Science
Stage 6

Draft Sample Learning Unit for Chemistry

Sample Learning Units/Units of Work

In reviewing the *1999 Stage 6 Support Document* the sample programs were revised and changes have been made to incorporate:

- amendments to the syllabuses (2002)
- some of the learning–teaching activities
- a greater focus on assessment for learning in the learning units
- a continuum in the approach to programming and assessment that is consistent with *Science Years 7–10 Advice on Programming and Assessment*

Together with the *Stage 6 Support Document (2007)* the sample learning units/units of work are designed to assist teachers in implementing the *Science Stage 6 Syllabuses.* A learning unit for a Preliminary course module from each of Biology, Chemistry, Earth and Environmental Science, Physics and Senior Science is included.
The level of detail in the learning–teaching and assessment strategies is provided to illustrate one way in which the explicit integration and development of the 8.1 skills module content and PFA emphasis may be undertaken in developing a learning unit.

Overview of Planning and Programming Learning Units

Establishing a scope and sequence
The fundamental step in planning is establishing a scope and sequence plan (p 55 of the Support document) which contains the overview of the placement, sequence and duration of proposed learning units. The completed scope and sequence will also identify the outcomes targeted for each learning unit and any specific syllabus requirements including the open-ended investigation (p 35 of the Support document). Evaluation in relation to the *Science Stage 6 Syllabus* requirements of the scope and sequence and the developing units of work in the school's learning, teaching and assessment program for the course is essential.

Checklist: Syllabus Requirements

A school learning–teaching program for Stage 6 Preliminary and HSC science courses must include the following:

- all Prescribed Focus Area, Domain: knowledge, understanding, skills, values and attitudes outcomes
- the three syllabus content elements: Context, Prescribed Focus Areas (PFA) and Domain
- all the Domain: knowledge and understanding and skills content in the modules
- the integration of Modules 8.1 or 9.1 skills content within and across the learning units to develop the full range of skills by the end of the courses
- practical experiences with at least one open-ended investigation in both the Preliminary and HSC courses
- timetabling of 120 hours for each of the Preliminary and HSC courses
- evidence that 80 indicative hours of practical/field work during the Preliminary and HSC courses with no less than 35 hours of practical experiences in the HSC course have been completed
- compliance with:
  - mandatory safety requirements (p 44 of the Support document)
  - regulations related to the use of animals in teaching (p 46 of the Support document).

Planning and programming is a dynamic process involving a number of interrelated activities. In planning the school learning–teaching and assessment program for a course, teachers may choose to use the current units as the starting point, evaluate and revise some current units and design additional new ones, or devise completely new units for the whole program.

Gathering evidence of learning

The *Science Stage 6 Syllabuses* promote an approach to planning and programming that has outcomes as the focus. In the initial stage of the planning process a manageable number of outcomes for the learning unit/unit of work are identified. These targeted outcomes are central to decisions about the required evidence of learning to be observed through the learning, teaching and assessment experiences. Once specific evidence of learning has been identified, strategies to collect the required evidence are selected. Methods of gathering evidence could include informal teacher observation, questioning, peer and self-evaluation as well as more structured formal types of assessment activities.

Designing the unit

In planning the learning units a structure for presenting the teaching sequences needs to be decided. The design of the learning units should enable a clear link to be made between the targeted outcomes, the knowledge, understanding and skills content and the selected suggested integrated learning, teaching and assessment experiences. A sample page from a learning unit based on the sample learning unit proforma (p 57 of the Support document) identifies the basic elements of a learning unit/unit of work. The annotations show the characteristics of each part. Schools may choose to use or adapt the proforma provided to develop learning units that best meet their needs and circumstances.

Mapping the skills content

In Stage 6 the skills build on the essential content in the *Science Years 7–10 Syllabus*. During the Preliminary and HSC course, it is expected that students will further develop skills in planning and conducting investigations, communicating information and understanding, scientific thinking and problem-solving and working individually and in teams. Each syllabus module specifies content through which skill outcomes for the course can be achieved. Teachers should develop activities based on that content to provide students with opportunities to develop the full range of skills.

The skills content mapping grids can be used as a planning tool by broadly classifying the skills learning experiences into one of three developmental levels. In the learning phase (L) the teacher establishes the student's skill level/prior learning and uses this as the basis for developing student understanding through explicit teaching of the relevant knowledge, understanding and skills components. In the practising phase (P) the student uses the knowledge, understanding and/or skills in tasks to achieve specific goals. The application phase (A) is when the student independently uses the knowledge, understanding and skills in the course of regular work and as a foundation for the development of learning.

Based on an analysis of all of the learning units/units of work the school program should be evaluated and modified to ensure that all the mandated 8.1 (Preliminary) or 9.1 (HSC) skills content is addressed and that there is a continuum in the development of skills content within the course. During the planning and development of the learning units in the school program adjustments to the scope and sequence and skills content mapping grids will need to be made.

Programming the learning experiences

In the programming process, learning experiences are selected and sequenced to cater for the diversity of student learning needs. The lesson sequences in the units of work should highlight how students' knowledge, understanding and skills are developed through explicit, systematic teaching–learning that is clearly linked through the identified module and skill content to the syllabus outcomes for the course.

Assessment for learning (p 26 of the Support document) occurs as an integral part of learning and teaching and involves using a range of strategies to: enhance learning, clarify and promote deeper understanding, plan ways to remedy misconceptions, and develop and incorporate new knowledge, understanding and skills. Strategies should be supportive of the learning process, appropriate to the outcomes being assessed and provide students with feedback on what they have learned and what needs to be done to continue their learning. Assessment for learning encourages self-assessment and peer assessment with students developing and using a range of strategies to monitor and evaluate their own learning and the strategies they use.
The checklist provides a guide to developing learning experiences that are consistent with the requirements of the *Science Stage 6 Syllabuses*.

Checklist: Programming Learning Experiences

To meet syllabus requirements the range of learning experiences and strategies selected for a unit of work should:

- target and address an appropriate and manageable range of knowledge, understanding, skills, values and attitudes outcomes for the indicative time allocated to the module in the syllabus
- make explicit the contexts drawn from the module contextual outline, the selected Prescribed Focus Area (PFA) and the content statements in column 1 devised as the framework to assist students to use their current understanding to develop and apply more specialised scientific knowledge and skills
- relate explicitly the selected skills content from Module 8.1 (Preliminary) and 9.1 (HSC) to the specified module content (skills content mapping grids)
- identify and extend students' prior learning using an appropriate range of strategies (Continuum of Learning on p 7 of the Support document)
- emphasise learning in the lesson sequences that specifically develop the targeted PFAs and values and attitudes outcomes selected for the unit
- integrate assessment for learning as part of the learning-teaching process
- identify specific evidence of learning to be observed through the teaching, learning and assessment (informal and formal) experiences
- provide sufficient variety to meet the needs of a range of student learning styles
- include a balance between informal and formal strategies to provide students with feedback on their learning.

Adjusting and amending the learning program
Teacher reflection and evaluation (p 49 of the Support document) and students' feedback during and following the teaching of lesson sequences and/or the unit of work will result in amendments to the scope and sequence, skills mapping grids and the learning units that together make up the school program.

Recording evidence of learning
The school learning, teaching and assessment program should provide a range of opportunities for students to develop and demonstrate progress towards achievement of the Stage 6 syllabus knowledge, understanding and skills outcomes for the course. By integrating learning and assessment, the teacher can choose which aspects of a student's performance to record.
Recording student performance needs to be manageable. Teachers should make decisions about which aspects of student performance in an activity are to be recorded and in what format.

All assessment activities can be used to support learning and to provide feedback to students that enables them to actively monitor and evaluate their own learning. Teachers can use the evidence of learning gathered to extend the process of assessment for learning into the assessment of learning. In a standards-referenced framework this involves teachers making professional judgements about student achievement at key points in the course. The sample HSC course assessment plan (p 51 of the Support document) identifies these key points and the internal assessment mark provides a summation of each student's achievements measured at these points throughout the course. In the assessment plan for the course a variety of tasks should be used to give students the opportunity to demonstrate outcomes in different ways and to improve the validity and reliability of the assessment.

1 This column 1 content point is examinable. It can also provide a contextual focus for teaching and learning.

Sample Page from a Learning Unit

Stage 6 Earth and Environmental Science Syllabus

8.3.3: The impact of humans on local aquatic and terrestrial environments will differ with locality

8.3.3 Module Content (column 2 and 3)	Reg	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *explain why different groups in the local society have different views of the impact of human activity on the local environment *identify data, gather, process and analyse first-hand information and use available evidence to assess current human impact on the local biotic and abiotic environment.		Students: **12.3 gather information from secondary sources by:** d) summarising and collating information from a range of sources **13.1 present information** a) selecting and using app or combinations thereof, f presentations e) using a variety of pictorial representations to show relationships and presenting information clearly and succinctly **14.1 analyse information to:** e) make and justify generalisations g) use cause-and-effect relationships to explain phenomena h) identify examples of the interconnectedness of ideas or scientific principles **13.1 present information by:** e) using a variety of pictorial representations to show relationships and presenting information clearly and succinctly **14.1 analyse information to:** e) make and justify generalisations.	In a class activity, st - use a teacher-devel strip mine for coal in o find informa fossicking, o distinction between an exploration licence, a mineral claim and a mining lease o consider how land use changes over time, eg many mining operations only last for ten years o prepare an outline of the possible views of the different community groups such as residents, Aboriginal peoples, tourists, developers, environmentalists and local government o debate whether the co different views held b community of the imp environment o discuss why the envir land use should be reg Individually, students - *produce a summary table of the different viewpoints of each community group and the main arguments for and against the proposed coal mine that they identified* (P4, P13, P14). Focus Activity Task 3 Working as a project team, stude - discuss the impact of past huma terrestrial environment of the fiel considered in the context of the p development - monitor the team's progress towards the completion of the activity (P15). **Suggested Evidence of Learning activities are in italics*

2 Content related to the Prescribed Focus Area outcome (P4).

3 These content points contain the mandatory knowledge and understanding content of the syllabus.

4 Key words identifying the module 8.1 skill content to be addressed.

5 Module 8.1 skills content with a specific focus in the Suggested Learning–Teaching Experiences.

6 Explicit learning–teaching sequences that provide opportunity for students to develop the knowledge, understanding, skills values and attitudes to demonstrate evidence of learning in relation to the targeted outcomes.

7 Experience that can be used to provide observable evidence resulting from learning–teaching that will allow judgements to be made in relation to the progress towards achievement of the target outcomes. Suggested Evidence of Learning activities are indicated by the use of italics.

8 Problem-solving, contextually based, team activity undertaken throughout the unit. It integrates the skill and module content and develops students' understanding of the targeted Prescribed Focus Area outcome(s).

About the Sample Learning Units

The sample learning units have been designed to assist teachers in implementing the *Science Stage 6 Syllabuses*. Schools may choose to use or adapt these sample units in planning and developing units of work that will best meet the needs of the range of learning styles, abilities, circumstances and expectations of their students.

The sample units provide examples of how a manageable range of targeted knowledge, understanding, and values and attitude outcomes can be addressed. The lesson sequences within the units demonstrate ways that teachers can build on the foundation of scientific knowledge and skills in working scientifically that students have gained from their learning experiences based on the *Science Years 7–10 Syllabus*. The detail described in the Suggested Learning–Teaching Experiences column is provided to show how the targeted outcomes for the unit can be addressed through explicit and systematic learning. The sample learning units also model how an appropriate balance between student-centred and teacher-directed learning can be achieved in the suggested learning-teaching experiences.

In the Stage 6 syllabuses the Prescribed Focus Area (PFA) emphasis is embedded in the module content. The selected learning, teaching and assessment experiences within each unit provide examples that demonstrate how the identified module contexts and the intent of one or more targeted Prescribed Focus Area outcomes (Stage 6 syllabuses pages 12 and 13) are made explicit.

A syllabus requirement is that the module 8.1 skills content is integrated within and across the learning units of the school teaching program so that students have opportunities to develop the full range of skills by the end of the course. The sample units model how this skills content can be explicitly integrated within the specified content of each module. To assist teachers in developing the skills content continuum across all the units in the school program a suggested planning tool is to broadly classify the skills learning experiences into one of three developmental phases: learn (L), practise (P) and apply (A). In each of the sample units, the learning experiences provide opportunities for students to engage in learning, practising and/or applying the skill content for the targeted outcomes. At the end of each sample learning unit an overview is provided that shows the targeted skill outcomes with the skill content coded and mapped to the developmental levels of the learning experiences in each section of the unit.

For consistency with the focus on assessment for learning in Years 7–10, a range of specific evidence of learning experiences have been identified in italics within the Suggested Learning–Teaching Experiences column of the learning unit. These provide examples of evidence of learning that could be used to make judgements about students' progress towards the achievement of the outcomes targeted in the unit. The marking criteria and guidelines (HSC Assessment in a standards-referenced framework – A guide to best practice) developed by teachers for these experiences could be used to provide students with constructive and meaningful feedback in relation to their achievement of the targeted outcomes of the unit.

Focus activity

In developing each of the sample units of work, a focus activity has been incorporated which involves students in undertaking and managing a project throughout the unit. The focus activity models how the integrated module and skills content can be used to develop students understanding of the ideas embedded in the targeted Prescribed Focus Area outcome(s). The activity has been designed so that the core knowledge, understanding and skills required for the project are systematically addressed within the content of each section of the module and the project should therefore be able to be completed within the time allocation for the unit. An overview is provided to show for each focus activity the PFA emphasis explicitly applied through the learning–teaching

experiences in the learning unit provided for each course.

The focus activity in each of the learning units is based around the students using a real world setting of the project management process to create a specific product. By actively engaging in applying their learning in an authentic workplace context students can be encouraged to recognise and use their current understanding to further develop and apply more specialised knowledge and skills. In undertaking and managing the project students develop knowledge of and skills in working individually and in teams (P15) and have the opportunity to learn through problem-solving (P14). In the role of facilitator and advisor, the teacher assists in monitoring the progress of each team.

Project management necessitates the use of tools and techniques to organise activities for a specific purpose and requires the use of effective communication and interpersonal skills. In introducing the activity, and while students are undertaking the focus activity, opportunities may need to be provided for them to review their prior understanding and develop the communication and interpersonal skills – such as active listening, conflict resolution, negotiation skills and team building – that are needed to work effectively with others.

Students may need an introduction to project management methodology. A project can be basically organised into four phases: defining, planning, implementing and reviewing. The table provides an overview of each phase and how the main components of the process can clearly contribute to providing evidence of learning relating to the syllabus outcomes of problem-solving and working in teams.

Checklist: Project Management for the Focus Activities

Defining the project includes:

- clarifying the project brief by identifying, analysing and explaining the nature of a problem
- establishing the main elements of the project
- setting the goals that are key to the success of the project
- identifying the timing and deadlines (key dates) to be met
- determining tasks and resources
- assessing constraints and risk including social and ethical concerns
- defining individual and team roles and responsibilities
- showing flexibility and responsiveness to ideas and evidence.

Planning the project includes:

- identifying, and describing different strategies that could be used to solve the problem
- choosing the most appropriate strategies to solve the problem
- agreeing on tasks, resources and timelines
- evaluating potential risk factors that could impact on the completion of the project
- identifying the specific roles needed and matching team members to tasks according to the requirements of the task
- negotiating and allocating individual roles and responsibilities
- respecting differing opinions and viewpoints about the issues being considered.

Implementing the project includes:

- conducting the investigation using the identified strategies
- modifying the plan and processes where issues are identified or arise during the investigation
- gathering data and communicating information and understanding
- completing progress reports which evaluate the appropriateness of strategies, processes and modifications used in solving the problem
- working effectively in individual roles and as a team to meet timelines and goals
- monitoring team progress to completion of the task
- demonstrating confidence and a willingness to make decisions and to take responsible actions.

Reviewing the project includes:

- presenting the product using an appropriate medium
- evaluating the plan, strategies and processes used by the team
- evaluating the effectiveness of the team in completing the task
- acknowledging the role of science in providing information and understanding about issues being considered and the impact of science on aspects of everyday life.

If the focus activity is to be used to gather evidence of student learning the students need to be informed of the criteria that will be used to assess their learning. The sample feedback template provides an example of one model that could be used with the focus activity to inform students what they need to do to demonstrate evidence of learning in relation to working in a team. It could also be used to provide effective student feedback that enables them to recognise their strengths and areas for development.

Sample feedback template – Working in a team

Teamwork criteria	Low	Satisfactory	High
Defines team responsibilities	With teacher guidance outlines individual and/or team responsibilities	Defines individual and/or team responsibilities	Demonstrates confidence in describing individual and/or team responsibilities
Identifies and accepts roles	With teacher guidance identifies and accepts specific individual and/or team roles	Identifies and accepts individual and/or team roles specific to the task	Matches team members to roles according to the specific requirements of the task and accepts roles based on the skills of the individual
Sets goals and timelines	With teacher guidance identifies goals and set timelines for the task	Identifies goals and sets timelines	Demonstrates high-level skills in setting realistic goals and timelines
Communicates opinions/ideas	With teacher guidance expresses opinions and ideas	Clearly expresses opinions and ideas	Communicates opinions and ideas succinctly and logically
Uses listening and negotiation skills	With teacher guidance uses active listening and negotiation skills	Demonstrates some skills in active listening and negotiation	Demonstrates high level active listening and negotiation skills
Engages in teamwork	With teacher guidance uses a limited number of strategies to work within the team to complete the task	Identifies and uses a range of cooperative learning strategies to work efficiently as a team member to complete the task	Demonstrates a sound understanding of cooperative learning strategies and uses these to work collaboratively to complete the task
Makes decisions and takes responsible actions	With teacher guidance takes responsibility in a negotiated role to follow a plan to meet goals and timelines	Takes responsibility for roles within the team and works with others to meet goals, timelines and monitor progress of the task	Demonstrates responsibility in a number of roles and in decision-making so that goals and timelines are met and the progress of the task is monitored
Team effectively completes the task	With teacher guidance identifies some processes which assisted the team to complete the task	Describes the effectiveness of some parts of the plan and some processes used by the team to complete the task	Evaluates the effectiveness of the plan and processes used by the team in completing the task

Overview of Sample Learning Units

Stage 6 Syllabus Module	Unit Target Outcomes	Prescribed Focus Area Emphasis	Focus Activity
Biology 8.3 Patterns in Nature	P1 P3 P6 P11 P12 P13 P14 P15 P16	The PFA emphasis in this unit is on developing students' knowledge and understanding of: - biology as an ever-developing body of knowledge - the relevance, usefulness and applicability of biological concepts and principles.	Your team of four is involved in major research investigating the structure and function of cells. Your manager requests that the team submit an article about your research projects for the magazine produced by your company. The magazine is read widely by the general public and it is also an important resource used by Years 11 and 12 Biology students. The article must be informative, scientifically accurate, interestingly written and be no longer than 4000 words. It must include a brief outline of the investigation methods used by the team and how the findings from this research has increased understanding of the relationship between cells, organs and organ systems in the functioning of multicellular plants and/or animals. You will work as a team to produce the article, with each member negotiating to prepare and present specific investigation methods and findings for inclusion in the article.
Chemistry 8.4 Water	P2 P4 P6 P10 P11 P12 P13 P14 P15 P16	The PFA emphasis in this unit is on developing students' knowledge and understanding of: - the process and methods of exploring, generating, testing and relating ideas - the impact and the role of chemistry in society and the environment - skills in decision-making about issues concerning chemistry, society and the environment	Your chemistry class has been contracted as chemical consultants to undertake an environmental impact study on the development of a desalination plant on the shore of a coastal bay. Your team will prepare part of the report that describes the key scientific principles being applied in the operation of the plant (eg how energy is supplied, how pure water is separated, how the properties of water and water solutions are applied in the separation process), possible social and environmental impacts of the desalination plant, including the possible forms and impact of pollution that may occur, key considerations that will influence where the plant is located and the arrangements for returning wastewater to the bay. You will work in a small team, with each member negotiating to prepare and present specific aspects of the final environmental impact assessment report.
Earth and Environmental Science 8.3 The Local Environment	P2 P4 P7 P11 P12 P13 P14 P15 P16	The PFA emphasis in this unit, through a field study investigation, is on developing students': - knowledge and understanding of the process and methods of exploring, generating, testing and relating ideas - skills in decision-making about issues concerning society and the environment - awareness of science that relate to distinctively Australian environments.	You are part of a team of environmental scientists undertaking an environmental impact assessment of an area which has been selected as a potential site for a major residential development. The team will need to investigate the relationship between geology, landscape, soils, climate, plants and animals with a particular focus on the impact of humans on the local environment. You will work as a project team with each member negotiating to research, report and present a specific part of the final environmental impact assessment report.

Stage 6 Syllabus Module	Unit Target Outcomes	Prescribed Focus Area Emphasis	Focus Activity
Physics 8.2 The World Communicates	P2 P3 P5 P7 P8 P11 P12 P13 P14 P15 P16	The PFA emphasis in this unit is on developing students' knowledge and understanding of: - the process and methods of exploring, generating, testing and relating ideas - how increases in our understanding in physics have led to the development of useful technologies and systems - the contributions physics has made to society, with a particular emphasis on Australian achievements	You are a member of a project team of telecommunications experts whose task is to develop a plan for a safe, energy efficient and sustainable communications system for a mining community in an isolated area of Australia. You will present a short, creative and scientifically accurate presentation on your plan to a local community forum. The report you prepare should include the plan, an outline of how increases in our understanding in physics and the application of present-day understanding of the electromagnetic spectrum have led to the development of useful communication technologies and an evaluation of the social and environmental impacts of the proposed communications system. You will work as a project team with each member negotiating to research, report and present one or two specific technological aspects for the team.
Senior Science 8.2 Water for Living	P2 P4 P7 P9 P11 P12 P13 P14 P15 P16	The PFA emphasis in this unit is on developing students: - understanding of the interrelatedness of people and their surrounds - skills in decision making about water resource management - awareness of science that relate to distinctively Australian environments.	Your Senior Science class has been contracted as consultants by a local government organisation to research and prepare a series of short, creative and scientifically accurate presentations to inform the community about strategies to maintain the quality and sustainability of the local water supplies. The presentation must be no longer than 4 minutes and must include relevant information on the issues and strategies to reduce the impacts and consequences of human activity on water usage and pollution in the local catchment area. You will work as a project team with each member negotiating to research, report and present information for a specific part of the team presentation.

Science
Stage 6
Draft Sample Learning Unit – Chemistry

Module 8.4 Water

Sample Stage 6 Chemistry Course **Module 8.4 Water (30 indicative hours)**

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:

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

5.7.3e) qualitatively describe the reactants and products in precipitation reactions

This unit of work builds on the essential content of the Prescribed Focus Area and the skills described in the *Science Years 7–10 Syllabus*.

Targeted Outcomes

P2 applies the processes that are used to test and validate models, theories and laws of science, with particular emphasis on first-hand investigations
P4 describes applications of chemistry which affect society or the environment
P6 explains trends and relationships between elements in terms of atomic structure and bonding
P10 applies simple stoichiometric relationships
P11 identifies and implements improvements to investigation plans
P12 discusses the validity and reliability of data gathered from first-hand investigations and secondary sources
P13 identifies appropriate terminology and reporting styles to communicate information and understanding in Science
P14 draws valid conclusions from gathered data and information
P15 implements strategies to work effectively as an individual or as a member of a team
P16 demonstrates positive values about and attitudes towards both the living and non-living components of the environment, ethical behaviour and a desire for critical evaluation of the consequences of the applications of science

Focus Activity

Throughout this unit the emphasis of learning is on developing students' understanding of the impact and role of chemistry in society and the environment and their skills in decision-making about issues concerning society and the environment (P4).The processes and methods of exploring, generating, testing and relating ideas (P2) is also a focus of learning and teaching in the unit. In developing this sample unit of work, a focus activity has been incorporated to model how these targeted Prescribed Focus Area outcomes can be developed through the module knowledge, understanding content and Module 8.1 skills content.

The focus activity in this learning unit is based around the students using a project management process to create a specific product. This approach provides an example of how, by actively engaging in an authentic strategy applied in a real-world setting, students can be encouraged to recognise and use their current understanding to further develop and apply more specialised knowledge and skills. In undertaking and managing the project students have the opportunity to work individually and in teams (P15) and to learn through problem-solving (P14).

Students will need access to the internet and a range of software applications including word processors, spreadsheets, databases and presentation and multimedia players to enable them to process, analyse and present information. Throughout the unit, and in undertaking the project, students will need to have access to individual and shared files for collecting, organising, storing and retrieving data.

Each student will keep an individual logbook/journal that records a summary of what they did each time they worked on the project. It would include ideas, planning, summaries of research information, appropriately acknowledged relevant references, resources with annotations and evaluation of strategies and solutions.

Focus Activity: 8.4 Water

Your chemistry class has been contracted as chemical consultants to undertake an environmental impact study on the development of a desalination plant on the shore of a coastal bay. Your team will prepare part of the report that describes the key scientific principles being applied in the operation of the plant (eg how energy is supplied, how pure water is separated, how the properties of water and water solutions are applied in the separation process), possible social and environmental impacts of the desalination plant including the possible forms and impact of pollution that may occur, key considerations that will influence where the plant is located and the arrangements for returning wastewater to the bay. You will work in a small team, with each member negotiating to prepare and present specific aspects of the final environmental impact assessment report. This activity is due for completion by the end of this module.

Resources

Examples would include:

- texts, references, scientific journals and library resources
- current websites, digital, audio and visual technologies
- specific materials, resources and equipment (including safety)

8.4.1. Water is distributed on Earth as a solid, liquid and gas

8.4.1 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *outline the significance of the different states of water on Earth in terms of water as: – a constituent of cells – an agent of weathering of rocks both as liquid and solid – a natural resource for humans and other organisms		Students: **13.1 present information by:** a) selecting and using appropriate text types, or combinations thereof, for oral and written presentations e) using a variety of pictorial representations to show relationships and presenting information clearly and succinctly f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately	Introductory Activity: reviewing Prior Learning In a class activity, through teacher questions, students: - recall facts about and some properties of water including water's melting and boiling points (4.7.2e, 4.7.5e, 4.8.1c, 4.9.5a, 4.9.6b) - record this information in an agreed format accessible to the class - review the purpose of mind maps and, with teacher guidance, develop a mind map that records and links this information. Students will add information and annotations to the mind map throughout the unit. Individually, students: - develop a summary based on the class mind-map to indicate the main features of the role of water in cells, as a weathering agent and as a natural resource, in whatever form is most meaningful - use the agreed format to collect and record local area meteorological data on water temperature, air temperature and humidity over the period of the unit. Tabulate the data and present in graph form. This data will be required at the end of the unit. (8.5.5) Teacher introduces the focus activity
*perform an investigation involving calculations of the density of water as a liquid and a solid using *density = mass/volume*		**12.1 perform first-hand investigations by:** a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments **12.2 gather first-hand information by:** a) using appropriate data collection techniques, employing appropriate technologies including data loggers and sensors b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate	Practical Investigation: does the density of water vary with temperature? In pairs, students: - use a teacher-provided procedure to conduct a first-hand investigation to measure masses and volumes of water and ice - select and draw graphs to show the measured relationship between temperature and density - calculate densities of water and ice at different temperatures, including 4 °C and record in a format accessible to the class - write a full practical report, including the question, investigation procedure, results, discussion and conclusion.

8.4.1 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *analyse information by using models to account for the differing densities of ice and liquid water		Students: **12.4 process information to:** c) best illustrate trends and patterns by selecting and using appropriate methods, including computer-assisted analysis **13.1 present information by:** f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately **14.1 analyse information to:** a) identify trends, patterns and relationships as well as contradictions in data and information f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause and effect relationships to explain phenomena **13.1 present information by:** a) selecting and using appropriate text types or combinations thereof, for oral and written presentations f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately	In a teacher-guided class activity, students: - review and discuss the pooled class data collected in their investigation to: - identify the components and the relationship between them - account for group differences in results - identify trends shown in their graphs - draw conclusions about the differences in structure between water and ice, made evident through measured differences in density. (In this discussion and analysis, students should refer to concepts of bonding from module 8.2.3 and 8.2.5.) In a teacher-lead discussion, students: - identify and discuss a number of questions relating to the behaviour of water as it freezes. Examples could include: how does the fact that ice floats in water help keep a drink cooler than if it sank?; what is the significance to the survival of living things in winter in high latitudes that ice floats on seawater?; why is the submerged volume of iceberg in cold water greater than the volume above the water's surface? - summarise their ideas from the discussion and record in a format accessible to the class. Individually, students: - *present an outline that summarises the importance and applicability of the anomalous behaviour of water as it freezes*. (P4, P6, P13, P14)
*compare the state, percentage and distribution of water in the biosphere, lithosphere, hydrosphere and atmosphere *define the terms solute, solvent and solution		**14.1 analyse information to:** a) identify trends, patterns and relationships as well as contradictions in data and information f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause and effect relationships to explain phenomena	In project teams, students: - collect and tabulate or graph teacher-supplied data comparing the distribution and significance of different states of water on Earth - develop a paragraph that summarises this information. In a class activity, students: - discuss, with teacher guidance, the nature of solutions, referring to the mind map (8.4.1) and making appropriate annotations - recall and record examples and definitions relating to solutions.

8.4.1 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *plan and perform an investigation to identify and describe the effect of anti-freeze or salt on the boiling point of water		Students: **11.2 plan first-hand investigations to:** b) identify variables that need to be kept constant, develop strategies to ensure that these variables are kept constant, and demonstrate the use of a control c) design investigations that allow valid and reliable data and information to be collected **12.1 perform first-hand investigations by:** a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments **12.2 gather first-hand information by:** a) using appropriate data collection techniques, employing appropriate technologies including data loggers and sensors b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate **13.1 present information by:** a) selecting and using appropriate text types, or combinations thereof, for oral and written presentations f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately **14.1 analyse information:** a) identify trends, patterns and relationships as well as contradictions in data and information e) make and justify generalisations f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause and effect relationships to explain phenomena **14.3 use available evidence to:** c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations	Practical Investigation: is there any effect of solute on the boiling point of water? In pairs, students: - plan and record a first-hand investigation to examine the effect of salt and/or anti-freeze on the boiling point of water. - develop a risk assessment for the investigation. In discussion with the teacher, students: - check their planned procedure and make any modifications necessary to their plan. In pairs, students: - perform the planned investigation, implementing correct safety procedures, recording results and any modifications made to the plan during the activity. - write a practical report for the investigation based on their individual data, which includes the procedure, results, relevant graphs, identifies trends and draws valid conclusions - participate in a teacher-led discussion on their results and conclusions, relating them to concepts of bonding and change of state. (refer Module 8.2.1 and 8.2.5) Individually, students: - *prepare and present a written explanation for the effect on boiling point of adding a solute, including justifying any generalisations they make based on the class information*. (P6, P13, P14)

8.4.1 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *identify the importance of water as a solvent *outline the significance of the different states of water on Earth in terms of water as: - its role as both a solvent and a raw material in metabolism - a habitat in which temperature extremes are less than nearby terrestrial habitats		Students: **14.1 analyse information to:** g) use cause and effect relationships to explain phenomena h) identify examples of the interconnectedness of ideas or scientific principles **14.2 solve problems by:** a) identifying and explaining the nature of the problem b) describing and selecting from different strategies those which could be used to solve a problem **14.3 use available evidence to:** c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations d) formulate cause and effect relationships	In a class activity, students: - recall water as a major constituent in cells and the significance of the different states of matter for life on Earth - research examples of the use and significance of water as a solvent in living organisms, and as a raw material in metabolism - use data collected to draw conclusions about the significance of water in moderating the temperature variations of habitats. Focus Activity Task 1: Working as a project team, students: - develop an appropriate project plan for undertaking the focus activity with timelines and identified team roles and responsibilities - use teacher-selected resources to collect and summarise information about the ongoing research and developments on desalination as a source of drinking water - review collated and acknowledged data and information to make predictions and justify conclusions about the impact on the biotic and abiotic components of the environment of the influx into waterways of water from industrial cooling towers and desalination plants - select and use an appropriate format to prepare a summary of the different methods of desalination in terms of the separation of solute from solvent. (P15) **Suggested Evidence of Learning Activities are in italics*

8.4.2 The wide distribution and importance of water on Earth is a consequence of its molecular structure and hydrogen bonding

8.4.2 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *process information from secondary sources to graph and compare the boiling and melting points of water with other similar sized molecules *compare the molecular structure of water, ammonia and hydrogen sulfide, the differences in their molecular shapes and in their melting and boiling points *construct Lewis electron dot structures of water, ammonia and hydrogen sulfide to identify the distribution of electrons *choose equipment and perform first-hand investigations to demonstrate the following properties of water: - surface tension - viscosity *identify data and process information from secondary sources to model the structure of the water molecule and effects of forces between water molecules *describe hydrogen bonding between molecules *identify the water molecule as a polar molecule *describe the attractive forces between polar molecules as dipole-dipole forces		Students: **13.1 present information by:** f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately **14.1 analyse information to:** a) identify trends, patterns and relationships as well as contradictions in data and information f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause-and-effect relationships to explain phenomena **11.3 choose equipment or resources by:** a) identifying and/or setting up the most appropriate equipment or combination of equipment needed to undertake the investigation **12.1 perform first-hand investigations by:** a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources d) identifying and using safe work practices during investigations **12.2 gather first-hand information by:** b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate	In pairs, students: - use molecular model kits to prepare models of compounds with similar molecular mass, including NH_3, H_2S, HF - graph, using teacher-provided data, the melting points and boiling points of water and other compounds - draw conclusions, through teacher-led discussion, about patterns or trends in this data - review, through teacher questioning, the drawing of Lewis electron dot structures (refer Module 8.2.3) and molecular structures of water, ammonia, hydrogen sulphide and hydrogen fluoride - write a paragraph to relate the electron distribution in these three molecules to the differences in their shapes. Practical Investigation: how does water demonstrate the properties of surface tension and viscosity? In pairs, students: - select from a range of teacher-provided procedures, that best explore, generate, test and relate ideas about properties of water - choose the appropriate equipment to demonstrate some properties of water, including surface tension and viscosity and carry out their selected procedure - record their observations as labelled diagrams - compare these properties to another common, safe liquid such as ethanol in the discussion of the results - write a valid conclusion for the question tested based on their results. In a class activity, students: - use teacher-selected resources and notes that cover hydrogen bonding, polar molecules and dipole-dipole attractive forces in undertaking a jigsaw activity to analyse and explain the observations made in their investigation.

8.4.2 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *explain the following properties of water in terms of its intermolecular forces: - surface tension - viscosity - boiling and melting points		Students: **13.1 present information by:** a) selecting and using appropriate text types, or combinations thereof, for oral and written presentations e) using a variety of pictorial representations to show relationships and presenting information clearly and succinctly **14.1 analyse information to:** e) make and justify generalisations f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause and effect relationships to explain phenomena h) identify examples of the interconnectedness of ideas or scientific principles **14.2 solve problems by:** b) describing and selecting from different strategies those which could be used to solve a problem c) using identified strategies to develop arrange of possible solutions to a particular problem **14.3 use available evidence to:** b) propose ideas that demonstrate coherence and logical progression and include correct use of scientific principles and ideas	Individually, students: *- draw labelled diagrams with captions in order to define relevant terms and relate them to both the shape of the water molecule and intermolecular forces and their impact on the observed properties of water* *- relate the distribution and importance of water on Earth to its molecular structure.* (P4, P6, P13, P14) Focus Activity Task 2: Working as a project team, students: - research and use an appropriate format to record and acknowledge information on how the concentrated discharge of desalination plants can affect the characteristics of seawater in terms of increased solutes, surface tension and viscosity - assess the environmental impacts of the different methods of water purification based on the properties of water - monitor team progress towards completion of the project. (P15) **Suggested Evidence of Learning Activities are in italics*

8.4.3. Water is an important solvent

8.4.3 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *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 *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 *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: **12.1 perform first-hand investigations by:** a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources c) disposing of any waste materials produced carefully and safely during the investigation d) identifying and using safe work practices during investigations **12.3 gather information from secondary sources by:** b) practising efficient data collection techniques to identify useful information in secondary sources **12.4 process information to:** a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered	Practical Investigation: what types of substances do (or do not) dissolve in water to produce solutions that conduct an electric current? In pairs, students: - review and discuss a teacher-planned procedure to test the solubility of compounds such as sodium chloride, sucrose, iodine, silicon dioxide and polythene, with reference to minimising hazards and wastage of resources. This list should be extended to cover compounds to be used in the following precipitation (8.4.4) reactions and heat capacity (8.4.5) investigation. - recall a suitable experimental technique that can identify a solution that conducts electricity - select appropriate equipment and include in the investigation procedure - construct a table to record observations. With the teacher making observations to check and record practical skills, individually students: - *select appropriate equipment, carry out the planned procedure using safe and environmentally sound work practices to conduct their investigation.* (P2, P11, P12) In a class activity, through teacher questioning, students: - use chemical data books to identify the chemical bonding involved in the compounds/elements used, and annotate their results tables - review the classification of substances based on chemical bonding. Individually, students: - use teacher-selected references, draw out the information that describes the processes of dissolution in water of ionic and molecular substances and relate the implications - relate this information to the solubility and conductivity observations and data collected in the practical investigation - use the first-hand and secondary sources of information to develop notes on solubility and conductivity including the role of the polar water molecule in the dissolution process

8.4.3 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *analyse the relationship between the solubility of substances in water and the polar nature of the water molecule		Students: d) evaluate the relevance of first-hand and secondary information and data in relation to the area of investigation **13.1 present information by:** d) using symbols and formulae to express relationships and using appropriate units for physical quantities **14.1 analyse information to:** a) identify trends, patterns and relationships as well as contradictions in data and information b) justify inferences and conclusions c) identify and explain how data supports or refutes an hypothesis, a prediction or a proposed solution to a problem **14.2 solve problems by:** c) using identified strategies to develop a range of possible solutions to a particular problem **14.3 use available evidence to:** c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations d) formulate cause and effect relationships	- with teacher assistance, make annotations and use the notes to develop relevant chemical equations that show the changes that occur, during dissolution, to the particles of substances used in their practical investigation - draw, label and caption two sequences of diagrams which illustrate the process of an ionic solid and a molecular solid dissolving into water. In a teacher-led discussion, students: - draw out and relate the implications of their data to provide an explanation for the inability of some substances to dissolve in water. Individually, students: - *explain insolubility in water by comparing forces between:* o *ions and the forces between water molecules and ions* o *identical molecules and the forces between water molecules and these molecules.* (P6, P14) Focus Activity Task 3: Working as a project team, students: - investigate the pre-treatment of seawater in desalination plants to remove particulate matter - consider the chemical and physical issues in the separation of Na^+ and Cl^- from water - compare the different methods of desalination in terms of the purity of water produced and their environmental impacts - monitor team progress towards completion of the project. (P15) **Suggested Evidence of Learning Activities are in italics*

8.4.4. The concentrations 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

8.8.4 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *identify some combinations of solutions which will produce precipitates, using solubility data *perform a first-hand investigation, using micro-techniques, to compare the solubility of appropriate salts in solution through precipitation reactions *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 *describe a model that traces the movement of ions when solution and precipitation occur		Students: **11.3 choose equipment or resources by:** b) carrying out a risk assessment of intended experimental procedures and identifying and addressing potential hazards c) identifying technology that could be used during investigations and determining its suitability and effectiveness for its potential role in the procedure or investigation **14.2 solve problems by:** a) identifying and explaining the nature of a problem c) using identified strategies to develop a range of possible solutions to a particular problem **12.1 perform first-hand investigations by:** a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources c) disposing of any waste materials produced carefully and safely during the investigation **14.1 analyse information to:** c) identify and explain how data supports or refutes an hypothesis, a prediction or a proposed solution to a problem d) predict outcomes and generate plausible explanations related to the observations	In a teacher-guided class activity, in pairs students: - name some specific examples of precipitation reactions they have observed - predict combinations of solutions prepared in 8.4.3 that will produce precipitates, and check their predictions with reference to extracts from a chemical data book - review their ideas about the provisional nature of explanations, the evidence supporting these and the process and methods of exploring, testing and relating ideas - review teacher-selected investigations using micro-techniques to confirm precipitation reactions and the safe disposal of waste products - discuss the effectiveness of using micro-techniques in minimising quantities of resources required and waste disposal. In project teams, students: - *carry out a teacher-designed investigation using micro-techniques to confirm the precipitation reactions identified with the teacher checking that students are following safe work practices and are disposing of waste substances appropriately* (P2, P4, P12) - record their observations in table form - compare their results with information from a chemical data book - discuss any differences between their existing views and the evidence they collected that supports or contradicts them. In a class activity, through teacher questioning, students: - relate the effect of solution concentration on results, modifying their experimental procedure and repeating if necessary - write, with teacher guidance, both overall and ionic equations for all precipitation reactions, using appropriate phase descriptors - investigate the different units for the measurement of

8.8.4 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning**
Students learn to/students: *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: $c = \frac{n}{V}$ *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)		Students: **13.1 present information by:** d) using symbols and formulae to express relationships and using appropriate units for physical quantities **11.1 identify data sources to:** c) identify the orders of magnitude that will be appropriate and the uncertainty that may be present in the measurement of data d) identify and use correct units for data that will be collected **12.4 process information to:** b) identify and apply appropriate mathematical formulae and concepts **11.3 choose equipment or resources by:** a) identifying and/or setting up the most appropriate equipment or combination of equipment needed to undertake the investigation **12.1 perform first-hand investigations by:** b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources d) identifying and using safe work practices during investigations **12.4 process information to:** a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered b) identify and apply appropriate mathematical formulae and concepts	concentration and explain why they have been developed/used - undertake a teacher-supplied jigsaw activity and describe in words and diagrams the movement and dynamic nature of ions in dissolution and saturated dissolutions (precipitations). Individually, students: - develop their own notes from this activity and record their understandings of these concepts, including sets of labelled and captioned diagrams which show the dynamic nature of dissolution and dynamic equilibrium in a saturated solution. In a class activity, through teacher questioning, students: - revise the mole concept. (refer module 8.3 4) Individually or in pairs, with teacher guidance, students: - use the mole concept to explain the importance of a knowledge of solution concentration in various circumstances - identify a word definition for the term ‘molarity’ with respect to solutions and relate it to a mathematical expression, giving examples - apply mathematical expressions for calculating molarity to various teacher-selected examples, including those required for the following practical investigation. Practical Investigation: how do the actual and calculated masses of a precipitate compare? In a class activity, students: - review and clarify the procedure to be used and plan how they will conduct their investigation - discuss the selection of equipment that has the appropriate sensitivity to measure the masses involved to the required accuracy and consider ways of reducing the magnitude of experimental errors - use teacher-provided resources to compare the effectiveness of appropriate techniques used for filtration and evaporating solutions to dryness - select procedures that maximise the collected mass of their sample.

8.8.4 Module Content (Columns 2 and 3)	**Reg.**	**8.1 Skills Content**	**Suggested Learning–Teaching Experiences and *Evidence of Learning****
Students learn to/students: *calculate mass and concentration relationships in precipitation reactions as they are encountered		Students: **13.1 present information by:** d) using symbols and formulae to express relationships and using appropriate units for physical quantities **12.4 process information to:** a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered b) identify and apply appropriate mathematical formulae and concepts **14.1 analyse information to:** f) use models, including mathematical ones, to explain phenomena and/or make predictions **14.2 solve problems by:** c) using identified strategies to develop a range of possible solutions to a particular problem **14.3 use available evidence to:** a) design and produce creative solutions to problems	Individually, students: - calculate, using the relevant mathematical expressions, the masses of chemicals required to prepare specified volumes of a solution of given concentration, using the correct units - prepare and combine dilute solutions of known concentration of two appropriate compounds - use safe work practices to accurately measure and combine specified volumes of each solution carefully separate and dry the precipitate - weigh the mass of precipitate formed. In a teacher-guided class activity, students: - write balanced chemical equations and use them to calculate the masses of products expected from the combination of specified volumes of solutions of known concentrations - compare the predicted and the yield of precipitate from the investigation - draw conclusions about the accuracy of their practical measurements Individually, students: - practise mathematical calculations relating to molarity and the expected number of moles and masses of precipitates in unknown situations *- reach a pre-specified achievement standard in a class quiz on concentrations of solutions and formation of precipitates*.(P10, P12, P14) Focus Activity Task 4: Working as a project team, students: - continue research and preparation of parts of their report - monitor team progress towards completion of the project. (P15) **Suggested Evidence of Learning Activities are in italics*

8.4.5. Water has a higher heat capacity than many other liquids

8.4.5 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning*
Students learn to/ Students: *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 *process and present information from secondary sources to assess the limitations of calorimetry experiments *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 and use the equation $\Delta H = -mC\Delta T$		Students: **12.3 gather information from secondary sources by:** b) practising efficient data collection techniques to identify useful information in secondary sources c) extracting information from numerical data in graphs and tables as well as from written and spoken material in all its forms **12.4 process information to:** d) evaluate the relevance of first-hand and secondary information and data in relation to the area of investigation **14.1 analyse information to:** d) predict outcomes and generate plausible explanations related to the observations e) make and justify generalisations **12.4 process information to:** b) identify and apply appropriate mathematical formulae and concepts	In project teams, students: - identify using teacher-selected resources a range of situations in which water is used in industry, such as in cooling towers and bomb calorimetry - predict, based on their prior knowledge and newly learned chemical information, some reasons for the choice of water in these technologies - access information from secondary sources to write a suitable definition for the term 'heat capacity', compare water's heat capacity with other solvents - compare their information and explain their findings about the heat capacity of water and other solvents with another team - discuss the environmental advantages and consequences of the high heat capacity of water. In a class activity, students: - recall their investigation into dissolution, referring to their table (8.4.3) of observations - identify those compounds that demonstrated a temperature change during dissolution in their investigation - make a generalisation about the energy implications (refer to Modules 8.2.3 and 8.2.4). - define the terms 'exothermic' and 'endothermic' and provide examples from their previous investigation. Individually, with teacher support, students: - use a range of teacher-selected resources to make notes on the quantitative application of these observations - apply this to selected examples using the mathematical model. $\Delta H = -mC\Delta T$ - classify a list of teacher-provided examples of reactions as endothermic or exothermic.

8.4.5 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning*
Students learn to/students: *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 *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		Students: **11.1 identify data sources to:** e) recommend the use of an appropriate technology or strategy for data collection or gathering information that will assist efficient future analysis **11.3 choose equipment or resources by:** c) identifying technology that could be used during investigations and determining its suitability and effectiveness for its potential role in the procedure or investigations **12.1 perform first-hand investigations by:** b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources **14.1 analyse information to:** a) identify trends, patterns and relationships as well as contradictions in data and information b) justify inferences and conclusions d) predict outcomes and generate plausible explanations related to the observations **12.3 gather information from secondary sources by:** a) accessing information from a range of resources including popular scientific journals, digital technologies and the internet b) practising efficient data collection techniques to identify useful information in secondary sources d) summarising and collating information from a range of resources	Individually, students: - *review and revise their mind map (8.4.1) and annotate it to identify and include new knowledge and understanding.* (P4, P6, P10, P13, P14) In pairs, students: - compare and discuss their mind maps, making any clarifications and amendments as necessary. Practical Investigation: what is the molar heat of solution of sodium thiosulfate? In a class activity using teacher-selected resources, students: - review and discuss the different technologies available and their suitability for collecting appropriate data for the investigation - select an appropriate procedure for the investigation from a range provided by the teacher. Several different methods could be used by the students and then the results compared across the class - agree on how data will be recorded in a format that will be accessible to the class Individually, students: - perform the selected investigation, record the procedure including any modifications and all appropriate data - use their data and the appropriate equation to calculate a molar heat of solution - compare their experimental value with that in a chemical data book - propose explanations for any discrepancies in these values - compare their results and explanations with another member of the class. In project teams, students: - participate in a discussion to share their ideas and make links between their predictions about the effect of discharged water from cooling towers with their current knowledge about the properties of water, and refer to their collected meteorological

8.4.5 Module Content (Columns 2 and 3)	Reg.	8.1 Skills Content	Suggested Learning–Teaching Experiences and *Evidence of Learning*
		Students: **13.1 present information by:** a) selecting and using appropriate text types, or combinations thereof, for oral and written presentations **14.2 solve problems by:** d) evaluating the appropriateness of different strategies for solving an identified problem **14.3 use available evidence to:** b) propose ideas that demonstrate coherence and logical progression and include correct use of scientific principles and ideas c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations	data (8.4.1). - use their collected data and other resources to: (i) define 'thermal pollution' (ii) make notes, using examples to describe the implications for living things if a body of water is affected by thermal pollution. (iii) prepare a summary that explains how water's ability to absorb heat is important to the survival of aquatic organisms and life on Earth Focus Activity Task 5: Working as a project team, students: - complete their report - submit the report, and their individual logbooks with a brief evaluation of the process used by the team and the effectiveness of the team in completing the task. (P4, P12, P13, P14, P15) **Suggested Evidence of Learning Activities are in italics*

Overview of Skills Development Module 8.4 – Water

Knowledge & Understanding	Skill Development		Skills Content Reference
8.4.1. Water is distributed on Earth as a solid, liquid and gas.	**P11** identifies and implements improvements to investigation plans	**P**	11.2 b,c
	P12 discusses the validity and reliability of data gathered from first-hand investigations and secondary sources	**P/A**	12.1a; 12.2a,b; 12.4c
	P13 identifies appropriate terminology and reporting styles to communicate information and understanding in science	**P/A**	13.1a,e,f
	P14 draws valid conclusions from gathered data and information	**P/A**	14.1a,e,f,g,h; 14.2a,b; 14.3c,d
	P15 implements strategies to work effectively as an individual or as a member of a team	**L**	
8.4.2 The wide distribution and importance of water on Earth is a consequence of its molecular structure.	**P11** identifies and implements improvements to investigation plans	**P/A**	11.3a
	P12 discusses the validity and reliability of data gathered from first-hand investigations and secondary sources	**P/A**	12.1a,b,d; 12.2b
	P13 identifies appropriate terminology and reporting styles to communicate information and understanding in science	**P/A**	13.1a,e,f
	P14 draws valid conclusions from gathered data and information	**P/A**	14.1a,e,f,g,h; 14.2b,c; 14.3b
	P15 implements strategies to work effectively as an individual or as a member of a team	**P**	
8.4.3. Water is an important solvent.	**P12** discusses the validity and reliability of data gathered from first-hand investigations and secondary sources	**A**	12.1a,b,c,d; 12.3b; 12.4a,d
	P13 identifies appropriate terminology and reporting styles to communicate information and understanding in science	**A**	13.1d
	P14 draws valid conclusions from gathered data and information	**A**	14.1a,b,c;14.2c; 14.3c,d
	P15 implements strategies to work effectively as an individual or as a member of a team	**P/A**	
8.4.4. The concentrations 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.	**P11** identifies and implements improvements to investigation plans	**A**	11.1c,d; 11.3a,b,c
	P12 discusses the validity and reliability of data gathered from first-hand investigations and secondary sources	**A**	12.1a,b,c,d; 12.4a,b
	P13 identifies appropriate terminology and reporting styles to communicate information and understanding in science	**A**	13.1d
	P14 draws valid conclusions from gathered data and information	**A**	14.1c,d,f; 14.2a,c; 14.3a
	P15 implements strategies to work effectively as an individual or as a member of a team	**P/A**	
8.4.5. Water has a higher heat	**P11** identifies and implements improvements to investigation plans	**A**	11.1e; 11.3c

capacity than many other liquids.	**P12** discusses the validity and reliability of data gathered from first-hand investigations and secondary sources	**A**	12.1b; 12.3a,b,c,d; 12.4b,d
	P13 identifies appropriate terminology and reporting styles to communicate information and understanding in science	**A**	13.1a
	P14 draws valid conclusions from gathered data and information	**A**	14.1a,b,d,e; 14.2d; 14.3b,c
	P15 implements strategies to work effectively as an individual or as a member of a team	**P/A**	

Draft Sample Learning Unit Feedback

Please respond to the following statements by **circling** the appropriate response.

Which Preliminary Course Draft Sample Learning Unit did you teach?

Biology Chemistry Earth and Environmental Science

Physics Senior Science

School: Government Non-government

Other (please specify)_____

Location: Metropolitan Non-metropolitan

Size of school: less than 100 students 100–299 300–499

500–1000 more than 1000 students

Total years teaching Stage 6 Science: 0–5 6–10 11–20 more than 20

Number of years teaching this Preliminary course: 0–4 more than 4

For the Draft Sample Learning Unit you taught please provide comments for each of the following questions:

1. Was the unit able to be completed in the allocated indicative time? YES NO

If NO, please comment.

2. Did the Suggested Learning–Teaching Experiences provide sufficient flexibility to adjust the program during the unit to address your student learning needs? YES NO

3. Which of the Suggested Learning–Teaching Experiences did you modify or change? Please provide reasons for these amendments.

You may provide comments and annotations on a copy of the sample learning unit.

4. Did the learning strategies provide sufficient detail on how to explicitly develop the targeted module 8.1 skills content in the unit? YES NO

5. Did the Suggested Learning–Teaching Experiences provide appropriate guidance on how to:

- develop the targeted Prescribed Focus Area (PFA) outcomes YES NO
- emphasise the values and attitudes outcome? YES NO

6. Could the *Evidence of Learning* activities (assessment **for** learning) be modified or further developed to:

- focus more clearly on syllabus outcomes YES NO
- provide clearer communication to students on the task requirements and/or ways in which they could improve their level of achievement? YES NO

7. Was there an appropriate balance in the unit Suggested Learning–Teaching Experiences between student-centred and teacher-directed learning? YES NO

If NO, please comment.

8. Did the organisation of the Focus Activity into smaller tasks in each section provide sufficient opportunity for you to guide and monitor student learning throughout the unit?

YES NO

9. Did the Focus Activity provide students with a scaffold to structure the development of the targeted thinking/problem solving skills? YES NO

10. Please comment on the effectiveness of the project management strategy for the Focus Activity in:

- engaging students in learning
- consolidating the ideas and understanding within and across the sections of the unit
- developing students' skills in teamwork.

Other comments/suggestions:

Thank you for taking the time to comment on the Draft Sample Learning Unit. Your feedback and suggestions are appreciated. Please send your feedback comments by:

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