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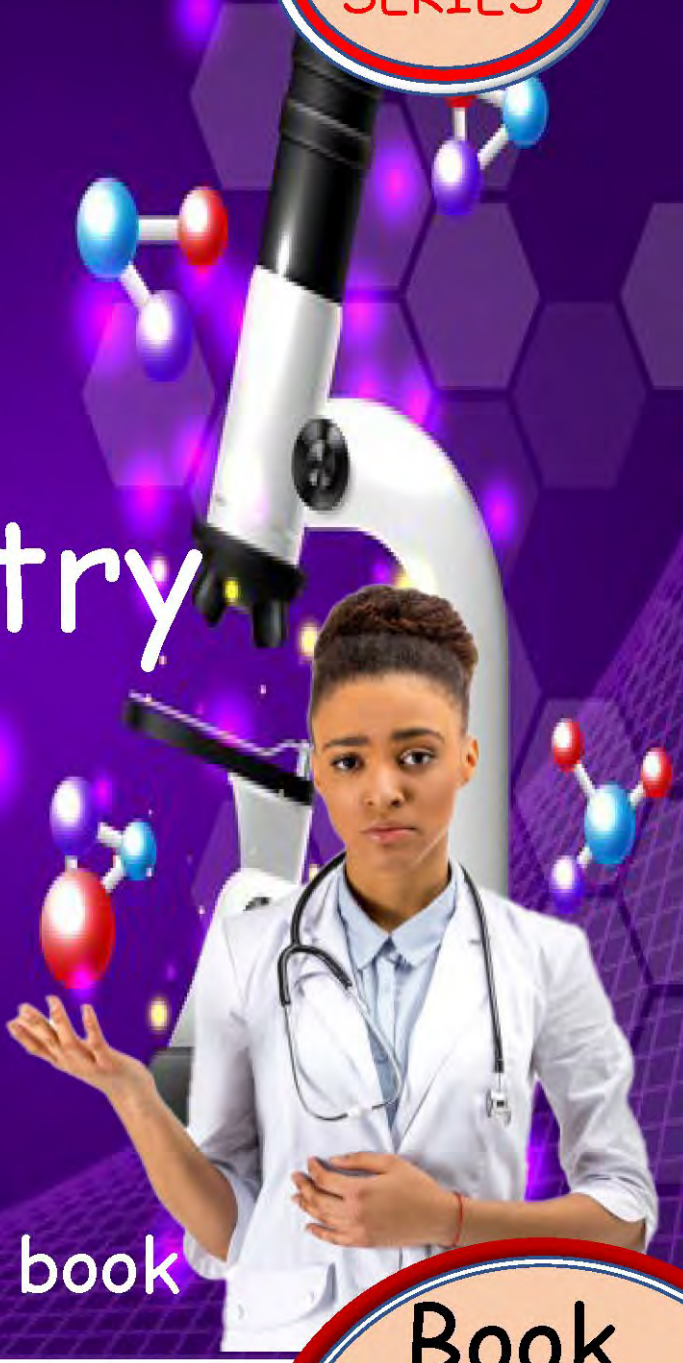

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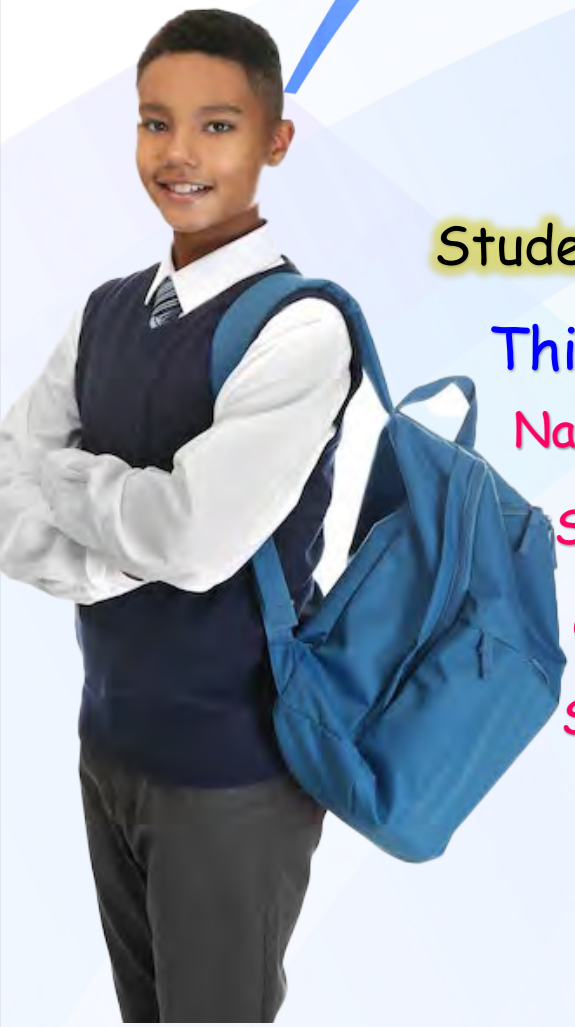

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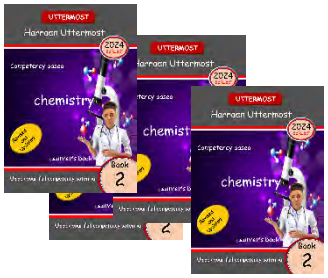

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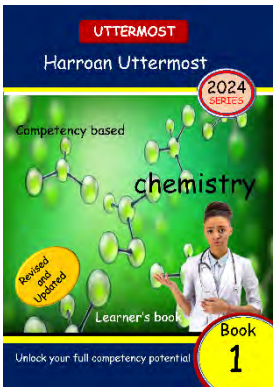

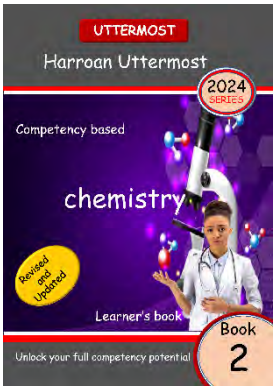

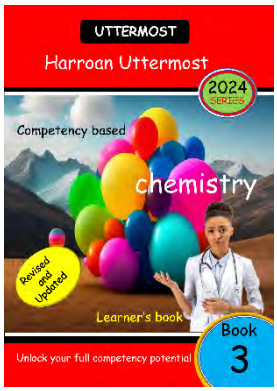

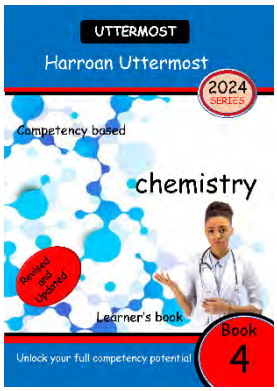

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Chapter 1

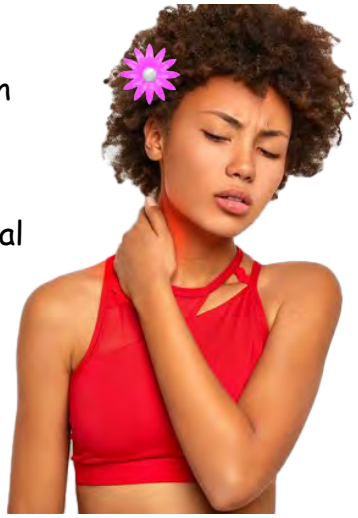
ACIDS AND ALKALIS

By the end of this chapter, you should be able to;

- Recognize that locally available materials and substances are either acidic or alkaline.
- Describe the importance of acids in daily life
- Describe the importance of alkalis in daily life
- Explain the concept of PH as a measure of strength of acids and alkalis
- Understand neutralization reaction and its application in daily life.

1.1 Classifying substances as acids or alkaline

Introduction



Have you ever wondered about the substances that give certain foods their tangy taste, or the chemicals responsible for the cleaning power of household products? Well, look no further than the intriguing world of acids and alkalis. These fundamental substances in chemistry hold the key to understanding a multitude of everyday phenomena and are essential to various scientific and industrial processes. Acids and alkalis are fundamental substances in the field of chemistry, playing a crucial role in a wide range of chemical processes

Key question: How can you classify a substance as acidic or alkaline?

An acid is a substance that donates protons (hydrogen ions) when dissolved in water. It is characterized by its sour taste and ability to turn blue litmus paper red. Acids can be found in various forms, such as liquids, solids, or gases. They are classified into two main categories: organic acids, which contain carbon atoms, and inorganic acids, which do not. One of the most well-known acids is hydrochloric acid (HCl). It is a strong acid commonly found in our stomachs, aiding in the digestion of food. Sulphuric acid (H_2SO_4) is another potent acid widely used in industrial processes, such as manufacturing fertilizers and dyes. Acetic acid (CH_3COOH) is a milder acid found in vinegar and is used in food preservation and cooking.

An alkali is a substance that accepts protons or donates hydroxide ions (-OH) when dissolved in water. Alkalis have a bitter taste and feel slippery to the touch. They have the ability to turn red litmus paper blue. Like acids, alkalis can exist in various forms, including solids, liquids, or gases. One of the most common alkalis is sodium hydroxide (NaOH), also known as caustic soda. It is widely used in industries such as soap-making and cleaning products. Ammonia (NH_3) is another well-known alkali often used in household cleaning products and fertilizers. Calcium hydroxide ($Ca(OH)_2$), commonly known as slaked lime, is used in construction, agriculture, and wastewater treatment

Sodium hydroxide is used in soap making and cleaning products.

Daily Life Connections

Acids and alkalis are used in various ways in our daily lives. For example, vinegar, which contains ethanoic acid, is used in cooking. Lemon juice, which contains citric acid, is used to add flavor to food. Ant stings contain formic acid, and bee stings contain formic acid too. In addition, acids are used in car batteries, and alkalis are used in cleaning products. Common Sources of Acids and Alkalis Acids are found in many things, including fruits, vinegar, and car batteries. Alkalis are found in cleaning products, such as bleach and ammonia. They are also found in some foods, such as baking soda

Lemon juice contains citric acid

Cleansing agent contains alkalis

Common sources of acids and alkali

We use acids and alkali in our daily lives for things like cleaning, cooking and you even eat and drink some substances that are acidic or alkaline. The word **acid** means 'sour' and all acids possess this property. They are also soluble in water and are corrosive. **Alkalis** are very different from acids. They are the chemical 'opposite' of acids. They remove the sharp taste from an acid. They have a soapy feel. Acids release hydrogen ions when dissolved in water. It's the hydrogen ions in an aqueous solution that make the substance acidic. Therefore, an acid is a compound which when dissolved in water produces hydrogen ions as the only positively charged ion. **Examples of acids include** sulphuric acid, hydrochloric acid, nitric acid, carbonic acid.

Alkalis release hydroxide ions when dissolved in water. It's the hydroxide ions that make a substance alkaline in an aqueous solution. Therefore, an alkali is a base that dissolves in water to produce hydroxide ions as the only negatively charged ion. A solution of a base in water is called an alkaline solution. **Examples of alkalis** include sodium hydroxide, calcium hydroxide, and potassium hydroxide. Acetic acid is found in vinegar as well as products that contain vinegar. Citric acid is found in jams and jellies and it adds a tangy flavour to other foods. Lactic acid is found in milk and other dairy products.

Ascorbic acid is vitamin C found in citrus fruits as well as some other fruits and juices. Sulphuric acid is found in car batteries and some drain cleaners. Another source of acids in nature is through the acidic rain. The acidity of rain water is due to the carbon dioxide in the atmosphere, the carbon dioxide dissolves in rain water to produce carbonic acid

Vinegar contains acetic acid

Lactic acid is found in milk

Common sources of alkalis include sodium bicarbonate. It is found in most homes and it is also known as baking soda. It is used as a cooking ingredient. Calcium carbonate or limestone is another source of alkalis. It is used to make chalk, farmers use it to neutralize soils and humans take pills of calcium carbonate to neutralize stomach acid. Slaked lime cement calcium hydroxide, and household ammonia are other common sources of alkalis

Baking soda contains alkalis

Calcium carbonate is used in making chalk

Group activity:

Group activity:

Classifying substances as either acidic or alkaline

You are provided with the following substances which are either acidic or alkaline. You are to carry out investigations to identify the nature of each

Lemons

Tooth paste

Baking powder

Soda

Okra

Avocado

Kaziire

Tomatoes

Detergent powder

Pineapple

Orange

Red pepper

What to do

- Wash the lemons, avocado, okra, orange, pineapple, red pepper and tomatoes
- Cut a piece of each of the fruits and taste.
- Touch on the cut piece of the fruits and feel them
- Pour a small portion of the soda on the ground, observe. You can also taste part of it
- Pour a small portion of kaziire on the ground and observe. Taste part of it
- Taste a small portion of the baking powder. Touch and feel it
- Pour some detergent in water. Touch and feel. Do not taste the detergent
- Touch and feel part of the opened Colgate. Taste a piece of it.

Note, don't taste the detergent

a) Complete the table below by filling in the texture and taste of the substances

substance	texture	taste	Is it acidic or alkaline
Lemons			
Toothpaste			
Baking powder			
Okra			
Avocado			
Kaziire			
Tomatoes			
Red paper			
Orange			
Pine apple			
Detergent			

b) State your observation when you poured;

i) Soda on the ground ii) Kaziire on the ground

c) From the activity, outline the properties of,

i) Acids ii) Alkalines

2. In a chemistry lab, you are given two unknown solutions, one acidic and one alkaline. Your task is to determine whether the substance is acidic or alkaline How can you identify the acidic and alkaline substances without any prior knowledge about them & without using any chemical.

Use your brain power!

3. In a kitchen setting, you come across various substances commonly found in cooking. Your task is to determine whether these substances are acids or alkalis. The substances are two, solids and soluble in water. As a scientist, how can you classify the daily life substances found in the kitchen as either acids or alkalis without using any specialized equipment?

My notes

Answer template

1.2 Importance of acids and alkalis in daily life

Key question: How are acids and alkalis important in daily life?

Acids and alkalis play significant roles in our daily lives, with applications ranging from household chores to industrial processes. Acids, known for their sour taste and ability to turn blue litmus paper red, have various uses such as cleaning, food preparation, and medicine. Alkalis, on the other hand, are characterized by their ability to turn red litmus paper blue and have applications in cleaning, agriculture, and personal care products.

Some of the uses of acids

1. Cleaning: Acids like vinegar and lemon juice are commonly used as natural cleaning agents due to their ability to dissolve dirt and grime. They are effective in removing mineral deposits, stains, and soap scum from surfaces.
2. Food Preparation: Acids such as citric acid and acetic acid (found in vinegar) are used for food preservation, flavor enhancement, and baking. They contribute to the tangy taste in foods like pickles, sourdough bread, and citrus-based recipes.
3. Medicine: Acids like hydrochloric acid are crucial for our digestive system, aiding in the breakdown of food. Additionally, citric acid and ascorbic acid (vitamin C) are commonly used in pharmaceuticals and dietary supplements.

Uses of common acids in daily life

The five common acids have several uses in medicine, industries and at home. The five common acids are sulphuric acid, lactic acid, hydrochloric acid, nitric acid and acetic acid.

1. **Sulphuric acid;** It is an oily highly corrosive liquid. It is formed naturally in Sulphide minerals. It is a dangerous chemical and should be handled with caution. Sulphuric acid is used as an ingredient in skin ointments to treat skin infections such as canker sores. Concentrated sulphuric acid is harmful to the skin, it can cause severe skin injury. So a dilute one is used in skin ointments Sulphuric acid can damage cancerous cell DNA; thus, it is used to manufacture chemotherapy drugs.
2. **Hydrochloric acid;** It is formed when hydrogen chloride is dissolved in water. It is a strong acid, which is colourless and viscous. It is extremely corrosive and has a distinctively pungent smell. Hydrochloric acid is mixed with other chemical ingredients to make fertilizers for plants which grow in acidic soils.
3. **Nitric acid;** Is a strong acid which is colourless, highly corrosive and toxic. It reacts with hydroxide metals and oxides to form nitrate salts. Nitric acid is used in making explosives when mixed with incompatibles, it results into violent spontaneous reactions, and explosions.
4. **Lactic acid;** Is an organic acid also known as milk acid. It is formed when milk sugar (lactose) undergoes fermentation. It is found in cottage cheese, sour milk, yogurt etc. Lactic acid is used as a flavouring agent and preservative in processed cheese, and carbonated beverages.
5. **Acetic acid;** It is also known as ethanoic acid. It is clear, colourless with a pungent smell. Vinegar is a dilute form of acetic acid. Acetic acid is the main component of vinegar and gives its characteristic smell. Acetic acid is used in medical field as an antiseptic agent, postoperative scar reduction and managing soft tissue injuries.

Nitric acid is used in explosives

Sulphuric acid is used in skin ointments

Hydrochloric acid is used in fertilizers

Some of the uses of alkalis

1. Cleaning: Alkalis such as sodium hydroxide (caustic soda) and ammonia are widely used in cleaning products like detergents, soaps, and drain cleaners. They help break down grease, oils, and other organic materials.
2. Agriculture: Alkalis like lime and potassium hydroxide are used to adjust soil pH levels. They help neutralize acidic soil, making it suitable for plant growth. Alkalis are also used in the production of fertilizers.
3. Personal Care Products: Alkalis such as sodium hydroxide are used in the production of soaps, shampoos, and toothpaste. They help create a lathering effect and contribute to the cleansing properties of these products.

Uses of common alkalis in daily life

The most used alkalis in daily life include; sodium hydroxide, sodium fluoride, sodium bicarbonate, magnesium hydroxide, calcium hydroxide and ammonia.

1. **Sodium hydroxide:** It is sometimes called caustic soda. It is a common ingredient in cleaners and soaps. At room temperature, it is a white, odorless solid, liquid sodium hydroxide is colourless and has no smell. Sodium hydroxide is used in pharmaceutical industry in the manufacturing of various drugs like aspirin which is a pain reliever
2. **Sodium bicarbonate:** It is commonly known as baking soda or bicarbonate of soda. It's a white solid that is crystalline, but often appears as a fine powder. Sodium bicarbonate is used as an antacid to relieve heart burn and ulcers.
3. **Magnesium hydroxide:** It's an inorganic compound which occurs in nature as the mineral brucite. It's a white solid with low solubility in water. It's a common component of antacids. Magnesium hydroxide is used to make laxative medicines which are used to treat constipation in children and adults. It works by causing water to be retained with stool
4. **Ammonia:** Is a colourless highly irritating gas with a sharp suffocating smell. It dissolves easily in water to form ammonium hydroxide solution which can cause irritation and burns Ammonia gas is easily composed and forms a clear, colourless liquid under pressure. Ammonia is used in the manufacture of fertilizers to replenish nitrogen in the soil
5. **Sodium fluoride:** It is a white solid that is readily soluble in water. It is used in trace amounts in fluoride of drinking water to prevent tooth decay. Toothpaste which we mostly use contains sodium fluoride which is slightly basic in nature. This kills the bacteria in the mouth

Toothpaste which we mostly use contains sodium fluoride

Sodium hydroxide is used in the manufacturing of various drugs

Ammonia is used in making fertilizers.

Group activity:

Uses of acids and alkalis in daily life

1. Apart from the uses mentioned, describe how the following acids are used in daily life.
   i) sulphuric acid ii) hydrochloric acid iii) nitric acid iv) acetic acid iv) lactic acid.
2. Apart from the uses mentioned, describe how the following alkalis are used in daily life.
   i) sodium hydroxide ii) ammonia iii) sodium fluoride iv) sodium carbonate v) magnesium hydroxide
3. The pictures below show various ways acids are used in daily life. For each, identify the acids being used

Making plastics

Making mayonnaise

Laundry and cleaning

Leather tanning

Car batteries

Textile dyeing

Fireworks

Furniture vanish

Removing metal stains

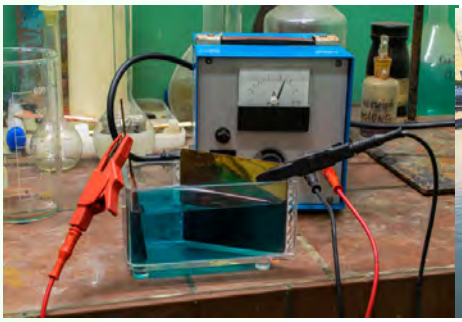
Liquid fueled rockets

4. The pictures below show various ways alkalis are used in daily life. For each, identify the alkali being used

Unclogging pipes

Cleaning agents

Paper production



Electroplating

Water treatment

Manufacture of soap

Use your brain power!

5. A gardener wants to adjust the pH level of their soil to promote optimal plant growth. Provide recommendations on the suitable alkali to be used for pH adjustment in the garden soil. Consider the desired pH range, appropriate application methods, and potential long-term effects on plant health.

1.3 Effects of acids and alkalis

Key question: Describe the effects of acids and alkalis.

Acids and alkalis can have significant effects on plants and animals, with varying degrees of impact depending on the concentration and exposure duration. Acids, characterized by their ability to release hydrogen ions, can cause damage to plant tissues and disrupt physiological processes. On the other hand, alkalis, also known as bases, can be equally damaging to plants and animals due to their ability to accept hydrogen ions.

Effects of Acidic Rain on Plants:

Acidic rain, which is rain with a pH lower than 5.6, can have detrimental effects on plants. The acidity of the rain can damage plant tissues, leading to leaf discoloration, stunted growth, and even death. Acidic rain can leach essential nutrients from the soil, making it harder for plants to absorb them. It can also disrupt the pH balance of the soil, making it unsuitable for certain plants to grow

Acidic rain causes leaf discoloration

Effects of Acidic Rain on Fish and Aquatic Organisms

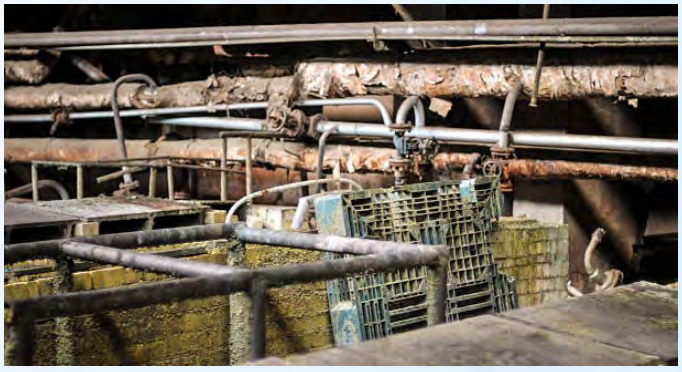
Fish dead due to acidic rain

Acidic rain, when it flows into rivers, lakes, and other water bodies, can lower the pH of the water. Fish and other aquatic organisms are highly sensitive to changes in pH levels, and acidic water can be toxic to them. Acidic water affects the gills of fish, impairing their ability to extract oxygen from the water and leading to suffocation. It can also disrupt the reproductive cycles of fish and other aquatic organisms, affecting their populations.

Effects of Acids on Household Metals:

Many acids, such as sulphuric acid or hydrochloric acid, can corrode household metals. When metals come into contact with acids, a chemical reaction occurs that leads to the formation of metal salts and the release of hydrogen gas. This corrosion process weakens the metal, causing it to degrade, tarnish, and eventually break down. Common examples of household metals that can be affected by acids include copper pipes, iron cookware, and aluminum surfaces.

Iron sheet affected by acid



Pipes affected by acid

Group activity:

Use your brain power!

effects of acids and alkalis in daily life

1. Using the pictures below as reference, describe various ways acids and Alkalis can affect people and substances if their use is not controlled

Use your brain power!

2. A farmer accidentally sprays a concentrated acid solution on their crops. What are the potential effects of the acid on the crops, and Advise the farmer on the immediate steps to minimize the effects of the acid on the crops, including rinsing techniques, neutralizing agents, and potential remediation strategies to support crop recovery.

3. A spill of a strong acid occurs in a laboratory, and a lab technician accidentally gets some on their skin. What immediate steps should be taken to minimize the effects of the acid on the technician's skin?

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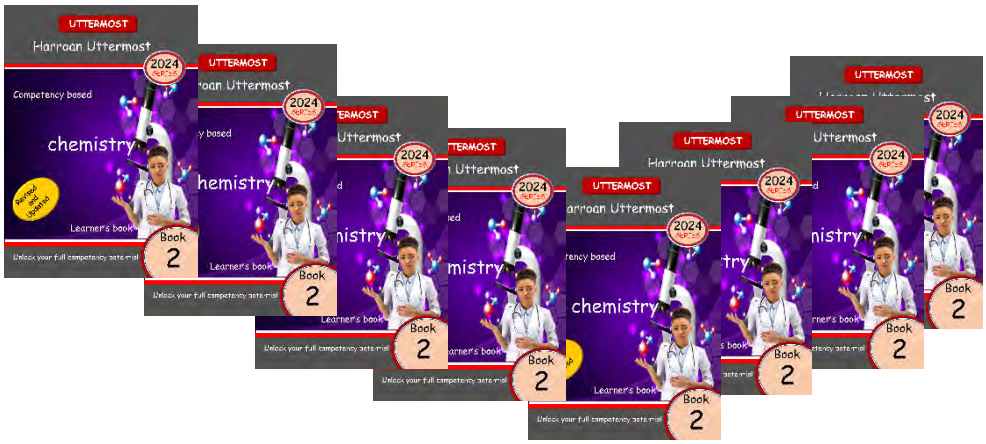

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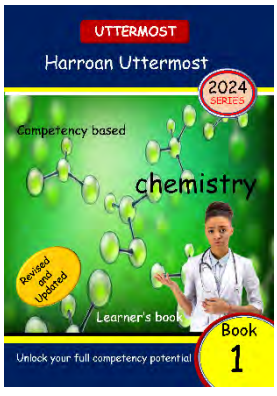
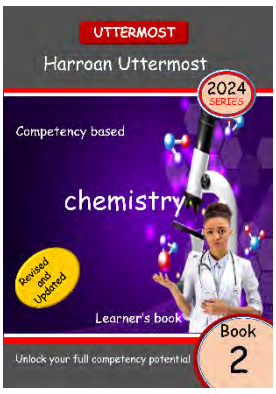
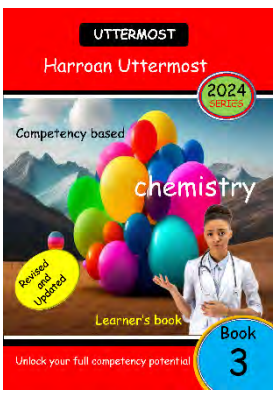
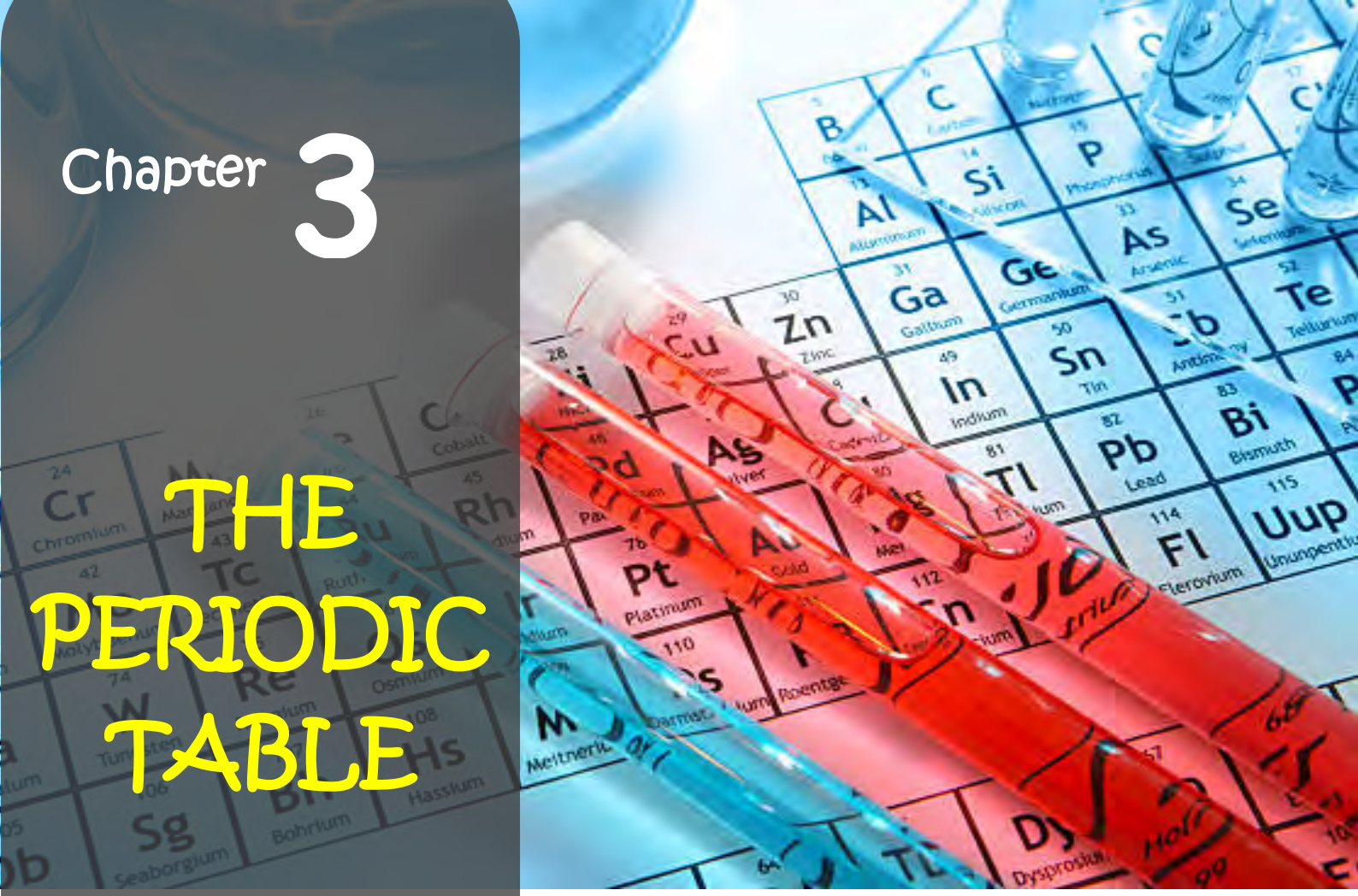






Chapter 3

THE PERIODIC TABLE



By the end of this chapter, you should be able to;

- Group elements as metals and non-metals
- Relate the physical properties of metals to their uses.
- Understand the periodic table
- Relate the arrangement of electrons in the first 20 elements to their positions in the periodic table
- Understand the relationships between position of elements

3.3 investigating malleability and ductility of elements

Key question: How do the malleability and ductility properties relate to their uses in daily life

malleability and ductility

Malleability and ductility are important properties that describe how materials respond to mechanical forces. Malleability refers to the ability of a material to be hammered or rolled into thin sheets without breaking, while ductility refers to its ability to be drawn into thin wires without fracturing. These properties are particularly significant in the study of metals and nonmetals, as they affect their applications in various industries.

Daily Life Connections:

1. Construction: Malleable metals like aluminum and copper are widely used in construction for their ability to be shaped into different forms, such as roofing materials, pipes, and wiring.
2. Jewelry Making: Ductile metals, such as gold and silver, are highly valued in jewelry making due to their ability to be drawn into fine wires or hammered into intricate designs.

Malleable metals are used in construction.

Ductile metals are used in making jewelry

Malleability in metals and non-metals

Malleability refers to the ability of a material to be hammered or pressed into thin sheets without breaking or shattering. In the context of metals, malleability is a prominent characteristic. Metals have a high degree of malleability due to their atomic structure and metallic bonding. The atoms in metals are arranged in a regular pattern, forming layers that can easily slide over one another when subjected to external force. This property allows metals to be easily shaped into various forms, such as foil, sheets, or intricate designs.

On the other hand, non-metals generally lack malleability. They have a more complex atomic structure, often characterized by covalent or ionic bonds. These bonds are typically stronger and less flexible than metallic bonds, making non-metals brittle and prone to fracturing when subjected to stress. Non-metals like carbon, sulfur, and phosphorus are examples of materials that lack malleability.

Ductility in metals and non-metals

Ductility refers to the ability of a material to be stretched or drawn into thin wires without breaking. Similar to malleability, ductility is a property predominantly observed in metals. Metals possess a high degree of ductility due to the nature of metallic bonding. The metallic bond allows the atoms to move and slide past each other under applied force, enabling the metal to be drawn into wires or stretched into various shapes. Non-metals, however, generally exhibit limited or no ductility. The atomic structure of non-metals often involves strong covalent or ionic bonds that resist deformation. As a result, non-metals tend to be brittle and prone to fracture when subjected to tension or stretching forces. Examples of non-metals like sulfur, phosphorus, and oxygen do not possess significant ductility.

Note: It is important to note that while malleability and ductility are primarily observed in metals, there can be exceptions. For instance, some non-metals, such as gold and silver, exhibit a certain level of malleability and ductility, making them unique among their non-metal counterparts.

Group activity:

Group activity: Investigating malleability and ductility in elements

A. Investigating malleability in elements

Aim: to investigate malleability in elements

Hypothesis: Metals are malleable and non-metals are not.

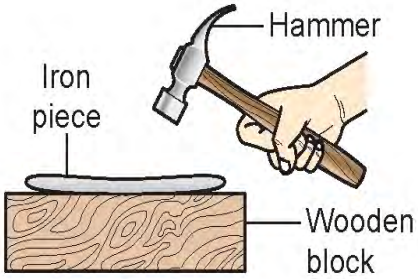
Variables

Manipulated variable: Type of material

Responding variable: The malleability of material

Constant variable: Size of material.

Materials; Iron piece, copper piece, sulphur piece, hammer, wooden block.



Procedure

- Knock an iron piece on a wooden block using a hammer several times.
- Observe the changes in the shape of the iron piece.
- Repeat steps 1 and 2 using the copper and sulphur piece.
- Record your observation.

B. Investigating ductility in elements

Aim: to investigate ductility in elements

Hypothesis: Metals are ductile and non-metals are not.

Variables

Manipulated variable: Type of material

Responding variable: The ductility of material

Constant variable: Size of material.

Materials; Copper wire, pencil lead

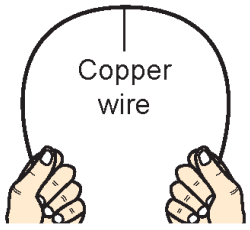


Figure 6.12

Procedure

- Bend a copper wire to form a circle.
- Repeat step 1 with a pencil lead.
- Record your observation.

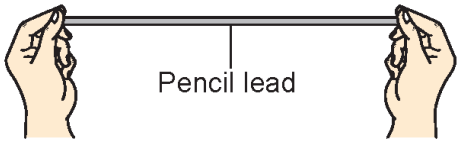


Figure 6.13

Questions

1. Write your observations for each of the experiments in A and B.
2. Which conclusion can you make on those experiments
3. Describe how the malleability and ductile properties of metals and non-metals relate to their uses in daily life.

Use your brain power!

4. A chemistry class is studying the relationship between the crystal structure of a metal and its malleability. How does the crystalline structure of a metal influence its malleability?
5. A student is researching the factors that affect the ductility of metals at different temperatures. What impact does temperature have on the ductility of metals? Analyze the underlying reasons for these temperature-dependent changes in ductility.

3.4 Investigating heat and electrical conductivities of elements

Key question: How do the heat and electrical conductivity properties of elements relate to their uses in daily life

heat and electrical conductivity

Heat conductivity and electrical conductivity are two important physical properties of materials that measure how well they can transfer heat and electric charge, respectively. These properties depend on the structure and composition of the materials, as well as the temperature and other external factors.

Daily life connections

Heat conductivity and electrical conductivity are relevant for many applications and phenomena in our daily life. For example:

- Cooking utensils are often made of metals, such as copper or aluminum, because they can conduct heat efficiently and evenly from the stove to the food.
- Electrical wires are also made of metals, such as copper or silver, because they can conduct electric current with low resistance and power loss.
- Thermal insulation materials, such as wool or fiberglass, are made of non-metals, such as organic fibers or glass, because they can prevent heat transfer by trapping air or gas molecules in their structure.
- Electrical insulation materials, such as rubber or plastic, are also made of non-metals, such as polymers or ceramics, because they can resist electric current and prevent electric shock or short circuit.

Thermal insulators insulated on a house

Electrical insulation materials

Cooking utensils made of metals

Heat conductivity in metals and non-metals

Heat conductivity, also known as thermal conductivity, is the property of a material that measures how fast heat can flow through it. Metals have many free electrons that can carry heat energy quickly and easily, so they have high thermal conductivity. Non metals have few or no free electrons, so they have low thermal conductivity.

Metals are generally excellent conductors of heat due to their unique atomic structure and the presence of free electrons. In metals, heat conduction primarily occurs through the movement of free electrons. These delocalized electrons can easily transfer thermal energy from higher temperature regions to lower temperature regions within the metal lattice. Consequently, metals exhibit high thermal conductivity. Some metals with exceptionally high thermal conductivity include silver (Ag), copper (Cu), and aluminum (Al).

Non-metals, on the other hand, generally possess lower thermal conductivity compared to metals. This is because non-metals lack the abundance of free electrons found in metals. Instead, heat conduction in non-metals occurs through lattice vibrations or phonons. However, non-metals exhibit a wide range of thermal conductivities. For instance, diamond, which is a non-metal, has an exceptional thermal conductor due to its unique crystal structure. Other non-metals such as gases, sulphur, and phosphorus have relatively poor thermal conductivity.

Electrical Conductivity in metals and non-metals

Electrical conductivity refers to the ability of a material to conduct an electric current. It is a measure of how easily electric charges can move through a substance. Metals are generally excellent conductors of electricity. This is because metals have a large number of free or delocalized electrons that are not tightly bound to individual atoms. These free electrons can move through the metal lattice under the influence of an electric field, facilitating the flow of electric current. Consequently, metals exhibit high electrical conductivity. Copper (Cu), silver (Ag), and gold (Au) are some of the best conductors of electricity among metals. Non-metals, in general, are poor conductors of electricity. This is because non-metals do not possess a significant number of free electrons. Their electrons are typically localized and tightly bound to their respective atoms. As a result, non-metals do not allow the easy movement of electric charges, resulting in low electrical conductivity. However, there are exceptions where certain non-metals can exhibit semiconducting or even conducting behavior. For example, graphite, which is a form of carbon, can conduct electricity due to the presence of delocalized electrons in its layered structure.

Group activity:

Group activity:

Investigating heat and electrical conductivities in elements

A. Investigating heat conductivity in elements

Aim: to investigate heat conductivity in elements

Hypothesis: Metals conduct heat and non-metals do not.

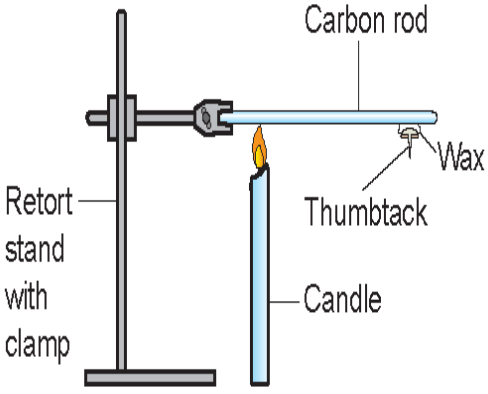
Variables

Manipulated variable: Type of material

Responding variable: Time taken for the thumbtack to drop

Constant variable: Size of material.

Materials; Carbon rod, iron rod, copper rod, candle, stopwatch, thumbtack, wax, retort stand with clamp.



Procedure

1. Clamp a carbon rod to the retort stand.
2. Put the thumbtack at the end of the carbon rod.
3. Heat the other end of the carbon rod.
4. Observe and record the time taken for the thumbtack to drop.
5. Repeat steps 1-4 by using an iron rod and copper rod.

B. Investigating electrical conductivity in elements

Aim: to investigate electrical conductivity in elements

Hypothesis: Metals conduct electricity

Variables

Manipulated variable: Type of material

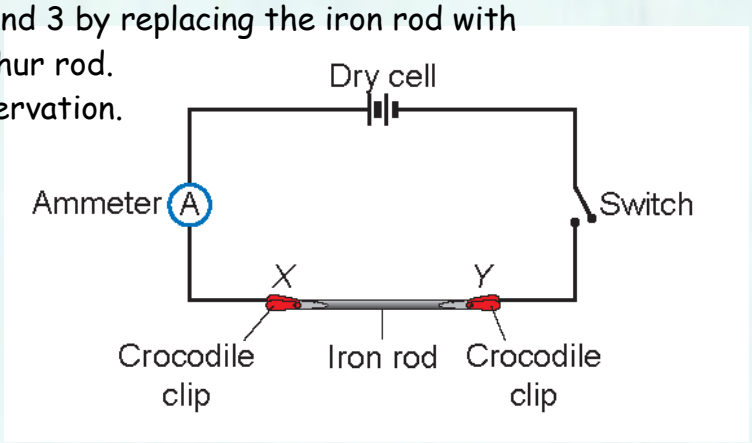
Responding variable: The deflection of the ammeter's needle

Constant variable: Size of material.

Materials; Dry cell, ammeter, crocodile clips, iron rod, carbon rod, sulphur rod.

Procedure

1. Set up the apparatus as shown in the figure.
2. Connect the ends of an iron rod with crocodile clips.
3. Observe the deflection of the ammeter's needle.
4. Repeat steps 2 and 3 by replacing the iron rod with carbon rod and sulphur rod.
5. Record your observation.



Questions

1. Write your observations for each of the experiments in A and B.
2. Which conclusion can you make on those experiments
3. Describe how the heat conductivity and electrical conductivity properties of metals and non-metals relate to their uses in daily life.

Use your brain power!

4. Sarah is investigating the thermal insulation properties of different materials for a home renovation project. She wants to understand how heat conductivity affects their effectiveness in reducing energy loss. How does heat conductivity influence the thermal insulation properties of materials, and which material would be the best choice for thermal insulation?

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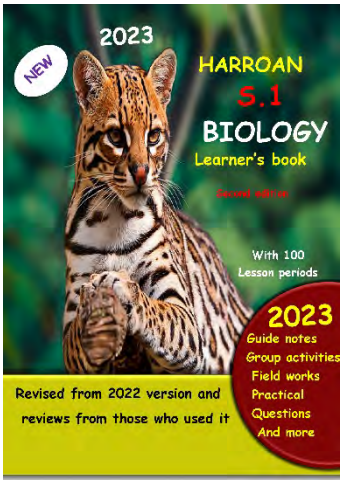

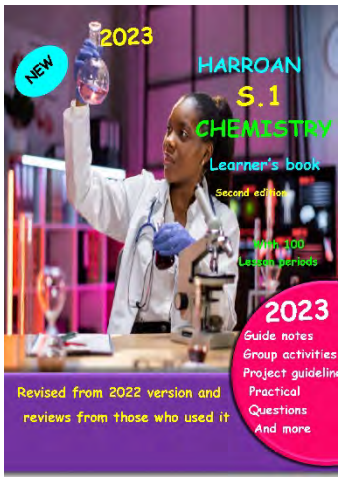

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Chapter 4

CARBON IN THE ENVIRONMENT

By the end of this chapter, you should be able to;

- Understand how and why carbon compounds are used as fuels.
- Know and appreciate the difference between renewable and non-renewable fuels.
- Know and appreciate the impacts of burning carbon based fuels on the environment.
- Understand the process of making charcoal.

4.2 Fuels

Key question: Describe the advantages of using carbon fuels.

Fuels

Fuels are substances that release heat and energy when they undergo a chemical reaction, typically through combustion. They play a crucial role in our daily lives by powering various forms of transportation, heating, electricity generation, and industrial processes.

Daily Life Connections:

1. Transportation: Fuels like gasoline, diesel, and aviation fuel are commonly used to power cars, trucks, airplanes, and ships.
2. Heating: Natural gas, propane, and heating oil are commonly used to provide warmth in residential and commercial buildings.
3. Electricity Generation: Coal, natural gas, and nuclear fuels are commonly used to generate electricity in power plants.

Classification of fuels.

Fuels can be classified into two major categories;

1. Carbon fuels: Carbon-based fuels are fuels that contain carbon and hydrogen atoms. Combustion of carbon-based fuels results in the release of carbon into the earth's atmosphere. It is estimated that more than 80% of all man-made carbon dioxide originates from fossil fuels combustion. The released carbon-based fuels can be in form of carbon dioxide or carbon monoxide.
2. Non-carbon fuels: Non-carbon-based fuels are fuels that do not contain carbon atoms. Non-carbon fuels do not produce carbon on combustion i.e. they do not release carbon dioxide or carbon monoxide. The non- carbon fuels can also be called the carbon neutral fuels.

Examples of non-carbon fuels

1. Hydrogen Fuel: Hydrogen is a versatile non-carbon fuel that can be used in fuel cells to produce electricity. It is used in various transportation applications, such as fuel cell vehicles, buses, and trains. Hydrogen fuel is also used in industrial processes, like hydrogenation in the production of margarine and ammonia synthesis in fertilizer production.
2. Nuclear Power: Nuclear power is generated through the process of nuclear fission, where the nucleus of an atom is split to release energy. It is primarily used to generate electricity in nuclear power plants. Nuclear power is a reliable and low-carbon energy source, but it also poses challenges in terms of waste management and safety.

Hydrogen is used as fuel in hydrogen cars.


Hydrogen is used in the production of margarine.

3. Biofuels: Biofuels are derived from organic matter, such as plants, crops, and agricultural waste. Ethanol, derived from crops like corn and sugarcane, is commonly used as a transportation fuel additive. Biodiesel, made from vegetable oils or animal fats, is used as an alternative to diesel fuel in vehicles.
4. Solar Power: Solar power harnesses energy from the sun using photovoltaic (PV) cells or solar thermal systems. PV cells convert sunlight directly into electricity, which can be used to power homes, businesses, and even entire cities. Solar thermal systems use sunlight to heat water or other fluids, providing hot water for residential and commercial use.
5. Wind Power: Wind power is generated by capturing the energy from wind using wind turbines. It is a renewable energy source that can be used to generate electricity on both small and large scales. Wind farms are commonly seen in open areas and coastal regions, providing clean energy to power homes and communities.
6. Geothermal Energy: Geothermal energy is derived from the heat stored within the Earth's crust. It is used for heating and cooling purposes in residential, commercial, and industrial buildings. Geothermal power plants also generate electricity by tapping into naturally occurring steam or hot water reservoirs underground.


Wind turbines use wind power to generate electricity


PV cells convert sunlight directly into electricity

Biofuel is used as an alternative to diesel vehicles in cars

Advantages and disadvantages of non-carbon fuels

Advantages

- Reduced Carbon Emissions: Non-carbon-based fuels generally produce fewer greenhouse gas emissions, helping combat climate change.
- Renewable Potential: Many non-carbon-based fuels can be produced from renewable sources, reducing dependence on finite resources.
- Diversification: Non-carbon-based fuels offer a more diverse energy portfolio, decreasing reliance on a single fuel source.

Disadvantages

- Limited Infrastructure: The infrastructure for producing, distributing, and utilizing non-carbon-based fuels is still developing.
- Energy Density: Some non-carbon-based fuels have lower energy densities, requiring larger storage or transportation infrastructure.
- Production Challenges: The production of certain non-carbon-based fuels may require significant resources, land, or water.

Group activity:

Group activity:

1. Outline examples of carbon-based fuels.

2. The pictures below show items which use fuels. For each, identify item and the name of the fuel used.

A

B

C

D

E

F

3. describe the

i) advantages of using carbon fuels over the non- carbon fuels

ii) Disadvantages of using carbon fuels

Use your brain power!

4. Imagine you are a farmer who grows crops that require nitrogen fertilizers. The fertilizers are made from natural gas, which releases carbon dioxide into the atmosphere. How can you reduce the carbon footprint of your farm?

4.3 Carbon fuels

Key question: Describe the properties of an ideal fuel.

Carbon fuels

Carbon-based fuels are a type of fuel derived from organic matter, primarily consisting of carbon and hydrogen atoms. They play a crucial role in various aspects of daily life, serving as a major source of energy for transportation, electricity generation, and heating. Carbon fuels can be broadly classified into three categories: liquid, solid, and gaseous carbon fuels basing on their physical states.

Solid carbon fuels

Solid carbon fuels are fuels that are in solid form at room temperature and pressure, such as coal, charcoal, wood, and biomass. Solid carbon fuels can be bio fuels or fossil fuels. Solid fuel from biomass is regarded as a renewable energy source where as solid fuel from fossil fuels is not a renewable energy.

Examples of solid carbon fuels; wood, coal, oil shale. Briquettes, straw, tanbark.

wood

briquettes

charcoal

Solid carbon fuels primarily refer to coal, a combustible black or brownish-black sedimentary rock formed from the fossilized remains of plants. It is composed primarily of carbon, along with varying amounts of hydrogen, sulfur, oxygen, and nitrogen. Examples: Different types of coal include anthracite, bituminous coal, sub-bituminous coal, and lignite.

Uses: Coal is predominantly used for electricity generation in power plants, heating residential and commercial buildings, and as a raw material in various industrial processes, including steel production.

Advantages of coal: Coal is abundant and widely available, providing a reliable source of energy. It has a high energy density, making it suitable for large-scale applications. It is also relatively inexpensive compared to other fuels.

Disadvantages of coal: The combustion of coal releases large amounts of carbon dioxide, sulphur dioxide, nitrogen oxides, and particulate matter, contributing to air pollution and climate change. The extraction and mining of coal can have significant environmental impacts, such as deforestation, habitat destruction, and water pollution.

Coal mineral

Coke being used to smelt iron in still industry

Liquid Carbon Fuels

These are combustible substances in liquid form which is used to obtain thermal energy when they undergo oxidation, they release energy and carbon compounds. Liquid fuel means the fuel is in liquid form at standard temperature and pressure. Examples of liquid carbon fuels; petroleum, kerosine, alcohol, coal-tar. Petroleum is a fossil carbon fuel

Workers at a petroleum refinnery

Petroleum refinning involves turning petroleum into useful products.

When petroleum is refined, other fuels can be formed. Which include; Diesel, petrol and Kerosene. Bio carbon fuels include; ethanol, biodiesel, green diesel

Kerosene. Kerosene is also called paraffin or paraffin oil. It's a pale yellow or colourless, flammable liquid which is obtain from petroleum. It is used as fuel for oil lamps. It is used as a cleaning agent, It can be used as fuel for cooking.

Gaseous carbon fuels

These are fuels which are in a gaseous form at standard temperature and pressure. Gaseous fuels occur in nature, besides being manufactured from solid and liquid fuels. Most gaseous fuels are composed of hydrocarbons, carbonmonoxide, hydrogen or a mixture of them all. Examples of gaseous carbon fuels: Coal gas, producer gas, Water gas, hydrogen gas, Oil gas, blast furnace gas, Natural gas and petroleum gas.

Natural gas is used for heating residential and commercial buildings, cooking, electricity generation, and as a fuel for vehicles. Petroleum gas is commonly used for cooking, heating, and as a fuel for vehicles and appliances

Natural gas is used for heating in residential buildings

Natural gas being used for cooking food.

Group activity:

Group activity:

1. Describe the advantages and disadvantages of:

a) solid carbon fuels b) liquid carbon fuels c) Gaseous carbon fuels

2. Carry out research from the internet and textbooks and describe how solid carbon fuels are used in daily life. Describe as many as you can.

b) Describe how liquid carbon fuels are used in daily life. Describe as many as you can.

c) Describe how gaseous carbon fuels are used in daily life. Describe as many as you can.

3. Describe the properties of an ideal fuel

4. a) Write short notes on fossil and bio fuel classification of carbon fuels.

b) Describe the advantages and disadvantages of using bio fuels and fossil fuels

Use your brain power!

4. You work in a chemical plant that produces plastics from oil. You use natural gas as a fuel and a feedstock for the production process. You are aware that oil and natural gas are non-renewable and finite resources that will eventually run out. You also know that they contribute to greenhouse gas emissions and climate change. You want to reduce your dependence on fossil fuels and improve your environmental performance. Research and propose alternative sources of fuel and feedstock that are low-carbon or no-carbon and sustainable. Explain how they work, what benefits and challenges they have.

My notes

Answer template

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Chapter 5

THE REACTIVITY SERIES

By the end of this chapter, you should be able to;

- Define and write a reactivity serie
- Describe how metals react with oxygen, water and acids.
- Describe how different metals differ when reacting with various substances
- Appreciate that metals varry in their chemical reactivity.
- Understand that alloys are mixtures of a metal with other metals.

5.1 Defining a Reactivity series.

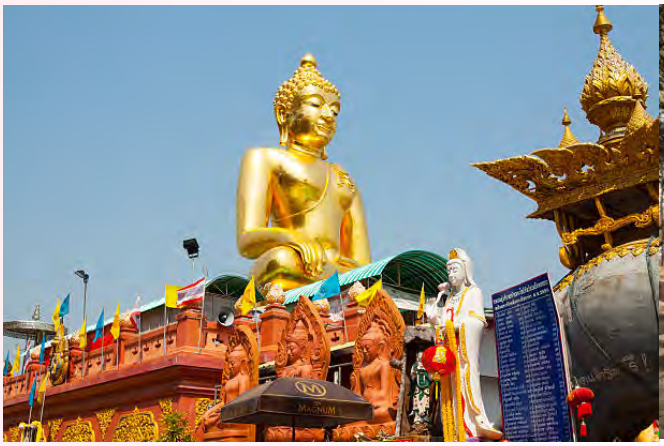
Key question: How can you use the reactivity series to identify a metal?

Introduction

The reactivity series is a concept in chemistry that helps us understand the behavior of metals in various chemical reactions. It provides a hierarchical arrangement of metals based on their reactivity, with the most reactive metals placed at the top and the least reactive ones at the bottom. The reactivity series of metals is a list of metals arranged in the descending order of their reactivities. The reactivity of a metal is its tendency to lose electrons and form positive ions (cations). Metals that are more reactive can displace less reactive metals from their compounds in solution or from their ores.

Daily Life Connections

- The corrosion of metals is influenced by their reactivity. Metals that are higher in the reactivity series corrode more easily than metals that are lower. For example, iron rusts when exposed to moist air, but gold does not tarnish even after many years.
- The extraction of metals from their ores depends on their reactivity. Metals that are higher in the reactivity series require more energy and different methods to be isolated from their ores than metals that are lower. For example, potassium is extracted by electrolysis of molten potassium chloride, but copper is extracted by smelting and reduction of copper oxide with carbon.
- The recycling of metals is also related to their reactivity. Metals that are higher in the reactivity series are more difficult and costly to recycle than metals that are lower. For example, aluminium is recycled by melting and casting, but lithium is recycled by chemical processes.



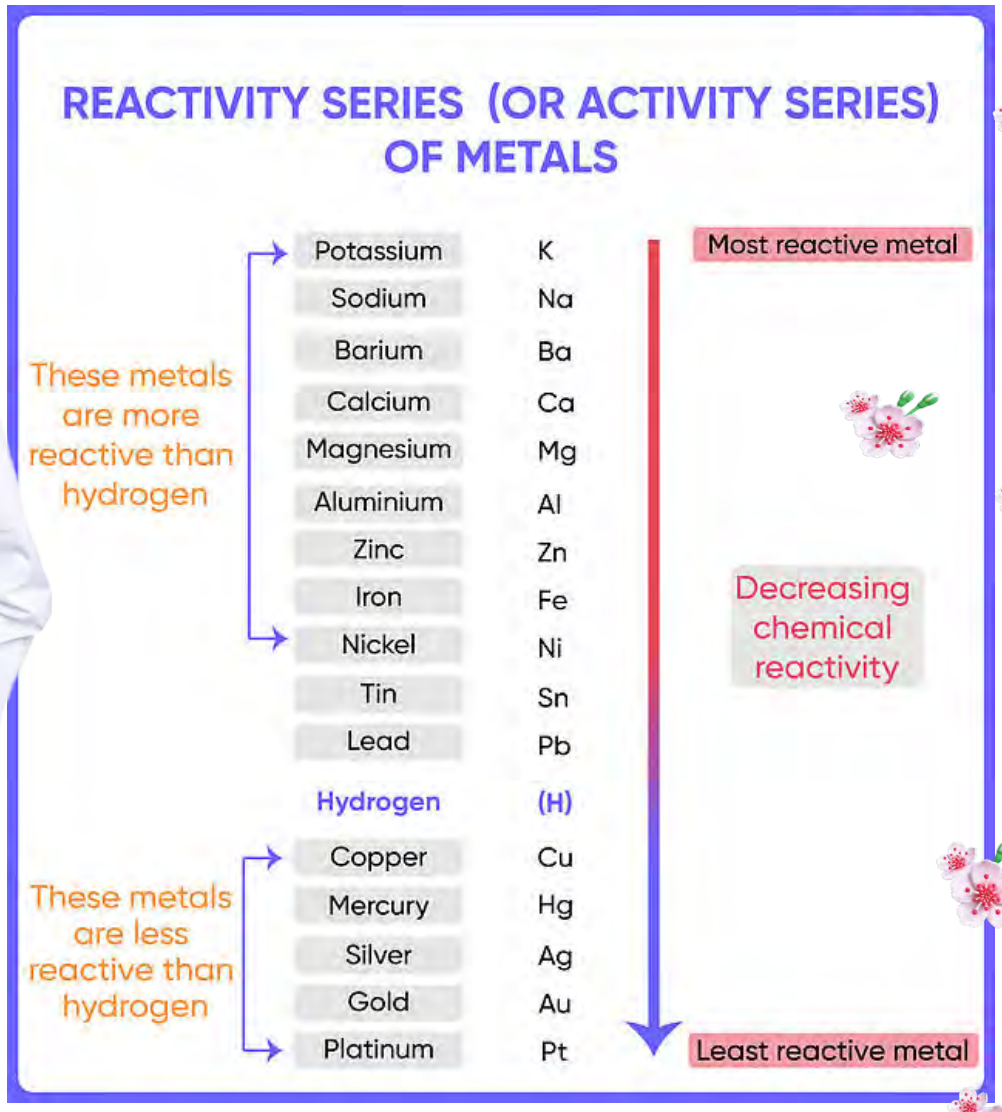
Gold doesnot rust even for years

Iron rusts when exposed to moist air

Definition of the Reactivity Series

The reactivity series of metals refers to the arrangement of metals in the descending order of their reactivities. It helps predict the behavior of metals when they come into contact with substances like acids, water, or other metal ions. The series is based on the observation that more reactive metals displace less reactive metals from their compounds during a reaction.

A chart of reactivity series of common metals is provided below



Salient features about the reactivity serie of metals.

1. Placement in the Series: Metals like potassium, sodium, and calcium are highly reactive and are placed at the top, while metals like gold and platinum, which are less reactive, are placed at the bottom.
2. Displacement Reactions: Metals higher in the reactivity series can displace metals below them from their compounds during a reaction.
3. Reaction with Water: Highly reactive metals react vigorously with water to form metal hydroxides and release hydrogen gas.
4. Reaction with Acids: Reactive metals readily react with acids to produce a salt and release hydrogen gas.
5. Corrosion: Metals higher in the reactivity series are more prone to corrosion, while metals lower in the series are more resistant to oxidation and corrosion.
6. Reduction and oxidation: The metals at the top of the reactivity series are powerful reducing agents, since they are easily oxidized. These metals tarnish or corrode very easily. The metals at the bottom of the reactivity series are noble metals, since they are resistant to oxidation. These metals are often used as catalysts or in jewellery.
7. Reaction of metals: The reactivity of metals decreases while moving down the reactivity series. The metals in the middle of the reactivity series are moderately reactive and have varying properties depending on the conditions.

Table of metal reactions.

Metal	Reaction with cold water	Reaction with acid	Reaction with oxygen
Most reactive			
Potassium	Reacts violently	Reacts violently	Reacts quickly in air
Sodium	Reacts quickly	Reacts violently	Reacts quickly in air
Calcium	Reacts less strongly	Reacts vigorously	Reacts readily
Magnesium	Slow reaction (reacts with steam)	Reacts vigorously	Reacts readily
Aluminium	Slow reaction (reacts with steam)	Reacts readily	Reacts readily
Carbon			
Zinc	Very slow reaction (reacts slowly with steam)	Reacts less strongly	Reacts
Iron	Very slow reaction (reacts slowly with steam)	Reacts less strongly	Reacts
Hydrogen			
Copper	No reaction with water or steam	No reaction	Reacts
Silver	No reaction with water or steam	No reaction	Reacts
Gold	No reaction with water or steam	No reaction	No reaction
Least reactive			

Points to note on the reactivity of metals

Metals that react more vigorously with water or acids are more reactive than metals that react less vigorously or not at all.

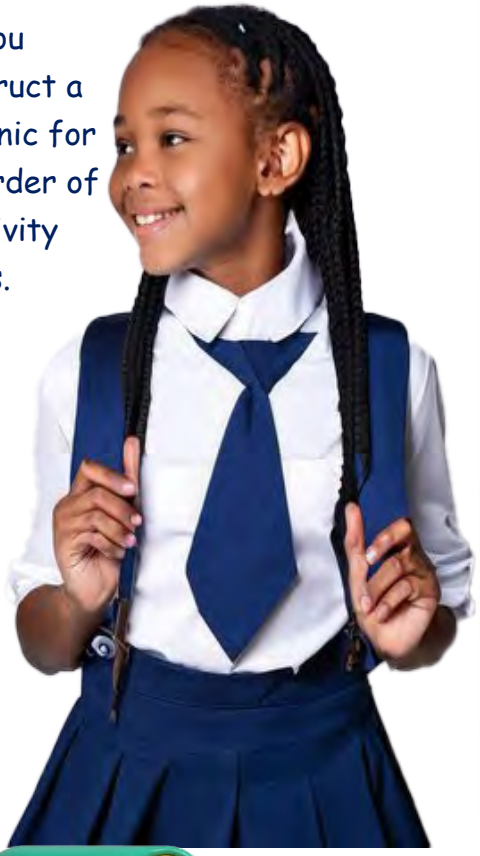
Metals that can displace other metals from their salt solutions are more reactive than metals that cannot.

Metals that have more negative standard electrode potentials are more reactive than metals that have more positive standard electrode potentials.

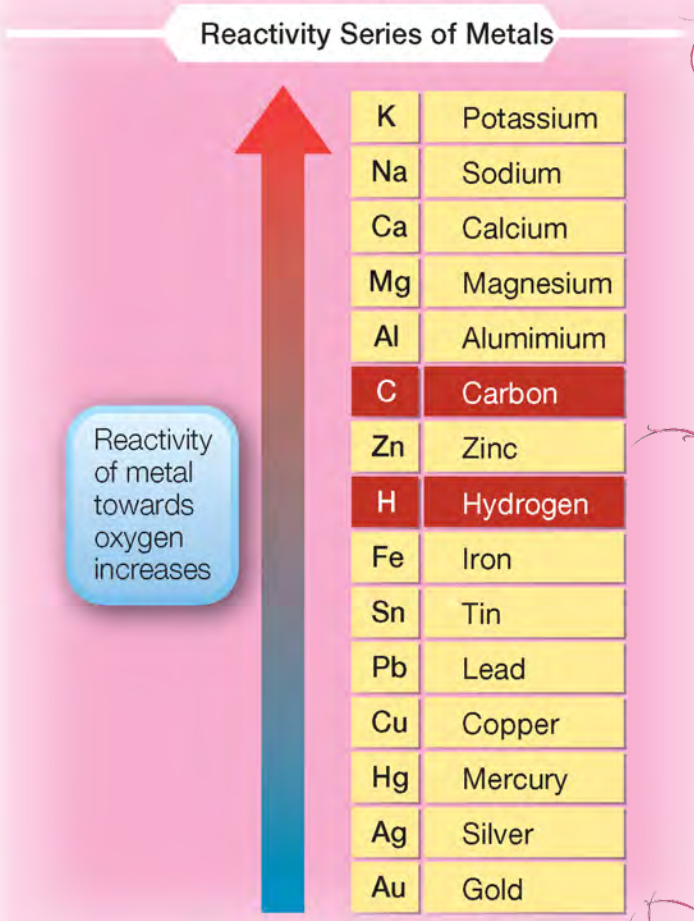
The reactivity series memonic

Challenger

Can you construct a memonic for the order of reactivity series.



Present your memonic to the rest of the class



Group activity:

Group activity:

Constructing a reactivity series of given metals.

Aim: to construct a reactivity series of given metals.

Hypothesis: The more reactive metal will react more ovigorously and the less reactive metal will react less vigorously.

Variables:

Dependent variable: the extent of reaction of a metal.

Independent variable: type of the metal being tested.

Controlled variable: temperature, surface area of metals, time of reaction

Materials: Potassium manganate(VII) crystals, magnesium powder, aluminium powder, zinc powder, iron powder, lead powder and glass wool

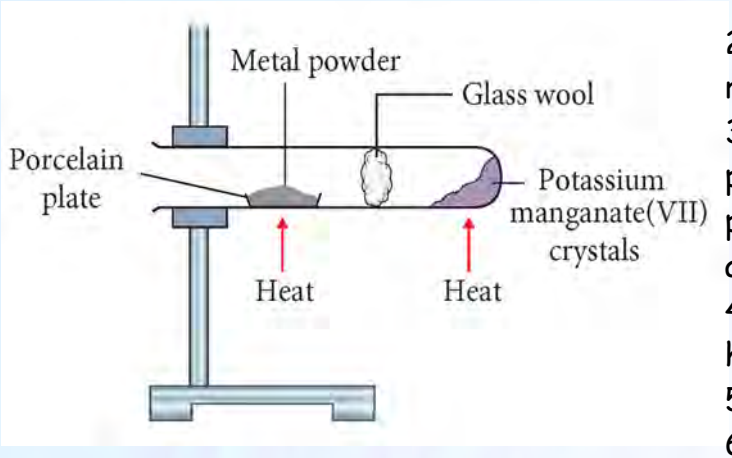
Apparatus: Boiling tube, retort stand with clamp, porcelain plate, spatula and Bunsen burner

Safety precautions

- Glass wool fibres are very dangerous. Use forceps to handle them. Make sure you wear safety glasses and cover your mouth and nose when handling glass wool. Do not allow glass wool to enter your body. Wash your hands after handling glass wool.
- Potassium manganate(VII) crystals and metal powder can explode if mixed during heating. Make sure both of these materials are always kept apart.
- Make sure you wear safety glasses and do not look directly at the flame caused by heating metal powder with oxygen.
- Use only a small amount of metal powder.

Procedure

1. Put a spatula of potassium manganate(VII) crystals into a dry boiling tube. Use some glass wool to prevent it from coming out as shown in the figure below.



2. Clamp the boiling tube horizontally onto the retort stand as shown in the figure above
3. Put a spatula of magnesium powder on a small porcelain plate. Put the porcelain plate into the boiling tube as shown in figure above.
4. Heat the magnesium powder strongly. Then, heat the potassium manganate(VII) crystals.
5. Observe the vigour of the reaction.
6. Record your observations in a table.
7. Repeat steps 1 to 6 using the powdered form of the metals listed in the following table. Use a tick for yes or a cross for no to fill the table below.

Observations

Metal	Observation				
	Metal burns very quickly and brightly	Metal burns quickly and brightly	Metal burns slowly	Metal glows brightly	Metal glows dimly
Magnesium					
Aluminium					
Zinc					
Iron					
Lead					

Questions.

1. Based on the results from this activity, organize the metals in the order of reactivity.
2. Give reasons for your arrangement.
3. You are given a piece of metal that is either zinc, iron, or copper. You want to identify the order of reactivity of the 3 metals by using a simple test. Design an experiment to test the metal with hydrochloric acid, observe the results and arrange the metals in the order of reactivity. Use the reactivity series of metals to explain your observations.

Use your brain power!

4. John wants to store a metal rod for a long time without it corroding. Which metal should he choose? Explain fully why using the knowledge of the reactivity series?