Teacher's Guide for Grade 10 Chemistry Textbook

I. How to use this Teacher's Guide

This Grade 10 Chemistry Teacher's Guide is designed to make the features of the Grade 10 Chemistry Textbook more useful to you as you teach the course, to give you information that aids in adapting the course to your teaching style, and to provide you with an additional information and resources you may want to use in your presentations, discussions, or other classroom teaching.

1. Important Features of This Teacher's Guide

There are eight chapters in this Teacher's Guide. Each chapter contains several activities. They have the following format: Learning Outcomes, Skill Development and Support Materials for the activities are described at the beginning of each chapter.

Each section in every chapter is divided into four stages: the Introduction stage (*Lesson Objectives* and *Introduction*), the Teach stage (*Teaching* and *More information for teacher*), the Practise stage (*Suggestion for Practising and Evaluation,* and *Reflection on Learning*) and the Review stage (Key for Review Questions and Exercises). Answers to questions can be found under the activity numbers in the section-by-section portion. Sample data is provided where appropriate. Keep in mind that values listed as sample data are only examples of possible answers. At the end of chapter, teachers can recheck their lessons with the SUMMARY and Chapter Review.

Lesson Objectives

The Grade 10 Chemistry Teacher's Guide directs the teachers to use the outcomes approach in their classrooms. This guide also gives teachers to decide easily what the most appropriate way of achieving the lesson objectives is. Lesson objectives provide a clear focus on what students should learn.

Introduction

This portion introduces the teachers to link the prior knowledge of the students and a new concept, and also helps the students to think more critically and analytically.

Teaching

Being a teacher, the ideas, teaching strategies and activities must be accompanied by clear directions and wide knowledge on subject to achieve learning outcomes.

More information for teacher

Extending knowledge other than text will enhance teacher's creativity and help to

develop high level teaching programme. Therefore, more information is provided in each section. The teachers should learn further information from other resources such as library and electronic resources.

Suggestion for Practising and Evaluation

This teacher's guide gives some suggested learning and teaching activities which might be used to ensure active learning in each section. Emphasise the topics you want to teach, teach every lesson with confidence, and reach students of every ability level. The teachers should prepare resources of relevant activities depending on the class size. If the teachers ascertain the objective of the activity, the teachers can make clear instructions and fair assessment to the students. The teachers ask the students self-management of their activities in the classroom.

Before beginning any experimental work, call attention to CAUTION statements included in the procedure, and review appropriate lab safety and equipment use guidelines.

The contents provided from the Grade 10 Chemistry Textbook 'Chapter 1 (Chemistry: The Central Science)' and 'Chemistry in Society / Chemistry in Daily Life' in each chapter can enhance the awareness of the importance of chemistry in the society. Teachers should encourage the students to learn extending knowledge from library and electronic resources as well as to learn by repetition the terms and definitions from the Textbook.

Reflection on Learning

The teachers should reflect the students' achievements for learning objectives in each work. The activities, results and discussion of the students should be evaluated among themselves. Teachers can moderate the students' performance in the classroom.

2. Overview of Student-centred Pedagogy

Student-centered secondary school classroom will be activated by using different strategies which include group work, practical work, quiz, assignments, etc. Teachers should not only explain the main idea of content in the Textbook but also support the knowledge of Chemistry in daily life. Thus the lessons become more interesting, relevant and meaningful to students' lives. Students participate actively and in collaboration with their peers while they are practising the activity, assignment work and laboratory. Teachers make the students to prepare the resources for learning by themselves as much as possible since the students can face the challenges and acquire the best formula for success.

3. Overview of 21st Century Skills and Soft Skills

Young people need 21st century skills and soft skills in the work place and to navigate our daily life. The 5 C's- important skills for learning are:

- Collaboration
- Communication
- Critical Thinking and Problem Solving
- Creativity and Innovation
- Citizenship

For collaboration and communication skills, teachers encourage students to work in groups, share ideas, and find solutions together while they are doing experiments and activities. Teachers make students find solutions to problems from review questions and exercises by themselves. Students create new ideas to solve the problems especially open questions and finally make evaluation themselves to develop the skills: critical thinking and problem solving skills, creativity and innovation skills. To become good citizens, teachers ask students to prepare resources, learn actively in classroom, do activities and laboratory work together and peer evaluation. Desired positive attitudes and values of the lessons in the classroom will be developed.

4. Overview of Classroom Level Assessment

Classroom level assessment intends to inform the teachers about a student's learning progress, so the teacher can help the student's improvement. Teachers will need to determine how best the students can learn so the teachers will be able to adjust their teaching to improve the quality of learning. Development of Soft Skills is an ideal place to begin to develop the teachers' formative assessment capability and techniques.

Strategies for conducting classroom level formative assessments include the following:

- Observation: Observe the students directly and record observations, including behaviour in group work in preparation for practical or activities. Also observe one or more of the 5Cs.
- Questioning: Ask the questions to the students to determine the level of understanding (Bloom's taxonomy) and adjust their teaching approach according to the result. This may happen at any time in the lesson as well as in the Review for the final stage of section.

Questions that could be asked at different stages of a lesson are given below:

✔ At the beginning of a section

- How will the students be stimulated the prior knowledge and connect the real world experiences?
- How will the students be organised for the planned activities?
- What information do the teachers need? What information do the students need?

- What equipment or materials do you need? What equipment or materials do the students need?
- How will the materials be available, organised, and used?
- What do you think the result will be?

✔ At the end of each section
- Ask yourself "is the lesson / activity going as expected"?
- Ask yourself "is there any other information might be needed to help students understand the lesson"?
- Ask yourself "can it be done in different ways?

✔ At the end of the chapter
- Did your work meet the expected outcomes?
- What have the students learned in this chapter?
- Has the work helped you to assess individual student's conceptual understanding?

5. Social Dimensions in Basic Education High School Classroom

Social dimension meaning extends beyond classroom boundaries. To diminish social inequality in the outside world, teachers should provide equal opportunities for all students inside school walls. Social dimension of contents in Textbook and Teacher's Guide goes far beyond interpersonal relationships and developing the soft skills which will support all students including disabilities, lower socioeconomic status, and minority groups. Education advocates consensus in social thought and cooperation. Education encourages people to examine the places where a society may need improvement. Those attitudes and values will inspire students to become good citizens. Also teachers should be aware of and avoid some social biases in the classroom. Education supports the social system; its citizens' collective ideals and goals. Learning outcomes are statements that clearly define what students are expected to know, understand and be able to do in terms of knowledge in alignment with global sustainable development goals and National Education Strategic Plan.

II. Syllabus and Year Plan

1. Syllabus

The syllabus for Grade 10 Chemistry includes four content components, five soft skills and learning objectives.

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
Chapter 1 Chemistry: The Central Science *Collaboration Communication Analysis and Reasoning Citizenship*	• To know various branches of chemistry and how society is impacted by them • To understand the role and impact of chemistry in daily life	• Chemistry as Central Science	• Describe the role of chemistry in some science topics • Distinguish the chemicals used in food, medicine, agriculture and cleansing agent	• Experiment 1: Laboratory Safety Rules and Writing Report	• Summary • Key for Exercises • Chapter Review
	• To achieve the knowledge of the history of chemistry	• Milestones in the History of Chemistry	• Match the famous chemists with the main period of chemistry • Get the knowledge of Myanmar alchemy		
	• To verify the importance of chemistry in daily life	• Importance of Chemistry	• Explore the name of chemicals involved in classroom, school bag and your body • Recognise the uses of household items and their chemical ingredients		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To investigate the branches of chemistry	• Branches of Chemistry	• Describe the main branches of chemistry and their application areas • Describe the five main branches with available examples described in Grade 10 Chemistry Textbook		
	• To justify why we have to study chemistry	• Understanding Chemistry	• Describe the importance of studying chemistry • Recognise the chemical reactions in real world		
	• To develop and practise higher order thinking skills such as reasoning, analysis, synthesis and evaluation	• The Principal Goals in Basic Education High School Chemistry	• Describe the basic process skills obtained by studying chemistry • Describe the main themes in high school chemistry course		
Chapter 2 Matter and Solutions *Collaboration Communication Critical Thinking*	• To differentiate between the states of matter based on the arrangement of atoms and molecules	• States of Matter and Arrangement of Particles in Matter	• Describe the characteristics of matter based on their physical states • Examine the diffusion of solid, liquid and gas	**Experiment 2:** Separation techniques (a) Separation of a Mixture of Common Salt and Sand (b) Separation of the Different Colouring Matters from Ink	• Key for Review Questions • Summary • Key for Exercises • Chapter Review

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To analyse the changes of states based on the movement of atoms and level of energy	• Changes in Matter	• Investigate the changes of matter by precipitation and dissolution process • Determine physical change and chemical change	**Experiment 3:** Determination of the Solubility of Common Salt in Water at Room Temperature	
	• To examine the characteristics of elements, compounds and mixture • To investigate separation techniques as applied to mixture	• Elements, Compounds and Mixtures	• Understand and distinguish among elements, compounds and mixtures • Verify the mixture using suitable separation techniques		
	• To compare the behaviours of solute, solvent and solution • To investigate the solubility of substances and the effect of temperature on it	• Solutions and Solubility	• Classify the unsaturated, saturated and supersaturated solutions of household common items • Predict the solubility of solids with increasing temperature		
Chapter 3 The Electronic Structures of Atoms and Periodic Table *Collaboration Communication Creativity and Critical Thinking*	• To understand the structure of atom • To identify isotopes and isobars based on sub-atomic particles	• Structure of Atom	• Write the symbol notation of unknown elements		• Key for Review Questions • Summary • Key for Exercises • Chapter Review

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
			• Identify the isotopes and isobars based on the number of the fundamental particles		
	• To explain the electronic structure of atoms	• Electronic Structures (Electron Configurations)	• Understand how to arrange the electrons in appropriate sub-shell • Determine the valence electrons of different elements using the Periodic Table		
	• To explain how the Periodic Table is organised based on atomic structure • To classify elements based on electron configurations	• The Periodic Table	• Determine the position of unknown elements in the Periodic Table • Categorise the given elements as metal, non-metal or metalloid		
	• To describe the periodic properties of common elements	• Periodic Properties	• Determine the periodic trends in electronegativity and atomic radii • Determine the periodic trends in ionisation energy and electron affinity		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To understand the different types of bonds that form between atoms when molecules are formed	• Bonds between Atoms	• Draw electron dot diagrams using valence electrons of each atom • Distinguish between ionic and covalent compounds based on their physical properties		
Chapter 4 The Quantities of Substances: Chemical Calculations *Collaboration Communication Critical Thinking and Problem Solving*	• To determine relative atomic mass of elements • To determine relative molecular mass and relative formula mass of substances	• Relative Masses of Atoms and Molecules	• Distinguish between the formula mass and molecular mass of compounds • Classify the ionic and molecular compounds	**Experiment 4:** Determination of the Empirical Formula of Magnesium Oxide	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To understand the symbols of the elements and formulae (empirical and molecular formulae) of the compounds	• Chemical Symbols, Formulae, Writing and Naming Formulae	• Understand the naming system of compounds with fixed or variable oxidation numbers of first element • Describe the names and chemical formulae of compounds		
	• To write word and symbolic equations based on information provided	• Chemical Equations	• Write the correct formulae of the substances in a chemical equation (not necessary to balance the equation)		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To understand how to write and interpret chemical equations with physical states		• Balance the above chemical equations by the Law of Conservation of Mass		
	• To understand the calculations involving the molar mass, number of moles and the mass of a substance • To determine the mole ratio of the reactants and products by using balanced chemical equations	• The Mole Concept	• Describe Avogadro's constant as "HUGE NUMBER" [6.02×10^{23}] • Prove the molar mass of carbon-12 as 12		
Chapter 5 Non-Metals: Oxygen, Carbon and Halogens *Collaboration Communication Critical Thinking*	• To describe the properties and behaviours of oxygen and oxides • To classify the main types of oxides based on their properties	• Oxygen	• Achieve knowledge about alternative methods for the preparation of oxygen • Classify the types of oxides and their uses	**Experiment 5:** Preparation of Calcium Oxide (Quicklime) and Study on Some of Its Chemical Properties **Experiment 6:** Preparation of Carbon Dioxide Gas from Calcium Carbonate and Study on Some of Its Physical Properties (a)Preparation of Carbon Dioxide Gas from Calcium Carbonate	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To explain the properties and behaviours of carbon and its allotropes	• Carbon	• Describe the allotropes of carbon in student's environment		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
			• Examine the application of soft graphite as a conductor or lubricant	(b)Study on the Physical Properties of Carbon Dioxide **Experiment 7:** Tests for Carbonate, Chloride, Bromide and Iodide Anions	
	• To investigate the properties and behaviours of halogens and halides	• Halogens	• Organise the physical and chemical properties of halogens • Describe the uses of halides in daily life		
Chapter 6 Acids, Bases and Salts *Collaboration Communication Critical Thinking and Problem Solving*	• To realise the properties of acid used in daily life • To understand the different types of acids	• Acids and Their Properties	• Determine whether the solution used in daily life is acidic or not • Describe the formulae and uses of acids	**Experiment 8:** Neutralisation of Acids and Bases and Preparation of Salt (a)Neutralisation of Acids and Bases (b)Preparation of Copper(II) Sulphate Crystals	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To understand the properties and uses of bases and alkalis in daily life • To distinguish between bases and alkalis	• Bases, Alkalis and Their Properties	• Decide whether the substances collected from the home are bases or not • Explain the common sources and uses of base in the kitchen (e.g., ash)		
	• To investigate the role of indicators and the pH scale used in chemistry	• Indicators and the pH Scale	• Measure the pH of various substances by using pH paper • Understand the role of indicator in acid or base solutions		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To assess the acid-base reaction (neutralisation) • To identify the different types of salts and their uses	• Salts	• Predict the salts formed from the neutralisation of various acids and bases • Recognise the application of salts in daily life		
Chapter 7 Air, Water and Soil *Collaboration Communication Analysis and Reasoning*	• To describe the composition of air, and the various forms of air pollutants and the sources of these pollutants • To assess the role of various pollutants on global warming and greenhouse effect	• Air	• Estimate the composition of air in the surrounding • Describe the air pollutants and classify their sources (indoor or outdoor)	**Experiment 9:** Differentiation between Temporary and Permanent Hardness of Water **Experiment 10:** Examination of Alkalinity and Acidity of Soil (a) To examine the soil alkalinity and acidity (b) To determine the presence or absence of lime in the soil	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To describe the Earth's surface water, both salt and fresh, including the composition, hardness and various forms of water pollution • To purify the water by simple distillation, ion exchange, and the Permutit method	• Water	• Determine the hardness of water • Explore the cause and effect, and removal methods of water hardness		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To describe the various types of soil found on the surface of the Earth, including the composition and the various forms of waste and pollutants found in the soil • To understand the information about layers, textures, composition and pH of soil	• Soil	• Observe the water absorption capacity of different types of soil • Explore the functions of nutrients for plants and humans		
Chapter 8 Fuels and Crude Oil *Collaboration Communication Critical Thinking and Problem Solving Creativity and Innovation*	• To understand the formation and extraction, usefulness, composition and properties of fossil fuels	• Fossil Fuels	• Classify the types of fuel as renewable or non-renewable based on the sources and time duration of their formation • Describe how required energy can be obtained from safe and renewable resources	**Experiment 11:** Examination of Relationship between Number of Carbon atoms in Petroleum Products and Their Flow Time	• Key for Review Questions • Summary • Key for Exercises • Chapter Review

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To understand the separation of crude oil based on different boiling points of these constituents (fractions)	• Fractional Distillation of Crude Oil	• Motivate the learning skill on petroleum products and refinery process • Give knowledge on the fractional distillation products and some of their uses in society		
	• To understand the cracking of refined crude oil	• Catalytic Cracking	• Understand the classes of gasoline • Recognise the usefulness of cracking product "ethene"		
	• To understand the importance of exploration for alternative fuels for future use	• Alternative Fuels	• Describe the sources of biogas and biodiesel • Verify safe and long-last energy resources (nuclear power and solar power)		

2. Year Plan

The year plan for Grade 10 Chemistry Textbook includes 33 sections for 8 chapters, allocation of periods for each section, 11 experiments and revision and examination periods.

Schedule week	Chapter	Section	Period	Total period for each chapter
1	Chapter 1 Chemistry: The Central Science	1.1 Chemistry as Central Science	2	12
		1.2 Milestones in the History of Chemistry	2	
		1.3 Importance of Chemistry	2	
2		1.4 Branches of Chemistry	1	
		1.5 Understanding Chemistry	2	
		1.6 The Principal Goals in Basic Education High School Chemistry	1	
3		Review Exercises	1	
		Experimental Work (Experiment 1)	1	
4	Chapter 2 Matter and Solutions	2.1 States of Matter and Arrangement of Particles in Matter	2	18
		2.2 Changes in Matter	3	
		2.3 Elements, Compounds and Mixtures	3	
5		2.4 Solutions and Solubility	2	
		Review Exercises	2	
6		Experimental Work (Experiments 2 and 3)	6	

Schedule week	Chapter	Section	Period	Total period for each chapter
7	Chapter 3 The Electronic Structures of Atoms and Periodic Table	3.1 Structure of Atom	2	15
		3.2 Electronic Structures (Electron Configurations)	3	
8		3.3 The Periodic Table	2	
		3.4 Periodic Properties	3	
9		3.5 Bonds between Atoms	3	
		Review Exercises	2	
10	Chapter 4 The Quantities of Substances: Chemical Calculations	4.1 Relative Masses of Atoms and Molecules	3	22
11		4.2 Chemical Symbols, Formulae, Writing and Naming Formulae	5	
12		4.3 Chemical Equations	4	
13		4.4 The Mole Concept	5	
		Review Exercises	3	
14	Revised Chapterwise			
15	Examination			
16		Experimental Work (Experiment 4)	2	
17	Chapter 5 Non-metals: Oxygen, Carbon and Halogens	5.1 Oxygen	4	25
		5.2 Carbon	4	

Schedule week	Chapter	Section	Period	Total period for each chapter
18		Experimental Work (Experiment 5)	2	
		5.3 Halogens	6	
19				
		Review Exercises	3	
20		Experimental Work (Experiment 6)	4	
		Experimental Work (Experiment 7)	2	
21	Chapter 6 Acids, Bases and Salts	6.1 Acids and Their Properties	3	
22	Revised Chapterwise			
23	Examination			
24		6.2 Bases, Alkalis and Their Properties	3	19
		6.3 Indicators and the pH Scale	3	
25		6.4 Salts	3	
		Review Exercises	3	
26		Experimental Work (Experiment 8)	4	
27	Chapter 7 Air, Water and Soil	7.1 Air	5	20
28		7.2 Water	4	

Schedule week	Chapter	Section	Period	Total period for each chapter
29		7.3 Soil	4	
		Review Exercises	3	
30		Experimental Work (Experiment 9)	2	
		Experimental Work (Experiment 10)	2	
31	Chapter 8 Fuels and Crude Oil	8.1 Fossil Fuels	3	19
		8.2 Fractional Distillation of Crude Oil	4	
32		8.3 Catalytic Cracking	4	
33		8.4 Alternative Fuels	3	
		Review Exercises	3	
34		Experimental Work (Experiment 11)	2	
35	Revised Chapterwise			
36	Examination			

Note worthy:

Chemistry being an experimental science, all activities and experiments should be either done with demonstrations or by means of the projection of improvised video clips.

Please remember that the TG is provided as an aid in planning the best course for your students. TG is designed for maximum flexibility. Refer to the chapter planning guides for a correlation of Text program components with each numbered text section. You should use this in relation to the interests and ability levels of the classes you teach, the materials available for activities, and the time available for teaching. You may decide to extend the scope and time devoted to certain topics through the use of enrichment activities and supplementary materials presented in this book.

II. Syllabus and Year Plan

1. Syllabus

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	• To achieve the knowledge of the history of chemistry	• Milestones in the History of Chemistry	• Match the famous chemists with the main period of chemistry • Get the knowledge of Myanmar alchemy		
	• To verify the importance of chemistry in daily life	• Importance of Chemistry	• Explore the name of chemicals involved in classroom, school bag and your body • Recognise the uses of household items and their chemical ingredients		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To investigate the branches of chemistry	• Branches of Chemistry	• Describe the main branches of chemistry and their application areas • Describe the five main branches with available examples described in Grade 10 Chemistry Textbook		
	• To justify why we have to study chemistry	• Understanding Chemistry	• Describe the importance of studying chemistry • Recognise the chemical reactions in real world		
	• To develop and practise higher order thinking skills such as reasoning, analysis, synthesis and evaluation	• The Principal Goals in Basic Education High School Chemistry	• Describe the basic process skills obtained by studying chemistry • Describe the main themes in high school chemistry course		
Chapter 2 Matter and Solutions *Collaboration Communication Critical Thinking*	• To differentiate between the states of matter based on the arrangement of atoms and molecules	• States of Matter and Arrangement of Particles in Matter	• Describe the characteristics of matter based on their physical states • Examine the diffusion of solid, liquid and gas	**Experiment 2:** Separation techniques (a) Separation of a Mixture of Common Salt and Sand (b) Separation of the Different Colouring Matters from Ink	• Key for Review Questions • Summary • Key for Exercises • Chapter Review

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	• To analyse the changes of states based on the movement of atoms and level of energy	• Changes in Matter	• Investigate the changes of matter by precipitation and dissolution process • Determine physical change and chemical change	**Experiment 3:** Determination of the Solubility of Common Salt in Water at Room Temperature	
	• To examine the characteristics of elements, compounds and mixture • To investigate separation techniques as applied to mixture	• Elements, Compounds and Mixtures	• Understand and distinguish among elements, compounds and mixtures • Verify the mixture using suitable separation techniques		
	• To compare the behaviours of solute, solvent and solution • To investigate the solubility of substances and the effect of temperature on it	• Solutions and Solubility	• Classify the unsaturated, saturated and supersaturated solutions of household common items • Predict the solubility of solids with increasing temperature		
Chapter 3 The Electronic Structures of Atoms and Periodic Table *Collaboration Communication Creativity and Critical Thinking*	• To understand the structure of atom • To identify isotopes and isobars based on sub-atomic particles	• Structure of Atom	• Write the symbol notation of unknown elements		• Key for Review Questions • Summary • Key for Exercises • Chapter Review

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
			• Identify the isotopes and isobars based on the number of the fundamental particles		
	• To explain the electronic structure of atoms	• Electronic Structures (Electron Configurations)	• Understand how to arrange the electrons in appropriate sub-shell • Determine the valence electrons of different elements using the Periodic Table		
	• To explain how the Periodic Table is organised based on atomic structure • To classify elements based on electron configurations	• The Periodic Table	• Determine the position of unknown elements in the Periodic Table • Categorise the given elements as metal, non-metal or metalloid		
	• To describe the periodic properties of common elements	• Periodic Properties	• Determine the periodic trends in electronegativity and atomic radii • Determine the periodic trends in ionisation energy and electron affinity		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To understand the different types of bonds that form between atoms when molecules are formed	• Bonds between Atoms	• Draw electron dot diagrams using valence electrons of each atom • Distinguish between ionic and covalent compounds based on their physical properties		
Chapter 4 The Quantities of Substances: Chemical Calculations *Collaboration Communication Critical Thinking and Problem Solving*	• To determine relative atomic mass of elements • To determine relative molecular mass and relative formula mass of substances	• Relative Masses of Atoms and Molecules	• Distinguish between the formula mass and molecular mass of compounds • Classify the ionic and molecular compounds	**Experiment 4:** Determination of the Empirical Formula of Magnesium Oxide	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To understand the symbols of the elements and formulae (empirical and molecular formulae) of the compounds	• Chemical Symbols, Formulae, Writing and Naming Formulae	• Understand the naming system of compounds with fixed or variable oxidation numbers of first element • Describe the names and chemical formulae of compounds		
	• To write word and symbolic equations based on information provided	• Chemical Equations	• Write the correct formulae of the substances in a chemical equation (not necessary to balance the equation)		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To understand how to write and interpret chemical equations with physical states		• Balance the above chemical equations by the Law of Conservation of Mass		
	• To understand the calculations involving the molar mass, number of moles and the mass of a substance • To determine the mole ratio of the reactants and products by using balanced chemical equations	• The Mole Concept	• Describe Avogadro's constant as "HUGE NUMBER" [6.02×10^{23}] • Prove the molar mass of carbon-12 as 12		
Chapter 5 Non-Metals: Oxygen, Carbon and Halogens *Collaboration Communication Critical Thinking*	• To describe the properties and behaviours of oxygen and oxides • To classify the main types of oxides based on their properties	• Oxygen	• Achieve knowledge about alternative methods for the preparation of oxygen • Classify the types of oxides and their uses	**Experiment 5:** Preparation of Calcium Oxide (Quicklime) and Study on Some of Its Chemical Properties **Experiment 6:** Preparation of Carbon Dioxide Gas from Calcium Carbonate and Study on Some of Its Physical Properties (a)Preparation of Carbon Dioxide Gas from Calcium Carbonate	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To explain the properties and behaviours of carbon and its allotropes	• Carbon	• Describe the allotropes of carbon in student's environment		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
			• Examine the application of soft graphite as a conductor or lubricant	(b)Study on the Physical Properties of Carbon Dioxide **Experiment 7:** Tests for Carbonate, Chloride, Bromide and Iodide Anions	
	• To investigate the properties and behaviours of halogens and halides	• Halogens	• Organise the physical and chemical properties of halogens • Describe the uses of halides in daily life		
Chapter 6 Acids, Bases and Salts *Collaboration Communication Critical Thinking and Problem Solving*	• To realise the properties of acid used in daily life • To understand the different types of acids	• Acids and Their Properties	• Determine whether the solution used in daily life is acidic or not • Describe the formulae and uses of acids	**Experiment 8:** Neutralisation of Acids and Bases and Preparation of Salt (a)Neutralisation of Acids and Bases (b)Preparation of Copper(II) Sulphate Crystals	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To understand the properties and uses of bases and alkalis in daily life • To distinguish between bases and alkalis	• Bases, Alkalis and Their Properties	• Decide whether the substances collected from the home are bases or not • Explain the common sources and uses of base in the kitchen (e.g., ash)		
	• To investigate the role of indicators and the pH scale used in chemistry	• Indicators and the pH Scale	• Measure the pH of various substances by using pH paper • Understand the role of indicator in acid or base solutions		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To assess the acid-base reaction (neutralisation) • To identify the different types of salts and their uses	• Salts	• Predict the salts formed from the neutralisation of various acids and bases • Recognise the application of salts in daily life		
Chapter 7 Air, Water and Soil *Collaboration Communication Analysis and Reasoning*	• To describe the composition of air, and the various forms of air pollutants and the sources of these pollutants • To assess the role of various pollutants on global warming and greenhouse effect	• Air	• Estimate the composition of air in the surrounding • Describe the air pollutants and classify their sources (indoor or outdoor)	**Experiment 9:** Differentiation between Temporary and Permanent Hardness of Water **Experiment 10:** Examination of Alkalinity and Acidity of Soil (a) To examine the soil alkalinity and acidity (b) To determine the presence or absence of lime in the soil	• Key for Review Questions • Summary • Key for Exercises • Chapter Review
	• To describe the Earth's surface water, both salt and fresh, including the composition, hardness and various forms of water pollution • To purify the water by simple distillation, ion exchange, and the Permutit method	• Water	• Determine the hardness of water • Explore the cause and effect, and removal methods of water hardness		

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To describe the various types of soil found on the surface of the Earth, including the composition and the various forms of waste and pollutants found in the soil • To understand the information about layers, textures, composition and pH of soil	• Soil	• Observe the water absorption capacity of different types of soil • Explore the functions of nutrients for plants and humans		
Chapter 8 Fuels and Crude Oil *Collaboration Communication Critical Thinking and Problem Solving Creativity and Innovation*	• To understand the formation and extraction, usefulness, composition and properties of fossil fuels	• Fossil Fuels	• Classify the types of fuel as renewable or non-renewable based on the sources and time duration of their formation • Describe how required energy can be obtained from safe and renewable resources	**Experiment 11:** Examination of Relationship between Number of Carbon atoms in Petroleum Products and Their Flow Time	• Key for Review Questions • Summary • Key for Exercises • Chapter Review

Chapter & Soft Skills	Learning Objectives	Topics	Activities	Experiments	Review
	• To understand the separation of crude oil based on different boiling points of these constituents (fractions)	• Fractional Distillation of Crude Oil	• Motivate the learning skill on petroleum products and refinery process • Give knowledge on the fractional distillation products and some of their uses in society		
	• To understand the cracking of refined crude oil	• Catalytic Cracking	• Understand the classes of gasoline • Recognise the usefulness of cracking product "ethene"		
	• To understand the importance of exploration for alternative fuels for future use	• Alternative Fuels	• Describe the sources of biogas and biodiesel • Verify safe and long-last energy resources (nuclear power and solar power)		

2. Year Plan

The year plan for Grade 10 Chemistry Textbook includes 33 sections for 8 chapters, allocation of periods for each section, 11 experiments and revision and examination periods.

Schedule week	Chapter	Section	Period	Total period for each chapter
1	Chapter 1 Chemistry: The Central Science	1.1 Chemistry as Central Science	2	12
		1.2 Milestones in the History of Chemistry	2	
		1.3 Importance of Chemistry	2	
2		1.4 Branches of Chemistry	1	
		1.5 Understanding Chemistry	2	
		1.6 The Principal Goals in Basic Education High School Chemistry	1	
3		Review Exercises	1	
		Experimental Work (Experiment 1)	1	
4	Chapter 2 Matter and Solutions	2.1 States of Matter and Arrangement of Particles in Matter	2	18
		2.2 Changes in Matter	3	
		2.3 Elements, Compounds and Mixtures	3	
5		2.4 Solutions and Solubility	2	
		Review Exercises	2	
6		Experimental Work (Experiments 2 and 3)	6	

Schedule week	Chapter	Section	Period	Total period for each chapter
7	Chapter 3 The Electronic Structures of Atoms and Periodic Table	3.1 Structure of Atom	2	15
		3.2 Electronic Structures (Electron Configurations)	3	
8		3.3 The Periodic Table	2	
		3.4 Periodic Properties	3	
9		3.5 Bonds between Atoms	3	
		Review Exercises	2	
10	Chapter 4 The Quantities of Substances: Chemical Calculations	4.1 Relative Masses of Atoms and Molecules	3	22
11		4.2 Chemical Symbols, Formulae, Writing and Naming Formulae	5	
12		4.3 Chemical Equations	4	
13		4.4 The Mole Concept	5	
		Review Exercises	3	
14	Revised Chapterwise			
15	Examination			
16		Experimental Work (Experiment 4)	2	
17	Chapter 5 Non-metals: Oxygen, Carbon and Halogens	5.1 Oxygen	4	25
		5.2 Carbon	4	

Schedule week	Chapter	Section	Period	Total period for each chapter
18		Experimental Work (Experiment 5)	2	
		5.3 Halogens	6	
19				
		Review Exercises	3	
20		Experimental Work (Experiment 6)	4	
		Experimental Work (Experiment 7)	2	
21	Chapter 6 Acids, Bases and Salts	6.1 Acids and Their Properties	3	
22	Revised Chapterwise			
23	Examination			
24		6.2 Bases, Alkalis and Their Properties	3	19
		6.3 Indicators and the pH Scale	3	
25		6.4 Salts	3	
		Review Exercises	3	
26		Experimental Work (Experiment 8)	4	
27	Chapter 7 Air, Water and Soil	7.1 Air	5	20
28		7.2 Water	4	

Schedule week	Chapter	Section	Period	Total period for each chapter
29		7.3 Soil	4	
		Review Exercises	3	
30		Experimental Work (Experiment 9)	2	
		Experimental Work (Experiment 10)	2	
31	Chapter 8 Fuels and Crude Oil	8.1 Fossil Fuels	3	19
		8.2 Fractional Distillation of Crude Oil	4	
32		8.3 Catalytic Cracking	4	
33		8.4 Alternative Fuels	3	
		Review Exercises	3	
34		Experimental Work (Experiment 11)	2	
35	Revised Chapterwise			
36	Examination			

Note worthy:

Chemistry being an experimental science, all activities and experiments should be either done with demonstrations or by means of the projection of improvised video clips.

Please remember that the TG is provided as an aid in planning the best course for your students. TG is designed for maximum flexibility. Refer to the chapter planning guides for a correlation of Text program components with each numbered text section. You should use this in relation to the interests and ability levels of the classes you teach, the materials available for activities, and the time available for teaching. You may decide to extend the scope and time devoted to certain topics through the use of enrichment activities and supplementary materials presented in this book.

CHAPTER 1

CHEMISTRY: THE CENTRAL SCIENCE

Total Number of Lesson Periods: 12 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:
- know various branches of chemistry and how society is impacted by them;
- understand the role and impact of chemistry in daily life;
- verify the importance of chemistry in daily life;
- develop and practise higher order thinking skills.

Skill Development

- Collaboration (when working successfully in groups)
- Communication (when reporting progress on exercises and activities)
- Analysis and Reasoning (when finding solutions to problems)
- Citizenship (when learning the chemistry principles and doing activities and experimental work)

Section 1.1 CHEMISTRY AS CENTRAL SCIENCE

Number of lesson periods: 2

Lesson Objectives

- To know various branches of chemistry and how society is impacted by them
- To understand the role and impact of chemistry in daily life

Introduction

Most everything we do and encounter in daily life involves chemistry. Teacher should ask the students as follows: Do you know that chemistry plays a crucial role in addressing the challenges such as climate change, water contamination, air pollution and food shortages? We can find chemistry in the foods, the air, cleaning chemicals, emotions and every object made up of matter-even our own bodies.

The purpose of learning this section is to understand the role and impact of chemistry in daily life and in the network of every issue that we all faced in our society.

Teaching

Teacher should explain that chemistry is the study of matter and the changes it can undergo. Understanding basic chemistry concepts is important for almost every profession. In all branches of science, chemistry takes part in the central role that helps us to describe and explains the states of matter and the processes in our world.

More information for teacher

- All the activities of human beings are controlled by chemicals.
- Chemical reactions also take place in plants and animals, and these results in the formation of substances that can be used to treat illness.
- Natural resources, such as minerals, ores and fossil fuels are important to the life on our Earth.
- The food that is consumed daily comes directly from chemical processes.
- Students should notice that their lives involve chemistry. Making coffee, cooking curry, breathing and bathing involve chemistry. The products we use - like soap and shampoo, the fabrics we wear, the electronics and the click gadgets that keep us connected to our world - all of these and more involve chemical substances and processes.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on chemistry; a science that touches our society every moment.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe the role of chemistry in some science topics

Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the role of chemistry in the following sectors:
- Group A: food science
- Group B: forensic science
- Group C: medical science
- Group D: environmental science

Resources and Preparation

- Encourage the students to search the role of chemistry in some science topics by using library / online resources before discussion.

Reflection on Learning

- Group A: Chemical reactions in the combination of food chemicals to form a new food product
- Group B: Chemical reactions to analyse substances such as blood, DNA and gunpowder residue
- Group C: Chemicals and chemical reactions used for treatment or prevention of a disease

- Group D: Chemical reactions that happen in atmosphere, water and soil
- Other appropriate answers should be accepted.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To distinguish the chemicals used in food, medicine, agriculture and cleansing agent

Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the name of chemicals used in the following:
- Group A: food
- Group B: medicine
- Group C: agriculture
- Group D: cleansing agent

Resources and Preparation

- Encourage the students to collect the name of chemicals used in food, medicine, agriculture and cleansing agent by using library / online resources before discussion.

Reflection on Learning

- For example,

Food	Medicine	Agriculture	Cleansing agent
protein, fat, carbohydrate, water, dietary fibre, vitamins and minerals, food colour, food sweetener	antibiotics, antiseptics, analgesics, penicillins, tetracyclines, amoxicillin, aspirin	pesticides, herbicides, insecticides and fungicides, fertilisers	water, soap or detergent, ammonia solution, sodium hypochlorite (liquid bleach), acetic acid (vinegar)

- Other appropriate answers should be accepted.

Section 1.2 MILESTONES IN THE HISTORY OF CHEMISTRY

Number of lesson periods: 2

Lesson Objective

- To achieve the knowledge on the history of chemistry

Introduction

The students have learnt the role and impact of chemistry in daily life. Teacher should extend their knowledge about the history of chemistry. When and how long have humans tried to identify Chemistry? Since humans have always tried to identify, use and change the materials in our environment, the history of civilisation is the history of chemistry, i.e., the study of matter and its properties.

The purpose of learning this section is to obtain the knowledge about the history of chemistry.

Teaching

Teacher should explain that chemistry is about what things are made of, and how we can change them. In prehistoric times, a simple reaction known as combustion is considered as a chemical reaction. The history of chemistry is often divided into four periods: Black Magic, Alchemy, Traditional Chemistry and Modern Chemistry.

More information for teacher

- In Europe, the study of chemistry was conducted by alchemists with the goals of transforming common metals into gold or silver and inventing a chemical elixir that would prolong life. Although these goals were never achieved, there were some important discoveries made in the attempt.
- The field of chemistry has contributed to this development, and this discipline has given us some of our basic knowledge of the globalisation.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the milestones in the history of chemistry.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To match the famous chemists with the main period of chemistry

Instruction

- Make the class into two groups: A and B.
- Tell them to mention the following:
- Group A: the name of chemists
- Group B: the period of chemistry related to the chemist

Resources and Preparation

- Encourage the students to search the name of chemists in each period of chemistry by using Grade 10 Chemistry Textbook / online resources before discussion.

Reflection on Learning

- For example,

Chemist (Group A)	Period (Group B)
John Dalton (1766 - 1844)	Traditional chemistry
Aristotle (384 BC - 322 BC)	Black magic
Amedeo Avogadro (1776 - 1856)	Traditional chemistry
Marie Curie (1867 - 1934)	Modern
Antoine Lavoisier (1743 - 1794)	Traditional chemistry
Alfred Nobel (1833 - 1896)	Modern
Rosalind Franklin (1920 - 1958)	Modern
Robert Boyle (1627 - 1691)	Alchemy
Dmitri Mendeleev (1834 - 1907)	Modern

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To get the knowledge of Myanmar alchemy

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the name of the following:
- Group A: four elements (Dat-gyi-lay-bar)
- Group B: noble metals
- Group C: important metal elements that are used in Myanmar alchemist experiments

Resources and Preparation

- Encourage the students to search the knowledge of Myanmar alchemy by using Grade 10 Chemistry Textbook / online resources before discussion.

Reflection on Learning

- Group A: earth, fire, water and air
- Group B: silver, gold
- Group C: iron, mercury

Section 1.3 IMPORTANCE OF CHEMISTRY Number of lesson periods: 2

Lesson Objective

- To verify the importance of chemistry in daily life

Introduction

After learning the beginning of its modernisation at the end of the 18th century, teacher should ask that how chemistry has been continuously and rapidly developing. As the beginning of the 21st century approached, chemistry had much success in greatly enlarging its scope.

The purpose of learning this section is to gain the knowledge of chemistry for improving the quality of society.

Teaching

Teacher should explain that chemistry will help us to solve many future problems, including sustainable energy and food production, managing our environment, providing safe drinking water and promoting human and environmental health.

More information for teacher

- The applications of chemistry are essential in daily life such as food, clothing, transportation, sports and recreation, ventilation, heating and cooling, communication, decoration, construction, sanitation, and education.
- Activities of everybody accompany with chemistry; from batteries to painkillers, chemistry is essential to our modern lives.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the description of the chemicals around them and their uses.

Activity (1)

The teacher should identify this activity as a group work.

Objective

- To explore the name of chemicals involved in classroom, school bag and your body

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the names of chemicals in the following:
- Group A: classroom

Resources and Preparation

- Encourage the students to search the name of chemicals in their surroundings by using Library / online resources before discussion.

- Group B: school bag
- Group C: your body

Reflection on Learning

- Group A: the seat (plastic polymers with polyurethane; foam seat padding and metal support; wood made of cellulose, lignin), the room (cement, plastic, concrete and glass)
- Group B: book (wood pulp or cellulose), pencil (graphite), ruler (plastic polymer), eraser (butyl rubber and copolymers), pen (ink)
- Group C: human body (protein, sugar, water, blood, and so on), air (a mixture of elements like oxygen and nitrogen), clothes (polymers such as nylon or terylene)
- Other appropriate answers should be accepted.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To recognise the uses of household items and their chemical ingredients

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the following:
- Group A: the common names of household items
- Group B: their uses
- Group C: names of chemical ingredients

Resources and Preparation

- Encourage the students to mention the name of household items and their uses and chemical names by using Library / online resources before discussion.

Reflection on Learning

- For example,

No.	Common name	Uses	Chemicals
1	baking powder	baking	sodium hydrogen carbonate
2	soap	bathing and washing	sodium salt of organic fatty acid
3	toothpaste	cleaning teeth	calcium carbonate, sodium fluoride
4	detergent	washing	phosphate compounds
5	table salt	cooking	sodium chloride
6	vinegar	cooking/ pickling	acetic acid
7	graphite	in pencil	carbon
8	sugar	sweetener	sucrose

Continued from ***Reflection on Learning***

No.	Common name	Uses	Chemicals
9	aspirin	medicine	acetyl salicylic acid
10	mothball	personal hygiene	1, 4 - dichlorobenzene / naphthalene
11	chalk	marking	calcium carbonate

- Other appropriate answers should be accepted.

Section 1.4 BRANCHES OF CHEMISTRY Number of lesson period: 1

Lesson Objective

- To investigate the branches of chemistry

Introduction

Teacher should recall the students' knowledge that the different branches of science focus on different aspects of matter. Similarly, there are many branches of chemistry or chemistry disciplines.

The purpose of learning this section is to understand the branches of chemistry focused on different aspects of matter.

Teaching

A lot of chemical reactions occur daily in our environment. Let the students predict how many branches are there in chemistry. There are five main branches of chemistry, namely: Physical Chemistry, Analytical Chemistry, Organic Chemistry, Inorganic Chemistry and Biochemistry; other branches are Materials Chemistry, Theoretical Chemistry, Macromolecular Chemistry, Nuclear Chemistry, etc.

More information for teacher

- Chemistry is a branch of science dealing with matter and its properties. But the subject is so vast and detailed that it has to be studied in branches and sub-branches. All the branches are useful for human beings and they are also offered as part of a different set of courses and degrees.
- They are useful in medicine, technology, food and environment which make it essential to study them.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the disciplines and branches of chemistry.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

- To describe the main branches of chemistry and their application areas

Instruction

- Tell the class to mention individually the main branches of chemistry and the examples of application areas.

Reflection on Learning

- Refer to Grade 10 Chemistry Textbook

Resources and Preparation

- Encourage the students to mention the branches of chemistry and examples of application areas by using Grade 10 Chemistry Textbook / online resources before discussion.

Activity (2)

The teacher should identify this activity as an individual work.

Objective

- To describe the five main branches with available examples described in Grade 10 Chemistry Textbook

Instruction

- Teacher should encourage the students to describe the branches of chemistry.
- Tell them to mention the sub-branches of chemistry:
- Group A: organic chemistry
- Group B: inorganic chemistry
- Group C: physical chemistry
- Group D: analytical chemistry
- Group E: biochemistry

Resources and Preparation

- Encourage the students to mention the sub-branches of chemistry by using Grade 10 Chemistry Textbook / online resources before discussion.

Reflection on Learning

- Group A: medicinal chemistry, organometallic chemistry, polymer chemistry, physical organic chemistry, stereochemistry
- Group B: bioinorganic chemistry, geochemistry, nuclear chemistry, organometallic chemistry, solid state chemistry
- Group C: photochemistry, surface chemistry, chemical kinetics, quantum chemistry, spectroscopy
- Group D: forensic chemistry, environmental chemistry, bioanalytical chemistry,

- Group E: molecular biology, genetics, pharmacology, toxicology, clinical biochemistry, agricultural chemistry
- Other appropriate answers should be accepted.

Section 1.5 UNDERSTANDING CHEMISTRY Number of lesson periods: 2

Lesson Objective

- To justify why we have to study chemistry

Introduction

Students have learnt that the science of chemistry actually links out to other branches or sub-branches. Teacher should extend their understanding on the nature of every form of matter due to the principles of chemistry.

The purpose of learning this section is to understand the basic chemistry and chemical knowledge that will make our world meaningful.

Teaching

Teacher should emphasise that learning chemistry drives learning how to be objective, how to reason and how to solve problems. Chemistry helps us to understand current events, including news about petroleum, product recalls, pollution, the environment and technological advances.

More information for teacher

- Chemistry is referred to as the central science because it joins together physics and mathematics, biology and medicine, and the Earth and environmental sciences.
- Chemistry opens up career options. There are many careers in chemistry, but even looking for a job in another field, the analytical skills you gained in chemistry are helpful.
- There are lots of interesting activities you can do using common materials. They can glow in the dark, change colours, produce bubbles and change states.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the importance of chemistry.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

- To describe the importance of studying chemistry

Instruction

- Teacher should encourage the students to give the reasons for studying chemistry.
- Record the students' expression.

Reflection on Learning

- to understand the usefulness of chemistry in real world
- to understand the labels of products
- to make informative decisions
- to keep your life safe
- to know a key role in preparing food
- to provide new solutions to the problems in health, materials and energy usage
- Other appropriate answers should be accepted.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To recognise the chemical reactions in real world

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the chemical reactions in real world as follows:
- Group A: in digestion
- Group B: in cooking
- Group C: interaction between drug and food

Resources and Preparation

- Encourage the students to mention the name of household items and their uses and chemical name by using Library / online resources before discussion.

Reflection on Learning

- Group A: (Digestion relies on chemical reactions of food, acids and enzymes to break down molecules into nutrients that the body can absorb and use.)
- Group B: (Cooking is a chemical change that alters food to make it more palatable and digestible. The heat of cooking may denature proteins and kill dangerous microorganisms, and promote chemical reactions of ingredients, sugars, etc.)
- Group C: (Interaction makes the drugs compromised or overly strengthened by the foods. For example, many drugs should not be taken with alcohol. Some medicines containing caffeine as an active ingredient should not be taken with coffee or cola, and it may become overdose.)

Section 1.6 THE PRINCIPAL GOALS IN BASIC EDUCATION HIGH SCHOOL CHEMISTRY

Number of lesson period: 1

Lesson Objective

- To develop and practise higher order thinking skills such as reasoning, analysis, synthesis and evaluation

Introduction

Let the students know that basic knowledge of chemistry helps them for better understanding on the benefits and hazards to human.

The purpose of learning this section is to develop the higher thinking skills through studying chemistry and to understand the principal goals in basic education high school chemistry.

Teaching

Teacher should explain that basic chemistry is the branch of science that studies the preparation and reactions of material substances. Chemistry contributes to a large extent in the growth and development of a nation. A developing country, like Myanmar, needs creative chemists who can be contributed by Basic Education High School Chemistry Course.

More information for teacher

- Higher order thinking skills is currently at the centre of educational attention. The chemistry curriculum has shifted its emphasis to the fostering of higher order thinking skills.
- In general, measures of higher order thinking skills include all intellectual tasks that call for more than the retrieval of information.
- Six fundamental higher order thinking skills have been identified in this syllabus. They are: problem solving skills, inquiring skills, reasoning skills, communicating skills, conceptualising skills, and creative and innovative skills. These skills and intertwining ways of learning chemistry, thinking and using chemical knowledge are importantly considered in chemistry education.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the development of higher order thinking skills and principal goals.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

- To describe the basic process skills obtained by studying chemistry

Instruction

- Teacher should encourage the students to identify the basic process skills that can be obtained from chemistry subject.

Reflection on Learning

- By chemistry principles and experiments, basic skills (observing, classifying, inferring, communicating, measuring, predicting, and so on) will be developed.

Activity (2)

The teacher should identify this activity as an individual work.

Objective

- To describe the main themes in high school chemistry course.

Instruction

- Teacher should encourage the students to mention the main themes of chemistry in high school course.

Reflection on Learning

- Refer to Grade 10 Chemistry Textbook.

Experimental Work **Number of practical period: 1**

Suggestion for Practical

- Refer to Grade 10 Experimental Chemistry book.
- Both teacher and students read "**To the Students**" section and discuss what students must follow the rules and regulations of Laboratory before doing the experiments.

Experiment 1 Laboratory Safety Rules and Writing Report

Teacher should direct how to use the apparatus systematically with caution.

SUMMARY

The highlights of this chapter:

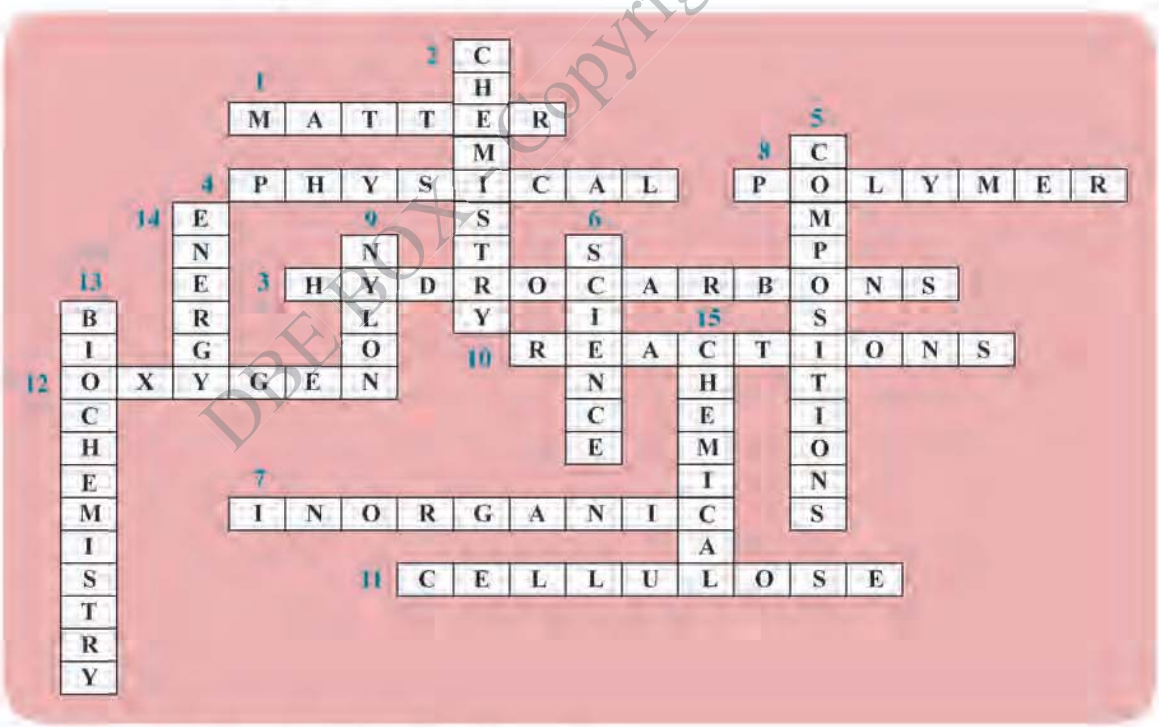
- the role of chemistry in society for better lives
- the milestones in the history of chemistry
- the importance of chemistry
- the branches of chemistry
- the reasons and facts why we study chemistry
- the basic process skills to develop higher order thinking skills through studying chemistry

KEY FOR EXERCISES **Number of review exercises period: 1**

1. **Understanding key ideas**

List A	List B
(a) Aristotle	(vi) formulated the theories on the behaviour of matter
(b) Robert Boyle	(vii) developed the basic ideas about the behaviour of gases
(c) Joseph Priestley	(i) discovered the gas, oxygen
(d) Antoine Lavoisier	(v) explained the Law of Conservation of Matter
(e) John Dalton	(ii) postulated the atomic theory
(f) Amedeo Avogadro	(iii) laid the background for a more quantitative approach to chemistry
(g) Alchemist	(iv) very early chemist tried to turn cheaper metals to gold

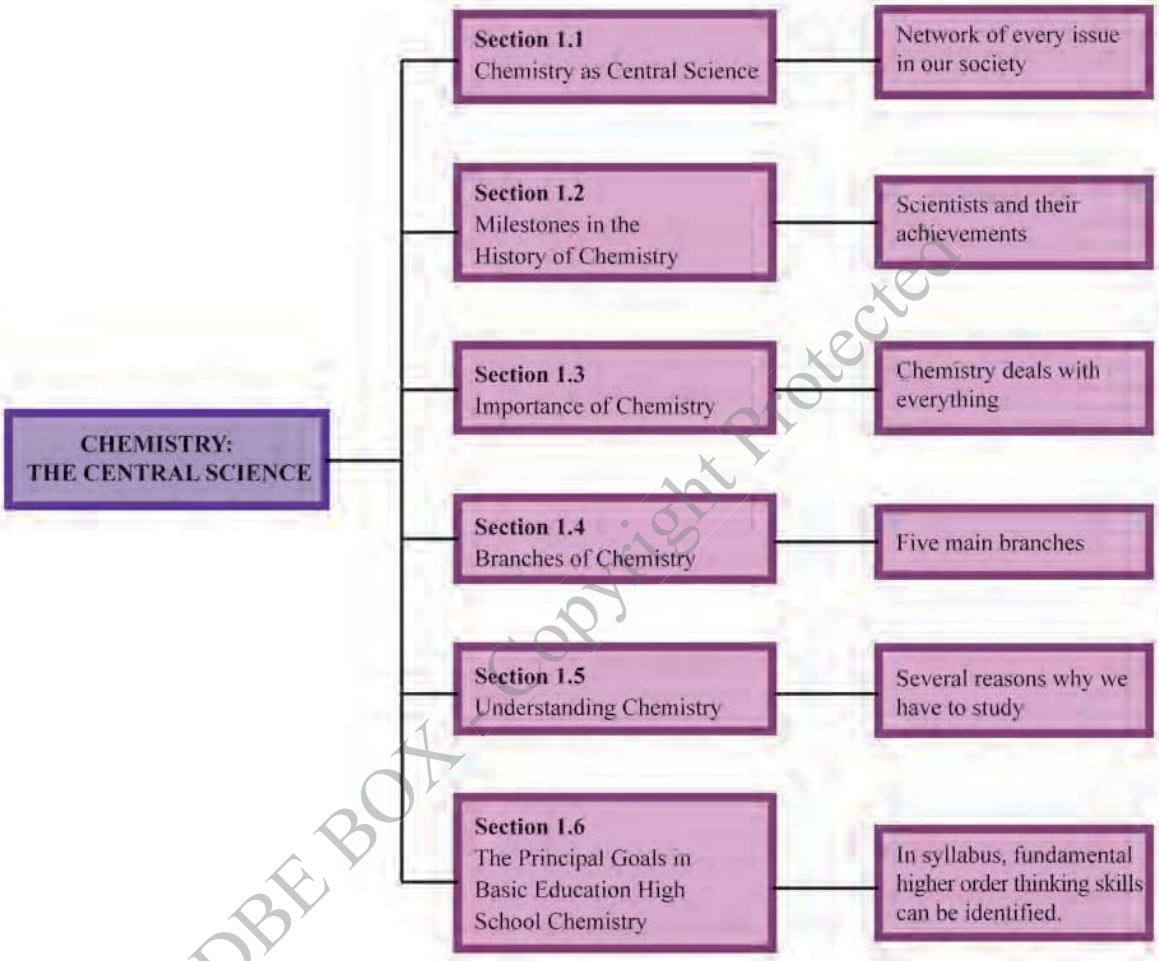
2. **Creative thinking**



Understanding key ideas (Q.3 and Q.4)

3. Refer to Grade 10 Chemistry Textbook (Section 1.1).
4. Refer to Grade 10 Chemistry Textbook (Section 1.3).

CHAPTER REVIEW



CHAPTER 2

MATTER AND SOLUTIONS

Total Number of Lesson Periods: 18 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:

- differentiate between the states of matter based on the arrangement of atoms and molecules;
- analyse the changes of states based on the movement of atoms and level of energy;
- examine the characteristics of elements, compounds and mixtures;
- investigate the separation techniques as applied to mixtures;
- compare the behaviours of solute, solvent and solution;
- investigate the solubility of substances and the effect of temperature on it.

Skill Development

- Collaboration (when working successfully in groups)
- Communication (when reporting progress on exercises and activities)
- Critical Thinking (when finding solutions to problems)

Support Materials

- Chalk, food dyes, incense stick, a glass of water, matches, limewater, table salt, effervescent tablet, baking soda, milk, vinegar, ice cube, beaker, measuring cylinder, glass rod, alum powder, teaspoon, cups, spirit burner / hot plate

Section 2.1 STATES OF MATTER AND ARRANGEMENT OF PARTICLES IN MATTER

Number of lesson periods: 2

Lesson Objective

- To differentiate between the states of matter based on the arrangement of atoms and molecules

Introduction

Teacher should initiate the students with their prior knowledge from middle school Textbooks. Teacher should ask questions about different states of matter that students have learnt in their previous lessons from Science Textbooks of Grades 6 and 7. Matter is anything that has mass and takes up space. Chemistry is the study of all matter, their

composition, properties and changes of states from one form to another by changing energy. Matter can exist in one of the three states: solid, liquid and gas.

The purpose of learning this section is to understand the differences of three states of matter based on the arrangement of atoms and molecules.

Teaching

Teacher should assess the students' understanding about arrangement of particles from the Grade 10 Chemistry Textbook (Section 2.1) and then explain in detail with the help of the following question. How are particles arranged in solids, liquids and gases? To clearly understand the arrangement of particles, teacher should explain diffusion process with suitable examples, refer to Grade 10 Chemistry Textbook (Section 2.1).

The next portion (extending knowledge other than Grade 10 Chemistry Textbook) will enhance teachers' creativity and help to develop high level teaching program.

More information for teacher

- On the basis of physical properties, matter is classified as solids, liquids and gases. On the basis of chemical properties, they are classified as elements, compounds and mixtures.
- The evidence for the existence of particles in matter and their motion comes from the experiments on diffusion and Brownian motion.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the state of matter and its diffusion.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe the characteristics of matter based on their physical states

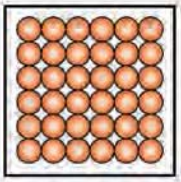
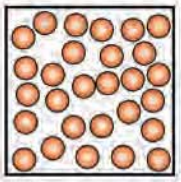
Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the following:
- Group A: the arrangement of particles
- Group B: movement of particles
- Group C: the diagram of movement
- Group D: examples for solid, liquid and gas

Resources and Preparation

- Encourage the students to collect the characteristics and examples of solids, liquids and gases by using library / online resources before discussion.

Reflection on Learning

Group	Solid	Liquid	Gas
A	regular arrangement, close to each other	random or irregular arrangement, close to each other	random arrangement and wide apart
B	very little movement in the form of vibration	particles can move around each other	quick movement in random direction
C			
D	ice, coal, wood, stone, iron, etc.	water, milk, fruit juice, ink, petrol, etc.	air, oxygen, hydrogen, nitrogen, steam, etc.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To examine the diffusion of solid, liquid and gas

Instruction

- Make the class into three groups: A, B and C.
- Tell them to perform the following:
- Group A: to draw a picture on a blackboard and leave it unclean for 2 weeks
- Group B: to spread the coloured food dye in a glass of water
- Group C: to light an incense stick at a corner of classroom

Resources and Preparation

- Chalk, food dyes, incense stick, a glass of water, matches

Reflection on Learning

- Group A: Draw a picture on the blackboard with chalk and leave it unclean for two weeks. After two weeks, we will find that it becomes quite difficult to clean this blackboard. This is due to the fact that some of the particles of chalk have diffused into the surface of blackboard.
  (Diffusion in solid is a very slow process. (OR) Diffusion does not happen in solids – the particles in a solid can only vibrate and cannot move from place to place.)

- Group B: The spreading of colour of food dye in water is due to the diffusion of coloured particles in water.
  (Diffusion in liquid is slower than that of gas. (OR) The particles in liquids can move around each other, which means that they are evenly mixed.)
- Group C: When we light an incense stick at the corner of classroom, its fragrance spreads in the whole room very quickly due to the diffusion of gas particles into the air.
  (Diffusion in gas is a fast process. (OR) When chemicals such as the smell of perfume, smoke or burning toast, are let loose in a room, the particles mix with the air particles. The particles of smelly gas are free to move quickly in all directions. They eventually spread through the whole room. This is known as Brownian Motion.)

Key for Review Questions

(1)

Solid	Liquid	Gas
It has definite volume and shape.	It has definite volume but no definite shape.	It does not have a definite volume and shape of its own.
It cannot be compressed, and does not flow.	It cannot be compressed but flows in all directions.	It can easily be compressed, and flows in all directions.

(2)

Solid	Liquid	Gas
iron, gold, copper	water, mercury, vinegar	argon

Section 2.2 CHANGES IN MATTER Number of lesson periods: 3

Lesson Objective

- To analyse the changes of states based on the movement of atoms and level of energy

Introduction

Students have learnt changes in matter in Grades 6 and 7 Science Textbooks. Teacher should recall students' basic knowledge by asking questions: burning magnesium ribbon, dissolving sugar in water, etc. According to their answers, teacher should ask the students which changes can form new substances or not. Chemical change can form new substances and physical change cannot.

The purpose of learning this section is to study the changes of states based on the movement of atoms and level of energy.

Teaching

Refer to Grade 10 Chemistry Textbook (Section 2.2), and ask the students the names of changing processes from one state to another. Teacher should clearly explain the physical change and chemical change with suitable examples. Teacher should emphasise the process or chemical reactions for every physical change or chemical change.

More information for teacher

- Energy is either lost or gained during a change of state. When energy is applied to a solid, the tightly packed particles of matter begin to move around, flowing over each other. The solid then turns into a liquid. The shape becomes indefinite. The volume, however, does not change, because the particles are still part of one another. When energy is applied to a liquid, the particles of liquid begin to move about so rapidly, that they can no longer hold themselves together. The liquid then turns into a gas. The shape is indefinite, and the volume becomes indefinite. The reverse process occurs when energy is taken away from gas.
- Mercury is a metal in liquid state at room temperature. But when it is cooled below – 40 °C, it freezes to a solid. At 357 °C, it boils and becomes vapour. In this process, changes of state depend on the changes of temperature and energy.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the changes in matter.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To investigate the changes in matter by precipitation and dissolution process

Instruction

- Make the class into two groups: A and B.
- Tell them to do by each group as follows:
- Group A: to make a cup of limewater, exhale air from your nose/ mouth into the limewater continuously
- Group B: to mix 5 ~ 10 g of table salt and water in a glass

Resources and Preparation

- A cup of limewater, table salt, a glass of water

Reflection on Learning

- Group A: Exhaled air (carbon dioxide) is passed into limewater, white substance is observed. Liquid form ($Ca(OH)_2$) changes to solid form ($CaCO_3$). This is **Precipitation.**

- Group B: After stirring for a while, clear solution is obtained. Solid form (table salt) changes to liquid form (salt solution). This is **Dissolution/Dissociation reaction**.

Activity (2)

The teacher should identify this activity as a group discussion in the class.

Objective

- To determine physical change and chemical change

Instruction

- Make the class into three groups: A, B and C.
- Tell them to do by each group as follows:
- Group A: to put one effervescent tablet into a beaker containing distilled water
- Group B: to mix 50 mL of milk and 30 mL of vinegar in a beaker [If it is not available, the volumes of milk and vinegar can be reduced (5 : 3).]
- Group C: to add an ice cube to a beaker
- Let the students examine what type of changes is happening in these experiments.

Resources and Preparation

- Effervescent tablet, milk, vinegar, ice cube, beaker, measuring cylinder, glass rod

Reflection on Learning

- Group A: When adding one effervescent tablet into a beaker containing distilled water, effervescence took place and gas was evolved. Therefore, new substances were formed. (This is a chemical change.)
- Group B: When milk and vinegar were mixed, two separate layers appeared after a few minutes. New substances were formed. (This is a chemical change.)
- Group C: For a while, ice cube in a beaker dissolved and changed into water. In this change, no new substance was formed. (This is a physical change.)

Key for Review Questions

(1) Squeezing juice from lime is a physical change because no new substance is formed.

(2)

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

(3) (a) sublimation (b) condensation (c) precipitation

Section 2.3 ELEMENTS, COMPOUNDS AND MIXTURES

Number of lesson periods: 3

Lesson Objectives

- To examine the characteristics of elements, compounds and mixtures
- To investigate separation techniques as applied to mixtures

Introduction

Teacher should ask the students to describe element, compound and mixture with examples. In this way, teacher should recall students' knowledge from Grade 6 Science Textbook in which they have learnt. From the students' answers, select the pure substances. Are these pure substances either element or compound? What is the main difference between pure substance and mixture? Pure substance has definite and constant composition but mixture has different compositions.

The purpose of learning this section is to understand the characteristics of elements, compounds and mixtures and the differences among them.

Teaching

Teacher should ask the students to look at Table 2.1 from Grade 10 Chemistry Textbook (Section 2.3) to classify the elements as metals or non-metals based on the properties of the elements mentioned. Teacher should focus on differences between molecular elements and molecular compounds with examples and explain the types of compounds based on the combination of number of atoms or elements and also the formation of mixture (Table 2.2). Teacher should clearly explain the examples of homogeneous and heterogeneous mixtures according to Table 2.3. By using Table 2.4, teacher should ask the students to decide the appropriate separation methods based on the physical states of mixture components.

More information for teacher

- According to their different physical and chemical properties, the useful parts or unwanted parts of mixtures can be separated by various methods such as decantation, filtration, evaporation, centrifugation and crystallisation methods for solid and liquid mixture, magnetic separation for solids mixture, simple and fractional distillation for liquids mixture, and chromatography for colouring mixture.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the classification of the substances around them whether they are elements or compounds or mixtures.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

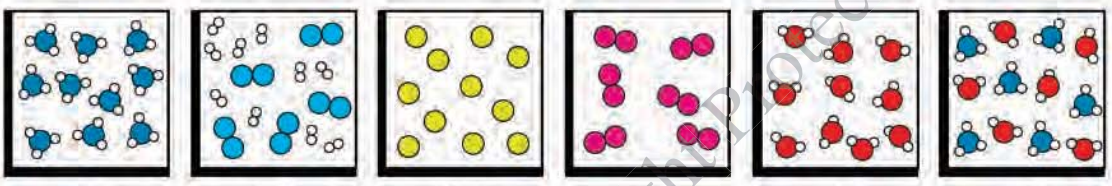
- To understand and distinguish among elements, compounds and mixtures

Instruction

- Tell the students to study the following Figures: A, B, C, D, E and F, and to answer the questions given.
- Which one represents the arrangement of atoms in each of the following molecules?
  (1) Molecules of ammonia (NH_3)
  (2) Molecules of water (H_2O)
  (3) Molecules of oxygen (O_2)
  (4) A mixture of two molecules
  (5) A mixture of two compounds
  (6) An element

Resources and Preparation

- Worksheet papers with pictures as shown below



(A) (B) (C) (D) (E) (F)

Reflection on Learning

- (1) A (2) E (3) D (4) B / F / both (5) F (6) C / D/ both
- Ask more questions as below:
  (i) Give three examples each for metal and non-metal. (Metals: gold, aluminium, copper) (Non-metals: carbon, bromine, oxygen)
  (ii) How do you understand about the term "fixed proportion" in forming a compound? (constant composition or definite amount of composition)
  (iii) Differentiate between molecular elements and molecular compounds with appropriate examples. [A molecule of an element (molecular element) consists of atoms of the same kind. e.g., H_2, O_2, O_3]; [A molecule of a compound (molecular compound) consists more than one kind of atoms. e.g., H_2O, CO_2, NO_2]
  (iv) Give examples for diatomic, triatomic, and polyatomic molecules. [Diatomic molecules are molecules made of two atoms chemically bonded together (e.g., O_2, CO), triatomic molecules are molecules composed of three atoms of the same or different elements (e.g., O_3, H_2O, CO_2), polyatomic molecules are groups of more than three atoms held together by covalent bond (e.g., C_2H_5OH, CH_3COOH).]
- Other suitable examples should be accepted.

Activity (2)

The teacher should identify this activity as a group discussion in the class and ask them to mention the types of mixture with suitable examples.

Objective

- To verify the mixture using suitable separation techniques

Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the following:
- Group A: the pairs of mixture (e.g., solid / solid)
- Group B: the suitable example
- Group C: the types (e.g., homogeneous or heterogeneous)
- Group D: name of the separation techniques
- Record the students' answer.

Resources and Preparation

- Encourage the students to mention the types of mixture and the separation techniques by using Grade 10 Chemistry Textbook / internet before discussion.

Reflection on Learning

No.	Pairs (Group A)	Example (Group B)	Types (Group C)	Separation techniques (Group D)
1	solid / solid	steel (mixture of carbon and iron)	homogeneous	electrolysis*
		sand and iron powder	heterogeneous	using magnet
2	solid / liquid	sugar solution	homogeneous	evaporation
		sand and water	heterogeneous	filtration
3	solid / gas	dust in air/cigarette smoke	homogeneous	filtration
		aerosol	heterogeneous	filtration
4	liquid / liquid	alcohol and water	homogeneous	fractional distillation
		oil and vinegar	heterogeneous	decantation
5	liquid / gas	fizzy drink	homogeneous	shaking the container or stirring the liquid
		crude oil and natural gas	heterogeneous	fractional distillation
6	gas / gas	air	homogeneous	fractional distillation

*** Teacher should describe the answer just for knowledge.**

Key for Review Questions

(1) Substance A is an element because it cannot be broken down into other simpler substances through chemical means.
(2) The original substance is a compound because it can be broken down into other substances by chemical means.

Experimental Work **Number of practical periods: 3**

Suggestion for Practical

- Refer to Grade 10 Experimental Chemistry book, Experiment 2.
- Both teacher and students read "**To the Students**" section and discuss what students must follow the rules and regulations of Laboratory before doing the experiments.

Experiment 2 Separation Techniques

Experiment 2 (a) Separation of a Mixture of Common Salt and Sand

In this experiment, students separate a mixture of sand and salt. This illustrates the fundamental meaning of separating an insoluble substance from one which is soluble. This is a very straightforward experiment. It can be carried out individually or in groups. Students must stand up during heating activities and be aware of hot salts splitting until complete evaporation. Teacher should demonstrate how to manipulate the apparatus including in this experiment (e.g., folding the filter paper). Then, teacher should remind the caution that must be followed.

Experiment 2 (b) Separation of the Different Colouring Matters from Ink

In this experiment, teacher should recall the background knowledge about chromatography. The process of separating dissolved constituents of a mixture by adsorption over an adsorbing material is called chromatography. Paper chromatography is a simpler technique that works because some compounds dissolve better in a solvent than others. When a solvent moves along a strip of paper, it carries the different substances in the mixture at different speeds, so they are separated. Detailed procedure must be followed in this experiment. If not, inaccurate results will be obtained. Teacher should preliminarily carry out the experiment.

Section 2.4 SOLUTIONS AND SOLUBILITY **Number of lesson periods: 2**

Lesson Objectives

- To compare the behaviours of solute, solvent and solution
- To investigate the solubility of substances and the effect of temperature on it

Introduction

Teacher should start this lesson by making questions. Have you ever prepared a solution? Give an example of a solution. To make a solution, how many things are needed?

Then, teacher should refer to Grade 6 Science Textbook and explain again. The purpose of learning this section is to understand the behaviours of solute, solvent, solution and effect of temperature on solubility.

Teaching

A solution is a mixture of solute and solvent. A solvent is the medium in which the solutes are dissolved. Solutes usually dissolve to give ions or molecules in solution. Teacher should refer to Table 2.5 (Section 2.4) and explain how the solubility and temperature are related.

More information for teacher

- Our daily life is encountered with this lesson. In making coffee, sugar, cream and coffee powder are solutes, hot water is solvent and hot coffee is a solution. The amount of solute that is soluble in the solvent depends on the temperature.
- According to experimental temperature and solubility, the solutions can be classified as unsaturated, saturated and supersaturated solutions.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the classification of unsaturated solution, saturated solution and supersaturated solution, and the effect of temperature on the solubility.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To classify the unsaturated, saturated and supersaturated solutions of household common items

Instruction

Resources and Preparation

- Alum powder, a teaspoon, a glass of water, spirit burner / hot plate

- Make the class into groups.
- Tell them to do as follows:
- to add one teaspoon of alum powder into a glass of water and stir it (denoted as solution A)
- to add more alum powder into the solution A until no more alum powder is dissolved (denoted as solution B)
- to heat gently this solution B and add more alum powder, and to make all alum powder dissolve (denoted as solution C)
- Finally, to cool down the solution C to room temperature
- Record the observation and make some questions related with this experiment.

Reflection on Learning

- For solution A, is it still possible to add more alum powder? (Yes, it can, so it is unsaturated solution; capable of having more alum powder dissolved in it.)
- Name the solution B. (It is saturated solution because it has the maximum amount of alum powder dissolved in it; more alum powder added will settle down and remain undissolved.)
- Name the solution C. (It is supersaturated solution.)

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To predict the solubility of solids with increasing temperature

Instruction

- Make the class into groups.
- Tell them to do as follows:
- to put same number of coloured candy (1 or 2) into each cup
- to pour same volume of cold water, water at room temperature and hot water into these cups to cover the candy
- Record the observation of each group.

Resources and Preparation

- Cold water, hot water, water at room temperature, three cups

Reflection on Learning

- Students will observe that there is a significant difference in solubility of candy among three types of water.
- The reason why candy dissolves at a faster rate in hot water is due to increase molecular motion. The higher the temperature, the faster is the motion of water molecules and thus, the faster the vibration of sugar (sucrose) molecules.
- This added movement tends to make the bonds between sucrose molecules easier to overcome. When faster-moving water molecules attach to sucrose molecules, a higher proportion of these sucrose-water interactions have enough energy to pull sucrose molecules away from other sucrose molecules, so the rate of dissolving increases.

Key for Review Questions

(1) (a) sugar, glucose (b) sand, chalk (c) oil, petrol

(2) When 100 g of solution is evaporated, 20 g of solid is obtained.

$$\therefore 25 \text{ g of solution is evaporated} \text{ --- } ? = 20 \text{ g} \times \frac{25 \text{ g}}{100 \text{ g}} = 5 \text{ g of solid}$$

(3) the amount of saturated solution of copper(II) sulphate at 60 ℃ = 40 g + 100 g = 140 g

the amount of saturated solution of copper(II) sulphate at 90 ℃ = 67.5 g + 100 g = 167.5 g

the amount of copper(II) sulphate which would come out of the solution = 167.5 g – 140 g = 27.5 g

(OR)

the solubility of copper(II) sulphate at 60 ℃ = 40 g/ 100 g water

the solubility of copper(II) sulphate at 90 ℃ = 67.5 g/ 100 g water

When the temperature is cooled down 90 ℃ to 60 ℃, the amount of copper(II) sulphate which would come out of the solution = 67.5 g – 40 g = 27.5 g

Experimental Work

Number of practical periods: 3

Suggestion for Practical

- Refer to Grade 10 Experimental Chemistry book, Experiment 3.
- Both teacher and students read "**To the Students**" section and discuss what students must follow the rules and regulations of Laboratory before doing the experiments.

Experiment 3 Determination of the Solubility of Common Salt in Water at Room Temperature

In this experiment, teacher should explain the procedure described in the **Grade 10 Experimental Chemistry** and discuss the theory based on this experiment. The temperature of a solvent affects its ability to dissolve solutes. Teacher should instruct how to use the apparatus systematically. Care must be taken when burner is used.

SUMMARY

The highlights of this chapter:

- states of matter based on physical properties – solids, liquids and gases
- states of matter based on chemical changes – elements, compounds and mixtures
- arrangement of particles in matter and their movement – transformation of matters
- changes of the state of matter physically or chemically
- changing process – melting, freezing, condensation, vaporisation, sublimation, deposition, etc.
- classification of elements – metals and non-metals
- classification of compounds – binary compounds and ternary compounds
- classification of mixtures – homogeneous and heterogeneous mixtures
- separation of mixtures–filtration, decantation, evaporation, crystallisation, distillation, fractional distillation, centrifugation, chromatography, etc.
- dissolution of soluble substances in solvents (water) to form solutions
- solubility of the solute depends on the temperature

KEY FOR EXERCISES **Number of review exercises periods: 2**

Understanding key ideas (Q.1 to Q.4)

1.

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

2. (a) A= freezing, B = melting, C = condensation, D = vaporisation , E = sublimation , F = deposition
   (b) water
   (c) The solid particles change directly from a solid to a gas.
   (d) ammonium chloride (or) iodine

3. (a) The particles in solids are very tightly packed whereas the particles in liquids and gases are freely packed. So that is why solid do not undergo diffusion whereas liquid and gas undergo diffusion readily. The atoms and molecules in gases are much more spread out than in liquids. They vibrate and move freely at high speed.

   (b) The following examples are given. Other appropriate answers are accepted.

   Diffusion of gas

   When a few drops of perfume are released into a room, the particles of a fume move through the air and spread the room.

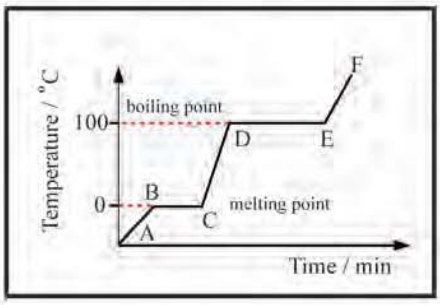
   Diffusion of liquid

   When a drop of food colouring matter is added to a glass containing water, the entire solution will be coloured.

4. When a jar of coffee is opened, people in all parts of the room soon notice the smell because the particles of coffee flavour move through the air and spread out in the room.

5. (a) The melting point of the substance is 17 °C. **(Understanding key ideas)**
   (b) The temperature stays steady while the substance changes state. **(Understanding key ideas)**
   (c) It is because it takes more energy to separate completely the particles in liquid state (in boiling) than that from a solid state (in melting). **(Critical thinking)**
   (d) The substance is not water because the melting point and boiling point of water are 0 °C and 100 °C, respectively. **(Critical thinking)**

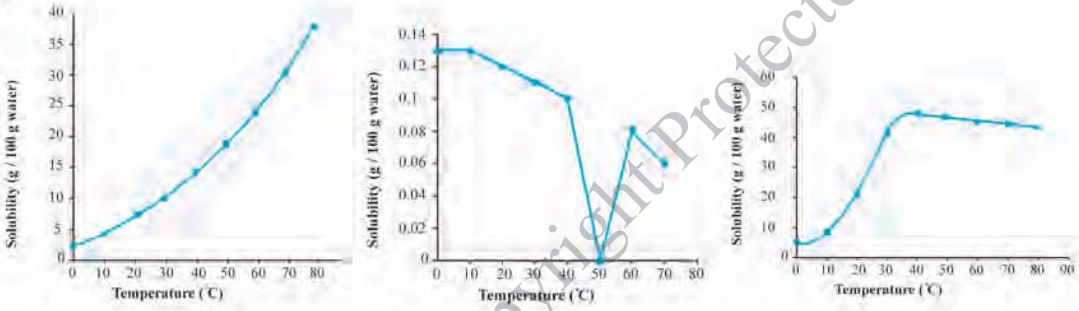
(e) **Creativity and Innovation**



Point A to B ----- ice (solid)
Point B to C ----- ice melting
(both solid and liquid)
Point C to D ----- water liquid
Point D to E ----- water boiling
(both liquid and gas)
Point E to F ----- steam (gas)

6. **Analytical thinking**

(a)



(A) (B) (C)

Figure Solubility curves of (A) potassium chlorate, (B) calcium hydroxide and (C) sodium sulphate

(b) The solubility of potassium chlorate increases with increase in temperature.
The solubility of calcium hydroxide decreases with increase in temperature up to 50 °C.
The solubility of sodium sulphate increases with increase in temperature up to 40 °C and then it decreases beyond 40 °C.

(c) The solubility of potassium chlorate at 25 °C = 8.2 g / 100 g water
The solubility of calcium hydroxide at 25 °C = 0.118 g / 100 g water
The solubility of sodium sulphate at 25 °C = 33 g / 100 g water

(d) When potassium chlorate solution at 70 ºC is cooled down to 30 ºC, solid potassium chlorate comes out.
When calcium hydroxide solution at 70 ºC is cooled down to 30 ºC, more calcium hydroxide is dissolved.
When sodium sulphate solution at 70 ºC is cooled down to 30 ºC, solid sodium sulphate comes out.

Critical thinking (Q.7 and Q.8)

7. (a) The solubility of sodium nitrate at 40 °C = 104 g / 100 g water

Amount of sodium nitrate = 104 g
Amount of water = 100 g
∴ Amount of saturated solution = 104 g + 100 g = 204 g

At 40 °C, 204 g of saturated solution is evaporated to obtain 104 g of sodium nitrate.

25.5 g of saturated solution is evaporated to obtain ------ = ?

$$= 104 \text{ g} \times \frac{25.5 \text{ g}}{204 \text{ g}} = \mathbf{13.0\ g} \text{ of sodium nitrate}$$

(b) At 40 °C, 100 g of water contains 104 g of sodium nitrate.

250 g of water contains ------- = ?

$$= 104 \text{ g} \times \frac{250 \text{ g}}{100 \text{ g}}$$

= **260 g** of sodium nitrate at 40 °C

8. The solubility of solid A at 60 °C = 24 g / 100 g water

Amount of solid A = 24 g
Amount of water = 100 g
∴ Amount of saturated solution = 24 g + 100 g = 124 g

(a) At 60 °C,

100 g of water to saturate, 24 g of solid A is required.

∴ 30 g of water to saturate, --------- = ?

$$= \frac{30 \text{ g} \times 24 \text{ g}}{100 \text{ g}}$$

= 7.2 g of solid A is required.

(b) At 60 °C,

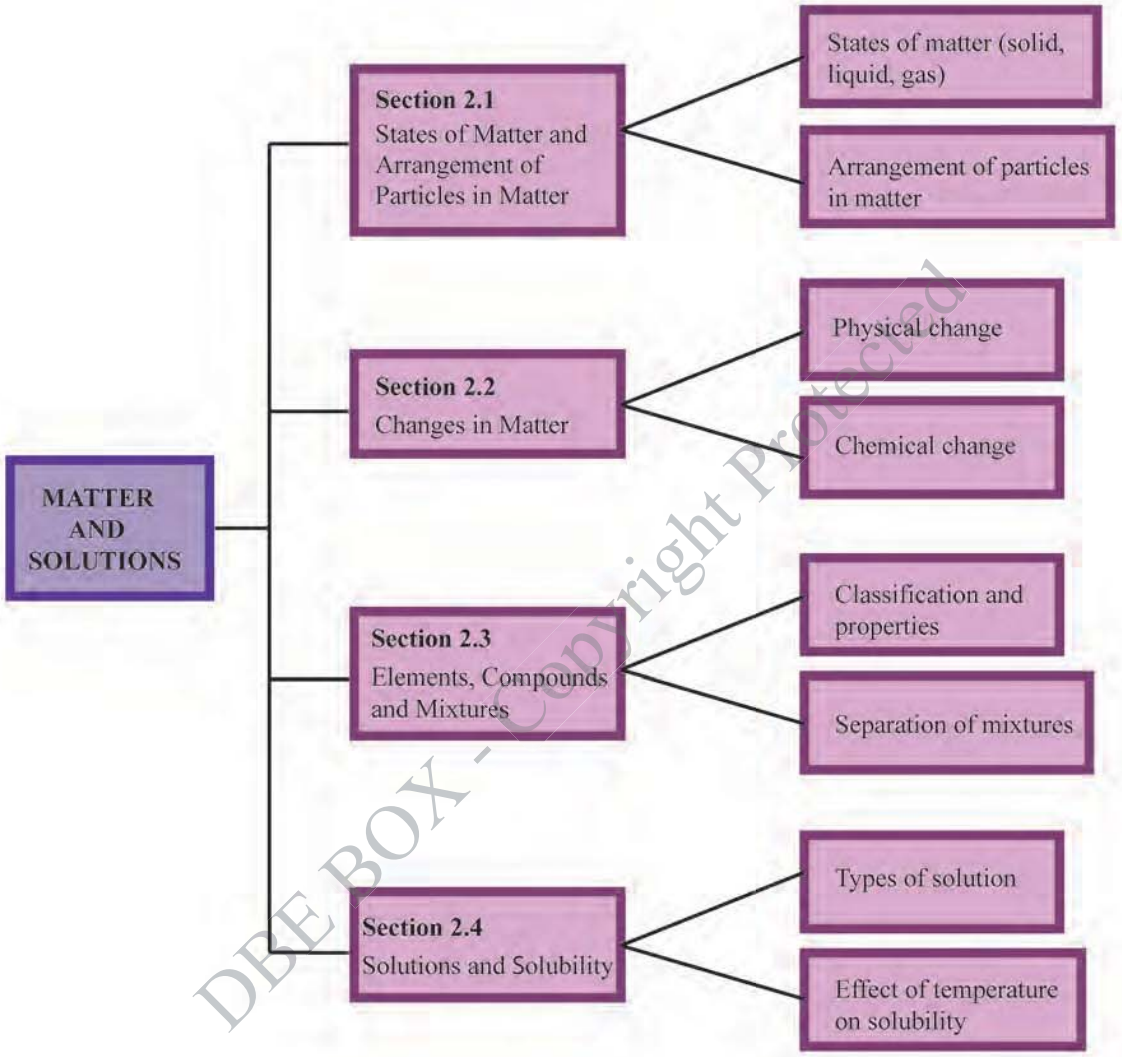
24 g of solid A is used to prepare 124 g of saturated solution.

∴ 12 g --------- = ?

$$= \frac{12 \text{ g} \times 124 \text{ g}}{24 \text{ g}}$$

= **62 g** of saturated solution

CHAPTER REVIEW



CHAPTER 3

THE ELECTRONIC STRUCTURES OF ATOMS AND PERIODIC TABLE

Total Number of Lesson Periods : 15 (1 period - 45minutes)

Learning Outcomes

It is expected that students will be able to:
- explain the electronic structures of atoms;
- explain how the Periodic Table is organised based on atomic structure;
- classify elements based on electronic structures (electron configurations);
- describe the periodic properties of common elements;
- evaluate the different types of bonds between atoms when molecules are formed.

Skill Development

- Collaboration (when doing activity as a group work, evaluating the results obtained by group discussion)
- Communication (when discussing the knowledge about the lessons each other and doing team work to collect their ideas about lessons)
- Creativity and Critical Thinking (when solving problems and answering assignment questions as an individual work)

Support Materials

- Periodic Table, worksheet containing blank table with 18 columns (Groups I to VII, 0) and 4 rows

Section 3.1 STRUCTURE OF ATOM

Number of lesson periods: 2

Lesson Objectives

- To understand the structure of atom
- To identify isotopes and isobars based on sub-atomic particles

Introduction

After discussing the atom in Grade 7 Science Textbook, let the students predict the composition of an atom. In this section, the knowledge will be extended to the aspects of atomic structure and types of atoms depending on their sub-atomic particles.

The purpose of learning this section is to understand the structure of atom and to identify isotopes and isobars.

Teaching

Look at the Figure 3.1 (from Grade 10 Chemistry Textbook) that indicates the atomic structure of an atom. Generally, all atoms are composed of three sub-atomic particles (protons, neutrons and electrons) except hydrogen. Hydrogen is an exception to all atoms as it contains one proton and one electron but lacks neutrons. Refer to Table 3.1 in Grade 10 Chemistry Textbook, students should notice the differences in the properties of fundamental particles. After that, explain the terms atomic number and mass number. The number of protons indicates the atomic number of the element. The number of electrons indicates the characteristic property of the element.

More information for teacher

- Atom is a Greek word which means 'indivisible'. The Greeks believed that matter can be broken down into very small invisible particles called atoms. Greek philosopher, Democritus, proposed that all substances are made up of matter.
- Atoms of every one of the elements are so small that they cannot be seen even under a microscope. So we need a special instrument to measure the relative atomic masses. The latest instrument used nowadays is called the mass spectrometer. The principal parts of a mass spectrometer are described in the following diagram.

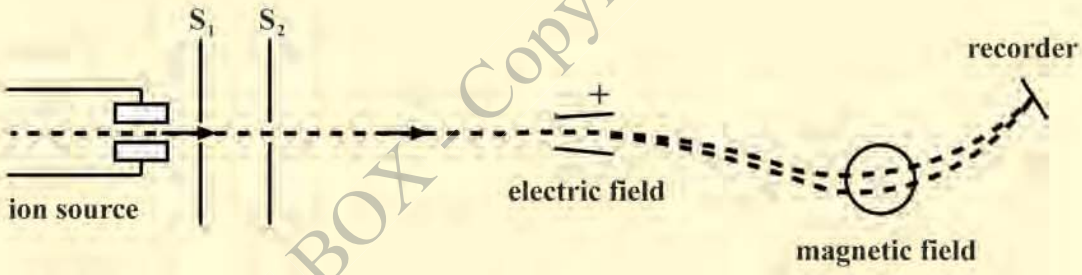


Figure Schematic representation of the mass spectrometer

- A mass spectrometer record for chlorine is shown in Figure.
- The record shows that natural chlorine consists of two kinds of chlorine atoms with different masses. These are isotopes of chlorine.

Note: Do not explain the principle of a mass spectrometer to the students.

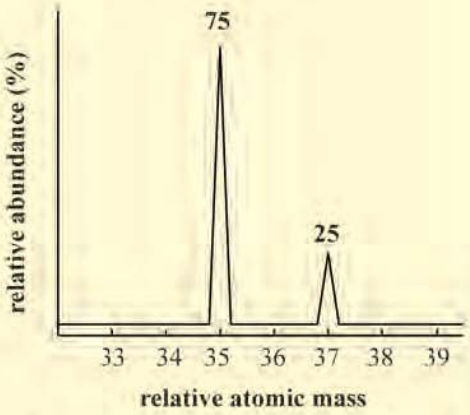


Figure Mass spectrum of chlorine

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the structure of atom, atomic number, mass number, isotopes and isobars.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To write the symbol notation of unknown elements

Instruction

- Make the class into two groups: A and B.
- Tell them to mention the symbols of unknown elements.
- Group A: symbols only
- Group B: symbols with notations

Resources and Preparation

- Unknown elements with number of protons and neutrons, e.g., Y (p = 35, n = 45), Z (p = 26, n = 30) [Y and Z are not chemical symbols.]

Reflection on Learning

- For example, for the unknown element Y.

  Group A: Br

  Group B: $^{80}_{35}Br$

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To identify the isotopes and isobars based on the number of the fundamental particles

Instruction

- Make the class into three groups: A, B and C.
- Tell them to identify the following:
- Group A: isotopes
- Group B: isobars
- Group C: sub-atomic particles for isobars

Resources and Preparation

- Given: $^{40}_{18}Ar$, $^{39}_{19}K$, $^{40}_{20}Ca$, $^{35}_{17}Cl$, $^{37}_{17}Cl$, $^{1}_{1}H$, $^{3}_{1}H$, $^{2}_{1}H$, $^{16}_{8}O$, $^{17}_{8}O$, $^{24}_{12}Mg$, etc.

Reflection on Learning

- Group A: Isotopes - ($^{37}_{17}Cl$ and $^{35}_{17}Cl$), ($^{1}_{1}H$, $^{3}_{1}H$, $^{2}_{1}H$), ($^{16}_{8}O$ and $^{17}_{8}O$)
- Group B: Isobars - ($^{40}_{18}Ar$ and $^{40}_{20}Ca$)
- Group C: sub-atomic particles for isobars as shown in the following Table:

Element	Atomic number	Mass number	Number of protons	Number of electrons	Number of neutrons
$^{40}_{18}Ar$	18	40	18	18	22
$^{40}_{20}Ca$	20	40	20	20	20

Key for Review Questions

(1)

Atoms	Electrons	Protons	Neutron
$^{16}_{8}O$	8	8	8
$^{39}_{19}K$	19	19	20
$^{207}_{82}Pb$	82	82	125

(2) Isotopes are $^{238}_{92}U$ and $^{235}_{92}U$ because they have same number of protons but different number of neutrons. They are atoms of the same elements with different masses.

Isobars are $^{39}_{19}K$ and $^{39}_{17}Cl$ because they are atoms of different elements with same mass number but different atomic numbers.

Section 3.2 ELECTRONIC STRUCTURES (ELECTRON CONFIGURATIONS)

Number of lesson periods: 3

Lesson Objective

- To explain the electronic structure of atoms

Introduction

After learning about the structure of atoms, make some questions to assess students' understanding on the fundamental particles of atom. From their answers, let them predict which one has the key role to combine with another atom. The correct answer is 'electron'. Among the three sub-atomic particles, only the electron is involved in the chemical reactions. That is why the arrangement of electrons in the appropriate sub-shells will be learnt in this section. The students have to notice that the electrons in the outermost shell determine the chemical properties of atoms. So the knowledge will be extended to determine essential electronic structure and valence.

The purpose of learning this section is to understand the arrangement of the electrons in an appropriate sub-shell, valence electrons and valence.

Teaching

Based on Figure 3.3 and Table (Section 3.2) in Grade 10 Chemistry Textbook, teacher should ask the students to calculate the maximum number of electrons in the main shells (K, L, M, N...). By learning Figure 3.4 from Grade 10 Chemistry Textbook, the

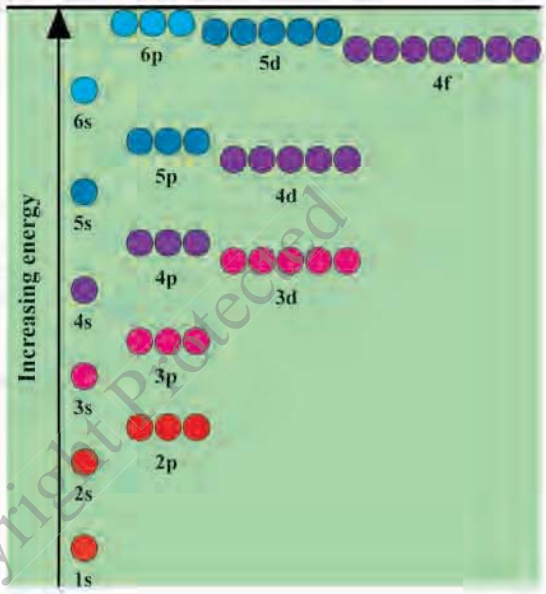
students should be encouraged to sketch the electron distribution for the first 20 elements of the Periodic Table. By referring Figure 3.5 from Grade 10 Chemistry Textbook, allow the students to practise more for writing electronic structures in various ways for a given atomic number. From the information given in Section 3.2 (d) from Grade 10 Chemistry Textbook, let the students distinguish between valence electrons and valence in relation with electronic structure.

More information for teacher

- Electrons are arranged in an atom by their corresponding energy levels. The arrangement of electrons is based on the following rules:

  (a) Aufbau principle
  (b) Pauli's exclusion principle
  (c) Hund's rule

The form of expression for electronic structure in appropriate sub-shells can be illustrated by the diagram.



Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the arrangement of electron configuration.

Activity (1)

The teacher should identify this activity as a group work in the class.

Objective

- To understand how to arrange the electrons in appropriate sub-shell

Instruction

- Make the class into four groups: A, B, C, and D.
- Tell them to select the following elements among the first 20 elements:
- Group A: the elements of odd atomic number
- Group B: those of even atomic number
- Groups C and D: those of atomic number divisible by 3 or 4

Resources and Preparation

- Blank worksheet having six columns with the titles: Element, Integer electronic structure, Complete electronic structure, Shorthand notation with noble gas as a core, Number of valence electrons, Valence

- Complete the blanks in table of the worksheet.

Reflection on Learning

- Group A: H, Li, B, N, F, Na, Al, P, Cl, K
- Group B: He, Be, C, O, Ne, Mg, Si, S, Ar, Ca
- Group C: Li, C, F, Mg, P, Ar
- Group D: Be, O, Mg, S, Ca
- e.g., for S,

Element	Integer electronic structure	Complete electronic structure	Shorthand notation with noble gas as a core	Number of valence electron	Valence
S	2.8.6	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$	$[Ne]3s^2 3p^4$	6	2

- Check the results in the table and make evaluation by themselves.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To determine the valence electrons of different elements using the Periodic Table

Instruction

- Make the class into seven groups: I, II, III, IV, V, VI and VII.
- Tell them to fill up the essential electronic structures of the elements in their respective group from periods 1 to 4.

Resources and Preparation

- Worksheet having blank table with 18 columns (Groups I to VII, 0) and 4 rows

Reflection on Learning

- In Periodic Table, the elements in the same period possess the same number of main shell and the elements in the same group contain the same number of valence electrons.

	I	II							III	IV	V	VI	VII	0
1	$1s^1$													
2	$2s^1$	$2s^2$							$2s^2 2p^1$	$2s^2 2p^2$	$2s^2 2p^3$	$2s^2 2p^4$	$2s^2 2p^5$	
3	$3s^1$	$3s^2$							$3s^2 3p^1$	$3s^2 3p^2$	$3s^2 3p^3$	$3s^2 3p^4$	$3s^2 3p^5$	
4	$4s^1$	$4s^2$							$4s^2 4p^1$	$4s^2 4p^2$	$4s^2 4p^3$	$4s^2 4p^4$	$4s^2 4p^5$	

Key for Review Question

Element	Integer electronic structure	Complete electronic structure	Essential electronic structure	Valence
Li	2.1	$1s^2\ 2s^1$	$2s^1$	1
B	2.3	$1s^2\ 2s^2\ 2p^1$	$2s^2\ 2p^1$	3
Na	2.8.1	$1s^2\ 2s^2\ 2p^6\ 3s^1$	$3s^1$	1
Al	2.8.3	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$	$3s^2\ 3p^1$	3
K	2.8.8.1	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$	$4s^1$	1
Cl	2.8.7	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$	$3s^2\ 3p^5$	1

Section 3.3 THE PERIODIC TABLE Number of lesson periods: 2

Lesson Objectives

- To explain how the Periodic Table is organised based on atomic structure
- To classify elements based on electron configurations

Introduction

After learning the essential electronic structure of atoms, ask question why the outer electrons in an atom play the important role in the property of the element. After knowing the electron configuration of atom, introduce the fact that all of the known elements can be arranged in an informative array called the Periodic Table.

The purpose of learning this section is to understand how the Periodic Table is organised based on electronic structure and classify types of elements.

Teaching

By interpreting the Periodic Table (Figure 3.6), students should notice that elements are arranged from left to right and top to bottom in order of increasing atomic number. Order generally coincides with atomic mass. Teacher should ask them to describe the group number and period number of elements in the Periodic Table. The number of valence electrons indicates the group number, and the number of occupied electron shell refers to the period number in the Periodic Table.

More information for teacher

- In the modern Periodic Table, the group numbers were organised based on British system. For numbering the group, the letters A and B were designated to the left (A) and right (B) parts of the table according to the old IUPAC system. The new IUPAC system simply numbers the groups increasingly from left to right on the standard Periodic Table (group 1 to group 18). The number of vertical column (group number) stated by Roman letter I to VII and 0 has come to be referred to as the common or standard form, on account of its popularity.
- 118 elements known to us, out of which 92 are naturally occurring, while the rest have been prepared artificially.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the arrangement of elements in the Periodic Table.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

- To determine the position of unknown elements in the Periodic Table

Instruction

Resources and Preparation

- Blank Periodic Table

- Tell the students to do individually as follows:
- to read the descriptions of unknown elements in Table.
- to place the elements A to G in the correct position of blank Periodic Table (The letters A to G do not represent the chemical symbols of elements.)

Table Descriptions of Some Elements

Unknown Elements	Descriptions
A	It is present in all acids.
B	Its electron configuration is 2.8.1.
C	It is the smallest atom in group V.
D	Its symbol is Ne.
E	Its electron configuration is 2.1.
F	It has 17 electrons.
G	It has a relative atomic mass of 24.

Reflection on Learning

	I	II		III	IV	V	VI	VII	0
1	A								
2	E					C			D
3	B	G						F	
4									

Activity (2)

The teacher should identify this activity as an individual work.

Objective

- To categorise the given elements as metal, non-metal or metalloid

Instruction

- Tell the students to do individually as follows:
- to prepare the blank Periodic Table having the letters R, S, T, V and W (R, S, T, V and W are not the chemical symbols of the elements)
- to state the chemical symbols for given letters
- to categorise these elements as metal, non-metal or metalloid

	I	II		III	IV	V	VI	VII	0
1									
2				S				T	
3	R								V
4		W							

Reflection on Learning

R (Na in group I and period 3, metal)
S (B in group III and period 2, metalloid)
T (F in group VII and period 2, non-metal)
V (Ar in group 0 and period 3, non-metal)
W (Ca in group II and period 4, metal)

Key for Review Question

(a) Electronic structures

$_{10}A$ (2.8), $_{17}B$ (2.8.7), $_{3}C$ (2.1), $_{9}D$ (2.7), $_{11}E$ (2.8.1), $_{18}F$ (2.8.8), $_{19}G$ (2.8.8.1)

(b) Alkali metals = $_{3}C$, $_{11}E$, $_{19}G$

(c) Noble gases = $_{10}A$, $_{18}F$

(d) Halogens = $_{17}B$, $_{9}D$

(e) *s*- block elements = $_{3}C$, $_{11}E$, $_{19}G$

Section 3.4 PERIODIC PROPERTIES Number of lesson periods: 3

Lesson Objective

- To describe the periodic properties of common elements

Introduction

Teacher should initiate this lesson by asking the question that how the Periodic Table can be organised. The students should recognise that the Periodic Table shows the arrangement of elements in order of increasing proton number. Elements with similar properties reappear at regular intervals. And let the students predict the changes of the chemical and physical properties by using the trends of periodic properties in the Periodic Table.

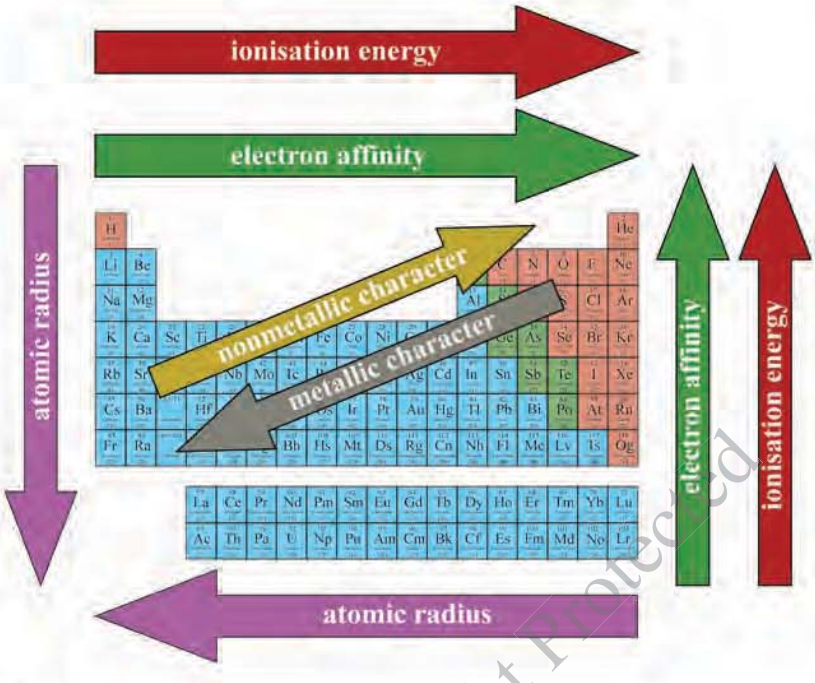
The purpose of learning this section is to understand the trends of periodic properties and to predict the chemical and physical properties of elements.

Teaching

By discussing the facts in Grade 10 Chemistry Textbook (Section 3.4), let the students describe the changes of the metallic character, electronegativity, sizes, ionisation energy and electron affinity of the elements in the Periodic Table. Teacher should ask the students to predict the given elements according to the trend of periodic property.

More information for teacher

- Periodic trends are specific patterns that are present in the Periodic Table to illustrate the changes in properties such as atomic radius, ionic radius, ionisation energy, metallic and non-metallic character, electron affinity, and electronegativity.
- Many periodic trends are general. In Grade 10 Chemistry Textbook, the overall trend is considered across a period from left to right or down a group of the Periodic Table.
- As the knowledge for teachers, to consider the trend, there is an increasing order approach using the following chart with detailed explanation.



- **Atomic radius:**
  - is a measure of a **neutral atom's size** based on **the radius of a sphere**;
  - **increases going down** because there are more energy levels of electrons and therefore **more repulsion between electrons**;
  - increases going left because as you move across a period from right to left, an atom has less number of protons and therefore its electrons become slightly **less tight and less compact.**
- **Ionic radius:**
  - is not the same as that of the parent neutral atom;
  - **increases for anions (negatively charged ions)** because they gain an electron, which leads to **more repulsion between electrons**;
  - **decreases for cations (positively charged ions)** because they lose an electron, which means **less repulsion between electrons.**
- **Ionisation energy:**
  - is the amount of **energy** needed **to remove an outer electron** from a gaseous atom to form a gaseous ion;
  - **increases going from left to right** because there are **more protons in the nucleus** pulling in electrons, so it **requires more energy** to remove an outer electron;
  - **increases going up** because there are fewer energy levels and **less repulsion between electrons**, so **the outer electrons are more tightly held** by the nucleus.

- **Metallic character:**
  - is the **tendency of an atom to lose an electron** (a key characteristic of **metals** is to **lose electrons** and form cations);
  - **increases going from right to left** because **metals are on the left** side of the Periodic Table and they have **fewer protons** in their nucleus that are holding in the outer electrons;
  - **increases going down** because there is **more repulsion**, so outer electrons are easier to lose.
- **Non-metallic character/ Electron affinity:**
  - is the **tendency of an atom to gain an electron** (a key characteristic of **non-metals** is to **gain electrons** to become anions);
  - **increases going right** because **non-metals are on the right** side of the Periodic Table and they have **more protons** in their nucleus that attract outer electrons;
  - increases **going up** because there are **less electron energy levels** and therefore a **greater attraction to the nucleus** for electrons.
- **Electronegativity:**
  - is the tendency of an atom **to attract a shared electron in a chemical bond**;
  - **increases going from left to right** because there are more protons in the nucleus attracting outer electrons;
  - **increases going up** because there are **fewer energy levels** of electrons repelling new outer electrons.
  - Fluorine is the most electronegative element because it has $2s^2\ 2p^5$ essential electron configuration. It is so closed to noble gas (Ne) electron configuration ($2s^2\ 2p^6$), thus the electrons are held tightly to the nucleus.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the relationships between electron configuration and their properties.

Activity (1)

Teacher should identify this activity as a group work in the class.

Objective

- To determine the periodic trends in electronegativity and atomic radii

Instruction

- Make the class into two groups; A and B
- Tell them to decide the trends of the following:

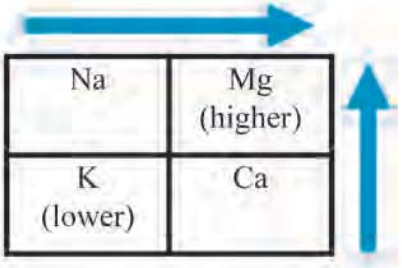
Resources and Preparation

- Elements that form rectangle in the Periodic Table

- Group A: electronegativity
- Group B: atomic radii

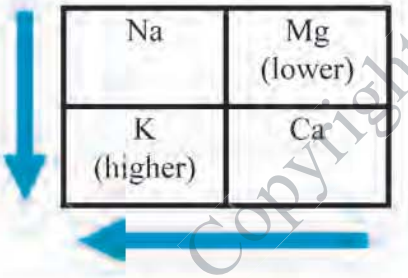
Reflection on Learning

- Group A:



(Electronegativity increases from left to right in a row and from bottom to top of a column.)

- Group B:



(Atomic radii increase from right to left in a row and from top to bottom of a column.)

Activity (2)

The teacher should identify this activity as a group work in the class.

Objective

- To determine the periodic trends in ionisation energy and electron affinity

Instruction

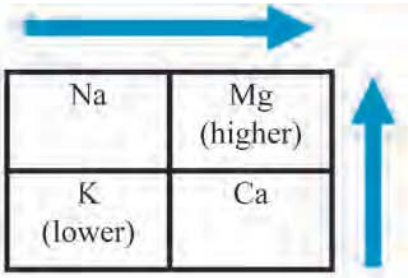
- Organise any elements that form rectangle or right angle in the Periodic Table e.g., (Ca, K, Mg, Na), (P, O, S), etc.
- Make them into two groups; A and B
- Tell them to decide the trends of the following:
- Group A: ionisation energy
- Group B: electron affinity

Resources and Preparation

- Elements that form rectangle or right angle in the Periodic Table

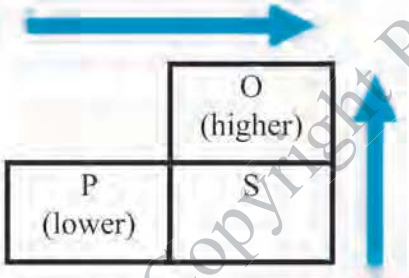
Reflection on Learning

- Group A:



(Ionisation energies increase from left to right in a row and from bottom to top of a column.)

- Group B:



(Electron affinity increases from left to right in a row and from bottom to top of a column.)

Key for Review Questions

(1) (a) Fe^{2+}, Fe^{3+}

Fe^{2+} is formed by removal of two electrons from Fe atom.

Fe^{3+} is formed by removal of three electrons from Fe atom.
They both have the same nuclear charges.

Number of electrons	$Fe^{2+} > Fe^{3+}$
Repulsion between electrons	$Fe^{2+} > Fe^{3+}$
Size	$Fe^{2+} > Fe^{3+}$

(b) Cl, Cl^-

Cl^- is formed by addition of one electron to Cl atom.

They both have the same nuclear charges.

Number of electrons	$Cl^- > Cl$
Repulsion between electrons	$Cl^- > Cl$
Size	$Cl^- > Cl$

(c) Li, Na, K

They are in the same group. Atomic radius increases from top to bottom in a group.

∴ K has the largest radius.

(d) C, N, O

They are in the same period. Atomic radius decreases from left to right across a period.

∴ C has the largest radius.

(2) They are in the same period. Ionisation energy increases from left to right across a period.

∴(c) 2.8.8 has the highest ionisation energy.

(3) carbon, nitrogen, oxygen, fluorine $\longrightarrow$ increasing electronegativity

Section 3.5 BONDS BETWEEN ATOMS Number of lesson periods: 3

Lesson Objective

- To understand the different types of bonds that form between atoms when molecules are formed

Introduction

There has been discussion in previous lesson about the trend of metallic and non-metallic characters in the Periodic Table. The teacher should ask the students to indicate where metals and non-metals are in the Periodic Table. From interpreting the changing in the metallic and non-metallic characters in the Periodic Table, the knowledge will be extended to the formation of different types of chemical bonds and illustration of electron dot-cross structure of a compound.

The purpose of learning this section is to understand the formation of ions and chemical bonds.

Teaching

Based on Section 3.5 (c) and Figure 3.8 from Grade 10 Chemistry Textbook, the teacher should ask the students to practise illustrating electron dot structures for ionic bond formation. By referring Section 3.5 (a to e) from Grade 10 Chemistry Textbook, let them sketch the electron dot-cross formulae for ionic and covalent compounds. Students have to differentiate between ionic and covalent compounds according to Table 3.2 from Grade 10 Chemistry Textbook. Students also have to notice the fact that atoms combine with each other in order to gain a stable arrangement (eight electrons) of outer- shell electrons (Octet Rule).

More information for teacher

- To reach the most stable (lowest energy) state, the atom gains or loses or shares electrons via chemical bonds. In general, the loss of an electron by one atom and gain of an electron by another atom must happen at the same time and form the ionic bond between these oppositely charged ions.
- In another way, atoms can become more stable by sharing electrons, thus forming covalent bonds. Covalent bonds are more common than ionic bonds in the molecules of living organisms.
- The composition, solubility, volatility and electrical conductivity of ionic and covalent compounds depend on the type of bonding in each compound.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the different ways of forming chemical bonds between atoms.

Activity (1)

The teacher should identify this activity as an individual work in the class.

Objective

- To draw electron dot diagrams using valence electrons of each atom

Instruction

- Tell the students to do individually as follows:
- to mention the type of various elements
- to determine the number of valence electrons in each atom
- to draw their electron dot diagrams

Resources and Preparation

- Elements, e.g., O, C, S, Na, Al, Br, N, B, Li, He, F, Ca, Be, K, etc.

Reflection on Learning

For example, $_{8}O$

- Non-metal
- Number of valence electrons = 6 (electronic structure = 2.6)
- Dot diagram 

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To distinguish between ionic and covalent compounds based on their physical properties

Instruction

- Make the class into two groups: A and B
- Tell them to mention the physical properties of the following compounds:
- Group A: ionic compounds
- Group B: covalent compounds

Reflection on Learning

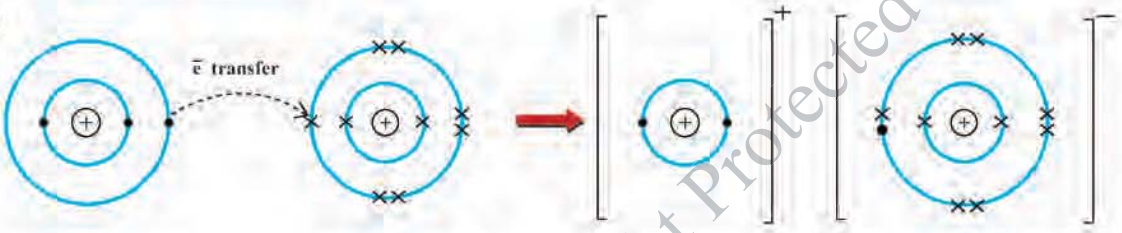
- Refer to Grade 10 Chemistry Textbook

Resources and Preparation

- Encourage the students to find the physical properties and examples of ionic and covalent compounds by using Grade 10 Chemistry Textbook / online resources before discussion.

Key for Review Questions

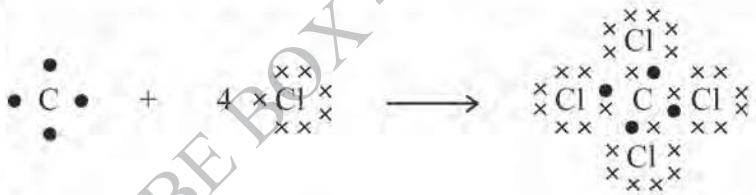
(1)



Lithium (2.1) Fluorine (2.7) Lithium ion (2) Fluoride ion (2.8)

- Lithium reacts with fluorine to form lithium fluoride. In this reaction, a lithium atom loses an electron to become a lithium ion, Li^+. The electron is taken by a fluorine atom to become a fluoride ion, F^-. There is transfer of an electron from lithium atom to the fluorine atom.

(2)



SUMMARY

The highlights of this chapter:

- the structure of atoms, including the masses, electrical charges, and locations of protons, neutrons, and electrons
- the number of sub-atomic particles that relates the atomic number (Z) and mass number (A) of the element, and the terms isotopes and isobars
- classification of elements into metals, non-metals and metalloids based on their properties, which are correlated with their positions in the Periodic Table
- two main categories in the Periodic Table: Groups (the 18 vertical columns) and Periods (the 7 horizontal rows)
- *s*-block elements (groups I and II) and *p*-block elements (groups III through VII and 0)

- the periodic properties, viz., atomic size, electronegativity, ionisation energy, and electron affinity, vary within a period and a group
- the valence of the atom which is very useful for the formation of chemical bond
- the octet electron configuration of noble gas which influence the chemical bonding
- two types of chemical bonds: viz., ionic bond and covalent bond

KEY FOR EXERCISES **Number of review exercises periods: 2**

1. **Critical thinking**

(a) FALSE because isotopes are atoms of the same element with different number of neutrons.
(b) TRUE
(c) TRUE
(d) TRUE
(e) FALSE because the fundamental particle not present in a hydrogen atom is neutron.
(f) FALSE because the mass of electron is $\frac{1}{1837}$ amu and the mass of proton is 1 amu.

Understanding key ideas (Q.2 to Q.4)

2.

List A	**List B**
(a) proton	(v) in the nucleus
(b) alkali metals	(iv) lowest electron affinity
(c) sharing electrons	(ii) covalent bond
(d) number of electrons in the main n^{th} shell	(iii) $2 \times n^2$ (n = shell number)
(e) atomic size	(i) increases down the group

3. (a) isotopes (b) nucleons (c) increases (d) higher (e) 1 (f) nucleus

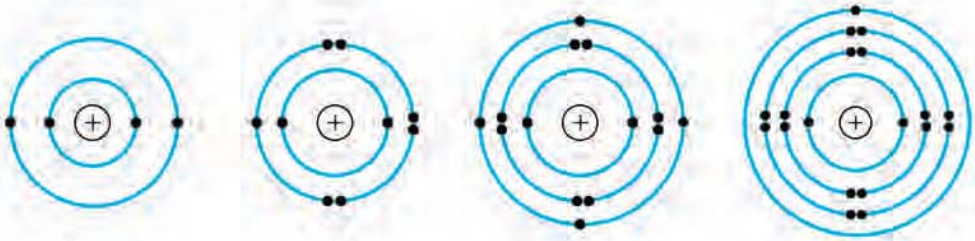
4. (a) hydrogen (b) group number (c) Z (2.8.7) (d) 6 (e) Cl^-

5. (a) **Creativity**

Element	Electrons	Neutrons	Protons	Complete electronic structure
$^{12}_{6}C$	6	6	6	$1s^2\ 2s^2 2p^2$
$^{56}_{26}Fe$	26	30	26	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$
$^{35}_{17}Cl$	17	18	17	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
$^{40}_{20}Ca$	20	20	20	$1s^2\ 2s^2 2p^6\ 3s^2\ 3p^6 4s^2$
$^{48}_{22}Ti$	22	26	22	$1s^2\ 2s^2 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$
$^{55}_{25}Mn$	25	30	25	$1s^2\ 2s^2 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^5$
$^{45}_{21}Sc$	21	24	21	$1s^2\ 2s^2 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$

(b) (i) $^{35}_{17}Cl$ (ii) $^{24}_{12}Mg$ (iii) $^{9}_{4}Be$ (iv) $^{39}_{19}K$

6. (a) **Understanding key ideas**



(b)	$^{9}_{4}Be$	$^{19}_{9}F$	$^{28}_{14}Si$	$^{39}_{19}K$
valence	2	1	4	1
neutron	5	10	14	20

7. (a) **Critical thinking**

(i) $1s^2\ 2s^2 2p^6$ (ii) $1s^2 2s^2\ 2p^5$ (iii) $1s^2\ 2s^2\ 2p^6\ 3s^2 3p^3$ (iv) $1s^2\ 2s^2\ 2p^6\ 3s^2 3p^6\ 4s^1$

(b) (i) $_{11}Na$ (ii) $_{7}N$ (iii) $_{17}Cl$

8. **Understanding key ideas**

(a) $[He]\ 2s^1$ = Li (b) $[Ne]\ 3s^2\ 3p^3$ = P (c) $[Ar]\ 4s^2$ = Ca

9. **Critical thinking** (a), (b)

Element	Complete electronic structure	Essential electronic structure	Group	Period	Valence
$_{3}Li$	$[He]\ 2s^1$	$2s^1$	I	2	1
$_{8}O$	$[He]\ 2s^2\ 2p^4$	$2s^2\ 2p^4$	VI	2	2
$_{12}Mg$	$[Ne]\ 3s^2$	$3s^2$	II	3	2
$_{13}Al$	$[Ne]\ 3s^2 3p^1$	$3s^2 3p^1$	III	3	3
$_{17}Cl$	$[Ne]\ 3s^2\ 3p^5$	$3s^2\ 3p^5$	VII	3	1
$_{20}Ca$	$[Ar]\ 4s^2$	$4s^2$	II	4	2

(c) Mg is in period 3 and group II. **(Understanding key ideas)**

10. **Critical thinking**

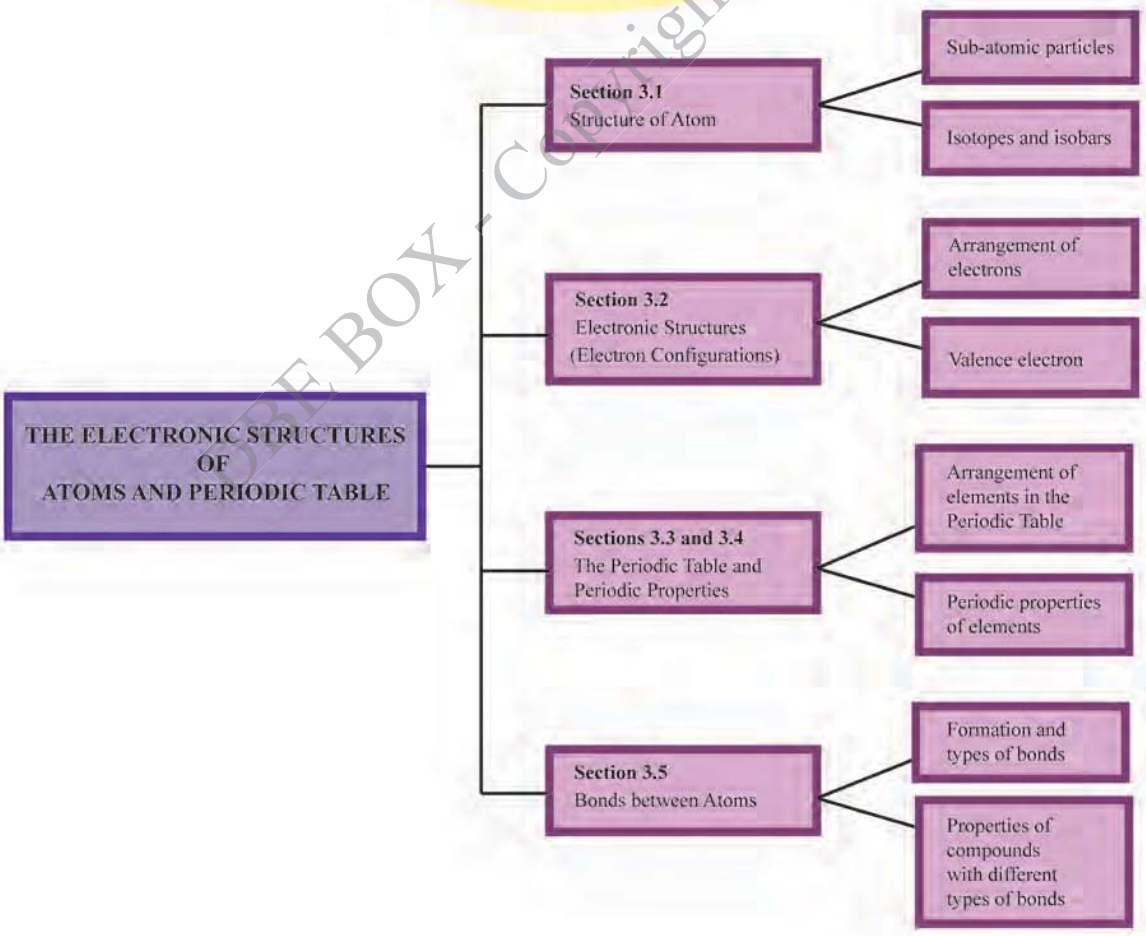
(a) X (2.8.6), group = VI; (b) name = sulphur, symbol = S;
(c) 3 (d) non-metal (e) 16

11. **Application**

	Element X	Element Y	Element Z
atomic number	11	6	16
number of protons	11	6	16
number of neutrons	12	6	16
mass number	23	12	32
electronic structure	2.8.1	2.4	2.8.6
valence	1	4	2
position in Periodic Table	group I, period 3	group IV, period 2	groupVI, period 3

(a) Element **X** is metal. (b) Ionic bond exists between **X** and **Z**; formula = X_2Z

CHAPTER REVIEW



CHAPTER 4

THE QUANTITIES OF SUBSTANCES: CHEMICAL CALCULATIONS

Total Number of Lesson Periods: 22 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:
- calculate relative atomic mass of elements;
- calculate relative molecular mass and relative formula mass of substances;
- write chemical symbols, formulae, word equations and chemical equations based on information provided;
- solve problems based on chemical equations;
- determine the molar volume of the gas based on information provided;
- explain the connection between the mole and Avogadro's constant;
- solve mole calculations;
- solve the mole ratio of the reactants and products based on balanced chemical equations.

Skill Development

- Collaboration (when working successfully in groups)
- Communication (when reporting progress on exercises and activities)
- Critical Thinking and Problem Solving (when finding solutions to problems)

Support Materials

- Table with four blank columns, rice grain, a glass of water

Section 4.1 RELATIVE MASSES OF ATOMS AND MOLECULES

Number of lesson periods: 3

Lesson Objectives

- To determine relative atomic mass of elements
- To determine relative molecular mass and relative formula mass of substances

Introduction

Teacher should start the Section 4.1 with leading questions based on prior knowledge like that: atoms and molecules are the same or not, and name of element which has the same number of protons but different number of neutrons. Mass of an atom is so small to measure directly but it can be measured by comparing with the lightest atom (hydrogen). Atoms and molecules have mass. The purpose of this section is to determine relative molecular mass of substances based on the relative atomic mass.

Teaching

Teacher should explain how to distinguish and determine relative atomic mass, relative molecular mass and formula mass. Teacher should correlate students' knowledge in measuring the mass of atom by using new standard carbon-12 scale and basic unit of 1 amu.

Teacher should remind that relative atomic mass is the most fundamental key for calculation of relative molecular mass of compounds and formula mass of salts.

Teacher should encourage to practise more calculations of relative molecular mass and formula mass by pointing out the differences between molecular compounds and ionic compounds (salts).

More information for teacher

- The fulfillment of study on chemistry essentially depends on the calculation for the amount of substance participating in the chemical reactions. Chemical calculation is the part of chemistry which deals with quantities of substances taking part in the chemical reactions.
- Teacher should contribute the knowledge about the seven basic measurements (viz., mass, length, amount of substance, intensity of light, electric current, time, and temperature). These measurements can be expressed in units such as amount of substance in mole (mol), mass of substance in gram (g) or amu, volume in cubic centimeter (cm^3) or cubic decimeter (dm^3) or litre (L) and time in second (s) or minute (min) or hour (h), etc.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the relative atomic mass of atoms and molecules.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To distinguish between the formula mass and molecular mass of compounds

Instruction

- Make the class into two groups: A and B
- Tell them to calculate the following:
- Group A: formula mass of salts
- Group B: molecular mass of molecular compounds

Resources and Preparation

- Given: copper(II) sulphate ($CuSO_4$), sulphuric acid (H_2SO_4), lead(II) nitrate ($Pb(NO_3)_2$), potassium permanganate ($KMnO_4$), nitric acid (HNO_3), ethanoic acid (CH_3COOH), sugar ($C_{12}H_{22}O_{11}$), urea ($CO(NH_2)_2$), ammonia (NH_3), distilled water (H_2O)

Reflection on Learning

- The teacher should make questions which are composed of molecules and which are not. Copper(II) sulphate, lead(II) nitrate and potassium permanganate are salts and calculate as formula mass, and the rest are calculated as molecular mass.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To classify the ionic and molecular compounds

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the following:
- Group A: types of elements in the given compound
- Group B: types of bonds
- Group C: types of compounds

Resources and Preparation

- Given: KI, H_2O_2, $CHCl_3$, Li_2CO_3

Reflection on Learning

Compound	Types of elements		Types of bond	Types of compound
	Metal	Non-metal		
KI	K	I	ionic	ionic
H_2O_2		H,O	covalent	molecular (or) covalent
$CHCl_3$		C,H,Cl	covalent	molecular (or) covalent
Li_2CO_3	Li	C,O	ionic	ionic

Key for Review Questions

(1) Relative formula mass of sodium chloride (NaCl) = Relative atomic mass of one sodium atom + Relative atomic mass of one chlorine atom

= 23 + 35.5

= 58.5

(2) Relative molecular mass of glucose = Relative atomic masses of six carbon atoms + Relative atomic masses of twelve hydrogen atoms + Relative atomic masses of six oxygen atoms

$(C_6H_{12}O_6)$ = 6×12 + 12×1 + 6×16

= 72 + 12 + 96

= 180

Section 4.2 CHEMICAL SYMBOLS, FORMULAE, WRITING AND NAMING FORMULAE

Number of lesson periods: 5

Lesson Objective

- To understand the symbols of the elements and formulae (empirical and molecular formulae) of the compounds

Introduction

Based on the relative masses of atoms and molecules in the previous section, how would you determine formula mass of sodium chloride (table salt)? In this section, teacher should focus that how chemical symbols of elements (Tables 4.1 and 4.2) and valencies are correlated with each other. Moreover, determination of empirical formulae and molecular formulae should be carried out (Table 4.3).

The purpose of studying this section is to understand the correct symbols and formulae of elements and compounds.

Teaching

Teacher should ask the students to distinguish between symbols and formulae by refreshing the knowledge that they have learnt. Teacher should explain in detail molecular formulae and percent composition of elements in compounds, formulae for non-molecular compounds, empirical formula and molecular formula with examples. For writing and naming compounds, teacher should emphasise combining capacity and common oxidation number of elements shown in Table 4.4. Moreover, teacher should give clear explanation on the writing and naming rules for binary compounds, acids and acid radicals, bases and basic radicals (Tables 4.5 and 4.6), salts and hydroxides and make more practices.

More information for teacher

- Each element possesses its own symbol and name (English name and Latin name).
- The main difference between valence and oxidation number is that valence is the combing capacity of an element whereas oxidation number is the charge on an atom when it combines with other atoms.
- Valence is only a number and does not have positive or negative sign whereas oxidation number is a number with positive or negative sign. The symbol of ion form has to be stated with the number followed by the positive or negative charge as a superscript.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the analyses of formulae for molecular and non-molecular compounds.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To understand the naming system of compounds with fixed or variable oxidation numbers of first element

Instruction

- Make the class into three groups: A, B and C.
- Tell them to select and name the compounds with the following oxidation number:
- Group A: fixed oxidation number of basic radicals
- Group B: variable oxidation number of basic radicals
- Group C: variable oxidation number of non-metallic elements in their oxides

Resources and Preparation

- Given: NaCl, CaO, $FeCl_2$, HgO, N_2O, CuO, $PbCl_2$, PbO_2, PbO, $SnCl_2$, Fe_2O_3, P_4O_{10}, SO_3, $AlCl_3$, ZnO, NO_2, NO, CO, CO_2, etc.

Reflection on Learning

- Group A: NaCl (sodium chloride), CaO (calcium oxide), $AlCl_3$ (aluminium chloride), ZnO (zinc oxide)
- Group B: $FeCl_2$ (iron(II) chloride), HgO (mercury(II) oxide), CuO (copper(II) oxide), $PbCl_2$ (lead(II) chloride), PbO_2 (lead(IV) oxide), PbO (lead(II) oxide), $SnCl_2$ (tin(II) chloride), Fe_2O_3 (iron(III) oxide)
- Group C: N_2O (dinitrogen oxide), P_4O_{10} (phosphorus(V) oxide), SO_3 (sulphur trioxide), NO_2 (nitrogen dioxide), NO (nitrogen oxide), CO_2 (carbon dioxide), CO (carbon monoxide)

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe the names and chemical formulae of compounds

Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the following based on the given cations and anions:
- Group A: oxidation number of cation
- Group B: oxidation number of anion
- Group C: compound formula
- Group D: compound name

Resources and Preparation

- Table with four blank columns

Reflection on Learning

Cation	Oxidation number	Anion	Oxidation number	Compound formula	Name of compound
Na^+	+1	OH^-	−1	NaOH	sodium hydroxide
Mg^{2+}	+2	PO_4^{3-}	−3	$Mg_3(PO_4)_2$	magnesium phosphate
Ca^{2+}	+2	Cl^-	−1	$CaCl_2$	calcium chloride
Cu^{2+}	+2	OH^-	−1	$Cu(OH)_2$	copper(II) hydroxide
Zn^{2+}	+2	Br^-	−1	$ZnBr_2$	zinc bromide
Mn^{2+}	+2	S^{2-}	−2	MnS	manganese(II) sulphide
B^{3+}	+3	O^{2-}	−2	B_2O_3	boron oxide
K^+	+1	NO_3^-	−1	KNO_3	potassium nitrate
Ba^{2+}	+2	Br^-	−1	$BaBr_2$	barium bromide

Key for Review Questions

(1)

	Name of compound	Molecular formula	Empirical formula
(a)	hydrazine	N_2H_4	NH_2
(b)	octane	C_8H_{18}	C_4H_9
(c)	benzene	C_6H_6	CH
(d)	ammonia	NH_3	NH_3

(2)

	C	H
The percent by mass	90	10
Divided by relative atomic mass	90/12	10/1
	7.5	10
	3	4

Empirical formula C_3H_4

(3)

Name	Formula
magnesium sulphate	$MgSO_4$
potassium carbonate	K_2CO_3
lead(II) chloride	$PbCl_2$
zinc oxide	ZnO
ammonium sulphate	$(NH_4)_2SO_4$
aluminium chloride	$AlCl_3$
sulphur trioxide	SO_3
sodium bromide	$NaBr$

Experimental Work

Number of practical periods: 2

Suggestion for Practical

- Refer to Grade 10 Experimental Chemistry, Experiment 4.

Experiment 4 Determination of the Empirical Formula of Magnesium Oxide

In this experiment, teacher should explain the procedure described in the Grade 10 **Experimental Chemistry** and discuss the theory concerning with this experiment. Teacher should demonstrate how to manipulate the apparatus. Teacher should remind the caution that must be followed. Before asking to do this experiment, teacher should be well-prepared. Heat is required in this experiment so that teacher must pay attention to the students and ask for manipulating apparatus carefully.

Section 4.3 CHEMICAL EQUATIONS

Number of lesson periods: 4

Lesson Objectives

- To write word and symbolic equations based on information provided
- To understand how to write and interpret chemical equations with physical states

Introduction

Since students have a good analysing skill from Section 4.2, teacher should ask them to distinguish between empirical and molecular formulae with some examples. Teacher should indicate the importance of chemical equation in which substances are consumed in the reaction and what new substances are formed. Systematic teaching for writing chemical equations are essential because equations are life of chemistry. The purpose of the study of this section is to write systematic balanced chemical equations.

Teaching

Teacher should notice that a chemical equation is a chemist's shorthand expression for describing a chemical change and it must be balanced to confirm Law of Conservation of Mass. As described in Grade 10 Chemistry Textbook (Section 4.3), teacher should systematically explain step by step in writing chemical equations and importance of physical states of the reactants and products. Ionic equations and spectator ions can be distinguished in this section.

More information for teacher

- In writing chemical equation, there are two facts to be understood. They are subscripts, which are part of the chemical formulae of the reactants and products and coefficients, which are placed in front of the formulae to indicate how many molecules of that substance is used or produced.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on writing the chemical equation.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To write the correct formulae of the substances in a chemical equation (not necessary to balance the equation)

Instruction

- Tell the students to write chemical equations in symbols for the following chemical reactions:
- sodium combines with chlorine to produce sodium chloride.
- sulphuric acid and sodium hydroxide react to form sodium sulphate and water.
- aluminum reacts with oxygen to produce aluminum oxide.
- liquid carbon disulphide reacts with oxygen gas to produce carbon dioxide and sulphur dioxide gases.

- aqueous barium chloride solution is added to aqueous sodium sulphate to produce barium sulphate as a precipitate.
- calcium carbonate decomposes to calcium oxide and carbon dioxide.
- solid ammonium nitrate decomposes to dinitrogen oxide gas and water.

Reflection on Learning

- $Na + Cl_2 \longrightarrow NaCl$
- $H_2SO_4 + NaOH \longrightarrow Na_2SO_4 + H_2O$
- $Al + O_2 \longrightarrow Al_2O_3$
- $CS_2 + O_2 \longrightarrow CO_2 + SO_2$
- $Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + NaCl$
- $CaCO_3 \longrightarrow CaO + CO_2$
- $NH_4NO_3 \longrightarrow N_2O + H_2O$

Activity (2)

The teacher should identify this activity as an individual work.

Objective

- To balance the above chemical equations by the Law of Conservation of Mass

Instruction

- Ask some questions as follows:
- describe what the reactants and products are in above chemical equations
- balance the chemical equations
- describe coefficients and symbols for each substance in above chemical equations

Reflection on Learning

- The substances on the left hand side are reactants and the substances on the right hand side are products.
- $2Na(s) + Cl_2(g) \longrightarrow 2NaCl(s)$
- $H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$
- $4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$
- $CS_2(l) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g)$
- $Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$
- $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$
- $NH_4NO_3(s) \longrightarrow N_2O(g) + 2H_2O(l)$

Key for Review Questions

(1) (a) sodium + chlorine ⟶ sodium chloride

$2Na(s) + Cl_2(g) \longrightarrow 2NaCl(s)$

(b) sodium + water ⟶ sodium hydroxide + hydrogen

$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

(c) zinc + sulphuric acid ⟶ zinc sulphate + hydrogen

$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$

(2) $Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$

$Zn(s) + Cu^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow Cu(s) + Zn^{2+}(aq) + SO_4^{2-}(aq)$

$Zn(s) + Cu^{2+}(aq) \longrightarrow Cu(s) + Zn^{2+}(aq)$

Section 4.4 THE MOLE CONCEPT Number of lesson periods: 5

Lesson Objectives

- To understand the calculations involving the molar mass, number of moles and the mass of a substance
- To determine the mole ratio of the reactants and products by using balanced chemical equations

Introduction

Teacher should recall the relative atomic mass and relative molecular mass, the usefulness of chemical equations that have been learnt in the previous sections. The relative atomic mass or relative molecular mass of a substance expressed in gram is the mass of one mole of that substance (molar mass).

Teacher should emphasise that mole is the principal way of measuring in chemical substances. Conversion of the quantity of substances from mass or volume to mole as well as molecules or formula units can be practically focused in this section.

The purpose of studying this section is to apply the amount of chemical substances in terms of mole.

Teaching

Teacher should explain that mole is a junction point of the chemical reaction. The importance and correlation of mole and Avogadro's constant according to Amedeo Avogadro are described in Grade 10 Chemistry Textbook (Section 4.4). Students must recognise the relation between mole and other parameters: molar volume, molar mass and numbers of particles. Molar volume of gas at r.t.p. and STP should be noticed distinctively.

More information for teacher

- Avogadro's constant is a key factor for the quantitative determination of the numbers of atoms, molecules, formula units, ions and electrons. For example, one mole of nitrogen gas contains 6.02×10^{23} **molecules**. One molecule of nitrogen gas contains 2 **atoms** of nitrogen. Thus, one mole of nitrogen gas contains **($2 \times 6.02 \times 10^{23}$) atoms** of nitrogen or (**2 mol** of nitrogen **atoms**). It is noted that molecule is used for covalent or molecular compound, however, formula unit is used for ionic or electrovalent compound.
- For determination of the volume of gas, there are two conditions; STP and r.t.p. For STP condition, one mole of any gas has a volume of **22.4 dm^3** at standard temperature (0 °C) and pressure (1 atm). For r.t.p. condition, one mole of any gas has a volume of **24 dm^3** at room temperature (25 °C) and pressure (1 atm).

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the mole concept and application in calculation.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe Avogadro's constant as 'HUGE NUMBER' (6.02×10^{23})

Instruction

- Make the class into three groups: A, B and C
- Let them assume 1 grain of rice = 1 molecule and tell them to estimate the following:
- Group A: the number of persons to consume one mole of rice for 1 day
- Group B: the mole and number of water molecules in one glass of water
- Group C: the mole and molecules in an inflate balloon at r.t.p.

Resources and Preparation

- Mass of a rice grain (~ 0.03 g), mass of rice to be consumed by 1 person in 1 day (~ 600 g),
- A glass of water (containing 180 g of water), molar mass of water (18 g / mol)
- Molar volume of gas at r.t.p. (24 dm^3)

Reflection on Learning

Group A: 1 mole of grains = 6.02×10^{23} grains

No. of rice grains consumed by 1 person in 1 day = 600 g / 0.03 g = 2×10^4 grains

No. of persons to consume 1 mole of rice = $(6.02 \times 10^{23}) / (2 \times 10^4) \approx 3 \times 10^{19}$

- Group B: 1 glass of water = 180 g of water
  No. of mole of water in 1 glass = 180 g / 18 g mol^{-1} = 10 mol
  No. of water molecules = 10 × 6.02 × 10^{23} = 6.02 × 10^{24} molecules
- Group C: 1 inflate balloon = 2.4 dm^3 at r.t.p.
  No. of mole of air in one balloon = 2.4 dm^3 / 24 dm^3 mol^{-1} = 0.1 mol
  No. of air molecules = 0.1 × 6.02 × 10^{23} = 6.02 ×10^{22} molecules

Note : the unit of mole is mol.

Activity (2)

The teacher should identify this activity as an assignment work.

Objective

- To prove the molar mass of carbon-12 as 12

Instruction

- Calculate the molar mass of C-12. (Given: The mass of one proton is 1 amu. The mass of one neutron is 1 amu. The mass of electron can be negligible. 1 amu = 1.66 × 10^{-24} g)

Reflection on Learning

Carbon-12 has 6 protons and 6 neutrons.
mass of one proton = 1 amu
mass of one neutron = 1 amu
mass of one atom of carbon = (6 × 1 amu) + (6 × 1 amu) = 12 amu
The mass of one mole of C-12 atom = 12 × 1.66 × 10^{-24} g × 6.02 × 10^{23}
= **11.99 g ≈ 12 g**
(It is equal to molar mass of carbon.)

Key for Review Questions

(1) molar mass of sulphur = 32 g mol^{-1}
mole of sulphur = mass of sulphur / molar mass of sulphur = 10.7 g / 32 g mol^{-1}
= **0.3344 mol**

(2) molar mass of carbon dioxide = 12 + 32 = 44 g mol^{-1}
mass of carbon dioxide = mole of carbon dioxide × molar mass of carbon dioxide
= 0.20 mol × 44 g mol^{-1} = **8.8 g**

(3) (a) molar mass of FeS = 56 + 32 = 88 g mol^{-1}
mole of FeS = mass of FeS / molar mass of FeS = 56 g / 88 g mol^{-1}
= **0.6364 mol**

(b) 1 mole of FeS contains 6.02×10^{23} molecules.
Molecules contained in FeS = 0.6364 mol × 6.02×10^{23} molecules
= **3.831×10^{23} molecules**

(4) (a) number of mole of SO_2 gas = (volume of gas (in dm^3)) / (molar volume of gas at r.t.p.)
= 1.2 dm^3 / 24 dm^3 mol^{-1} at r.t.p. = **0.05 mol**

(b) number of mole of CH_4 = (volume of gas (in dm^3)) / (molar volume of gas at r.t.p.)
= 0.24 dm^3 / 24 dm^3 mol^{-1} at r.t.p. = **0.01 mol**

(c) number of mole of CO_2 = (volume of gas (in dm^3)) / (molar volume of gas at r.t.p.)
= 120×10^{-3} dm^3 / 24 dm^3 mol^{-1} at r.t.p. = **0.005 mol**

SUMMARY

The highlights of this chapter:

- the mass of an atom (atomic mass) which is impossible to measure the mass of an individual atom and thus, compared with the standard mass (atomic mass unit- amu)
- one amu which is equivalent to one-twelfth the mass of one atom of C-12
- symbols of elements, formulae of elemental molecule and compound molecule
- the concept of combining capacity or valence of an element in the compound
- empirical formulae and molecular formulae
- balanced chemical equations and moles of reactants and products involved in the chemical reactions
- the relationship among the mole of substances, mass of substances (molar mass), numbers of atoms and molecules (Avogadro's number), volume of gaseous substance (molar volume) involved in the chemical reactions

KEY FOR EXERCISES

Number of review exercises periods: 3

1. **Understanding key ideas**

List A	List B
(a) Number of acid radicals in H_2SO_4	(v) 2
(b) The mass of a compound of giant structure	(iv) formula mass
(c) The formula of magnesium oxide	(ii) MgO
(d) Molar volume of gas	(i) 24 dm^3 at r.t.p.
(e) The mass of a mole of substance	(iii) molar mass

Problem solving and Critical thinking (Q.2 to Q.10)

2. (a)

	C	O
The mass of each element	3.0	4.0
Divided by relative atomic mass	$\frac{3.0}{12}$	$\frac{4.0}{16}$

		0.25	0.25
		1	1
	Empirical formula	**CO**	
(b)		Fe	O
	The percent by mass	77.7	22.3
	Divided by relative atomic mass	$\frac{77.7}{56}$	$\frac{22.3}{16}$
		1.4	1.4
		1	1
	Empirical formula	**FeO**	
(c)		H	O
	The mass of each element	1	8
	Divided by relative atomic mass	$\frac{1}{1}$	$\frac{8}{16}$
		1	0.5
		2	1
	Empirical formula	**H_2O**	

3. For compound A,
Empirical formula mass of C_3H_5 $= (3 \times 12) + (5 \times 1) = 41$
molecular formula = n × empirical formula (n = 1,2,3,...)

$$n = \frac{\text{molecular formula mass}}{\text{empirical formula mass}} = \frac{82}{41} = 2$$

Molecular formula = $2 \times C_3H_5$ = **C_6H_{10}**

For compound B,
Empirical formula mass of CCl_3 = $12 + (3 \times 35.5) = 118.5$

$$n = \frac{237}{118.5} = 2$$

Molecular formula = $2 \times CCl_3$ = **C_2Cl_6**

For compound C,

Empirical formula mass of CH_2 = $12 + (2 \times 1)$ = 14

$$n = \frac{112}{14} = 8$$

Molecular formula = $8 \times CH_2$ = **C_8H_{16}**

4. (a)

	C	H
The percent by mass	80	20
Divided by relative atomic mass	$\frac{80}{12}$	$\frac{20}{1}$
	$\frac{20}{3}$	$\frac{20}{1}$
	1	3

Empirical formula **CH_3**

(b) Empirical formula mass of CH_3 = $12 + (3 \times 1)$ = 15

$$n = \frac{30}{15} = 2$$

Molecular formula = $2 \times CH_3$ = **C_2H_6**

5. (a)

	C	H	O
The percent by mass	39.9	6.7	53.4
Divided by relative atomic mass	$\frac{39.9}{12}$	$\frac{6.7}{1}$	$\frac{53.4}{16}$
	3.3	6.7	3.3
	1	2	1

Empirical formula **CH_2O**

(b) Empirical formula mass of CH_2O = $12 + (2 \times 1) + 16$ = 30

$$n = \frac{60}{30} = 2$$

Molecular formula = $2 \times CH_2O$ = **$C_2H_4O_2$**

6. Molar mass of H_2O_2 = $(2 \times 1) + (2 \times 16)$ = 34 g mol^{-1}

$$\text{Mole of } H_2O_2 = \frac{\text{mass of } H_2O_2}{\text{molar mass of } H_2O_2} = \frac{1.7 \text{ g}}{34 \text{ g mol}^{-1}} = 0.05 \text{ mol}$$

$2H_2O_2$ (l) $\longrightarrow$ $2H_2O$ (l) + O_2(g)

2 mol 1 mol

$$\frac{\text{number of moles of } O_2}{\text{number of moles of } H_2O_2} = \frac{1}{2}$$

number of moles of $O_2 = \frac{1}{2} \times$ number of moles of $H_2O_2 = \frac{1}{2} \times 0.05$ mol $= 0.025$ mol

volume in dm^3 of O_2 at r.t.p. = number of moles of $O_2 \times 24\ dm^3\ mol^{-1}$ at r.t.p.

$= 0.025\ mol \times 24\ dm^3\ mol^{-1} = 0.6\ dm^3 =$ **600 cm^3**

7. Molar mass of $SnO_2 = 119 + (2 \times 16) = 151\ g\ mol^{-1}$

$$\text{Mole of } SnO_2 = \frac{\text{mass of } SnO_2}{\text{molar mass of } SnO_2} = \frac{14\ g}{151\ g\ mol^{-1}} = 0.092\ mol$$

$SnO_2(s) + 2C(s) \longrightarrow Sn(s) + 2CO(g)$

1 mol 2 mol

$$\frac{\text{number of moles of C}}{\text{number of moles of } SnO_2} = \frac{2}{1}$$

number of moles of C = $2 \times$ number of moles of $SnO_2 = 2 \times 0.092$ mol $= 0.184$ mol

mass of C = number of moles of C $\times 12\ g\ mol^{-1} = 0.184\ mol \times 12\ g\ mol^{-1}$

= **2.208 g**

8. Molar mass of octane $C_8H_{18} = (8 \times 12) + (18 \times 1) = 114\ g\ mol^{-1}$

$$\text{Mole of octane} = \frac{\text{mass of octane}}{\text{molar mass of octane}} = \frac{68.4\ g}{114\ g\ mol^{-1}} = 0.6\ mol$$

Number of molecules of octane = number of moles of octane $\times 6.02 \times 10^{23}$ molecules mol^{-1}

$= 0.6\ mol \times 6.02 \times 10^{23}$ molecules mol^{-1}

= **3.612×10^{23} molecules**

9. Molar mass of bromine $Br_2 = 2 \times 80 = 160\ g\ mol^{-1}$

$$\text{Mole of } Br_2 = \frac{\text{mass of } Br_2}{\text{molar mass of } Br_2} = \frac{4\ g}{160\ g\ mol^{-1}} = 0.025\ mol$$

Number of molecules of Br_2 = number of moles of $Br_2 \times 6.02 \times 10^{23}$ molecules mol^{-1}

$= 0.025\ mol \times 6.02 \times 10^{23}$ molecules mol^{-1}

$= 0.1505 \times 10^{23}$ molecules

1 molecule of bromine contains 2 atoms of bromine.

0.1505×10^{23} molecules contain $2 \times 0.1505 \times 10^{23}$ atoms = **0.301×10^{23} atoms**

10. (a) $Na_2CO_3(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$

(b) Molar mass of $Na_2CO_3 = (2 \times 23) + 12 + (3 \times 16) = 106\ g\ mol^{-1}$

$$\text{Number of moles of } Na_2CO_3 = \frac{\text{mass of } Na_2CO_3}{\text{molar mass of } Na_2CO_3} = \frac{4.15\ g}{106\ g\ mol^{-1}} = 0.0392\ mol$$

$Na_2CO_3(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$

1 mol 2 mol

$$\frac{\text{number of moles of HCl}}{\text{number of moles of } Na_2CO_3} = \frac{2}{1}$$

number of moles of HCl $= 2 \times$ number of moles of $Na_2CO_3 = 2 \times 0.0392$ mol

$= \mathbf{0.0784\ mol}$

11. **Application**

(a) $Na_2SO_4(aq) + Ba(NO_3)_2(aq) \longrightarrow BaSO_4(s) + 2\ NaNO_3(aq)$

$2\ Na^+(aq) + SO_4^{2-}(aq) + Ba^{2+}(aq) + 2NO_3^-(aq) \longrightarrow BaSO_4(s) + 2\ Na^+(aq) + 2NO_3^-(aq)$

$SO_4^{2-}(aq) + Ba^{2+}(aq) \longrightarrow BaSO_4(s)$

$Na^+(aq)$ and $NO_3^-(aq)$ ions are spectator ions.

(b) $CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2H^+(aq) + 2Cl^-(aq) \longrightarrow Ca^{2+}(aq) + 2Cl^-(aq) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$

Cl^- ion is spectator ion.

Note: $CaCO_3$ does not break apart into ions on the reactant side of the chemical equation. The solid $CaCO_3$ is attacked by the H^+ ions which breaks down the structure into its ions.

(c) $(NH_4)_2SO_4(aq) + 2\ NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l) + 2\ NH_3(g)$

$2NH_4^+(aq) + SO_4^{2-}(aq) + 2Na^+(aq) + 2OH^-(aq) \longrightarrow 2Na^+(aq) + SO_4^{2-}(aq) + 2H_2O(l) + 2NH_3(g)$

$2NH_4^+(aq) + 2OH^-(aq) \longrightarrow 2H_2O(l) + 2NH_3(g)$

$NH_4^+(aq) + OH^-(aq) \longrightarrow H_2O(l) + NH_3(g)$

Na^+ and SO_4^{2-} ions are spectator ions.

Note: Do not split up any substance that is a solid, liquid or gas.

Problem solving (Q.12 and Q.13)

12. (a) Molar mass of sulphur molecules $S_8 = (8 \times 32) = 256 \text{ g mol}^{-1}$

$$\text{mole of S} = \frac{\text{mass of S}}{\text{molar mass of S}} = \frac{64.2 \text{ g}}{256 \text{ g mol}^{-1}} = \mathbf{0.25 \text{ mol}}$$

(b) Molar mass of iron(III) nitrate $Fe(NO_3)_3 = 56 + (3 \times 14) + (9 \times 16) = 242 \text{ g mol}^{-1}$

$$\text{mole of iron(III) nitrate} = \frac{\text{mass of Fe(NO}_3)_3}{\text{molar mass of Fe(NO}_3)_3} = \frac{60.45 \text{ g}}{242 \text{ g mol}^{-1}} = \mathbf{0.25 \text{ mol}}$$

13. (a) Molar mass of sodium carbonate $Na_2CO_3 = (2 \times 23) + 12 + (3 \times 16) = 106 \text{ g mol}^{-1}$

mass of Na_2CO_3 = number of moles of Na_2CO_3 × molar mass of Na_2CO_3

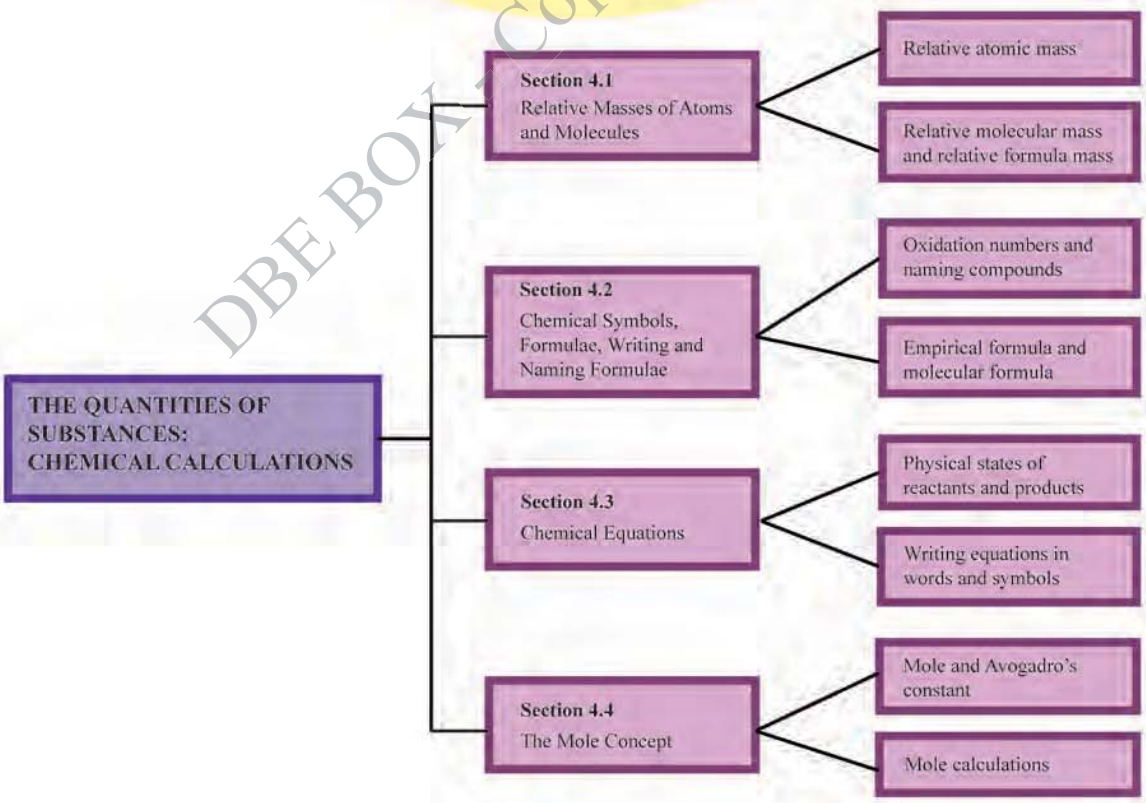
= $0.05 \text{ mol} \times 106 \text{ g mol}^{-1}$ = **5.3 g**

(b) Molar mass of iron(II) hydroxide $Fe(OH)_2 = 56 + (2 \times 16) + (2 \times 1) = 90 \text{ g mol}^{-1}$

mass of $Fe(OH)_2$ = number of moles of $Fe(OH)_2$ × molar mass of $Fe(OH)_2$

= $5.00 \text{ mol} \times 90 \text{ g mol}^{-1}$ = **450 g**

CHAPTER REVIEW



CHAPTER 5

NON-METALS: OXYGEN, CARBON AND HALOGENS

Total Number of Lesson Periods: 25 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:
- describe the properties and behaviours of oxygen and oxides;
- classify the main types of oxides based on their properties;
- explain the properties and behaviours of carbon and its allotropes;
- investigate the properties and behaviours of halogens and halides;
- discuss the role of oxygen, oxides, carbon and halogens in daily life.

Skill Development

- Collaboration (when working successfully in group)
- Communication (when reporting progress on exercises and activities)
- Critical Thinking (when finding solutions to the problems)

Support Materials

- battery, bulb, wire, clip, copper rod/ iron nail, lead pencil, a lock and a key

Section 5.1 OXYGEN

Number of lesson periods: 4

Lesson Objectives

- To describe the properties and behaviours of oxygen and oxides
- To classify the main types of oxides based on their properties

Introduction

Recall the knowledge of the occurrence and properties of oxygen by discussing with students according to the following outlines:

- Occurrence of oxygen in air, water and Earth
- Importance of oxygen gas in respiration, industrial purposes, medicine and technology

The purpose of learning this section is to study the preparation and properties of oxygen and then classification of oxides.

Teaching

Refer to Figure in Grade 10 Chemistry Textbook (Section 5.1) and explain the preparation of oxygen in the laboratory. Teacher should ask the students how to correlate

method of collection of oxygen gas and its physical properties; e.g., oxygen is collected by downward displacement of water because one of its physical properties is slightly soluble in water. It is similar to the collection methods of hydrogen gas and nitrogen gas, because these gases are also slightly soluble in water.

The teacher should ask the students to decide which products are formed by burning metals / non-metals in oxygen and then to write the balanced chemical equations (recall Chapter 4).

Then let students classify the oxides in accordance with their properties. Finally, extend their knowledge about oxides and the uses of some oxides in their society.

More information for teacher

- Oxygen can be prepared by various methods. These methods are - heating a mixture of potassium chlorate and manganese(IV) oxide; dropwise addition of hydrogen peroxide on the acidified potassium permanganate; the reaction between water and sodium peroxide; heating on metal nitrates (e.g., sodium nitrate); heating on certain oxide of the least active metals (e.g., mercuric oxide or silver oxide); high temperature heating on oxides of certain metals with more than one oxidation state (e.g., lead(IV) oxide or manganese(IV) oxide); and electrolysis of water.
- The classification of oxides depends on the types of elements that combined with oxygen. Water (oxide of hydrogen) is an amphoteric oxide. The oxidation number of oxygen in compounds is usually (−2) but it is (−1) in peroxide.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the preparation of oxygen and its physical and chemical properties.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To achieve knowledge about alternative methods for the preparation of oxygen

Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the preparation of oxygen based on the following:
- Group A: preparation method
- Group B: reactants used
- Group C: products formed
- Group D: chemical equation

Resources and Preparation

- Encourage the students to search the methods of oxygen preparation by using library / online resources before discussion.

Reflection on Learning

- Example 1 Group A: heating a mixture of potassium chlorate and manganese(IV) oxide Group B: $KClO_3$ Group C: KCl and O_2

  Group D: $2KClO_3(s) \xrightarrow{MnO_2, \Delta} 2KCl(s) + 3O_2(g)$

  Note: MnO_2 is used as a catalyst for the decomposition of $KClO_3$. A catalyst can hasten a chemical reaction but the amount of catalyst remains unchanged after reaction.

- Example 2 Group A: electrolysis of water Group B: H_2O

  Group C: H_2 and O_2 Group D: $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

- Other appropriate methods should be accepted.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To classify the types of oxides and their uses

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention about the oxides as follows:
- Group A: names
- Group B: types
- Group C: uses

Resources and Preparation

- Encourage the students to note the oxides and their uses by using library / Grade 10 Chemistry Textbook / online resources before discussion.

Reflection on Learning

For example,

- Group A : SO_2
- Group B : It is an acidic oxide because sulphur is non-metal.
- Group C : SO_2 is used as bleaching agent in our society.
- Refer to 'Chemistry in Society' in Section 5.1.

Key for Review Questions

(1) The level of oxygen is very low on the high mountains. In the deep sea, the solubility of oxygen is very low which are not sufficient for human. Thus, mountaineers and divers need to carry oxygen cylinders.

(2) Manganese(IV) oxide is used as a catalyst for the preparation of oxygen in the laboratory to speed up the decomposition of hydrogen peroxide.

(3) (a) neutral oxide (b) compound oxide (c) acidic oxide
(d) peroxide (e) basic oxide (f) amphoteric oxide

Experimental Work

Number of practical periods: 2

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 5.

Experiment 5 Preparation of Calcium Oxide (Quicklime) and Study on Some of Its Chemical Properties

In this experiment, care must be taken while heating strongly the paste of calcium hydroxide in a crucible. It is noted to avoid the prepared calcium oxide (CaO) not to become expose to moisture. The students must pay attention when they add sulphuric acid into a beaker containing a small amount of CaO.

Section 5.2 CARBON

Number of lesson periods: 4

Lesson Objective

- To explain the properties and behaviours of carbon and its allotropes

Introduction

The teacher should ask the students which element is mainly composed in lead pencil. Let the students discuss the appearances of diamond, graphite, carbon soot and charcoal. Make the discussion on the properties of allotropes of carbon. After learning this section, students will be able to distinguish the allotropes of carbon and their uses.

Teaching

Refer to Grade 10 Chemistry Textbook (Section 5.2), discuss the similarities and differences for the structures of diamond, graphite, fullerene, carbon nanotube and graphene (Figures 5.1 to 5.4). Let the students find out the relationship between some properties or uses and the structures of the allotropes of carbon.

More information for teacher

- Carbon compounds found in nature are petroleum, coal, natural gas, limestones and carbon dioxide. In addition, carbohydrates, fats, lipids, nucleic acids and proteins are found as carbon compounds in living things.
- Although diamond is the hardest allotrope of carbon, the melting point (m.pt.) of diamond is 3550 °C which is lower than that of graphite (m.pt. = 3700 °C). In each layer of graphite, carbon atoms are covalently bonded by sp^2 hybridisation. In diamond crystal, carbon atoms are covalently bonded by sp^3 hybridisation. The composition of the ***s*** orbital is more hybrid in sp^2 than in sp^3. Thus, the bond length of graphite is shorter (1.42×10^{-10} m) than that of diamond (1.55×10^{-10} m). The intermolecular force between the graphite layers determines the properties of graphite. Due to shorter bond length and strong intermolecular force among graphite atoms, the melting point of graphite is higher than that of diamond.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on behaviours of carbon, its allotropes and usefulness.

Activity (1)

The teacher should identify this activity as a group discussion in the class.

Objective

- To describe the allotropes of carbon in student's environment

Instruction

- Make the class into two groups: A and B.
- Tell them to mention as follows:
- Group A: names of carbon allotropes
- Group B: their uses

Resources and Preparation

- Encourage the students to collect the names and uses of carbon allotropes by using library / online resources before discussion.

Reflection on Learning

Carbon allotropes	Uses
charcoal	fuel for cooking
soft graphite	lead pencil
hard graphite	dry cell batteries (such as battery used in torch lights, clocks, or TV remote controls)

- Other appropriate answers should be accepted.

Activity (2)

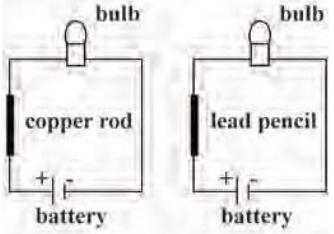
Teacher should identify this activity as a group work depending on the class size.

Objective

- To examine the application of soft graphite as a conductor or lubricant

Instruction

- Make the class into two groups: A and B.
- Tell them to do as follows:
- Group A: to examine the conductivity of copper rod/ iron nail and lead pencil, and to construct the electrical circuit as shown in the following figure:



Resources and Preparation

- Battery, bulb, wire, clip, copper rod / iron nail, lead pencil, a lock and a key

- Group B: to test the lubricating property of soft graphite, by rubbing the key line with lead pencil on the key sticking in a lock to note whether it is smooth or not

Reflection on Learning

- Group A: First, the bulb is connected with battery using copper rod and the bulb lights up. Then, the bulb is connected again with battery like previous action including lead pencil. The bulb also lights up. The lead pencil is graphite and it can conduct electricity. So soft graphite is a conductor.
- Group B: It is observed that the key rubbed with soft graphite may be smoother than the sticking one. The graphite makes a slippery texture to the key as a dry lubricant.

Key for Review Questions

(1) In diamond, each carbon atom is surrounded by four other carbon atoms. It has a giant structure. It contains millions of carbon atoms in three dimensional network of strong carbon-carbon covalent bonds. Therefore, it is very hard. In graphite, each carbon atom is surrounded by three other carbon atoms in the same plane, and therefore layers of hexagons are obtained. The distance between the layers is more than the distance between adjacent carbon atoms and so the layers are weakly bonded to each other. Therefore, graphite is soft.

(2) Graphite is a good conductor of electricity due to the presence of free electrons. However, diamond is not a good conductor because diamond contains millions of carbon atoms in three dimensional network of strong carbon-carbon covalent bonds. It has no free electron.

(3) Fullerene (C_{60}) is an allotrope of carbon in the form of a hollow sphere, ellipsoid, tube, and many other shapes and sizes.

(4) Graphite has the multilayers of hexagonal ring structure. So it has three-dimensional structure. Graphene has the single layer (monolayer) of graphite. So it has the two-dimensional crystalline structure.

Experimental Work

Number of practical periods: 4

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 6.

Experiment 6 Preparation of Carbon Dioxide Gas from Calcium Carbonate and Study on Some of Its Physical Properties

Experiment 6 (a) Preparation of Carbon Dioxide Gas from Calcium Carbonate

Experiment 6 (b) Study on the Physical Properties of Carbon Dioxide

In this experiment, care must be taken when adding hydrochloric acid into a flat-bottomed flask (the level of acid must cover the marble chips, the tip of thistle funnel must be dipped in the acid solution). The students must pay attention when they use burning candle.

Section 5.3 HALOGENS **Number of lesson periods: 6**

Lesson objective

- To investigate the properties and behaviours of halogens and halides

Introduction

The teacher should ask the students about the chemical components in table salt and the tincture of iodine. Recall the name of group VII in the Periodic Table and the possible essential electronic structure of these elements (Grade 10 Chemistry Textbook Chapter 3). After learning this section, students will be able to understand the preparation and properties of halogens and also differentiate the halide ions in the solution.

Teaching

Refer to the preparation of chlorine gas from Section 5.3 (a) in Grade 10 Chemistry Textbook. Let the students predict the preparation of bromine and iodine from their sodium or potassium salts and write down the balanced chemical equations. Link the collection method for chlorine gas (upward displacement of air) with its properties (soluble in water and denser than air). After that, let the students compare the collection methods of oxygen (downward displacement of water) and carbon dioxide (upward displacement of air).

Discuss some properties of halogens (bleaching, oxidising, replacement, etc.) with relevant chemical equations.

More information for teacher

- Halogens are reactive elements since they require just one more electron to obtain the stable outer shell of 8 electrons. So they have a strong tendency to react with other elements or compounds to gain electron octet.
- The halogens are in group VII of the Periodic Table consisting of five elements: fluorine, chlorine, bromine, iodine and astatine (unstable radioactive element).
- The most abundant anion in sea water is chloride. Iodide is found in seaweed. Bromide is also found in sea water and the Earth crust.
- In laboratory, chlorine can be collected as a gas, bromine as a liquid and iodine as a solid.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on halogens and their properties.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To organise the physical and chemical properties of halogens

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention about halogens according to the following:
- Group A: names and physical states (solid, liquid or gas)
- Group B: colours
- Group C: reactivities

Resources and Preparation

- Encourage the students to revise the properties of halogens by using library / Grade 10 Chemistry Textbook before discussion.

Reflection on Learning

Halogens	Physical state at room temperature	Reactivity trend
fluorine, F_2	a pale yellow gas	increasing reactivity ↑
chlorine, Cl_2	a yellowish green gas	
bromine, Br_2	a reddish brown liquid	
iodine, I_2	a black solid	

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe the uses of halides in daily life

Resources and Preparation

- Encourage the students to revise the name of substances containing halides by using library / Grade 10 Chemistry Textbook before discussion.

Instruction

- Make the class into two groups A and B.
- Tell them to mention the following:
- Group A: names of substances containing halides
- Group B: names of halides

Reflection on Learning

Substances	Halides
toothpaste	fluoride (F^-)
food seasoning	chloride (Cl^-)
fire retardant	bromide (Br^-)
tincture	iodide (I^-)

Key for Review Questions

(1) Halogens mean salt formers.
(2) Halogens are highly reactive since essential electronic structure of halogens is $ns^2\ np^5$, and they try to get essential electronic structure of the noble gases.
(3) Iron(III) chloride is formed. Chlorine shows oxidising property in this reaction.
(4) This reaction shows the displacement property.
(5) It shows oxidising property.

Experimental Work

Number of practical periods: 2

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 7.

Experiment 7 Tests for Carbonate, Chloride, Bromide and Iodide Anions

In this experiment, care must be taken especially when the students handle nitric acid, hydrochloric acid and silver nitrate solution. If the solutions spill, clean with water.

SUMMARY

The highlights of this chapter:

- occurrence of oxygen and its utilisation
- laboratory preparation of oxygen from hydrogen peroxide catalysed by manganese(IV) oxide
- physical and chemical properties of oxygen gas
- six main classes of oxides with their properties
- carbon and its crystalline allotropes: diamond (the hardest material known), graphite (widely used in machinery and other utensils), fullerene (a synthetic allotrope) and graphene (good conductors used in computers)
- carbon and its amorphous allotropes: charcoal as fuel in domestic use, coal as source of useful chemicals, coke as fuel and reducing agent for metal industries, and carbon black (soot) as printing ink and boot-polish
- laboratory preparation of halogens by the action of concentrated sulphuric acid with sodium or potassium halide using manganese(IV) oxide as an oxidising agent
- reactivity and properties of halogens
- application of halides in society as salt NaF (used in toothpaste), NaCl (common salt) and NaI (in iodised common salt)

KEY FOR EXERCISES

Number of review exercises periods: 3

1. **Analytical thinking**

(a) FALSE, Oxygen will not burn but support combustion; (b) FALSE, Carbon can exhibit allotropy or polymorphism; (c) TRUE; (d) TRUE; (e) FALSE, Bromine cannot displace the chlorine from metal chloride; (f) FALSE, Carbon dioxide is used as fire extinguisher; (g) TRUE

Application (Q.2 to Q.7)

2. (a) sulphur dioxide (b) oxyacetylene (c) nonmetallic (d) element
   (e) fullerene (f) iodine (g) bromine

3. (a) carbon dioxide + water ⟶ carbonic acid
   $CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$
   (b) carbon dioxide + sodium hydroxide ⟶ sodium carbonate + water
   $CO_2(g) + 2NaOH(aq) \longrightarrow Na_2CO_3(aq) + H_2O(l)$

4. carbon + copper(II) oxide ⟶ copper + carbon monoxide
   $C(s) + CuO(s) \longrightarrow Cu(s) + CO(g)$
   carbon + zinc oxide ⟶ zinc + carbon monoxide
   $C(s) + ZnO(s) \longrightarrow Zn(s) + CO(g)$

5. (a) chlorine + potassium iodide ⟶ potassium chloride + iodine
   $Cl_2(g) + 2KI(aq) \longrightarrow 2KCl(aq) + I_2(g)$
   (b) copper + chlorine ⟶ copper(II) chloride
   $Cu(s) + Cl_2(g) \longrightarrow CuCl_2(s)$
   Zinc + chlorine ⟶ zinc chloride
   $Zn(s) + Cl_2(g) \longrightarrow ZnCl_2(s)$
   (c) iron + chlorine ⟶ iron(III) chloride
   $2Fe(s) + 3Cl_2(g) \longrightarrow 2FeCl_3(s)$
   (d) bromine + sodium hydroxide ⟶ sodium bromide + sodium hypobromite + water
   $Br_2(g) + 2NaOH(aq) \longrightarrow NaBr(aq) + NaOBr(aq) + H_2O(l)$
   (e) iodine + hydrogen sulphide ⟶ hydrogen iodide + sulphur
   $I_2(g) + H_2S(g) \longrightarrow 2HI(g) + S(s)$

6. (a) Oxidation reaction of chlorine
   iron(II) chloride + chlorine ⟶ iron(III) chloride
   $2FeCl_2(aq) + Cl_2(g) \longrightarrow 2FeCl_3(aq)$
   (b) Displacement reaction of bromine
   bromine + sodium iodide ⟶ sodium bromide + iodine
   $Br_2(g) + 2NaI(aq) \longrightarrow 2NaBr(aq) + I_2(s)$

(c) Affinity for hydrogen

iodine + hydrogen $\rightleftharpoons$ hydrogen iodide

$I_2(g) + H_2(g) \rightleftharpoons 2HI(g)$

(d) bromine + potassium hydroxide $\longrightarrow$ potassium bromide + potassium bromate + water

$3Br_2(g) + 6\,KOH(aq) \longrightarrow 5KBr(aq) + KBrO_3(aq) + 3H_2O(l)$

(e) sodium iodide + silver nitrate $\longrightarrow$ sodium nitrate + silver iodide

$NaI(aq) + AgNO_3(aq) \longrightarrow NaNO_3(aq) + AgI(s)$

(f) iodine + potassium hydroxide $\longrightarrow$ potassium iodide + potassium hypoiodite + water

$I_2(s) + 2KOH(aq) \longrightarrow KI(aq) + KOI(aq) + H_2O(l)$

7. potassium bromide + manganese(IV) oxide + sulphuric acid (conc.) $\xrightarrow{\Delta}$ potassium hydrogen sulphate + maganese(II) sulphate + bromine + water

$2KBr(s) + MnO_2(s) + 3H_2SO_4(l) \xrightarrow{\Delta} 2KHSO_4(aq) + MnSO_4(aq) + Br_2(g) + 2H_2O(l)$

potassium iodide + manganese(IV) oxide + sulphuric acid (conc.) $\longrightarrow$ potassium hydrogen sulphate + maganese(II) sulphate + iodine + water

$2KI(s) + MnO_2(s) + 3H_2SO_4(l) \longrightarrow 2KHSO_4(aq) + MnSO_4(aq) + I_2(g) + 2H_2O(l)$

8. **Analytical thinking**

The presence of chloride, bromide or iodide ions can be detected by silver nitrate test.

Chloride ion gives white precipitates of silver chloride. Bromide ion gives cream coloured precipitates of silver bromide. Iodide ion gives yellow precipitates of silver iodide.

9. **Application**

iron(II) chloride + chlorine ⟶ iron(III) chloride

$2\ FeCl_2(aq) + Cl_2(g) \longrightarrow 2FeCl_3(aq)$

red phosphorus + bromine ⟶ phosphorus(III) bromide

$2P(s) + 3Br_2(g) \longrightarrow 2PBr_3(l)$

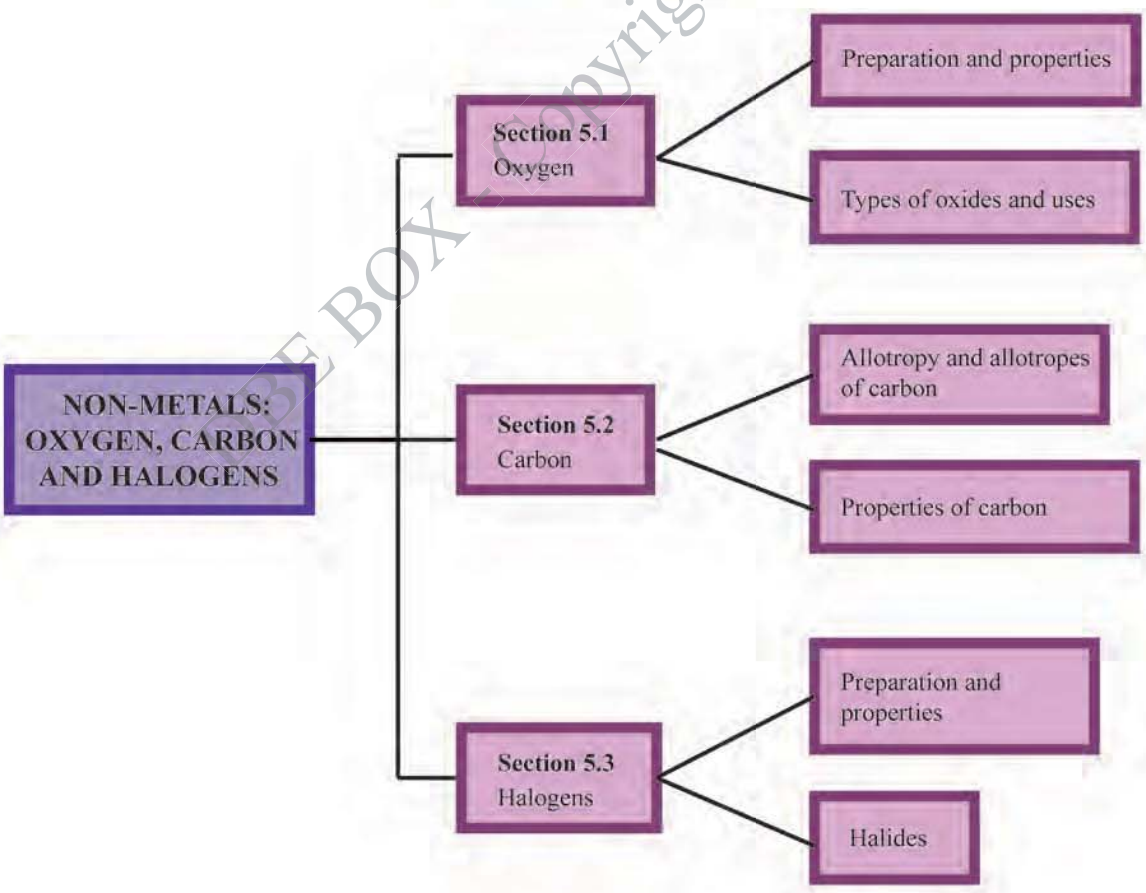
hydrogen sulphide + iodine ⟶ hydrogen iodide + sulphur

$H_2S(g) + I_2(s) \longrightarrow 2\ HI(g) + S(s)$

10. **Critical thinking**

Chlorine is added to swimming pool water to kill bacteria in water.

CHAPTER REVIEW



CHAPTER 6

ACIDS, BASES AND SALTS

Total Number of Lesson Periods: 19 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:

- identify the properties and behaviours of acids, bases and alkalis with examples;
- describe the formation, properties and behaviours of salts;
- distinguish between strong acids and weak acids;
- distinguish between strong bases and weak bases;
- differentiate between base and alkali;
- investigate the uses of acids and bases in daily life;
- investigate the role of indicators and the pH scale used in chemistry;
- assess the acid-base reaction (neutralisation);
- prepare the soluble and insoluble salts.

Skill Development

- Collaboration (working in groups, sharing ideas, and finding solutions together)
- Communication (when reporting progress on exercises and activities)
- Critical Thinking and Problem Solving (finding solutions to problems and correcting errors)

Support Materials

- Test tubes, conical flasks, glass rods, glass tubes, beakers / cups, filter papers, pH papers, litmus papers (red and blue), vinegar, water, fruit juices, ash, ladyfinger (Yone-pa-ti-thee), stalks of roselle (Chin Baung), Tayaw, washing powder, caustic soda and limewater

Section 6.1 ACIDS AND THEIR PROPERTIES Number of lesson periods: 3

Lesson Objectives

- To realise the properties of acids used in daily life
- To understand the different types of acids

Introduction

Teacher should recall previous knowledge about acid that students have learnt in Grade 8 Science Textbook and start with question. Why do some food and fruits have sour taste? They contain acids. Other familiar foods with sour taste get from acids: orange and

lemon contain citric acid, soft drink contains carbonic acid, and wine contains tartaric acid. Where can acids be found else? Acids are commonly found in daily life: sulphuric acid in car batteries, hydrochloric acid in pickling metals for coating paint, and nitric acid in manufacturing fertilisers.

The purpose of learning this section is to understand the properties of acids and their uses.

Teaching

Teacher should explain the differences between strong acids and weak acids based on their dissociation reactions in water. Refer to Table 6.1 from Grade 10 Chemistry Textbook, assess the students' understanding on the different types of acids from their environment and then explain about the properties of acids and uses in daily life with more information other than Grade 10 Chemistry Textbook.

More information for teachers

- Citrus fruits usually contain citric acid and ascorbic acid, which is better known as vitamin C.
- Solid form of acids (e.g., oxalic acid) cannot conduct electricity. Aqueous solutions of acids are electrolytes, meaning that they can conduct electrical current.
- Strong acids are strong electrolytes because they ionise completely in water. Weak acids are weak electrolytes that exist primarily in a non-ionised form when dissolved in water.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the names, formulae and the properties of acids.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To determine whether the solution used in daily life is acidic or not

Instruction

- Make the students into three groups: A, B and C.
- Tell them to do as follows:
- Group A: to fill the test tube/cup with vinegar, test with litmus paper and record the colour change
- Group B: to repeat the above procedure with water
- Group C: to repeat the above procedure with fruit juice

Resources and Preparation

- Test tube / cup, vinegar, water, fruit juice (e.g., orange or lime or lemon, etc.), litmus papers (red and blue)

Reflection on Learning

Substance	Red litmus paper	Blue litmus paper	Acid
vinegar	no colour change	colour changes to red	yes
fruit juice	no colour change	colour changes to red	yes
water	no colour change	no colour change	no

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe the formulae and uses of acids

Instruction

- Make the class into two groups: A and B.
- Tell them to mention the following:
- Group A: formulae of acids
- Group B: uses of acids

Resources and Preparation

- Encourage the students to mention the uses of acids by using Grade 10 Chemistry Textbook / online resources before discussion.

Reflection on Learning

Acid	Group A	Group B
ethanoic acid	CH_3COOH	to produce vinegar
nitric acid	HNO_3	to prepare fertiliser
citric acid	$C_6H_8O_7$	in fruit juice
sulphuric acid	H_2SO_4	in car batteries
phosphoric acid	H_3PO_4	to prevent rusting

Key for Review Questions

(1) After rubbing an old copper coin with lemon juice, the coin is shiny once again. Old copper coin is dull because patina formed on surface of copper or brass by atmospheric oxidation, consisting of copper(II) carbonate / copper salt. Lemon juice contains citric acid. When old copper coin is rubbed with lemon juice, copper(II) carbonate / copper salt dissolves in citric acid. As a result, shiny and bright coin is obtained. (Patina is a thin layer that variously forms on the surface of copper, bronze, brass and similar metals during exposure to atmospheric oxidation.)

(2) It can be detected by blue litmus paper. Acid turns blue litmus paper red.

(3) The organ of ant contains methanoic (formic) acid. Injection of acid by ant causes the pain at the place of bite.

(4) Baking powder which is base, neutralises the methanoic acid injected by bee.

(5) Solution A is more concentrated. Both solutions are hydrochloric acid solutions. Hydrochloric acid is a strong acid.

Section 6.2 BASES, ALKALIS AND THEIR PROPERTIES

Number of lesson periods: 3

Lesson Objectives

- To understand the properties and uses of bases and alkalis in daily life
- To distinguish between bases and alkalis

Introduction

Teacher should introduce to class by asking with questions. When you wake up, you wash your face every morning. What kind of chemicals contain in soap? Is it acidic or basic? Since soap is prepared from fatty acids and alkali (NaOH/KOH),soap is basic. Generally, base is defined as a substance which can produce hydroxide ions (OH^-) in water solution. Alkali, a special type of base, is a base dissolved in water. All alkalis are bases but not all bases are alkalis.Because all bases do not dissolve in water. What are the uses of bases? Give some examples of bases used in daily life. Bases can be used in anti-acid drugs for stomachache,used as degreasing agents and glass cleaner,and used in production of soap.

The purpose of learning this section is to identify the bases, alkalis and their properties.

Teaching

Refer to Table 6.2 from Section 6.2 (b) in Grade 10 Chemistry Textbook, assess the students' understanding on the properties of bases and alkalis. Explain about the properties of bases and alkalis and uses in daily life with more information other than Grade 10 Chemistry Textbook.

More information for teacher

- Many substances we use in home are bases. Dishwasher cream, washing powder and cleaning liquids all contain bases.
- Antacid tablets used to treat indigestion contain bases such as magnesium oxide or magnesium hydroxide.
- Most strong bases (alkalis) contain hydroxides. Bases can be oxides, hydroxides, or carbonates of metals.
- Ammonia is a base even though it does not contain a metal.
- Aqueous solutions of bases are also electrolytes. Bases can be either strong or weak, just as acids can. Strong alkalis are corrosive in nature.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the base and their properties.

Activity (1)

Teacher should identify this activity as a group work depending on the class size.

Objective

- To decide whether the substances collected from the home are bases or not

Instruction

- Make the class into groups.
- Collect any substances by each group.
- If the sample is a solid form, chop the sample, immerse it in the water and filter.
- If the sample is powder or paste form, dissolve in water and filter it.
- Examine whether it is slippery or not, and record it.
- Test with litmus papers.

Resources and Preparation

- Any substances such as ladyfinger (Yone-pa-ti-thee), stalks of roselle (Chin Baung), Tayaw, washing powder, etc., water, beaker, blue and red litmus papers

Reflection on Learning

Substance	Slippery	Litmus paper	Base
ladyfinger	yes	no change	no
stalks of roselle	yes	no change	no
washing powder	yes	red litmus paper turns blue	yes
Tayaw	yes	red litmus paper turns blue	yes

Activity (2)

Teacher should identify this activity as a group work in the class.

Objective

- To explain the common sources and uses of base in the kitchen (e.g., ash)

Instruction

- Make the class into groups.
- Tell them to do the following by each group:
- to collect ash from nearby places
- to dissolve ash in water in a cup and stir well, then to settle for 10 minutes, and decant the solution
- to test the solution with litmus paper
- to discuss some uses of ash

Resources and Preparation

- Cup, water, ash, glass rod, litmus paper
- Encourage the students to read the uses of ash by using library / online resources before discussion.

Reflection on Learning

- The decantate from ash solution turns red litmus blue. So it is a base solution.
- Ash is used in :
  - garden (raising soil pH, nutrients, slug and snail repellent, cockroach repellent)
  - cleansing (dust-bath for poultry, glass cleaner, silver polish, smell absorber)
- Ash solution is used in :
  - recipe (medicated egg)
  - feed supplement (chicken feed supplement)

Key for Review Questions

(1) The active ingredient in the cleaner is sodium hydroxide (NaOH). Sodium hydroxide converts the grease to soap (neutralises).

(2) Plaque carries bacteria that can convert sugars into acids. These acids can damage tooth enamel and lead to cavities. Aluminium hydroxide ($Al(OH)_3$) neutralises the acid to remove plaque.

Section 6.3 INDICATORS AND THE pH SCALE

Number of lesson periods: 3

Lesson Objective

- To investigate the role of indicators and the pH scale used in chemistry

Introduction

The acidic or basic nature of a liquid is important in determining the uses of liquid. Since the students have learnt about acids and bases in previous sections, the teacher should ask them the following questions and make them recognise the differences between acid and base. How can you identify the given solution is acid or base? It can be identified by litmus papers, indicators, or pH meters (Figure 6.2 and Figure 6.3 from Grade 10 Chemistry Textbook). What is an indicator? An indicator is a substance whose solution changes colour due to changes in pH.

The purpose of learning this section is to understand the acidic or basic properties of a solution by using indicators and pH values.

Teaching

Teacher should extend the students' understanding about indicators that can be found not only in laboratory but also in household items, for example, coloured fruits and vegetables (dragon fruit, red cabbage, etc.) and household items (turmeric, yellow in acid and neutral, but turns bright red when it is exposed to basic solutions). Moreover, teacher should explain the pH range in acid and alkaline solutions (Table 6.3).

More information for teacher

- Indicators are used in titration process to signal the completion of the acid-base reaction. They change in colour with change of pH of the solution.
- Indicators are usually weak acids or bases. When dissolved in water, they dissociate slightly to form ions.
- At room temperature, pure water is neither acidic nor basic, i.e., it is neutral, and has a pH of 7.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the bases and basic properties.

Activity (1)

Teacher should identify this activity as a group work depending on the class size.

Objective

- To measure the pH of various substances by using pH paper

Instruction

- Make the class into groups based on the class size.
- Tell them to do the following by each group:
- to collect the substances from their environment and make them liquid or solution
- to soak the solution on pH paper
- to match it with standard colour and determine if it is acidic, basic or neutral

Reflection on Learning

- There are 14 colour bars in Reference with respect to pH value 0 to 14.
- If the observed colour matches with colour at pH less than 7, the substance is acidic.
- If the observed colour matches with colour at pH = 7, the substance is neutral.
- If the observed colour matches with colour at pH greater than 7, the substance is basic.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To understand the role of indicator in acid or base solutions

Instruction

- Make the class into three groups, A, B and C.
- Tell them to prepare the following solutions:

Resources and Preparation

- Red dragon fruit juice, water, vinegar, lemon juice, caustic soda, limewater

- Group A: indicator solution (red dragon fruit juice solution)
- Group B: acid solution (vinegar/ lemon juice)
- Group C: base solution (caustic soda/ limewater)
- Then tell them to add 2-3 drops of indicator solution to each acid or base solution, and to record the changes of colour before and after adding indicator.

Reflection on Learning

Test sample	Observed colour (before adding indicator)	Observed colour (after adding indicator)	Acid/ base/ neutral
water	colourless	magenta	neutral
vinegar	colourless	pink	acid
lemon juice	pale yellow	pink	acid
caustic soda	colourless	greenish yellow	base
limewater	milky white	greenish yellow	base

Note: Organic dyes are commonly used as indicators in ordinary acid-base neutralisation. Dye molecules whose colour depends on the H^+ concentration provide the way of estimating the pH of a solution. These indicators are weak acid or weak bases.

Key for Review Questions

(1) (a) acidic (b) acidic (c) neutral (d) alkaline
(2) Pancreatic juice is basic.
(3) We can detect by using litmus paper whether a soil is acidic or basic. If blue litmus paper turns red, the soil is acidic, and if red litmus paper turns blue, the soil is basic.
(4) (a) baking soda (b) vinegar (c) purified drinking water

Section 6.4 SALTS **Number of lesson periods: 3**

Lesson objectives

- To assess the acid-base reaction (neutralisation)
- To identify the different types of salts and their uses

Introduction

Teacher should ask the students how salts can be obtained and how it is related with acids. Salts are compounds that are formed by the neutralisation of acids and bases. A salt consists of a positively charged metallic ion and negatively charged ion which is derived from the corresponding acid by loss of H^+.

The purpose of learning this section is to understand the acid-base neutralisation, classification of salts and their uses.

Teaching

Refer to Table 6.4 from Section 6.4 in Grade 10 Chemistry Textbook, assess the students' understanding on the formation of salts from acid and base neutralisation. Teacher should explain that some salts are soluble in water but some are not (Table 6.5). Soluble salts are prepared by crystallisation and insoluble salts are prepared by precipitation.

More information for teacher

- Salts are formed by the reactions of acids with bases, and they always contain either a metal cation or ammonium (NH_4^+) ion. Some examples of salts are NaCl, NH_4F, $MgCO_3$ and $Fe_2(HPO_4)_3$.
- Table salt contains sodium ion, which is an essential nutrient needed by the body in small amounts. It is needed to transmit nerve impulses, contract and relax muscle fibres (including those in the heart and blood vessels), and maintain a proper fluid balance. When salt is added in the processing of meats, it restructures the proteins, which then acts as a binding and emulsifying agent.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the formation of salts and their solubility.

Activity (1)

Teacher should identify this activity as a group work depending on the class size.

Objective

- To predict the salts formed from the neutralisation of various acids and bases

Instruction

- Make the class into four groups: A, B, C and D.
- Prepare 6 cards for acids with their respective formulae and 6 cards for bases with their respective formulae.
- Tell them to mention the following:
- Group A: names of acids
- Group B: names of bases
- Group C: names of salts
- Group D: formulae of salts

Reflection on Learning

For example,

- Group A: nitric acid
- Group B: ammonium hydroxide
- Group C: ammonium nitrate
- Group D: NH_4NO_3

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To recognise the application of salts in daily life

Instruction

- Make the class into two groups: A and B.
- Tell them to mention the following:
- Group A: common names of salts
- Group B: applications of salts

Resources and Preparation

- Encourage the students to mention the common name and the application of salts by using Grade 10 Chemistry Textbook / online resources before discussion.

Reflection on Learning

Salt	Common name	Application
NaCl	table salt	seasoning of food
$MgSO_4$	Epsom salt	purgative in medicine
KNO_3	nitre	fertiliser
$NaHCO_3$	baking powder	bakery

Experimental Work **Number of practical periods: 4**

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 8.

Experiment 8 Neutralisation of Acids and Bases and Preparation of Salt

Experiment 8 (a) Neutralisation of Acids and Bases

In this experiment, teacher should explain the procedure described in the Grade 10 Experimental Chemistry and discuss the theory based on this experiment. Teacher should direct how to use the apparatus systematically. Care must be taken when acid and base are used. Teacher must be safety conscious at all times.

Experiment 8 (b) Preparation of Copper(II) Sulphate Crystals

In this experiment, teacher should explain the procedure described in the Grade 10 Experimental Chemistry and discuss the theory based on this experiment. Teacher should direct how to use the apparatus systematically. Care must be taken when heating copper(II) sulphate. Teacher must be safety conscious at all times.

Key for Review Questions

(1) Hydrochloric acid which is spilled on the floor can be neutralised by using baking soda (sodium hydrogen carbonate).

(2) Many plants do not grow properly in highly acidic soil. The purpose of adding lime is to neutralise the acidic soil.

(3) Many plants do not grow properly in alkaline soil. Thus, gypsum was added to neutralise the soil alkalinity.

(4) The gastric juice is hydrochloric acid. The gastric medicine is actively neutralised to acidic juice which causes stomach pain.

SUMMARY

The highlights of this chapter:

- the importance of acids in everyday life – in food, industry and medicine
- physical and chemical properties of acids
- dissociation of acids in water
- bases or alkalis which can produce hydroxide ions in water and neutralise with acids
- an indicator that is a substance with different colours in acidic and alkaline solutions
- a measure of the acidity or alkalinity of a solution which is known as pH (Solutions with pH < 7 are acidic, and those with pH > 7 are alkaline. The solutions of pH 7 are neutral.)
- neutralisation reaction between acid and base
- the classification of salts as soluble and insoluble and their preparations

KEY FOR EXERCISES

Number of review exercises periods: 3

Understanding key ideas (Q.1 to Q.4)

1. (a) TRUE
   (b) FALSE (Copper(II) hydroxide is a weak base and it is insoluble in water.)
   (c) TRUE (d) TRUE (e) TRUE

2. (a) $K_2SO_4 + 2H_2O$ (b) sodium hydroxide (c) ammonia
   (d) strongly alkaline (e) calcium oxide

3. (a) neutralisation (b) 7 (c) red (d) pH (e) preparation (f) preservative

4. (a) dissolves, ions, hydrogen, proton, base
   (b) dissolves, hydrogen, salt, oxides, hydroxides, water
   (c) soluble, ammonia, hydroxide, acids, salt
   (d) scale, alkaline, acidic, high, neutral, seven, universal

Critical thinking (Q.5 to Q.10)

5. (a) HCl (complete dissociation) (b) H_2SO_4 (has higher concentration of H^+ ions)

6. (a) sulphuric acid (H_2SO_4)

(b) magnesium oxide + sulphuric acid ⟶ magnesium sulphate + water

$MgO(s) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2O(l)$

(c) $H_2SO_4(aq) \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$

H^+ ion causes the solution acidic.

7. aluminium hydroxide + hydrochloric acid ⟶ aluminium chloride + water

$Al(OH)_3(s) + 3HCl(aq) \longrightarrow AlCl_3(aq) + 3H_2O(l)$

calcium carbonate + hydrochloric acid ⟶ calcium chloride + carbon dioxide + water

$CaCO_3(s) + 2HCl(aq) \longrightarrow 2CaCl_2(aq) + CO_2(g) + H_2O(l)$

8. (a) solutions (A) potassium sulphate K_2SO_4 (B) barium chloride $BaCl_2$
(C) barium sulphate $BaSO_4$ (D) potassium chloride KCl

(b) potassium hydroxide + sulphuric acid (dil.) ⟶ potassium sulphate + water

$2KOH(s) + H_2SO_4(aq) \longrightarrow K_2SO_4(aq) + 2H_2O(l)$

barium hydroxide + hydrochloric acid (dil.) ⟶ barium chloride + water

$Ba(OH)_2(s) + 2HCl(aq) \longrightarrow BaCl_2(aq) + 2H_2O(l)$

potassium sulphate + barium chloride ⟶ barium sulphate + potassium chloride

$K_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2KCl(aq)$

9. (i) (a) $CuSO_4$ (soluble in water)
(b) NaCl (soluble in water), $CaCO_3$ (insoluble in water)
(c) KNO_3 (soluble in water)

(ii) $CuSO_4$ and KNO_3 can be obtained by crystallisation.

(iii) $CaCO_3$ can be obtained by precipitation.

(iv) (a) copper(II) oxide + sulphuric acid ⟶ copper(II) sulphate + water

$CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$

(b) calcium chloride + sodium carbonate ⟶ calcium carbonate + sodium chloride

$CaCl_2(aq) + Na_2CO_3(aq) \longrightarrow CaCO_3(s) + 2NaCl(aq)$

(c) potassium hydroxide + nitric acid ⟶ potassium nitrate + water

$KOH(aq) + HNO_3(aq) \longrightarrow KNO_3(aq) + H_2O(l)$

10. (a) Reaction between copper(II) oxide and ethanoic acid gives salt and water only.

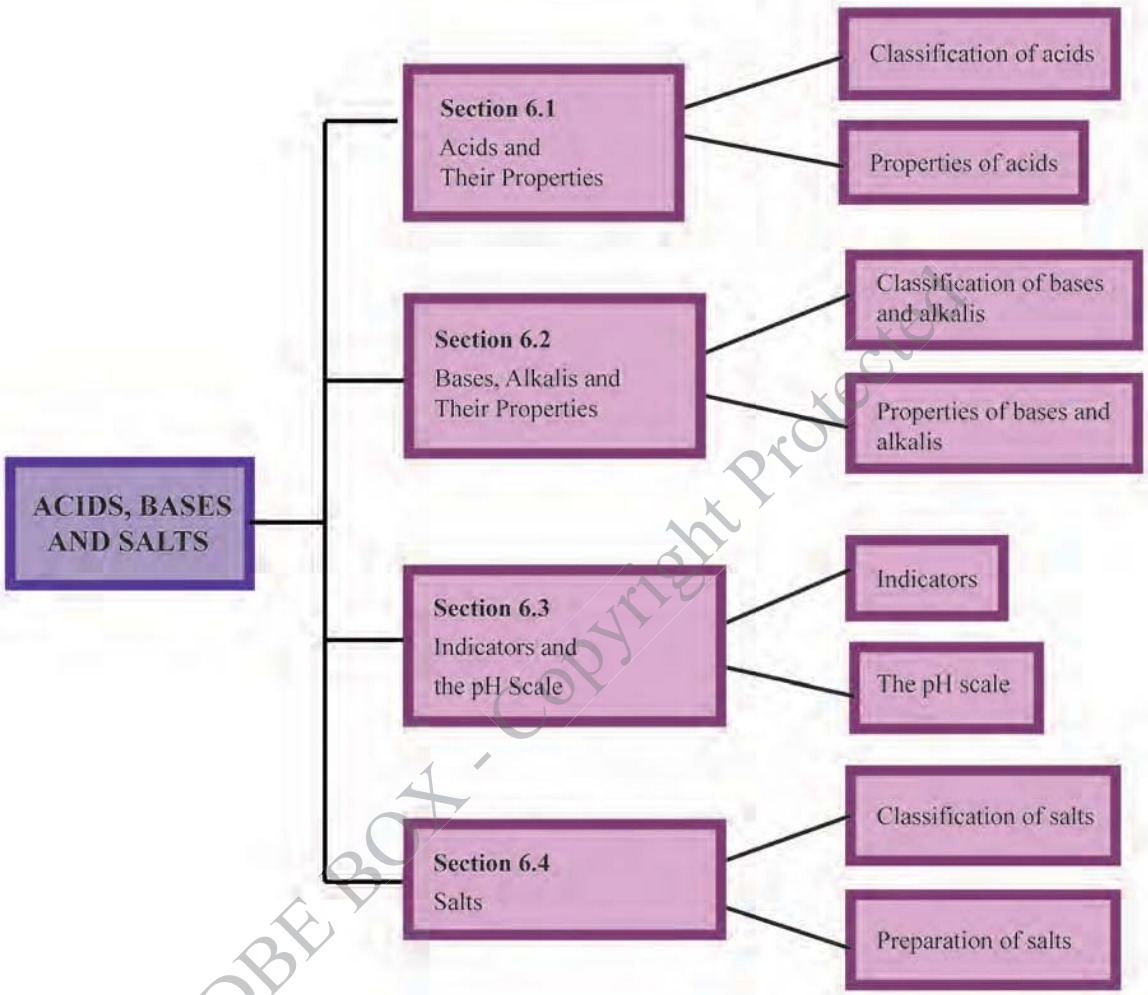
$CuO(s) + 2CH_3COOH(aq) \longrightarrow (CH_3COO)_2Cu(aq) + H_2O(l)$

CuO as a base and CH_3COOH as an acid neutralise each other and form salt (copper(II) ethanoate) and water only.

11. **Application**

No.	Salts	Preparation	Uses
(a)	sodium sulphate	$2NaOH(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$	food preservatives
(b)	ammonium nitrate	$NH_4OH(aq) + HNO_3(aq) \longrightarrow NH_4NO_3(aq) + H_2O(l)$	fertiliser
(c)	magnesium sulphate	$Mg(OH)_2(l) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + 2H_2O(l)$	medicinal uses (Epsom salt)

CHAPTER REVIEW



CHAPTER 7

AIR, WATER AND SOIL

Total Number of Lesson Periods: 20 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:

- describe the composition of air, the various forms of air pollution and the sources of these pollutants;
- assess the role of various pollutants on global warming and greenhouse effect;
- describe the Earth's surface water, both salt and fresh, including the composition, hardness and various forms of water pollution;
- discuss the purification process of water in terms of simple distillation, ion exchange and the Permutit method;
- describe the composition and the various types of soil found on the surface of the Earth, and the various forms of waste and pollutants in the soil;
- understand the information about layers, textures, composition and pH of soil.

Skill Development

- Collaboration (when working successfully in groups)
- Communication (when reporting progress on exercises and activities)
- Analysis and Reasoning (when finding solutions to problems)

Support Materials

- a bowl or a plate, a candle, a match, measuring cylinder, gas jar, five equally divided marked glasses, teaspoon, plastic zip-top bags, labelling tape or marker, pH paper, funnel, filter paper, Epsom salt, cups of the same size, soap

Section 7.1 AIR

Number of lesson periods: 5

Lesson Objectives

- To describe the composition of air, and the various forms of air pollutants and the sources of these pollutants
- To assess the role of various pollutants on global warming and greenhouse effect

Introduction

Since the students have learnt some gases from air (oxygen and carbon dioxide) in Chapter 5, the teacher should ask the following questions to the students and make them recognise the importance of air around us. Why do living things need air to survive?

Although we can withstand the lack of water and food for sometimes, we cannot live without air, mainly oxygen, for a few minutes. What gases do we breathe? We breathe in oxygen and breathe out carbon dioxide. All living things use oxygen to breathe in. Plants take carbon dioxide from air to make their food.

The purpose of learning this section is to identify the structure of atmosphere and composition of air around us relating air pollutants, their sources and harmful effects.

Teaching

Refer to Figure 7.1 from Grade 10 Chemistry Textbook, the teacher should assess the students' understanding on the structure of atmosphere from this figure and then explain about the sphere. The student should be encouraged to get information about air composition from Figure 7.2 in Grade 10 Chemistry Textbook and then teacher should explain clearly.

In Figure 7.3, students should notice the behaviour of gases in air rises up the column in order of their boiling points (the gas with the lowest boiling point boils off first). Students should discuss the cause and effect of air pollution by themselves according to Table 7.1, Figures 7.4 and 7.5. At the end of lesson, teacher should ask some cross questions to make more understanding.

The students should be encouraged to observe their surroundings through the information mentioned in 'Chemistry in Daily Life'.

More information for teacher

- The nearest layer from the Earth is troposphere and it is about 20 km thick. In this troposphere, airplanes are flying.
- The next region is stratosphere where ozone layer is found. The function of ozone layer is to protect the harmful ultraviolet ray from the sun.
- The outermost layer of the atmosphere is exosphere. It extends from the top of the thermosphere to about ~ 10,000 km (6,200 miles) above the Earth. In this layer, atoms and molecules escape into space, and satellites orbit the Earth.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the composition of air, pollutant gases and air pollution.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To estimate the composition of air in the surrounding

Instruction

- Make the class into groups.
- Tell them to do by each group as follows:

- to place a candle in the plate containing some water and mark the water level and then to light the candle
- to invert the gas jar filled with air on this lighted candle and watch it
- A few seconds later, the candle stops burning and water level rises up about one-fifth.
- Observe and discuss the process leading to the composition of air.

Resources and Preparation

- A bowl or a plate, a candle and a match, measuring cylinder / gas jar

Reflection on Learning

- The candle is lighting for a few seconds. (because the glass contains oxygen)
- After a few seconds, the candle stops burning. (because the oxygen in the gas jar is used up; and the rest of other gases in air, namely, nitrogen and argon are inert; carbon dioxide does not support combustion)
- Water level rises up about one-fifth (due to about 21 % of oxygen present in air).

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe the air pollutants and classify their sources (indoor or outdoor)

Instruction

- Make the class into two groups: A and B.
- Tell them to mention the following:
- Group A: name of air pollutants
- Group B: the source (indoor or outdoor)

Resources and Preparation

- Encourage the students to be aware of air pollution and harmful sources of air pollutants by using library / online resources before discussion.

Reflection on Learning

- Sources of indoor air pollutants:
  - paints, tobacco smoke, mosquito repellent smoke, chemicals that are used for polishing furniture and carpeting, building materials, cleaning products, mold and pet dander
- Sources of outdoor air pollutants:
  - incomplete combustion of carbon-containing substances, combustion of fossil fuels in motor vehicles, industries, chemical plants by human activities, forest fire
  - volcanic eruptions, lightning, anaerobic decomposition in natural wetlands and rice fields
- Other appropriate answers should be accepted.

Key for Review Questions

(1) Nitrogen gas is distilled over first from the fractional distillation of liquid air because it has the lowest boiling point in all gases present in the air.

(2) Two greenhouse gases are carbon dioxide and methane. These gases in the air trap infrared radiation from the sun and prevent much of it from escaping into space. The greater the amount of these gases in the air, the longer is the amount of heat trapped and the Earth becomes warmer and warmer, and it is leading to the greenhouse effect.

(3) Nitrogen dioxide and sulphur dioxide are two pollutants that cause acid rain. Nitrogen dioxide and sulphur dioxide are released as industrial waste into atmosphere. When these dissolve in the rain it becomes acid rain.

nitrogen dioxide + oxygen + water ⟶ nitric acid

$4NO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 4HNO_3(l)$

sulphur dioxide + oxygen + water ⟶ sulphuric acid

$2SO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 2H_2SO_4(l)$

(4) Carbon monoxide as an air pollutant comes from incomplete combustion of carbon-containing substances such as charcoal, wood and petrol.

Section 7.2 WATER **Number of lesson periods: 4**

Lesson Objectives

- To describe the Earth's surface water, both salt and fresh, including the composition, hardness and the various forms of water pollution
- To purify the water by simple distillation, ion exchange and the Permutit method

Introduction

After studying air (oxygen) (Section 7.1 in Grade 10 Chemistry Textbook), then teacher should introduce the Section 7.2 by asking the questions as follows: Is there another essential element for human life in order to survive? Is there any life that doesn't need water? All living things need water to survive. Without water, life as we know it would not exist. Water is needed to the functioning of every single cell and organ system in the body. Why do humans need water to survive? The body uses water to help regulate its temperature and maintain other bodily functions. Because the body loses water through breathing, sweating and digestion, it is important to rehydrate by drinking fluids and eating foods that contain water.

The purpose of learning this section is to describe the sources of water and occurrence, hardness and various forms of water pollution, removal of hardness and purification of water.

Teaching

The students should notice that water is the main constituent in organisms based on the composition of water in our bodies and environment. And its unique properties should be noted. The students have learnt the hardness of water in Grade 8 Science Textbook. In this section, the teacher should ask the students to recall and recognise more clearly upon chemical equations and classification of water based on degree of hardness of water (Table 7.2).

Students should discuss the cause and effect of water pollution by themselves according to Table 7.3 prior to teaching. At the end of lesson, teacher should ask some cross questions to assess their understanding. The students should be encouraged to link the lesson and their surroundings by studying the information mentioned in 'Chemistry in Daily Life'.

More information for teacher

- Water is the most universal solvent.
- Water has high heat capacity. It absorbs a lot of heat before it becomes to get hot. High heat capacity of water has huge role to play in the Earth's climate. It helps to regulate the rate of air-water and air-land heat exchange. The temperature change between seasons is gradual rather than sudden, especially near the ocean. It also helps the habitability of many places around the world. For instance, the aquatic animals can live in water because temperature of water is relatively the same from day to night.
- Minerals like calcium, magnesium or iron are naturally dissolved in the water. These minerals interfere with the cleaning ability of soap. Water pollution has become a major problem in the world today. It has an adverse effect on both the environment and health. The water treatment for pure drinking water should become an important role (Figure 7.6).

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the hardness of water, removal of hardness and purification of water.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To determine the hardness of water

Instruction

- Make the class into groups.
- Tell them to do as follows:

- to fill each of the five cups with the same amount of distilled water
- to fill the cups with 1, 2, 3, 4 and 5 teaspoons of Epsom salt, respectively
- to stir well until all the salts in each cup are dissolved
- to put one teaspoon of soap powder in each cup and shake it well
- record the observations on how easy it is to produce bubbles.

Resources and Preparation

- Distilled water, Epsom salt, labelling tape, 5 cups of the same size, teaspoons, soap powder

Reflection on Learning

- The water with the highest amount of dissolved salts will be the hardest.
- Epsom salt is a common name of magnesium sulphate.
- When mixed with water, it separates into Mg^{2+}, a component of water hardness, and sulphate anion, SO_4^{2-}. The more salt in the water, the higher dissolved magnesium concentration will be, causing the water to be harder.
- The harder the water, it will be difficult to produce bubbles. Cup number 5 will be the hardest to form lather, and may feel sticky and dirty.

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To explore the cause and effect, and removal methods of water hardness

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention water hardness based on the following:
- Group A: the cause
- Group B: the effect
- Group C: removal methods of water hardness

Resources and Preparation

- Encourage the students to search the causes, effect and solution to water hardness by using library / online resources before discussion.

Reflection on Learning

- Group A: the presence of calcium and magnesium salts; formed when water passes through or over limestone or chalk areas, and calcium and magnesium ions dissolve into the water
- Group B: causes limescale, interferes with the lathering properties of soaps and detergents, reduces the effectiveness of heat transfer, causes corrosion in the towers, affects the colour of the clothes

- Group C: to use a water softener, a resin bed, Reverse Osmosis method
- Other appropriate methods should be accepted.

Key for Review Questions

(1) Hardness in water will be tested with soap. If the water becomes cloudy instead of forming lather, the water is hard.

(2) (a) Temporary hardness is caused by the presence of dissolved calcium hydrogen carbonate and magnesium hydrogen carbonate.
(b) Permanent hardness is caused by the presence of dissolved calcium sulphate and magnesium sulphate.

(3) sodium stearate + calcium hydrogen carbonate $\longrightarrow$ calcium stearate(scum) + sodium hydrogen carbonate

$$2C_{17}H_{35}COONa(s) + Ca(HCO_3)_2(aq) \longrightarrow (C_{17}H_{35}COO)_2Ca(s) + 2\,NaHCO_3(aq)$$

(4) Temporary hardness is easily removed from water by boiling. When heated, the calcium hydrogen carbonate decomposes, producing insoluble calcium carbonate.

calcium hydrogen carbonate $\xrightarrow{\Delta}$ calcium carbonate + water + carbon dioxide

$$Ca(HCO_3)_2(aq) \xrightarrow{\Delta} CaCO_3(s) + H_2O(l) + CO_2(g)$$

(5) If the hardness of water can be removed by boiling, the water is temporary hard water. Temporary hard water contains calcium and magnesium hydrogen carbonates. These substances are decomposed by boiling and producing calcium and magnesium carbonates.
Permanent hardness cannot be removed by boiling. Permanent hard water contains calcium or magnesium sulphates and chlorides. These substances are not decomposed when heated.

(6) The effects of temporary and permanent hardness of water are (i) furring of kettles and (ii) blockages in hot water pipes. (Other appropriate answers should be accepted.)

Experimental Work

Number of practical periods: 2

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 9.

Experiment 9 Differentiation between Temporary and Permanent Hardness of Water

This experiment can be carried out in groups. Teacher should demonstrate how to manipulate the apparatus including in this experiment. Think of the volumes from burette

as 'units of hardness', arbitrary, but enable comparisons to be made between boiled and unboiled samples. The volume of the unboiled water gives the total hardness units. The difference between the volumes of the boiled and unboiled samples, gives the units of temporary hardness. Then, teacher should remind the caution that must be followed. It is noted that this method does not distinguish between hardness caused by magnesium compounds and calcium compounds in water.

Section 7.3 SOIL Number of lesson periods: 4

Lesson Objectives

- To describe the various types of soil found on the surface of the Earth, including the composition and the various forms of waste and pollutants found in the soil
- To understand the information about layers, textures, composition and pH of soil

Introduction

In the previous sections, students have learnt that air and water are important factors for living things to survive. To describe the importance of soil that contains air and water, teacher should ask the questions as follows: What would happen if there was no soil on the Earth? Life could not exist on the Earth without trees because they produce most of the oxygen that humans and wildlife breathe. There would also be no rain without trees since trees absorb water from the soil and release it through transpiration. Why soil is important to all living things? Soil contains food, water and air that are needed for plants. The healthier the soil, the more nutrients a plant can soak up. It also harbours worms, beetles, fungi and bacteria, providing them with the nutrients they need to live. What are soil pollution and its effects? Soil pollution is defined as the presence of toxic materials in soil, in high enough concentrations to pose a risk to human health and / or the ecosystem.

The purposes of learning this section are to classify the types of soil and the composition, and to study the plant nutrients in soil, soil pH and pollutants in soil.

Teaching

Refer to Figures 7.7 and 7.8 from Grade 10 Chemistry Textbook, the teacher should assess the students' understanding on the layers and composition of soil from these figures and then explain about the soil clearly. Teacher should make the students more practice to determine the soil texture using various ratios of sand, silt and clay and the texture triangle. Teacher should emphasise to explain clearly one of the most important functions of soil in supporting plant growth and nitrogen pathway.

Students should discuss the cause and effect of soil pollution by themselves before teacher's explanation. At the end of lesson, teacher should ask some cross questions to assess their understanding.

The students should be encouraged to connect the lesson and their surroundings by studying the information mentioned in 'Chemistry in Daily Life'.

More information for teacher

- General composition of soil and nutrients in the soil are important information for our ecosystem.
- The value of soil pH is one of the important parameters for determination of soil. Thus, the value of pH from soil sample should be studied.
- Excessive uses of chemical fertilisers and pesticides in farmland as well as large quantity of waste products threaten the soil fertility.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the classification of the types of soil, pollutants and treatment methods.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To observe the water absorption capacity of different types of soil

Instruction

Resources and Preparation

- Garden soil samples: sand, clay, loam, measuring cylinders, funnels, filter paper

- Make the class into three groups: A, B and C, and give each garden soil sample: sand, clay, loam.
- Tell them to do as follows:
- to place equal amount of the soil on the filter paper fitted with a funnel into the measuring cylinder
- to pour equal amount of water into each soil sample
- to collect the water as it drains through the soil in 1, 2 and 5 min intervals
- to measure the collected volumes (mL) of water passed
- Make questions to discuss their activities.

Reflection on Learning

- Which soil let the water to pass through the most rapidly? (sandy soil)
- Which soil let the water to pass through the least rapidly? (clay)
- Which soil holds the most amount of water? (clay)
- Which soil holds the least amount of water? (sand)
- Which soil do you think would be best for plants? Why? (loam soil. A loam soil contains a nice balance of silt, sand, and clay along with humus. The factors that make this soil type so desirable and good for growing plants including higher pH level: the best pH for most plants is between 6.0 and 7.0.)
- Identify the type of soil in your school grounds.
- Which type of soil would be best for building a dam? Why? (clay)

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To explore the functions of nutrients for plants and humans

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the nutrient based on the following:
- Group A: name
- Group B: how it does for plants
- Group C: how it does for humans

Resources and Preparation

- Encourage the students to search the functions of nutrients for plants and humans by using library / online resources before discussion.

Reflection on Learning

- For example,

Nutrient	How nutrient does for plants	How nutrient does for humans
hydrogen	helps to create food for plants	keeps us hydrated in the form of water
oxygen	helps to create food for plants	helps us breathe
carbon	helps to create food for plants	forms carbohydrates, proteins and many other compounds which are essential for humans
nitrogen	necessary for every part of the plants, building block	necessary for every part of the humans, building block
phosphorus	helps to form strong roots and seeds	necessary for parts of our bone's formation
potassium	helps in fruit formation	helps the heart to beat and the muscle to move properly
calcium	supports stem stability, essential for nut production in peanuts	builds bones and muscles

Key for Review Questions

(1) The typical layers found in a soil profile are top soil, subsoil and bedrock.

(i) The top layer is known as the top soil or the humus layer, which is rich in organic materials.

(ii) Just below the top soil lies another layer called subsoil. It is comparatively harder and more compact than top soil. It is lighter in colour than the top soil because there is less humus in this layer.

(iii) The next layer is bedrock or parent rock, which lies just below the subsoil. It contains no organic matter and made up of stones and rocks, so it is very hard.

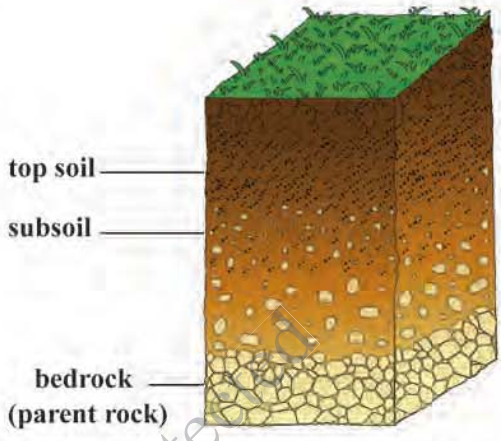
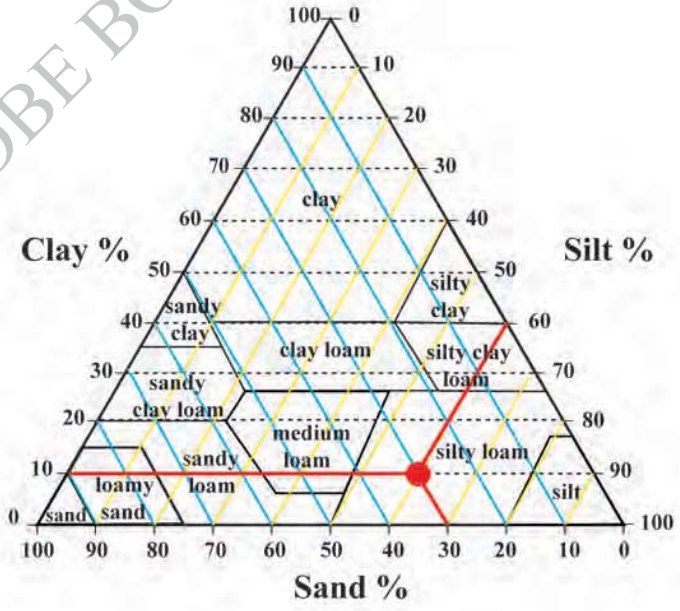


Figure Typical Layers Found in a Soil Profile

(2) Macro-nutrients are those elements that occur in substantial levels in plant materials or in fluids in the plant. Micro-nutrients are elements that are essential only at very low levels and generally are required for the functioning of essential enzymes.

(3) If the proportion of the sand in the soil is increased, the average size or soil particles increases and the resultant soil becomes coarser in texture. Thus, the soil cannot retain the water for growing crops.

(4) Silty loam



Experimental Work **Number of practical periods: 2**

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 10.

Experiment 10 Examination of Alkalinity and Acidity of Soil

Experiment 10 (a) To examine the soil alkalinity and acidity

In this experiment, students examine the soil pH using litmus papers. This is a very straightforward experiment. It can be carried out individually or in groups. Teacher should demonstrate how to manipulate the apparatus including in this experiment. Then, teacher should remind the caution that must be followed.

Experiment 10 (b) To determine the presence or absence of lime in the soil

In this experiment, students determine the presence or absence of lime in the soil. It can be carried out individually or in groups. Then, teacher should remind the caution that must be followed.

SUMMARY

The highlights of this chapter:

- the structure of atmosphere; mainly surrounded by troposphere, stratosphere, mesosphere, ionosphere, and thermosphere
- troposphere including atmosphere composing of 78 % nitrogen, 21 % oxygen, 0.97 % noble gases (mainly argon), and the rest of 0.03 % (present value 0.04 %) carbon dioxide
- the air pollutants such as sulphur dioxide and nitrogen dioxide (causing acid rain), nitrous oxide, methane, carbon dioxide, CFCs, HFCs and PFCs (causing global warming), carbon monoxide, and unburnt hydrocarbons
- the sources of natural water: rain water, river water and sea water
- hard water containing dissolution of calcium and magnesium ions
- temporary hard water containing calcium and magnesium hydrogen carbonate whereas permanent hard water containing chloride and sulphate salts of calcium and magnesium
- the hardness of water that can be removed by boiling or adding washing soda
- the upper layer of the Earth (soil) composed of top soil, subsoil, and bedrock
- the texture of soil classified by % composition of sand, silt, and clay
- soil pH and nutrient contents in soil which govern the growth of plants
- plants survival mainly based on NPK (nitrogen, phosphorus, and potassium)
- soil contaminants caused by overuse of fertilisers, insecticides and herbicides from farmlands, waste chemicals from industries, sulphuric acid and nitric acid from acid rain

KEY FOR EXERCISES **Number of review exercises periods: 3**

Understanding key ideas (Q.1 to Q.3)

1. (a) FALSE (Oxygen and nitrogen are the major gases in air.)
   (b) FALSE (Green plants require carbon dioxide for photosynthesis to produce glucose.)
   (c) TRUE
   (d) FALSE (The proportion of the sand in the soil is increased, the average size or soil particles increases.)
   (e) TRUE
   (f) TRUE

2. (a) carbon monoxide (b) less than 5 (c) top soil
   (d) texture (e) boiling (f) carbon

3. (a) sulphur dioxide and nitrogen dioxide (b) fractional distillation
   (c) calcium carbonate (d) biodegradation
   (e) boiling (f) bedrock

4. **Critical thinking and problem solving**

   (a) (i) 50 cm^3 of gas mixture contains 18 cm^3 of oxygen.

   $\therefore$ 100 cm^3 of gas mixture contains $= \frac{18\ cm^3}{50\ cm^3} \times 100\ cm^3 = 36\ cm^3$ of oxygen

   percentage of oxygen present in the sample of air = 36 %

   (ii) calculated percentage of oxygen in sample of air = 36 %

   percentage of oxygen in the atmosphere = 21 %.

   $\therefore$ percentage of oxygen in the sample of air > percentage of oxygen in the atmosphere

   (b) 78 % of atmospheric air is nitrogen.
   (c) Oxygen is more soluble in water.

Critical thinking (Q.5 to Q.8)

5. In the early morning, the concentrations of all pollutants are low. Among the three pollutants, the concentrations of hydrocarbons > NO > NO_2. They gradually increase with increasing time. The concentrations of hydrocarbons, NO and NO_2 are highest at about noon. This is due to the rush hour of busy city and many vehicles are running on the road. The concentrations of all pollutants gradually decrease in the afternoon.

6. (a) Hard water contains calcium or magnesium hydrogen carbonates and sulphate salts. When water containing any of these substances is evaporated, a white solid deposit of calcium or magnesium sulphate and / or calcium carbonate (limescale) is left behind. Blockages in hot water pipes in industry are caused by a thick deposit of limescale builds up. Therefore, industry normally requires soft water.

(b) Calcium carbonate causes the 'furring' in kettles that occurs in hard water areas. This furring may be removed by the addition of dilute acid.

hydrochloric acid	+	calcium carbonate	⟶	calcium chloride	+	water	+	carbon dioxide
$2HCl(aq)$	+	$CaCO_3(s)$	⟶	$CaCl_2(aq)$	+	$H_2O(l)$	+	$CO_2(g)$

(c) Hard water contains a significant concentration of hydrogen carbonate, chloride and sulphate salts of Ca or Mg that react with soap to produce a curdy precipitate before a permanent lather is formed. Hard water is water which will not readily form a permanent lather with soap. So hard water wastes soap.

(d) Calcium carbonate is formed from the decomposition of calcium hydrogen carbonate by heating. This can coat lead pipes and reduce the possibility of lead poisoning.

7. (a) industries, agriculture fields
   (b) industrial waste, pesticides, fertilisers, oil spill
   (c) Proper disposal of sewage and industrial wastes, reduces the use of herbicides, pesticides and fertilisers.

8. (a) distillation, the water is distilled away from the dissolved substances (salts, gases and organic matter)
   (b) filtration

9. **Understanding key ideas**

   Refer to Grade 10 Chemistry Textbook (Figure 7.10)

10. **Critical thinking**

    (a) aluminium sulphate (for sedimentation) (b) chlorine (for sterilising the microbes)
    (c) sodium hydroxide (for neutralisation) (d) sulphur dioxide (for dechlorination)

Understanding key ideas (Q.11 to Q.13)

11. Soil pH is important because of its effect on the availability of essential elements or nutrients in soil.

12. The presence of substances in the air and water that are harmful to living things and to the environment is termed pollution.

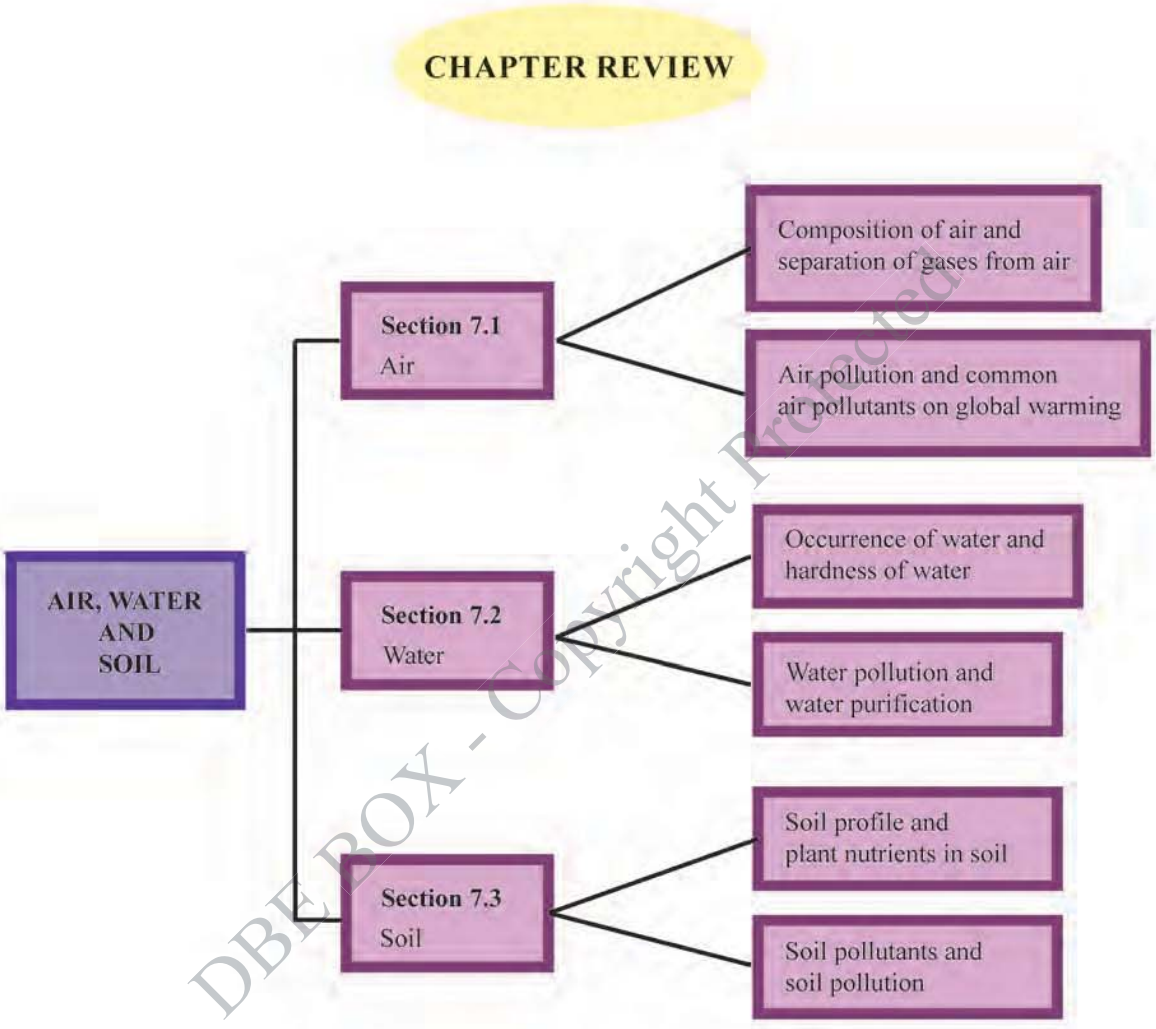
13. (a) sulphur dioxide (b) carbon monoxide

14. **Creative thinking**

    Acidic soil can be treated by adding lime. Lime is alkaline and it will neutralise the acidity of the soil and make it more neutral.

15. **Understanding key ideas and critical thinking**

Refer to Grade 10 Chemistry Textbook (Table 7.3)



CHAPTER 8

FUELS AND CRUDE OIL

Total Number of Lesson Periods: 19 (1 period - 45 minutes)

Learning Outcomes

It is expected that students will be able to:
- identify the sources, properties and behaviours of the fossil fuels;
- explain the process of fractional distillation as applied to crude oils;
- understand the refining of the separated products (cracking);
- describe the manufacture of useful products from by-product of catalytic cracking;
- recognise the preparation and uses of biodiesel, biogas and hydrogen as other kinds of fuels.

Skill Development

- Collaboration (when working successfully in groups)
- Communication (when reporting progress on exercises and activities)
- Creative Thinking and Problem Solving (when exploration of new source of fuels)
- Creativity and Innovation (when making of useful materials from cracking by-products)

Support Materials

- Puzzle worksheet

Section 8.1 FOSSIL FUELS

Number of lesson periods: 3

Lesson Objective

- To understand the formation and extraction, usefulness, composition and properties of fossil fuels

Introduction

Teacher should recall students' prior knowledge about fuels by asking the questions as follows: What is fuel? A fuel is a substance that is changed in some way to produce heat, electricity or other forms of energy.

What is the usefulness of fuels at present time? Nowadays, fuels are very important resources for our modern society. They are essential for transportation, manufacturing processes, production of electricity, and cooking and heating for domestic uses.

The purpose of learning this section is to understand how the fossil fuels formed, what the composition and properties of these fuels are, and why these are very important in our society.

Teaching

Teacher should explain the sources of three major fossil fuels and time duration of their formation. Then, teacher should refer to Figure 8.1 from Grade 10 Chemistry Textbook, and assess the students' understanding on the differentiation of coal and coke.

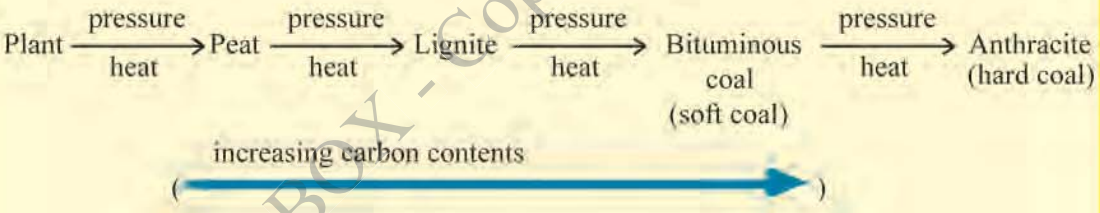
Refer to Figure 8.2 from Grade 10 Chemistry Textbook, students should understand the formation of crude oil and natural gas, and production method of these fuels. The students should be encouraged to connect the lesson and their surroundings by studying the information mentioned in 'Chemistry in Society'.

At the end of lesson, teacher should make some cross questions to assess their understanding.

More information for teacher

- Coal comes from fossil plant residues by the action of pressure and temperature through geological forces.
- Crude oil and natural gas come from marine microorganisms by the action of high pressure and temperature for millions of years.
- Coal is composed mainly of carbon together with hydrogen, nitrogen and sulphur.
- The plant residues were gradually changed as shown below:

Plant residue to anthracite



- **Production of coke from coal**

Coal (mixed compounds of C, N, H and S) —heated strongly in the absence of air→ Coke (pure C)

- Burning of coal can produce various kinds of air pollutants such as soot (unburnt carbon), oxides of sulphur and nitrogen, and solid residue or particulate matter (commonly known as ash). However, burning of coke does not produce such pollutants.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the sources of fossil fuels and their properties.

Activity (1)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To classify the types of fuel as renewable or non-renewable based on the sources and time duration of their formation

Instruction

- Make the class into four groups: A, B, C and D.
- Tell them to mention the fuels based on the following:
- Group A: name of fuel
- Group B: source
- Group C: types of resource (renewable or non-renewable)
- Group D: time duration of formation

Resources and Preparation

- Encourage the students to collect the name and source of fuel by using library / online resources before discussion.

Reflection on Learning

Fuel	Source	Resource	Time duration of formation
kerosene, butane (gas), gasoline and coke	fossil	non-renewable	over millions of years
wood, charcoal, dry leaves and bamboo sticks	plants	renewable	can be grown successively within a few years

Activity (2)

The teacher should identify this activity as a group work depending on the class size.

Objective

- To describe how energy required can be obtained from safe and renewable resources

Instruction

- Make the class into three groups: A, B, and C.
- Tell them to mention the source, instrument and energy conversion of the following:
- Group A: solar power
- Group B: wind power
- Group C: hydropower

Resources and Preparation

- Encourage the students to collect the safe power sources and ways to get energy from these sources by using library / online resources before discussion.

Reflection on Learning

- For example,

Item	Solar power (Group A)	Wind power (Group B)	Hydropower (Group C)
source	sun	speed of wind	waterfalls/river
instrument/ something to support the function	solar panels	wind turbine	water reservoir/dam
	lenses or mirror		
energy conversion pattern	solar energy to electrical energy	kinetic energy (speed of wind) to mechanical energy	kinetic energy (water flowing) to mechanical energy
	solar energy to heat energy		

Key for Review Questions

(1) Petroleum is called a fossil fuel because it has been formed from the fossilised remains of prehistoric plants and animals.

(2) Coal is used to produce coke and electricity.

Section 8.2 FRACTIONAL DISTILLATION OF CRUDE OIL

Number of lesson periods: 4

Lesson Objective

- To understand the separation of crude oil based on different boiling points of these constituents (fractions)

Introduction

After studying fossil fuels from Section 8.1, teacher should start Section 8.2 with questions as follows: Which materials can be produced from crude oil? Refinery gas, petrol, naphtha, paraffin, diesel oil, lubricating oil, fuel oil and bitumen can be obtained from crude oil. How can the components of crude oil be separated? The components of crude oil can be separated by fractional distillation based on their different boiling points.

The purpose of learning this section is to realise what physical properties of these components used in the separation process based on.

Teaching

Teacher should point out the differences between the components of crude oil due to the number of carbon atoms present by referring to Figure 8.3 and Table 8.1. Teacher should inform the different terms of fuel used in UK and USA. Teacher

Reflection on Learning

- For example,

Item	Solar power (Group A)	Wind power (Group B)	Hydropower (Group C)
source	sun	speed of wind	waterfalls/river
instrument/ something to support the function	solar panels	wind turbine	water reservoir/dam
	lenses or mirror		
energy conversion pattern	solar energy to electrical energy	kinetic energy (speed of wind) to mechanical energy	kinetic energy (water flowing) to mechanical energy
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The purpose of learning this section is to realise what physical properties of these components used in the separation process based on.

Teaching

Teacher should point out the differences between the components of crude oil due to the number of carbon atoms present by referring to Figure 8.3 and Table 8.1. Teacher should inform the different terms of fuel used in UK and USA. Teacher

should relate the knowledge gained from Table 8.1, the facts from 'Chemistry in Society', and students' activities expressed in suggestion for practising and evaluation. At the end of lesson, teacher should make some short questions on their understanding.

More information for teacher

- In the fractional distillation column of an oil refinery, the fractions condense and come out of the column at different heights depending on their boiling points.
- Due to high intermolecular forces among long chain hydrocarbons, the forces are more difficult to break. Such long chain hydrocarbons are strong, viscous liquids, or waxy solids.
- Paraffin is suitable for indoor uses because it produces less soot. Kerosene produces more soot, so it is suitable for outdoor uses.
- Fractional distillation method can also be used in the manufacture of methanol industrially.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the knowledge of fractional distillation products and some of their uses in society.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

- To motivate the learning skill on petroleum products and refinery process

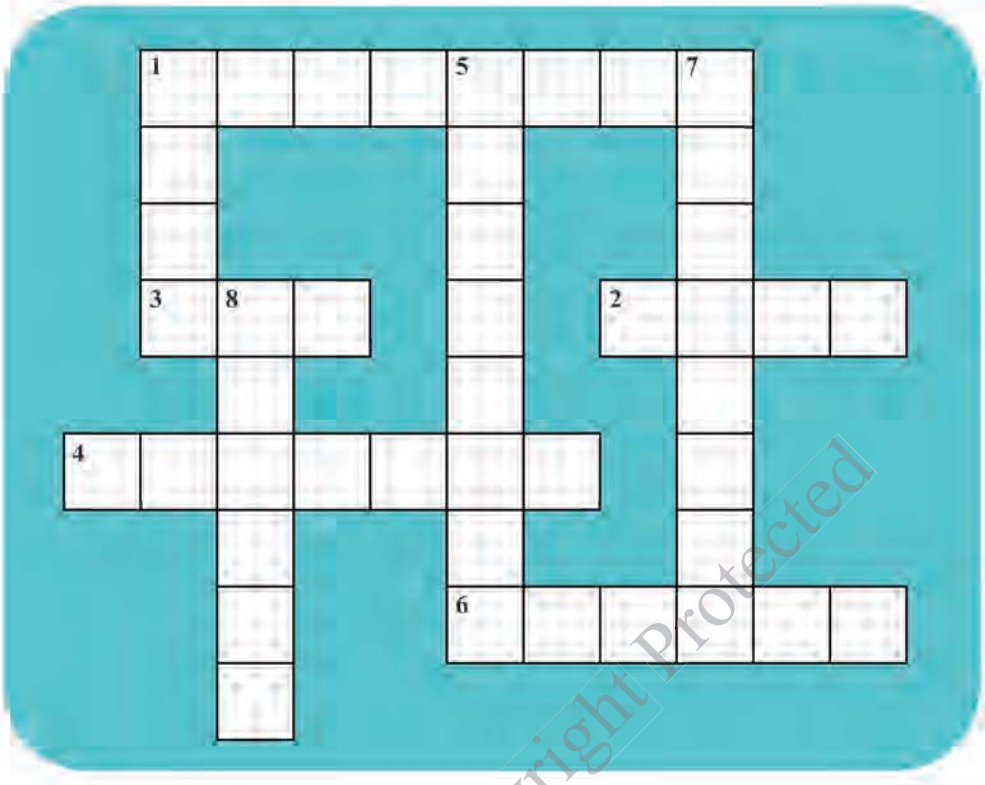
Instruction

- Give the students the blank puzzle worksheet.
- Complete it according to the given description.

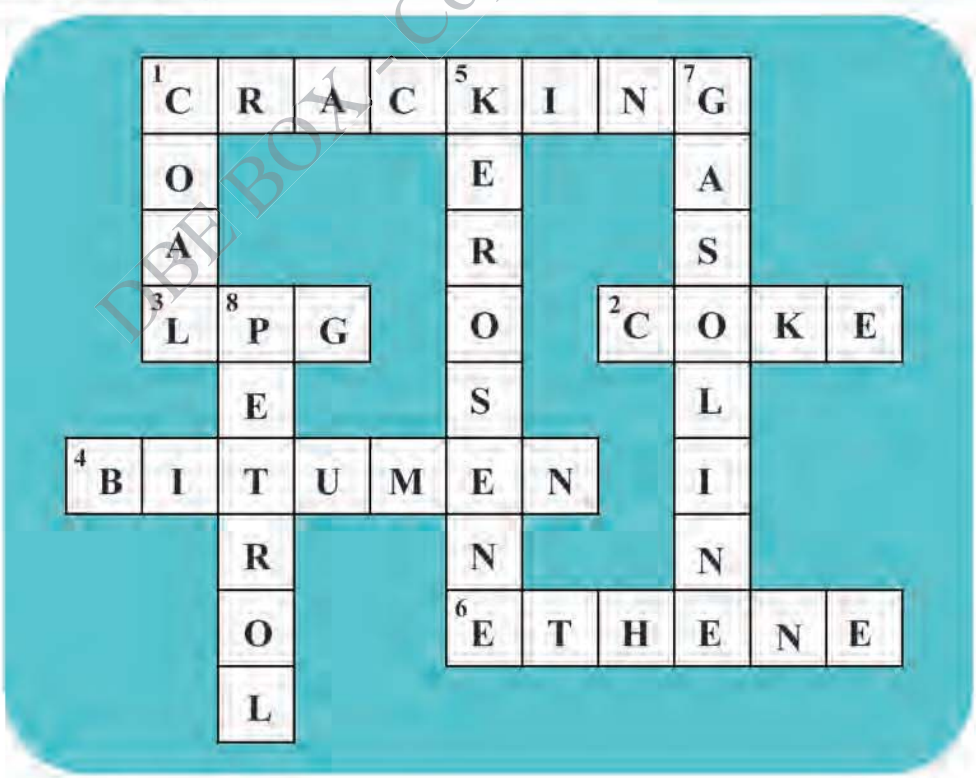
Resources and Preparation

- Puzzle worksheet
- Encourage the students to search about the fuel and refinery process by using Textbook / library / online resources before discussion.

CROSS →	DOWN ↓
1 process of breaking a large molecule into useful small molecules	1 plant fossil fuel
2 pure form of coal	5 jet fuel oil
3 short form of petrol gas in liquid state	7 fuel containing $C_5 \sim C_{10}$ used in car
4 road surfacing material	8 other name of gasoline
6 starting material for plastics	



Reflection on Learning



Activity (2)

The teacher should identify this activity as the individual work.

Objective

- To give knowledge on the fractional distillation products and some of their uses in society

Instruction

- Tell the class to do individually as follows:
- to name the first product (the lowest boiling point product) of fractional distillation
- to describe its constituents
- to mention the materials that can be prepared from the first product

Resources and Preparation

- Encourage the students to collect the data of fractional distillation products by using library / online resources before discussion.

Reflection on Learning

- Refinery gas
- Refinery gas consists mainly of hydrogen, methane, ethane and olefins (alkenes).
- Olefins (alkenes) are starting materials for the production of plastics and other useful synthetic polymers.

Key for Review Questions

(1) (a) kerosene (b) petroleum gases (c) bitumen (d) lubricating oil

(2) (a) naphtha (b) bitumen (c) lubricating oil (d) paraffin (e) diesel oil

(3)

Fraction X	Fraction Y	Reason
less number of carbon atoms	more number of carbon atoms	boiling point of **X** is lower than **Y**.
smaller molecules	larger molecules	number of carbon atoms in **X** is lesser than **Y**.
mostly molecules **X** are in gaseous state.	mostly molecules **Y** are in liquid state.	the molecular masses of hydrocarbon molecules in **X** are smaller than those in **Y**.

(4) Turn off the lights if unnecessary.
Use energy-saving bulbs.
Walk or use bicycle instead of car, bus, etc.
Other reasonable answers must be accepted.

Experimental Work **Number of practical periods: 2**

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 11.

Experiment 11 Examination of Relationship between Number of Carbon Atoms in Petroleum Products and Their Flow Time

In this experiment, teacher should lead and perform the experiment, and ask the students to examine the flow time of samples. The number of carbon atoms in the liquids can be estimated by their flow time due to the physical properties of samples such as density and viscosity. Teacher should aware the class to keep away the petroleum products from naked flame.

Section 8.3 CATALYTIC CRACKING Number of lesson periods: 4

Lesson Objective

- To understand the cracking of refined crude oil

Introduction

In the previous section, the students have learnt the separation of components of crude oil. Teacher should make the following questions and promote the students' interest in this lesson. Among refinery products from fractional distillation, which one is more demandable? It is gasoline because it is eco-friendly and most of the vehicles and generators use it. Is it harmony between production and consumption? Why and how to solve the problem? Refined 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.

The purpose of learning this section is to realise why the cracking is needed to make the refined crude oil.

Teaching

Firstly, teacher should inform that cracking process is essential to harmonise the production and consumption of fuels, and it is required to make catalytic cracking. Students should learn the chemical reactions occurred in cracking process starting from decane into two main types of products (refer to Grade 10 Chemistry Textbook, Section 8.3).

Based on Figure 8.4, teacher should explain the useful products from ethene and relate the information obtained from 'Chemistry in Society'.

At the end of lesson, teacher should make some cross questions on their understanding and promoting their knowledge on cracking products in society based on the students' activities.

Experimental Work **Number of practical periods: 2**

Suggestion for Practical

Refer to Grade 10 Experimental Chemistry, Experiment 11.

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More information for teacher

- Knocking in engines can be reduced by adding tetraethyl lead **(TEL, $(C_2H_5)_4Pb$)** to gasoline. But it can cause harmful effect on the environment due to the presence of lead that can come out from combustion of gasoline.
- The most common type of octane rating worldwide is the **Research Octane Number (RON)**. RON is determined by running the fuel in a test engine with a variable compression ratio under the controlled conditions, and comparing the results with those for mixtures of *iso*-octane and *n*-heptane.
- Then ethene produced from the cracking can be successively utilised to produce ethanol. Ethanol can be used as beverages, alternative fuel and solvent for extracting natural products from plants.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding about the cracking and octane number of fuels.

Activity (1)

The teacher should identify this activity as an individual work.

Objective

To understand the classes of gasoline

Instruction

- Tell the class to do individually as follows:
- to look at the display on the signboard in the gasoline stations
- to record the names of fuels and their prices

Resources and Preparation

- Encourage the students to search the classes of gasoline by using library / online resources before discussion.

Reflection on Learning

- Name of fuels: '92 RON', '95 RON','97 RON', 'diesel', or 'premium diesel'.
- Price is for 1 litre of fuel.
- Teacher should explain that '92' and '95' show the octane number, and '95' contains more amount of *iso*-octane than '92'.

Activity (2)

The teacher should identify this activity as a group work.

Objective

To recognise the usefulness of cracking product "ethene"

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the materials made from the following:
- Group A: polyethene
- Group B: polyvinyl chloride
- Group C: polystyrene

Resources and Preparation

- Encourage the students to note the usefulness of cracking product "ethene" by using library/ online resources before discussion.

Reflection on Learning

- Group A: plastic ruler, ball pen, pencil box, plastic bags, etc., are made of PE (polyethene)
- Group B: water pipeline, gutter and electrical switch used in your school are made up of PVC (polyvinyl chloride)
- The snack boxes (packaging) and foam are made up of PS (polystyrene).
- Other appropriate answers should be accepted.

Key for Review Questions

(1) Larger molecules can be broken into smaller molecules. Cracking is a thermal decomposition process in which large alkane hydrocarbon molecules are broken down by passing them over heated catalyst under pressure.

(2) Because cracking takes place at high temperature to break down the larger molecules into smaller ones. You can explain with the chemical equation.

(3) The conditions for cracking are high temperature (about 500 °C), moderately low pressure and catalyst (silica / alumina / zeolites).

(4) Because fuels made from oil mixtures containing large hydrocarbon molecules 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.

Section 8.4 ALTERNATIVE FUELS Number of lesson periods: 3

Lesson Objective

- To understand the importance of exploration for alternative fuels for future use

Introduction

In previous section, the demand of petrol and diesel has been supported by various methods such as fractional distillation and catalytic cracking. Furthermore, fossil fuels are used not only as fuels but also as other useful products. Teacher should explain that by the present rate of consumption of fossil fuels, crude oil and natural gas may run out within 50 years and coal will only last for a further 250 years. Teacher should lead the students to describe the energy sources other than fossil fuels for our society. Solar power, hydropower, wind power and nuclear power are the energy sources for our society.

Instruction

- Make the class into three groups: A, B and C.
- Tell them to mention the materials made from the following:
- Group A: polyethene
- Group B: polyvinyl chloride
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Resources and Preparation

- Encourage the students to note the usefulness of cracking product "ethene" by using library/ online resources before discussion.

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The purpose of learning this section is to understand how the shortage of fossil fuels compensate by exploration of alternative fuels.

Teaching

Based on Table 8.2, teacher should encourage the students to point out the sources, composition and uses of the alternative fuels. Teacher should inform that Myanmar has many sources for the production of alternative fuels such as biodiesel from plant and animal oils, hydrogen from offshore natural gas, and biogas from cow breeding farms of milk and dairy factories.

At the end of this lesson, teacher should assess the students' feedback on their understanding about alternative fuels.

More information for teacher

- Biogas can be obtained from organic waste (biomass) by anaerobic fermentation. Biogas is mainly composed of methane that can contribute to the greenhouse effect.
- It must be noted that the composition of biogas and natural gas are nearly the same, but natural gas can only be obtained together with the formation of crude oil.
- Hydrogen can be manufactured from natural gas. This fuel can be used in space shuttles, rockets and experimental hydrogen powered cars.
- Among the alternative fuels, biodiesel, biogas and plant oils are renewable; LPG, CNG and gasohol are non-renewable fuels.

Suggestion for Practising and Evaluation

A range of activities can be used to evaluate the students' progress and understanding on the sources and preparation of alternative fuels.

Activity (1)

The teacher should identify this activity as a group work.

Objective

- To describe the sources of biogas and biodiesel

Instruction

- Make the class into two groups: A and B.
- Tell them to mention sources of the following:
- Group A: biogas
- Group B: biodiesel

Resources and Preparation

- Encourage the students to search the sources of biogas and biodiesel by using library / online resources before discussion.

Reflection on Learning

- Group A: cow dung, kitchen waste, plant residue
- Group B: any plant oil

Activity (2)

The teacher should identify this activity as a group work.

Objective

- To verify safe and long-last energy resources (nuclear power and solar power)

Instruction

- Make the class into two groups: A and B.
- Tell them to mention the pros and cons for the following energy sources;
- Group A: nuclear power
- Group B: solar power

Resources and Preparation

- Encourage the students to search the pros and cons of nuclear power and solar power by using library / online resources before discussion.

Reflection on Learning

- Group A: huge energy source but disposal of nuclear waste is dangerous
- Group B: environmental friendly resource but limited for some parts of the world
- Other appropriate answers should be accepted.

Key for Review Questions

(1) (a) biogas (b) biodiesel (c) biomass (d) biodiesel

(2)

Fuels	Source	Composition	Uses
diesel	petroleum	C_{15} ~ C_{20} hydrocarbons	as a fuel in buses, cars and lorries
gasohol	petrol and ethanol	90 % petrol + 10 % ethanol, 15 % petrol + 85 % ethanol (US)	as a fuel in vehicles

SUMMARY

The highlights of this chapter:

- the meaning and importance of fuels
- main resources of fuel: coal (from fossil plants), crude oil and natural gas (from marine microorganisms)
- the separation of different components of hydrocarbon molecules by fractional distillation
- the relation between boiling points and viscosities of hydrocarbon molecules: the greater the number of carbon atoms per molecule of the distillate, the higher the boiling points and their viscosities
- catalytic cracking of large hydrocarbon molecules into smaller and more useful molecules
- compensation of the shortage of fossil fuels by exploring alternative fuels

KEY FOR EXERCISES **Number of review exercises periods: 3**

Understanding key ideas (Q.1 to Q.3)

1. (a) FALSE (All fossil fuels are used up rapidly because fossil fuels are non-renewable and their amounts are limited in the Earth. Rate of consumption of fossil fuels also increases.)
   (b) TRUE (c) TRUE
   (d) FALSE (because there are alternative fuels such as biogas, biodiesel, plant oils, hydrogen fuel, etc.)
   (e) TRUE

2.

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

3. (a) Fossil fuels are classified into crude oil, natural gas, and coal. Petroleum is a mixture of hydrocarbons. It is separated into different fractions by fractional distillation. As the boiling points of the fractions increase, the number of carbon atoms of the fractions increases. The last fraction is fuel oil and the residue is bitumen.
   (b) Plant oils can be converted to biodiesel by using transesterification. The plant oils are treated with sodium hydroxide catalyst, in the presence of 100 % pure alcohol at 60 °C. The resultant product is ester. It is a potential substitute for petro-diesel and so it is an alternative transport fuel.

Critical thinking (Q.4 and Q.5)

4. Petroleum is considered as a non-renewable fuel because it takes millions of years to form and it is used up at a rapid rate.
   Palm oil from palm tree is a renewable fuel because it cannot be used up or it can be made at a rate faster than the rate of use.

5. (a) Hydrogen is used as a rocket fuel because on burning it produces huge amount of energy which is required to launch the rocket.This is why it is used as a fuel in space shuttles and other big rockets.
   (b) (i) Methane (natural gas) can be passed with steam over nickel catalyst.

$$\text{methane} + \text{steam} \xrightarrow{\text{Ni}} \text{carbon monoxide} + \text{hydrogen}$$
$$CH_4(g) + H_2O(g) \longrightarrow CO(g) + 3H_2(g)$$

The carbon monoxide is then reacted with more steam.

$$\text{carbon monoxide} + \text{steam} \longrightarrow \text{carbon dioxide} + \text{hydrogen}$$
$$CO(g) + H_2O(g) \longrightarrow CO_2(g) + H_2(g)$$

The hydrogen is separated from carbon dioxide by passing the gases through an alkali to absorb the acidic carbon dioxide.

(ii) Hydrogen is obtained by electrolysis of water containing sulphuric acid.

$$\text{water} \xrightarrow{\text{electrolysis}} \text{hydrogen} + \text{oxygen}$$

$$2H_2O(l) \xrightarrow{\text{electrolysis}} 2H_2(g) + O_2(g)$$

6. **Understanding key ideas**

Transesterification is the conversion of a carboxylic acid ester into a different carboxylic acid ester. This reaction is usually carried out in the presence of alkali as a catalyst in alcohol.

Transesterification is used to produce biodiesel.

$$\underset{\text{carboxylic acid ester}}{R\text{-}COO\text{-}R_1} + \underset{\text{alcohol}}{R_2\text{-}OH} \xrightarrow{\text{alkali}} \underset{\text{carboxylic acid ester}}{R\text{-}COO\text{-}R_2} + \underset{\text{alcohol}}{R_1\text{-}OH}$$

$$R_1 \neq R_2$$

Analytical thinking (Q.7 and Q.8)

7. **Octane rating (octane number)** is a measure of a fuel's ability to resist 'knock.'
It is significant to know octane number for petrol because a fuel with too low octane number can lead to knock the engine which can cause engine damage.

8. (a) Crude oil (petroleum), a mixture of many different hydrocarbons is separated into useful fuels and chemicals. That is known as refining petroleum.

(b) Fractional distillation method

(c) Liquid to vapour at A

(d) Petroleum is separated into different fractions depending on their boiling points at B. Naphtha with lower boiling point comes out first followed by kerosene. Diesel comes out last because of its high boiling point.
(Any reasonable answers can be accepted.)

(e) (i) - Hydrocarbon molecules
- liquid state

(ii) - Different boiling points
- naphtha is used to make chemicals and diesel is used as fuels

(f) Hydrogen fuel and biodiesel are suitable for cars.

(g) Naphtha has the lowest boiling point and diesel oil has the highest boiling point.

(h) Naphtha contains the smallest molecules and diesel oil contains the biggest molecules.

9. **Understanding key ideas and applying**

(a) Hydrocarbon is any of a class of organic chemical compounds composed only of the elements carbon and hydrogen.

(b) Fractional distillation is used to separate the petroleum in oil refineries.
Separation by using fractional distillation depends on the different boiling points of components in the mixture.

(c) (i) bitumen (ii) petroleum gas (iii) lubricating oil (iv) lubricating oil

10. **Critical thinking and understanding key ideas**

(a) - to get more branched alkanes
- to get higher octane rating

(b) catalyst, high temperature, moderately low pressure

(c) $C_{11}H_{24} \xrightarrow[\text{moderately low pressure}]{\text{heat, catalyst}} 2\,C_2H_4 + C_7H_{16}$

(d) $C_{11}H_{24} \xrightarrow[\text{moderately low pressure}]{\text{heat, catalyst}} C_2H_4 + C_3H_6 + C_6H_{14}$

Critical thinking (Q.11 to Q.12)

11. Correct answer is (a).
X (refinery gas) has the lower boiling point (< 40 °C) than that of **Y** (bitumen).
So **X** is more volatile and burns more easily than **Y**.

12. (a) decreasing order of volatilities : petroleum gas, naphtha, kerosene, diesel oil, bitumen

(b) (i) diesel oil (ii) petroleum gas (iii) petroleum gas

13. **Problem solving**

(a) % of carbon = 82.8 %
% of hydrogen = 100 – 82.8 = 17.2 %

	C	H
The percent by mass	82.8	17.2
Divided by relative atomic mass	$\frac{82.8}{12}$	$\frac{17.2}{1}$
	6.9	17.2
	$\frac{6.9}{6.9}$	$\frac{17.2}{6.9}$
	1.0	2.49
	2	5

∴ The empirical formula of **Q** = C_2H_5

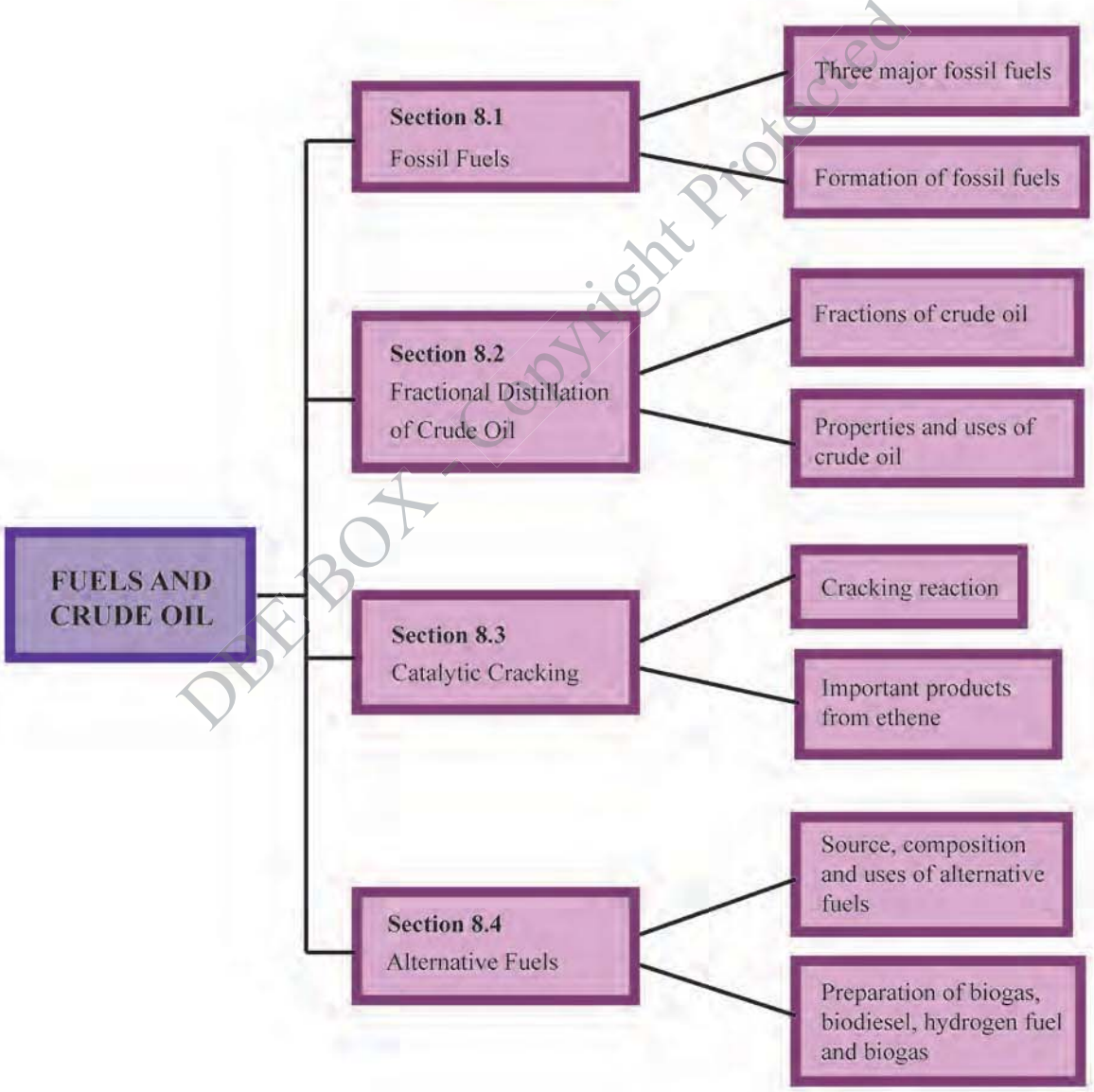
(b) $(C_2H_5)_n = C_xH_{10} = (C_2H_5)_2$

$\therefore$ n = 2

$\therefore$ The molecular formula of **Q** = C_4H_{10}

"Q" can be found in petroleum gases because the petroleum gas consists approximately of 1~ 4 carbon atoms per molecule.

CHAPTER REVIEW



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