Physical Sciences

LEVEL 3	15 TCE CREDIT POINTS
COURSE CODE	PSC315118
COURSE SPAN	2018 — 2023
READING AND WRITING STANDARD	NO
MATHEMATICS STANDARD	YES
COMPUTERS AND INTERNET STANDARD	NO

This course was delivered in 2018. Use A-Z Courses to find the current version (if available).

In studying Physical Sciences learners have the opportunity to explore concepts, models and theories of both physics and chemistry

Physics and chemistry are fundamental sciences that: provide a foundation for undertaking investigations; endeavour to explain physical and chemical phenomena that occur in the universe; and can be applied to, and have an impact on, issues in society.

Learner Requirement

Learners enrolled in this course are required to work responsibly and safely in practical situations in a laboratory using potentially dangerous materials and equipment.

Rationale

Knowledge and understanding of science, scientific literacy and scientific methods are necessary for learners to develop the skills to resolve questions about their natural and constructed world.

The purpose of science education is to develop scientific literacy, helping learners to:

- be interested in, and understand, the world around them
- engage in discourse about the scientific and technological aspects underlying global and local issues
- understand the testable and contestable nature of science, to question the claims made by others about scientific matters
- be able to identify questions, draw evidence-based conclusions and discuss their validity
- form opinions, that are reasoned and informed, about the environment, about their own health and well-being and about the role and impact of science on society.

In studying *Physical Sciences* learners have the opportunity to explore concepts, models and theories of both physics and chemistry. Physics and chemistry are fundamental sciences that:

- provide a foundation for undertaking investigations; endeavour to explain physical and chemical phenomena that occur in the universe
- can be applied to, and have an impact on, issues in society.

Aims

Physical Sciences aims to develop learners':

- interest in and appreciation of physics and chemistry, and their usefulness in helping to explain phenomena and solve problems encountered in their ever-changing world
- understanding of the theories and models used to describe, explain and make predictions about diverse natural phenomena and chemical systems, structures and properties
- understanding of the ways in which matter and energy interact in physical systems across a range of scales
- understanding of the factors that affect chemical systems, and how chemical systems can be controlled to produce desired products
- appreciation of physics and chemistry as experimental sciences that have developed through independent and collaborative research, and that have significant impacts on society and implications for decision making
- expertise in conducting a range of scientific investigations, including the collection and analysis of qualitative and quantitative data and the interpretation of evidenc
- ability to critically evaluate and debate scientific arguments and claims in order to solve problems and generate informed, responsible and ethical conclusions
- ability to communicate scientific understanding and findings to a range of audiences, including through the use of appropriate representations, language and nomenclature.

Learning Outcomes

On successful completion of this course, students will be able to:

1. plan activities, monitoring and evaluating progress while completing activities, meeting deadlines and contributing to completion of group activities in the context of physics and chemistry
2. communicate, predict and explain physical science phenomena, using qualitative and quantitative representations in appropriate modes and genres, and following accepted conventions and terminology
3. apply discriminating research skills and apply the principles of academic integrity; collecting and recording primary and secondary data from a variety of relevant sources
4. utilise practical skills safely, and competently select and use scientific techniques and equipment to collect and organise data related to physics and chemistry
5. use scientific inquiry skills to enable them to perform and evaluate experiments relating to physics and chemistry; analysing and interpreting data to draw valid conclusions
6. make connections between knowledge of physics and chemistry and ethical, political, cultural, social, economic and scientific considerations in differing contexts
7. apply physics and chemistry concepts, models and theories to analyse physical and chemical phenomena
8. apply physics and chemistry processes to analyse physical and chemical phenomena.

Pathways

Physical Sciences is designed for learners whose future pathways may involve the study of further senior secondary science or a range of disciplines at the tertiary level.

It is highly recommended that learners undertaking Physical Sciences will have satisfactorily completed Australian Curriculum: Science. It is also highly recommended that, as a minimum, students studying this course have studied, or are currently studying General Mathematics Level 2, or equivalent.

The successful completion of Physical Sciences - Foundation Level 2, would provide useful preparation for the study of Physical Sciences.

The study of Physical Sciences is highly recommended as a foundation course for the study of Physics Level 4, and Chemistry Level 4. It is also useful as a foundation to the study of Biology Level 3.

Resource Requirements

This course requires a suitably equipped laboratory and resources to conduct experiments safely and effectively. Students need to be able to access a wide range of reliable sources of information about the uses and applications of science within the wider community. For information regarding the use of a calculator when studying this course, refer to the current Calculator Policy that applies to Level 3 and 4 courses. This policy is available at http://www.tasc.tas.gov.au.

Course Size And Complexity

This course has a complexity level of 3.

At Level 3, the learner is expected to acquire a combination of theoretical and/or technical and factual knowledge and skills and use judgment when varying procedures to deal with unusual or unexpected aspects that may arise. Some skills in organising self and others are expected. Level 3 is a standard suitable to prepare learners for further study at tertiary level. VET competencies at this level are often those characteristic of an AQF Certificate III.

This course has a size value of 15.

OVERVIEW

For the content areas of *Physical Sciences*, the three (3) interrelated strands:

- Science Inquiry Skills (Criterion 2)
- Science as a Human Endeavour (Criterion 3)
- Science Understanding (Criteria 4 to 8)

build on students' learning in F-10 Australian Curriculum: Science

All course content is compulsory. The order of delivery is not prescribed.

In the practice of science, the three strands are closely integrated. The work of scientists reflects the nature and development of science, is built around scientific inquiry, and seeks to respond to and influence society.

Science Inquiry Skills and Science as a Human Endeavour strands (respectively):

- undertake, interpret and analyse experiments and investigations (Criterion 2)
- analyse the application and impact of physical science in society (Criterion 3)

must be integrated into the five interwoven threads of Science Understanding strand:

- atoms and nuclear reactions (Criterion 4)
- motion and force (Criterion 5)
- conservation laws in physics (Criterion 6)
- chemical fundamentals: structures and properties (Criterion 7)
- principles of chemical reactions and reacting quantities (Criterion 8).

COMMUNICATION AND ORGANISATION SKILLS

Apply skills to plan, organise and communicate (Criterion 1)

Criterion 1 is assessed within all threads of the Science Understanding strand requiring students to complete activities and communicate using the appropriate and agreed conventions, including:

- using Système Internationale Units (SI), scientific notation, standard notation and the correct number of significant figures
- interpreting a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
- selecting, constructing and using appropriate chemical, physical and mathematical representations to communicate conceptual understanding, solve problems and make predictions
- communicating information or findings to others through selecting and constructing appropriate language, nomenclature, modes and genres, including scientific reports
- adhering to the principles of academic integrity.

SCIENCE INQUIRY SKILLS

Develop, interpret and evaluate Physical Science experiments (Criterion 2)

Learners will have the opportunity to:

- conduct investigations, including the use of devices to safely, competently and methodically collect valid and reliable data
- represent data in meaningful and useful ways, including the use of appropriate graphic representations and correct units and symbols; organise and process data to identify trends, patterns and relationships;

- interpret a range of scientific data and texts, and evaluate processes and conclusions by considering the quality of available evidence and use reasoning to construct scientific arguments
- identify sources of random and systematic error, identify anomalous data, select, analyse and use evidence to make and justify conclusions
- identify, research and refine questions for investigation, propose hypotheses, and predict possible outcomes.

SCIENCE AS A HUMAN ENDEAVOUR

Analyse the impact of Physical Sciences on society (Criterion 3)

Learners will engage with the following concepts, emphasising the physical sciences as human endeavour:

- science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility
- development of complex models and/or theories often requires a wide range of evidence from multiple individuals and across disciplines
- advances in science understanding in one field can influence other areas of science, technology and engineering
- the use of scientific knowledge is influenced by social, economic, cultural and ethical considerations
- the use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences
- science knowledge can enable scientists to offer valid explanations and make reliable predictions.

Support materials that illustrate some possible contexts for exploring Science as a Human Endeavour concepts in relation to Science Understanding content are found in *Appendix A*.

SCIENCE UNDERSTANDING

Properties of atoms and nuclear reactions (Criterion 4)

This thread covers atoms, a fundamental building block of matter. How the physical properties and composition of atoms determine and explain what occurs on a larger scale chemically and physically.

Properties and structures of atoms

- the structure of the periodic table is based on the electron configuration of atoms. Similarities and trends in the observable physical properties of elements, including atomic radii and valencies, are evident in periods and groups in the periodic table:
    - atoms can be modelled as a nucleus surrounded by electrons in distinct energy levels, held together by electrostatic forces of attraction. Atoms can be represented using electron shell diagrams (elements 1 to 20 only; does not include any s, p, d, f orbital theory)
    - physical trends in periods 2 and 3 and groups 1, 2 and 17 (or I, II and VII) in the periodic table: atomic radii and valencies
    - the charge on a stable ion is related to the number of electrons in the outer shell of the parent atom.
- isotopes are atoms of an element with the same number of protons but different number of neutrons; different isotopes of elements are represented using atomic symbols, for example ${}^{12}_{6}\mathrm{C}$, ${}^{13}_{6}\mathrm{C}$ and ${}^{14}_{6}\mathrm{C}$
    - isotopes of an element have the same electron configuration and possess similar chemical properties but have different physical properties
    - mass spectroscopy involves the ionisation of substances and their separation using a magnetic field
    - spectra generated can be analysed to determine the isotopic composition of elements (NOT to include how the mechanics of the instrument works)
    - the relative atomic mass of an element is the ratio of the weighted average mass per atom of the naturally occurring form of the element to $\frac{1}{12}$ the mass of an atom of carbon-12
    - relative atomic masses reflect the isotopic composition of the element.

Nuclear Reaction

- nuclear model of the atom
    - examples of natural and artificial isotopes.
- spontaneous decay; alpha, beta negative and gamma rays
    - decay equations for alpha, beta negative and gamma decay

    - inclusion of metastable isotopes for pure gamma emissions, using “m” notation, for example ${}^{99m}_{43}\mathrm{Tc}$.
- background radiation
    - the difference between background radiation and other types of radiation, for example, mobile phones and fluorescent lights.
    - the effects of nuclear radiation on living organisms
    - alpha, beta negative and gamma radiation have sufficient energy to ionize atoms and molecules
    - definition of ion as a charged molecule or atom
    - discuss and explain the penetrating properties and ionising ability of alpha, beta negative and gamma radiation
    - potential effects of ionization on DNA.
- nuclear reactions
    - induced nuclear fission is a reaction in which a heavy nuclide splits
    - a fission chain reaction is a self-sustaining process that may be controlled to produce thermal energy, or uncontrolled to release energy explosively
    - writing of nuclear equations for the above reactions (excluding production of neutrinos and antineutrinos).
- half-lives of radioisotopes in terms of activity (Bq), mass, count-rate or numbers of atoms
    - definition of half-life – the time taken for half of the sample to decay to a new isotope
    - use of decay graphs and calculations based on whole numbers of half-lives.

Motion and force (Criterion 5)

This thread is associated with motion and force. Motion and force can be modelled, predicted and measured using theoretical and mathematical approaches.

Motion and force

- uniformly accelerated motion; scalar and vector quantities, including distance, displacement, speed, velocity, acceleration
    - differences between scalar and vector quantities: speed/velocity, distance/displacement.
- graphical treatment of accelerated motion
    - construction and interpretation of constant acceleration cases of s-t graphs, v-t graphs and a-t graphs
    - construction of v-t and a-t graphs using data from the slopes of s-t and v-t graphs respectively
    - calculation and interpretation of slopes and areas of motion graphs.
- average and instantaneous speeds, velocities, and acceleration
    - $\mathrm{speed}_{av} = \dfrac{\text{total distance}}{\text{total time}}$, $\mathrm{velocity}_{av} = \dfrac{\text{total displacement}}{\text{total time}}$, $\mathrm{acceleration}_{av} = \dfrac{\text{change in velocity}}{\text{total time}}$
    - calculations involving equations of motion
      $v = u + at$, $s = ut + \dfrac{1}{2}at^2$, $v^2 = u^2 + 2as$
- vertical motion under gravity near the Earth’s surface
    - terminal velocity (qualitative only.)
- draw scale diagrams of vectors in two dimensions
    - calculation of resultant vectors based on right angle situations only.
- analysis of horizontal projectile motion
    - calculation of resultant final velocity.
- Newton’s Three Laws of Motion
- relationship to momentum $F_{\text{net}} = \dfrac{\Delta p}{\Delta t} = \dfrac{m(v-u)}{\Delta t}$ or $F_{\text{net}} = ma$ under limited circumstances

  Note:

    - excludes rate of change of mass problems and graphical treatment
    - the term impulse can be used to describe Δp (no conceptual understanding of impulse is required)
    - weight as a force $F_g = mg$
    - normal reaction force
    - force diagrams
    - problems involving the addition of two forces in one (1) dimension only
    - reference Newton’s laws to motion (both in terms of force and momentum) to qualitatively describe the change in motion due to a net external force.

Conservation in physics (Criterion 6)

This thread applies the concept that energy and momentum are conserved. Using this concept we can model and explain the behaviour of objects when they collide and trace the movement of energy through systems. Common transfers of energy occur between gravitational potential energy and kinetic energy. The transfer and conversion of electrical energy provides a familiar context for other energy transformations.

Momentum conservation

- momentum and conservation of momentum in one dimension
  - mass as a property of matter
  - $p = mv$ (excludes graphical treatment)
  - $\sum p_{\text{before}} = \sum p_{\text{after}}$, collision and explosion style of problems in one dimension.

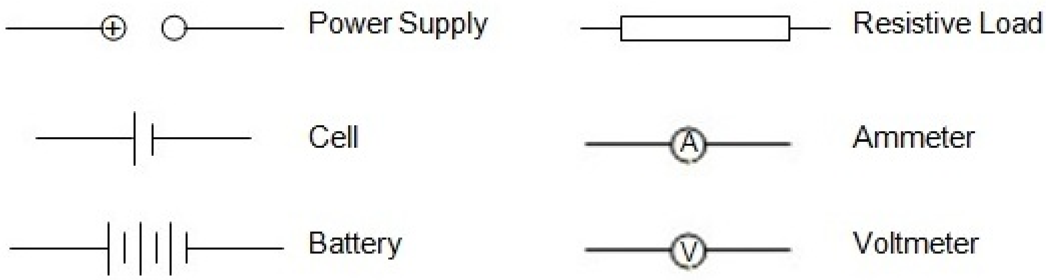
Energy conservation

- definition of work and energy
  - $\text{Work Done} = Fs$, forces and displacements in same direction (excludes graphical treatment)
  - $\Delta\text{Energy} = \text{Work Done}$
  - work and energy are scalar quantities.
- various forms of energy
  - list various forms of common energies including:
  - gravitational potential, kinetic, nuclear, elastic potential, light, electromagnetic radiation, sound, chemical potential, heat, and electrical
  - relate the above energy forms to simple examples.
- conservation of energy
  - energy transfers and transformations including the formation of heat in many systems (qualitative only)
  - a perfectly elastic collision is defined as one in which there is no loss of kinetic energy during a collision
  - an inelastic collision is one in which part of the kinetic energy is changed to some other for of energy during a collision.
- gravitational potential energy and kinetic energy applications, and calculations
  - $E_k = \frac{1}{2}mv^2$
  - $E_p = mgh$
- calculations including transformations between the two in isolated systems.
- elastic and inelastic collisions
  - qualitative only, for example, bouncing a foam ball on the floor as opposed to billiard balls colliding on billiard table.
- definition of average power
  - $P_{av} = \frac{W}{t}$, $P_{av} = \frac{\Delta E}{t}$
- power in changing kinetic energy and gravitational potential energy situations, and calculations
  - numerical problems associated with power and energy (excludes graphical treatment)
  - relate work done to transformation of energy and power.

Electric circuits

- transfer and transformation of electrical energy into a range of other useful forms
- distinguish between current and static electricity
  - static electricity as a surplus or deficiency of electrons
  - static effects, for example, electrostatic attraction and repulsion
  - current electricity definition $I = \frac{q}{\Delta t}$
- charge on an electron and a proton
  - $e = 1.60 \times 10^{-19} C$
  - calculation of current, charge and number of electrons.
- potential difference definition;
  - energy is required to separate positive and negative charge carriers; charge separation produces an electrical potential difference that can be used to drive current in a circuit
  - $V = \frac{W}{q}$, $V = \frac{\Delta E}{q}$
- definition of power
  - $P_{av} = \frac{W}{t}$, $P_{av} = \frac{\Delta E}{t}$
  - household power and definition of kilowatt-hour energy. Calculations based on power bills, for example, *total cost = kWh* x *rate*
- resistance for ohmic and non-ohmic components

  - slope of V-I graph for ohmic devices
  - trends on V-I graph for the following non-ohmic devices, diode and light bulb.
- Ohm's Law
  - $V = IR$
- circuit analysis and design; series and parallel circuits (combination circuits NOT included)
  - drawing of simple circuit diagrams; required component identification for:



  - analysis of series circuits up to 3 resistors, $R_T = R_1 + R_2 + R_3$, where R_T is the total resistance of the circuit
  - analysis of parallel circuits with 2 resistors $R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ or $\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ (totalling only)
  - understanding potential differences and currents around series and parallel circuits (Kirchhoff's Laws NOT included)
  - placement of ammeters and voltmeters in circuits.

Chemical structures and properties (Criterion 7)

This thread describes the properties of atoms that lead to chemical interactions. This knowledge can be used to explain and predict the chemical properties, structures and behaviour of substances.

Chemical properties and the structures of atoms

- the structure of the periodic table is based on the electron configuration of atoms. Similarities and trends in the observable properties of elements, including chemical behaviour and reactivity, are evident in periods and groups in the periodic table
  - division of elements into metals and non-metals
  - elements are arranged into groups of similar elements with similar properties. Main features, including common ionic charges, of groups 1, 2, 17, 18 (or I, II, VII, VIII)
  - reactivity trends in periods 2 and 3 and groups I, II and VII in the periodic table (qualitative)
  - the properties of atoms, including their ability to form chemical bonds, are explained by their electron configurations.

Properties and structures of materials

- the type of bonding within substances explains physical properties
- the structure and properties of metallic, ionic and covalent substances
  - chemical bonds are caused by electrostatic attractions that arise because of the sharing or transfer of electrons between participating atoms; the valency is a measure of the number of bonds that an atom can form
  - ions are atoms or groups of atoms that are electrically charged due to an imbalance in the number of electrons and protons; ions are represented by formulae that include the number of constituent atoms and the charge of the ion, for example $\mathrm{SO_4}^{2-}$, Na^+
  - the properties of ionic compounds, for example, high melting point, brittleness, ability to conduct electricity when molten or in solution, are explained by modelling ionic bonding as ions arranged in a crystalline lattice structure with forces of attraction between oppositely charged ions
  - naming and finding the formula of ionic compounds using tables of common anions and cations
  - the characteristic properties of metals, for example, malleability, thermal conductivity, electrical conductivity are explained by modelling metallic bonding as a regular arrangement of positive ions (cations) made stable by electrostatic forces of attraction between these ions and delocalised electrons that are free to move within the structure
  - covalent substances are modelled as molecules or covalent networks that comprise atoms that share electrons, resulting in electrostatic forces of attraction between electrons and the nucleus of more than one atom
  - the distinction between intra and inter molecular forces in covalent molecular elements and compounds i.e. strong forces between atoms and weak forces between molecules.
  - electron dot diagrams for molecules of elements and covalent compounds (e.g. simple hydrocarbons and simple common molecular compounds)
  - focus only on water as an example of a highly polar covalent molecule (only refer to the concept that covalent molecular substances can have differing degrees of polarity)

    - polar molecules (only use water as an example) have increased attraction between molecules resulting in increased:
        - melting points
        - boiling points.
    - naming of covalent molecular compounds based on formulae and vice versa
    - elemental carbon exists as a range of allotropes including graphite, diamond and fullerenes, with significantly different structures and physical properties
    - prediction of the type of structure likely to be present in an element or compound by investigating its physical properties.
- the presence of specific ions in solutions can be identified using analytical techniques such as flame tests (excludes the need to recall specific colour for elements) or chemical reactions
- use the solubility table to predict products of precipitation reactions; write overall and net ionic equations for reactions and identify spectator ions
- H_2, O_2 and CO_2 can be identified using simple gas tests
- identification of unknown inorganic compounds based on solubility.

Carbon Compounds

- carbon forms aliphatic hydrocarbon compounds including alkanes, alkenes, alkynes, cyclic alkanes and cyclic alkenes, with properties that are influenced by the nature of the bonding within the molecules
- structure and naming of organic compounds using IUPAC nomenclature. The stem to contain a maximum of 10 carbon atoms. This is limited to branched and unbranched alkanes, alkenes, alkynes and cyclic organic compounds containing one or more atoms of F, Cl, Br and I (NO other functional group chemistry)
- the concept of an isomer, writing structural formulae for a given molecular formula
- saturated and unsaturated hydrocarbons
- the distinctions between empirical, molecular and structural formulae (structural formula must include all constituent atoms and bonds)
- simple reactions of alkanes, alkenes and cyclic organic compounds:
    - complete and incomplete combustion reactions to given products
    - substitution reactions with X_2 (X =halogen)
    - addition reactions with H_2, X_2 and HX
    - test for unsaturation using bromine solution.

Chemical reactions and reacting quantities (Criterion 8)

This thread links chemical knowledge with readily measurable quantities in the laboratory. Measuring mass and volume during chemical reactions allows the calculation of properties such concentration and chemical composition, and gives insight into behaviour at the atomic, ionic and molecular level.

Chemical Reactions

- all chemical reactions involve the creation of new substances and can be represented by a chemical equation
- all physical changes are reversible, whereas only some chemical reactions are reversible
- a mole is a precisely defined amount of substance equal to Avogadro's number of particles
    - $n = \frac{N}{N_A}$
- the mole concept and the Law of Conservation of Mass can be used to calculate the mass of reactants and products in a chemical reaction
    - $n = \frac{m}{M}$
- calculations of percentage composition (by mass) of compounds, including percentage water of crystallization
- calculations using relative atomic mass, formula mass, molecular mass, and molar mass (simple stoichiometry excluding limiting and excess reactants)
- calculations to determine empirical and molecular formulae.

Aqueous Solutions and Acidity

- the concentration of a solution:
    - is defined as the amount of solute divided by the volume of solution
    - $c = \frac{n}{v}$
    - can be represented in a variety of ways including by the number of moles of the solute per litre of solution (mol L^{-1}) and the mass of the solute per litre of solution (g L^{-1})
        - convert between mol L^{-1} and g L^{-1}

- the properties of acids and bases (brief treatment only, for example, taste, feel)
    - review everyday cases, for example, citric acid in lemons.
- identify and name common acids: hydrochloric acid ($HCl_{(aq)}$); sulfuric acid ($H_2SO_{4(aq)}$); nitric acid ($HNO_{3(aq)}$); and ethanoic acid (acetic acid) ($CH_3COOH_{(aq)}$)
- identify and name common bases: sodium hydroxide ($NaOH_{(aq)}$) and ammonia ($NH_{3(aq)}$)
- some covalent molecules dissolve in water to produce acids (with $NH_{3(aq)}$ being one notable exception)
- the relationship between acids and bases can be explained using the Brønsted-Lowry model and represented using chemical equations that illustrate the donation of protons (equations should use hydrogen ions and not hydronium ions)
    - acids are substances that can act as proton (hydrogen ion) donors and can be classified as monoprotic or polyprotic depending on the number of protons donated by each molecule of the acid
    - bases are substances that can act as a proton acceptor
    - soluble bases are called alkalis.
- the pH scale is used to compare the levels of acidity or alkalinity of aqueous solutions
    - the pH is dependent on the concentration of hydrogen ions in the solution (qualitative only)
    - review common examples of acids and bases and their pH.
- patterns of the reactions of acids and bases allow products to be predicted from known reactants
    - acid plus reactive metal (not nitric or concentrated sulfuric)
    - acid plus base (hydroxide or oxide)
    - acid plus carbonate
    - acid plus hydrogen carbonate.
- strong and weak vs dilute and concentrated acids
- identification of unknown inorganic compounds (reactive metals, metal carbonates and hydroxides) based on acid reactions
- concentration and volume – dilution of solutions, simple acid-base titrations
    - Calculations using
- $c = \frac{n}{v}$ and $n = \frac{m}{M}$
- volumetric analysis methods involving acid-base reactions rely on the identification of an equivalence point using acid-base indicator or pH meter to reveal an observable endpoint.

Work Requirements

Practical work

At least 40 hours will be spent on practical activities, which are an integral part of the course, and are to be used as a means of teaching and consolidating the course content, as well as a context for assessment. The purpose of practicals varies and includes:

- learning and practising scientific techniques
- safe practices to avoid health and safety issues to be used independently throughout the year
- illustration of concepts
- exploring components of experimental practice
- meeting the requirements of experimental practice while addressing Criterion 2.

On at least three occasions learners will document an experiment to address all standard elements of Criterion 2 in a form that will include:

- the purpose of the experiment
- clearly presented data:
    - representing data in meaningful and useful ways:
        - using appropriate graphic representations
        - using the correct units and symbols
        - organising and processing data to identify trends, patterns and relationships.
    - qualitative and/or quantitative observations to assist in assessing the reliability and validity of the data
- a discussion including:
    - use and analysis of evidence to make and justify conclusions
    - explaining the relationship between variables using the scientific theories or models studied in the **Science Understanding** strand
    - identifying:
        - anomalous data
        - sources of random and systematic error.
    - evaluation of the processes and conclusions considering the quality of available evidence
    - recommending areas for further investigation, using reasoning to predict possible outcomes.

Examples of suitable practical activities include but are not limited to:

- investigating half-lives of radioisotopes (C4)
- predicting and measuring projectile motion (C5)
- investigating conservation of momentum (C6)
- identification of unknown substances using chemical and physical properties (C7)
- finding unknown concentration of solution using acid-base titration (C8).

Assessment

Criterion-based assessment is a form of outcomes assessment that identifies the extent of learner achievement at an appropriate end-point of study. Although assessment – as part of the learning program – is continuous, much of it is formative, and is done to help learners identify what they need to do to attain the maximum benefit from their study of the course. Therefore, assessment for summative reporting to TASC will focus on what both teacher and learner understand to reflect end-point achievement.

The standard of achievement each learner attains on each criterion is recorded as a rating 'A', 'B', or 'C', according to the outcomes specified in the standards section of the course.

A 't' notation must be used where a learner demonstrates any achievement against a criterion less than the standard specified for the 'C' rating.

A 'z' notation is to be used where a learner provides no evidence of achievement at all.
Providers offering this course must participate in quality assurance processes specified by TASC to ensure provider validity and comparability of standards across all awards. Further information on quality assurance processes, as well as on assessment, is on the TASC website: http://www.tasc.tas.gov.au

Internal assessment of all criteria will be made by the provider. Providers will report the learner's rating for each criterion to TASC.

TASC will supervise the external assessment of designated criteria which will be indicated by an asterisk (*). The ratings obtained from the external assessments will be used in addition to internal ratings from the provider to determine the final award.

Quality Assurance Process

The following processes will be facilitated by TASC to ensure there is:

- a match between the standards of achievement specified in the course and the skills and knowledge demonstrated by learners
- community confidence in the integrity and meaning of the qualification.

Process – TASC gives course providers feedback about any systematic differences in the relationship of their internal and external assessments and, where appropriate, seeks further evidence through audit and requires corrective action in the future.

External Assessment Requirements

The external assessment for this course will comprise:

- a written examination assessing criteria: 4, 5, 6, 7 and 8

For further information see the current external assessment specifications and guidelines for this course available on the TASC website.

Criteria

The assessment for Physical Sciences Level 3 will be based on the degree to which the learner can:

1. apply skills to plan, organise, and communicate
2. undertake, interpret and analyse physical science experiments
3. analyse the application and impact of physical sciences in society
4. apply concepts and processes of atomic properties and nuclear reactions*
5. apply concepts and processes of motion and force*
6. apply concepts and processes of conservation in physics*
7. apply concepts and processes of chemical structures and properties*
8. apply concepts and processes of chemical reactions and reacting quantities.*

* = denotes criteria that are both internally and externally assessed

Standards

Criterion 1: apply skills to plan, organise, and communicate

The learner:

Rating A	Rating B	Rating C
meets planned timelines and meets all requirements of the activity	meets planned timelines and addresses all requirements of the activity	meets planned timelines and addresses most requirements of the activity
performs tasks and monitors own contribution, and guides others in their contribution to successful completion of group activities	performs tasks and can explain their contribution to successful completion of group activities	performs tasks and identifies contribution to successful completion of group activities
accurately and concisely uses physics and chemistry terminology	accurately uses physics and chemistry terminology	selects and uses appropriate physics and chemistry terminology
selects and uses appropriate scientific formats and units to accurately communicate data and information	selects and uses appropriate scientific formats and units to clearly communicate data and information	uses appropriate scientific formats and units to communicate data and information
selects a variety of relevant resources to collect information, and critically evaluates their reliability	selects a variety of relevant resources to collect information, and analyses their reliability	selects a variety of relevant resources to collect information
clearly differentiates the information, images, ideas and words of others from the learner's own	clearly differentiates the information, images, ideas and words of others from the learner's own	differentiates the information, images, ideas and words of others from the learner's own
referencing conventions and methodologies are followed with a high degree of accuracy	referencing conventions and methodologies are followed correctly	referencing conventions and methodologies are generally followed correctly
creates appropriate, well structured reference lists/bibliographies.	creates appropriate, structured reference lists/bibliographies.	creates appropriate reference lists/bibliographies.

Criterion 2: undertake, interpret and analyse physical science experiments

The learner:

Rating A	Rating B	Rating C
follows instructions accurately, selecting, adapting and using techniques and equipment safely, competently and methodically to achieve optimum accuracy	follows instructions accurately, selecting and using techniques and equipment safely, competently and methodically	follows instructions accurately using routine techniques and equipment safely and competently
collects a wide range of appropriate experimental data, and accurately records it methodically for analysis	collects appropriate experimental data and accurately records in a clear and useful format	collects, and clearly and accurately records experimental data
organises and represents data to correctly identify trends, patterns or relationships and analyses the validity and reliability of data	organises and represents data to identify trends, patterns or relationships and discusses the validity and reliability of data	organises and represents data to identify a trend, pattern or relationship
interprets, evaluates and explains evidence to make and justify a valid conclusion	interprets and analyses evidence to make and justify a valid conclusion	uses evidence to make and justify a valid conclusion

identifies and analyses anomalous data and significant sources of random and/or systematic error	identifies and discusses anomalous data and significant sources of random and/or systematic error	correctly identifies sources of random and/or systematic error
evaluates conclusions and processes when recommending further valid investigation, predicting possible outcomes.	applies reasoning to conclusions and processes when recommending further valid investigation, predicting possible outcomes.	refers to conclusions and processes when recommending further valid investigation.

Criterion 3: analyse the application and impact of physical sciences in society

The learner:

Rating A	Rating B	Rating C
evaluates relevant science background to issues	analyses relevant science background to issues	describes relevant science background to issues
evaluates significant components of an issue, and presents a detailed and balanced discussion	analyses components of an issue, and presents a balanced discussion	identifies and describes key components of an issue
clearly describes and critically evaluates the tensions and connections between an issue and significant relevant influences (ethical, political, cultural, social, economic)	analyses the tensions and connections between an issue and relevant influences (ethical, political, cultural, social, economic)	describes connections between an issue and more than one relevant influence (ethical, political, cultural, social, economic)
evaluates benefits of the use of scientific knowledge to present a complex argument, and any harmful or unintended consequences from such use	analyses benefits of the use of scientific knowledge, and any harmful or unintended consequences arising from such use	describes benefits of the use of scientific knowledge, and any harmful or unintended consequences arising from such use
argues a reasoned conclusion, evaluating evidence and assessing the relative impact of influences on their decision making.	argues a reasoned conclusion, analysing relevant evidence.	articulates a reasoned conclusion, using relevant evidence.

Criterion 4: apply concepts and processes of atomic properties and nuclear reactions

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
applies and describe physical similarities and differences in Groups 1, 2, 17 and 18 of the periodic table in familiar and unfamiliar contexts	applies and describes physical similarities in Groups 1, 2, 17 and 18 of the periodic table in familiar contexts	applies and describes physical similarities in Groups 1, 2, 17 and 18 of the periodic table in simple, familiar contexts
applies and describes physical trends in groups and periods of the periodic table in familiar and unfamiliar contexts	applies and describes physical trends in groups and periods of the periodic table in familiar contexts	applies and describes physical trends in groups and periods of the periodic table in simple familiar contexts
applies concepts of isotopic composition to analyse and calculate atomic masses, isotopic masses, and percentage composition	applies concepts of isotopic composition to describe and calculate atomic masses in familiar contexts	applies concepts of isotopic composition to explain isotopic and atomic masses in simple familiar contexts
applies fundamental concepts of nuclear reactions to analyse nuclear processes	applies fundamental concepts of nuclear reactions to describe nuclear processes in familiar contexts	applies fundamental concepts of nuclear reactions to nuclear processes in simple familiar contexts

analyses graphical and tabular data, generates additional data and information, and makes generalisations associated with nuclear decay	correctly interprets graphical and tabular data and generates additional data and information associated with nuclear decay	correctly interprets graphical and tabular data associated with nuclear decay
applies concepts to interpret complex problems related to nuclear radiation sources, and makes reasoned, evidence-based predictions in familiar and unfamiliar contexts.	applies concepts to interpret problems related to nuclear radiation sources, and makes evidence-based predictions in familiar contexts.	uses evidence to address simple problems related to nuclear radiation sources, and make plausible predictions in familiar contexts.

Criterion 5: apply concepts and processes of motion and force

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
applies fundamental concepts related to motion and force to analyse physical system	applies fundamental concepts related to motion and force to describe familiar physical systems	applies fundamental concepts related to motion and force in simple familiar physical systems
constructs clear diagrams to illustrate, investigate and resolve problems related to motion and force	constructs clear diagrams to illustrate and investigate problems related to motion and force	uses clear diagrams to illustrate problems related to motion and force
applies concepts to interpret complex problems related motion and force, and makes reasoned, evidence-based predictions in familiar and unfamiliar contexts	applies concepts to interpret problems related to motion and force, and makes evidence based predictions in familiar contexts	interprets simple problems related to motion and force, and uses evidence to make plausible predictions in familiar contexts
selects, applies and manipulates appropriate formulae to solve complex numerical problems related to motion and force, and analyses the validity of the solution	selects, applies and manipulates appropriate formulae to solve numerical problems related to motion and force using steps provided	manipulates formulae to solve simple numerical problems related to motion and force
correctly analyses data sets in relation to force and generates additional data and information	correctly interprets data sets in relation to force, and generates additional data and information	correctly interprets simple data sets in relation to force
analyses graphical and tabular data and generates additional evidence-based data and information, and makes generalisations in relation to motion.	correctly interprets graphical and tabular data and generates additional evidence-based data and information in relation to motion.	correctly interprets graphical and tabular data in relation to motion.

Criterion 6: apply concepts and processes of conservation in physics

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
applies fundamental concepts related to analyse conservation of momentum in physical systems	applies fundamental concepts to describe conservation of momentum in familiar physical systems	applies fundamental concepts related to identify conservation of momentum in simple familiar physical systems
selects, applies and manipulates appropriate formulae to solve complex	selects, applies and manipulates appropriate formulae to solve stepped numerical	manipulates formulae to solve simple numerical conservation of

numerical conservation of momentum problems	conservation of momentum problems	momentum problems
selects, applies and manipulates appropriate formulae to solve complex numerical conservation of energy problems	selects, applies and manipulates appropriate formulae to solve numerical conservation of energy problems	manipulates formulae to solve simple numerical conservation of energy problems
selects, applies and manipulates appropriate formulae to solve complex numerical problems in relation to electricity	selects, applies and manipulates appropriate formulae to solve stepped numerical problems in relation to electricity	manipulates formulae to solve simple numerical problems in relation to electricity
analyses diagrammatic, graphical and tabular data in relation to electricity, and generates additional evidence-based data and information.	correctly interprets diagrammatic, graphical and tabular data in relation to electricity, and generates additional evidence-based data and information.	correctly interprets diagrammatic, graphical and tabular data in relation to electricity.

Criterion 7: apply concepts and processes of chemical structures and properties

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
names and constructs chemical formulae and structures, including aliphatic hydrocarbons, and analyses relationship between their structures and their chemical and physical properties	names and constructs chemical formulae and structures, including aliphatic hydrocarbons, and relates them to chemical and physical properties	names and constructs simple chemical formulae and structures, including aliphatic hydrocarbons
applies chemical similarities in Groups I, II, VII and VIII of the periodic table to analyse chemical species and properties	applies chemical similarities in Groups I, II, VII and VIII of the periodic table to describe familiar chemical species and properties	applies chemical similarities in Groups I, II, VII and VIII of the periodic table to identify chemical species and properties
applies chemical trends in groups and periods of the periodic table to analyse properties and behaviour	applies the chemical trends in groups and periods of the periodic table to describe familiar properties and behaviour	applies chemical trends in groups and periods of the periodic table to identify properties and behaviour
explains and contrasts the properties associated with the four major bonding types, applying relevant models to analyse familiar and unfamiliar contexts	explains properties associated with the four major bonding types, applying relevant models to describe familiar contexts	describes properties associated with the four major bonding types, using examples
applies concepts of chemical structures and properties, to interpret complex problems, and makes reasoned, evidence-based predictions in familiar and unfamiliar contexts	applies concepts of chemical structures and properties, to interpret problems, and makes evidence-based predictions in familiar contexts	using evidence, interprets simple problems, and makes plausible predictions in familiar contexts
applies concepts of chemical structures and properties to construct complex, relevant, balanced equations - including	applies concepts of chemical structures and properties to construct relevant, balanced equations - including ionic	using evidence, constructs relevant, balanced

ionic equations where appropriate; in familiar and unfamiliar contexts.	equations where appropriate; in familiar contexts.	equations; in simple familiar contexts.

Criterion 8: apply concepts and processes of chemical reactions and reacting quantities.

This criterion is both internally and externally assessed.

The learner:

Rating A	Rating B	Rating C
using an evidence-based justification identifies reaction type in familiar and unfamiliar contexts	using an evidence-based explanation identifies reaction type in familiar contexts	using evidence, identifies reaction type in simple familiar contexts
applies and describes fundamental concepts related to chemical reactions and mole theory in familiar and unfamiliar contexts	applies and describes fundamental concepts related to chemical reactions and mole theory in familiar contexts	applies fundamental concepts related to chemical reactions and mole theory in simple familiar contexts
applies concepts of chemical reactions to interpret complex problems, and makes reasoned, evidence-based predictions in familiar and unfamiliar contexts	applies concepts of chemical reactions to interpret problems, and makes evidence-based predictions in familiar contexts	addresses problems related to simple chemical reactions, and uses evidence to make plausible predictions in familiar contexts
constructs complex, relevant, balanced equations - including ionic equations where appropriate - in familiar and unfamiliar contexts	constructs relevant, balanced equations - including ionic equations where appropriate - in familiar contexts	constructs relevant, balanced equations in simple familiar contexts
selects appropriate mathematical formulae to perform complex calculations relating to familiar and unfamiliar chemical equations and formulae.	selects appropriate mathematical formulae to perform calculations relating to familiar chemical equations and formulae.	selects appropriate mathematical formulae to perform basic calculations relating to simple chemical equations and formulae.

Qualifications Available

Physical Sciences Level 3 (with the award of):

EXCEPTIONAL ACHIEVEMENT
HIGH ACHIEVEMENT
COMMENDABLE ACHIEVEMENT
SATISFACTORY ACHIEVEMENT
PRELIMINARY ACHIEVEMENT

Award Requirements

The final award will be determined by the Office of Tasmanian Assessment, Standards and Certification from 13 ratings (8 from the internal assessment, 5 from external assessment).

The minimum requirements for an award in *Physical Sciences* Level 3 are as follows:

EXCEPTIONAL ACHIEVEMENT (EA)
11 'A' ratings, 2 'B' ratings (4 'A' ratings, 1 'B' rating from external assessment)

HIGH ACHIEVEMENT (HA)
5 'A' ratings, 5 'B' ratings, 3 'C' ratings (2 'A' rating, 2 'B' ratings and 1 'C' rating from external assessment)

COMMENDABLE ACHIEVEMENT (CA)
7 'B' ratings, 5 'C' ratings (2 'B' ratings, 2 'C' ratings from external assessment)

SATISFACTORY ACHIEVEMENT (SA)
11 'C' ratings (3 'C' ratings from external assessment)

PRELIMINARY ACHIEVEMENT (PA)
6 'C' ratings

A student who otherwise achieves the ratings for a CA (Commendable Achievement) or SA (Satisfactory Achievement) award but who fails to show any evidence of achievement in one or more criteria ('z' notation) will be issued with a PA (Preliminary Achievement) award.

Course Evaluation

The Department of Education's Curriculum Services will develop and regularly revise the curriculum. This evaluation will be informed by the experience of the course's implementation, delivery and assessment.
In addition, stakeholders may request Curriculum Services to review a particular aspect of an accredited course.

Requests for amendments to an accredited course will be forward by Curriculum Services to the Office of TASC for formal consideration.

Such requests for amendment will be considered in terms of the likely improvements to the outcomes for learners, possible consequences for delivery and assessment of the course, and alignment with Australian Curriculum materials.

A course is formally analysed prior to the expiry of its accreditation as part of the process to develop specifications to guide the development of any replacement course.

Course Developer

The Department of Education acknowledges the significant leadership of Deborah Beswick, Trish Rowley, Sue Saunders, Peter Smythe and Peter Wright in the development of this course.

Expectations Defined By National Standards In Content Statements Developed by ACARA

The statements in this section, taken from documents endorsed by Education Ministers as the agreed and common base for course development, are to be used to define expectations for the meaning (nature, scope and level of demand) of relevant aspects of the sections in this document setting out course requirements, learning outcomes, the course content and standards in the assessment.

SCIENCE INQUIRY SKILLS

CHEMISTRY UNITS 1 AND 2, PHYSICS UNITS 1 AND 2

- Identify, research, construct and refine questions for investigation? propose hypotheses? and predict possible outcomes (ACSCH001), (ACSPH001)
- (Design) Plan investigations, including the procedure/s to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; (conduct) observe risk assessments; and consider research ethics (ACSCH002), (ACSPH002)
- Conduct investigations, (......) safely, competently and methodically for the collection of valid and reliable data (ACSCH003), (ACSPH003)
- Represent data in meaningful and useful ways, including using appropriate graphic representations and correct units and symbols; organise and process data to identify trends, patterns and relationships; identify sources of random and systematic error (......); and select, synthesise and use evidence to make and justify conclusions (ACSCH004)
- Interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments (ACSCH005), (ACSPH005)
- Select, construct and use appropriate representations, including text and graphic representations of empirical and theoretical relationships, (......) to communicate conceptual understanding, solve problems and make predictions (ACSCH006), (ACSPH006)
- Select and use appropriate mathematical representations (......) to solve problems and make predictions (ACSCH007), (ACSPH007)
- Communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports. (ACSCH008), (ACSPH008)

SCIENCE AS A HUMAN ENDEAVOUR

CHEMISTRY UNITS 1 AND 2, PHYSICS UNITS 1 AND 2

- Science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility (ACSCH009), (ACSPH009)
- Development of complex models and/or theories often requires a wide range of evidence from multiple individuals and across disciplines (ACSCH010), (ACSPH010)
- Advances in science understanding in one field can influence other areas of science, technology and engineering (ACSCH011), (ACSPH011)
- The use of scientific knowledge is influenced by social, economic, cultural and ethical considerations (ACSCH012), (ACSPH012)
- The use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences (ACSCH013), (ACSPH013)
- Scientific knowledge can enable scientists to offer valid explanations and make reliable predictions. (ACSCH014), (ACSPH014)

SCIENCE UNDERSTANDING
PHYSICS

Unit 1 – Ionising radiation and nuclear reactions

- The nuclear model of the atom describes the atom as consisting of an extremely small nucleus, that contains most of the atom’s mass and is made up of positively charged protons and uncharged neutrons surrounded by negatively charged electrons (ACSPH026)
- Some nuclides are unstable and spontaneously decay, emitting alpha, beta and/or gamma radiation over time until they become stable nuclides (ACSPH028)
- Each species of radionuclide has a specific half-life (ACSPH029)
- Alpha, beta and gamma radiation have sufficient energy to ionise atoms (ACSPH030)

- Alpha and beta decay are examples of spontaneous transmutation reactions, while artificial transmutation is a managed process that changes one nuclide into another (ACSPH032)
- Neutron-induced nuclear fission is a reaction in which a heavy nuclide captures a neutron and then splits into two smaller radioactive nuclides, with the release of neutrons and energy (ACSPH033)
- A fission chain reaction is a self-sustaining process that may be controlled to produce thermal energy, or uncontrolled to release energy explosively. (ACSPH034)

Unit 1 – Electrical circuits

- Electrical circuits enable electrical energy to be transferred efficiently over large distances and transformed into a range of other useful forms of energy including thermal and kinetic energy, and light.(ACSPH037)
- Electric current is carried by discrete charge carriers; charge is conserved at all points in an electrical circuit (ACSPH038)
- Energy is conserved in the energy transfers and transformations that occur in an electrical circuit (ACSPH039)
- The energy available to charges moving in an electrical circuit is measured using electric potential difference, that is defined as the change in potential energy per unit charge between two defined points in the circuit (ACSPH040)
- Energy is required to separate positive and negative charge carriers; charge separation produces an electrical potential difference that can be used to drive current in circuits (ACSPH041)
- Power is the rate at which energy is transformed by a circuit component; power enables quantitative analysis of energy transformations in the circuit (ACSPH042)
- Resistance for ohmic and non-ohmic components is defined as the ratio of potential difference across the component to the current in the component (ACSPH043)
- Circuit analysis and design involve calculation of the potential difference across, the current in, and the power supplied to, components in series, parallel and series/parallel circuits. (ACSPH044)

Unit 2 – Linear motion and force

- Uniformly accelerated motion is described in terms of relationships between measurable scalar and vector quantities, including displacement, speed, velocity and acceleration (ACSPH060)
- Representations, including graphs and vectors, and/or equations of motion, can be used qualitatively and quantitatively to describe and predict linear motion (ACSPH061)
- Vertical motion is analysed by assuming the acceleration due to gravity is constant near Earth’s surface (ACSPH062)
- Newton’s Three Laws of Motion describe the relationship between the force or forces acting on an object, modelled as a point mass, and the motion of the object due to the application of the force or forces (ACSPH063)
- Momentum is a property of moving objects; it is conserved in a closed system and may be transferred from one object to another when a force acts over a time interval (ACSPH064)
- Energy is conserved in isolated systems and is transferred from one object to another when a force is applied over a distance; this causes work to be done and changes to kinetic and/or potential energy of objects (ACSPH065)
- Collisions may be elastic and inelastic; kinetic energy is conserved in elastic collisions. (ACSPH066)

CHEMISTRY

Unit 1 – Properties and structure of atoms

- Trends in the observable properties of elements are evident in periods and groups in the periodic table (ACSCH016)
- The structure of the periodic table is based on the electron configuration of atoms, and shows trends, including in atomic radii and valencies (ACSCH017)
- Atoms can be modelled as a nucleus surrounded by electrons in distinct energy levels, held together by electrostatic forces of attraction between the nucleus and electrons; atoms can be represented using electron shell diagrams (all electron shells or valence shell only) or electron charge clouds (ACSCH018)
- Flame tests (......) are analytical techniques that can be used to identify elements; these methods rely on electron transfer between atomic energy levels (ACSCH019)
- The properties of atoms, including their ability to form chemical bonds, are explained by the arrangement of electrons in the atom and in particular by the stability of the valence electron shell (ACSCH020)
- Isotopes are atoms of an element with the same number of protons but different numbers of neutrons; different isotopes of elements are represented using atomic symbols (for example, C-12, C-13) (ACSCH021)
- Isotopes of an element have the same electron configuration and possess similar chemical properties but have different physical properties, (........) (ACSCH022)
- Mass spectrometry involves the ionisation of substances and generates spectra that can be analysed to determine the isotopic composition of elements (ACSCH023)
- The relative atomic mass of an element is the ratio of the weighted average mass per atom of the naturally occurring form of the element to 1/12 the mass of an atom of carbon-12; relative atomic masses reflect the isotopic composition of the element. (ACSCH024)

Unit 1 – Properties and structure of materials

- The type of bonding within substances explains their physical properties, including melting and boiling point, conductivity of both electricity and heat, strength and hardness (ACSCH027)
- Chemical bonds are caused by electrostatic attractions that arise because of the sharing or transfer of electrons between participating atoms; the valency is a measure of the number of bonds that an atom can form (ACSCH029)
- Ions are atoms or groups of atoms that are electrically charged due to an imbalance in the number of electrons and protons; ions are represented by formulae that include the number of constituent atoms and the charge of the ion (for example, O2–, SO42–) (ACSCH030)
- The properties of ionic compounds (for example, high melting point, brittleness, ability to conduct electricity when liquid or in solution) are explained by modelling ionic bonding as ions arranged in a crystalline lattice structure with forces of attraction between oppositely charged ions (ACSCH031)
- The characteristic properties of metals (for example, malleability, thermal conductivity, electrical conductivity) are explained by modelling metallic bonding as a regular arrangement of positive ions (cations) made stable by electrostatic forces of attraction between these ions and the electrons that are free to move within the structure (ACSCH032)
- Covalent substances are modelled as molecules or covalent networks that comprise atoms that share electrons, resulting in electrostatic forces of attraction between electrons and the nucleus of more than one atom (ACSCH033)
- Elemental carbon exists as a range of allotropes, including graphite, diamond and fullerenes, with significantly different structures and physical properties (ACSCH034)
- Carbon forms hydrocarbon compounds, including alkanes and alkenes, with different chemical properties that are influenced by the nature of the bonding within the molecules. (ACSCH035)

Unit 1 – Chemical reactions: reactants, products and energy change

- All chemical reactions involve the creation of new substances (.........) (ACSCH036)
- A mole is a precisely defined quantity of matter equal to Avogadro's number of particles; the mole concept and the Law of Conservation of Mass can be used to calculate the mass of reactants and products in a chemical reaction. (ACSCH039)

Unit 2 – Intermolecular forces and gases

- Observable properties, including (...), melting point, boiling point (...), can be explained by considering the nature and strength of intermolecular forces within a substance (ACSCH055)
- The shape and polarity of (water) molecules can be used to explain and predict the nature and strength of intermolecular forces, including dispersion forces, dipole-dipole forces and hydrogen bonding. (ACSCH058)

Unit 2 – Aqueous solutions and acidity

- The unique properties of water can be explained by its molecular shape and hydrogen bonding between molecules (ACSCH062)
- The concentration of a solution is defined as the amount of solute divided by the amount of solution; this can be represented in a variety of ways including by the number of moles of the solute per litre of solution (mol L-1) and the mass of the solute per litre of solution (g L-1) (ACSCH063)
- The presence of specific ions in solutions can be identified using analytical techniques based on chemical reactions, including precipitation and acid-base reactions (ACSCH064)
- The pH scale is used to compare the levels of acidity or alkalinity of aqueous solutions; the pH is dependent on the concentration of hydrogen ions in the solution (ACSCH066)
- Patterns of the reactions of acids and bases (for example, reactions of acids with bases, metals and carbonates) allow products to be predicted from known reactants. (ACSCH067)

Unit 3 – Chemical equilibrium systems

- The relationship between acids and bases (......) can be explained using the Brønsted-Lowry model and represented using chemical equations that illustrate the transfer of hydrogen ions (ACSCH099)
- Volumetric analysis methods involving acid-base reactions rely on the identification of an equivalence point by (........), using chemical indicators (.....), to reveal an observable end point. (ACSCH102)

Unit 4 – Properties and structure of organic materials

- Organic molecules have a hydrocarbon skeleton (............). (ACSCH127)

Accreditation

The accreditation period for this course has been renewed from 1 January 2022 until 31 December 2023.

During the accreditation period required amendments can be considered via established processes.

Should outcomes of the Years 9-12 Review process find this course unsuitable for inclusion in the Tasmanian senior secondary curriculum, its accreditation may be cancelled. Any such cancellation would not occur during an academic year.

Version History

Version 1 – Accredited on 30 July 2017 for use from 1 January 2018. This course replaces *Physical Sciences* (PSC315114) that expired on 31 December 2017.

Version 1.1 - Addition of standard element (#6) to criterion 7 (19 January 2018).

Accreditation renewed on 22 November 2018 for the period 1 January 2019 until 31 December 2021.

Version 1.2 - 17 December 2018. Numerous amendments and refinements to Content section of course.

Version 1.3 - Renewal of Accreditation on 14 July 2021 for the period 31 December 2021 until 31 December 2023, without amendments.

Appendix A

The following support materials that illustrate some possible contexts for exploring Science as a Human Endeavour concepts in relation to Science Understanding content, are sourced from Australian Curriculum: Physics and Chemistry.

PHYSICS

Radioisotopes and radiometric dating

Radiometric dating of materials utilises a variety of methods depending on the age of the substances to be dated. The presence of natural radioisotopes in materials such as carbon, uranium, potassium and argon and knowledge about their half-life and decay processes enables scientists to develop accurate geologic timescales and geologic history for particular regions. This information is used to inform study of events such as earthquakes and volcanic eruptions, and helps scientists to predict their behaviour based on past events. Dating of wood and carbon-based materials has also led to improvements in our understanding of more recent history through dating of preserved objects.

Harnessing nuclear power

Knowledge of the process of nuclear fission has led to the ability to use nuclear power as a possible long-term alternative to fossil fuel electricity generation. Nuclear power has been used very successfully to produce energy in many countries but has also caused significant harmful consequences in a number of specific instances. Analysis of health and environmental risks and weighing these against environmental and cost benefits is a scientific and political issue in Australia which has economic, cultural and ethical aspects. The management of nuclear waste is based on knowledge of the behaviour of radiation. Current proposals for waste storage in Australia attempt to address the unintended harmful consequences of the use of radioactive substances.

Nuclear fusion in stars

Energy production in stars was attributed to gravity until knowledge of nuclear reactions enabled understanding of nuclear fusion. Almost all the energy used on Earth has its origin in the conversion of mass to energy that occurs when hydrogen nuclei fuse together to form helium in the core of the sun. According to the Big Bang Theory, all the elements heavier than helium have been created by fusion in stars. The study of nuclear fusion in the sun has produced insights into the formation and life cycle of stars. An unexpected consequence of early understanding of fusion in stars was its use to inform the development of thermonuclear weapons. Research is ongoing into the use of fusion as an alternative power source.

Electric energy in the home

The supply of electricity to homes has had an enormous impact on society and the environment. An understanding of Kirchhoff's circuit laws informs the design of circuits for effective and safe operation of lighting, power points, stoves and other household electrical devices. Increases in the use of household electricity due to extreme weather in Australian summers and European winters creates problems in supply, causing brownouts, power failures and damage to household appliances. Developing new household electrical devices, improving the efficiency of existing devices and ensuring consistency of electrical standards require international cooperation between scientists, engineers and manufacturers.

Electric lighting

The introduction of electric lighting had a significant impact on society and the environment. The first efficient electric lamps were the filament lamps developed by Thomas Edison in the 1880s. Since that time, social, economic and cultural influences have led to development of a vast array of electric light sources including fluorescent lamps, halogen lamps, sodium lamps, light-emitting diodes and lasers. Research and development of electric light sources has been underpinned by developments in our understanding of electricity, atomic physics and electromagnetism. Concerns about sustainable energy usage and global warming have led to international research and development to improve the energy efficiency of electric lighting.

Road safety and technology

Knowledge of forces and motion has led to developments that have reduced the risks for drivers, their passengers, and other road users such as cyclists and pedestrians. Car safety has improved through the development, and use of, devices such as seatbelts, crumple zones and airbags. An understanding of motion has also led to the design and implementation of traffic-calming devices such as speed bumps and safety barriers. Knowledge of force and linear motion is used in forensic investigations into car accidents. Road laws and regulations, including the setting of speed limits in particular locations, are based on these scientific investigations and have resulted in lower road accident injuries and fatalities.

Sports science

The study of linear motion and forces has led to major developments in athlete training programs, sporting techniques and equipment development. Biomechanics applies the laws of force and motion to gain greater understanding of athletic performance through direct measurement, computer simulations and mathematical modelling. Equipment such as bicycle frames and running shoes has been improved to reduce stresses and strains on athletes' bodies. Many sports teams employ biomechanics experts to improve kicking, throwing or other techniques using knowledge of forces and motion. Advances in interpretation of video technologies, data logging and electronic detection and timing systems has also significantly improved reliability of judgements in sporting events.

Development and limitations of Newton's laws

Isaac Newton's interest in how objects fall and the orbits of planets led to the writing and publication of Principia Mathematica, which outlined the Laws of Motion. Newton's laws provided an explanation for a range of previously unexplained physical phenomena and were confirmed by multiple experiments performed by a multitude of scientists. Newton's laws of motion enable scientists to make reliable predictions, except when considering objects travelling at or near the speed of light, or very small objects like atoms or subatomic particles, or when very strong gravitational fields are involved. Phenomena related to semiconductors, superconductors and errors in GPS systems cannot be predicted using Newton's laws and other theories must be used.

CHEMISTRY

Models of the atom

In the early nineteenth century, Dalton proposed some fundamental properties of atoms that would explain existing laws of chemistry. One century later, a range of experiments provided evidence that enabled scientists to develop models of the structure of the atom. These included using radiation in the form of X-rays and alpha particles, and the passing of particles through a magnetic field to determine their mass. Evidence from French physicist Becquerel's discovery of radioactivity suggested the presence of subatomic particles, and this was also a conclusion from gas discharge experiments. British physicist J.J. Thomson was able to detect electrons, and his results, combined with the later work of Millikan, an American experimental physicist, resulted in both the charge and mass of electrons being calculated. The British chemist Rutherford proposed a model of the atom comprising a heavy nucleus surrounded by space in which electrons were found, and Danish physicist Bohr's model further described how these electrons existed in distinct energy levels. The English physicist Chadwick discovered the last of the main subatomic particles, the neutron, in 1932, by bombarding samples of boron with alpha particles from radioactive polonium.

Radioisotopes

Radioisotopes have a wide variety of uses, including carbon-14 for carbon dating in geology and palaeobiology; radioactive tracers such as iodine-131 in nuclear medicine; radioimmuno-assays for testing constituents of blood, serum, urine, hormones and antigens; and radiotherapy that destroys damaged cells. Use of radioisotopes requires careful evaluation and monitoring because of the potential harmful effects to humans and/or the environment if their production, use and disposal are not managed effectively. Risks include unwanted damage to cells in the body, especially during pregnancy, and ongoing radiation produced from radioactive sources with long half-lives.

Distribution of elements in the universe

Analysis of the distribution of elements in living things, Earth and the universe has informed a wide range of scientific understandings, including the role of calcium exclusion from bacteria in the evolution of shells and bones; the proliferation of carbon (rather than silicon, which has similar properties and is more abundant in Earth's crust) in living things; the elemental composition of historical artefacts; and the origin of elements through nuclear fusion in stars. Analysis of element distribution is informed by data from spectral analysis and other technologies. Evidence from these techniques enables scientists to draw conclusions about a range of phenomena, such as the chemical changes involved in natural processes in both biological and cosmological systems, and the geographic source of historical artefacts.

Nanomaterials

Development of organic and inorganic nanomaterials is increasingly important to meet a range of contemporary needs, including consumer products, health care, transportation, energy and agriculture. Nanomaterials have special physical and chemical properties that make them useful for environmentally friendly products, such as more durable materials, dirt- and water- repellent coatings designed to help reduce cleaning efforts, and insulating materials that improve the energy efficiency of buildings. Although there are many projected environmental benefits, there are also potential risks associated with the use of nanomaterials due to the size of the particles involved (for example, some are able to cross the human blood-brain or placental barrier) and the unknown effects of these particles on human health and the environment.

The importance of purity

There is a large range of situations in chemistry where knowing and communicating the level of purity of substances is extremely important. Impurities can affect the physical and chemical properties of substances, resulting in inefficient or unwanted chemical reactions. Scientists use methods such as mass spectrometry to identify impurities and the level of contamination. Separation methods that improve the purity of substances are used for food, fuels, cosmetics, medical products and metals used in microelectronic devices.

Scientific conventions and international standards are used to represent the purity of materials to ensure consistent applications of standards.

Use of fuels in society

A significant majority of the energy used for production of electricity, transport and household heating is sourced through the combustion of fuels. Fuels, including fossil fuels and biofuels, can be compared in terms of efficiency and environmental impact, for example by calculating the amount of carbon emissions produced per tonne of fuel used. Decisions about which fuels to use can reflect social, economic, cultural and political values associated with the source of the fuel. For example, cultural values might inform the use of wood for heating houses; economic and social values might inform the use of crops for biofuel production instead of food production; and economic, social and political values might inform the use of brown coal rather than black coal, despite its being considered a low grade fuel.

Analysing the structure of materials – forensic chemistry

Forensic science often relies on chemical processes to analyse materials in order to determine the identity, nature or source of the material. This requires detailed knowledge of both chemical and physical properties of a range of substances as well as the structure of the materials. Analysis techniques include different forms of chromatography to determine the components of a mixture, for example analysis of urine samples to identify drugs or drug by-products, identification of traces of explosives, or the presence of an unusual substance at a crime scene. Evidence from forensic analysis can be used to explain the nature and source of samples and predict events based on the combination of evidence from a range of sources. Calculations of quantities, including the concentrations of solutions, are an essential part of forensic chemistry, as is consideration of the reliability of evidence and the accuracy of forensic tests.

Acid rain

Rainwater is naturally acidic as a result of carbon dioxide dissolved in water and from volcanic emission of sulfur. However scientists have observed an ongoing increase in the acidity of rain and the reduction of the pH of the oceans, which has been explained by an increased release of acidic gases including carbon dioxide, nitrogen oxides and sulfur dioxide into the atmosphere. Most sulfur dioxide released to the atmosphere comes from burning coal or oil in electric power stations. Scientists have used trends in data to predict that continued increases in acidic emissions would have adverse effects on aquatic systems, forests, soils, buildings, cultural objects and human health. Concern over acid rain has led to the design of technical solutions such as flue-gas desulfurisation (FGD) to remove sulfur-containing gases from coal-fired power station stacks, and emissions controls such as exhaust gas recirculation to reduce nitrogen oxide emissions from vehicles. A number of international treaties and emissions trading schemes also seek to lower acidic emissions.

Development of acid/base models

Lavoisier, often referred to as the father of modern chemistry, believed that all acids contained oxygen. In 1810, Davy proposed that it was hydrogen, rather than oxygen, that was common to all acids. Arrhenius linked the behaviour of acids to their ability to produce hydrogen ions in aqueous solution, however this theory only related to aqueous solutions and relied on all bases producing hydroxide ions. In 1923 Brønsted (and at about the same time, Lowry) refined the earlier theories by describing acids as proton donators. This theory allowed for the description of conjugate acid-bases, and for the explanation of the varying strength of acids based on the stability of the ions produced when acids ionise to form the hydrogen ions. This concept has been applied to contemporary research into 'superacids', such as carborane acids, which have been found to be a million times stronger than sulfuric acid when the position of equilibrium in aqueous solution is considered.

Water quality

The issue of security of drinking water supplies is extremely important in Australia and many parts of the Asia region. Scientists have developed regulations for safe levels of solutes in drinking water and chemists use a range of methods to monitor water supplies to ensure that these levels are adhered to. Water from different sources has differing ionic concentrations, for example, bore water has a high iron content. Knowledge of the composition of water from different sources informs decisions about how that water is treated and used. Desalination plants have been built around Australia to meet the supply needs of drinking water. These have high energy requirements and can have unwanted environmental impacts where the water is extracted from the oceans. Scientific knowledge and experimental evidence informs international action aimed at addressing current and future issues around the supply of potable water.

Blood chemistry

Blood plasma is an aqueous solution containing a range of ionic and molecular substances. Maintenance of normal blood solute concentrations and pH levels is vital for our health. Changes in blood chemistry can be indicative of a range of conditions such as diabetes, which is indicated by changed sugar levels. Pathologists compare sample blood plasma concentrations to reference ranges that reflect the normal values found in the population and analyse variations to infer presence of disease. Knowledge of blood solute concentration is used to design intravenous fluids at appropriate concentrations, and to design plasma expanders such as solutions of salts for treatment of severe blood loss.

Line Of Sight

Line of Sight

Learning Outcome	Criterion/ia	Criteria Elements	Content/ Work Requirements
plan activities, monitoring and evaluating progress whilst completing activities, meeting deadlines and contributing to completion of group activities in the context of physics and chemistry	1	C1 E1 E2	All
communicate, predict and explain physical science phenomena, using qualitative and quantitative representations in appropriate modes and genres, and following accepted conventions and terminology	1	C1 E3 E4 E5	All
apply discriminating research skills and apply the principles of academic integrity; collecting and recording primary and secondary data from a variety of relevant sources	1	C1 E6 E7 E8	All
utilise practical skills safely, and competently select and use scientific techniques and equipment to collect and organise data related to physics and chemistry	2	C2 E1 E2	Content: Science Inquiry Skills Work requirements: Practical Work
use scientific inquiry skills to enable them to perform and evaluate experiments relating to physics and chemistry; analysing and interpreting data to draw valid conclusions	2	C2 E3 E4 E5 E6	Content: Science Inquiry Skills Work requirements: Practical Work
make connections between knowledge of physics and chemistry and ethical, political, cultural, social, economic and scientific considerations in differing contexts	3	All	Content: Science as a Human Endevour
apply physics and chemistry concepts, models and theories to analyse physical and chemical phenomena	4, 5, 6, 7, & 8	C4 E1 E2 E3 E4 C5 E1 E2 E3 C6 E1 E2 E3 C7 E1 E2 E3 C8 E1 E2 E3	4. Properties of atoms and nuclear reactions 5. Motion and force 6. Conservation in physics 7. Chemical structures and properties 8. Chemical reactions and reacting quantities
apply physics and chemistry processes to analyse physical and chemical phenomena	4, 5, 6, 7, & 8	C4 E2 E3 E5 E6 C5 E2 E3 E4 E5 E6 C6 E2 E3 E4 E5 E6	4. Properties of atoms and nuclear reactions 5. Motion and force 6. Conservation in physics 7. Chemical structures and

		C7 E1 E4 E5 C8 E3 E4 E5	properties 8. Chemical reactions and reacting quantities

Supporting documents including external assessment material

- PSC315114 Assessment Report 2016.pdf (2018-02-07 01:46pm AEDT)
- PSC315114 Exam Paper 2016.pdf (2018-02-07 01:47pm AEDT)
- PSC315114 Exam Paper 2017.pdf (2018-02-07 01:47pm AEDT)
- PSC315114 Assessment Report 2017.pdf (2018-03-08 11:41am AEDT)
- PSC315118 Physical Sciences TASC Exam Paper 2018.pdf (2018-12-09 09:56am AEDT)
- PSC315118 - Assessment Panel Report and Solutions 2018.pdf (2019-02-19 02:24pm AEDT)
- PSC315118 Physical Sciences TASC Exam Paper 2019.pdf (2019-11-18 08:45am AEDT)
- PSC315118 Assessment Report 2019.pdf (2020-01-24 03:04pm AEDT)
- PSC315118 Physical Sciences TASC Exam Paper 2020.pdf (2020-11-19 09:12pm AEDT)
- PSC315118 Assessment Report 2020.pdf (2021-01-13 10:42am AEDT)
- PSC315118 Information Sheet.pdf (2021-03-22 01:06pm AEDT)
- PSC315118 External Assessment Specifications.pdf (2024-01-09 03:39pm AEDT)
- PSC315118 Physical Sciences TASC Exam Paper 2021.pdf (2021-11-16 05:21pm AEDT)