4



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Rationale

The change in learning

This text book is designed to support and guide you, as the learner who has reached senior four in the new reviewed curriculum. The review focused on building you or any learner with; competences and abilities that are required in the job market, promoting values and attitudes that will make the community you live in be proud of you, providing effective learning and acquisition of skills in order to reduce unemployment among you (as learners) who upon reaching any level of lower secondary education. This implies that any time you leave school, you are as good as a school graduate because you will have acquired some skills to demonstrate to in real life circles and support others.

This Chemistry Learner's Book 4 fully covers all the topics and content required in Senior four Chemistry syllabus. It will equip you with the knowledge, understanding, practical skills applicable in real life, generic skills, values and attitudes for the job market and prepare you for Uganda Lower Secondary School Certificate of Education (ULSCE) examinations. -

This learner's book therefore, is written with instructions that encourage you to study and discover new knowledge and skills on your own. You need to read the texts carefully and do all the activities in relation to the materials that are available from the local environment. You have to engage yourself in conducting research using the available resources such as the library and the Internet in order to enrich yourself in the course of study.

The learning outcomes

It is important that you carefully read through the first section of each chapter, which outlines what the you are expected to achieve. It states, "By the end of this chapter, you should be able to". This is meant to arouse your self-esteem and to motivate you as a self-assured individual.

For the different materials suggested to be used in the different chapters, you are notlimited to the lists provided. Improvisation of locally available materials and low cost is allowed where possible, since you live within a rich environment. You are encouraged as much as possible to use the your experiences to demystify difficult concepts within the chapters. For example, to understand the concept of boiling, use your experience of covering the saucepans for boiling water and then explain why. You are encouraged to share with your peers as you work in

groups to achieve the learning outcomes. Always remind yourself that one cannot live alone and succeed in life; one will always need support from a colleague.

The values

The content and activities in this text book are organised such that one can work as an individual as well as in groups. This is organised in such a way that your are inspired to work and live with each other in harmony. Always support and encourage yourselves to respect each other, be honest and fair as you work in groups. Endeavor as much as possible to understand and apply chemical concepts and principles and different styles of learning and needs, so that the you will develop skills that will be long- term value in an increasingly technological world, rather than focusing on large quantities of factual information.

Generic skills

By using this' text book, you should be inspired to think critically and solve problems, both at school and at your home. As such you encouraged to be creative and innovative in your approach to application of science and technology to solve problems of society. There are activities that prompt you to conduct research. In such instances, you seek guidance from your teacher on how to communicate well with the other people involved. Chemistry has got various dimensions in the 21st century. Hence, your teacher will facilitate you to integrate Information and Communication Technology (ICT) tools and skills into learning of chemical concepts.

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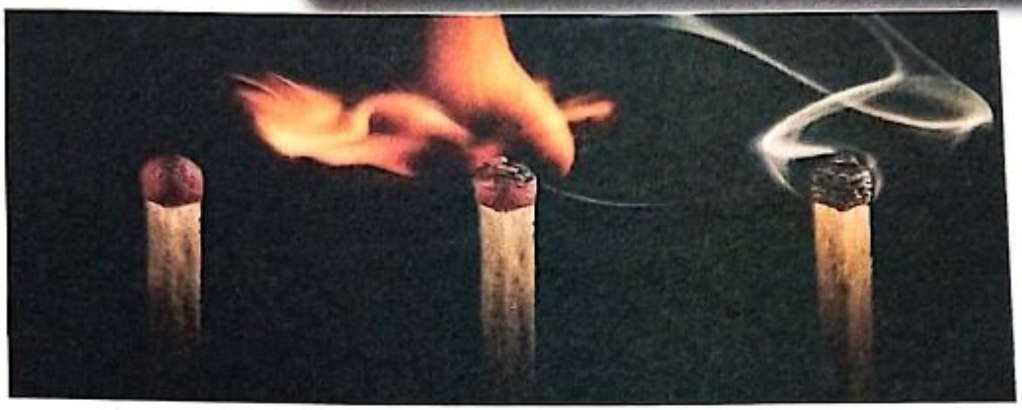
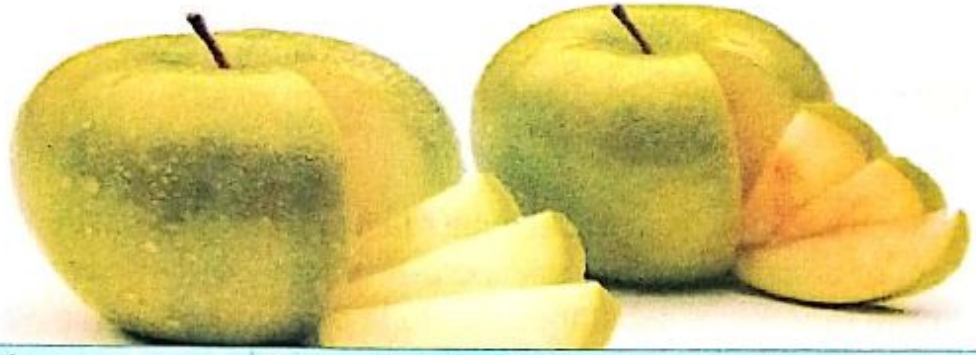
CHAPTER 1: Oxidation and Reduction Reactions





Key words	By the end of this chapter, you should be able to;
o Electrode o Electrolysis o Electrolyte o Electrolytic cell o Electron transfer o Extraction o Oxidation o Reduction o Redox o Oxidation number	o understand the processes of oxidation and reduction and their importance in the chemical industry. o explain redox reactions in terms of electron transfer o understand the changes that take place during the electrolysis of somecompound.

COMPETENCY

The leaner understands oxidation and reduction in terms of gain or loss of oxygen and in terms of electron transfer, and appreciates that the two processes always occur together.

Introduction

Figure.1.1. Browning of an apple

Have you ever cut an apple or avocado into two halves?

Then you might have noticed that immediately on cutting the apple, the cut surface begins to turn brown on exposure to air as shown in Fig.1.1.

If you take a very close look at the cut pieces, you might notice that they turn dark brown on prolonged exposure to air. The browning is as a result of a chemical reaction involving the processes of oxidation and reduction. In this chapter, you will therefore learn more about oxidation, reduction and redox reactions in terms of gain or loss of oxygen and in terms of electron transfer; and also appreciate that the two processes always occur together.

1.1 Oxidation and Reduction Reactions

Oxidation Reactions

The term oxidation was first used to describe reactions in which oxygen combined with an element or a compound to form another substance. However, in terms of a typical chemical reaction, a substance is said to be oxidised if;

- it gains oxygen,
- loses hydrogen,
- loses electrons or increases its oxidation state after a reaction

You are going to explore more about these oxidation reactions in the activities and examples that follow.

Oxidation – In terms of Gain of Oxygen

Activity 1.1: Investigating Burning of Magnesium metal in Oxygen

In this activity, you will work in groups to investigate what happens to magnesium metal when burned in air (oxygen).

What you need;

- Magnesium ribbon
- Sand paper
- Watch glass
- weighing scale
- Spirit lamp or Bunsen burner
- Ruler
- Safety goggle
- Chemical balance
- Pair of tongs

What to do

1. Using ruler measure about 3 - 5cm long piece of magnesium ribbon.
2. Using the sand paper, clean the magnesium ribbon by scrubbing it.
3. Weigh the empty watch glass (mass 1) and then the watch glass containing magnesium (mass 2). Record the masses in your notebook
4. Hold the piece of magnesium with a pair of tongs as in Fig. 1.2.

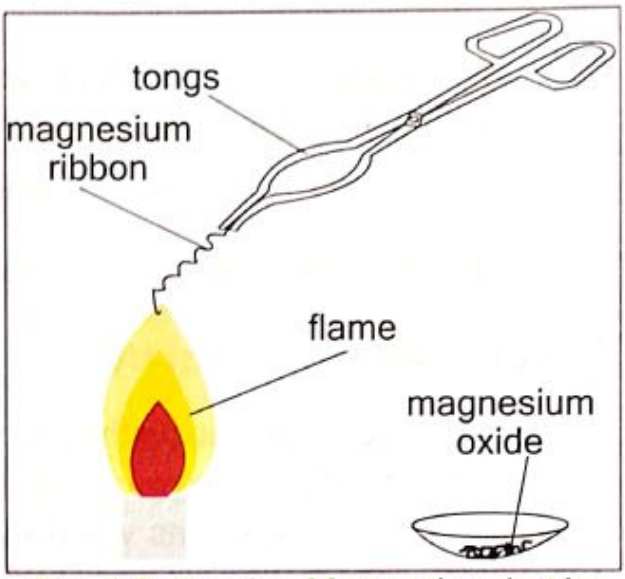


Fig. 1.2. Burning Magnesium in air

5. Burn the magnesium ribbon in the flame and observe what takes place.
6. Collect product formed in the watch-glass as it falls from the pair of tongs.
7. Weigh the watch glass again with the product that is formed after burning magnesium, and record the mass.

Discussion Questions

a. Why was the Magnesium ribbon first scrubbed with sand paper?
b. Describe how the Magnesium ribbon burned in air.
c. What was the colour of the product formed when magnesium burned in air?
d. Determine the mass of the product formed from the results you obtained.
e. What can you deduce about the result you have obtained?
f. Write a word and chemical equation for the reaction between magnesium and oxygen.
g. What conclusion can you make about the reactions that took place when magnesium ribbon burnt in air?
h. In your own words, explain the meaning of term oxidation in terms of oxygen transfer.

EXERCISE 1.1

1. What happens to magnesium when it is oxidised to magnesium oxide,
2. Identify the substances that are oxidised in the reaction below:
   a) Copper + oxygen ⟶ copper(II) oxide
   b) Hydrogen + oxygen ⟶ water

Oxidation as Transfer of Hydrogen.

In activity 1.1 you learnt about the process of oxidation as a chemical reaction that involves the addition of oxygen to a substance. You can also describe oxidation of some chemical reactions when mass involves transfer of hydrogen from a substance.

In activity 1.2, you will explore the process of oxidation in terms of transfer of hydrogen from a substance.

Activity 1.2: Studying the meaning of oxidation in terms of hydrogen

In this activity, you will work in groups as guided by your teacher.

What you need;

- Internet or a chemistry text book.
- Illustration of an equation involving a reaction in which hydrogen atom(s) is or are being lost or removed from a compound as shown in equation below;

Hydrogen Sulphide + Chlorine ⟶ Sulphur + Hydrogen Chloride

$$H_2S_{(g)} + Cl_{2(g)} \longrightarrow S_{(s)} + 2HCl_{(g)}$$

What to do

1. Using internet or text book search for the meaning of oxidation in terms of hydrogen transfer.
2. Critically study the equation above and compare it with your findings from your search from internet or text book.
3. Use the results of your comparison in step 2 above to discuss and explain the meaning of oxidation in term of hydrogen.
4. Present your findings to rest of the class for discussion.

Discussion Questions

a. Explain the meaning of oxidation in terms of transfer of hydrogen

b. Given the equation below,

$H_2S_{(g)} + Cl_{2(g)} \longrightarrow S_{(s)} + 2HCl_{(g)}$

From the equation explain which of the element or compound is;

i) Oxidised

ii) An oxidizing agent

Oxidation in terms of Loss of Electrons

Oxidation reactions can take place even if there is no oxygen or hydrogen present. When a substance loses electrons during a reaction, it is **oxidised**. Therefore, in terms of electron transfer, *oxidation is defined as the loss of electrons from a substance.*

Reduction Reactions

What is reduction?

A reduction reaction is the reverse process of an oxidation reaction. Reduction is said to have taken place if a substance loses oxygen, gains hydrogen, gains electrons or decreases its oxidation state after a reaction. In the following activity you are going to study an example of the process of reduction in terms of loss of oxygen

Reduction in terms of loss of Oxygen

Activity 1.3: Studying what happens when hydrogen is passed over heated copper(II) oxide

In this activity, the teacher will demonstrate what happens when hydrogen is passed over heated copper(II) oxide. You will observe the demonstration by the teacher, and write a report in groups to present to the whole class.

What you need

- Combustion tube
- Copper(II) oxide
- Source of heat
- Bunsen gas
- delivery tubes
- Cork with short glass tube
- Retort stands
- hard glass tube with a small hole near the end

⚠ Caution!!
Be careful as you conduct the heating because the gases can explode

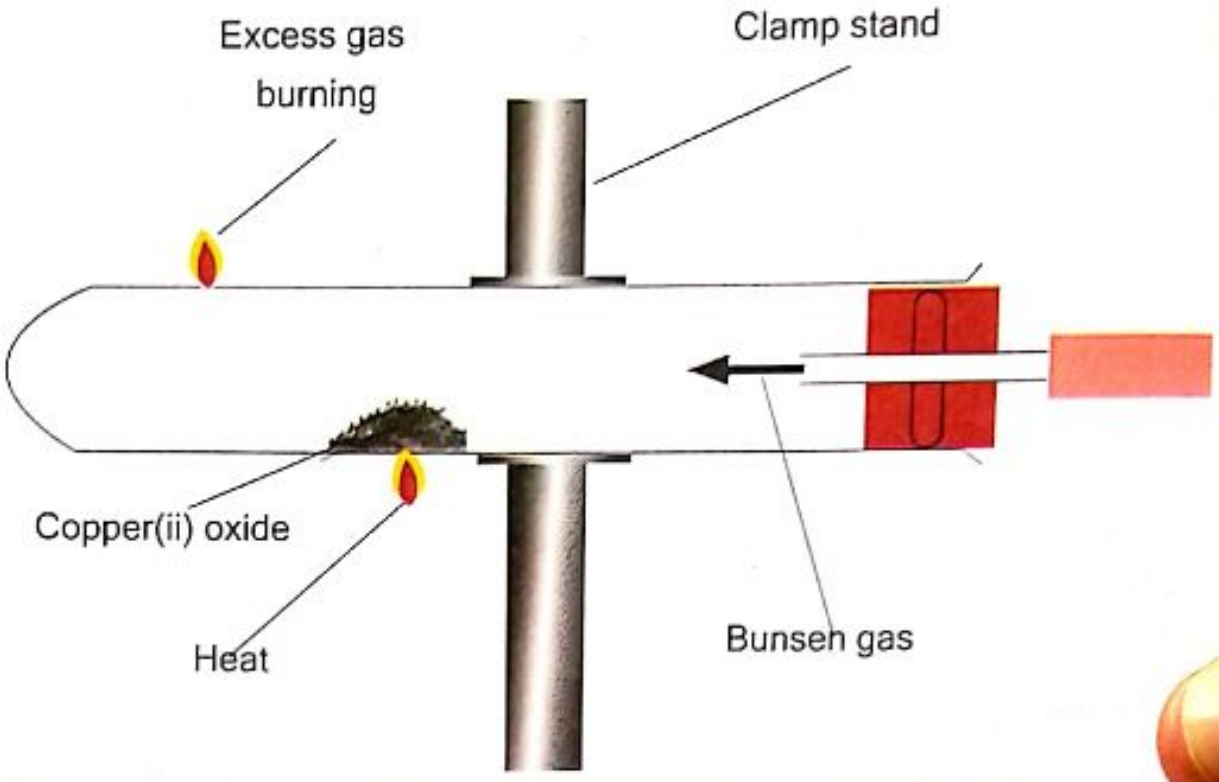


Figure 1.3: Passing hydrogen gas gas over copper (ii) oxide

What to do

1. Place a spatula load of black copper oxide in the combustion tube set up the apparatus as shown in Fig. 1.3.
2. Insert a rubber cork with a short glass tube in the test tube.
3. Connect a rubber tube from a gas cylinder containing Bunsen gas to the glass tube.
4. Allow a very slow stream of gas to flow through the apparatus and burn it at the small hole. Adjust the gas so that the flame is no more than 2 cm in height
5. Heat the copper oxide with a burner until there is a change in colour
6. Remove the heat but maintain the flow of the Bunsen gas of the until combustion tube cooled.
7. Turn off the Bunsen gas once the test tube is cool.

NB: Bunsen gas which contains methane is used instead of using hydrogen which is dangerous and difficult to handle.

Discussion Questions

a. Why was Bunsen gas allowed to flow through the test tube before burning it at the small hole of the test tube?

b. Describe the colour of the product formed on heating copper oxide and allowing hydrogen (Bunsen gas) to pass over it.

c. Why was the Bunsen gas allowed to continue pass through the test tube until it cooled?

d. What is the role of the Bunsen gas (containing hydrogen) in this experiment?
e. What are the products of the reaction?
f. Write a word equation and chemical equation for reaction which took place.
g. In your groups, search for information in books or internet and explain the process of reduction in terms of electron transfer and also gain of hydrogen

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Another example of reduction or oxidation in term of oxygen transfer is;

When a mixture of zinc powder and copper(II) oxide is heated, the following reaction occurs:

$$\text{Zinc(s)} + \text{copper (II) oxide} \longrightarrow \text{zinc oxide} + \text{copper}$$

$$Zn_{(s)} + CuO_{(s)} \longrightarrow ZnO_{(s)} + Cu_{(s)}$$

In this reaction, the copper (II) oxide has lost its oxygen. It is reduced to copper metal.

1.2 Redox reactions

In many chemical reactions both reduction and oxidation take place at the same time. Such reactions are known as **redox** reactions which means reduction oxidation reaction

Redox reactions in terms of electron transfer

Consider the reaction between magnesium and chlorine to form magnesium chloride.

$$\text{magnesium} + \text{chlorine} \longrightarrow \text{magnesium chloride}$$

$$Mg_{(s)} + Cl_{2\,(g)} \longrightarrow MgCl_{2\,(s)}$$

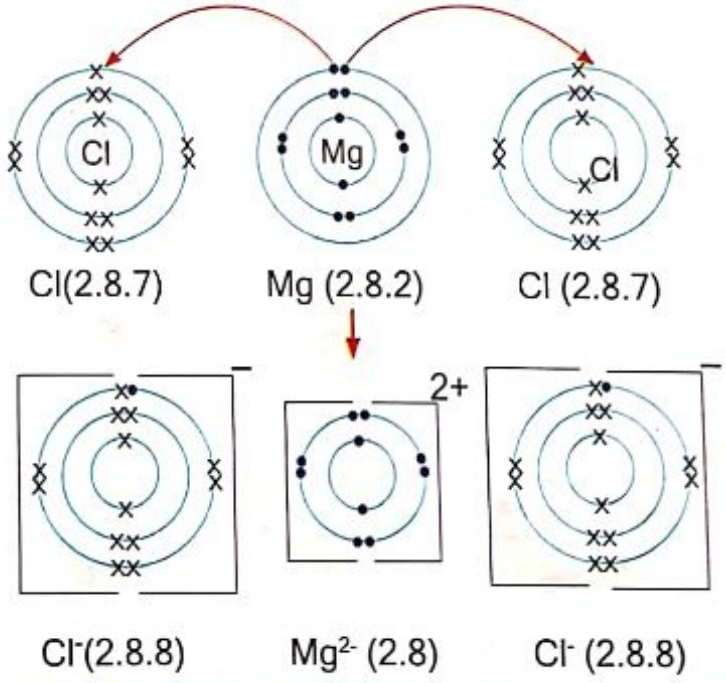


Fig. 1.4. Transfer of electrons during redox reaction

Electrons have been transferred during this reaction. The following half equations represent the transfer of electrons.

$Mg_{(s)} - 2e \rightarrow Mg^{2+}$ — Magnesium atoms lose electrons to form magnesium ions

$Cl_{2(g)} + 2e \rightarrow 2Cl_{(s)}$ — Chlorine molecules gain electrons to form chloride ions

EXERCISE 1.2:

1. What has been oxidised in this reaction between magnesium and chlorine?
2. What happens when copper is placed into silver nitrate solution?

Activity 1.4: Studying what happens when copper metal is placed in a solution of silver nitrate.

In this activity, you will work in groups and find out what happens when strips of copper are placed in a solution of silver nitrate.

What you need;

- silver nitrate solution
- strip of copper metal
- piece of wood
- beakers

What to do;

1 Hang the strip of copper metal onto the wooden rod

2 Place the strip of copper into a beaker containing silver nitrate solution as shown in Fig. 1.5.

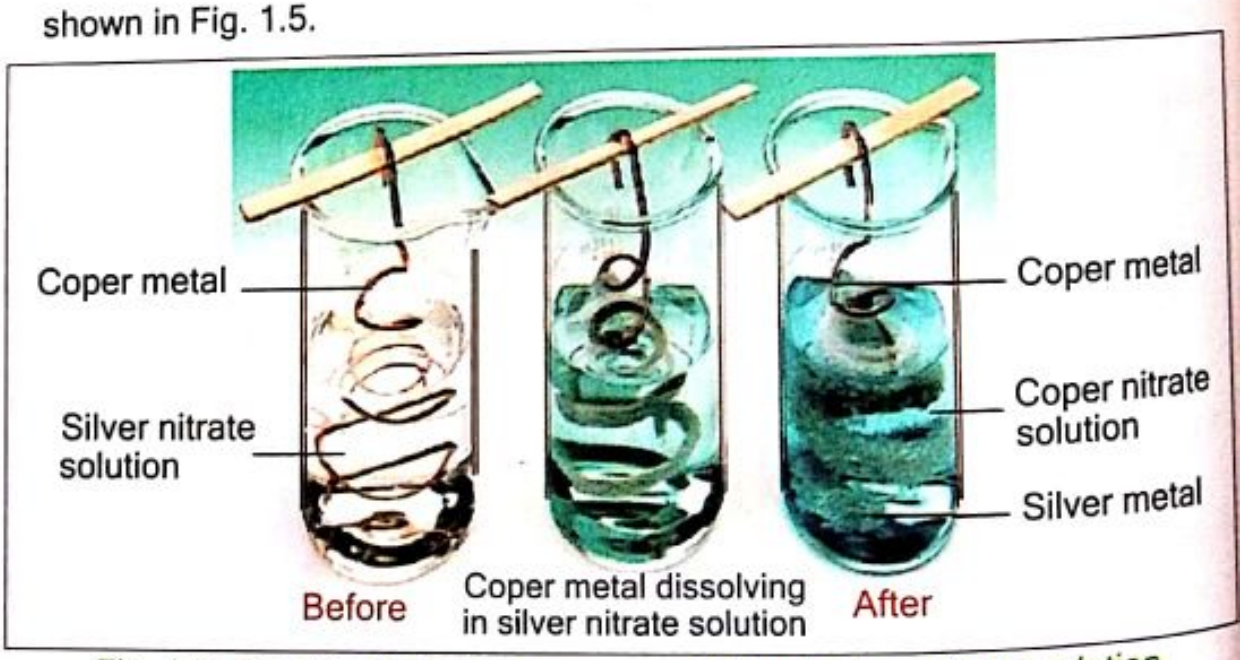


Fig. 1.5. Reaction between copper metal and silver nitrate solution

3 Allow the set up to stand for some time, observe and record what takes place.

Discussion Questions

a. Describe what you observe in the beaker after the reaction.

b. Write a word equation for the reaction that took place.

c. Explain what happens in the reaction using equations.

Oxidation State

The oxidation state is the charge an atom of an element would have if it existed as an ion in a compound (even if it is actually covalently bonded). To work out the oxidation state of an atom, we apply the following rules:

Rule	Example	Oxidation state
1. The oxidation state of a free element is zero.	Cu S Cl_2	0 0 0
2. The oxidation state of a simple ion is equal to the charge on the ion.	Na^+ Cl^- Zn^{2+} O^{2-}	+1 -1 +2 -2
3. The oxidation states on the atoms in the formula of a compound add up to zero. For example Sodium oxide (Na_2O)	2Na O^2	+2 -2

EXERCISE 1.3:

1. a. Determine the oxidation states of the elements in the following compounds:

   i. Na Cl ii. MgO iii. Ca Cl_2

b. Determine the oxidation state of Copper in the following oxides:

   i. CuO ii Cu_2O

Reduction – Gain of Electrons

In terms of electrons, Reduction is gain of electrons by a substance. When hydrogen sulphide gas is passed into iron(III) chloride solution, a green solution of iron(II) chloride and a light yellow precipitate of Sulphur are produced.

iron (III) chloride + hydrogen sulphate → iron (II) chloride + hydrogen chloride + Sulphur

$$2FeCl_{3(aq)} + H_2S_{(g)} \rightarrow 2FeCl_{2(aq)} + 2HCl_{(g)} + S_{(s)}$$

We can rewrite the above chemical equation in the form of an ionic equation.

$$2Fe^{3+}_{(aq)} + H_2S_{(g)} \rightarrow 2Fe^{2+}_{(aq)} + 2H^{+}_{(aq)} + S_{(s)}$$

In this reaction, each iron(III) ion has gained an electron to form an iron(II) ion, i.e

$$2Fe^{3+}_{(aq)} + e^- \rightarrow 2Fe^{2+}_{(aq)}$$

This means that iron(III) ions are reduced to iron(II) ions.

EXERCISE 1.4:

1. Which reaction is an example of reduction?
   a. Copper(II) oxide to copper
   b. Copper(II) oxide to copper(II) sulphate
   c. Iron(II) chloride to iron(III) chloride
2. Which substance is reduced in each of the following equations?

   $PbO_{(s)} + H_{2(g)} \rightarrow Pb_{(s)} + H_2O_{(l)}$

   $H_2S_{(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} + S_{(s)}$
3. Complete the table comparing oxidation and reduction.

Process	Oxygen	Hydrogen	Electrons	Oxidation number
Oxidation				
Reduction				

Redox Reactions

Oxidation and reduction always take place together. In other words, there can be no oxidation without reduction and vice versa. We call the combined process a **redox reaction**.

When steam is passed over heated magnesium, magnesium oxide and hydrogen gas are produced.

magnesium + steam → magnesium oxide + hydrogen

$$Mg_{(s)} + H_2O_{(g)} \rightarrow MgO_{(s)} + H_{2(g)}$$

Has a redox reaction taken place? If yes, explain your answer.

What happens when a black-and -white film is exposed to sunlight?

Black-and-white photographic film contains tiny crystals of silver bromide suspended in gelatin. When a photographic film is exposed to sunlight, the following redox reaction takes place:

$$2AgBr_{(s)} \rightarrow 2Ag_{(s)} + Br_{2(g)}$$

Fig. 1.6: Old black - and - white photographic film turning brown

EXERCISE 1.5:

1. Given the equation below deduce which substance is reduced and which is oxidised.

   (a). $Ag^{+}_{(s)} + e^{-} \rightarrow Ag_{(s)}$

   (b). $2Br^{-}_{(s)} \rightarrow Br_{2(g)} + 2e$

2. For the equation below,fill in words in spaces having question marks to describe the process taking place.

$$2Ag^{+}Br^{-}_{(s)} \xrightarrow{?} 2Ag_{(s)} + Br_{2(g)}$$

Using Oxidation Numbers or Oxidation States

Oxidation number is a number, which is assigned to an atom present in a chemical combination. This number represents the number of electrons that an atom can gain, lose, or share with atom of another element.

Oxidation numbers are typically represented by integers which can be positive, negative or zero.

Oxidation number indicates the oxidation state of an element in a compound.

It is determined by a set of rules according to which electron in a covalent bond belongs entirely to more electronegative element (i.e. the element which has a higher tendency to attract valency electrons toward itself).

$$\overset{+2}{Cu}O_{(s)} + \overset{0}{H_2}{}_{(g)} \xrightarrow{\Delta} \overset{0}{Cu}_{(s)} + \overset{+1}{H_2}O_{(g)}$$

The oxidation number of hydrogen is increased from 0 to +1 and thus hydrogen is oxidized. While the oxidation number of copper is decreased from +2 to 0, and therefore copper is reduced.

Similarly, sodium and chlorine react with each other and form sodium chloride, as shown below:

$$\overset{0}{Na} + \overset{0}{Cl_2} \rightarrow 2\overset{+1}{Na}\overset{-1}{Cl}$$

Oxidised; Reduced

The oxidation number of sodium is increased from 0 to +1 and thus sodium is oxidized. The oxidation number of chlorine is decreased from 0 to -1, and therefore chlorine is reduced.

Activity 1.5: Deducing Oxidised and Reduced Species in a Chemical Reaction

In this activity, you will work in pairs to determine which species are oxidised or reduced in a chemical reaction.

What you need

- Description of some examples of reaction in Table 1.1 below

Table1.1 description of some reaction

List	Example of reaction
a)	Passing ammonia gas over heated Copper oxide
b)	Copper metal and zinc sulphate solution
c)	Burning of magnesium metal in oxygen

What to do

1. Critically study the reaction described in Table 1.1 above.
2. For each of the reactions discuss and find out which species is oxidised or reduced

Discussion Questions

a. Write down the results of your discussion and present your work to the rest of the class.

b. Write five more equations and indicate the oxidised and reduced species in each case

Oxidizing and Reducing Agents

What is an oxidizing agent?

A substance that causes another substance to be oxidised is called an oxidizing agent. An oxidizing agent is reduced when it oxidises another substance.

What is a reducing agent?

A substance that causes another substance to be reduced is called a reducing agent. The reducing agent is oxidised in the process.

In the next activity, you will research and find out the common oxidising and reducing agents.

Activity 1.6: Researching on the Oxidising and Reducing Agents

In this activity, you will work in pairs.

What you need

Internet or chemistry textbooks in the library.

What to do;

1. Using internet or chemistry text book search for information about oxidising and reducing agents.
2. Identify some common oxidizing and reducing agents.

Discussion Questions

a. Write names of the reducing and oxidizing agents you have identified in Table 1.2 below and give reasons for choosing them.

b. Present your findings in Table 1.2 and compare your results with those of other groups.

Table 1.2. Showing examples of oxidising and reducing agents

Oxidising agents	Reducing agents	Reason for classification
$KMnO_4$	KI	

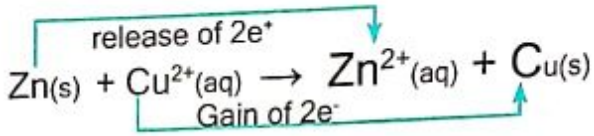
EXERCISE 1.6:

1. Consider the following redox reaction, involving the displacement of copper from its solution:

a) Identify the oxidizing and reducing agents.

b) Explain the reasons for your answers in (a)

2. We can also examine the reaction between zinc and copper(II) sulphate in terms of oxidation states.



$$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$$

a. What has happened to the oxidation states of zinc and copper in the reaction?

b. Giving reasons, explain which of the two is an oxidising and a reducing gent.

c. Write ionic equations to illustrate your answers.

Potassium dichromate as an example of oxidising agent

Acidified Potassium dichromate ($K_2Cr_2O_7$) is a common oxidizing agent. When it oxidises substances in solution, it is also reduced. In activity 1.7 you will demonstrate how Potassium dichromate can oxidises ethanol.

Activity 1.7: Showing that potassium dichromate oxidises ethanol

What you need

- Ethanol.
- Boiling tube.
- Dilute sulphuric acid (2M).
- Potassium dichromate solution.
- Water bath.

⚠ Caution!!
Sulphuric acid is an irritant and should be handled with care.
Ethanol is flammable and should not be heated directly

What to do

1. Transfer about $10cm^3$ of potassium chromate solution into a clean boiling tube.

2. Add about 3cm³ of dilute sulphuric acid.
3. Transfer about 10cm³ of ethanol into the boiling tube.
4. Warm the mixture in a water bath as shown in the Fig. 1.7 .

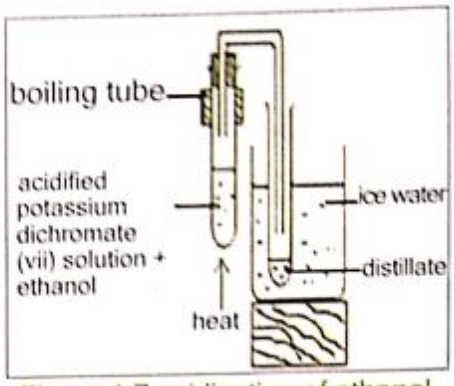


Figure 1.7 oxidisation of ethanol

Discussion Questions

a. State your observation in the boiling tube.
b. Explain the change your observed in the boiling tube.
c. Which other substance can change to the solution of potassium dichlomate

1.3 Electrolysis

Electrolysis is a process where an electric current drives a chemical reaction (which would otherwise not occur) across the electrodes. The medium is called an electrolyte, which may be an ionic solution or a molten mass. A difference in voltage potential across the electrodes causes the ions to migrate according to the electrode potentials, resulting in a complete circuit. The reaction is complete when the ions are exhausted in the electrolyte.

Electrolysis is primarily used in mining where an electric current is passed through a solution containing dissolved metals, causing the metals to be deposited onto the cathode. The electric current causes a forced oxidation-reduction reaction. Electrolysis is an integral part of electro metallurgy and highly pure elements can be produced using this process.

In the next activity, you will research on the key terms used in understanding electrolysis.

Activity 1.8A: Researching on the key terms in understanding electrolysis

In this activity, you will work in groups to find the meaning of the following terms: electrolyte, electrode, conductor, non - conductor, anode, cathode, anion and cation.

What you need

Internet or chemistry text book.

What to do

Using internet or chemistry text book search for information about the meaning

of the following terms; electrolyte, electrode, conductor, non - conductor, anode, cathode, anion and cation

Discussion Questions

a. Explain the meaning of the terms you have obtained from your search from internet or chemistry text book.

b. Present your work to the rest of the class for discussion.

Electrical Conductivity of substances in molten state or solution of electrolyte

A liquid only shows conductivity of electricity with the presence of the free moving charged particles. What happens when electricity is passed through a molten substance or in an aqueous state? In the following activity, you will investigate what happens when electricity is passed through some substances.

Activity 1.8B: Investigating the electrical conductivity of solid and molten substances

In this activity, you will work in groups to classify substances into electrolytes and non- electrolytes. You will investigate what happens when electric current is passed through the substances.

What you need;

- dry cells and bulb
- sodium chloride solution
- connecting wires
- carbon electrodes
- crucible
- pipe clay
- spatula
- beaker
- lead (II) bromide powder
- naphthalene
- tripod stand
- sugar

What to do;

1 Fill two-thirds of the crucible with solid lead(II) bromide.

2 Place the crucible and its contents on a pipe- clay triangle on a tripod stand.

3 Dip the two carbon electrodes into the solid lead(II) bromide and connect the batteries by the connecting wires as shown in Fig. 1.8.

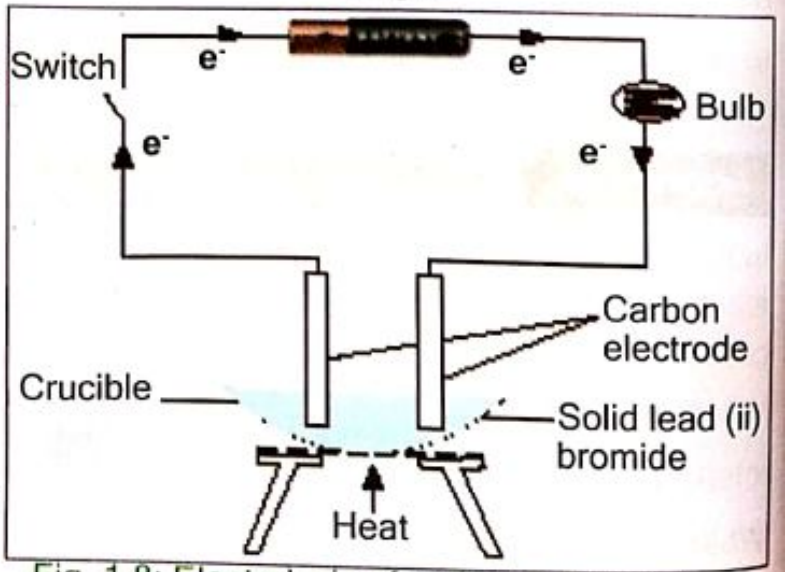


Fig. 1.8: Electrolysis of molten substance

4 Turn on the switch and check whether the bulb lights up. Record your

observation as shown in Table 1.2.

5 Now, heat the lead(II) bromide in the crucible until it melts.

6 Turn on the switch. Observe the changes that take pace to bulb and the electrodes.

7 Repeat steps 1 to 6 by replacing the solid lead(II) bromide with sugar and naphthalene respectively

> ⚠ **Caution!!**
> Be careful not to inhale the bromine vapour as its poisonous.

Table 1.3: Showing results of passing electricity through substances.

Substance	Physical state	Does the bulb light up?	Observation at the electrode	Inference
Lead(II) bromide	solid			
	molten			
Naphthalene	solid			
	Molten			
Sodium chloride	solid			
	aqueous solution			
Glucose	solid			
	aqueous solution			

Discussion Questions

a Which substances conducted electricity? Explain how you arrived at your conclusion.

b Which substances did not conduct electricity? Explain why the other substances did not conduct electricity.

c Make a conclusion about the electrical conductivity of the solid, molten or liquid substances.

Activity 1.8c: Investigating the electrical conductivity of aqueous solution

In this activity, you will work in groups to find out what happens when electricity is passed through a liquid.

What you need;

- Dry cells and bulb
- Connecting wires

- Beaker
- Carbon electrodes
- Sodium chloride solution
- Glucose

What to do;

1 Fill the beaker with sodium chloride solution until it is half full.

2 Dip the two carbon electrodes into the sodium chloride, solution and connect to the batteries by the connecting wires as shown in Fig. 1. 9.

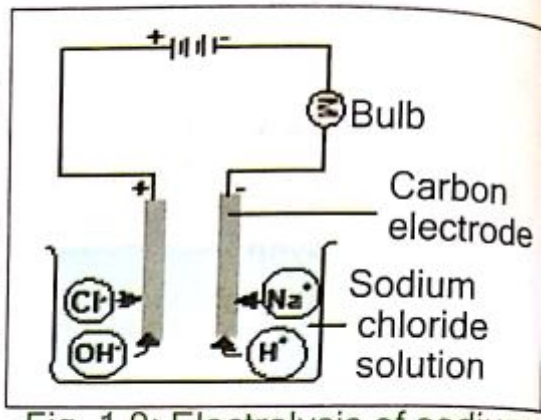


Fig. 1.9: Electrolysis of sodium chloride solution

3 Turn on the switch and observe the changes which place to the bulb and electrodes. Record your observations as shown in Table 1.2.

4 Repeat steps 1 to 3, by replacing the sodium chloride, NaCl solution with glucose, $C_6H_{12}O_6$ solution.

Discussion Questions

a. State what you observed using sodium chloride and glucose.

b. Explain the observation in the experiment.

c. Write equation for the reaction that took place at the electrodes when sodium chloride was used.

d. Explain the effect of electrolysing sodium chloride sodium.

e. How do the results in 1.8B differ from the results in 1.8C?

EXERCISE 1.7:

1. Mark using a tick (✓) for an electrolyte and (X) for non-electrolyte for each of the followings substances.

Table 1.4

Substance	✓for an electrolyte and 'X' for non-electrolyte
a) Bromine water	
b) Potassium nitrate solution	
c) Copper(II) sulphate solution	
d) Molten candle	

3. Explain why molten lead(II) chloride can conduct electricity but solid lead (II) chloride cannot.

The meaning of electrolysis

Electrolysis is the chemical decomposition of an electrolyte into its constituent elements by a flow of electric current.

- Direct current is passed through the compound (the compound can be in molten or aqueous state).
- Electrical energy (From the direct current) is changed into chemical energy (the decomposition of the compound).
- One common example is the electrolysis of water, where water decomposes to hydrogen and oxygen.

Activity 1.9: Analysing the functions of the electrolytic cell

In this activity, you will work in groups and analyse the electrolytic cell to understand the meaning of electrolysis.

What you need

- Internet or chemistry text book
- Diagram of electrolytic cell as in Fig. 1.10

What to do

1. Using internet search for information about,
   a the main components of the electrolytic cell.
   b How the battery is connected in the electrolytic cell. What kind of compounds or substances conduct electricity in the electrolytic cell?
   c What happens to the compounds when they conduct electricity?
2. Critically study the diagram in of electrolytic cell in Fig. 1.10 and compare it with your findings from the search in internet.
3. Present your findings to the rest of the class.

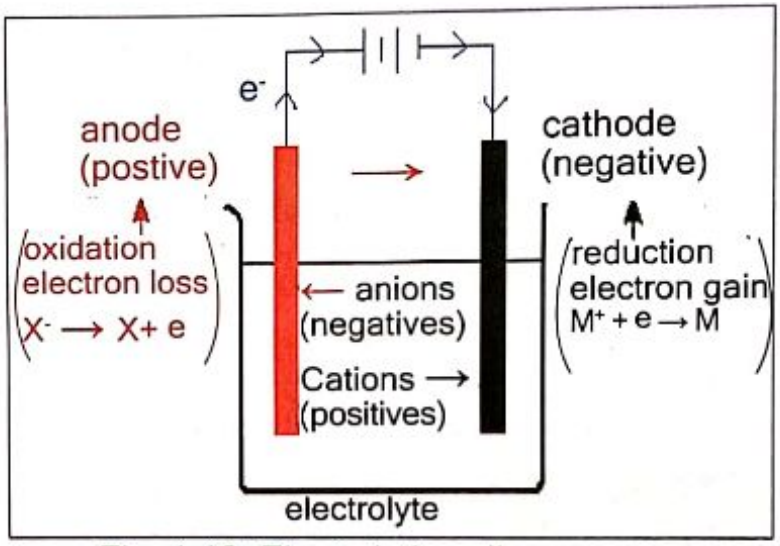


Fig. 1.10: Electrolytic cell

Discussion Questions

a. Name the main components of the electrolytic cell.
b. Describe how the battery is connected in the electrolytic cell.
c. What kind of compounds or substances conduct electricity in the electrolytic cell?
d. What happens to the compounds when they conduct electricity?
e. Describe the part of the electrolytic cell through which the electrons enter and leave the electrolyte.
f. Describe what happens during electrolysis.

Electrolysis of aqueous solutions

An aqueous solution of a salt solution is produced when the salt is dissolved in water. It will contain: anions and cations of the salt; hydrogen ions, H^+ and hydroxide ions, OH^- from the partial dissociation of water molecules.

$$H_2O\ (l) \rightleftharpoons H^+\ (aq) + OH^-\ (aq)$$

For example, an aqueous solution of sodium chloride contains"

a) cations which are sodium ions, Na^+ and hydrogen ions, H^+,

b) anions which are chloride ions, Cl^- and hydroxide ions, OH^-

During electrolysis of an aqueous solutions, the cations move towards the cathode and the anions move towards the anode as shown in Fig. 1.10

More than one type of ions is attracted towards the cathode and anode. Thus selective discharge takes place because only one type of ion will be discharged. In the next activities, you will demonstrate the electrolysis of some aqueous solutions

Selective or Preferential Discharge of ions

Selective discharge means that in case of more than one kind of cations and anions in the electrolyte, the one with higher concentration or at a lower position in activity series will get discharged first. In the following activity, you will research on selective discharge during electrolysis.

Activity 1.10: Researching on the selective discharge of ions during electrolysis

In this activity, you will work in pairs to research on and find out about the selective discharge of ions during electrolysis.

What you need;

Internet or chemistry textbook

What to do;

Using or chemistry textbook, for information about the factors that determine the selective discharge of ions at the electrodes during electrolysis and the explanations.

Discussion Questions

a. Identify and explain the factors that determine discharge of ions at electrodes during electrolysis.

b. Present your finding to the rest of the class.

Activity 1.11: Electrolysis of copper(II) sulphate solution

In this activity, you will work in groups to carry out the electrolysis of copper(II) sulphate solution using carbon electrodes.

What you need;

- carbon electrode with holders
- batteries
- connecting wires
- switch

What to do;

1 Half-fill a beaker with copper(II) sulphate solution.

2 Set up the apparatus as in Fig. 1.11.

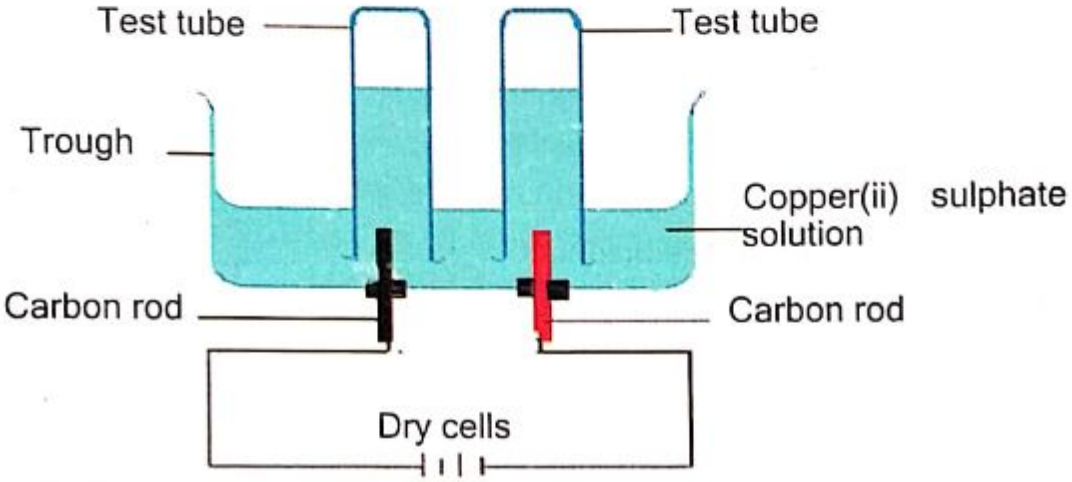


Fig. 1.11: Electrolysis of Copper(II) sulphate solution

3 Switch on the current and after a short time, observe what happens at the electrodes. Note your observations.

4 Present your findings to the rest of the class.

Discussion Questions

a. What is the purpose of the bulb?

b. What is the purpose of the switch?

c. What are the ions from copper(II) sulphate solution?

d. What did you observe at the each of the electrodes?

e. Write ionic equations for the reactions that have occurred at each of the electrode

f. What happens to the colour of the solution at the end of the experiment?

g. What can you conclude from this activity?

Activity 1.12: Electrolysis of dilute sulphuric acid

In this activity, you will work in groups to carry out the electrolysis of copper(II) sulphate solution using carbon electrodes.

What you need;

- batteries
- beaker
- switch
- test tubes
- carbon electrode with holders
- wooden splinter
- connecting wires
- dilute sulphuric solution
- ammeter or bulb
- Stop clock

What to do;

1. Fill the electrolytic cell as set up in Fig. 1.12. with 0.5 mol dm^{-3} dilute sulphuric acid, until it is half full.
2. Fill a test tube will dilute sulphuric acid and then immerse it at the anode and cathode as shown in Fig. 1.12.
3. Turn on the switch on and allow the current to flow for 20 minutes. Observe any changes at the anode, cathode, electrolyte and then record your observations.
4. Test the gas liberated at the anode with a glowing splint, while the one at the cathode using a lighted (burning) splint. Record your observations.

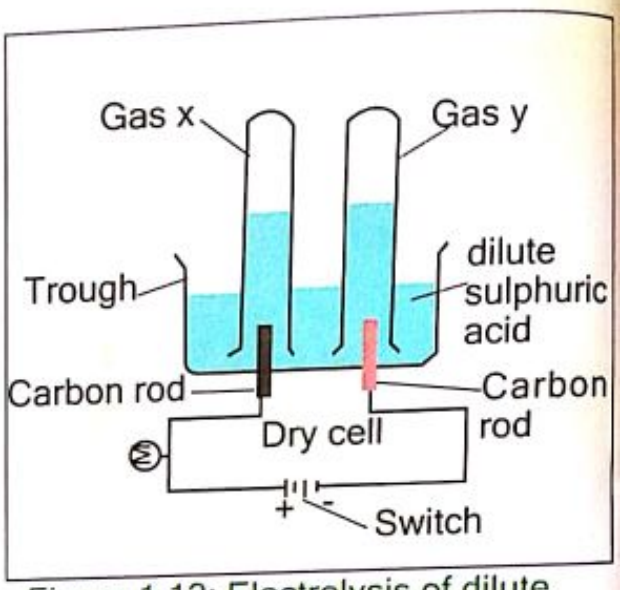


Figure 1.12: Electrolysis of dilute sulphuric acid solution

Discussion Questions

a. What are the ions from dilute sulphuric acid solution?
   i. What did you observe at the each of the electrodes?
   ii. Write ionic equations for the reactions that have occurred at each of the electrodes
   iii. Identify gases x and y.
b. What happens to the colour of the solution at the end of the experiment?
c. What can you conclude about the electrolysis of dilute sulphuric acid using inert carbon electrodes?

Activity of integration

The "Nduu" community that live in part of Uganda that borders with Democratic Republic of Congo are predominantly known for being good black smiths and metal craftsmen. Apart from use of locally smelted iron, this community has also adopted the use of copper and aluminium scraps

Many other rural communities still treasure some of these traditionally made metal tools because of versatility garden and domestic work. They even prefer some of the tools to modern ones.

However they discovered that surfaces of the tools locally made from iron or copper aluminium tarnish and get corroded.

This Nduu community and their neighbouring communities also love growing of avocado plants whose fruits are their favourites. They are equally are wondering why the cut surfaces avocado fruits get tarnished to brown when prepared and kept as they wait for meal time. Being rural communities they feel that these substances seen on the surfaces of tools and avocado fruits are not normal. They have started attributing them to some evil curse or evil. They have sought for cultural cleansing but nothing has helped.

An enlightened member of the communities has come out and approached you to help them understand the problem faced by the community.

TASK

Prepare a written message that you can use to help the community understand that problem they are facing are normal changes.

Chapter Summary

In this chapter, you have learnt that:

- A redox reaction is a reaction in which oxidation and reduction occur together.
- An oxidation-reduction reaction is any chemical reaction in which the oxidation number of a molecule, atom, or ion change by gaining or losing an electron.
- A substance is oxidised if it gains oxygen, loses hydrogen, loses electrons or increases its oxidation state after a reaction.
- Oxidation number, also called oxidation state, is the net chage that an atom should have if the compound was ionic.
- Oxidising agent is a substance that tends to bring about oxidation by being reduced and gaining electrons.
- Reducing agent is a substance that tends to bring about reduction by being oxidized and losing electrons.
- Reduction is gaining of electrons during a reaction by a molecule, an atom or an ion.
- Oxidation is the loss of electrons during a reaction by a molecule, atom or ion.
- Electrolysis is the process by which there is a chemical decomposition, brought about by passing an electric current through an electrolyte.
- Cathode is the negatively charged electrode by which electrons enter an electrolyte.
- Anode is the positively charged electrode by which the electrons leave the electrolyte.
- Electroplating is the process of coating layer of a metal onto another by electrolysis. It is most commonly used for decorative purposes or to prevent corrosion of a metal.

End - Of - Chapter Questions

1. a) Copy and complete the following sentences:

   i) Oxidation is the loss of or the of oxygen.

   ii) Reduction is the gain of or the of oxygen.

   b) State, with reasons, if each of the following reactions are redox reactions.

   $2I^-(aq) + Br_2 \rightarrow I_2(aq) + 2Br^-(aq)$

   $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$

   $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

2. Oxidation can be described as the loss of electrons. In the following reactions, have the underlined substances been oxidised or reduced?

   a) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

   b) $2Ag(s) + Pb^{2+}(aq) \rightarrow 2Ag^+(aq) + Pb(s)$

   c) $2Ni(s) + Sn^{4+}(aq) \rightarrow Ni^{2+}(aq) + Sn(s)$

3. When copper(I) oxide dissolves in dilute sulphuric acid, copper(II) sulphate and copper are produced.

   a) Write the balanced chemical equation for the reaction.

   b) Discuss the changes in the oxidation states of copper in this reaction.

   c) copper (I) oxide oxidised or reduced in this reaction?

4. Choosing only words from the following list, write the appropriate words to fill in the blank spaces. From (a) to (b) below: [anion, anode, cathode, cations, electrode, electrolyte, nickel, and voltameter]

   To electroplate an object with nickel requires (a) ___ which must be a solution containing (b) ions. The article to be plated is placed as the (c) of the cell in which the plating is carried out. The (d) of the cell is made of pure nickel

5. Study the diagram given and answer the questions that follow:

End – Of – Chapter Questions

1. a) Copy and complete the following sentences.
   i) Oxidation is the loss of or the_____of oxygen.
   ii) Reduction is the gain of or the of oxygen.

   b) State, with reasons, if each of the following reactions are redox reactions.

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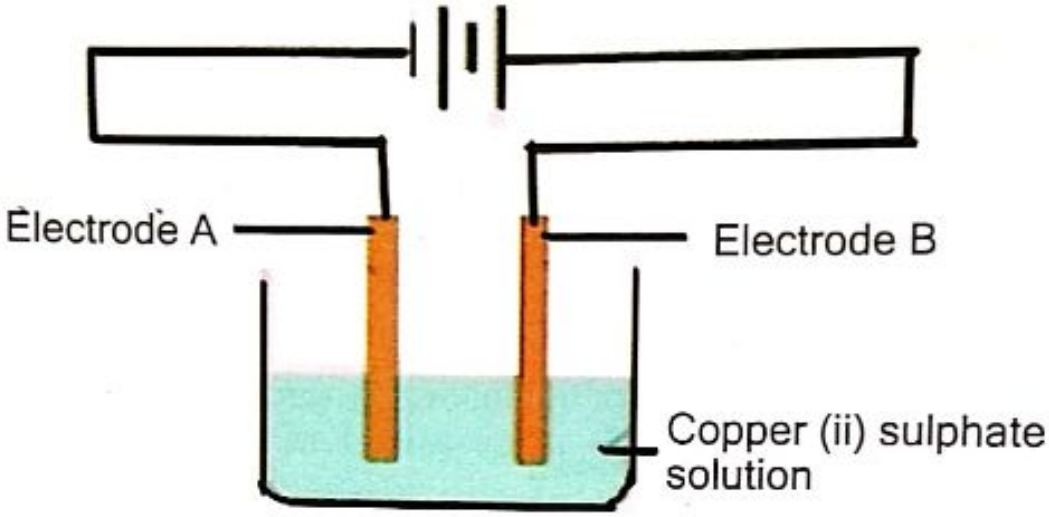


Give the names of the electrodes A and B.

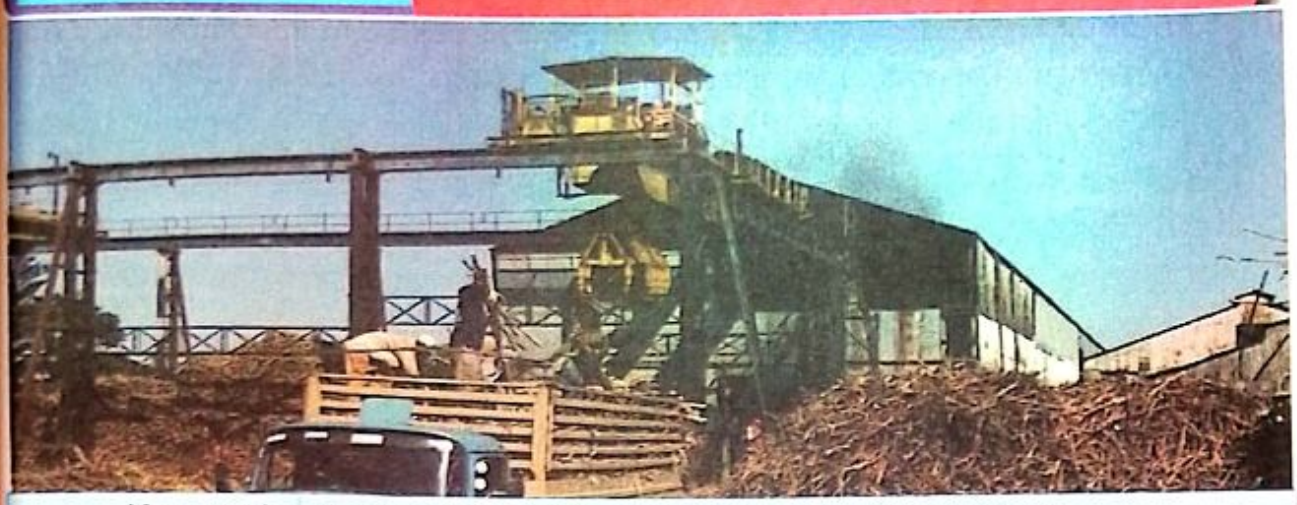
a) Which electrode is oxidising?

6. What is an electrolyte

7. Classify the following substances as strong,weak electrolytes or non electrolytes:

Acetic acid ammonium hydroxide, ammonium chloride, carbon tetrachloride, dilute hydrochloric acid, sodium acetate, dilute sulphuric acid

CHAPTER 2: Industrial Processes



Key words	By the end of this chapter, you should be able to;
o Cement o Electrolysis o Extraction o Fertilizers o Metal wastes o Metallurgical o Resources	o know about some of the main industries that produce useful chemicals, such as the oil industry for organic chemicals, the production of metals, the acid industry, the alkali industry the fertiliser and the cement industry o understand the processes for obtaining useful chemicals from rocks o understand the processes involved in extracting and purifying metals, with particular reference to processes used inUganda o understand the importance of nitrates as fertilisers in food productionand know how they are produced from nitrogen in the air o outline four industrial processes that make use of natural resources obtained in Uganda o recognise the importance of industrial processes in utilising natural resources to make useful chemicals, and appreciate that industrial processes have social benefits and cause problems of pollutionand environment destruction o describe some of the dangers to the community arising from these industrial processes and the steps that may be taken to minimise these dangers o understand the process in the manufacture of lime and cement o understand the production of alkali and chlorine by the electrolysis ofsalt solution o evaluate uses of synthetic polymers

COMPETENCY

By the end of this chapter, you should be able to appreciate the principles behind some industrial processes and the importance of the products formed.

Introduction

The economy and growth of a nation depends mainly on its natural resources and how they are harnessed to improve the well being of the population. The key in utilisation of natural resources is the industries. In the industries, various processes take place to yield different products.

The chemical industry is one of the key industries involved in the production of the products. It involves the use of chemical processes such as chemical reactions and refining methods to produce a wide variety of materials with desirable properties and quality to satisfy social needs.

Most of these products are consumed but others can be used to produce other materials. In this chapter you are going to learn about the different industrial processes, what they are used for and the products they form.

2.1 Products produced in Ugandan industries

There is a vast number of natural resources in Uganda ranging from minerals, stones, plants and animals. These are a good starting point for manufacturing industries. In the following activity you will be required to look at the materials from some few industries in Uganda and identify where they are produced.

Activity 2.1: Identifying some materials produced in Ugandan industries

What you need

A collection/assortment of materials produced from industries in Uganda given in Fig. 2.1.

Fig. 2.1: Some products produced in Uganda

What to do

1. Study the products in Fig. 2.1 carefully.
2. As, a group try to identify the products and where they produced.

Discussion question

a. Name each of the materials provided in figure 2.1
b. Name the industries where each of the materials provided is manufactured.
c. Organise your findings in table form.

No.	Material	Industry	Location
1	soda drinks	coca cola	Kampala
2			

Present your findings to rest of the class.

2.2 Minerals are key elements in industry

The elements or compounds, which occur naturally in the earth's crust, are known as **minerals**. All minerals are not suitable for the extraction of elements. Minerals from which elements can be extracted easily and economically are called ores.

Thus, all ores are minerals, but all minerals are not ores, because a mineral may not contain sufficient percentage of an element for economic extraction. To get profit from minerals, the cost of extracting the element from the ore must be less than the cost of selling the element.

All ores are minerals, but all minerals are not ores

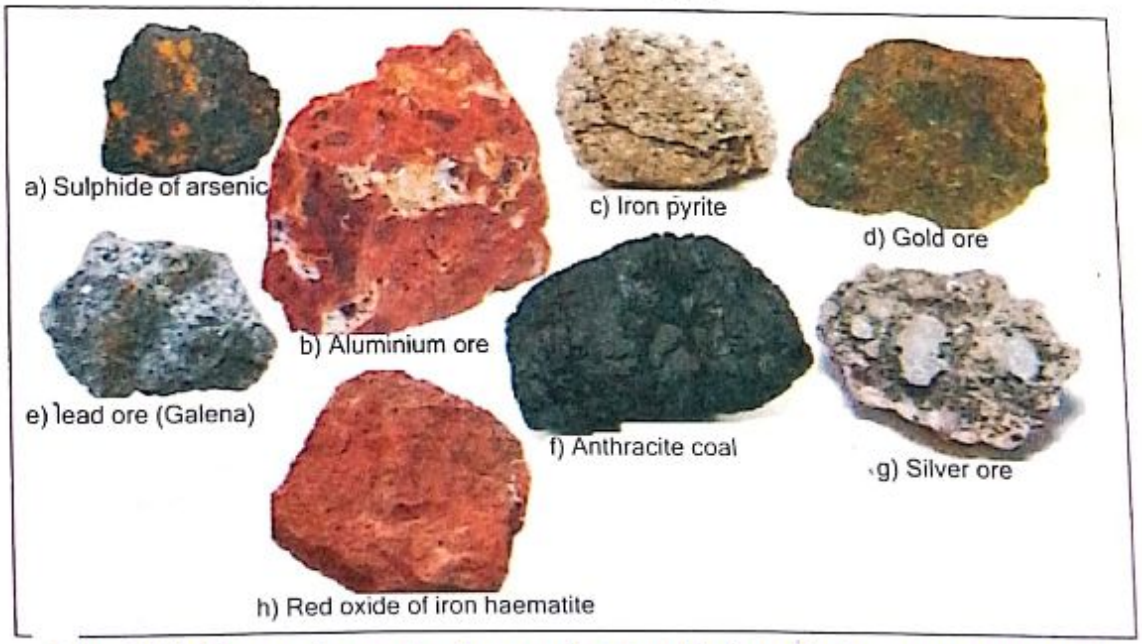


Fig. 2.2: Some important ores from which metals are extracted

Activity 2.2: Identifying processes for obtaining useful chemical from rocks

In this activity, you will work in groups to identify chemical found in rocks and process by which they can be obtained from their ores in the rocks.

What you need

Internet and chemistry textbook

What to do

1. Using the internet or relevant textbook search for information about chemicals in rocks and processes of isolating them .

Discussion question

a. Name five(5) different ores and the mineral elements they contain.

b. Explain how the following processes can be used in obtaining minerals from their ores

   i. Chemical reduction ii. Electrolysis iii. Sorting iv. Heating/roasting.

c. Present your findings to the rest of the class.

2.3 Extraction of Important Metals

The process of obtaining a metal from its ore is known as extraction of metal. The various processes involved in the extraction of metals from their ores along with its refining or purification is known as metallurgy. The method of extraction of a metal from its ore is determined by its reactivity.

In activity 2.3, you will research on the various processes involved in obtaining metal from its ore.

Activity 2.3: Exploring reactions involved in extracting metals

In this activity, you will work in groups to research on the different processes involved in extracting metals from their ores.

What you need

Internet or chemistry text book

What to do

Using internet or chemistry textbook, search for information about;

- Metals extracted in Uganda,
- Names/formulae of the ores of each of the metal
- Process of extraction of each of the metal

- Method of extraction of each of the metal
- Method of purification of each of the metal

Discussion Questions

a. Write a report describing the processes by which the different metals obtained in Uganda are extracted. The report should include:
   - Named metal and its ore
   - Process of extraction of each of the metal
   - Method of extraction of each of the metal
   - Method of purification of each of the metal
   - Diagrams to illustrate some of the processes of each of the metal
   - Chart for the extraction of metals of each of the meta

b. Present your report to the rest of the class.

Extraction of iron from iron ore

The main ore of iron is called haematite. Iron can be extracted from the ore by the process of chemical reduction. The reduction takes place in a blast furnace

In activity 2.4, you will research about the blast furnace, how it works and make your own model of the furnace.

Activity 2.4: Making a Model of a blast furnace

In this activity, you will work in groups to make a model of the blast furnace.

What you need

- Internet or chemistry text book.
- Some examples of materials that can be used to build a model of a blast furnace as shown in Figure 2.3.

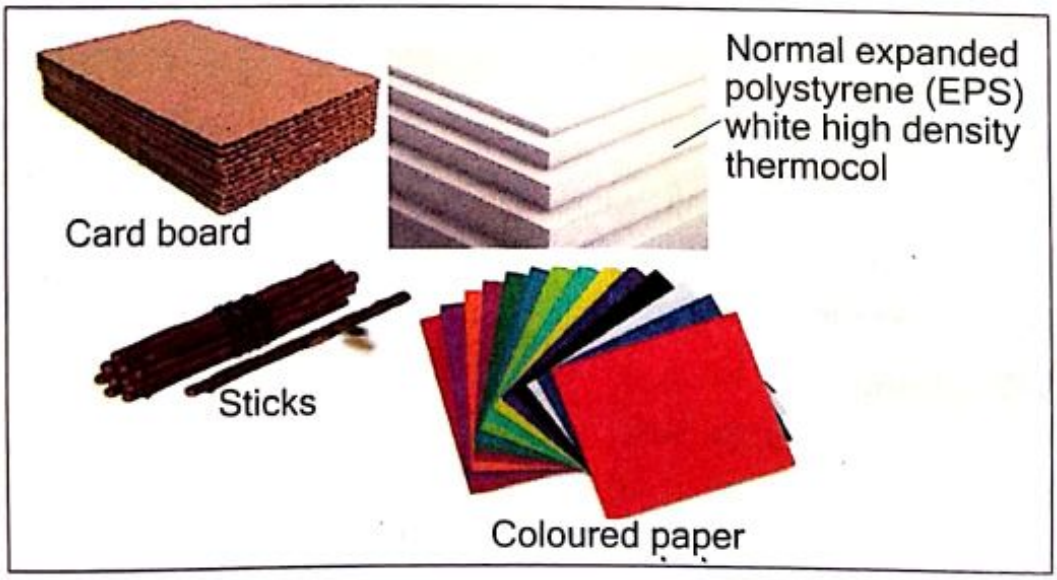


Fig. 2.3: Materials for modelling blast furnace

What to do

With help of your group members, think of ways in which you can assemble the materials above into a model of furnace

Discussion Questions

a. Describe the process involve in modelling a blast furnace using the materials above.

b. Make a written explanation of the structure and uses of the parts of the model of the blast furnace you have constructed.

c. Display your model for comparison to the rest of the class

EXERCISE 2.1:

1 Make a list of materials made of iron and steel you encounter at home, and inthe city or town where you live. Briefly state how they are used.

2 Briefly state how materials identified in (a) are used.

In the laboratory iron can be extracted by reducing iron(iii) oxide with carbon on a match head.

Description of the process is provides in Activity 2.5 below;

Activity 2.5: Extraction of iron by reducing iron(III) oxide with carbon on a match head

In this activity, you will work in groups to carry out the reduction of iron(iii) oxide using carbon.

What you need

- Tongs (crucible tongs)
- Water
- Weighing boat (small white plastic ones are ideal)
- Carbon powder/charcoal
- Spatula
- Source of heat
- Magnet (e.g., bar magnet)
- Iron(III) oxide powder

⚠ Caution!!

You need to take precaution when handling sodium carbonate powder as it is an irritant.

What to do

1. Dip the head of a non-safety match in water to moisten it.
2. Roll the damp match head first in charcoal powder, then in iron (III) oxide powder, as shown in Figure 2.4.
3. Hold the match in a pair of tongs. Put the head of the match into a blue Bunsen flame (air-hole open). The match will flare and burn. Do not allow the match to burn more than half way along its length.

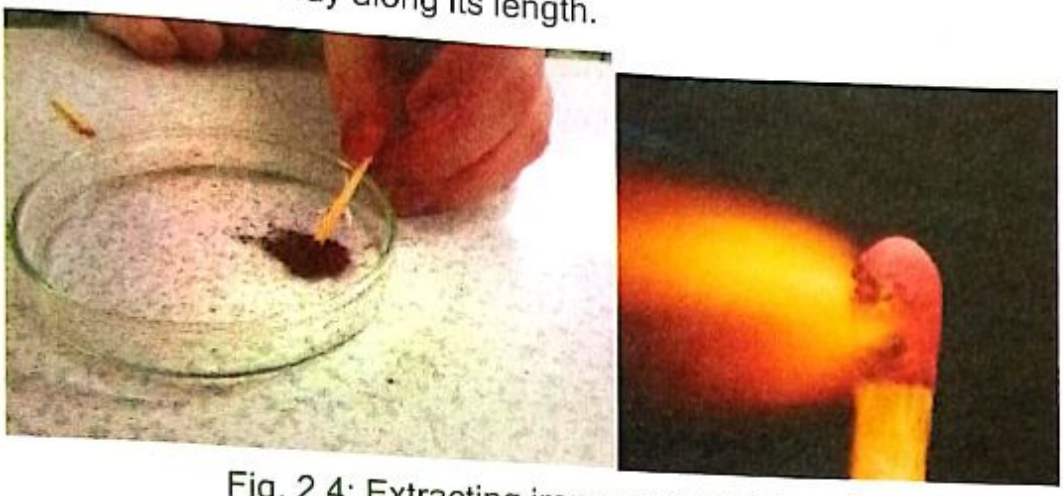


Fig. 2.4: Extracting iron on a match head

4. Allow the match to cool for about 30 seconds.
5. Use a spatula to crush the charred part of the match into a small plastic weighing boat.
6. Move a magnet around under the weighing boat - some of the small particles will move around in the weighing boat following the track of the magnet. Do not dip the magnet into the particles directly, unless you have first wrapped the magnet in cling film - any pieces of iron will stick to the magnet and will be difficult to clean off.

Discussion questions

a What did you observe when the head of the match moistened with charcoal powder and iron(III) oxide was brought into a blue Bunsen flame?

b What did you observe when a weighing boat was moved around the magnet?

c Write equation for the reaction taking place between Iron(iii) oxide and carbon?

d What is the role of charcoal powder in this experiment?

e Write up solutions to the discussion question and present it to the rest of the class

2.4 Recycling of metal waste

Metals are valuable materials that can be recycled repeatedly without altering their properties. The most common recyclable metals include aluminium and steel. The other metals for example silver, copper, brass and gold are so valuable that they are rarely thrown away to be collected for recycling.

Therefore, they do not create a waste disposal crisis or problem.

Activity 2.6: Researching on recycling of metal wastes

In this activity, you will work in groups to carry out research on recycling of metal wastes.

What you need

- Internet

What to do

1. In your learner groups search for information from internet about
   - How the metallic materials we buy can be reused
   - Types of metals that can be recycled
   - The metal recycling process
   - Advantages of recycling
2. Develop your own ideas on how to reuse any of the named metal wastes.

Discussion questions

a. Write a report about your findings on the topic of recycling metal wastes. Your report should include the following:
   - How the metallic materials we buy can be reused
   - Types of metals that can be recycled
   - The metal recycling process
   - Advantages of recycling
   - Your own ideas on how to reuse any of the named metal wastes

b. Present your findings to the rest of the class.

Importances of recycling materials

Have you observed people collecting scrap in your area? If materials were not collected, the whole environment would be littered by scrap! The materials collected are recycled and made into useful products. Thus it is important to sensitise our people about recycling different materials as away of sustainable

management of our waste.

Activity 2.7: Making posters for promote recycling of materials

In this activity, you will work in groups to make posters to promote recycling of metal wastes in your community. You will then display the poster for the whole class observe and critique.

What you need

- Manila paper
- Markers (assorted)
- Coloured pencils/ paint

What to do

1. In your learner groups plan on how to draw posters that can explain the concept of three Rs i.e., Reduce, Reuse and Recycle.

Figure 2.5: Representation of the 3Rs

Discussion Questions

a. Draw a suitable poster that can be used to encourage members of the community to practise the concept of 3Rs

b. In which other ways can you encourage the public to reduce the use of plastic bags?

2.5 Industrial chemicals

Industrial chemicals are those with an industrial use - this covers a broad range of chemicals used in inks, plastics, adhesives, paints, glues, solvents, cosmetics, soaps and many other products. We define industrial use by exclusion. This means that an industrial use is any use that is not:

- an agricultural chemical product
- a veterinary chemical product
- use as a substance or mixture of substances prepared by a pharmacist or veterinary surgeon, or in the preparation of these
- a therapeutic good
- Use as food for humans or animals, or in the preparation of it. Figure 2.6 show different industrial chemical produced in Uganda

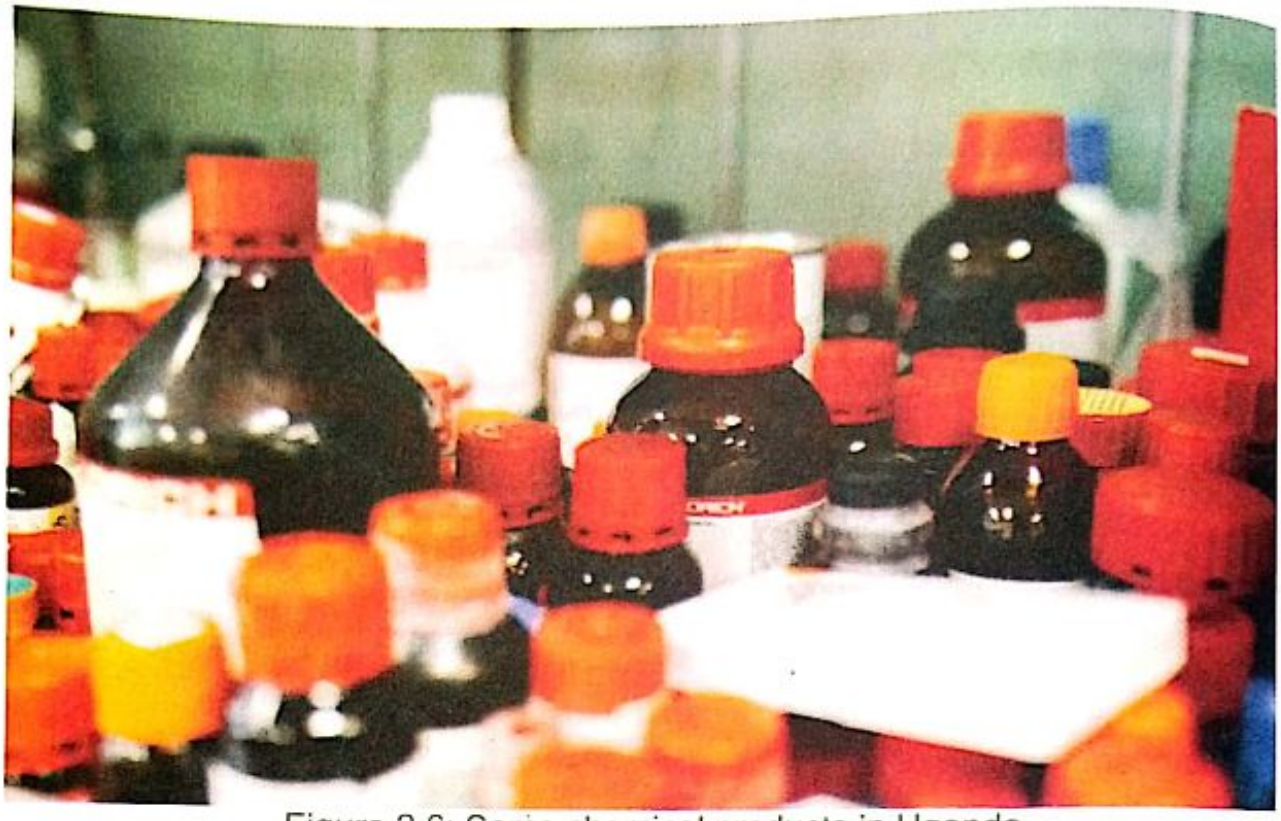


Figure 2.6: Some chemical products in Uganda

The different chemicals produced in Uganda have various uses, for each use the chemical has specific regulation for safe use.

In the next activity, you will research on how some selected chemicals are manufactured and find their common uses in everyday life.

Activity 2.8: Exploring manufacture and uses of common industrial chemicals

What you need

- Internet or chemistry textbook

What to do

In your groups; search for information about how common industrial chemical are manufactured and used in everyday life

Discussion question

a. Identify any five common industrial chemicals used in Uganda.
b. Explain how the chemical identified in (a) can be manufactured.
c. State the uses of the industrial chemicals identified in (a) above.
d. Present your findings to the rest of the class

Nitrogen

Occurrence and Production

Nitrogen occurs in nature in the elemental form. It also exists in the form of compounds. In the elemental state, it exists as a diatomic molecule, N_2, in atmospheric air. It constitutes about 80% by volume of the atmosphere.

In the form of compounds, it exists as sodium nitrate (Chile salt petre, $NaNO_3$) and potassium nitrate (KNO_3) also called saltpetre. It is also found in DNA molecules and proteins of all living things.

Activity 2.9: Research on the industrial manufacture of nitrogen by fractional distillation

In this activity, you will work in groups to research on the industrial preparation of nitrogen gas.

What you need

- Internet or chemistry text book

What to do

1. In your learner groups search for information from internet or chemistry textbook about;
   - the steps involved in preparation of nitrogen
   - the conditions required in preparation of nitrogen
   - illustration or diagram for the process in preparation of nitrogen
   - uses of nitrogen gas
2. Prepare a written report of your findings which should include:
   - the steps involved in preparation of nitrogen
   - the conditions required in preparation of nitrogen
   - illustration or diagram for the process in preparation of nitrogen
   - uses of nitrogen gas

Historical Note

Haber, Fritz (1868-1934), was a German chemist and Nobel laureate. He is best known for his development of an economical method of ammonia synthesis. Haber was born in Breslau (now Wroclaw, Poland) and educated at the Technische Hochschule in Berlin. He was appointed as professor of physical chemistry at the University of Berlin in 1911. Subsequently, he became director of the Kaiser Wilhelm Institute for Physical Chemistry in Berlin. During World War I, Haber was chief of the German chemical warfare service, and he directed the chlorine gas attack at the Second Battle of Ypres. In 1933, because of anti-Semitic policies in Germany, Haber resigned and went to Switzerland, where he died the following year. Haber's greatest achievement was his discovery, in 1913, of a process for synthesizing ammonia by the direct combination of nitrogen and hydrogen. The method was adapted to commercial use in the 1930s by the German chemist Karl Bosch. The Haber-Bosch process is used in the manufacture of explosives and in the production of fertilizers. Haber also made fundamental contributions to the field of electrochemistry. He was awarded the 1918 Nobel Prize in chemistry.

Haber Fritz

Discussion questions

Present your report to the whole class.

Ammonia

Activity 2.10: Studying the industrial manufacture of ammonia

In this activity, you will work in groups or individually to research on the industrial preparation of ammonia gas.

What you need

- Internet or chemistry text book

What to do

1. Using internet or chemistry text book search for information about;
   - the steps involved in preparation of ammonia
   - the conditions required in preparation of ammonia
   - illustration or diagram for the process in preparation of ammonia
   - uses of ammonia gas
2. Prepare a written report of your findings which should include:

Discussion Question

a. Describe the process of industrial manufacture of ammonia
b. Justify the condition involved in the process of manufacture of ammonia.
c. Explain the different uses of ammonia
d. Present your finding to the rest of the class.

Sulphuric acid

One of the uses of ammonia gas is in the manufacture of fertilisers. Do you know of any other chemical used to make fertilisers?

One such industrial chemical used in the manufacture of fertilisers is Sulphuric acid. Sulphuric acid is manufactured on large scale by the contact process. The acid is also used in other many ways as will be explored in the Activity 2.11. In the following activity you will find out more about the manufacture and uses of sulphuric acid.

Activity 2.11: Studying about the industrial manufacture of sulphuric acid

In this activity, you will work in groups or individually to research on the industrial preparation of sulphuric acid.

What you need

- Internet or chemistry text book

What to do

1. Using internet or chemistry text book search for information about
   - the steps involved in the industrial preparation of sulphuric acid
   - the conditions required in the industrial preparation of sulphuric acid
   - illustration or diagram for the industrial preparation of sulphuric acid - uses of sulphuric acid

Discussion questions.

a. Describe the process of industrial manufacture of sulphuric acid.
b. Discuss the conditions involved in the process of manufacture of sulphuric acid
c. Explain the use of sulphuric acid.
d. Prepare a written report of your findings which should include:

2.6 Manufacture of fertilizers for crop production

Mineral fertilizers play a central role to achieve the yield and returns expected by farmers and required by a growing world population. Figure 2.7, shows different fertilisers produced in Uganda

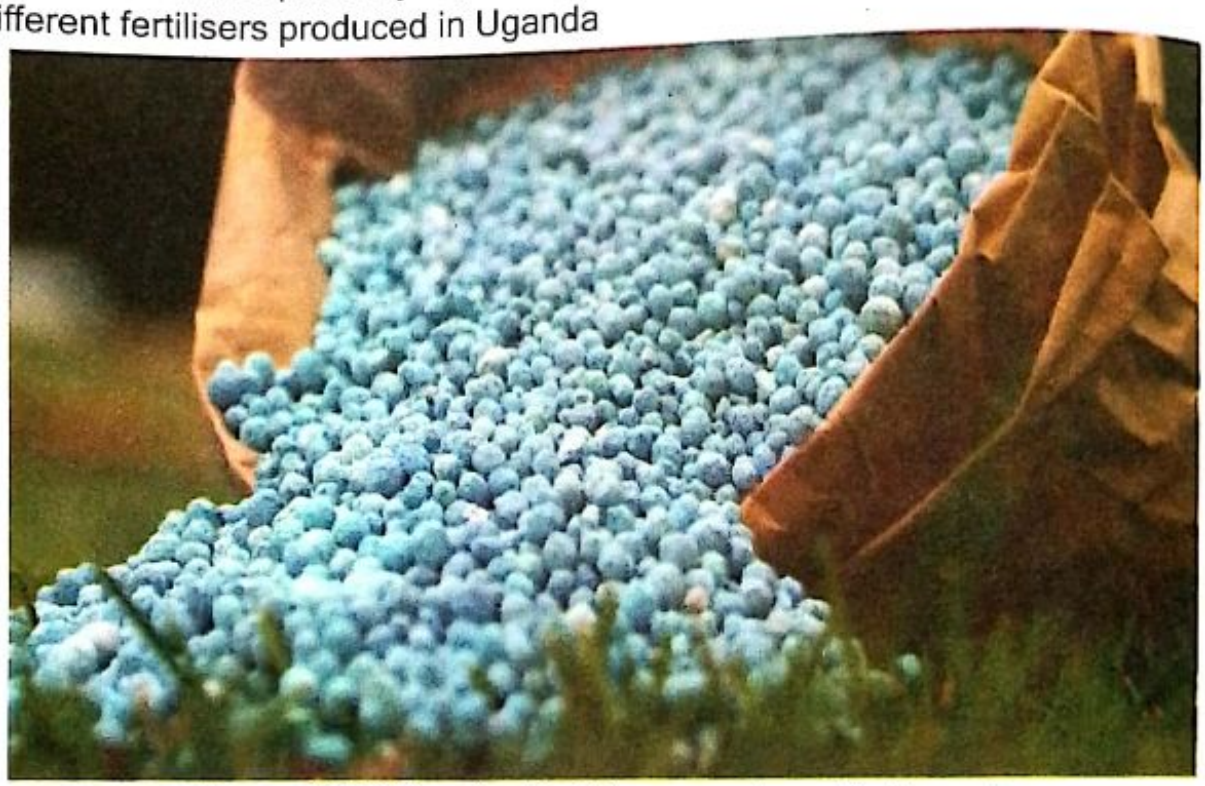


Figure 2.7: Chemical fertilisers produced in Uganda

Do you know where different chemical fertilisers come from? Under which conditions are they produced? Is production sustainable?

In the following activity, you will carry out research on how different ammonium fertilisers are manufactured and find out their uses in crop production. You will also research on the effect of the use of the fertilisers on environment.

Activity 2.12: Researching on the industrial manufacture of fertilisers and their uses

In this activity, you will work in groups or individually to research on the industrial preparation of fertilisers

What you need

- Internet or chemistry text book

What to do

1. Using internet or chemistry text book search for information about
   - The steps involved in the manufacture of nitrate fertilizer.

- illustration or diagram for the preparation of common nitrogen fertiliser
- Uses of fertiliser in food production.
- Effects of artificial fertilizers.

2. Prepare a written report of your findings.

Discussion questions

a. Describe the process of manufacturing nitrate fertilizers.

b. Draw a flow chart to describe the steps in the manufacture of a named nitrate fertiliser.

c. Discuss the effect of using nitrate artificial fertilisers in farming.
d. Explain how the effects can be controlled.
e. Share your findings with the rest of the class

2.7 Cement manufacturing

Uganda has a lot of potential for development in the infrastructure and construction sector and the cement sector is expected to largely benefit from it. One of the major requirements in construction is cement.

Cement is made by heating limestone (chalk), alumina (Al_2O_3) and silica-bearing materials such as clay to 1450°C in a kiln. This process is known as calcination. Figure 2.8 shows atypical rotary kiln used in the manufacture of cement.

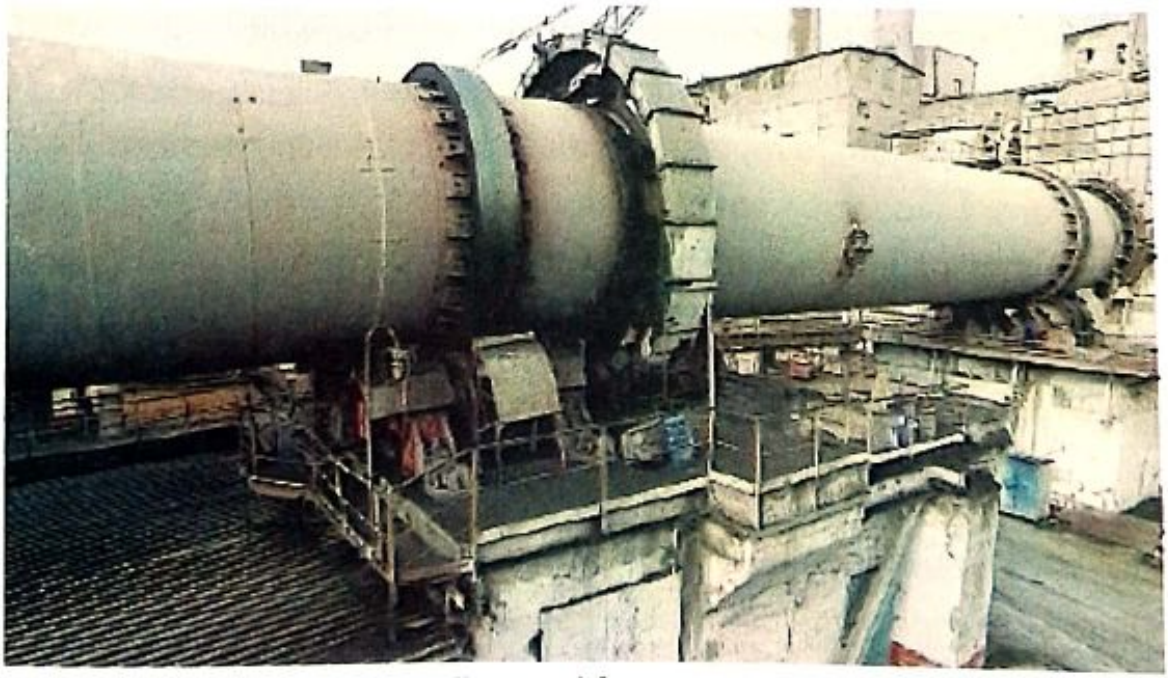


Figure 2.8: Giant kiln used for manufacturing cement

The resulting hard substance called **clinker** is then ground with a small amount

calcium sulphate into a powder to make Ordinary Portland Cement (OPC).

Cement mainly consists of calcium silicate ($CaSiO_3$), calcium aluminate ($CaAl_2O_4$), iron(III) oxide (Fe_2O_3) and magnesium oxide (MgO). Portland cement is a very important building material. It received its name because, on setting, it hardens to a stone-like mass. It is a mixture of calcium and aluminium silicates with gypsum.

In the following activity, you will do research of the cement making process, the social benefits and dangers of using cement.

Activity 2.13: Researching on the industrial manufacture of cement

In this activity, you will work in groups or individually to research on the industrial preparation of cement

What you need

- Internet or chemistry text book

What to do

Using internet or chemistry text book search for information about

- the steps involved in industrial manufacture of cement
- the conditions required in industrial manufacture of cement
- illustration or diagram for the process in industrial manufacture of cement
- uses of cement

1. Prepare a written report of your findings which should include:

Discussion questions

a. Describe the process involved in manufacture of cement.
b. Name the condition necessary for making cement.
c. Draw a flow diagram to represent the process of making cement.
d. Identify any 4 products from cement.
e. Explain what influences the location of the cement industries in Uganda.

2.8 Manufacture of sodium hydroxide and chlorine

Chlorine can be manufactured by the electrolysis of a sodium chloride solution (brine), which is known as the Chloralkali process. Chlorine is produced together with sodium hydroxide in the diaphragm cell. A simple diagram of the cell is shown in Fig. 2.9 below.

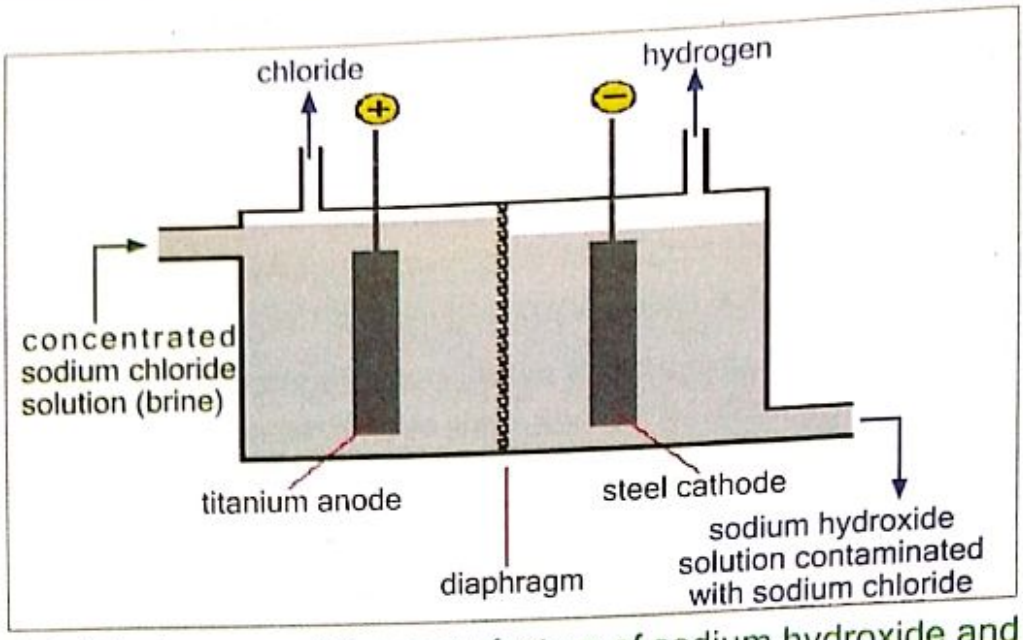


Figure 2.9: Diaphragm cell for manufacture of sodium hydroxide and chlorine

In the next activity, you will research on how sodium hydroxide is manufactured together with chlorine by electrolysis. You will also find out the uses of the products of the electrolysis.

Activity 2.14: Exploring the production of sodium hydroxide and chlorine by electrolysis

In this activity, you will work in groups or individually to research on the production of sodium hydroxide and chlorine by electrolysis.

What you need

- Internet or chemistry text book

What to do

1. Using internet or chemistry text book search for information from internet about
   - name electrolyte used
   - diagram to illustrate the production process
   - steps involved in the production and the equations of the reactions taking place at the electrodes
   - uses of sodium hydroxide and chlorine produced
2. Prepare a written report of your findings which should include:
   - name electrolyte used
   - diagram to illustrate the production process
   - steps involved in the production and the equations of the reactions taking place at the electrodes uses of sodium hydroxide and chlorine produced
3. Present your report to the whole class.

2.9 Utilisation of natural resources to make useful chemicals

Humans, animals, and other living organisms have relied on natural resources for survival since the beginning of time. The conservation of natural resources is important as the world population continues to grow, with many of the most important natural resources being finite and non-renewable.

Natural resources are materials and substances that occur naturally and can be used for economic gain. They include minerals, forests, fertile land, and water. Some natural resources, such as soil and water, are essential for the existence of life.

Non-renewable natural resource is defined as a resource that cannot be replaced in our lifetime. They include metal ores, fossil fuels, earth minerals, and in some in certain situations groundwater.

Renewable natural resources are resources that can be replaced naturally in our lifetime, and used repeatedly. Examples include fresh water, timber, oxygen, and solar energy. Resources such as bauxite, iron, and copper form the basis of everyday items, while water, soil, and salt are required for life.

Negative impact of industrialization on environment

Industrialization contributes major part for the economic development and prosperity of a country. On one hand it provides employment opportunities and wealth generation while on other hand it leads to following environmental deterioration.

In the following activity, you will research on and describe some of the dangers arising from the industrial processes. You will also find out about the measures that can be taken to reduce the effects.

Activity 2.15: Identifying on the dangers and measures to reduce bad effects of industrial processes

In this activity, you will work in pairs to carry out research on the dangers arising from industrial processes. You will also find out the steps taken to minimise the dangers.

What you need

- Internet or chemistry text book

What to do

1. Using internet or chemistry text book search for information about

- the dangers identified arising from industrial processes
- description of the dangers and how it affects the environment
- the steps taken to minimise the dangers
- any illustrations to show some of the dangers.

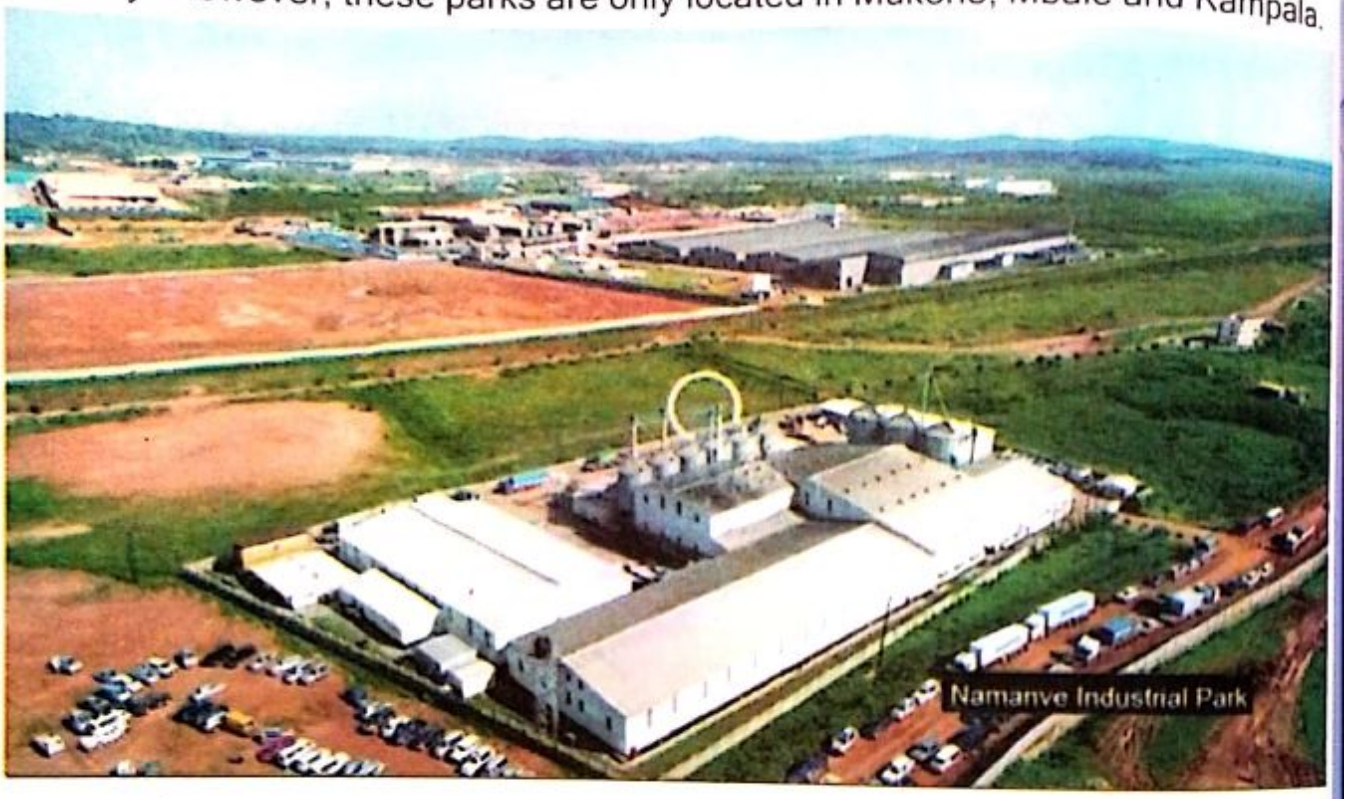
2. Prepare a written report of your findings, which should include
   - the dangers identified arising from industrial processes
   - description of the dangers and how it affects the environment
   - the steps taken to minimise the dangers
   - any illustrations to show some of the dangers

Discussion questions

a. Explain the dangers that arise from different industrial processes
b. Identify the measures that must be put in place to minimise the dangers of industrial processes.
c. Design a poster that can be used to warn the public about the dangers of a named industrial process.
d. Display your poster for comparison with those of other members in the member in the class.

Activity of integration

Currently, there are 22 Industrial and Business Parks in Uganda spread throughout the Country aimed at boosting value addition and job creation. The parks gazetted and set up by the Uganda Investment Authority (UIA) are mainly for value addition to local raw materials as well as increasing revenue for the country. However, these parks are only located in Mukono, Mbale and Kampala.


Namanve Industrial Park

Government plans to start more industrial parks across all the new cities in Uganda. The Minister of state for Investment wants to have a meeting with Lord Mayors of all the new cities the importance of industrial formation in our life. He wants a speech that will be delivered to the Lord Mayors during the meeting.

TASK

Develop a speech for the Minister to deliver to the mayors. The speech should include: the importance of industrial formation to the communities of the cities and examples of the industrial processes that will be workable to the cities.

Chapter Summary

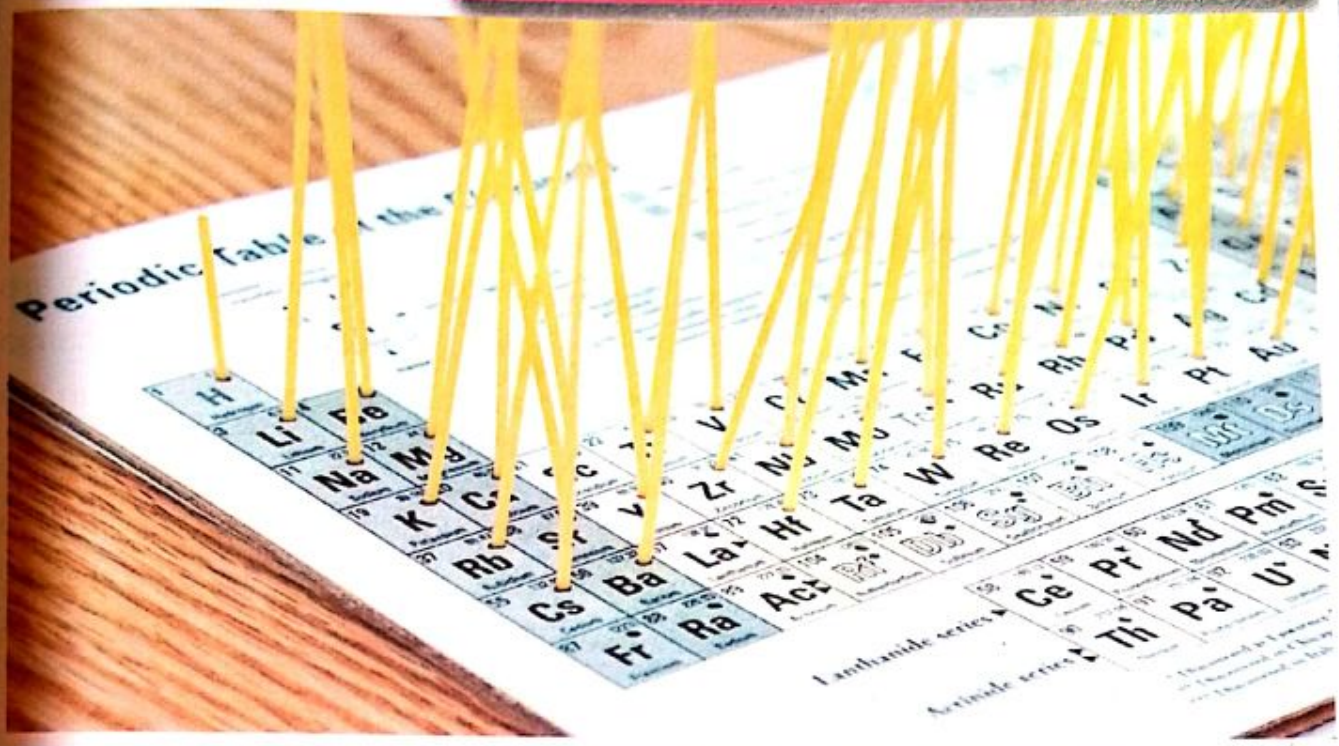
In this chapter, you have learnt that:

- Uganda has a vast number of natural resources from which industrial products can be obtained.
- Metals can be extracted from mineral ores. Ores are rocks containing minerals.
- The method used to extract an ore depends on the reactivity of the metal.
- Metals high in the reactivity series are extracted by electrolysis but those averagely reactive are extracted by chemical reduction.
- The most common reducing agent for extraction of metals is carbon in form of coke.
- In the extraction of sodium, molten sodium chloride is used as the electrolyte. Calcium chloride is added to bring its melting point down.
- The main ore of aluminium is bauxite (Hydrated aluminium oxide).
- Iron is extracted by heating a mixture of the ore, limestone and coke in a blast furnace.
- Copper is extracted from its ores cuprite or malachite. It can be refined by electrolysis of copper(II) sulphate using a copper cathode.
- Metals are valuable materials which can be recycled again and again without changing their properties.
- Ammonia is a useful gas especially in the manufacture of fertilisers and is obtained on large scale by the Haber process.
- Ammonium sulphate, ammonium nitrate, urea and DAP are some of the fertilisers from ammonia.
- Sulphuric acid is a useful chemical and is manufactured by the contact process.
- Fertilisers have many advantages but also some disadvantages.
- Organic fertilisers are useful substitutes for industrial fertilisers but may lack sufficient quantities of key elements for plant growth.
- Cement is made by heating a mixture of limestone, alumina and clay. It is a useful material in construction.
- Sodium hydroxide and chlorine are prepared by electrolysis of concentrated sodium Chloride (Brine) using a mercury cathode and a carbon anode.
- Industries help us to manufacture important materials but the process has some negative impacts on the environment.

End – Of – Chapter Questions

1. a) Write name and place of three important chemical industries in Uganda.
   b) What are the major sources of metals on Earth?
2. a) List the physical and chemical methods employed to concentrate an ore.
   b) Describe the electromagnetic separation method of ore concentration.
3. a) What happens when aluminium oxide reacts with sodium hydroxide?
   b) Explain roasting method of metal oxide formation.
4. a) Write four reducing agents used for reduction of metal oxides to metals.
   b) What are the three common purification procedures for metal extraction?
5. a) Describe how sodium metal extracted from sodium chloride?
   b) Explain why metal cannot be extracted from the electrolysis of aqueous sodium chloride solution? Explain.
6. a) State two important uses of copper.
   b) Name the elements used to form the alloys; bronze and brass.
7. a) What is the role of nitrogen in food packaging?
   b) Write a balanced chemical equation for the laboratory preparation of ammonia.
8. a) State why the drying agents like concentrated sulphuric acid, and calcium chloride cannot be used to dry ammonia?
   b) Explain how sulphur dioxide is converted to sulphur trioxide in the industrial manufacture of sulphuric acid.
9. a) Give two examples of fertilisers manufactured from ammonia.
   b) Explain the meaning of the term eutrophication?
   c) Explain the environmental impact of fertilizers?
   d) Write some examples of naturally occurring organic fertilizers.
   e) What are the advantages of organic fertilizers over chemical fertilizers? Explain.
10. Describe the process of manufacture of cement.
11. Why is metal recycling is essential?

CHAPTER 3: Trends in the Periodic Table



Key words	By the end of this chapter, you should be able to;
o Atomic radius o Electronic Configuration o Metallic character o Non-metallic character o Nuclear charge o Periodicproperty o Valency	o know the trends in physical properties of the elements across the periods in the Periodic Table o know the trends in typical physical and chemical properties of simple compounds of the elements of the thirdperiod o predict physical and chemical properties of different elements in Group 1.

COMPETENCY

By the end of this chapter, you should be able to appreciate the diversity of properties of elements and how these properties change across the periods and groups of the Periodic Table.

Introduction

A table is a very efficient way of displaying a lot of information. At school, you have a timetable to tell you what lessons will be taught at different times of the day, in which rooms, and how long each lesson will last.

You probably watch television at home. You can use the TV listing, which is also a table, to tell at a glance which programmes are on. You can then select the programmes you want to watch.

Chemists have a table to help them organise information too. It is called the Periodic Table. In Senior 2, you learnt that the elements and their symbols are recorded in the Periodic Table. The Periodic Table is useful to chemists because it can be used to predict the properties of an element based on its position in the table.

Major periodic trends include: electro negativity, ionization energy, electron affinity, atomic radius, melting point, and metallic character. Periodic trends, arising from the arrangement of the Periodic Table, provide chemists with an invaluable tool to quickly predict an element's properties.

Thus, in this chapter, you will appreciate the diversity of properties of elements and how these properties change across the periods and groups of the Periodic Table.

3.1 Physical properties of elements across the Periodic table

The Periodic Table is a list of elements arranged in order of their increasing proton (atomic) numbers. The Periodic Table divides the elements into periods and groups. Within the Periodic Table, you will observe regular variations (or patterns) of properties with increasing atomic number; both chemical and physical properties vary in a periodic (repeating pattern). This is called Periodicity.

Fig. 3.1 shows part of the Periodic Table. Study the table carefully and you will notice several important features about it.

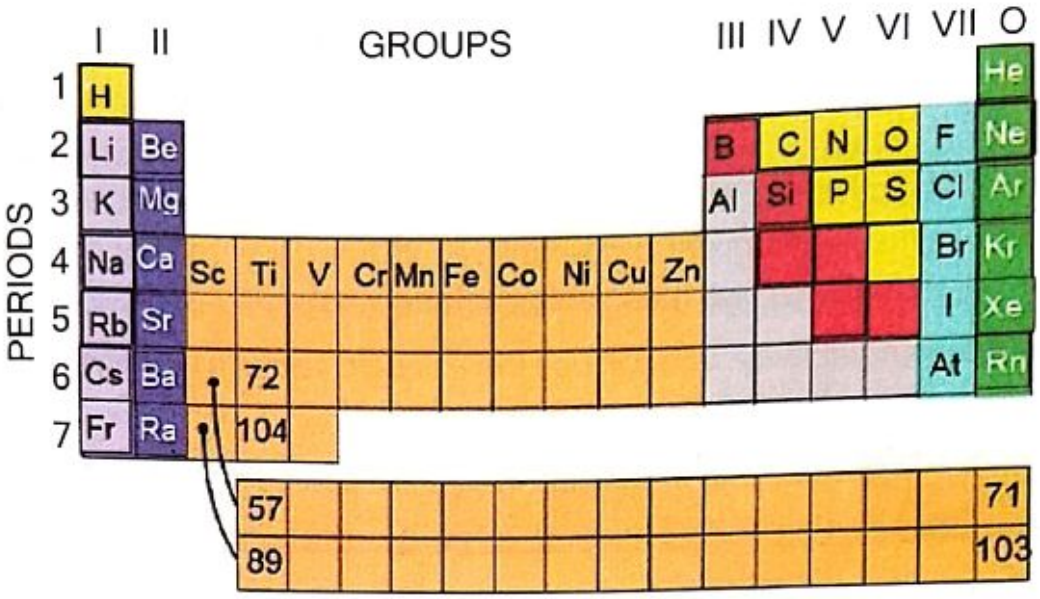


Fig. 3.1: A simplified Periodic Table

Activity 3.1: Identifying patterns in the arrangement of elements in the Periodic Table

In this activity, you will work in groups to identify the arrangement of elements in groups and periods.

What you need

- Periodic Table
- Flip charts
- Marker pens
- Internet or library

What to do

1 Study Fig.3.1 carefully.

Discussion Questions

a. Identify the number of periods and the groups.

b. Describe how the groups and periods are arranged in the Periodic Table

c. Discuss the characteristics of groups and periods in the Periodic Table.

Physical trends across Periods

There are periodic and group relationships among the elements in the Periodic Table. These include atomic radius, ionic radius, metallic character,melting and boiling points and also chemical reactivity. The periodic and group relationships between the elements are called **trends**. In the next sub-sections, you are going to examine the trends among elements across the Periods.

How does the metallic character vary in the Periodic Table?

Metallic character refers to extent by which the characteristics of an element resembles those of metals. These include the physical properties and also the chemical reactivity of the element. Metals tend to lose electrons in chemical reactions. These chemical properties result from how readily metals lose their electrons to form cations (positively charged ions).

In the following activity, you will use the Periodic Table to study whether or not an element will display metallic character.

Activity 3.2: Studying the trends in metallic character of the elements across the Periods

In this activity, you will work in groups to find out how metallic character varies across the periods in the Periodic Table.

What you need;

- Periodic Table
- Marker pens
- Flip charts
- Internet or library
- Support image of Periodic Table

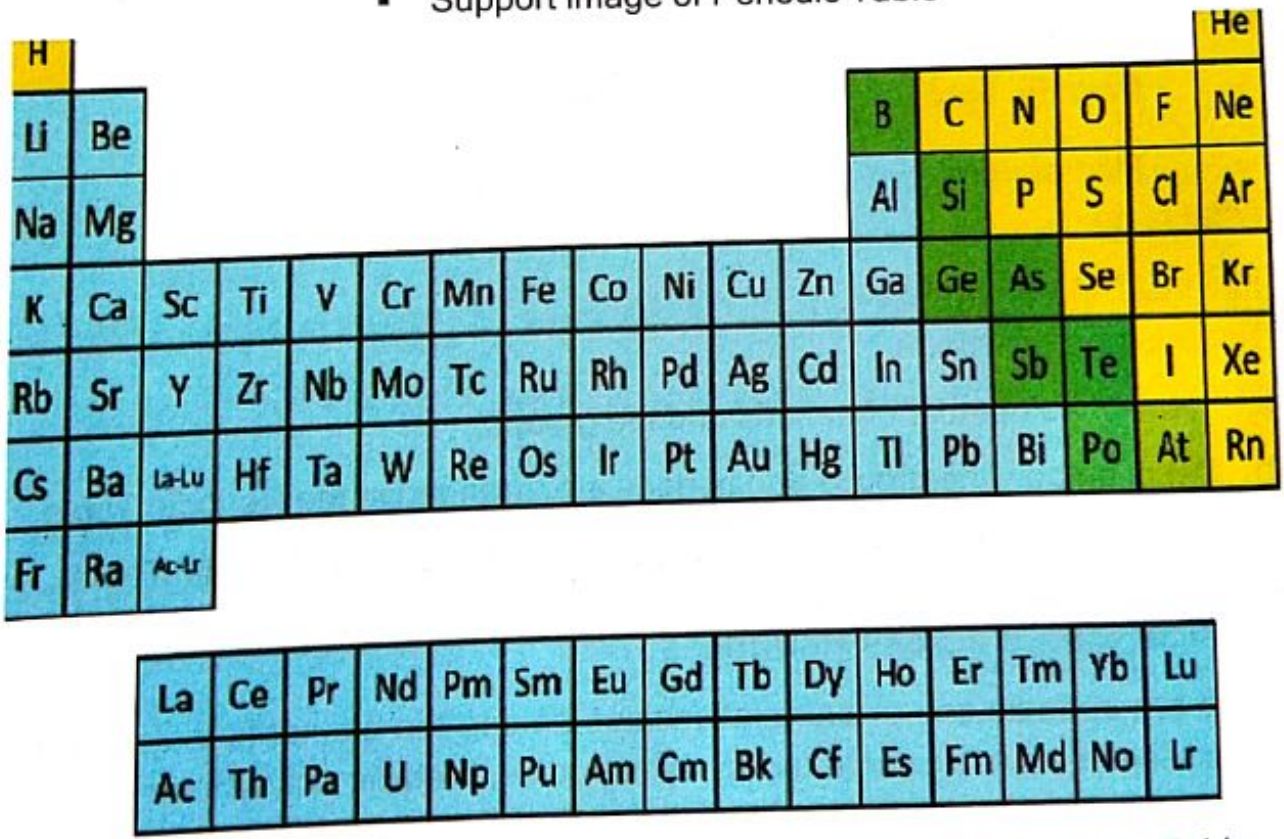


Fig. 3.2: Showing positions of metals and non-metals in the Periodic Table

What to do

Study Fig. 3.2 which displays metallic character by metals carefully.

Discussion Questions

a. Identify the location of metals in the Periodic Table and name any five metal elements
b. Identify the location of non-metals in the Periodic Table and name any five non-metals.
c. Describe the trend in metallic character among the elements in Period II and III of the Periodic Table.
d. Explain why some metals may not belong to the two categories named above
e. Share your responses with the rest of the class in the plenary.

Trends in melting and boiling points across the Periods

Elements of different groups and periods exhibit different trends in boiling and melting points. Melting points and boiling points depend on the strength of forces which exist between the particles which make up a substance.

Melting points and boiling points show periodic properties. This means that they vary in a regular way or pattern depending on their position in the Periodic Table.

Thus, in the following activity, you will find out how the melting points and boiling points vary across the periods and down the groups.

Activity 3.3: Studying trends in melting and boiling points across the Periodic Table.

In this activity, you will work in groups with the guidance of the teacher.

What you need

- support data on melting and boiling points of elements from Na to Ar
- access to internet/library

Table 3.1. Showing melting points and boiling points for elements Na to Ar.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic Number	11	12	13	14	15	16	17	18
Melting point (°C)	66	1195	1206	1956	590	665	445	357
Boiling point (°C)	1429	1653	3013	2901	826	991	511	360

What to do

1 Study and analyse the trends in the melting and boiling points shown in Table 3.1.

2 Using internet or library, find information about the trends in melting and boiling points of the elements across the period and down the groups.

Discussion question

a On the same axes, draw a graph of melting point and boiling point for the elements from Na to Argon.

b Then discuss and describe the trends in melting and boiling points across the period a above. Which factors contribute to the observed trends in the melting point and boiling point across the period.

c. What conclusion can you make in respect to the melting point and boiling point of the elements across the period

d. Present your findings to the rest of the class

Trends in density of elements across the period

There is a change in density among the elements in each period of the Periodic Table. The difference in density among the elements depends on the volume occupied by the elements and the atomic masses of the elements. It is also dependent on physical state and structure of the elements. In activity 3.4, the trend in density across the period will be explored.

Activity 3.4: Exploring the trends in density of the elements in period 3 of the Periodic Table

In this activity, you will work in groups to discuss the variation in density of the elements in period 3.

What you need

- Access to internet or library
- Data on the density of elements of period 3 as in Table 3.2.

Table 3.2. Showing density of elements in period 3.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic Number	11	12	13	14	15	16	17	18
Density (gcm^{-3})	1.0	1.7	2.7	2.3	1.8	2.1	<0.1	<0.1

What to do

1 Study and analyse the trends in the density of period 3 elements shown in Table 3.1.

2 Using internet or library, find information about the trends in density of the elements across the period.

Discussion Questions

a On the same axis, draw a graph of density against atomic number for the elements from Na to Argon.

b Discuss and describe the trends of density across the period.

c Explain the low density of chlorine and argon.

d Present your findings to the rest of the class.

3.2 Trends in properties of compounds of elements of the Period 3

Trends in physical properties of period 3 compounds

Each of the elements in period 3 forms a compound except the Argon which is a noble gas. The compounds range from oxides, halides, hydrides and even sulphides. In activity 3.5 you will analyse the physical properties of some compounds in Table 3.3 and their trends.

Table 3.3: Physical properties of some compounds

element	Sodium	Magnesium	Aluminum	Silicon	Phosphorus	Sulphur
Oxides	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_2
melting point	1275	2827	2017	1607	580	33
Bonding	ionic	ionic	ionic	covalent	covalent	covalent
Acid base nature	basic	basic	amphoteric	acidic	acidic	acidic
Chlorides	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	S_2Cl
melting	1465	1418	423	27	76	136
ionic character	ionic	ionic	covalent	covalent	covalent	covalent
Acid base nature	basic	basic	acidic	acidic	acidic	acidic

Activity 3.5: Investigating reactivity of sodium, magnesium and aluminium with water

In this activity, you will work in groups to analyse data about physical properties of compounds of elements in Period iii of the periodic table

What you need

- Table 3.3
- Internet or chemistry textbook

What to do

1. Study table 3.3 carefully and use it to respond to the tasks below
2. Using the Internet or textbooks search for information about physical properties of compounds of elements in period 3 of the periodic table

Discussion and questions

a. Discuss the trend in melting point of the oxides of period 3 elements
b. Explain the relationship between melting point of oxides and the structure of the oxides
c. Explain why the oxides on the right are acidic while the ones on left are alkaline
d. Discuss the trend in melting point of the chlorides of period 3 elements
e. Explain the relationship between melting point of chlorides and the structure of the oxides
f. Explain why chlorine has a negative melting point
g. Present your findings to the rest of the class

Trends in chemical properties of period 3 compounds.

You have just explored the physical properties of compounds of period 3 elements. Like the physical properties, there is a trend in the chemical properties of the compounds of the elements. In the next activity you will explore the trends in chemical reactivity of the compounds of elements in period 3.

Activity 3.6: Exploring the chemical properties of compounds of period 3 elements

In this activity, you will work in groups to explore the chemical properties of compounds of elements in Period iii of the periodic table

What you need

- Internet or chemistry text books

What to do

Use the internet or chemistry textbooks to search for information about chemical properties of compounds of elements in Period 3 of the periodic table

Discussion and questions

a. Discuss the reactions of period 3 oxides with water, hydrochloric acid and sodium hydroxide

3.3 Properties of Group I elements

Physical proprieties of Group (I) elements

In this section, we shall investigate the variation of some of the physical properties among Group (I) elements.

Activity 3.7A: Exploring in melting and boiling points of compounds elements group (I)of the Periodic Table

In this activity, you will work in pairs and discuss the trends in the boiling and melting points of the elements in group.

What learners will need

- flip chart
- marker pens
- notebook
- access to internet or support tool

Table 3.4: Showing melting and boiling points of group I elements

Element	Melting point/ °C	Boiling point/ °C
lithium	181	1342
sodium	98	883
Potassium	64	760

What to do

- Individually, first read about the melting and boiling points of Li, Na and K using internet or the library. Take note of your findings in your notebook.
- In your groups, study Table 3.4 carefully and discuss the trend in the melting and boiling points down the group. Record your findings in the notebook.
- Share your findings with the whole class.

Discussion Questions

a. How does the melting point and boiling point of group I elements vary down the group?

b. Briefly explain why your observation for the above trend/variation

c. Prepare a presentation on a flip chart for the whole class

Trends in Hardness of metals in group (I)

In this section, you will find out about the trends in the hardness of group I elements.

Activity 3.7B: Finding the trends in the hardness of group I elements of the Periodic Table

This activity will be demonstrated by your teacher. You will work in pairs and observe the experiment as the teacher demonstrates. Take notes and discuss in your pairs the trends in hardness of the elements in group I you have observed during the demonstration.

Caution!!

Do not handle potassium and sodium metals with bare hands. Use gloves.

Take care not to harm yourself when using razor blade or knife

For safety, put on your gloves before starting this activity. This can also be done by your teacher.

What you need

- knife or razor blade
- forceps
- sodium metal
- potassium metal
- dry white tile
- plastic gloves

What to do

1 With a pair of forceps, pick the sodium metal from the bottle and place it on the dry white tile.

2 Using a knife or the razor blade, cut the sodium metal as shown in Fig.

3 Record your observation in the notebook.

Figure 3.3: How sodium metal is being cut using a knife.

Discussion Questions

a. State your observations in the experiment.

b. Arrange the element in order of the hardness.

c. Predict the trend of hardness among group II elements.

Trends in density of group (I) elements

You can remember that density is change in mass per unit volume of the substance. Thus, density depends on two factors, both of which change down

the group. The atoms are packed in the same way, so the two factors considered are how many atoms can be packed in a given volume, and the mass of the individual atoms. The amount packed depends on the individual atoms' volumes; these volumes, in turn, depends on their atomic radius.

So, in the following activity, you will find out about the variation of the density of the group I elements.

Activity 3.7C: Finding the trends in the density of group (I) elements of the Periodic Table

In this activity, you will work in groups to study the trends in the density of group I Elements.

What you need

- internet or Chemistry textbook
- Graph Fig. 3.4.

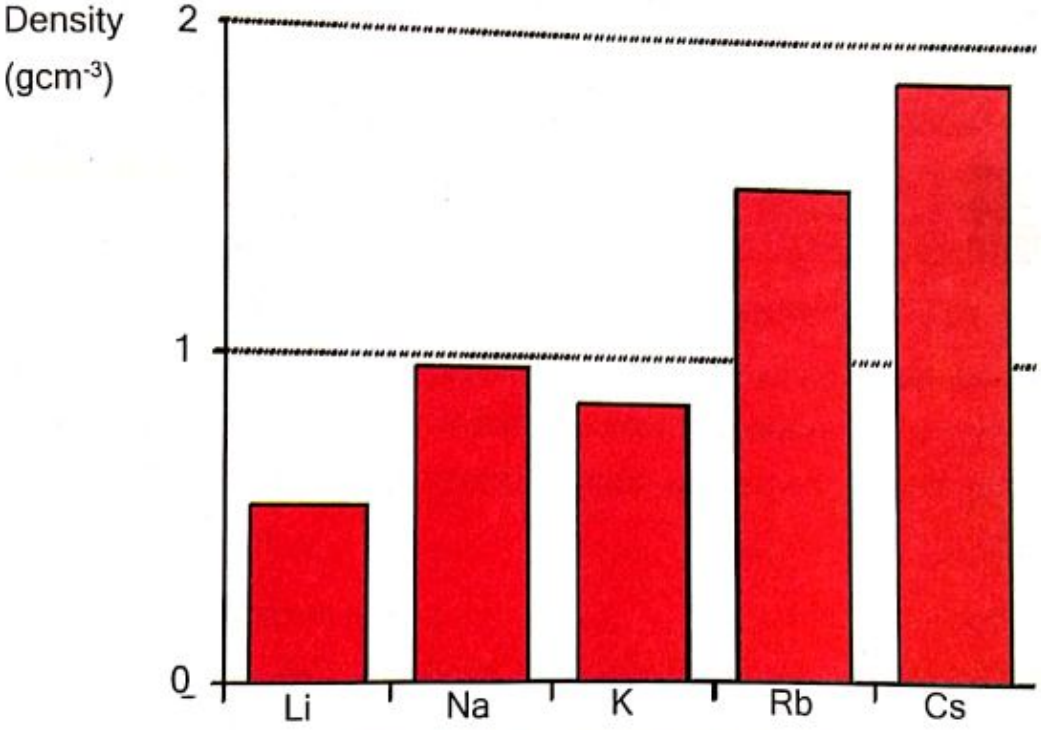


Fig. 3.4: Showing densities of group I elements

What to do

1 Individually, first read about the density of Li, Na and K using internet or the library. Take note of your findings in your notebook.

2 In your groups, study the support tool carefully and discuss the trend in the density of group I elements. Record your findings in the notebook.

3 Share your findings with the whole class.

Discussion Questions

a. How does the density of group I elements vary down the group?

b. Briefly explain your observation for the above trend/variation.

c. Which element(s) will float on water? Give a reason for your response.

e. Prepare a presentation on a flip chart and present to the whole class.

Chemical properties of Group (I) elements

A chemical property is a characteristic of a substance that may be observed when it participates in a chemical reaction. Remember, a chemical change must occur for a chemical property to be observed and measured. Knowing the properties helps chemists make predictions about the type of reactions to expect.

In this section, you will now study the chemical properties of group I elements.

Reaction of group I elements with water

You may have seen how metals like magnesium, iron and aluminium react with water. In this section, you will study how group I metals react with water

Activity 3.8: Investigating the trends in reaction of group (I) elements with water

In this activity, you will investigate reaction of group I elements with water.

Your teacher will help you by carrying out some of the activities on your behalf because of some possible hazards that may occur. You will need to pay very kin and serious attention as the teacher demonstrates/carries out the activities.

What you need

- glass beakers/basin
- plastic gloves
- litmus papers (red and blue)
- potassium metal
- pair of forceps
- water
- sodium metal

What to do

1 For safety, put on your gloves before starting this activity. This can also be done by your teacher.

2 Fill the basin until it is half-full with water.

3 With a pair of forceps, pick the sodium metal from the bottle and place it on the dry white tile.

4 Using a knife or the razor blade, cut a small piece (not more than half the size of ordinary bean seed) of the sodium metal and then drop it in the basin of cold water as shown in Fig. 3.5. Record your observation in the notebook.

5 Test the resulting solution with litmus papers (red and blue).

6 Repeat step 2 to 4 above with sample of potassium metal.

7 Share your findings with the whole class.

Fig.3.5. sodium metal reacting with water

Discussion Questions

a. Describe how the elements sodium and potassium reacted with water.
b. Write chemical equations for the reactions in (1) above.
c. What did you observe when the resulting solution was tested with litmus papers?
d. Draw a conclusion about the reactivity of the group I elements with water
e. Present your findings in a report to the rest of the class.

Reaction of Group (I) elements with air (Oxygen)

The elements in Group (I) react with air to form oxides, the trend in reactivity can be obtained by burning common group (I) elements and observing relative reactivity.

In Activity 3.9, you will investigate the trend in the reactivity of group (I)elements with oxygen

Activity 3.9: Investigating the trend of reactivity of Group I elements with air(oxygen)

In this activity, you will work in groups to investigate the reactivity of Group (I) elements with oxygen.

What you need

- Lithium metal
- Source of heat
- Spatula
- Sodium metal
- Potassium metal
- Knife

What to do

1. Cut a small piece of lithium metal and burn it on a spatula end and record your

observations.

2. Repeat the same procedure with sodium and then potassium metals.

Discussion and questions

a. What did you observe when different metal were burnt in air?

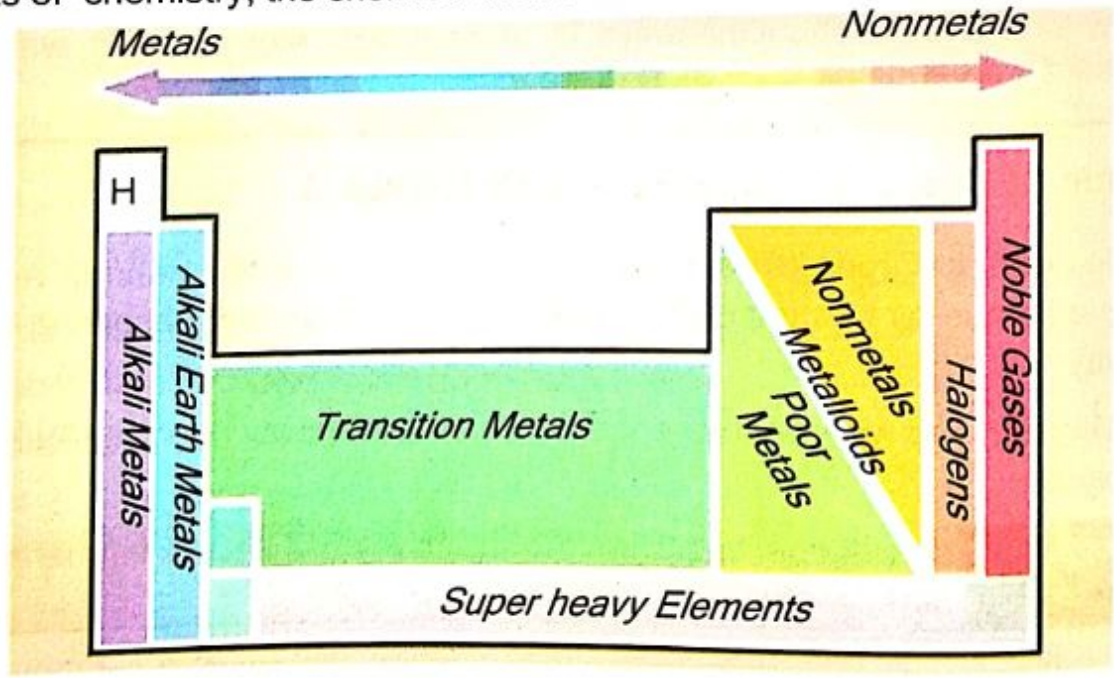
b. Explain the trend of reactivity of the elements with air.

c. Predict the trend of reactivity of any element with air below potassium

Activity of integration

In a number of schools, students believe studying the Periodic Table has very little importance and is uninteresting. It is difficult for them to appreciate the diversity of properties of elements and how these properties change across the periods and groups of the Periodic Table.

However, the headteacher of your school has tasked the head of department of science to organise an awareness of the school community about Periodic Table. He demands a poster to show that the Periodic Table is essential to anyone who wishes to untie the world and see how it is built up from the fundamental building blocks of chemistry, the chemical elements.

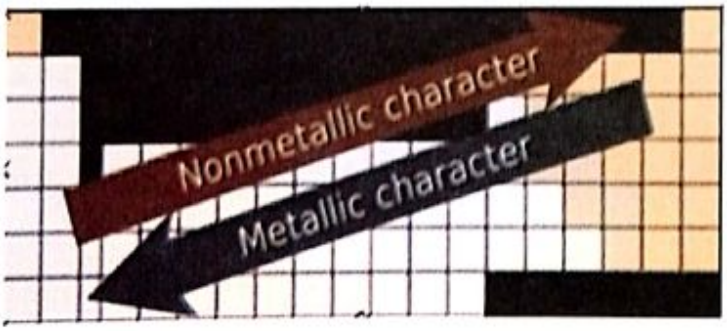


TASK

Prepare a poster showing that the best part about the Periodic Table is the real-life examples and interesting facts of where the elements that are part of matter in everyday life. These elements have behavioural pattern that makes them to be arranged in a table called the Periodic Table.

In this chapter, you have learnt that:

- The most important unifying principle in describing the chemistry of the elements is that the systematic increase in atomic number and the orderly filling of atomic energy levels leading to periodic trends in atomic properties.
- The major periodic t rends include: electro negativity, ionization energy, electron affinity, atomic radius, melting point, and metallic character.
- Elements can be classified as metals, metalloid and non-metals, or as a
- main-group elements and transition metals.
- Metallic character is the set of properties associated with metals. These properties include metallic luster, formation of cations, high electrical and thermal conductivity, and malleability.
- Metallic character is a Periodic Table trend. The elements with the most
- metallic character are on the left side of the Periodic Table (except hydrogen).
- Francium is the element with the highest metallic character.
- As we go from left to right in a period, the metallic character decreases, because of the addition of an electron in the same energy shell each time. So, attraction between the nucleus and the electrons in the outermost shell increases. Thus, tendency to lose an electron decreases and metallic character decreases.



- The most non-metallic elements are in the top right-hand corner of the Table

End – Of – Chapter Questions

1 Explain why while moving down in a group, the metallic character increases.

2 Explain why do all the elements of the same group have similar properties.

3 Which side of the periodic table contains the metals?

4 Describe and explain the trend in chemical reactivity in the group 11 alkali metals.

5 Compare the trend in reactivity between the group 77 and group 00 elements.

6 Explain giving justification the trends in the following properties of elements, on moving from left to right in a period, in the Modern periodic Table.

a) Variation of valency.

b) Change of atomic radius.

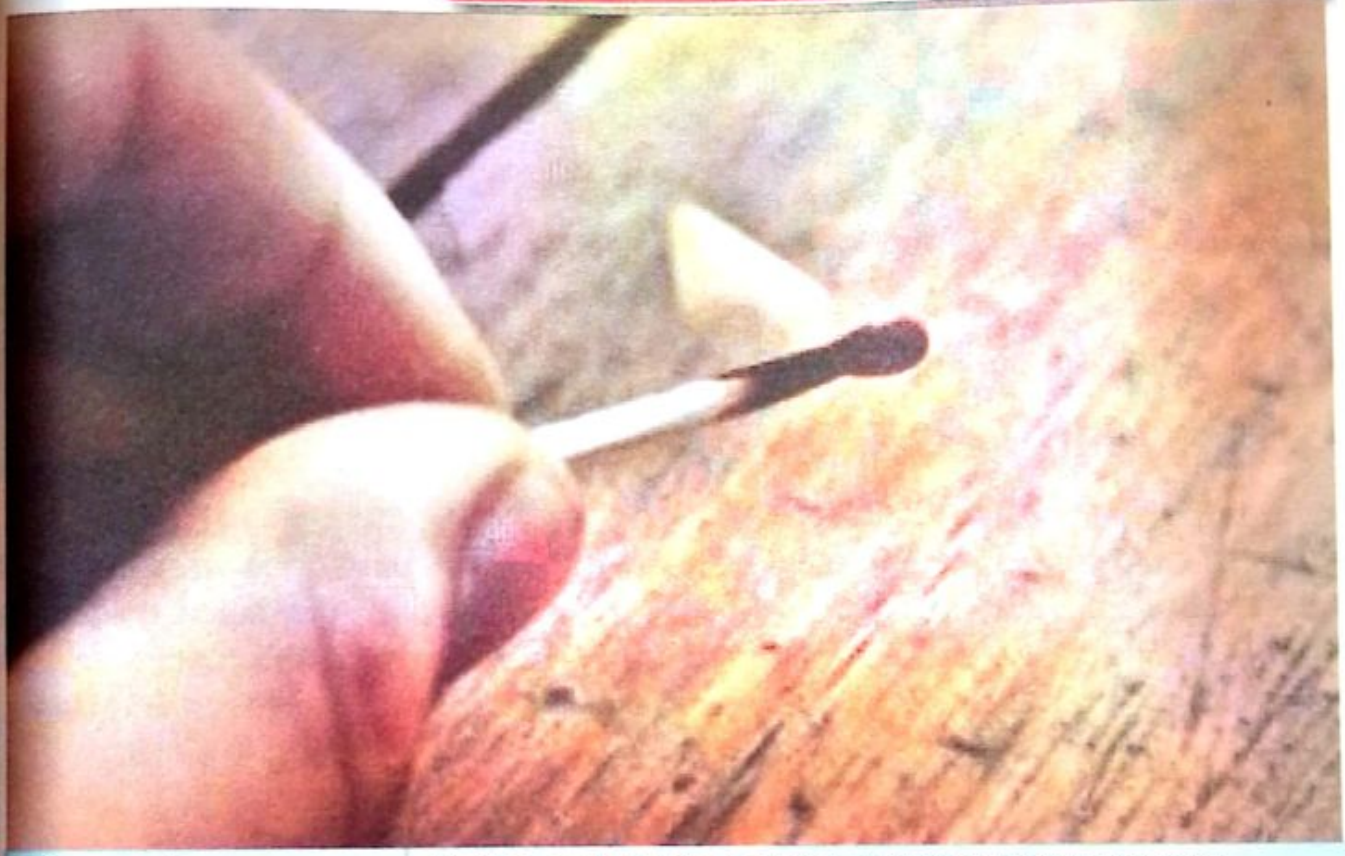
c) Metallic to non-metallic character.

d) Nature of oxides.

7 Explain why the boiling points of the halogens increase down the group.

8 Describe the trends in reactivity of groups 1 and 7 on moving down the groups.

CHAPTER 4: Energy Changes During Chemical Reactions



Key words	By the end of this chapter, you should be able to;
o Energy o Enthalpy o Enthalpychange o Exothermic reaction o Endothermic reaction o Fuel	o recognise and appreciate the difference between exothermic and endothermic reactions and understandthat substances store chemical energy in their bonds o understand and appreciate the importance of exothermic and endothermic reactions in our everyday lives o recognise that burning of fuels is an exothermic process producing useful energy o understand the concept of heat of reaction and interpret energy profiles of chemical reactions.

COMPETENCY

By the end of this chapter, you should be able to appreciate that in any chemical reaction, energy usually in the form of heat is lost or gained

Introduction

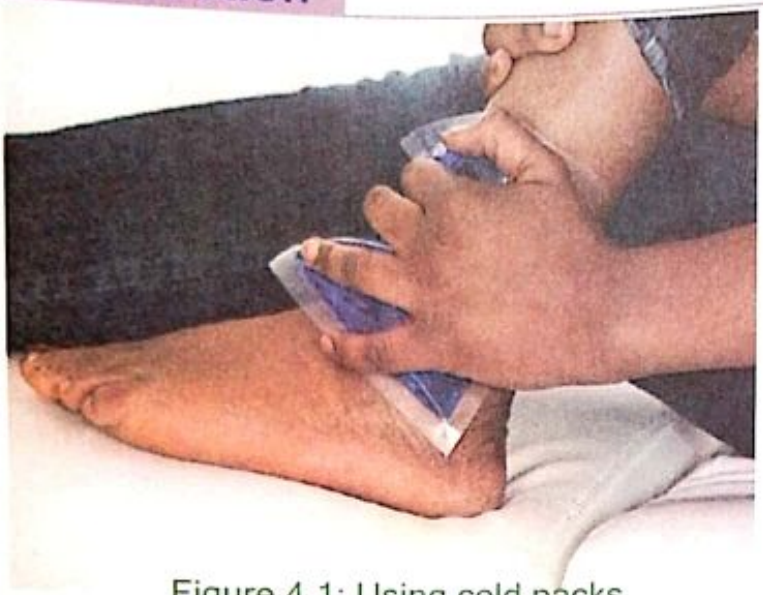


Figure 4.1: Using cold packs

What do you usually apply apart from a pain reliever when you have a headache? In most cases, people apply a cold pack to relieve the pain.

There are a number of benefits of using cold packs for injuries including pain relief . Applying cold will numb the painful area as in Fig. 4.1 and reduce swelling; will reduce internal bleeding; ease muscle spasm and aid muscle relaxation

Some cold packs contain chemicals which take in heat when they react. This is why cold packs have a cooling effect on their surroundings.

Chemical reactions often involve changes in energy due to the **breaking** and **formation of bonds**. Due to the absorption of energy when chemical bonds are broken, and the release of energy when chemical bonds are formed, chemical reactions almost always involve a change in energy between products and reactants.

Therefore, in this chapter you will learn about chemical reactions in which energy is given out or gained in the form of heat and their applications in everyday lives.

4.1 Bonds and energy changes

All chemical substances contain chemical energy stored in their bonds. Look at the following changes that take place in every day life (Figure 4.2)

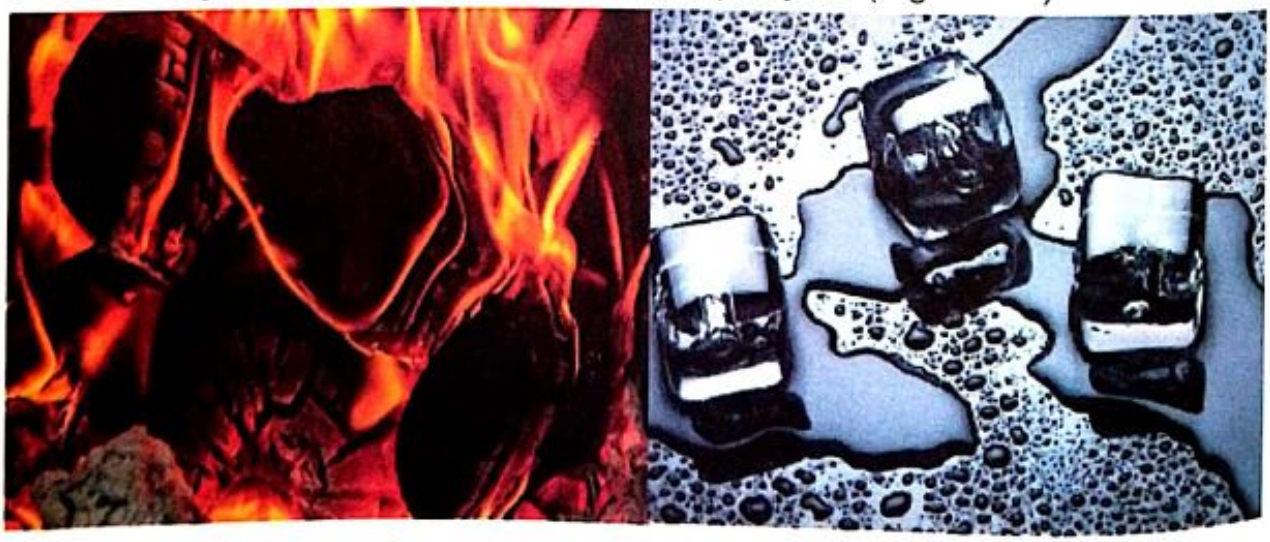


Figure 4.2: Some changes in everyday life(burning wood, melting of ice

The chemical changes involve increase or decrease of energy. During chemical reactions, energy is absorbed or released in the form of heat, light, or both.

The energy change in a chemical reaction is due to the difference in the amounts of stored chemical energy between the products and the reactants. This stored chemical energy, or heat content, of the system is known as its **enthalpy**.

This difference in the energy content of reactants and products results in energy/ **enthalpy change** during chemical reactions. This energy mainly takes place in form of heat energy and therefore is called heat change denoted by ΔH. Δ stands for change and H for heat, so ΔH simply means heat change or enthalpy change.

The general mathematical expression heat/enthalpy change(ΔH) can be represented as; ΔH = Energy content of Products (E_p) - Energy content of reactants (E_R)

Exothermic and endothermic reactions

In preceding introduction, you learnt about heat change (ΔH) and how it is derived using a general mathematical expression. In this section you are going to explore how to categorise heat changes into exothermic and endothermic, as well as the sign convention for the values of each of them. Figure 4.3 shows the changes that take place when ice melt and a fuel is burnt.

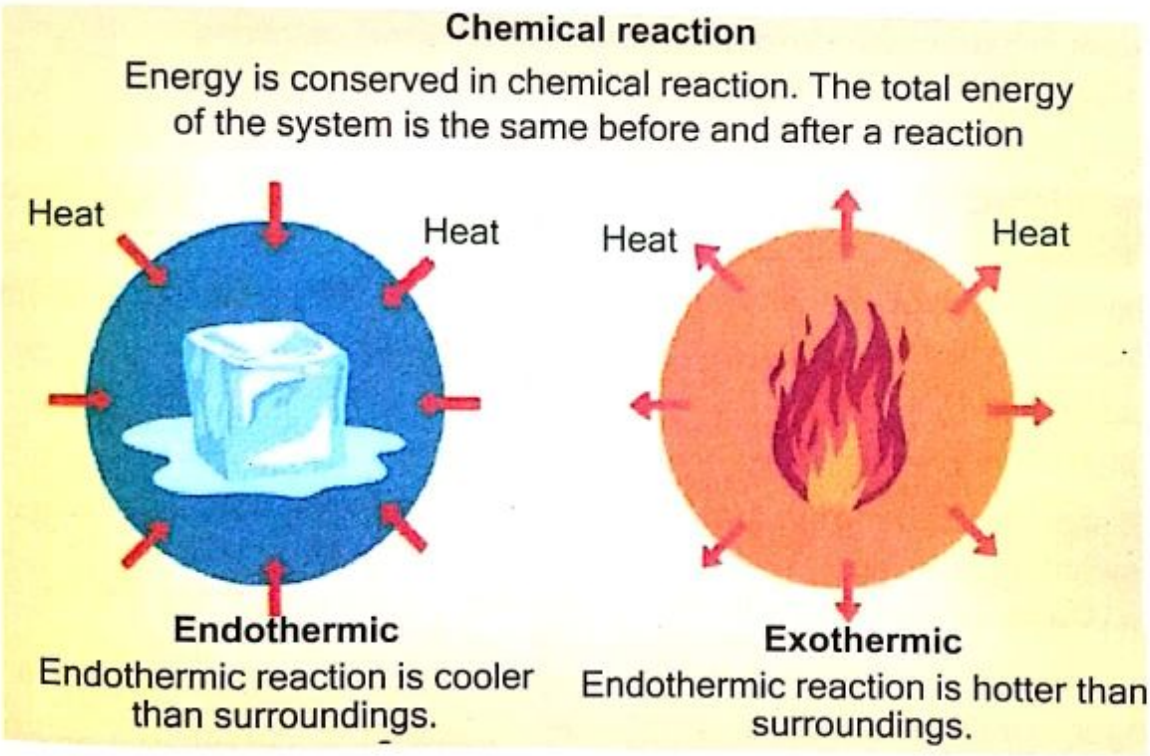


Fig. 4.3: Exothermic and Endothermic reaction

Each of the changes above causes a different effect on the environment. For example, when you touch ice it feels cold but a burning substance feels very hot In the next activity, you will explore more about these changes.

Activity 4.1: Exploring the meaning of exothermic and endothermic processes.

In this activity, you will work in groups to carry out research find and explain the meanings of exothermic and endothermic processes. You will also find out about the sign conventions given to values of heat changes of each of them and how they were derived.

What you need

- Internet or chemistry text book

What to do

1. Using internet or chemistry text book search for information about
   - the meaning of exothermic and endothermic processes
   - the signs (+ or -) given to the values to values of heat change of each of them.
   - how the signs (+ or -) given to the values of heat change of each of them are derived the using the general mathematical expression for ΔH as a basis
2. Prepare a written report of your findings

Discussion Questions

a. Explain the meanings of exothermic and endothermic processes
b. Identify examples of exothermic and endothermic reactions.
c. Present your report to the rest of the class.

Activity 4.2: Identifying reactions in which energy is given out or absorbed

In this activity, you will work in groups to discuss and find out examples of important reactions in which energy is either released or absorbed.

What you need

- Internet or chemistry text book
- List of the following every day changes or reactions; fermentation, respiration, sweating, burning,

What to do

Using internet or chemistry text book search for information about every day changes or reactions.

Discussion Questions

a. Classify the changes in table 4.1 below as endothermic or exothermic reactions and justify your classification

Table 4.1. Energy changes in some everyday reactions

Type of reaction	Energy absorbed	Energy given out
Fermentation		
Respiration		
Sweating		
Burning		
Dissolving salt in water		
Dissolving sugar		

Present the table containing your findings to the rest of the class for discussion

Temperature Changes in Dissolving

In the previous activity, you must have found out that when chemical reactions take place, energy is either gained or lost. How did you know energy is gained from the surrounding or lost to the surrounding? Energy cannot be created or destroyed. However, it can be changed from one form to another. Energy changes occur in chemical reactions and even in some physical processes, such as when solid dissolve in water.

In the next activity, you will investigate what happens when solids are dissolved in water.

Activity 4.3: Investigating changes in temperature as different substances dissolve in water

In this activity, you will work in groups to investigate which solute dissolves the most with absorbing heat from surrounding (endothermically) and which one dissolves the most with release of heat energy to the surrounding (exothermically).

What you need

- Potassium chloride
- Sodium carbonate
- Ammonium nitrate
- small cups
- Permanent marker or
- masking tape and pen
- Calcium chloride
- Sodium bicarbonate
- Water
- Gram balance
- Thermometer
- Graduated cylinder

What to do

1 Label the small plastic cups with the names of the chemical substances.

2 Transfer 2g of each solute and place it in respective labelled cups.

3 Add 10 ml of water to the small unlabelled cup and place a thermometer in the

water. Record this initial temperature in the table on the activity sheet.

4 Pour the potassium chloride into the water and swirl the cup. Record the final temperature of the solution.

Fig. 4.4. Measuring temperature change of a solution

Table 4.2

Experiment	Solid	Initial temperature of water (°C)	Temperature after adding solid (°C)
1	Potassium chloride,		
2	Calcium chloride		
3	Sodium carbonate		
4	Sodium bicarbonate		
5	Ammonium nitrate		
6	Sodium hydroxide		

1. Repeat steps 3 - 5 for each solute

Discussion Questions

(a) Which solute(s) dissolved;

i) endothermically?

ii) most endothermically?

iii) exothermically?

iv) most exothermically?

(b) Explain why some reaction are more endothermic or exothermic .

(c) Present your finding to the rest of the class.

EXERCISE 4.1

1. What are the characteristics of an exothermic reaction?
2. What are the characteristics of an endothermic reaction?

4.2 Importance of endothermic and exothermic reactions

When you think about chemical reactions, do you only think about those giving out heat? Some reactions take place such that they leave the surroundings colder. Endothermic reactions absorb heat and lead to the product being colder. Figure 4.5 shows a burning bush. What type of energy change do you think takes place?

Fig. 4.5: Diagrams showing burning bush

Most of the common reactions in everyday life are mainly exothermic. Reactions such as combustion of fuels, burning of wood, rusting and even fermentation involve a release of energy. In Activity 4.4, you will explore the importance of endothermic and exothermic reactions in everyday life.

Activity 4.4: Identifying importance of endothermic and exothermic reactions in everyday life

What you need;

Internet or chemistry textbooks

What to do;

In your groups, search for information about endothermic and exothermic reaction in every day life.

Discussion questions

a. Identify four endothermic and exothermic reactions in each cases which take place in every day life.

b. Discuss the importance of the reactions identified in (a) above to man

c. How can the concept of energy changes be applied in your environment for economic benefit.

4.3 Obtaining useful energy from burning fuels

Energy can be released in chemical reactions as light, sound or electrical but is most often released as heat. Measuring heat transfers or changes is called calorimetry. The calorimetry experiment can be used to measure the heat energy released from burning fuel. In the next activity, you will estimate the energy produced from burning ethanol.

Activity 4.5: Determining the amount of energy released by burning ethanol

In this activity, you will work in groups to determine amount of energy produced by burning ethanol

What you need

- spirit burner
- measuring cylinder
- thermometer
- wind shield
- copper can
- tripod stand
- water
- ethanol
- pea nut
- oils
- paper
- wood

What to do

2. Using a measuring cylinder, transfer 50cm^3 of water into a coper calorimeter
3. Record the starting temperature of the water.
4. Heat the water using the flame from the burning ethanol.
5. Record the final temperature of the water after 5 minutes
6. Weigh the spirit burner containing the fuel is before and after the experiment so that the mass of the fuel burned

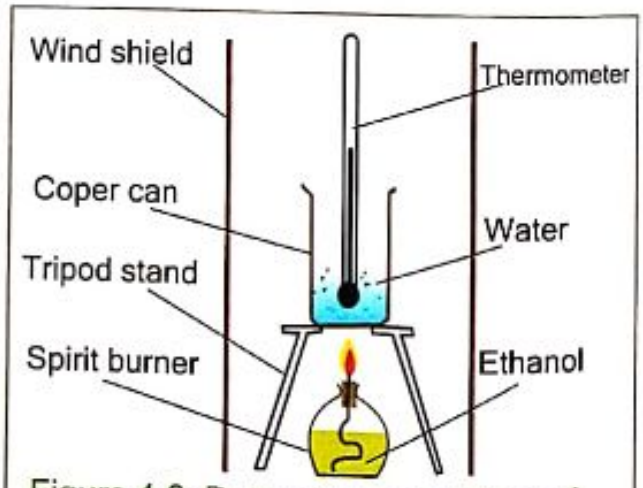


Figure 4.6: Determination of heat of combustion

can be found.

Discussion Questions

a. What is the temperature change of the water

b. What is the mass of ethanol used?

c. Calculate the enthalpy of combustion of ethanol (specific heat capacity of water is 4.2J/g°C)

d. Explain why ethanol is not commonly used as a fuel

Worked example - calculating energy per gram of fuel

3.5 g of a fuel is burned to heat 50 cm^3 of water. The temperature of the water increased from 22°C to 71°C. Calculate the energy released per gram of fuel using the following equation.

Energy given out = mass of water × 4.2 × temperature change Energy measured in joules, J

Mass of water measured in grams (1 cm^3 = 1 g) because density of water is 1g/cm^3.

4.2 is the specific heat capacity of water, J/g°C

Temperature change = temperature of water after heating - temperature of water before heating

Energy given out per gram = energy given out ÷ mass of fuel

Temperature change = 71 - 22 = 49°C

Energy given out = 50 × 4.2 × 49 = 10,290 J

$$\text{Energy per gram} = \frac{10,290}{3.5} = 2,940 J/g$$

EXERCISE 4.2:

1. 40g of ethanol was burnt completely in a calorimeter, the energy given out increased the temperature of 50cm^3 of water by 12°C. Given that the specific heat capacity of water is 4.2$Jmol^{-1}k^{-1}$, calculate the enthalpy of combustion of ethanol.

4.4 Interpreting energy profiles of chemical reactions

You have just learnt that chemical changes may involve loss of energy to the surroundings or gain of energy by the surroundings.

An energy profile of a reaction is a diagram showing the change in chemical potential energy of the reaction. It is also referred to as the energy pathway as a chemical reaction proceeds from reactants to product.

A chemical reaction involves the breakage of old bonds in reactants and formation of new bonds in the products. Obviously,the energy of reactants is different from the energy of products. This enables us to represent the changes in a profile. In the next activity you will explore how the energy profile of exothermic and endothermic reactions can be represented.

Activity 4.6: Representing energy profiles of endothermic and exothermic reactions

In this activity, you will work in groups to represent energy profile diagrams for endothermic and exothermic reactions.

What you need

- Internet or text book

What to do

1. Search for information about energy profile diagrams of different reactions and how to interpret them.
2. Discuss how you can represent the energy profiles

Discussion questions

a. Sketch and label energy profile diagrams for endothermic and exothermic reactions
b. Using materials from your environment design models representing the energy profile diagrams you drew in (a).
c. How is the information from energy diagram important?
d. Present your responses to the rest of the class

EXERCISE 4.3:

1. Two steps must take place, from reactants to products. What are they?
2. Some reactions are endothermic. Explain why, using the ideas of bond breaking and bond making.
3. Hydrogen reacts with oxygen. Draw the equation for the reaction as above, with lines to show the bonds.

Activity of integration

Certain community in "Ombakora" village in north western Uganda predominantly depends on cassava as one of their staple food and source livelihood. This community developed a practice of obtaining a particular quality of cassava flour by storing fresh cassava tubers in cold water until they turned soft. The soft tubers were peeled, dried and made into flour.

A neighbouring immigrant community were shocked by this practice. They could not believe that any conditions cooler than ordinary room condition could ever cause any such change or reaction in the fresh cassava tubers. This is because the immigrant community had a tradition of preparing cassava flour by warming peeled cassava tubers in the sun for two to three days depending on the sun heat. Warmed tubers are then piled and kept at an even higher temperature to ferment the tubers before dried flour were obtained. If higher temperatures are not provided, the tubers would never ferment, The resulting cassava flour after fermentation had a totally different quality and taste from that of the indigenous community.

The immigrant community accused the indigenous Ombakora community of using evil spirits in cool water sources to cause reactions that can soften fresh cassava tubers to obtain flour. They claimed the flour evil.

TASK

The local leaders have requested you to prepare a written sensitization message to solve the dispute about use of evil spirit that cause changes/reactions at low temperature

Chapter Summary

In this chapter, you have learnt that:

- Substances contain chemical energy in their bonds.
- Chemical changes involve the breakage of the bonds in reactants and formation of new ones in products.
- The breakage of bonds requires energy. And the formation of new bonds releases energy.
- Chemical reactions are either exothermic or endothermic.
- In endothermic reactions, energy is absorbed from the surroundings.
- In exothermic reactions energy is released to the surroundings.
- There are many reactions in life which are endothermic and others which are exothermic.
- Endothermic and exothermic reactions can be shown using an energy reaction profile diagram.

End – Of – Chapter Questions

1. Fill in the blanks with appropriate words

a) All chemical substances have energy stored in the form called_____.

b) For a reaction in beaker, the _____is the chemicals reacting in a beaker.

c) The symbol for enthalpy is_____.

d) ΔH is usually measured in_____.

e) For endothermic reactions, ΔH is_____.

f) White washing is_____in nature.

g) Respiration is a process of_____food molecules.

h) The energy released during respiration is trapped in the form of_____.

i) _____is the opposite of the cellular respiration.

j) Water evaporation is an example of_____reaction.

k) The SI unit of energy is _____.

l) The temperature products transfer heat to the surroundings_____.

2. Classify the following statements as True or False

a) Chemical reactions often involve changes in energy due to the breaking and formation of bonds.

b) The word outside the defined system is known as surroundings.

c) The burning of carbon with oxygen produces water.

d) For endothermic reactions, ΔH is negative.

e) Rusting of iron is an exothermic reaction.

f) White washing is exothermic in nature.

g) Respiration is a process of reducing food molecules.

h) Fuel combustion produces large amounts of heat.

i) Photosynthesis is found in plants and animals.

j) Frying an egg is an endothermic process.

k) Energy cannot be created or destroyed, instead it changes forms.

CHAPTER 5: Chemicals for consumers

Key words	By the end of this chapter, you should be able to;
o Detergents o Food additives o Hydrophilic o Hydrophobic o Medicines o Whitening agent o Preservatives o Drugs	o analyse properties of soap and detergent and compare and contrast the effectiveness of their cleaning action o evaluate the use of food additives o understand the importance of chemicals inmedicine o appreciate the importance of the chemical industry and its contribution to our lives.

COMPETENCY

By the end of this chapter, you should be able to appreciate that the products used in everyday life exist as chemicals and some of them can be prepared at home or in the laboratory.

Introduction

Think of the components of the food you consume every other day. If you took a closer analysis of the composition of the food, it will reveal a lot of chemicals that you consume in food. Generally, food may contain carbohydrates, fats, proteins and vitamins. Food we consume may also contain spices, salts, flavourings and additives.

Food is only a part of our life, but there are other chemicals which we use such as medicine, washing agents, cleaning agents, preservatives and stimulants that are useful for our health. So, chemicals play important roles in our everyday life. Nearly everything that we eat, drink and use every day is made of chemical substances.

In this chapter, you will learn to appreciate that the products used in everyday life exist as chemicals and some of them can be prepared at home or in the laboratory.

5.1 Soaps and Detergents

Soaps are cleansing agents or natural detergent, made from fats and oils of animals and vegetables. Soaps are sodium or potassium salts of fatty acids, formed by the reaction of fats and oils with an alkali. The development of soap as cleansing agent and soap making has improved the hygiene and possibly brought many diseases under control.

Activity 5.1: Exploring the history of soap manufacturing

In this activity, you will work in groups and explore the history of manufacturing soap.

What you need

- flip chart
- marker pens
- access to internet or chemistry textbook.

What to do

1 Carry out research using internet or text books about the history of soap-making.

2. Prepare a report of the research based on the tasks provided.

Discussion Questions

a. Where and in which century did manufacturing of soap start?

b. What were the first materials used for making soap and in which century was

the first value addition to soap done?

c. Until 19th century, soap was still expensive. Why was this so?

d. Who discovered the large-scale commercial soap making and in which year?

e. What is it that improved the production of soap and has made it affordable to everyone?

f. Present your findings to the rest of the class for discussion

What is chemical nature of soap?

Soaps are water-soluble sodium or potassium salts of fatty acids. Their nature depends on the chemicals used. Do you know the chemical composition of soap?

In Activity 5.2 you will find out more about the chemical composition of soap.

Activity 5.2: Investigating the composition of soap

In this activity, you will work in groups and research on the chemical composition of soap.

What you need

- Internet or chemistry text book

What to do

1 Using internet or chemistry textbooks, search for information about the composition of soap.

2. Use your findings to respond to the tasks below.

Discussion questions

a. What chemicals are used to make soap?

b. Write the general chemical name and formula for soap.

c. Give an example of a soap molecule and describe its structure.

d. Soaps are made from fats and oils, or their fatty acids with a strong alkali. What name is given to the process of soap-making?

e. Present your findings to the rest of the class.

Importance of Fats and oils in Soap-making

What are fats and oils? Where are fats and oils obtained? Why are they important in soap-making? These are the questions you will try to answer in the next activity.

Activity 5.3: Researching on the importance of fats and oils

In this activity, you will work in groups using internet or textbooks to find out why fats and oils are important in the soap industry.

What you need

- internet or chemistry text book

What to do

1. Using internet or chemistry textbook, search for information about the use of fats and oils in soap making.
2. Using the information to prepare a presentation for discussion based on the tasks below

Discussion questions

a. Fats and oils in soap making come from animals and plants . Name some of the animal or plant products from which the fats and oils are obtained
b. Explain the role of fats and oils in soap-making.
c. Under what circumstances should you opt to use oils instead of fats when making soap?

Mini project

You have discovered an essential oil for preparing soap. Draw a poster that can be used to excite the public about using soap made using the oil you have discovered.

Cleansing Action of Soap fats

Soaps are used for cleaning dirty clothes. Clothes become dirty due to deposition of dust and oily or greasy substances. Water alone is not capable of wetting and removing oily or greasy substances. However, the hydrocarbon residue R (alkyl group) of the soap anion $RCOO^-$ (Fig. 5.1) can do so.

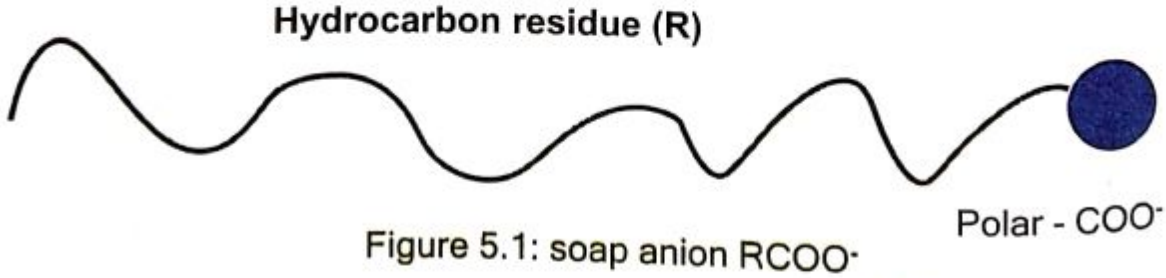


Figure 5.1: soap anion $RCOO^-$

Activity 5.4: Finding out how soap cleans and removes dirt

In this activity, you will work in groups to find out how soap cleans and removes dirt from fabrics, skin or utensils.

What learner will need

- Internet or chemistry text book.
- soap (10 g).
- water (500 cm^3).
- small bucket.
- mortar and pestle.
- piece of cloth stained with dirt (cooking oil, soil, dye, etc.).

What to do

1 in your groups, search for information from internet or chemistry text book about how soap works in removing dirt or grease
2 Grind the soap into fine powder with pestle in mortar.
3 Add the ground soap into water in the small bucket and dissolve it by stirring to make soap solution.
4 Soak the dirty piece of cloth in the soap solution for five minutes.
5 Shake the bucket gently for 3 - 4 minutes.
6 Then remove the piece of cloth from the soap solution and rinse.

Discussion Questions

a. Describe how the piece of cloth appears on rinsing.
b. What is the effect of the soap on the dirty piece of cloth?
c. Using a schematic diagram or flow chart, explain the cleansing action of soap. Share your flow chart with the whole class.

Project

Project preparing soap with additives.

- Plan and design an activity to prepare a sample of soap containing additives.
- Present your plan including all the necessary ingredients to your teacher for guidance.
- Prepare a sample of the soap and display in your class.
- Document the stages and processes involved in the activity and present the report to your teacher.

What is chemical nature of detergent?

Have you used a detergent? Figure 5.2 shows some of the common detergents used in Uganda.

Figure 5.2: Common detergents used in Uganda

Do you know the composition of a detergent? Figure 5.3 shows the basic structure of a detergent molecule. The detergent molecules have both hydrophilic (water loving heads) and hydrophobic (water hating tails) parts (Fig. 5.3).

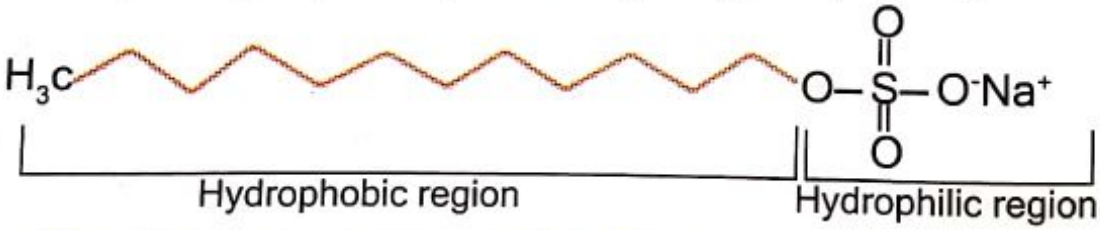


Figure 5.3: hydrophobic and Hydrophilic regions of the anionic detergent sodium dodecyl sulphate.

In the same molecule of the detergent, different parts have different affinity for the solvent and dirt. One part possesses a high affinity for polar solvents (such as water), and another part has a strong affinity for non-polar dirt particles. They are also known as surfactants because they decrease the surface tension of water. In Activity 5.5, more information about the chemical composition of detergents will be explored.

Activity 5.5: Exploring the chemical composition of detergent

In this activity, you will work in groups and research on the chemical composition of detergent.

What you need

- Internet or chemistry text book.

What to do

1. In your groups, search for information from internet or chemistry text book about the composition of detergents
2. Then discuss as a group and agree on the facts about the composition of detergents

Discussion Questions

a. What chemicals are used to make a detergent?
b. Write the general chemical name and formula for detergents.
c. Give an example of a detergent and describe its structure.
d. Prepare the findings of your discussion and present to the whole class.

What additives are present in detergents?

Different detergents with different characteristics carry out various cleansing functions. Many additives are added to detergents to provide different functions. Some additives are fluorescent whitening agents, fragrances, bleach, enzymes, fabric softening agents, drying agents, colourants and other ingredients.

In the next activity, you will explore the various additives and their uses in a detergent.

Activity 5.6: Finding out about additives for soap

In this activity, you will work in groups and research on the additives and their uses in a detergent.

What you need

- Internet or chemistry textbooks.

What to do

1 Using internet or chemistry textbooks search for information about the types of additives used in different detergents.

2 Discuss as a group and agree on the facts about the additives in the detergents.

Discussion questions

a. Identify examples of additives used in common detergents in Uganda
b. What is the use of each of the additives you have identified?
c. Organise your findings in tabular form with two columns as additives and uses.
d. Present your findings to the rest of the class.

Cleansing action of Detergents

Synthetic detergents have a similar type of molecular structure as soaps. The structure is a tadpole like molecule having two parts at each end. One of the ends is water loving and is ionic in nature. The other end is covalent in nature and easily dissolves in fatty substances. The two parts with opposing characteristics enable the detergent to dislodge dirt from surfaces and fabrics.

In activity 5.7 you will study the cleansing action of detergents.

Activity 5.7: Studying the cleansing action of detergents

In this activity, you will work in groups to find out how detergents clean and remove dirt from fabrics, skin or utensils.

What you need

- piece of cloth stained with dirt (cooking oil, soil, dye, etc.).
- detergent (10 g).
- water (500 cm^3).
- small bucket.
- mortar and pestle.

What to do

1. Add the detergent powder into a bucket of water to make a detergent solution.
2. Soak the dirty piece of cloth in the detergent solution for five minutes.
3. Shake the bucket with the piece of dirty cloth gently for 3 - 4 minutes.
4. Ensure that the clothes in the detergent solution are well agitated.
5. Then remove the piece of cloth from the detergent solution and rinse.

Discussion questions

a. Describe how the piece of cloth appears on rinsing.
b. What is the effect of the detergent on the dirty piece of cloth?

c. Using a schematic diagram or flow chart, explain the cleansing action of detergents.

d. Share your flow chart with the rest of the class.

Soap and detergent; Which one is a better cleansing agent?

Most people are convinced to think detergents are better cleansing agents than soaps. However, in order to decide which of the two is a better cleansing agent, there is need to compare their cleansing actions. Figure 5.4 shows different soaps and digests commonly used for cleaning in Uganda.

Figure 5.4: Soaps and detergents

Regardless of the purpose for cleaning, there is a difference in ability of soaps and detergents to remove dirt. In Activity 5.8, you will compare the cleansing action of detergents and soap.

Activity 5.8: Comparing the cleansing action of soap and detergents with soft water

In this activity, you will work in groups to compare the cleaning actions of detergents and soaps with soft water.

What you need

- detergent (10 g).
- soap (10 g).
- distilled water (1000 cm^3)
- chemical balance.
- measuring cylinder.
- pieces of cloth stained with dirt (cooking oil,

soil, dye, etc.) x 2.

- small bucket x2.
- mortar and pestle.

What to do

1. Measure 250 ml of distilled water using a measuring cylinder and pour in each of the small buckets.
2. Weigh 10g each of soap and detergent. Grind the soap using mortar and pestle into powder. Dissolve the soap in one of the small buckets
3. Soak the dirty pieces of cloth in each of the buckets containing detergent and soap solution for 10 - 15 minutes.
4. Shake the buckets with the pieces of dirty cloth gently for 3 - 4 minutes.
5. Remove the piece of cloth from the detergent and soap solutions and rinse.
6. Then rinse the pieces of cloth separately with clean distilled water.

Discussion Questions

a. Describe what you observed with each piece of cloth appears on rinsing.
b. Which piece of cloth had all the stains removed?
c. Based on the observations, what conclusion can you make about the effectiveness of soap and detergent as cleansing agent?
d. Present your findings to the rest of the class.

Most of the water used for cleaning and washing is not pure, it contains dissolved mineral salts, suspended particles and micro organism. Water containing a dissolved mineral salt is called hard water. Activity 5.9 investigates the effectiveness of soaps and detergent when cleaning using hard water.

Activity 5.9: Studying the effectiveness of cleansing actions of detergents and soaps using hard water

In this activity, you will work in groups to compare the cleaning actions of detergents and soaps with hard water.

What you need

- detergent (10 g).
- soap (10 g).
- magnesium sulphate solution (1M).
- beaker (100ml) x 2.
- measuring cylinder (50 ml).
- pieces of cloth stained with dirt (cooking oil, soil, dye, etc.) x 2.

What to do

1 Weigh 10g each of soap and detergent. Grind the soap using mortar and pestle into powder. Dissolve the soap in one of the small buckets with water to make soap solution and the detergent in the other.

2 Prepare 50ml of 5% each of the detergent and soap solutions and put them in separate beakers.

3 Soak the dirty pieces of cloth in each of the beakers containing detergent and soap solution for 10 - 15 minutes.

4 Shake the beakers with the pieces of dirty cloth gently for 3 - 4 minutes.

Discussion Questions

a. Describe what you observed with each piece of cloth appears on rinsing.

b. Which piece of cloth had all the stains removed?

c. Based on the observations, what conclusion can you make about the effectiveness of soap and detergent as cleansing agent?

d. Share your flow chart with the whole class.

Project

Project making a detergent.

1. Plan and design an activity to prepare a sample of a detergent.
2. Present your plan to teacher for approval.
3. Prepare a sample of detergent using the material you planned to use.
4. Document the step involved in the preparation of the detergent and
5. Present the report to your teacher.

EXERCISE 5.1:

1. Soaps are cleansing agents made from natural agents.

   a) Name one natural agent used to make soap

   b) Name the process of making soap

   c) State one of the disadvantages of soap.

5.2 Food additives?

What are food additives? What common things are added to our food at home? For example, we add salt and sugar to food always. Why do you add them?

Today, there are a few thousand of these Additives added to the processed food that we eat as shown in the Figure 5.5.

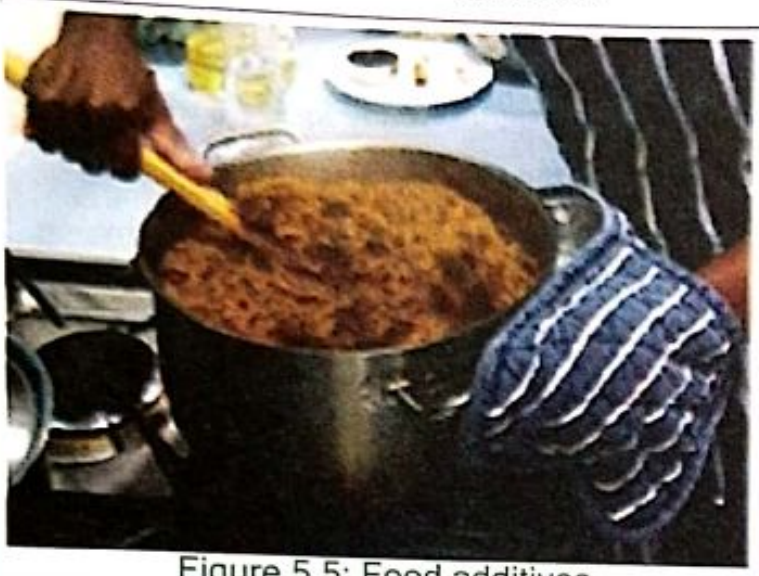


Figure 5.5: Food additives

Figure 5.6 :Food ingredients

Thus, an additive is any substance added to food in small quantities so as to that affect the characteristics of any food

This description includes any substance used in the production, processing, treatment, packaging, transportation or storage of food. Usually, additives added are listed on the ingredient label of foods as shown Fig. 5.6

What are the types of food additives?

Food additives can be classified by their source or function. In terms of source, we have natural and synthetic additives.

Activity 5.10: Finding out the types of food additives

What you need

- flip chart
- marker pens
- internet or chemistry text book

What to do

1. Using internet or chemistry text book, read about the types of food additives classified as natural and chemical additives with the following examples:

- Preservatives
- Antioxidants
- Flavourings
- Stabilizers
- Thickeners
- Colourings

2. Discuss as a group the functions of each type of food additive and prepare a write up of your discussions for presentation in a plenary.

Discussion Questions

a. What is the function of each type of the food additive?
b. What are the examples of each type of food additive?
c. Summarise your discussions and findings in a in a chart for presentation to the class.

5.3 Importance of chemicals in medicine

You have learnt about chemicals used in everyday cleaning of fabrics, surfaces and other materials. There is another category of chemicals used in medicine used to treat different diseases. These can be natural organic chemicals and processed ones. In the next activity, these different chemicals will be studied and explored.

Activity 5.11: Finding out about application of chemistry in medicines

In this activity you will work in groups as guided by your teacher.

What you need

- Internet

What to do

1. Using internet search for information about the different drugs used in medicine and their functions

Discussion Questions

a. Distinguish between traditional and conventional medicine
b. Explain what determines the persons choice between conventional and traditional medicine
c. Explain the different classes of conventional medicine and how they are used
d. Discuss the factors that affect use of drugs
e. Design a poster that can be used to convince people in your area to avoid self medication
f. Present your ideas from the above tasks to the rest of the class for discussion

5.4 Contribution of the chemical industry to our lives

In the previous sections of this chapter,you have explored the different chemicals used in everyday life. The chemical industry influences our life so much that we do not even realise that we come across chemicals at every moment.

Can you imagine a world without chemicals? Thinking of cleanliness and hygiene, garments material for clothing, beddings or other uses, building and electronic materials, utensils, you appreciate the importance of the chemical industry.

In the next Activity, you are going to learn about importance of chemical industry in our lives.

Activity 5.12: Finding about importance of the chemical industry in everyday life

In this activity you will work in groups as guided by your teacher.

What you need

- Internet or textbooks

What to do

1. Using the internet or textbooks, search for information about the importance of of the chemical industry in everyday life
2. Discuss your ideas with members of your group and prepare a report about your findings

Discussion questions

a. Identify and name the chemicals you use in your home

b. Give the use of the chemicals you have identified

c. Explain what would happen to your life in the absence of the chemicals identified

d. Write a 3 stanza poem praising the use of chemicals in everyday life

Activity of integration

The materials we use for our everyday livelihood including water are chemicals. Water and sanitation are essential for life and health, but they are also essential for dignity, empowerment and prosperity. Water and the use of some of these chemicals/materials that support sanitation/basic source of food are human rights, fundamental to every child and adult. However because of Covid-19 pandemic and lock down the prices of the cleaning agents have become high and they are also scarce.

Some of these chemicals/material including soap, utensils, fertilisers, food and others can be locally made from home.

TASK

Prepare a short write up to sensitise your community how you they can support their own sanitation by using locally prepared cleaning agents.

Chapter Summary

In this chapter, you have learnt that:

- Products or substances used in everyday life exist as chemicals and some of them can be prepared at home or in the laboratory.
- Chemicals are the building blocks of life. Every living, breathing creature is made of chemicals.
- Soaps and detergents are cleansing agents and are made from fats and oils of animals and vegetables.
- Soaps are sodium or potassium salts of fatty acids, formed by the reaction of fats and oils with an alkali.
- The first recorded evidence of the manufacture of soap-like materials dates back to around 2800 BC in Ancient Babylon. The first materials were: fats boiled with ashes and water.
- Examples of plant fats are sunflower oil, coconut oil, and olive oil.
- Animal fats are saturated fatty acids while plant fats are unsaturated fatty acids
- Examples of animal fats are butter and beef fats while plant fats are coconut oil and olive oil.
- Fats and oils help in the saponification reaction: the alkali reacts with each fatty acid, replacing the H (hydrogen) of the acid with the Na (sodium) or K (potassium) of the alkali, to produce a salt. This salt is the soap. The glycerine is left unchanged by this reaction, and mixes with the saponified salts to enhance the creamy texture of the resultant product.
- Additives in detergents: Biological enzymes: Builders, Fillers (Drying agent), Fragrance, Optical brighter, Stabilising agent, Suspension agent, and Whitening agent
- A detergent is a better cleansing agent than soap. Detergents are better and more effective cleaning agents in both soft and hard water than soap
- Food additives classified as natural and chemical additives and they include: Preservatives, Antioxidants, Flavourings, Stabilizers, Thickeners and Colouring.

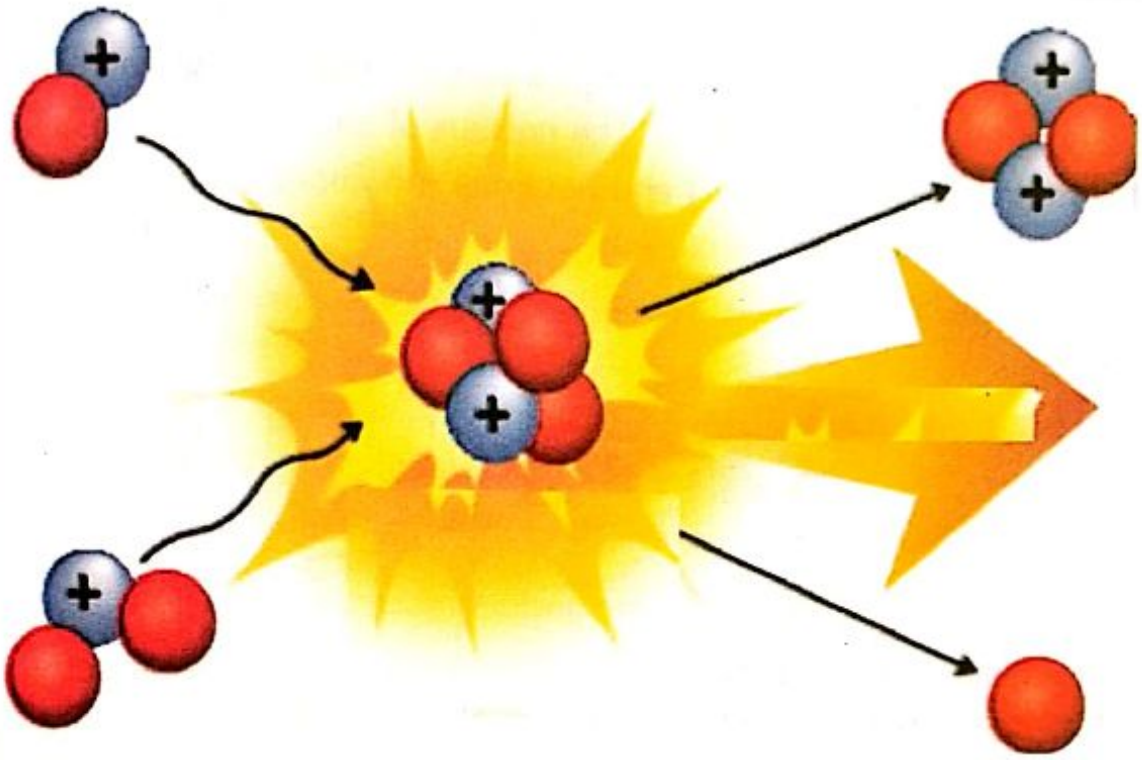
- Traditional medicines are derived from plants or animals. Conventional (Modern) medicines are made by scientists in laboratories and are based on substances found in nature.

End – Of – Chapter Questions

Chemicals for Consumers

1. What is soap and what is detergent?
2. Describe the process through which soap is prepared and also detergent by giving examples.
3. Describe the structure of soap and detergents and also the cleansing action of soaps and detergents
4. What is hard water in relation to the cleansing power of soap with hard water?
5. Compare and contrast the effectiveness of the cleansing action of soap and detergent.
6. What are food additives and state type of food additives and their examples and their functions.
7. What is the function of food label?
8. What happens to life without food additive?
9. What are drugs?
10. What are traditional medicines?
11. State examples of traditional medicines and modern medicine and their uses (functions).
12. What are the possible side effects of using traditional and modern medicine?
13. Describe the correct usage of modern and traditional medicines
14. What is the significance of chemicals in the world today and its side effects.

CHAPTER 6: Nuclear Processes



Key words	By the end of this chapter, you should be able to;
• Chain reaction • Emissions • Nuclear Fission • Nuclear Fusion • Half life • Isotopes • Nuclear decay • Radioactivity	• understand atomic structure, the processes of nuclear fission and fusion, the use we can make of them, and the dangers associated with them • understand the spontaneous and random nature of nuclear decay and interpret decay data in terms of half-life • understand and appreciate that there are significant social, political, and environmental dimensions associated with use of nuclear power.

COMPETENCY

By the end of this chapter, you should be able to understand atomic structure and the nuclear processes by which energy is released

Introduction

In senior two, we learnt that the atoms contain protons, neutrons, and electrons.

The electrons reside in the energy levels around the nucleus.

The nucleus contains the protons and neutrons and is very small in relation to the size of the atom. Nuclear energy is energy that holds together the particles in the nucleus, or at the centre of an atom. The nucleus of an atom is made of tiny particles of protons (positive charge) and neutrons (no charge). The electrons (negative charge) move around the nucleus.

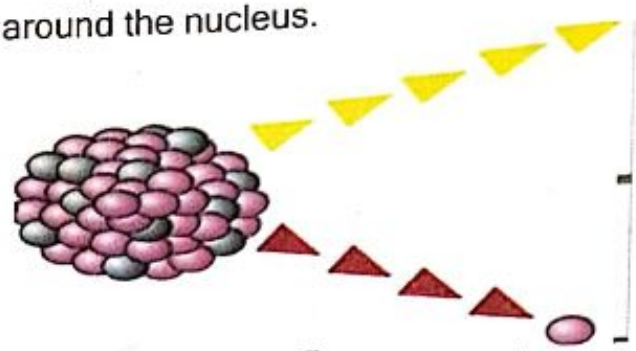


Fig. 6.1. Showing some nuclear reactions

This diagram could almost illustrate a pinball game. It actually illustrates the process of radioactive decay in Fig.6.1. This is a process that occurs all around you. It may even occur inside your body.

Based on the diagram, what happens during radioactive decay? The nucleus of a radioactive atom gives off radiation in the form of energy and a particle of matter.

In this chapter, we are going to learn about the atomic structure and the nuclear processes by which energy is released.

6.1 Structure of the atom and nuclear reactions

Radioactive decay is the process in which the nuclei of radioactive atoms emit charged particles and energy, which are called by the general term radiation. Radioactive atoms have unstable nuclei, and when the nuclei emit radiation, they become more stable. Radioactive decay is a nuclear–rather than chemical–reaction because it involves only the nuclei of atoms. In a nuclear reaction, one element may change into another.

Radiations

Energy that travels through space, in the form of particles or electromagnetic waves is called **radiation**. Sunlight is the commonest radiation. Nevertheless, there are those radiations which are invisible and these include: radio waves and television waves.

In the next activity, you will research about radiations and find out the different forms of radiations.

Activity 6.1: Identifying forms of radioactive energy

In this activity, you will work in groups to identify the different forms of radiative energy.

What you need;

Internet or chemistry textbooks

What to do;

Read about the different forms of radiations and their classes.

Discussion Questions

a. What is the difference between ionising and non-ionising radiations?
b. Give examples of each type of the radiations.
c. How different are the radiations in the examples given above in (2)?

Nuclear Fission Reaction

Nuclear fission is a process where the nucleus of an atom is split into two or more smaller nuclei, known as fission products. The fission of heavy elements is an exothermic reaction and huge amounts of energy are released in the process. This energy can be used to produce nuclear power or to make nuclear weapons, both of which we will discuss a little later.

Activity 6.2: Exploring nuclear fission

In this activity, you will work in groups to explore what nuclear fission reactions are.

What you need;

- Internet or chemistry textbooks

What to do;

1 Read about nuclear fission reactions using internet search or library and take note of your findings
2 As a group discuss how nuclear fission take place.

Discussion Questions

a. Explain what nuclear fission reaction is.
b. Describe how bombarding an atom with a neutron can cause nuclear reaction.
c. What is the result of nuclear fission?

d. Which kind of atoms can undergo nuclear fission?

e. Present your findings to the rest of the class.

Nuclear Fusion Reaction

You will remember that nuclei naturally repel one another because of the electrostatic force between their positively charged protons. So, in order to bring two nuclei together, a lot of energy must be supplied if fusion is to take place. If two nuclei can be brought close enough together however, the electrostatic force is overwhelmed by the more powerful strong nuclear force which only operates over short distances. If this happens, nuclear fusion can take place.

In the next activity, you will explore the meaning of nuclear fusion and how it takes place.

Activity 6.3: Exploring nuclear fusion reaction

In this activity, you will work in groups to explore what nuclear fusion reactions are.

What you need

- Internet or chemistry textbooks • Figure 6.2

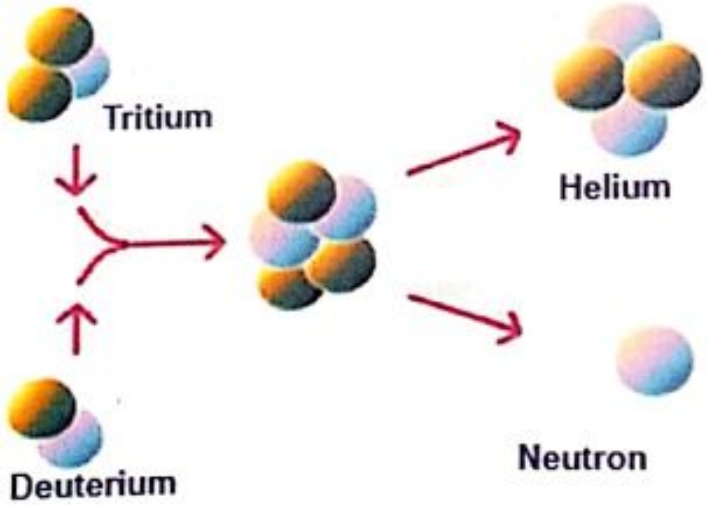


Fig. 6.2.nuclear fusion of deuterium and tritium (isotopes of hydrogen)

What to do;

1. Search for information about nuclear fusion reactions using internet or chemistry textbook.
2. Study the support tool shown in Fig. 6.2 carefully.
3. As a group share ideals about how nuclear fusion takes place.

Discussion Questions

a. Explain what nuclear fusion reaction is.
b. Describe how nuclear fusion reaction can generate energy.
c. What is the result of nuclear fusion?
d. Which kind of atoms can undergo nuclear fusion?
e. Present you findings to the rest of the class.

Making use of the nuclear reactions

What are the advantages and disadvantages of nuclear reactions?

Nuclear radiations cannot be seen or smelt, but we are constantly been exposed to them and every day in different ways. Excess exposure to radioactivity is thought to be dangerous and cause cancer.

In the next activity, you will debate on the use of nuclear reactions and its effects on humans.

Activity 6.4: A debate on Nuclear Power

In this activity, you will be divided into two groups to debate the pros and cons of nuclear energy.

What you need;

- Motion for debate "to use or not use nuclear energy"
- Internet or chemistry textbook.

What to do;

1. Search the information about the advantages and disadvantages of nuclear energy
2. Discuss with the ideas researched with members of our group

Discussion Questions

Summarise points raised in the debate and record them in your book

EXERCISE 6.1: Looking at half life

1 Imagine that you have 100 g of Na-24.

a) What is the half-life of Na-24?

b) How much of this isotope will be left after 45 hours?

c) What percentage of the original sample will be left after 60 hours?

2 A sample of Sr-90 is allowed to decay. After 84 days, 10 g of the sample remains.

a) What is the half-life of Sr-90?

b) How much Sr-90 was in the original sample?

c) How much Sr-90 will be left after 112 days?

Using Nuclear Power

Where do we experience use of nuclear reactions in everyday life? Nuclear energy has a variety of important uses. One of the uses of radioactivity is in the generation of energy. This generation of energy contributes a renewable option that relieves the pressure off the non-renewable energy sources such as fossil fuels. Figure 6.3 shows a large nuclear energy plant.

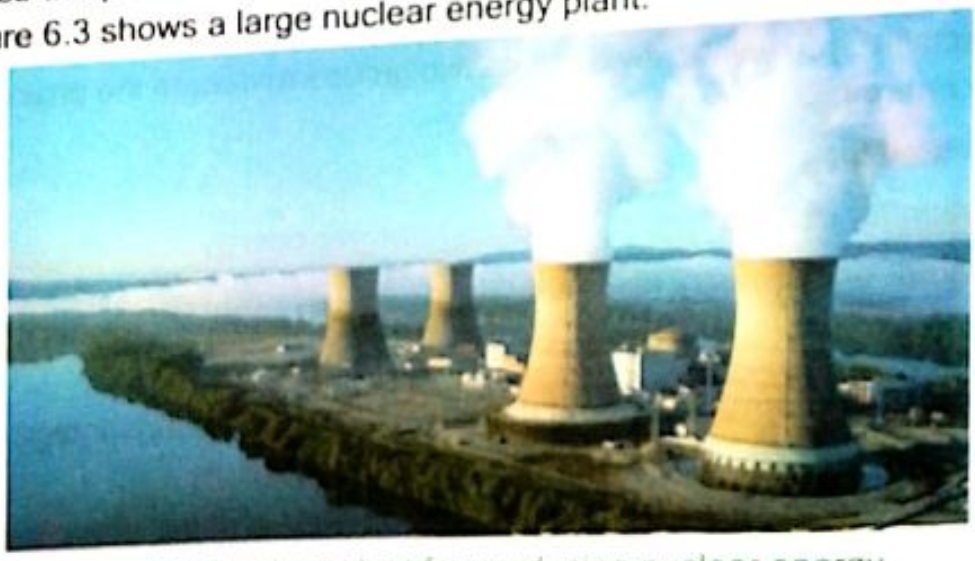


Figure 6.3: Nuclear plant for producing nuclear energy

What other uses of nuclear energy do you know? In activity 6.5, you will find out the different uses of nuclear energy.

Activity 6.5: Exploring the uses of radio isotopes in everyday life

In this activity, you will work in groups to find out about uses of radio isotopes in everyday life and those used to treat medical condition of; thyroid gland, kidneys, brain.

What you need;

- Internet or chemistry textbook.

What to do;

1. In your groups search for information from the internet about the uses radioisotopes

Discussion Questions

a. Identify the different uses of radioisotope.
b. Explain the source of the radio isotopes.
c. How can radioisotopes in a patients body be monitored.
d. Present your findings to the rest of the class.

6.2 Nuclear decay

You have just learnt about the uses of nuclear energy. You have also considered artificial sources of radioactivity in fusion and fission reactions. However, radioactivity is also a natural process. Some elements are naturally unstable and undergo nuclear decay to give particles and rays. In the next activity, you will explore the different particles emitted by unstable atoms and explain the reasons for the emission.

Activity 6.6: Exploring emissions from unstable atoms

In this activity, you will work in groups to identify the particles emitted by unstable particles and why the atoms are unstable

What you need

- Internet or chemistry textbooks

What to do

Using the Internet or textbooks search for information about stability of radioactive atoms

Discussion questions

a. Name the particles and rays emitted by radioactive atoms
b. Describe the difference in properties of the particles and rays emitted by unstable atoms
c. Explain the effect of the emissions on the structure of atoms
d. Write equations to represent the emission of radioactive particles

Rates of decay

You have ever watched athletes running a race. Do you think the athletes can run at the same speed? Definitely there will be winners and losers. Like in races, different radioactive atoms decay at different speeds. The rate of decay is the measure of how fast a radioactive sample undergoes nuclear transformation. The rate of decay is measured by the half-life which is the time taken for the counts of a radioactive sample to reduce to a half. In activity 6.7 you will use the data provided in Table 6.1 to interpret information on rates of decay.

Activity 6.7: Interpreting data on rates of decay

In this activity, you will work in groups to interpret data in table 6.1.

What you need

- Table 6.1
- Internet or chemistry text books

Table 6.1

Time (hrs)	0	1	2	3	4	5
Count rate (counts min-1)	200	110	57	35	20	13

What to do

1. Search for information about rates of decay using the Internet or textbooks
2. Study table 6.1 showing the rates of decay at different times

Discussion questions

a. Using the table provided, plot a graph of count rate against time for the atom above.

b. Explain the shape of the graph

c. Use the graph to determine the half life of the atom

d. Explain why the curve will finally level

EXERCISE 6.2:

1. The isotope $^{214}_{82}Pb$ undergoes radioactive decay and loses three alpha particles.

a) Write the chemical formula of the element that is produced as a result of the decay.

b) How many nucleons does this element contain?

2. Complete the following equation:

$$^{238}_{92}U \rightarrow \_\_\_ + {}^{4}_{2}He$$

3. Radium-228 decays by emitting a beta particle. Write an equation for this decay process.

4. Describe how gamma decay differs from alpha and beta decay.

6.3 Social, political and environmental aspects of nuclear power

You have learnt about the many uses and applications of nuclear reactions. However, like any other process, nuclear transformations and reactions have some effects on the environment. They also affect our social, and political aspects in a number of ways. One such effect is the leakage of nuclear material that can cause negative effects including death of people and animals. Do you know of other effects of nuclear energy? In activity 6.8, you will explore the various effect of nuclear energy.

Activity 6.8: Exploring the effects of nuclear power

In this activity you will work in groups to explore the environmental, social and political effects

What you need

Internet or chemistry textbook

What to do

Use Internet or chemistry textbook gather information about the effect of nuclear energy

Discussion questions

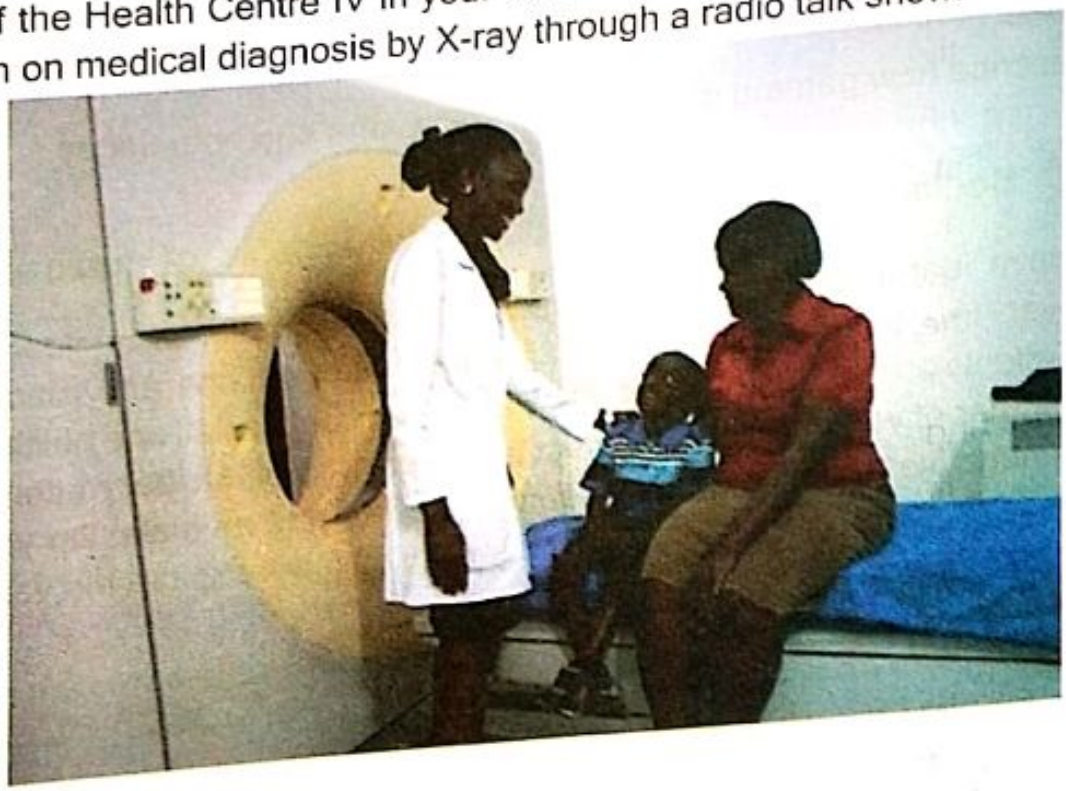
a. Discuss the social, political and environmental effects of nuclear power.

b. Explain how the negative effects can be prevented

c. Present your findings to the rest of the class

Activity of integration

A group of some young men came across brochure on nuclear process by which nuclear energy is released. The brochure contained limited information. It only outlined dangers of nuclear emissions such as causing cancer and uses of some radioactive isotopes such as medical screening of foetus in pregnant women. This information reached the pregnant mothers in the area. Many of the pregnant mothers still ask their doctors whether to X-ray or not to X-ray? This is because of the fear for the dangers of exposure to x-rays that causes cancer. The in-charge of the Health Centre IV in your Sub-County is organising an awareness campaign on medical diagnosis by X-ray through a radio talk show.



TASK

Prepare a message for his radio talk show. The message should include: a response to whether to or not to have X-rays and safety guidelines to reduce medical radiation risks.

Chapter Summary

In this chaster you have learnt:

- There are two forces between the particles of the nucleus. The strong nuclear force is an attractive force between the neutrons and the electromagnetic force is the repulsive force between like-charged protons.
- Radioactive decay occurs when an unstable atomic nucleus loses energy by emitting particles or electromagnetic waves.
- The particles and energy released are called radiation and the atom is said to be radioactive
- .Radioactive isotopes are called radioisotopes.
- Radioactivity was first discovered by Marie Curie and her husband Pierre.
- There are three types of radiation from radioactive decay: alpha (α), beta (β) and gamma (γ) radiation.
- During alpha decay, an alpha particle is released. An alpha particle consists of two protons and two neutrons bound together. Alpha radiation has low penetration power.
- During beta decay, a beta particle is released. During beta decay, a neutron is converted to a proton, an electron and a neutrino. A beta particle is the electron that is released. Beta radiation has greater penetration power than alpha radiation.
- During gamma decay, electromagnetic energy is released as gamma rays. Gamma radiation has the highest penetration power of the three radiation types.
- There are many sources of radiation. Some of natural and others are man-made.
- Natural sources of radiation include cosmic and terrestrial radiation.
- Man-made sources of radiation include televisions, smoke therapy. electors, X-rays and radiation
- The half-life of an element is the time it takes for half the atoms of a radioisotope to decay into other atoms.
- Radiation can be very damaging. Some of the negative impacts of radiation exposure include damage to cells, genetic abnormalities and cancer.

- However, radiation can also have many positive uses. These include use in the medical field (e.g., chemical tracers), biochemistry and genetics, use in food preservation, the environment and in archaeology.
- Nuclear fission is the splitting of an atomic nucleus into smaller fission products. Nuclear fission produces large amounts of energy, which can be used to produce nuclear power, and to make nuclear weapons.

End – Of – Chapter Questions

1. Explain each of the following terms:

a) electromagnetic force

b) radioactive decay

c) radiocarbon dating

2. For each of the following questions, choose the one correct answer:

a) The part of the atom that undergoes radioactive decay is the... i) neutrons ii) nucleus iii) electrons iv) entire atom

b) The radio-isotope Po-212 undergoes alpha decay. Which of the following statements is true?

i) The number of protons in the element remains unchanged.

ii) The number of nucleons after decay is 212. iii) The number of protons in the element after decay is 82. iv) The end product after decay is Po-208.

3. 20 g of sodium-24 undergoes radioactive decay. Calculate the percentage of the original sample that remains after 60 hours.

4. Nuclear physics can be controversial. Many people argue that studying the nucleus has led to devastation and huge loss of life. Others would argue that the benefits of nuclear physics far outweigh the negative things that have come from it.

a) Outline some of the ways in which nuclear physics has been used in negative ways.

b) Outline some of the benefits that have come from nuclear physics.

Glossary

Atomic radius: of a chemical element is a measure of the size of its atom, usually the mean or typical distance from the center of the nucleus to the .

alkali metal:any element, except hydrogen, from Group I of the Periodic Table, e.g. lithium, sodium, potassium, etc

alkaline earth metal: any element from Group II of the Periodic Table such as beryllium, magnesium, calcium, etc

alkali: a base that dissolves in water or reacts with water to produce hydroxide ions, e.g. sodium hydroxide.

allotropes: different forms of the same element, having different physical properties, but existing in the same state of matter, e.g. solid allotropes of carbon are graphite, diamond, amorphous carbon, such as charcoal and soot.

alloy: a material with metallic properties consisting of two or more metals or a metal with a non-metal

atom: is the smallest, electrically neutral particle of an element which can take part in a chemical reaction atomic number the number of protons in the nucleus

base: any compound that reacts with an acid to produce a salt and water, e.g. sodium hydroxide. A base that is soluble in water is called an alkali

carbon: an element with atomic number 6

cement: material that mixes with sand gravel and water to make concrete

crystallisation: is the process of forming crystals, particularly when used to purify a material or extract it from a solution

crystals: pieces of solid materials through which the atoms are

diamond: a crystalline allotrope of carbon and is the hardest known mineral and is widely used in cutting and drilling tools, and as a gem

displacement reaction: a chemical reaction in which one element, particularly a metal, is replaced by another, more reactive, element

electrode : the negatively charged terminal of a battery/cell

electrolyte substance that conducts electricity in molten or solution

energy level: inside an atom are the specific energies (electron shells) that electrons can have when occupying specific orbitals

extraction: the separation of a metal from its ore

fullerenes: are molecules of carbon atoms with hollow shapes. Their structures are based on hexagonal rings of carbon atoms joined by covalent bonds. Some fullerenes

include rings with five or seven carbon atoms. Two examples of fullerenes are buckminsterfullerene and nanotubes fuels

graphite: is a naturally-occurring form of crystalline carbon. It is a native element mineral found in metamorphic and igneous rocks

group: (also known as a family) is a column of elements in the Periodic Table of the chemical elements

hard water: is water that has high mineral content (in contrast with "soft water"). Hard water is formed when water percolates through deposits of limestone, chalk or gypsum which are largely made up of calcium and magnesium carbonates, bicarbonates and sulphates

Ions: is a charged atom or molecule. It is charged because the number of electrons do not equal the number of protons in the atom or molecule. An atom can acquire a positive charge or a negative charge depending on whether the number of electrons in an atom is greater or less than the number of protons in the atom

limestone: a hard-sedimentary rock, composed mainly of calcium carbonate or dolomite, used as building material and in the making of cement

mass number: or nucleon number, is the total number of protons and neutrons in an atomic nucleus

metals: are materials that, when freshly prepared, polished, or fractured, shows a lustrous appearance, and conducts electricity and heat relatively well. Metals are typically malleable or ductile

mineral acids: are acids derived from one or more inorganic compounds. All mineral acids form hydrogen ions when dissolved in water

neutron: is a subatomic particle, symbol n, with no net electric charge anda mass slightly greater than that of a proton. Protons and neutrons constitute the nuclei of atoms

non-metals: is a chemical element that mostly lacks the characteristics of a metal

non-renewable energy resources: energy that we use up faster than they are replenished, e.g.

fossil fuels

organic acid: is an organic compound with acidic properties. The most common organic acids are the carboxylic acids, whose acidity is associated with their carboxyl group -COOH.

period: is the name given to a horizontal row of the periodic table. The periodic table has seven periods

Periodic Table: also known as the periodic table of elements: is a tabular display of the chemical elements, which are arranged by atomic number, electron configuration, and recurring chemical properties

pH: is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14

proton: is a particle with a positive charge that is in the nucleus of an atom. An example of a proton is the single proton in the nucleus of a hydrogen atom.

reactivity series: is a series of metal, in order of reactivity from highest to lowest. It is used to determine the products of single displacement reactions, whereby metal A will replace another metal B in a solution if A is higher in the series

renewable energy: energy resources that will not run out, e.g. wind

salts: are substances which consist of the positive ion (cation) of an acid and the negative ion (anion) of a base. The reaction between an acid and a base is called a neutralisation reaction

soft water: is surface water that contains low concentrations of ions and in particular is low in ions of calcium and magnesium. Soft water naturally occurs where rainfall and the drainage basin of rivers are formed of hard, impervious and calcium-poor rocks

valency: a measure of power of elements (especially as measured by the number of hydrogen atoms it can displace or combine with) with other atoms when it forms chemical compounds or molecules

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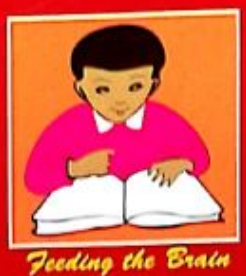

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