8.3 Metals

Contextual Outline

The cultural development of humans has been closely connected with their discovery of materials and invention of tools to the point where major advances in cultural achievement have been described in terms of the materials they learned to use. This has included their use of metals and discoveries of increasingly sophisticated methods of extraction of metals from their ores.

Because metals make up the majority of elements, an examination of the physical and chemical properties of metals is also an appropriate context in which to consider the organisation of the common Periodic Table. The development of a Periodic Table represented a breakthrough in the systematic organisation and study of chemistry and enabled scientists to predict the discovery of further elements.

This module increases students' understanding of the history, applications and use of chemistry and current issues, research and developments in chemistry.

Assumed Knowledge

Domain: knowledge and understanding

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

5.7.1b) distinguish between elements, using information about the numbers of protons, neutrons and electrons

5.7.1c) describe an appropriate model that has been developed to describe atomic structure

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

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

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

- ii) corrosion
- iv) acids on metals and acids on carbonates
- v) neutralisation

	Students learn to:	*Students:*
1. Metals have been extracted and used for many thousands of years	• outline and examine some uses of different metals through history, including contemporary uses, as uncombined metals or as alloys • describe the use of common alloys including steel, brass and solder and explain how these relate to their properties • explain why energy input is necessary to extract a metal from its ore • identify why there are more metals available for people to use now than there were 200 years ago	• gather, process, analyse and present information from secondary sources on the range of alloys produced and the reasons for the production and use of these alloys • analyse information to relate the chronology of the Bronze Age, the Iron Age and the modern era and possible future developments
2. Metals differ in their reactivity with other chemicals and this influences their uses	• describe observable changes when metals react with dilute acid, water and oxygen • describe and justify the criteria used to place metals into an order of activity based on their ease of reaction with oxygen, water and dilute acids • identify the reaction of metals with acids as requiring the transfer of electrons • outline examples of the selection of metals for different purposes based on their reactivity, with a particular emphasis on current developments in the use of metals • outline the relationship between the relative activities of metals and their positions on the Periodic Table • identify the importance of first ionisation energy in determining the relative reactivity of metals	• perform a first-hand investigation incorporating information from secondary sources to determine the metal activity series • construct word and balanced formulae equations for the reaction of metals with water, oxygen, dilute acid • construct half-equations to represent the electron transfer reactions occurring when metals react with dilute hydrochloric and dilute sulfuric acids

	Students learn to:	*Students:*
3. As metals and other elements were discovered, scientists recognised that patterns in their physical and chemical properties could be used to organise the elements into a Periodic Table	• identify an appropriate model that has been developed to describe atomic structure • outline the history of the development of the Periodic Table including its origins, the original data used to construct it and the predictions made after its construction • explain the relationship between the position of elements in the Periodic Table, and: - electrical conductivity - ionisation energy - atomic radius - melting point - boiling point - combining power (valency) - electronegativity - reactivity	• process information from secondary sources to develop a Periodic Table by recognising patterns and trends in the properties of elements and use available evidence to predict the characteristics of unknown elements both in groups and across periods • use computer-based technologies to produce a table and a graph of changes in one physical property across a period and down a group

	Students learn to:	*Students:*
4. For efficient resource use, industrial chemical reactions must use measured amounts of each reactant	• define the mole as the number of atoms in exactly 12g of carbon-12 (Avogadro's number) • compare mass changes in samples of metals when they combine with oxygen • describe the contribution of Gay-Lussac to the understanding of gaseous reactions and apply this to an understanding of the mole concept • recount Avogadro's law and describe its importance in developing the mole concept • distinguish between empirical formulae and molecular formulae	• process information from secondary sources to interpret balanced chemical equations in terms of mole ratios • perform a first-hand investigation to measure and identify the mass ratios of metal to non-metal(s) in a common compound and calculate its empirical formula • solve problems and analyse information from secondary sources to perform calculations involving Avogadro's number and the equation for calculating the number of moles of a substance: $n = \frac{m}{M}$ • process information from secondary sources to investigate the relationship between the volumes of gases involved in reactions involving a metal and relate this to an understanding of the mole

	Students learn to:	*Students:*
5. The relative abundance and ease of extraction of metals influences their value and breadth of use in the community	• define the terms mineral and ore with reference to economic and non-economic deposits of natural resources • describe the relationship between the commercial prices of common metals, their actual abundances and relative costs of production • explain why ores are non-renewable resources • describe the separation processes, chemical reactions and energy considerations involved in the extraction of copper from one of its ores • recount the steps taken to recycle aluminium	• discuss the importance of predicting yield in the identification, mining and extraction of commercial ore deposits • justify the increased recycling of metals in our society and across the world • analyse information to compare the cost and energy expenditure involved in the extraction of aluminium from its ore and the recycling of aluminium