8.4 Water

Contextual Outline

The first astronauts who viewed the Earth from space commented on the beauty of our water-rich blue planet. Earth's position in the solar system enables its retention of water in solid, liquid and gaseous forms on and around its surface. The particular properties of the water molecule assisted the evolution of life and continue to support life processes by maintaining a narrow temperature range on the Earth's surface.

The concepts of bonding and intermolecular forces are used to increase understanding of the special nature of the water molecule. The chemistry of solutions is examined in greater detail.

This module increases students' understanding of the nature and practice of chemistry and the implications of chemistry for society and the environment.

Assumed Knowledge

Domain: knowledge and understanding

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

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

	Students learn to:	*Students:*
1. Water is distributed on Earth as a solid, liquid and gas	• define the terms solute, solvent and solution • identify the importance of water as a solvent • compare the state, percentage and distribution of water in the biosphere, lithosphere, hydrosphere and atmosphere • outline the significance of the different states of water on Earth in terms of water as: - a constituent of cells and its role as both a solvent and a raw material in metabolism - a habitat in which temperature extremes are less than nearby terrestrial habitats - an agent of weathering of rocks both as liquid and solid - a natural resource for humans and other organisms	• perform an investigation involving calculations of the density of water as a liquid and a solid using: $\text{density} = \frac{\text{mass}}{\text{volume}}$ • analyse information by using models to account for the differing densities of ice and liquid water • plan and perform an investigation to identify and describe the effect of anti-freeze or salt on the boiling point of water
2. The wide distribution and importance of water on Earth is a consequence of its molecular structure and hydrogen bonding	• construct Lewis electron dot structures of water, ammonia and hydrogen sulfide to identify the distribution of electrons • compare the molecular structure of water, ammonia and hydrogen sulfide, the differences in their molecular shapes and in their melting and boiling points • describe hydrogen bonding between molecules • identify the water molecule as a polar molecule • describe the attractive forces between polar molecules as dipole-dipole forces • explain the following properties of water in terms of its intermolecular forces: - surface tension - viscosity - boiling and melting points	• process information from secondary sources to graph and compare the boiling and melting points of water with other similar sized molecules • identify data and process information from secondary sources to model the structure of the water molecule and effects of forces between water molecules • choose equipment and perform first-hand investigations to demonstrate the following properties of water: - surface tension - viscosity

	Students learn to:	*Students:*
3. Water is an important solvent	• explain changes, if any, to particles and account for those changes when the following types of chemicals interact with water: - a soluble ionic compound such as sodium chloride - a soluble molecular compound such as sucrose - a soluble or partially soluble molecular element or compound such as iodine, oxygen or hydrogen chloride - a covalent network structure substance such as silicon dioxide - a substance with large molecules, such as cellulose or polyethylene • analyse the relationship between the solubility of substances in water and the polar nature of the water molecule	• perform a first-hand investigation to test the solubilities in water of a range of substances that include ionic, soluble molecular, insoluble molecular, covalent networks and large molecules • process information from secondary sources to visualise the dissolution in water of various types of substances and solve problems by using models to show the changes that occur in particle arrangement as dissolution occurs

	Students learn to:	*Students:*
4. The concentration of salts in water will vary according to their solubility, and precipitation can occur when the ions of an insoluble salt are in solution together	• identify some combinations of solutions which will produce precipitates, using solubility data • describe a model that traces the movement of ions when solution and precipitation occur • identify the dynamic nature of ion movement in a saturated dissolution • describe the molarity of a solution as the number of moles of solute per litre of solution using: $c = \frac{n}{V}$ • explain why different measurements of concentration are important	• construct ionic equations to represent the dissolution and precipitation of ionic compounds in water • present information in balanced chemical equations and identify the appropriate phase descriptors (s), (l), (g), and (aq) for all chemical species • perform a first-hand investigation, using micro-techniques, to compare the solubility of appropriate salts in solution through precipitation reactions • carry out simple calculations to describe the concentration of given solutions, given masses of solute and volumes of solution • perform a first-hand investigation to make solutions to specified volume-to-volume and mass-to-volume specifications and dilute them to specified concentrations (cV = constant) • calculate mass and concentration relationships in precipitation reactions as they are encountered

	Students learn to:	*Students:*
5. Water has a higher heat capacity than many other liquids	• explain what is meant by the specific heat capacity of a substance • compare the specific heat capacity of water with a range of other solvents • explain and use the equation $\Delta H = -mC\Delta T$ • explain how water's ability to absorb heat is used to measure energy changes in chemical reactions • describe dissolutions which release heat as exothermic and give examples • describe dissolutions which absorb heat as endothermic and give examples • explain why water's ability to absorb heat is important to aquatic organisms and to life on earth generally • explain what is meant by thermal pollution and discuss the implications for life if a body of water is affected by thermal pollution	• choose resources and perform a first-hand investigation to measure the change in temperature when substances dissolve in water and calculate the molar heat of solution • process and present information from secondary sources to assess the limitations of calorimetry experiments and design modifications to equipment used