# NSW Stage 6 Science

EP Curriculum Map

# Senior Chemistry: Year 11

## Module 1: Properties and structure of matter

### Properties of Matter

| Content Descriptor | Lesson Names |
|---|---|
| Students:<br>explore homogeneous mixtures and heterogeneous mixtures through practical investigations:<br>– using separation techniques based on physical properties (ACSCH026)<br>– calculating percentage composition by weight of component elements and/or compounds (ACSCH007) | • Classification of Matter |
| investigate the nomenclature of inorganic substances using International Union of Pure and Applied Chemistry (IUPAC) naming conventions | *Further development planned* |
| classify the elements based on their properties and position in the periodic table through their:<br>– physical properties<br>– chemical properties | • What are Atoms, Elements and Compounds?<br>• Classification of Matter |

### Atomic structure and atomic mass

| Content Descriptor | Lesson Names |
|---|---|
| investigate the basic structure of stable and unstable isotopes by examining:<br>– their position in the periodic table<br>– the distribution of electrons, protons and neutrons in the atom<br>– representation of the symbol, atomic number and mass number (nucleon number) | • Colour of Transition Metals<br>• Electron Configuration of Atoms<br>• Electron Configuration of Ions<br>• Introduction to Orbitals<br>• Rutherford-Bohr Model<br>• The Structure of an Atom<br>• Atomic Symbols<br>• Group 14<br>• Group 17<br>• Group 18<br>• Groups 1 and 2<br>• Other Groups |

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| model the atom's discrete energy levels, including electronic configuration and spdf notation (ACSCH017, ACSCH018, ACSCH020, ACSCH022) | • Electron Configuration of Atoms |
| calculate the relative atomic mass from isotopic composition (ACSCH024) | • What are Isotopes?<br>• Isotope Properties |
| investigate energy levels in atoms and ions through:<br>– collecting primary data from a flame test using different ionic solutions of metals (ACSCH019)<br>– examining spectral evidence for the Bohr model and introducing the Schrödinger model | • Rutherford-Bohr Model |
| investigate the properties of unstable isotopes using natural and human-made radioisotopes as examples, including but not limited to:<br>– types of radiation<br>– types of balanced nuclear reactions | • Types of Radiation 1<br>• Types of Radiation 2<br>• Writing Nuclear Equations |

## Periodicity

| Content Descriptor | Lesson Names |
|---|---|
| demonstrate, explain and predict the relationships in the observable trends in the physical and chemical properties of elements in periods and groups in the periodic table, including but not limited to:<br>– state of matter at room temperature<br>– electronic configurations and atomic radii<br>– first ionisation energy and electronegativity<br>– reactivity with water | • Atomic Number<br>• Trends in the Periodic Table<br>• Periodic Trends: Electronegativity<br>• Periodic Trends: Ionisation Energy<br>• Periodic Trends: Metallic Character<br>• Periodic Trends: Atomic Radius |

## Bonding

| Content Descriptor | Lesson Names |
|---|---|
| investigate the role of electronegativity in determining the ionic or covalent nature of bonds between atoms | • Periodic Trends: Electronegativity |
| investigate the differences between ionic and covalent compounds through:<br>– using nomenclature, valency and chemical formulae (including Lewis dot diagrams) (ACSCH029)<br>– examining the spectrum of bonds between atoms with varying degrees of polarity with respect to their constituent elements' positions on the periodic table<br>– modelling the shapes of molecular substances (ACSCH056, ACSCH057) | • Ionic Bonding<br>• Covalent Bonding<br>• Physical Properties of Covalent Network Substances<br>• Physical Properties of Ionic Substances<br>• Comparing Substances<br>• Electron Dot Diagrams of Atoms<br>• Lewis Structures of Molecules and Ions<br>• Polarity of Molecules |
| investigate elements that possess the physical property of allotropy | • Carbon Chemistry<br>• Covalent Network Substances |

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| | • Allotropes of Carbon |
| investigate the different chemical structures of atoms and elements, including but not limited to:<br>– ionic networks<br>– covalent networks (including diamond and silicon dioxide)<br>– covalent molecular<br>– metallic structure | • Ionic Substances<br>• Covalent Bonding<br>• Covalent Network Substances<br>• Physical Properties of Covalent Network Substances<br>• Physical Properties of Ionic Substances<br>• Metals in the Periodic Table<br>• Metallic Substances<br>• Physical Properties of Metallic Substances |
| explore the similarities and differences between the nature of intermolecular and intramolecular bonds and the strength of the forces associated with each, in order to explain the:<br>– physical properties of elements<br>– physical properties of compounds (ACSCH020, ACSCH055, ACSCH058) | • Trigonal-Based Shapes<br>• Introduction to Shapes of Molecules<br>• Tetrahedral-Based Shapes<br>• Bipyramidal-Based Shapes<br>• Octahedral-Based Shapes<br>• Review of Molecule Shapes<br>• Polarity of Molecules<br>• The Ionic-Covalent Continuum<br>• Types of Intermolecular Forces<br>• Physical Properties of Molecular Substances |

# Module 2: Introduction to quantitative chemistry

## Chemical Reactions and Stoichiometry

| Content Descriptor | Lesson Names |
|---|---|
| conduct practical investigations to observe and measure the quantitative relationships of chemical reactions, including but not limited to:<br>– masses of solids and/or liquids in chemical reactions<br>– volumes of gases in chemical reactions (ACSCH046) | • Conservation of Mass<br>• Conservation of Mass Investigation |
| relate stoichiometry to the law of conservation of mass in chemical reactions by investigating:<br>– balancing chemical equations (ACSCH039)<br>– solving problems regarding mass changes in chemical reactions (ACSCH046) | Balancing Equations<br>Conservation of Mass<br>Conservation of Mass Investigation |

## Mole Concept

| Content Descriptor | Lesson Names |
|---|---|
| conduct a practical investigation to demonstrate and calculate the molar mass (mass of one mole) of:<br>– an element<br>– a compound (ACSCH046) | • Moles and Balanced Equations (Stoichiometry)<br>• Molecular and Empirical Formulae<br>• Moles and Molar Mass<br>• Conservation of Mass Investigation |

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| conduct an investigation to determine that chemicals react in simple whole number ratios by moles<br><br>explore the concept of the mole and relate this to Avogadro's constant to describe, calculate and manipulate masses, chemical amounts and numbers of particles in: (ACSCH007, ACSCH039)<br>– moles of elements and compounds $n = m\,MM$ (n = chemical amount in moles, m = mass in grams, MM = molar mass in gmol-1 )<br>– percentage composition calculations and empirical formulae<br>– limiting reagent reactions | |

## Concentration and Molarity

| Content Descriptor | Lesson Names |
|---|---|
| conduct practical investigations to determine the concentrations of solutions and investigate the different ways in which concentrations are measured (ACSCH046, ACSCH063) | • Properties of Water<br>• Solute, Solvent and Solution<br>• Solutions and Concentration<br>• Other Measures of Concentration<br>• Dilutions<br>• Standard Solutions |
| manipulate variables and solve problems to calculate concentration, mass or volume using:<br>– $c = n/V$ (molarity formula) (ACSCH063)<br>– dilutions (number of moles before dilution = number of moles of sample after dilution) | • Solutions and Concentration<br>• Other Measures of Concentration<br>• Dilutions |
| conduct an investigation to make a standard solution and perform a dilution | • Dilutions<br>• Standard Solutions |

## Gas Laws

| Content Descriptor | Lesson Names |
|---|---|
| conduct investigations and solve problems to determine the relationship between the Ideal Gas Law and:<br>– Gay-Lussac's Law (temperature)<br>– Boyle's Law<br>– Charles' Law<br>– Avogadro's Law (ACSCH060) | • Kinetic Theory and Gas Laws<br>• Ideal Gas Law: PV=nRT |

# Module 3: Reactive chemistry

## Chemical Reactions

| Content Descriptor | Lesson Names |
|---|---|
| investigate a variety of reactions to identify possible indicators of a chemical change | • Introduction to Chemical Reactions<br>• Identifying Chemical Reactions Investigation |
| use modelling to demonstrate<br>– the rearrangement of atoms to form new substances<br>– the conservation of atoms in a chemical reaction (ACSCH042, ACSCH080) | • Introduction to Chemical Reactions<br>• Identifying Chemical Reactions Investigation |
| conduct investigations to predict and identify the products of a range of reactions, for example:<br>– synthesis<br>– decomposition<br>– combustion<br>– precipitation<br>– acid/base reactions<br>– acid/carbonate reactions (ACSCH042, ACSCH080) | • Types of Reaction<br>• Acid Reactions<br>• Redox Reactions |
| investigate the chemical processes that occur when Aboriginal and Torres Strait Islander Peoples detoxify poisonous food items | *Further development planned* |
| construct balanced equations to represent chemical reactions | • Introduction to Writing Equations<br>• Balancing Equations<br>• Conservation of Mass |

## Predicting Reactions of Metals

| Content Descriptor | Lesson Names |
|---|---|
| conduct practical investigations to compare the reactivity of a variety of metals in:<br>– water<br>– dilute acid (ACSCH032, ACSCH037)<br>– oxygen<br>– other metal ions in solution<br><br>construct a metal activity series using the data obtained from practical investigations and compare this series with that obtained from standard secondary-sourced information (ACSCH103)<br><br>analyse patterns in metal activity on the periodic table and explain why they correlate with, for example:<br>– ionisation energy (ACSCH045)<br>– atomic radius (ACSCH007) | • Physical Properties of Metals<br>• Chemical Properties of Metals<br>• Metal Reactions with Oxygen<br>• Metal Reactions with Water<br>• Metal Reactions with Acid<br>• Organisation of the Periodic Table<br>• Trends in the Periodic Table |

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| – electronegativity (ACSCH057) | |
| apply the definitions of oxidation and reduction in terms of electron transfer and oxidation numbers to a range of reduction and oxidation (redox) reactions | • Introduction to Oxidation-Reduction<br>• Standard Reduction Potentials of Half-Cells |
| conduct investigations to measure and compare the reduction potential of galvanic half-cells | • Introduction to Electrolytic Cells and Electrolysis<br>• Introduction to Galvanic Cells<br>• Calculating Cell Potentials for Galvanic Cells<br>• Batteries |
| construct relevant half-equations and balanced overall equations to represent a range of redox reactions | • Introduction to Oxidation-Reduction Reactions<br>• Balancing Redox Half-Equations<br>• Balancing Overall Redox Equations |
| predict the reaction of metals in solutions using the table of standard reduction potentials | • Standard Reduction Potentials of Half-Cells |
| predict the spontaneity of redox reactions using the value of cell potentials (ACSCH079, ACSCH080) | • Standard Reduction Potentials of Half-Cells<br>• Calculating Cell Potentials for Galvanic Cells |

### Rates of Reactions

| Content Descriptor | Lesson Names |
|---|---|
| conduct a practical investigation, using appropriate tools (including digital technologies), to collect data, analyse and report on how the rate of a chemical reaction can be affected by a range of factors, including but not limited to:<br>– temperature<br>– surface area of reactant(s)<br>– concentration of reactant(s)<br>– catalysts (ACSCH042) | • Rate of Reaction<br>• Rate of Reaction Equations<br>• Factors Affecting Reaction Rates<br>• Maxwell-Boltzmann Distribution Curves<br>• Catalysts<br>• Activation Energy, Temperature and Catalysts<br>• Agitation, Concentration and Surface Area |
| investigate the role of activation energy, collisions and molecular orientation in collision theory | • Rate of Reaction<br>• Activation Energy and Energy Profiles<br>• Maxwell-Boltzmann Distribution Curves<br>• Activation Energy, Temperature and Catalysts<br>• Agitation, Concentration and Surface Area |
| explain a change in reaction rate using collision theory (ACSCH003, ACSCH046) | • Collision Theory and Rate of Reaction |

## Module 4: Drivers of reaction

### Enthalpy and Hess's Law

| Content Descriptor | Lesson Names |
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| explain the enthalpy changes in a reaction in terms of | • Exothermic and Endothermic Processes |

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| breaking and reforming bonds, and relate this to:<br>– the law of conservation of energy | • Calorimetry<br>• Energy Level Diagrams<br>• Enthalpy and Heat<br>• State Changes<br>• Standard Enthalpy Changes: Part 1<br>• Standard Enthalpy Changes: Part 2<br>• Thermochemical Equations<br>• Mole Ratios<br>• Calculating Enthalpy Changes<br>• Stoichiometry and Energy Calculations<br>• Bond Enthalpies of Molecules<br>• Bond Enthalpies of Reactions |
| investigate Hess's Law in quantifying the enthalpy change for a stepped reaction using standard enthalpy change data and bond energy data, for example: (ACSCH037)<br>– carbon reacting with oxygen to form carbon dioxide via carbon monoxide | • Hess's Law |
| apply Hess's Law to simple energy cycles and solve problems to quantify enthalpy changes within reactions, including but not limited to:<br>– heat of combustion<br>– enthalpy changes involved in photosynthesis<br>– enthalpy changes involved in respiration (ACSCH037) | • Standard Enthalpy Changes: Part 1<br>• Standard Enthalpy Changes: Part 2 |

## Entropy and Gibbs Free Energy

| Content Descriptor | Lesson Names |
|---|---|
| analyse the differences between entropy and enthalpy<br><br>use modelling to illustrate entropy changes in reactions<br><br>predict entropy changes from balanced chemical reactions to classify as increasing or decreasing entropy | • Entropy |
| explain reaction spontaneity using terminology, including: (ACSCH072)<br>– Gibbs free energy<br>– enthalpy<br>– entropy<br><br>solve problems using standard references and $\Delta Go = \Delta Ho - T\Delta So$ (Gibbs free energy formula) to classify reactions as spontaneous or nonspontaneous<br><br>predict the effect of temperature changes on spontaneity (ACSCH070) | • Spontaneity of Reactions |

# Senior Chemistry: Year 12

## Module 5: Equilibrium and acid reactions

### Static and Dynamic Equilibrium

| Content Descriptor | Lesson Names |
|---|---|
| conduct practical investigations to analyse the reversibility of chemical reactions, for example:<br>– cobalt(II) chloride hydrated and dehydrated<br>– iron(III) nitrate and potassium thiocyanate<br>– burning magnesium<br>– burning steel wool (ACSCH090) | • Chemical Systems<br>• Reversible Changes<br>• Equilibrium<br>• Energetics of Reversible Reactions |
| model static and dynamic equilibrium and analyse the differences between open and closed systems (ACSCH079, ACSCH091) | • Chemical Systems<br>• Reversible Changes<br>• Equilibrium<br>• Energetics of Reversible Reactions |
| analyse examples of non-equilibrium systems in terms of the effect of entropy and enthalpy, for example:<br>– combustion reactions<br>– photosynthesis<br><br>investigate the relationship between collision theory and reaction rate in order to analyse chemical equilibrium reactions (ACSCH070, ACSCH094) | • Collision Theory and Rate of Reaction |

### Factors that Affect Equilibrium

| Content Descriptor | Lesson Names |
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| investigate the effects of temperature, concentration, volume and/or pressure on a system at equilibrium and explain how Le Chatelier's principle can be used to predict such effects, for example:<br>– heating cobalt(II) chloride hydrate<br>– interaction between nitrogen dioxide and dinitrogen tetroxide<br>– iron(III) thiocyanate and varying concentration of ions (ACSCH095) | • Temperature and Equilibrium<br>• Concentration and Equilibrium<br>• Pressure and Equilibrium<br>• Le Chatelier's Principle<br>• Catalysts and Equilibrium |
| explain the overall observations about equilibrium in terms of the collision theory (ACSCH094) | • Concentration and Equilibrium<br>• Collision Theory and Rate of Reaction |
| examine how activation energy and heat of reaction affect the position of equilibrium | • Temperature and Equilibrium |

## Calculating the Equilibrium Constant (Keq)

| Content Descriptor | Lesson Names |
|---|---|
| deduce the equilibrium expression (in terms of Keq) for homogeneous reactions occurring in solution (ACSCH079, ACSCH096) | • The Equilibrium Constant<br>• Calculating Equilibrium Constants |
| perform calculations to find the value of Keq and concentrations of substances within an equilibrium system, and use these values to make predictions on the direction in which a reaction may proceed (ACSCH096) | • The Equilibrium Constant<br>• Calculating Equilibrium Constants |
| qualitatively analyse the effect of temperature on the value of Keq (ACSCH093) | • Changes in Temperature |
| conduct an investigation to determine Keq of a chemical equilibrium system, for example:<br>– Keq of the iron(III) thiocyanate equilibrium (ACSCH096) | *Further development planned* |
| explore the use of Keq for different types of chemical reactions, including but not limited to:<br>– dissociation of ionic solutions<br>– dissociation of acids and bases (ACSCH098, ACSCH099) | • Solubility in Water<br>• Effect of Temperature on Solubility<br>• Solubility Product Expressions<br>• Calculating Solubility Products<br>• Calculating Solubility |

## Solution Equilibria

| Content Descriptor | Lesson Names |
|---|---|
| describe and analyse the processes involved in the dissolution of ionic compounds in water | • Calculating Solubility<br>• Calculating Solubility Products |
| investigate the use of solubility equilibria by Aboriginal and Torres Strait Islander Peoples when removing toxicity from foods, for example:<br>– toxins in cycad fruit | *Further development planned* |
| conduct an investigation to determine solubility rules, and predict and analyse the composition of substances when two ionic solutions are mixed, for example:<br>– potassium chloride and silver nitrate<br>– potassium iodide and lead nitrate<br>– sodium sulfate and barium nitrate (ACSCH065) | • Factors Affecting Solubility: Common Ion Effect<br>• Factors Affecting Solubility: Acids, Bases and Complex Ions |
| derive equilibrium expressions for saturated solutions in terms of Ksp and calculate the solubility of an ionic substance from its Ksp value | • Saturated Solution Calculations |
| predict the formation of a precipitate given the standard reference values for Ksp | • Predicting Precipitation |

# Module 6: Acid/base reactions

## Properties of Acids and Bases

| Content Descriptor | Lesson Names |
|---|---|
| investigate the correct IUPAC nomenclature and properties of common inorganic acids and bases (ACSCH067) | • Acids<br>• Bases |
| conduct an investigation to demonstrate the preparation and use of indicators as illustrators of the characteristics and properties of acids and bases and their reversible reactions (ACSCH101) | *Further development planned* |
| predict the products of acid reactions and write balanced equations to represent:<br>– acids and bases<br>– acids and carbonates<br>– acids and metals (ACSCH067) | • Acids and Bases<br>• Reactions of Acids<br>• Metal Oxides and Hydroxides<br>• Metal Carbonates and Hydrogen Carbonates |
| investigate applications of neutralisation reactions in everyday life and industrial processes | • Neutralisation |
| conduct a practical investigation to measure the enthalpy of neutralisation (ACSCH093) | • Neutralisation |
| explore the changes in definitions and models of an acid and a base over time to explain the limitations of each model, including but not limited to:<br>– Arrhenius' theory<br>– Brønsted–Lowry theory (ACSCH064, ACSCH067) | • Conjugate Acid-Base Pairs<br>• Buffer Solutions<br>• Buffer Calculations |

## Using Brønsted–Lowry Theory

| Content Descriptor | Lesson Names |
|---|---|
| conduct a practical investigation to measure the pH of a range of acids and bases | • pH Scale<br>• pH |
| calculate pH, pOH, hydrogen ion concentration ([H+]) and hydroxide ion concentration ([OH−]) for a range of solutions (ACSCH102) | • pH<br>• Kw and pOH |
| conduct an investigation to demonstrate the use of pH to indicate the differences between the strength of acids and bases (ACSCH102) | • pH<br>• Relative Concentrations, pH and Conductivity |
| write ionic equations to represent the dissociation of acids and bases in water, conjugate acid/base pairs in solution and amphiprotic nature of some salts, for example:<br>– sodium hydrogen carbonate | • Conjugate Acid-Base Pairs<br>• Kw and pOH |

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| – potassium dihydrogen phosphate | |
| construct models and/or animations to communicate the differences between strong, weak, concentrated and dilute acids and bases (ACSCH099) | • Relative Concentrations, pH and Conductivity<br>• Weak Acids<br>• Weak Bases |
| calculate the pH of the resultant solution when solutions of acids and/or bases are diluted or mixed | • pH<br>• Kw and pOH<br>• Buffer Solutions<br>• Buffer Calcuations |

## Quantitative Analysis

| Content Descriptor | Lesson Names |
|---|---|
| conduct practical investigations to analyse the concentration of an unknown acid or base by titration | • Introduction to Titrations<br>• Titration Curves<br>• Titration Curve Calculations: Before Equivalence<br>• Titration Curve Calculations: To Equivalence and Beyond<br>• Performing a Titration |
| investigate titration curves and conductivity graphs to analyse data to indicate characteristic reaction profiles, for example:<br>– strong acid/strong base<br>– strong acid/weak base<br>– weak acid/strong base (ACSCH080, ACSCH102) | • Titration Curves<br>• Titration Curve Calculations: Before Equivalence<br>• Titration Curve Calculations: To Equivalence and Beyond |
| model neutralisation of strong and weak acids and bases using a variety of media | • Weak Acids<br>• Weak Bases |
| calculate and apply the dissociation constant (Ka) and pKa (pKa = -log10 (Ka)) to determine the difference between strong and weak acids (ACSCH098) | • Weak Acids |
| explore acid/base analysis techniques that are applied:<br>– in industries<br>– by Aboriginal and Torres Strait Islander Peoples<br>– using digital probes and instruments<br><br>conduct a chemical analysis of a common household substance for its acidity or basicity (ACSCH080), for example:<br>– soft drink<br>– wine<br>– juice<br>– medicine | *Further development planned* |
| conduct a practical investigation to prepare a buffer and demonstrate its properties (ACSCH080) | • Buffer Solutions<br>• Buffer Calculations |

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| describe the importance of buffers in natural systems (ACSCH098, ACSCH102) | |

# Module 7: Organic chemistry

## Nomenclature

| Content Descriptor | Lesson Names |
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| investigate the nomenclature of organic chemicals, up to C8, using IUPAC conventions, including simple methyl and ethyl branched chains, including: (ACSCH127)<br>– alkanes<br>– alkenes<br>– alkynes<br>– alcohols (primary, secondary and tertiary)<br>– aldehydes and ketones<br>– carboxylic acids<br>– amines and amides<br>– halogenated organic compounds | • Naming Alcohols<br>• Naming Alkanes<br>• Naming Alkenes<br>• Naming Amines<br>• Naming Esters<br>• Naming Haloalkanes<br>• Naming Amides<br>• Naming Aldehydes<br>• Naming Ketones<br>• Naming Alkynes<br>• Naming Carboxylic Acids |
| explore and distinguish the different types of structural isomers, including saturated and unsaturated hydrocarbons, including: (ACSCH035)<br>– chain isomers<br>– position isomers<br>– functional group isomers | • Alkene Isomerism<br>• Alkane Isomers<br>• Molecular and Structural Formulas of Alkanes<br>• Structural Isomers |

## Hydrocarbons

| Content Descriptor | Lesson Names |
|---|---|
| construct models, identify the functional group, and write structural and molecular formulae for homologous series of organic chemical compounds, up to C8 (ACSCH035) :<br>– alkanes<br>– alkenes<br>– alkynes | • Molecular and Structural Formulas of Alkanes<br>• Functional Groups Summary |
| conduct an investigation to compare the properties of organic chemical compounds within a homologous series, and explain these differences in terms of bonding (ACSCH035) | • Properties of Alkenes<br>• Properties of Alkanes<br>• Properties of Alkynes<br>• Functional Groups Summary |
| analyse the shape of molecules formed between carbon atoms when a single, double or triple bond is formed between them | • Properties of Alkenes<br>• Properties of Alkanes<br>• Properties of Alkynes |
| explain the properties within and between the homologous series of alkanes with reference to the intermolecular and intramolecular bonding present | • Properties of Alkenes<br>• Properties of Alkanes<br>• Properties of Alkynes |

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| describe the procedures required to safely handle and dispose of organic substances (ACSCH075) | *Further development planned* |
| examine the environmental, economic and sociocultural implications of obtaining and using hydrocarbons from the Earth | |

## Products of Reactions Involving Hydrocarbons

| Content Descriptor | Lesson Names |
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| investigate, write equations and construct models to represent the reactions of unsaturated hydrocarbons when added to a range of chemicals, including but not limited to:<br>– hydrogen (H2)<br>– halogens (X2)<br>– hydrogen halides (HX)<br>– water (H2O) (ACSCH136) | • Alkene Reactions |
| investigate, write equations and construct models to represent the reactions of saturated hydrocarbons when substituted with halogens | • Substitution Reactions of Alkanes |

## Alcohols

| Content Descriptor | Lesson Names |
|---|---|
| investigate the structural formulae, properties and functional group including:<br>– primary<br>– secondary<br>– tertiary alcohols | • Naming Alcohols<br>• Alcohol Isomerism |
| explain the properties within and between the homologous series of alcohols with reference to the intermolecular and intramolecular bonding present | • Properties of Alcohols |
| conduct a practical investigation to measure and reliably compare the enthalpy of combustion for a range of alcohols | • Combustion of Alcohols |
| write equations, state conditions and predict products to represent the reactions of alcohols, including but not limited to (ACSCH128, ACSCH136):<br>– combustion<br>– dehydration<br>– substitution with HX<br>– oxidation | • Substitution Reactions of Alcohol<br>• Elimination Reactions of Alcohols<br>• Oxidation Reactions of Alcohols |
| investigate the production of alcohols, including:<br>– substitution reactions of halogenated organic | • Substitution Reactions of Haloalkanes<br>• Fermentation and Ethanol Production |

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| compounds<br>– fermentation | |
| investigate the products of the oxidation of primary and secondary alcohols | • Oxidation Reactions of Alcohols |
| compare and contrast fuels from organic sources to biofuels, including ethanol | • Fermentation and Ethanol Production<br>• Fuels and Pharmaceuticals |

## Reactions of Organic Acids and Bases

| Content Descriptor | Lesson Names |
|---|---|
| investigate the structural formulae, properties and functional group including:<br>– primary, secondary and tertiary alcohols<br>– aldehydes and ketones (ACSCH127)<br>– amines and amides<br>– carboxylic acids | • Alcohol Isomerism<br>• Properties of Alcohols<br>• Properties of Amides<br>• Properties of Esters<br>• Properties of Amines<br>• Properties of Carbonyl Compounds<br>• Properties of Carboxylic Acids<br>• Distinguishing Organic Compounds |
| explain the properties within and between the homologous series of carboxylic acids amines and amides with reference to the intermolecular and intramolecular bonding present | • Properties of Amines<br>• Properties of Amides<br>• Properties of Carboxylic Acids<br>• Reactions of Primary Amines<br>• Formation & Hydrolysis of Amides |
| investigate the production, in a school laboratory, of simple esters | • Formation of Esters<br>• Hydrolysis of Esters |
| investigate the differences between an organic acid and organic base | • Formation & Hydrolysis of Amides |
| investigate the structure and action of soaps and detergents | • Soap Formation |
| draft and construct flow charts to show reaction pathways for chemical synthesis, including those that involve more than one step | • Reaction Schemes |

## Polymers

| Content Descriptor | Lesson Names |
|---|---|
| model and compare the structure, properties and uses of addition polymers of ethylene and related monomers, for example:<br>– polyethylene (PE)<br>– polyvinyl chloride (PVC)<br>– polystyrene (PS) | • Introduction to Polymers<br>• Addition Polymer Structure, Properties and Uses<br>• Condensation Polymer Structure, Properties & Uses<br>• Comparing Addition and Condensation Polymerisation |

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| – polytetrafluoroethylene (PTFE) (ACSCH136) | |
| model and compare the structure, properties and uses of condensation polymers, for example:<br>– nylon<br>– polyesters | • Introduction to Polymers<br>• Addition Polymer Structure, Properties and Uses<br>• Condensation Polymer Structure, Properties & Uses<br>• Comparing Addition and Condensation Polymerisation |

# Module 8: Applying chemical ideas

## Analysis of Inorganic Substances

| Content Descriptor | Lesson Names |
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| analyse the need for monitoring the environment | *Further development planned* |
| conduct qualitative investigations – using flame tests, precipitation and complexation reactions as appropriate – to test for the presence in aqueous solution of the following ions:<br>– cations: barium ($Ba^{2+}$), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), lead(II) ($Pb^{2+}$), silver ion ($Ag^{+}$), copper(II) ($Cu^{2+}$), iron(II) ($Fe^{2+}$), iron(III) ($Fe^{3+}$)<br>– anions: chloride ($Cl^{-}$), bromide ($Br^{-}$), iodide ($I^{-}$), hydroxide ($OH^{-}$), acetate ($CH_3COO^{-}$), carbonate($CO_3^{2-}$), sulfate ($SO_4^{2-}$), phosphate ($PO_4^{3-}$) | • Flame Tests<br>• Flame Test Investigation<br>• Testing for Anions<br>• Testing for Cations |
| conduct investigations and/or process data involving:<br>– gravimetric analysis<br>– precipitation titrations | *Further development planned* |
| conduct investigations and/or process data to determine the concentration of coloured species and/or metal ions in aqueous solution, including but not limited to, the use of:<br>– colourimetry<br>– ultraviolet-visible spectrophotometry<br>– atomic absorption spectroscopy | • Atomic Absorption Spectroscopy<br>• Emission Spectra |
| conduct qualitative investigations to test for the presence in organic molecules of the following functional groups:<br>– carbon–carbon double bonds<br>– hydroxyl groups<br>– carboxylic acids (ACSCH130) | • Distinguishing Organic Compounds |
| investigate the processes used to analyse the structure of simple organic compounds addressed in the course, including but not limited to: | • Mass Spectrometry of Compounds<br>• Infrared Spectroscopy<br>• Principles of NMR Spectroscopy |

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| – proton and carbon-13 NMR<br>– mass spectrometry<br>– infrared spectroscopy (ACSCH130) | • Carbon-13 NMR<br>• Proton NMR<br>• Structural Determination |

## Chemical Synthesis and Design

| Content Descriptor | Lesson Names |
|---|---|
| evaluate the factors that need to be considered when designing a chemical synthesis process, including but not limited to:<br>– availability of reagents<br>– reaction conditions (ACSCH133)<br>– yield and purity (ACSCH134)<br>– industrial uses (eg pharmaceutical, cosmetics, cleaning products, fuels) (ACSCH131)<br>– environmental, social and economic issues | • Designing Chemical Synthesis Processes<br>• Limiting Reagents and Theoretical Yield<br>• Actual and Percentage Yield<br>• Overall Reaction Efficiency<br>• The Haber-Bosch and Contact Processes<br>• The Chemical Industry<br>• Green Chemistry Principles<br>• Enzymes as Biological Catalysts |