9.2 Production of Materials

Contextual Outline

Humans have always exploited their natural environment for all their needs including food, clothing and shelter. As the cultural development of humans continued, they looked for a greater variety of materials to cater for their needs.

The twentieth century saw an explosion in both the use of traditional materials and in the research for development of a wider range of materials to satisfy technological developments. Added to this was a reduction in availability of the traditional resources to supply the increasing world population.

Chemists and chemical engineers continue to play a pivotal role in the search for new sources of traditional materials such as those from the petrochemical industry. As the fossil organic reserves dwindle, new sources of the organic chemicals presently used have to be found. In addition, chemists are continually searching for compounds to be used in the design and production of new materials to replace those that have been deemed no longer satisfactory for needs.

This module increases students' understanding of the implications of chemistry for society and the environment and the current issues, research and developments in chemistry.

	Students learn to:	*Students:*
1. Fossil fuels provide both energy and raw materials such as ethylene, for the production of other substances	• construct word and balanced formulae equations of chemical reactions as they are encountered • identify the industrial source of ethylene from the cracking of some of the fractions from the refining of petroleum • identify that ethylene, because of the high reactivity of its double bond, is readily transformed into many useful products • identify that ethylene serves as a monomer from which polymers are made • identify polyethylene as an addition polymer and explain the meaning of this term • outline the steps in the production of polyethylene as an example of a commercially and industrially important polymer • identify the following as commercially significant monomers: - vinyl chloride - styrene by both their systematic and common names • describe the uses of the polymers made from the above monomers in terms of their properties	• gather and present information from first-hand or secondary sources to write equations to represent all chemical reactions encountered in the HSC course • identify data, plan and perform a first-hand investigation to compare the reactivities of appropriate alkenes with the corresponding alkanes in bromine water • analyse information from secondary sources such as computer simulations, molecular model kits or multimedia resources to model the polymerisation process

	Students learn to:	*Students:*
2. Some scientists research the extraction of materials from biomass to reduce our dependence on fossil fuels	• discuss the need for alternative sources of the compounds presently obtained from the petrochemical industry • explain what is meant by a condensation polymer • describe the reaction involved when a condensation polymer is formed • describe the structure of cellulose and identify it as an example of a condensation polymer found as a major component of biomass • identify that cellulose contains the basic carbon-chain structures needed to build petrochemicals and discuss its potential as a raw material	• use available evidence to gather and present data from secondary sources and analyse progress in the recent development and use of a named biopolymer. This analysis should name the specific enzyme(s) used or organism used to synthesise the material and an evaluation of the use or potential use of the polymer produced related to its properties

	Students learn to:	*Students:*
3. Other resources, such as ethanol, are readily available from renewable resources such as plants	• describe the dehydration of ethanol to ethylene and identify the need for a catalyst in this process and the catalyst used • describe the addition of water to ethylene resulting in the production of ethanol and identify the need for a catalyst in this process and the catalyst used • describe and account for the many uses of ethanol as a solvent for polar and non-polar substances • outline the use of ethanol as a fuel and explain why it can be called a renewable resource • describe conditions under which fermentation of sugars is promoted • summarise the chemistry of the fermentation process • define the molar heat of combustion of a compound and calculate the value for ethanol from first-hand data • assess the potential of ethanol as an alternative fuel and discuss the advantages and disadvantages of its use • identify the IUPAC nomenclature for straight-chained alkanols from C1 to C8	• process information from secondary sources such as molecular model kits, digital technologies or computer simulations to model: - the addition of water to ethylene - the dehydration of ethanol • process information from secondary sources to summarise the processes involved in the industrial production of ethanol from sugar cane • process information from secondary sources to summarise the use of ethanol as an alternative car fuel, evaluating the success of current usage • solve problems, plan and perform a first-hand investigation to carry out the fermentation of glucose and monitor mass changes • present information from secondary sources by writing a balanced equation for the fermentation of glucose to ethanol • identify data sources, choose resources and perform a first-hand investigation to determine and compare heats of combustion of at least three liquid alkanols per gram and per mole

	Students learn to:	*Students:*
4. Oxidation-reduction reactions are increasingly important as a source of energy	• explain the displacement of metals from solution in terms of transfer of electrons • identify the relationship between displacement of metal ions in solution by other metals to the relative activity of metals • account for changes in the oxidation state of species in terms of their loss or gain of electrons • describe and explain galvanic cells in terms of oxidation/reduction reactions • outline the construction of galvanic cells and trace the direction of electron flow • define the terms anode, cathode, electrode and electrolyte to describe galvanic cells	• perform a first-hand investigation to identify the conditions under which a galvanic cell is produced • perform a first-hand investigation and gather first-hand information to measure the difference in potential of different combinations of metals in an electrolyte solution • gather and present information on the structure and chemistry of a dry cell or lead-acid cell and evaluate it in comparison to one of the following: - button cell - fuel cell - vanadium redox cell - lithium cell - liquid junction photovoltaic device (eg the Gratzel cell) in terms of: - chemistry - cost and practicality - impact on society - environmental impact • solve problems and analyse information to calculate the potential $E^{\ominus}$ requirement of named electrochemical processes using tables of standard potentials and half-equations

	Students learn to:	*Students:*
5. Nuclear chemistry provides a range of materials	• distinguish between stable and radioactive isotopes and describe the conditions under which a nucleus is unstable • describe how transuranic elements are produced • describe how commercial radioisotopes are produced • identify instruments and processes that can be used to detect radiation • identify one use of a named radioisotope: - in industry - in medicine • describe the way in which the above named industrial and medical radioisotopes are used and explain their use in terms of their properties	• process information from secondary sources to describe recent discoveries of elements • use available evidence to analyse benefits and problems associated with the use of radioactive isotopes in identified industries and medicine