PREFACE

Teaching higher order thinking skill is currently at the center of educational attention. In general, measures of higher order thinking include all intellectual tasks that call for more than the retrieval of information. Six fundamental higher order thinking skills have been identified in this textbook. They are problem solving skills, inquiring skills, reasoning skills, communicating skills, conceptualising skills and creative and innovative skills.

In this Grade 10 Science Textbook, students will be working with their teacher and other students to develop the basic knowledge and skills which will help them understand science more and to apply them in their daily life. They will learn how to show an interest in the creativity and innovation found in science.

After learning this course, students will develop and practise higher order thinking skills: comprehension, analysis, synthesis and evaluation. They will be able to participate actively in all lessons through the **5C's** as important 21st century skills for learning in the classroom.

Collaboration – in lessons students will be working in groups, to share ideas with their classmates and to find the solution together

Communication – students will develop verbal and non-verbal communication skills in group works

Critical Thinking and Problem Solving – students will be given interesting problems to solve – finding and explaining solutions, looking for correcting errors

Creativity and Innovation – thinking 'outside the box' is an important 21st century skill. Students will be encouraged to explore new ideas and solve problems in new ways

Citizenship - students will join the school community and develop fairness and conflict resolution skills

Grade 10 Science Curriculum covers 3 main portions: Chemistry, Physics and Biology. There are ten chapters included in this Textbook.

Science (Chemistry)

Chapter 1. Introduction to Chemistry

Chapter 2. Acids, Bases and Salts

Chapter 3. Fossil Fuels

Science (Physics)

Chapter 1. Measurement and Motion

Chapter 2. Force and Pressure

Chapter 3. Work, Energy and Heat

Chapter 4. Wave, Sound and Light

Chapter 5. Electricity and Magnetism

Science (Biology)

Chapter 1. Introduction to Biology

Chapter 2. Cell Structure and Organization

Goals of Grade 10 Science Textbook

The Grade 10 Science has been written for students who are studying social science subjects. By studying Grade 10 Science, students will be able to understand the fundamentals of chemistry, physics and biology. It is hoped that students will be able to participate successfully in 21st century learning based on the skills through the 5C's as well as to understand the benefits and hazards of the Material World through the knowledge they have learned.

CHAPTER 1

INTRODUCTION TO CHEMISTRY

Chemistry is an area of knowledge remarkable for its breadth and depth. Knowledge of chemistry is essential to improve the quality of our lives. For instance, faster electronic devices, stronger plastics, and more effective medicines and vaccines all rely on the innovations of chemists throughout the world. We cannot truly understand or even know very much about the world we live in or about our own bodies without knowing the fundamental concepts of chemistry.

Climate change, water contamination, air pollution, food shortages and other societal issues are regularly featured in the media. However, did you know that chemistry plays a crucial role in addressing these challenges? As the 'Central Science', chemistry is woven into the fabric of practically every issue that our society faces today.

Learning Outcomes

After completing this chapter, students will be able to:
- recognise the importance of chemistry in daily life;
- know the states of matter;
- differentiate between physical changes and chemical changes;
- classify the substances as elements, compounds and mixtures;
- understand the separation techniques of mixture;
- describe the solutes, solvents and solutions.

1.1 IMPORTANCE OF CHEMISTRY

Chemistry is **important** because everything you do is **chemistry**. **Chemical** reactions occur when you breathe, eat, or just sit there reading. You are surrounded by materials and substances, all chemicals. Even your body is made of chemicals. The air you are breathing is a mixture of elements like oxygen and nitrogen. The book you are reading is made from wood pulp or cellulose which has been bleached and treated with various chemicals. The clothes you are wearing are probably made from synthetic chemicals called polymers, such as nylon or terylene. The seat you are sitting on is perhaps a plastic polymer, with polyurethane; foam seat padding and metal support. The room you are in is made from cement, plastics, concrete and glass, all of which are chemicals. Chemicals provide us with luxuries and improve our leisure time.

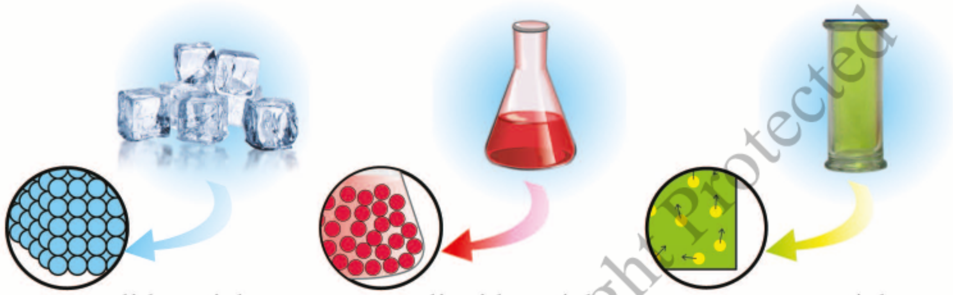
Some chemicals are toxic. Some causes cancer. Some chemicals are also beneficial. Some can save lives. Many are useful. All matter is made of chemicals, so the **importance** of chemistry is that it is the study of everything. **Chemistry deals with everything**. Perhaps a better understanding of chemistry would enable us to control the uses of chemicals so that we could maximise their benefits and minimise the risk involved in their use.

1.2 MATTER

All substances are **matter**. Matter is made up of tiny particles. These can be atoms or molecules (groups of atoms), and elements or compounds. This includes the air, the sea, the Earth, all living creatures and even the galaxies.

(a) States of Matter

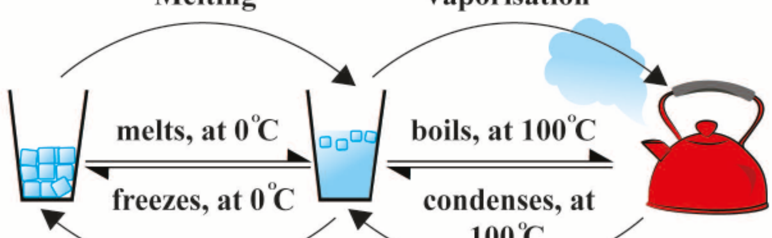
Solid, **liquid** and **gas** are the most common states of matter. Water is a substance, which exists in all three states of matter: ice (solid), water (liquid) and steam (gas). The properties of each state of matter depend on the forces of attraction between the particles which can be weak or strong.



(b) Changes in Matter

The materials around us are subject to constant change. Plants and animal materials decay, metals corrode, and land areas erode. Moreover, every substance – for example, water, sugar, salt, gold or silver – has a set characteristics or properties that distinguish it from all other substances and gives it a unique identity. One way to classify properties is based on whether or not chemical composition of an object is changed by the act of observing the property. Changes in substances can be classified as either physical or chemical.

Physical changes



A physical change is a change in which no new substances are formed. For example, when ice melts from solid to liquid, or when sand is ground to a fine powder, no new substance is formed. Melting, boiling, freezing, evaporation (liquid to gas), vaporisation (liquid to gas), condensation (gas to liquid), sublimation (solid to gas) and deposition (gas to solid) are considered as physical changes.

Chemical changes

A chemical change is a change in which one or more new substances are formed. Examples of chemical changes are cooking of rice from rice grains, green mangoes ripening, burning of a match, and burning of a candle.

Chemical changes occur via chemical reactions such as dissociation, neutralisation, precipitation, etc. For example,

- Heating of limestone or marble (dissociation or decomposition)
- Use of magnesia to treat gastric patient (neutralisation)
- Passing carbon dioxide into limewater (precipitation)

1.3 ELEMENTS, COMPOUNDS AND MIXTURES

All samples of matter can be divided into two categories: pure substances and **mixtures**. A pure substance is a form of matter that always has a definite and constant composition. Pure substances are classified as either **elements** or **compounds**. At the beginning of the 19th century, John Dalton proposed the theory of matter: that all matter was composed of atoms, which were invisible and indivisible. Today, the atom is still considered as the basic unit of any element. An atom may combine chemically to form molecules; the molecules become the smallest unit of any substances that possesses the properties of that substance. Modern experimental evidence has shown that atoms are divisible to create either lighter or heavier atoms.

(a) Elements

There are 92 known elements which occur naturally, either in the free or combined state. Some elements are solids such as copper, iron, zinc, silver, gold, carbon and phosphorus. Some elements are liquids. They are mercury and bromine. Some elements are gases such as oxygen, nitrogen, hydrogen and chlorine. Substances like these, which cannot be broken down into a simpler substance by chemical means, are called elements.

(b) Compounds

Molecules exist in elements as well as compounds. A molecule of an element (molecular element) consists of atoms of the same kind. A molecule of a compound (molecular compound) consists more than one kind of atoms. The atoms of different elements in the molecule of a compound are combined in a definite ratio.

Most substances on Earth occur as compounds, e.g., carbon dioxide (CO_2), water (H_2O), marble ($CaCO_3$), glucose ($C_6H_{12}O_6$), ethanol (C_2H_5OH) and ammonia (NH_3). Although there is only small number of elements, there are millions of compounds.

(c) Mixtures

Mixtures consist of two or more different substances that are mixed physically but not chemically combined. They do not have well defined specific properties and the substances are not in fixed ratios.

The substances in a mixture may be solids, liquids or gases. For example, brass, a solid, is a mixture of the elements copper and zinc; sea water is a mixture of compounds including mainly water and sodium chloride; air is a mixture of gases containing nitrogen, oxygen, argon, carbon dioxide and water vapour. The mixtures may also be heterogeneous or homogeneous (Table 1.1). Therefore, the mixtures can be classified as two main categories: homogeneous and heterogeneous mixtures.

Table 1.1 Different Types of Mixtures

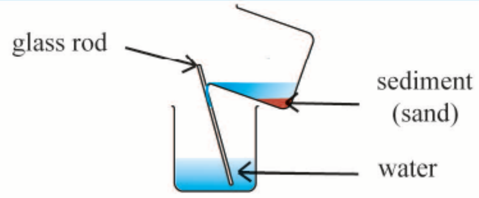
Physical state	Type of mixture	Example
solid-solid	homogeneous	stainless steel (mixture of iron and chromium)
solid-solid	heterogeneous	flour and rice powder
solid-liquid	homogeneous	sugar solution (sugar and water)
solid-liquid	heterogeneous	salt and oil
solid-gas	heterogeneous	dust in air
liquid-liquid	homogeneous	vinegar (mixture of acetic acid and water)
liquid-liquid	heterogeneous	oil and water
liquid-gas	homogeneous	soft drink (carbon dioxide gas dissolved in sterilised water at high pressure)
liquid-gas	heterogeneous	fossil fuel (mixture of crude oil and natural gas)
gas-gas	homogeneous	air (mixture of different gases)

(i) Separation of mixtures

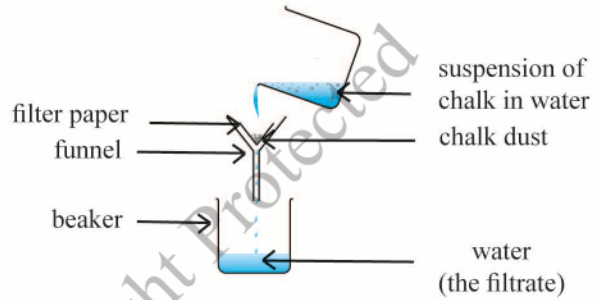
Most substances are naturally found as mixtures; therefore the separation methods shown in Table 1.2 indicate how the physical states of components in the mixture can be separated into pure substances.

Table 1.2 Some Separation Methods of Mixtures

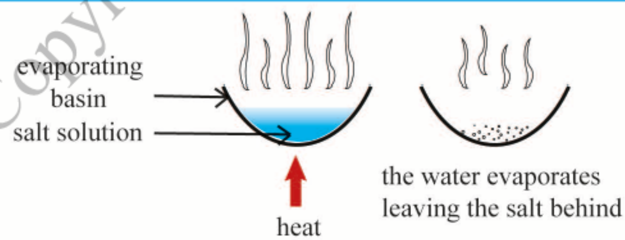
<table>
<tr><th>Types of mixtures and their separation techniques</th><th>Description</th></tr>
<tr><td>a liquid and a solid mixture such as a suspension (sand / water)

Decantation: a process to separate mixtures of solid and liquid or two immiscible liquids to settle and separate by gravity.</td><td>

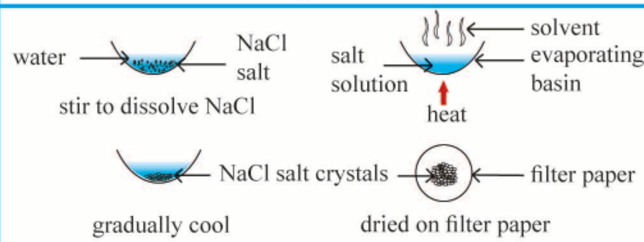
decantation</td></tr>
<tr><td>a solid from a liquid
(chalk dust from water)

Filtration: a method for separating an insoluble solid from a liquid. When a mixture of sand and water is filtered, the sand remains as residue on the filter paper and the water, which is also called filtrate, passes through the filter paper.</td><td>

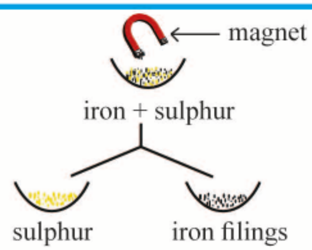
filtration</td></tr>
<tr><td>solute from its solution
(sodium chloride, NaCl salt from its solution)

Evaporation: the process of a substance in a liquid state changing to a gaseous state due to an increase in temperature and / or pressure.</td><td>

evaporation</td></tr>
<tr><td>a solute crystal from its solution
(sodium chloride, NaCl salt from its solution)

Crystallisation: a process by which a chemical is converted from a liquid solution into a solid crystalline state.</td><td>

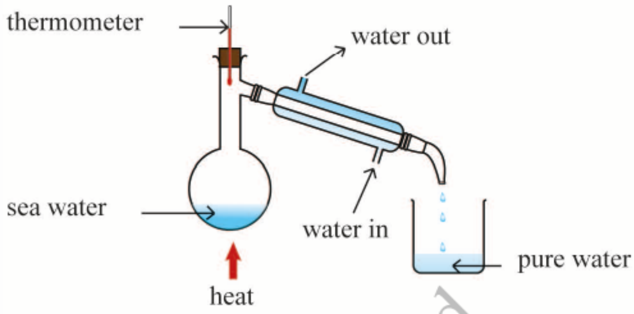
crystallisation</td></tr>
<tr><td>to attract magnetically susceptible materials (sulphur and iron mixture)

Magnetic separation: a method used to separate the components of a mixture when at least one of them is magnetic in nature.</td><td>

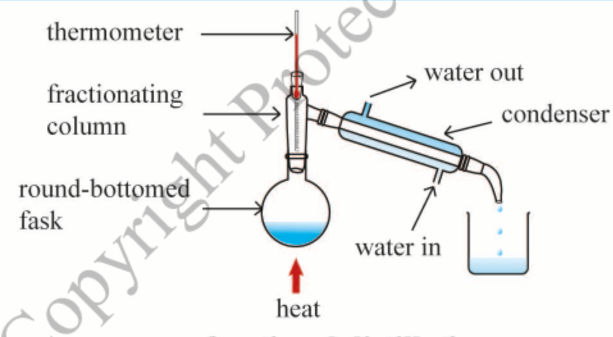
magnetic separation</td></tr>
</table>

Continued from **Table 1.2**

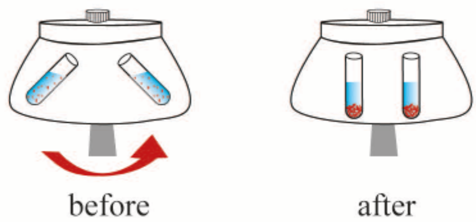
<table>
<tr><th>Types of mixtures and their separation techniques</th><th>Description</th></tr>
<tr><td>a solvent from a solution
(pure water from sea water)

Simple distillation: a procedure by which two liquids with different boiling points can be separated. It is used to separate solvent from a solution.</td><td>

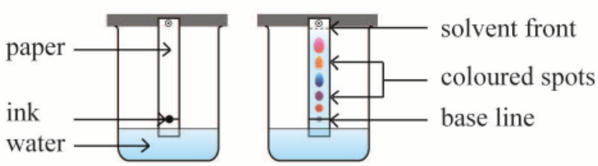
simple distillation</td></tr>
<tr><td>liquids from each other
(separation of petroleum)

Fractional distillation: a method for separation of a liquid mixture into fractions with different boiling points (and hence chemical composition) by means of distillation, typically using a fractionating column.</td><td>

fractional distillation</td></tr>
<tr><td>a solid from a liquid (milk, blood)

Centrifugation: a technique used for the separation of particles from a solution according to their size, shape, density, viscosity of the medium and rotor speed.</td><td>

centrifugation</td></tr>
<tr><td>different substances from a solution (separation of ink by paper chromatography)

Chromatography: a separation method of the mixed substances that depends on the speed at which they move through special media, or chemical substances. It consists of a stationary phase (a solid) and a mobile phase (a liquid or a gas).</td><td>

chromatography</td></tr>
</table>

(ii) Solutions

Some solids such as copper(II) sulphate, sugar and common salt are soluble in water but some solids such as sand, charcoal and chalk are insoluble in water. Some solids such as iodine are slightly soluble in water. When you mix sugar with water, it seems to disappear. That is because its particles spread all through the water particles. The sugar dissolves in water, giving the mixture called as a **solution**. Sugar is the **solute**, and water is the **solvent**.

Sugar (solute) + Water (solvent) = Sugar solution (solution)

Some liquids can mix with one another in all proportions (miscible liquids), while some liquids do not mix (immiscible liquids). For example, ethanol, acetic acid and sulphuric acid are soluble in water but petrol and oils are insoluble in water.

Some gases such as hydrogen chloride and ammonia are very soluble in water. Some gases such as oxygen, nitrogen and hydrogen are not very soluble in water.

Solutions may be gaseous, solid, or liquid in nature. Dry air is a familiar example of a gaseous solution. Brass (copper and zinc) is an example of a solid solution. Liquid solutions may contain solid, liquid or gaseous solutes. Salt water is a familiar example of a solid dissolved within a liquid. Vinegar is a solution containing two liquids, acetic acid and water. Carbonated water contains carbon dioxide gas molecules existing between molecules of water.

Solutions having water as the solvent are referred to as aqueous solutions. Many reactions including those vital for life processes occur in aqueous solutions. Blood and saliva are some of the more familiar solutions of biological importance.

Chemistry in Daily Life

- All substances in our environment are found in three states. Some are in solid (ice, sugar, salt, iron, copper, etc.); some are in liquid (water, oil, juice, etc.); some are in gaseous (air, oxygen, carbon dioxide, etc.) states.
- Mothballs used as deodorant for toilets and bathrooms sublime directly into vapour. It is also a physical change.
- In our daily life, cooking the foods, burning the candle, iron rusting, vegetables rotting, building a fire, photosynthesis reaction, making soaps and detergents, etc. are chemical changes.

Continued from **Chemistry in Daily Life**

- Solution can be found almost everywhere on the Earth, from the ocean to the sky. Every ocean and every lake on the Earth is a solution, because the water has mixed with dirt, salt and various substances.
- Colloidal mixtures (heterogeneous mixtures) have components that tend not to settle out. Milk is a colloid of liquid butter suspended in water.

Review Questions

Section 1.1

(1) Why is chemistry important? Give some examples for your answer.

Section 1.2

(1) Distinguish among the solid, liquid and gas.

(2) Which states can you see the following matter in our environment as solid or liquid or gas?
(a) iron (b) water (c) mercury (d) argon (e) gold (f) copper (g) vinegar

(3) Classify the following changes as either physical or chemical change:

(a) boiling an egg	(b) mixing sand and water	(c) making jelly
(d) evaporating alcohol	(e) souring of milk	(f) baking a cake
(g) digesting food	(h) crushing a can	(i) breaking a glass

(4) Is dissolving glucose in water a physical change or a chemical change? Give reason for your answer.

Section 1.3

(1) When attempts are made to break down substance **A** by chemical methods, the same original substance is always formed. Is substance **A** an element or a compound?

(2) When a substance is broken down by chemical means, two substances with different properties are formed. Is the original substance an element or a compound?

(3) Give two examples for each of the following:
(a) solids that dissolve in water
(b) insoluble solids in water
(c) solvents other than water.

Key Terms

- **Matter** is made up of tiny particles, and has mass and takes up space. Three common states of matter are solid, liquid and gas.
- A **solid** is a substance which has definite volume and shape because particles in a solid are held together in a fixed position. It cannot be compressed and does not flow.

- A **liquid** is a substance which has definite volume but no definite shape because particles in a liquid are not held in a fixed position. It takes the shape of the container in which it is placed and flows in all directions. It cannot be compressed.
- A **gas** is a substance which has no definite volume and shape because particles in a gas are in a random arrangement so that they can move freely. It fills up every space; it can enter and it takes up the volume and the shape of its container; it can easily be compressed, and flows in all directions.
- A **physical change** is a change in which no new substances are formed. There may be a temporary change in colour, temperature and state of the substances but no new substances are formed in the physical change.
- A **chemical change** is a change in which one or more new substances are formed. The substances change in colour, temperature and state but they also change into a new substance or substances in the chemical change.
- An **element** is a substance that cannot be broken down into other simpler substances through chemical means. Every element is made up of its own type of atoms. Therefore, it has a unique position in the Periodic Table.
- A **molecule** is the simplest unit of the chemical substance, usually a group of two or more atoms.
- A **compound** is a substance containing two or more different elements chemically joined together in a fixed ratio.
- A **mixture** is a combination of more than one substance, where these substances are not bonded to each other. It consists of two or more substances which may be present in any proportion by weight. The constituents of the mixture do not combine chemically.
- A **heterogeneous mixture** is one that is non-uniform, and where the different components of the mixture can be seen. The components separate, and the composition varies.
- A **homogeneous mixture** is one in which the composition of its components are uniformly mixed throughout. The components cannot be seen separately on visual or microscopic examination.
- A **solute** is a substance which dissolves in a solvent to give a solution.
- A **solvent** is a substance, mostly liquid, in which another substance dissolves to give a homogeneous mixture.
- A **solution** is a clear homogeneous mixture obtained when a substance dissolves in a solvent. In a solution the solute is uniformly distributed throughout the solution.

EXERCISES

1. Write TRUE or FALSE for the following statements. If FALSE, correct it.
   (a) Melting butter is a chemical change.
   (b) Lighting of candle is a physical change.
   (c) Mixtures consist of two or more different substances that are chemically combined.
   (d) Flour and rice powder are solid-solid homogeneous mixture.

(e) Separation of sugar from tea can be done with filtration.
(f) Sea water is a mixture and not a single substance.

2. Fill in the blanks with suitable word / words given below.

   components, separation, states, compounds, mixtures

   Many _____ can contain useful substances mixed with impurities. Chemists have developed different _____ methods for separating the _____ from complex mixture. The methods depend on the properties of the _____ of the mixture and the_____ of components to be separated.

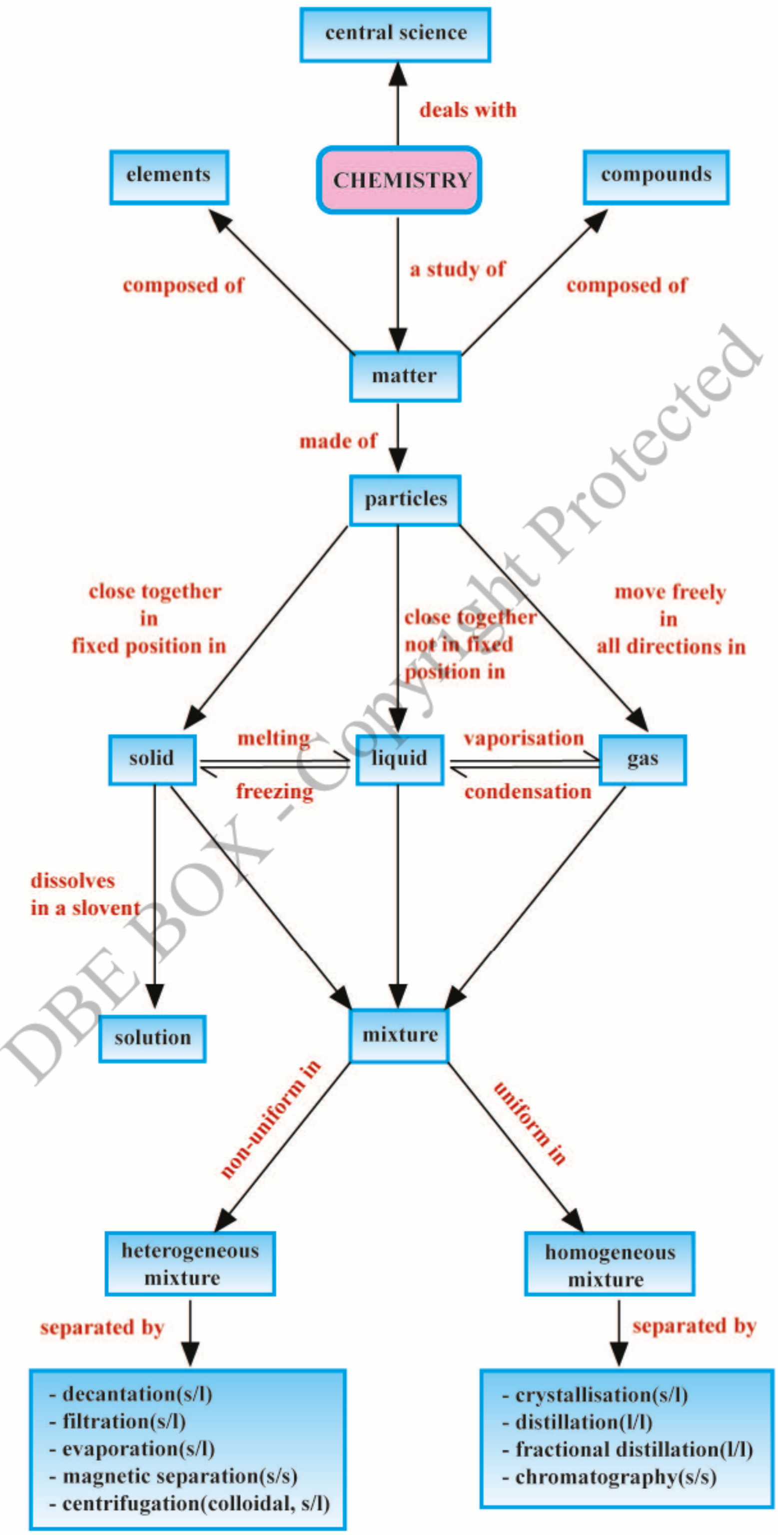
3. At room temperature and pressure, which of the substances listed below is a solid element, a liquid element, a solid compound, a liquid compound, a gas compound, a homogeneous solution, a heterogeneous solution, a gaseous mixture or a solid mixture? gold, ash, soil, carbon dioxide, air, mercury, limestone, bromine, milk, water, vinegar

4. (a) Which of the following can be classified as a mixture?
   yogurt, table salt, smoke, iron, soap solution, silver coin
   (b) Choose one correct answer from the following:
   An element can be defined as:
   (i) A substance that cannot be separated into two or more substances by ordinary chemical (or physical) means
   (ii) A substance with constant composition
   (iii) A substance that contains two or more substances, in definite proportion by weight
   (iv) A uniform substance

5. This question is about ways to separate and purify substances. Match each term from List A with the correct description from List B.

List A	List B
(a) evaporation	(i) a solid appears as the solution cools
(b) condensing	(ii) used to separate a mixture of two liquids
(c) filtering	(iii) the solvent is removed as a gas
(d) crystallising	(iv) this method allows you to recycle a solvent
(e) distillation	(v) a gas changes to a liquid, on cooling
(f) fractional distillation	(vi) separates an insoluble substance from a liquid

CHAPTER REVIEW
(Concept Map)



CHAPTER 2

ACIDS, BASES AND SALTS

Acid-Base chemistry is important in a wide variety of everyday life. In our bodies, in our home and in our industrial society, acids, bases and salts play key roles.

In our bodies, proteins, enzymes, blood, genetic materials and other components of living matter contain both acids and bases.

The organs of human and animals also contain acids. You probably know how painful a bee sting or an ant bite can be. The pain is caused by an acid called methanoic (formic) acid. The pain we sometimes feel in our leg muscles during exercise is caused by lactic acid. Our stomach produces an acid (HCl) for food digestion.

H_2SO_4 (battery acid)

HCl

HNO_3

CH_3COOH (vinegar)

Antacid tablets

NH_4OH (glass cleaner)

Learning Outcomes

After completing this chapter, students will be able to:

- describe the physical and chemical properties of acids, bases, alkalis and salts and their uses in daily life;
- distinguish between bases and alkalis;
- relate the role of indicators and the pH scale;
- classify the salts based on acids used.

We often use salts in our home. We sprinkled sodium chloride on our food to bring out its taste. We may use bath salts to help us relax in the bath and some of the medicines we take are salts. Salts are used as a preservative in pickles and in curing meat and fish, in the manufacture of soap, keeping ice from melting and making chemicals like washing soda, baking soda, etc.

2.1 ACIDS

Acid is a substance which when dissolved in water produces hydrogen ions (H^+). In other words, an acid increases the number of H^+ ions in an aqueous solution.

Many 'acids' are corrosive, meaning they destroy body tissue and clothing, and many are also poisonous. Acids can be found in many foods we eat. Some organic acids are used in food preservative, food fermentation, salad, etc., such as ethanoic acid (acetic acid). Some organic acids are found in the food presented in Figure 2.1.

Yogurt (lactic acid) | Apples (malic acid) | Citrus fruits (citric acid) | Grapes (tartaric acid) | Gooseberries (Zee Phyu) (ascorbic acid) | Roselle plant (Chin Baung) (oxalic acid)

Figure 2.1 Occurrence of Some Organic Acids in Nature

The word 'acid' comes from the Latin word *acidus*, which means sour. Acids can be classified as mineral acids (inorganic acids) and organic acids. Acids can be strong or weak. Strong acid cannot dissociate itself without water. When a strong acid dissolves in water, it completely dissociates to produce hydrogen ions, which are protons, (H^+), and a weak acid only partially dissociates in water. Mineral acids are strong acids and organic acids are weak acids. Some acids and their strengths are described in Table 2.1.

Table 2.1 Names and Formulae of Some Acids and Their Strengths

Name of acids	Chemical formula	Strength of acids
hydrochloric acid	HCl	strong
sulphuric acid	H_2SO_4	strong
nitric acid	HNO_3	strong
ethanoic acid	CH_3COOH	weak

(**Caution**: Always add strong acid slowly to water. This is because the acid becomes very hot and splashing may happen.)

Properties

An acid is a compound which becomes a proton (H^+) donor when dissolved in water. The properties and reactions of an acid are due to these hydrogen ions.

Physical properties

(i) Acids are hazardous, irritant and corrosive.
(ii) Acids have a sour taste. **(DON'T TASTE, DON'T TOUCH.)**
(iii) Acids dissolve in water to form solutions which conduct electricity.
(iv) Acid solutions have pH values less than 7.
(v) Acids have the ability to change the colour of indicators and turn blue litmus paper (an indicator) red.

Chemical properties

(i) Acid reacts with metals to form a salt and hydrogen.

metal + acid (dil.) $\longrightarrow$ salt + hydrogen

(ii) Acid reacts with carbonate to form a salt, carbon dioxide and water.

metal carbonate + acid (dil.) $\longrightarrow$ salt + carbon dioxide + water

2.2 BASES AND ALKALIS

Bases and alkalis are found in many cleaning agents such as soap and many household detergents. When ashes are burnt, the product is alkaline. The word **alkali** comes from the Arabic 'al-qili' which means burnt ashes. It is used traditionally by gardeners as a good source of potash.

(a) Bases

A **base** is usually a metallic oxide or hydroxide and will react with an acid to form a salt and water only.

For example,

metal oxide + acid (dil.) $\longrightarrow$ salt + water

metal hydroxide + acid (dil.) $\longrightarrow$ salt + water

(b) Alkalis

An alkali is a base that is soluble in water. An example of a soluble base is sodium oxide.

sodium oxide + water $\longrightarrow$ sodium hydroxide

$$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$$

Alkalis can be strong or weak. Strong alkalis dissolve in water to produce OH^- ions in solution. Sodium hydroxide and potassium hydroxide are examples of strong alkalis. Ammonium hydroxide is the most common example of a weak alkali.

Most bases are insoluble in water. MgO, CuO, Fe_2O_3, etc. are insoluble bases. They do not react with water and also not dissolve in water. Thus, it is a base and not an alkali.

(c) Properties

Physical properties

(i) Strong bases are hazardous to handle.
(ii) Bases have a bitter taste and soapy feel. **(DON'T TASTE)**
(iii) Bases cause a colour change in indicators. Litmus changes from red to blue in a basic solution.
(iv) Alkalis have pH values greater than 7.

Chemical properties

(i) Bases react with acids to neutralise each other and form a salt and water.
(ii) When alkalis are gently warmed with ammonium salt, it gives off ammonia gas.
(iii) Alkalis react with fatty acids to form soaps.

2.3 INDICATORS AND THE pH SCALE

Many brightly coloured flowers, vegetables and berries make good indicators. For example, the coloured juice extracted from red cabbage is pink in acids and green in alkalis. Hydrangea flowers are interesting natural indicators. They are blue when grown in acidic soil and pink or red when grown in alkaline soil.

(a) Indicators

Indicators are dyes, or a mixture of dyes, which change colour when they are added to acids or alkalis. Some indicators can be used to determine pH because of their colour changes somewhere along the pH scale (Figure 2.2). Litmus is red in acidic solution, purple in neutral and blue in alkaline solution.

(b) The pH Scale

A measure of the acidity or alkalinity of the solution is known as **pH**. The pH value can be measured by pH meter (Figure 2.3). It is a much more reliable and accurate method of measuring pH than the universal indicator paper.

Substances in the body have different pH values. Acidic conditions in the stomach (pH~1.5) are needed for good digestion. Usually the body maintains the pH of blood close to 7.4. The pH scale demonstrates the strength of an acid or alkali (Figure 2.2). Solutions and their pH values are described in Table 2.2.

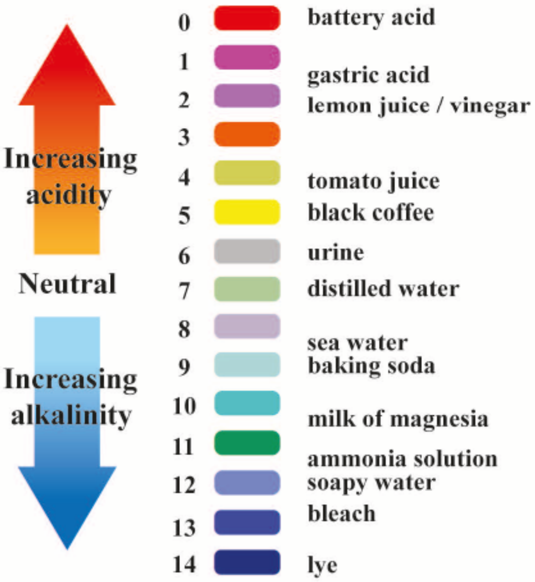


Figure 2.2 The pH Scale

Table 2.2 Solutions and Their pH Values

Solutions	pH value (0 to 14)
acidic	below 7
basic	above 7
neutral	equal to 7

(a) (b)

Figure 2.3 (a) The pH Meter
(b) Universal Indicator Paper

2.4 SALTS

Many different types of salts can be found in nature. The sea water contains many salts such as sodium chloride, potassium chloride, magnesium sulphate, magnesium chloride and magnesium bromide.

The Earth's crust is made up of minerals containing various types of salts such as calcium fluoride (fluorite), magnesium sulphate (Epsom salt), lead(II) sulphide (galena) and calcium carbonate (limestone), etc.

A salt is produced when an acid reacts with a base. The salt consists of two parts. One part comes from the base, the other from the acid. An example is sodium chloride, NaCl, produced from sodium hydroxide and hydrochloric acid.

Classification of Salts

The salts can be classified based on acids used. Some examples of salts (chloride, sulphate, nitrate, sulphite and carbonate salts) formed from different acids are shown in Table 2.3.

Some salts are soluble and some are insoluble depending on the types of metals.

Table 2.3 Some Salts Formed from Different Acids

Acids		Salts	
hydrochloric acid	HCl	**chloride salts** sodium chloride zinc chloride magnesium chloride	 $NaCl$ $ZnCl_2$ $MgCl_2$
sulphuric acid	H_2SO_4	**sulphate salts** sodium sulphate copper(II) sulphate	 Na_2SO_4 $CuSO_4$
nitric acid	HNO_3	**nitrate salts** sodium nitrate potassium nitrate ammonium nitrate copper(II) nitrate	 $NaNO_3$ KNO_3 NH_4NO_3 $Cu(NO_3)_2$
sulphurous acid	H_2SO_3	**sulphite salts** sodium sulphite	 Na_2SO_3
carbonic acid	H_2CO_3	**carbonate salts** sodium carbonate calcium carbonate	 Na_2CO_3 $CaCO_3$
ethanoic acid	CH_3COOH	**ethanoate salt** sodium ethanoate	 CH_3COONa

Chemistry in Daily Life

Some examples of most common uses of acids in daily life are listed in the following Table:

Acids	Formula	Uses
sulphuric acid	H_2SO_4	extraction of some metals such as copper, manufacture of fertilisers, detergents, paints, rubber, paper and pulp industry, car batteries and rust removal
hydrochloric acid	HCl	to help swimming pools be free of algae, to make aqua regia for dissolving gold and platinum

Continued from **Chemistry in Daily Life**

Acids	Formula	Uses
nitric acid	HNO_3	making fertilisers and explosives, to make aqua regia (a mixture of one part of the concentrated nitric acid and three parts of the concentrated hydrochloric acid) for dissolving gold and platinum
phosphoric acid	H_3PO_4	making fertilisers and rust inhibitor
carbonic acid	H_2CO_3	in fizzy drinks
citric acid	$C_6H_8O_7$	in fruit juices, in the preparation of effervescent salts, as a food preservative
ethanoic acid	CH_3COOH	in vinegar, used in salad dressings

Some common bases and alkalis and their uses are described in the following Table:

Bases and alkalis	Formula	Uses
sodium hydroxide	NaOH	making soap, paper, baking soda, oven cleaners
calcium hydroxide (slaked lime)	$Ca(OH)_2$	treating acidic soil (liming), making cement, limewater, mortar, plaster
calcium oxide (quicklime)	CaO	making cement
magnesium oxide	MgO	in antacids (gastric medicine), in toothpaste
ammonia	NH_3	in many household cleaners and production of fertilisers

- The pH is important for the correct functioning of the body, for food and water and for the growth of plants.
- Many plants do not grow properly in highly acidic or highly alkaline soil. Highly acidic soil is treated by spreading quicklime (CaO), slaked lime ($Ca(OH)_2$) or calcium carbonate ($CaCO_3$) to lower its acidity.
- Highly alkaline soil is treated by adding gypsum ($CaSO_4.2H_2O$) to lower its alkalinity.

Continued from **Chemistry in Daily Life**

Salts play an important role in our society. Some salts and their uses in society are described in the following Table:

Salts	Formula	Uses
sodium chloride	$NaCl$	food additive
sodium sulphate sodium nitrite sodium citrate	Na_2SO_4 $NaNO_2$ $Na_3C_6H_5O_7$	food preservatives
ammonium sulphate ammonium nitrate ammonium phosphate	$(NH_4)_2SO_4$ NH_4NO_3 $(NH_4)_3PO_4$	fertilisers
potassium chloride	KCl	fertiliser
magnesium sulphate magnesium hydroxide	$MgSO_4.7H_2O$ $Mg(OH)_2$	medical uses (Epsom salt) medical uses (milk of magnesia, MOM)
calcium sulphate	$CaSO_4$	medical uses (Plaster of Paris , POP)

Review Questions

Section 2.1

(1) After rubbing an old copper coin with lemon juice, what visible change happens to the coin? Why?

(2) How can you detect whether a solution is acidic or not? **(Not to taste)**

(3) Ant bite is painful. Why is it so?

(4) Why can you treat bee stings with baking powder?

Section 2.2

(1) What is the difference between base and alkali?

(2) Complete the following:

(a) All acidic solutions contain ______ ions.

(b) A base is a usually a ______ oxide or hydroxide.

(c) A base reacts with an acid to form a ______ and water only.

(d) Strong alkalis dissolve in water to produce ______ ions in solution.

(e) When alkalis are gently warmed with ammonium salt, it gives off ______ gas.

Section 2.3

(1) Which of the solutions having the following pH, are acidic or alkaline or neutral?
(a) pH 6 (b) pH 3 (c) pH 7 (d) pH 8
(2) The pH of pancreatic juice is 7.9. Is pancreatic juice acidic or basic?
(3) How do we detect whether a soil is acidic or basic?
(4) Name a common household substance with a pH (a) greater than 7 (b) less than 7 (c) almost 7.

Section 2.4

(1) How would you neutralise hydrochloric acid if you spill it on the floor of a laboratory?
(2) If the soil is too acidic, we add lime to the soil. Explain the purpose of this.
(3) Farmers treat the alkaline soil by using gypsum ($CaSO_4 . 2H_2O$). Why?
(4) We take gastric medicine when we feel stomach pain. Explain the action of this medicine.

Key Terms

- An **acid** is a compound that dissolves in water to produce hydrogen ions, H^+.
- A **base or** an **alkali** is a chemical compound that combines with an acid to form a salt and water. An **alkali** is a base which is soluble in water producing OH^- ions. All **alkalis** are bases but all bases are not alkalis.
- An **indicator** is a substance that has different colours in acidic and alkaline solutions.
- A measure of the acidity or alkalinity of a solution is known as its **pH**. Solutions with pH < 7 are acidic and those with pH > 7 are alkaline. The solutions of pH 7 are neutral. The pH of pure water is 7. The pH of a solution can be measured by using the pH meter.
- A **salt** is a substance produced from the reaction between an acid and a base or a metal. Based on the acids, salts can be classified as chlorides, sulphates, nitrates, sulphites and carbonates, etc.
- **Neutralisation** is the reaction between an acid and a base to form a salt and water only.

EXERCISES

1. Think carefully about the following statements. Are they TRUE or FALSE? If FALSE, correct it.
   (a) In general, all acid solutions contain hydrogen ions, H^+.
   (b) Copper(II) hydroxide is an alkali.
   (c) The smaller the pH value, the more acidic a solution is.
   (d) Strong acids and alkalis are harmful and corrosive.
   (e) Litmus paper can measure the range of pH of a solution.

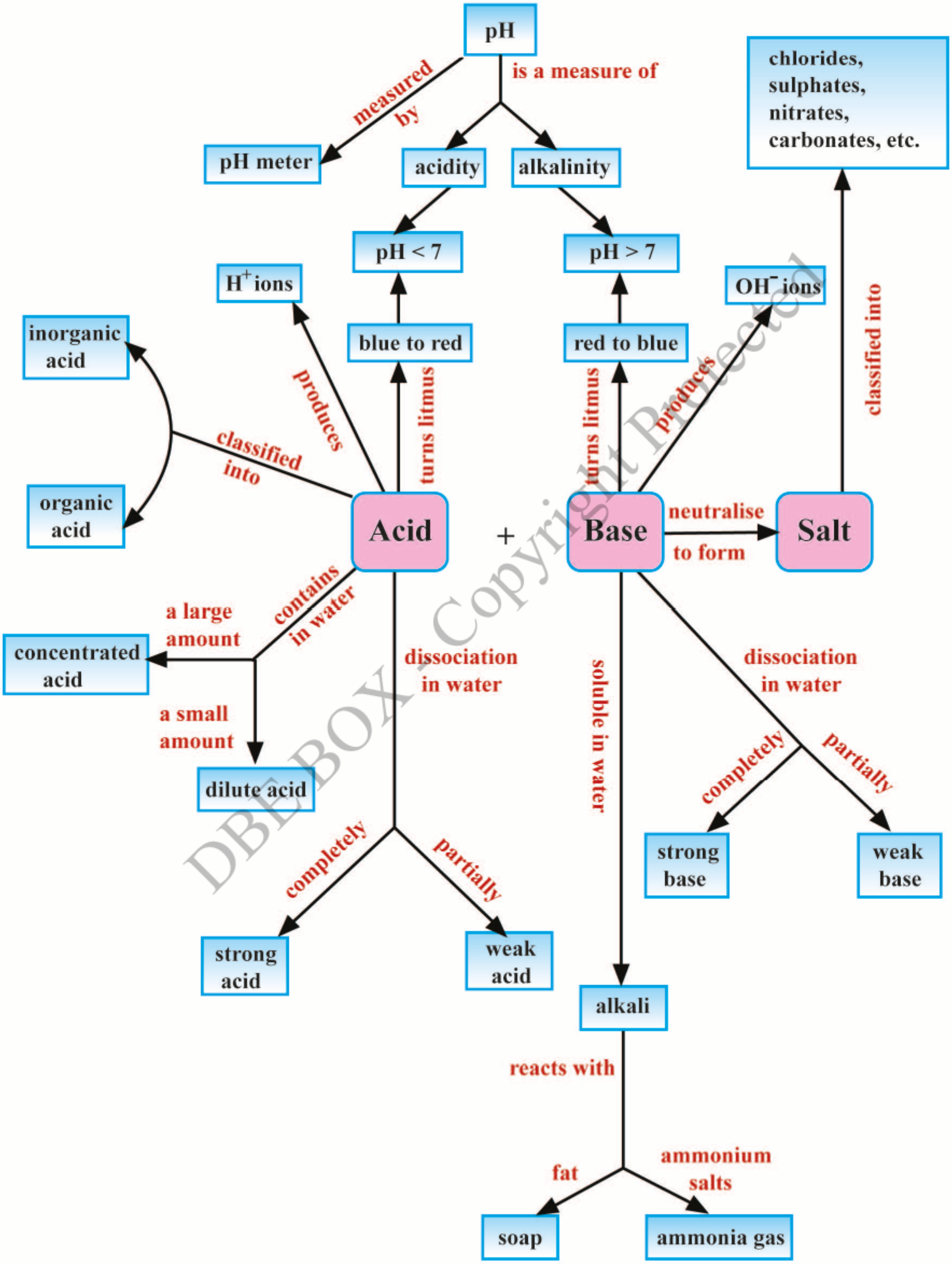
2. Select the correct word or words given in the brackets.
   (a) Which of the following compounds can form an aqueous solution of pH >7?
   (carbon dioxide; hydrogen chloride; sodium chloride; sodium hydroxide)

(b) Which of the following gases reacts with sulphuric acid to form a fertiliser? (ammonia; carbon dioxide; hydrogen; nitrogen)
(c) A sample of pond water has a pH value of 11.
This means that the water is (weakly acidic; neutral; weakly alkaline; strongly alkaline).
(d) Which of the following substances could be used in excess to change the pH of soil from 5 to 7? (sodium chloride; calcium oxide; hydrochloric acid; sulphuric acid)

3. Fill in the blanks with a suitable word or phrase or numerical value with unit as necessary.
(a) The combination of H^+ and OH^- ions to form water is called _____.
(b) The pH of alkali solution is greater than _____.
(c) Solutions having pH values below 4.5, turn blue litmus paper _____.
(d) A measure of the acidity or alkalinity of a solution is known as _____.
(e) The salts can be classified based on _____ used.

4. Complete the following sentences by using the words given below:
(a) hydroxides, hydrogen, dissolves, salt, oxides, water
An acid is a compound that _____in water to produce _____ions. Acids react with metals to form _____and hydrogen. When acids react with metal _____ or _____, a salt and _____are formed.
(b) acids, ammonia, hydroxide, salt, soluble
Alkalis are water _____ bases. Examples of alkalis are_____ and sodium _____. Alkalis react with_____ to form a _____and water.
(c) universal, alkaline, neutral, high, scale, seven, acidic
The pH_____ shows how acidic or _____a solution is. Strongly_____ solutions have a low pH, strongly alkaline solution have a _____ pH. A solution that is neither acidic nor an alkaline is called a_____ solution. It has a pH of _____. The pH of a solution can be measured using _____indicator or a pH meter.

CHAPTER REVIEW
(Concept Map)

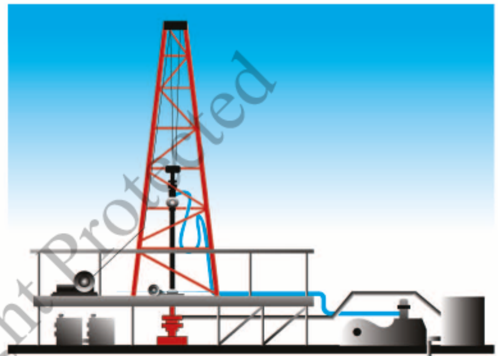


CHAPTER 3 FOSSIL FUELS

In the twenty first century society, the main energy source which is used to operate the machines, power cars and buses, daily cooking our food and lighting our homes is obtained from fossil fuels.

These fuels are classified as non-renewable and are finite (limited) resources because they take a very long time (millions of years) to form. Modern society is still using up fossil fuels reserved for heavy and soft industries, for non-stop transportation, generating electricity in power stations, and also for cooking.

There are three major fossil fuels. They are (a) coal (b) crude oil and (c) natural gas. Coal comes from fossil plant materials. Crude oil and natural gas are formed from the bodies of marine microorganisms. The formation of these fuels took place over many millions of years. That is why they are not only classified as non-renewable, but of finite (limited) reserved resources.


Oil and gas production

Learning Outcomes

After completing this chapter, students will be able to:
- identify the sources, properties and behaviours of fossil fuels;
- explain the process of fractional distillation as applied to crude oil;
- describe the cracking process used to split long chain hydrocarbon molecules into shorter ones;
- recognise the sources, compositions and uses of alternative fuels.

3.1 COAL

Coal is fossilised plant material containing mainly carbon together with hydrogen, nitrogen and sulphur. Most coal was formed during the Carboniferous period (286-360 million years ago). The action of pressure and heat through geological forces converted the plant material in stages from peat to lignite to bituminous soft coal to hard coal (anthracite). At each stage the percentage of carbon increases. Coal contains between 80 to 90 % carbon by mass. Coal is found in many countries. The United States, Russia, China and some European countries have large coal deposits. MYANMAR also has coal deposits in Shan State, Kachin State, Tanintharyi Region and Sagaing Region.

Coal is a black solid. It is mainly carbon, with small amounts of hydrogen, oxygen, nitrogen and sulphur. Coal is used in many countries to produce electricity. At a coal burning power station, coal is burnt in air to heat the water in a boiler. The steam produced turns the steam turbines to generate electricity (Figure 3.1). When coal is burnt, the main products are carbon dioxide and water.

$$\text{coal} + \text{air} \longrightarrow \text{carbon dioxide} + \text{water}$$

Quantities of soot, oxides of sulphur and nitrogen, and a solid residue called ash are also produced. Various kinds of pollutants are produced when coal is burnt.

Coal is also used to produce coke. When coal is strongly heated in the absence of air, a solid called **coke** is produced. Coke is almost pure carbon. It burns more cleanly than coal and it does not produce as much smoke. The main use of coke is as a reducing agent in the blast furnace for making iron. It is also used to produce zinc.

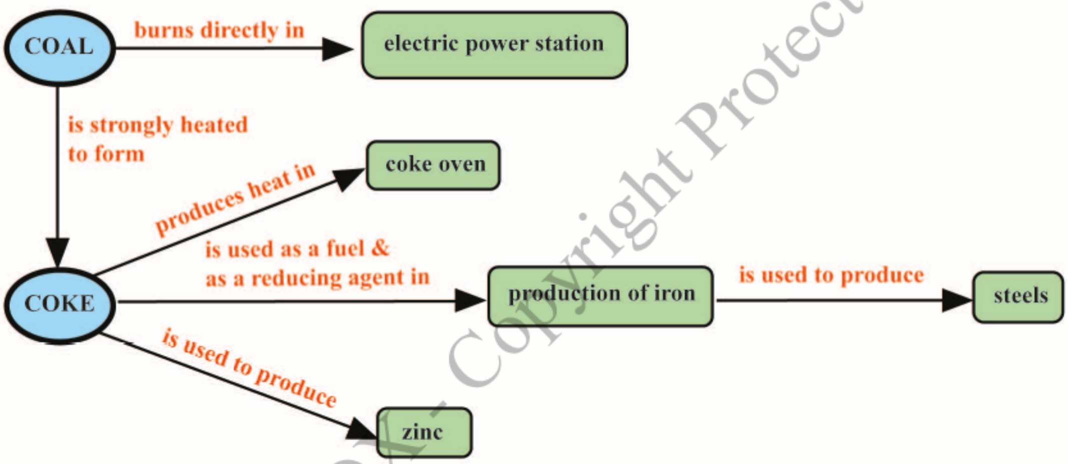


Figure 3.1 Uses of Coal and Coke

3.2 CRUDE OIL AND NATURAL GAS

The crude oil and natural gas were formed from dead animals and plants that lived in the sea a long time ago. The dead materials settled at the bottom of the sea, where it was covered with sand and other sediment. Rock then formed on top of the animal and plant remains. High pressure and temperature changed it into petroleum over millions of years. Some of it was changed into a gas - called natural gas.

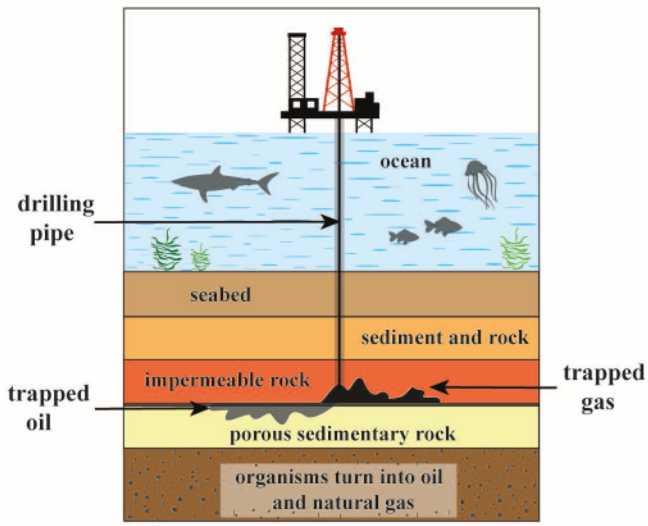


Figure 3.2 Extraction of Natural Gas and Oil from Seabed

Crude oil and **natural gas** are found together, held in between layers of non-porous rock in the ground (Figure 3.2). These fuels are extracted by a drilling pipe through the rock. These fuels are hydrocarbons. Hydrocarbons are made up of hydrogen and carbon only.

(a) Crude Oil

Crude oil (also called petroleum) is a thick black liquid. It is found together with natural gas in the Earth. Today, about 40 % of the world's energy comes from petroleum while 20 % comes from natural gas. Large amounts of petroleum are produced in the Middle East, the United States and Russia.

Myanmar is one of the world's oldest oil producers. British Burma exported its first barrel of crude oil in 1853. The London-based Burma Oil Company (BOC) was established in 1871 and began production in the Yenangyaung oil field in 1887 and the Chauk oil field in 1902.

(b) Natural Gas

Natural gas was formed at the same time as crude oil and the two are often found together, although it may occur on its own or with coal. It consists mainly of methane (85-95 %) with varying amounts of ethane, propane, butane and other gases such as carbon dioxide, nitrogen, hydrogen sulphide, etc.

3.3 FRACTIONAL DISTILLATION OF CRUDE OIL

Crude oil is a mixture of many different **hydrocarbon** molecules. These molecules have different sizes and number of carbon atoms. The small molecules have few carbon atoms and low boiling points, while the large molecules have many carbon atoms and high boiling points. Therefore, it is necessary to refine the crude oil into useful fuels and chemicals.

Separation of the crude oil takes place in a fractional distillation column, or fractionating tower into different fractions (parts) in an oil refinery.

Crude oil is heated in a furnace. Many fractions could be collected, each having a different boiling point range. The oil vaporises and passes up the fractionating column. The fractions condense and come out of the column at different heights depending on their boiling points. The petroleum gas fraction comes out first at the top of the column as its molecules have the lowest boiling points. Then, a series of fractions such as petrol, naphtha, kerosene and diesel comes out in order of increasing boiling points, number of carbon atoms and viscosity. The lubricating oil fraction comes out at the bottom because its molecules have higher boiling points, followed by fuel oil. Bitumen is the residue at the bottom of the column.

All the fractions are insoluble in water and burn in air. The properties and uses of some of the main fractions from the distillation of crude oil are given in Table 3.1.

Table 3.1 Some Important Crude Oil Fractions

Fraction	Approximate boiling point range / °C	Approximate number of carbon atoms per molecule		Important uses
refinery gas (petroleum gases)	below room temperature < 40	1 ~ 4	Increasing boiling point and viscosity ↓	bottled gas for gas cookers and motor cars
petrol (gasoline)	35 ~ 75	5 ~ 10		petrol for motor cars
naphtha	70 ~ 170	8 ~ 12		petrochemicals
paraffin (kerosene)	170 ~ 250	10 ~ 14		fuel for jet aircraft; kerosene lamps for light and kerosene stoves for cooking
diesel oil	250 ~ 340	15 ~ 25		fuel for diesel engines of buses, lorries, trucks, steamers and trains
lubricating oil	350 ~ 500	19 ~ 35		lubricant in engines to reduce friction; also for making waxes and polishes
fuel oil	500 ~ 600	30 ~ 40		fuel for ships, factories and central heating
bitumen (residue)	> 600	> 70		a black substance used to make surface roads and roofing

Note: 'Crude oil' (UK) is the same as 'petroleum' (USA); 'petrol' (UK) is the same as 'gasoline' (USA); and 'paraffin' (UK) is the same as 'kerosene' (USA).

There is a greater demand for petrol and kerosene than other fractions. Consequently, cracking method is used to produce smaller molecules from larger hydrocarbon molecules.

3.4 CRACKING

Fuels made from oil mixtures contain large hydrocarbon molecules and are not efficient. They do not flow easily and are difficult to ignite. Crude oil often contains too many large hydrocarbon molecules and not enough small hydrocarbon molecules to meet demand. Consequently, cracking is important to convert the larger hydrocarbon molecules to smaller ones.

Cracking takes place in huge reactor. In this reactor, particles of catalyst (made of powdered minerals such as silica, alumina and zeolites) are mixed with the hydrocarbon fraction at a temperature around 500 °C and moderately low pressure. The cracked vapours produced smaller molecules. All cracking reactions give two types of products:

(i) an alkane with a shorter chain than the original and

(ii) a short-chain alkene molecule.

Both these products are useful. The shortened alkanes can be blended with the gasoline fraction to enrich the petrol. The alkenes are useful as raw materials for making several important products. Figure 3.3 shows the various uses for the ethene produced; preparation of ethanol and plastics such as polyethene, polychloroethene and polystyrene. Here in, ethene polymerises to polyethene, i.e., many ethene molecules combine to form larger molecule polyethene that contains repeating structural units. Propene polymerises to polypropene (trade name 'polypropylene'), while butene polymerises to produce synthetic rubber.

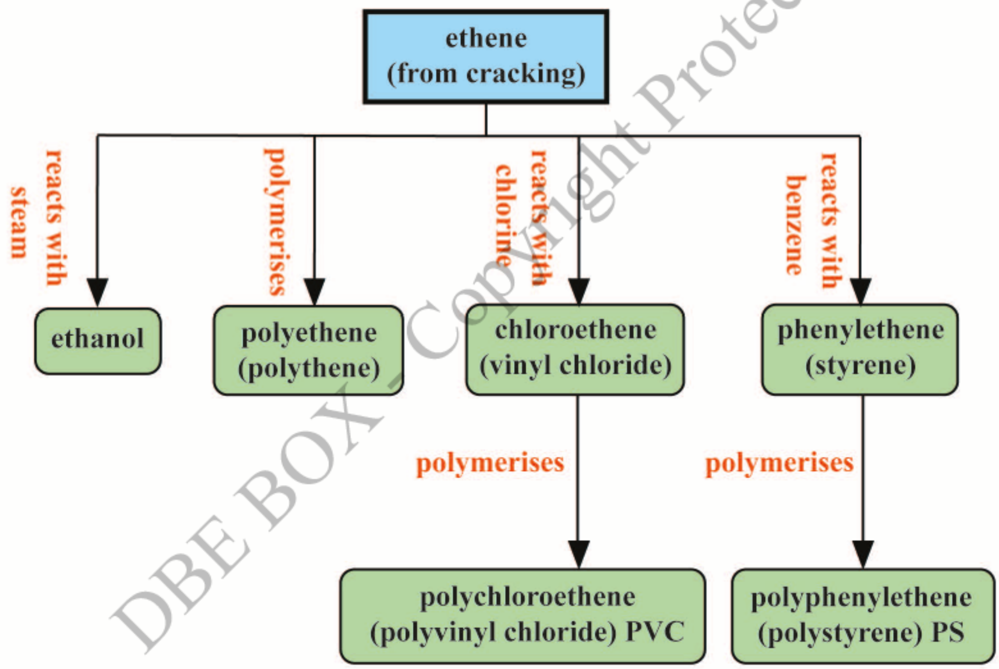


Figure 3.3 Important Products from Ethene

3.5 OTHER KINDS OF FUELS

Fossil fuels take millions of years to form. There are limited amounts in the Earth. At the present rate of consumption, petroleum and natural gas may run out within 50 years and coal will only last for a further 250 years. Therefore, scientists have tried to overcome the problem of limited crude oil supply by looking for alternative fuels to replace crude oil.

An **alternative fuel** is an internal combustion engine fuel other than gasoline or diesel oil. Alternative fuels include natural gas (methane, compressed natural gas - CNG), propane (liquefied petroleum gas - LPG), hydrogen fuel, biomass-derived fuels, biodiesel, bio-alcohols (including ethanol and methanol), alcohol mixtures with gasoline or other fuels (gasohol) and electricity

Hydrogen fuel, biomass-derived fuels, biodiesel, bio-alcohols (including ethanol and methanol) are renewable fuels, and also known as alternative transport fuels.

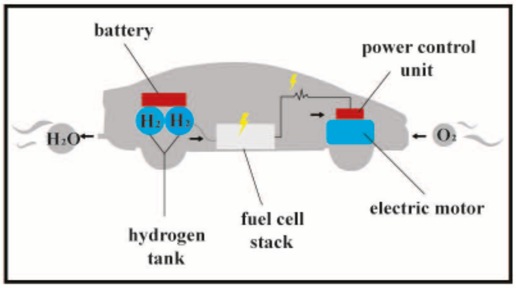
Some alternative fuels and their uses are described in Table 3.2.

Table 3.2 Some Alternative Fuels and Their Uses

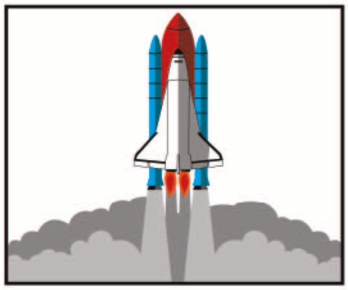
Fuels	Source	Composition	Uses
LPG (Liquefied Petroleum Gas)	petroleum gas	propane and butane	used as fuels in vehicles, cars, trucks and stationary power generation, for cooking and other heating systems
CNG (Compressed Natural Gas)	natural gas	90 % methane	used as fuels in vehicles, cars, trucks and stationary power generation
biodiesel	plant oils, animal oils	long chain esters	used in power tractor engines, petro-diesel engines and electricity generation engines
biogas	waste organic matter	methane	used for heating and cooking, and the solid residue is used as a fertiliser
hydrogen fuel	water, petrol and natural gas	hydrogen	used as fuels for cars, in space shuttles and other big rockets
gasohol	petrol and ethanol	90 % petrol + 10 % ethanol, 15 % petrol + 85 % ethanol (US)	used as fuels in vehicles

(a) Hydrogen Fuel

Most hydrogen is manufactured on a **large scale** in industry from petrol and natural gas. Hydrogen burns cleanly in air. The product is steam, which is a non-pollutant. However, hydrocarbon fuels, such as petrol and diesel, produce polluting oxides of carbon in combustion.



Hydrogen fuel cell car



Hydrogen fuel cell in space shuttle

Hydrogen produces at least twice as much heat energy per gram when burnt, than any other common fuel. This is why it is used as a fuel in space shuttles and other big rockets. Hydrogen has great possibilities as a fuel for cars, replacing petrol. Experimental hydrogen- powered cars are already being used.

(b) Biogas (Methane or Marsh gas)

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source.

Methane is produced from organic waste (biomass) when it decays in the absence of air. This can be exploited as a source of energy. In India and China, biomass digesters are important sources of fuel for villages. Industrialised countries produce large amounts of waste, which is deposited in landfill sites. Biogas forms as the rubbish decays.

Methane gas is formed naturally under a number of different circumstances. Anaerobic bacteria help decomposition of organic matter under geological conditions to produce natural gas. Methane accumulates in coal-mines, where it can cause explosions. Marsh gas, which bubbles up through the stagnant water of marshes, swamps and paddy fields, is also methane. Methane produced in this way contributes to the **'greenhouse effect'**.

What is greenhouse effect?

The gases occurred naturally in the atmosphere that trap heat are called **greenhouse gases** (GHGs) such as water vapour, carbon dioxide, methane, nitrous oxide and ozone. Besides, man-made chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), as well as sulphur hexafluoride (SF_6) are also GHGs.

Human activities, such as burning fossil fuels and farm-lands, and excessive use of fertilisers increase the amount of greenhouse gases. This greenhouse effect is gradually increasing the Earth's surface temperature, resulting in more extreme weather, such as flooding, drought, cyclone, forest fire, landslide, heat wave, etc. Another growing concern is the melting of glaciers and Artic ice which will increase sea levels resulting in many coastal communities being flooded and no longer habitable. The average temperature of the Earth increases leading to **global warming** (Figure 3.4).

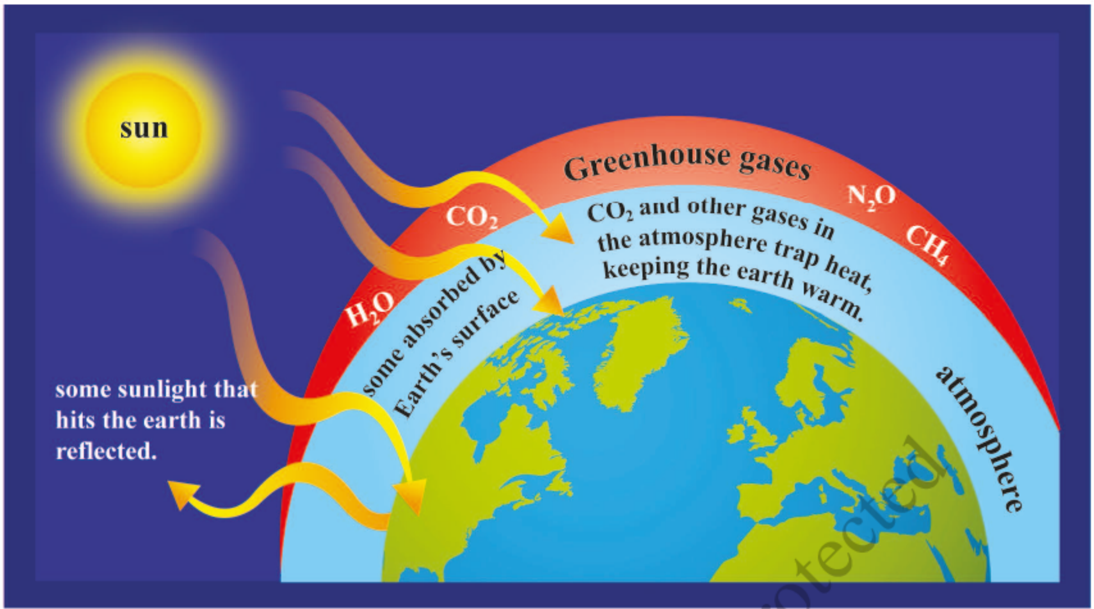


Figure 3.4 Global Warming and the Greenhouse Effect

Chemistry in Society

- The fuels that are derived from petroleum support more than half of the world's total energy production.
- The order for the main energy sources currently used in the world in terms of producing energy is:
  crude oil > coal > natural gas > hydroelectric > nuclear fission > wind > biofuels > solar > geothermal.
- Crude oil, coal and natural gas are non-renewable fossil fuels and contain stored energy from photosynthesis trapped millions of years ago.
- Plant oil, hydroelectric, wind, biofuels, solar and geothermal are all renewable energy sources.
- Fuel oil and natural gas are used to generate electricity. Petroleum products are used for the manufacture of synthetic fibers for clothing and in plastics, paints, chemicals, fertilisers, insecticides, soaps and synthetic rubber.
- Natural gas offshore projects in Myanmar are Yadana project, Yetagon project, Shwe Platform project and Zawtika project.



Natural gas offshore projects in Myanmar

Review Questions

Sections 3.1 and 3.2

(1) Why is petroleum called a fossil fuel?
(2) Describe the uses of coal.
(3) What gases are present in natural gas?

Section 3.3

(1) Name a crude oil fraction that: (a) is used for jet aircraft (b) has the smallest molecules (c) is the most viscous (d) has molecules with 19 ~ 35 carbon atoms.

(2) Consider the following petroleum fractions:
naphtha, paraffin, bitumen, diesel oil, lubricating oil
Which of the above fractions:
(a) has the lowest boiling point;
(b) has the highest boiling point;
(c) is used to make waxes;
(d) is used as a fuel for jet engines;
(e) contains $C_{15} \sim C_{25}$ carbon atoms per molecule?

(3) There is a limited quantity of petroleum on Earth. Describe two ways of conserving petroleum.

Section 3.4

(1) Describe the usual conditions needed for cracking a hydrocarbon in the petroleum refinery.
(2) What are always produced in a cracking reaction?

Section 3.5

(1) Name each alternative fuel that: (a) is used for cooking and heating systems (b) has the composition of long chain ester (c) is the source of waste organic matter (d) has molecules with 15 ~ 20 carbon atoms.
(2) What are the differences between diesel and gasohol?

Key Terms

- **Fossil fuels** consist of coal, petroleum and natural gas. **Natural gas** consists mainly of methane, CH_4. **Crude oil** (petroleum) is a mixture of many different hydrocarbon molecules.
- **Non-renewable fuels** are fuels which take millions of years to form and which are used up at a rapid rate.
- **Renewable fuels** are fuels produced from renewable resources. (e.g., vegetable oils, animal oils, etc.)
- **Biodiesel** refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters.
- **Biogas** is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen.

- **CNG** stands for Compressed Natural Gas (90 % methane).
- **LPG** stands for Liquefied Petroleum Gas which is composed of propane and butane.
- **Organic matter** is a substance that is made up of undecomposed and partially decomposed residue of plant and animal tissues of living and dead microorganisms.

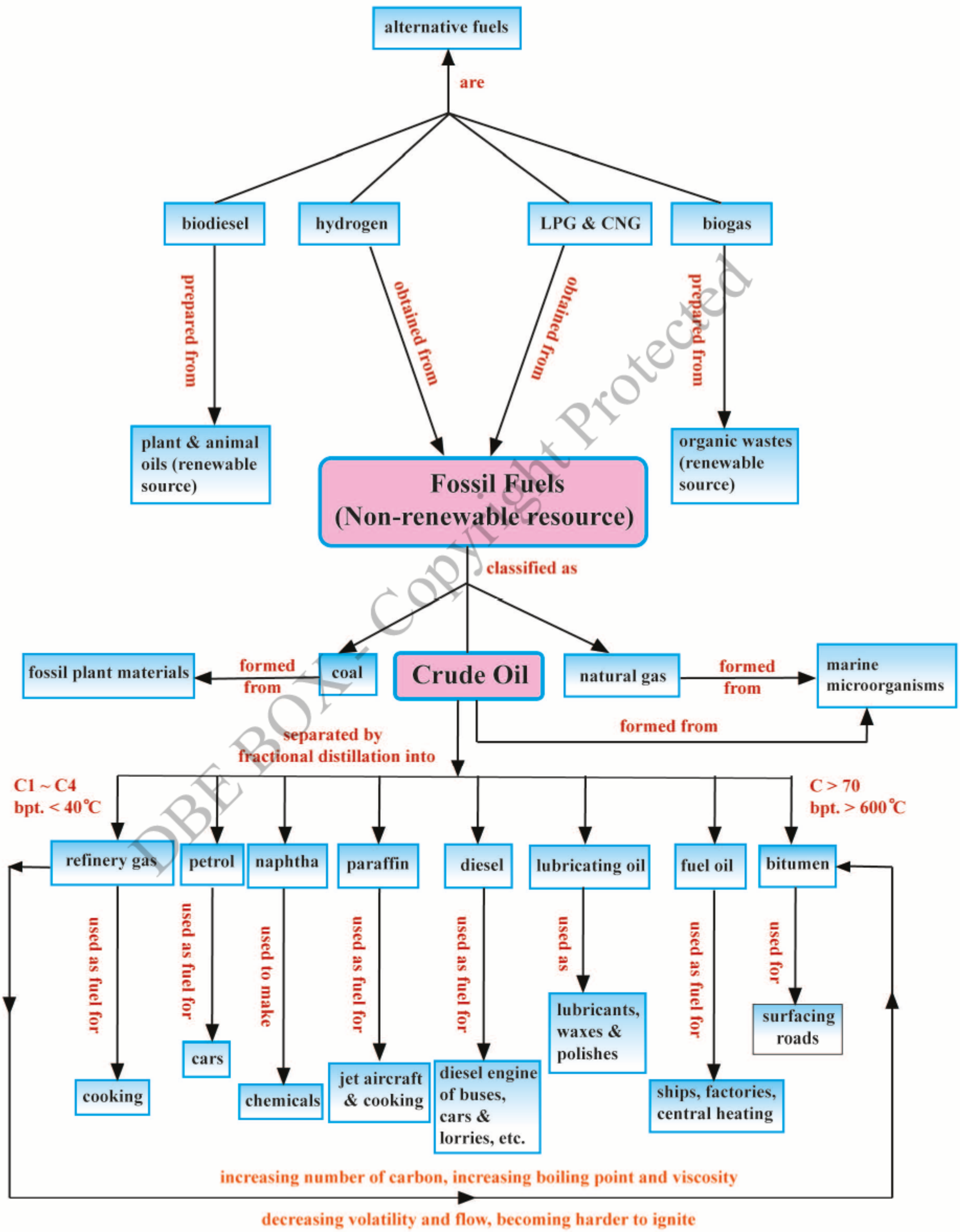
EXERCISES

1. Write TRUE or FALSE for each of the following statements. If FALSE, correct it.
   (a) Nowadays, all fossil fuels are not used up rapidly.
   (b) There is a gradual change in the physical properties of the petroleum fractions.
   (c) Hydrogen is a good fuel because it is non-polluting when it burns.
   (d) At present, there is no alternative fuel to fossil fuels.
   (e) Polychloroethene is also known as PVC.
2. Match each of the items given in List A with the appropriate correct item shown in List B.

List A	List B
(a) coke	(i) produced from plant oil
(b) methane	(ii) formed from waste organic matter
(c) biodiesel	(iii) blended fuel from petrol and ethanol
(d) biogas	(iv) a reducing agent
(e) gasohol	(v) main constituent of natural gas

3. (a) Name the method used to separate petroleum in oil refineries. What physical property of liquids mainly depends on this separation method?
   (b) State the uses of the following components of crude oil:
   (i) Gasoline (ii) Naphtha (iii) Paraffin (iv) Bitumen.
4. Suggest the name of a petroleum fraction that would be suitable for each of the following purposes:
   (a) seal cracks in the concrete tanks
   (b) boil a beaker of water in the laboratory
   (c) protect a wooden furniture
   (d) oil the sewing machine to reduce friction.
5. How do you produce coke from coal? Describe their uses.

CHAPTER REVIEW
(Concept Map)



GLOSSARY

Acid a compound that dissolves in water to produce hydrogen ions, H^+
Alkali a base which is soluble in water producing OH^- ions

Base a chemical compound that combines with an acid to form a salt and water
Biodiesel a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters
Biogas the mixture of gases produced by the breakdown of organic matter in the absence of oxygen

Centrifugation a technique used for the separation of particles from a solution according to their size, shape, density, viscosity of the medium and rotor speed
Chemical change a change in which one or more new substances are formed
Chromatography a separation method of mixed substances that depends on the speed at which they move through special media, or chemical substances
CNG Compressed Natural Gas (90 % methane)
Compound a substance containing two or more different elements chemically joined together in a fixed ratio
Crude oil a mixture of many different hydrocarbon molecules
Crystallisation a process by which a chemical is converted from a liquid solution into a solid crystalline state

Decantation a process to separate mixtures of solid and liquid or two immiscible liquid to settle and separate by gravity

Element a substance that cannot be broken down into other simpler substances through chemical means

Filtration a method for separating an insoluble solid from a liquid
Fossil fuel a fuel consisting of coal, petroleum and natural gas
Fractional distillation a method for separation of a liquid mixture into fractions with different boiling points (and hence chemical composition) by means of distillation, typically using a fractionating column

Heterogeneous mixture one that is non-uniform, and where the different components of the mixture can be seen (The components separate, and the composition varies.)
Homogeneous mixture one in which the composition of its components are uniformly mixed throughout (The components cannot be seen separately on visual or microscopic examination.)

Indicator a substance that has different colours in acidic and alkaline solutions

LPG Liquefied Petroleum Gas which is composed of propane and butane

Matter a substance made up of tiny particles, and has mass and takes up space. Three common states of matter are solid, liquid and gas

Mixture a combination of more than one substance, where these substances are not bonded to each other (It consists of two or more substances which may be present in any proportion by weight. The constituents of the mixture do not combine chemically.)

Molecule the simplest unit of a chemical substance, usually a group of two or more atoms

Neutralisation the reaction between an acid and a base to form a salt and water only

Non-renewable fuels are fuels which take millions of years to form and which are used up at a rapid rate

Organic matter a substance that is made up of undecomposed and partially decomposed residue of plant and animal tissues of living and dead microorganisms

pH a measure of the acidity or alkalinity of a solution

Physical change a change in which no new substances are formed (There may be a temporary change in colour, temperature and state of the substances but no new substances are formed.)

Renewable fuels fuels produced from renewable resources

Salt a substance produced from the reaction between an acid and a base or a metal

Simple distillation a procedure by which two liquids with different boiling points can be separated

Solute a substance which dissolves in a solvent to give a solution

Solution a clear homogeneous mixture obtained when a substance dissolves in a solvent (In a solution the solute is uniformly distributed throughout the solution.)

Solvent a substance, mostly liquid, in which another substance dissolves to give a homogeneous mixture

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