8.2 The Chemical Earth

Contextual Outline

The Earth includes a clearly identifiable biosphere, lithosphere, hydrosphere and atmosphere. All of these are mixtures of thousands of substances and the use of this pool of resources requires the separation of useful substances. The processes of separation will be determined by the physical and chemical properties of the substances.

In order to use the Earth's resources effectively and efficiently, it is necessary to understand the properties of the elements and compounds found in mixtures that make up earth materials. Applying appropriate models, theories and laws of chemistry to the range of earth materials allows a useful classification of the materials and a better understanding of the properties of substances.

This module increases students' understanding of the nature, practice, applications and uses of chemistry.

Assumed Knowledge

Domain: knowledge and understanding

Refer to the *Science Years 7–10 Syllabus* for the following:

5.7.1a) describe features of and the location of protons, neutrons and electrons in the atom

5.7.2a) identify the atom as the smallest unit of an element and distinguish between atoms and molecules

5.7.2b) describe some relationships between elements using the Periodic Table

5.7.3a) identify that a new compound is formed by rearranging atoms rather than by creating matter

5.7.3b) classify compounds into groups based on common chemical characteristics

5.7.3c) construct word equations from observations and written descriptions of a range of chemical reactions

5.7.3d) identify a range of common compounds using their common names and chemical formulae

5.7.3e) qualitatively describe reactants and products in the following chemical reactions:
vi) decomposition.

	Students learn to:	*Students:*
1. The living and non-living components of the Earth contain mixtures	• construct word and balanced formulae equations of chemical reactions as they are encountered • identify the difference between elements, compounds and mixtures in terms of particle theory • identify that the biosphere, lithosphere, hydrosphere and atmosphere contain examples of mixtures of elements and compounds • identify and describe procedures that can be used to separate naturally occurring mixtures of: - solids of different sizes - solids and liquids - dissolved solids in liquids - liquids - gases • assess separation techniques for their suitability in separating examples of earth materials, identifying the differences in properties which enable these separations • describe situations in which gravimetric analysis supplies useful data for chemists and other scientists • apply systematic naming of inorganic compounds as they are introduced in the laboratory • identify IUPAC names for carbon compounds as they are encountered	• gather and present information from first-hand or secondary sources to write equations to represent all chemical reactions encountered in the Preliminary course • identify data sources, plan, choose equipment and perform a first-hand investigation to separate the components of a naturally occurring or appropriate mixture such as sand, salt and water • gather first-hand information by carrying out a gravimetric analysis of a mixture to estimate its percentage composition • identify data sources, gather, process and analyse information from secondary sources to identify the industrial separation processes used on a mixture obtained from the biosphere, lithosphere, hydrosphere or atmosphere and use the evidence available to: - identify the properties of the mixture used in its separation - identify the products of separation and their uses - discuss issues associated with wastes from the processes used

	Students learn to:	*Students:*
2. Although most elements are found in combinations on Earth, some elements are found uncombined	• explain the relationship between the reactivity of an element and the likelihood of its existing as an uncombined element • classify elements as metals, non-metals and semi-metals according to their physical properties • account for the uses of metals and non-metals in terms of their physical properties	• plan and perform an investigation to examine some physical properties, including malleability, hardness and electrical conductivity, and some uses of a range of common elements to present information about the classification of elements as metals, non-metals or semi-metals • analyse information from secondary sources to distinguish the physical properties of metals and non-metals • process information from secondary sources and use a Periodic Table to present information about the classification of elements as: - metals, non-metals and semi-metals - solids, liquids and gases at 25˚C and normal atmospheric pressure

	Students learn to:	*Students:*
3. Elements in Earth materials are present mostly as compounds because of interactions at the atomic level	• identify that matter is made of particles that are continuously moving and interacting • describe qualitatively the energy levels of electrons in atoms • describe atoms in terms of mass number and atomic number • describe the formation of ions in terms of atoms gaining or losing electrons • apply the Periodic Table to predict the ions formed by atoms of metals and non-metals • apply Lewis electron dot structures to: - the formation of ions - the electron sharing in some simple molecules • describe the formation of ionic compounds in terms of the attraction of ions of opposite charge • describe molecules as particles which can move independently of each other • distinguish between molecules containing one atom (the noble gases) and molecules with more than one atom • describe the formation of covalent molecules in terms of sharing of electrons • construct formulae for compounds formed from: - ions - atoms sharing electrons	• analyse information by constructing or using models showing the structure of metals, ionic compounds and covalent compounds • construct ionic equations showing metal and non-metal atoms forming ions

	Students learn to:	*Students:*
4. Energy is required to extract elements from their naturally occurring sources	• identify the differences between physical and chemical change in terms of rearrangement of particles • summarise the differences between the boiling and electrolysis of water as an example of the difference between physical and chemical change • identify light, heat and electricity as the common forms of energy that may be released or absorbed during the decomposition or synthesis of substances and identify examples of these changes occurring in everyday life • explain that the amount of energy needed to separate atoms in a compound is an indication of the strength of the attraction, or bond, between them	• plan and safely perform a first-hand investigation to show the decomposition of a carbonate by heat, using appropriate tests to identify carbon dioxide and the oxide as the products of the reaction • gather information using first-hand or secondary sources to: - observe the effect of light on silver salts and identify an application of the use of this reaction - observe the electrolysis of water, analyse the information provided as evidence that water is a compound and identify an application of the use of this reaction • analyse and present information to model the boiling of water and the electrolysis of water tracing the movements of and changes in arrangements of molecules

5. The properties of elements and compounds are determined by their bonding and structure	*Students learn to:* • identify differences between physical and chemical properties of elements, compounds and mixtures • describe the physical properties used to classify compounds as ionic or covalent molecular or covalent network • distinguish between metallic, ionic and covalent bonds • describe metals as three-dimensional lattices of ions in a sea of electrons • describe ionic compounds in terms of repeating three-dimensional lattices of ions • explain why the formula for an ionic compound is an empirical formula • identify common elements that exist as molecules or as covalent lattices • explain the relationship between the properties of conductivity and hardness and the structure of ionic, covalent molecular and covalent network structures	*Students:* • perform a first-hand investigation to compare the properties of some common elements in their elemental state with the properties of the compound(s) of these elements (eg magnesium and oxygen) • choose resources and process information from secondary sources to construct and discuss the limitations of models of ionic lattices, covalent molecules and covalent and metallic lattices • perform an investigation to examine the physical properties of a range of common substances in order to classify them as metallic, ionic or covalent molecular or covalent network substances and relate their characteristics to their uses