Unit 2: Principles and Applications of Chemistry

Unit overview

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| Unit 2: Principles and Applications of Chemistry |
| **Assessment type: External** |
| **Content Area** |
| A: Atomic and electronic structure |
| B: Bonding and structure |
| C: Periodicity |
| D: Physical chemistry |
| E: Organic chemistry |
| Assessment overview  The unit will be assessed through one examination of 50 marks lasting 1 hour. The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented. The assessment availability is twice a year in January and May/ June.  The first assessment availability is May/June 2026.  Sample assessment materials will be available to help centres prepare students for assessment. |

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your learners to avoid and overcome these.

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| What is the misconception? | How to help learners overcome it |
| Students filling 3d subshell before 4s subshell for electronic configurations of atoms and removing from 3d before 4s for ions | Provide students with the sequence to assist recall of the order and revisit electronic configurations of atoms and ions regularly |
| Students writing the equation for a specific ionisation energy based upon the total number of electrons removed or the charge of the ion that the electron is removed from | Test students on different successive ionisation energies using multiple choice problems |
| Students thinking that ionic bonding is the transfer of electrons, not the electrostatic attraction between ions | Emphasise that electrostatic attraction is central to understanding any type of bonding |
| Students confusing ionic and covalent bonding in their drawings | Provide students with simple, general rules e.g. group 1 and 2 metals with non-metals = ionic bonding, non-metal with non-metal = covalent bonding  Draw attention to common examples which are exceptions (e.g. aluminum chloride) |
| Students sticking rigidly to the octet rule (8 electrons in outer shell) | Emphasise the link between the element, its outermost energy shell and maximum number of electrons that it can hold  Draw attention to common examples which are exceptions (e.g. sulfur hexachloride, boron trifluoride) |
| Students believing that the pi molecular orbital is two orbitals | Carefully show the way that p orbitals overlap above and below carbon nuclei to convey that only one molecular orbital is formed  Liken the pi molecular orbital to two ears providing one auditory system |
| Students assuming that covalent bonds are weak on the basis of low melting and boiling points of simple molecules | Revisit intermolecular forces regularly when discussing simple inorganic and organic molecules  Reinforce that giant covalent structures have high melting and boiling points because of covalent bonding |
| Students assuming that all metals have high melting and boiling points, and all non-metals do not conduct electricity | Ensure that students are aware that physical properties of elements are a generalisation and draw attention to exceptions (e.g. sodium and graphite) |
| Students using ionic, covalent, metallic and intermolecular forces interchangeably | Revisit bonding and intermolecular forces regularly when discussing different compounds |
| Students do not consider that charges need to balance in half equations and ionic equations, and combine half equations which do not show the same number of electrons | Practice constructing and balancing half equations and ionic equations regularly throughout the unit |
| Students mix up loss or gain of electrons and changes of oxidation number within redox reactions | Provide students with the acronym OIL-RIG to memorise the definitions of oxidation (is loss of electrons) and reduction (is gain of electrons) |
| Students assume that trends in ionic radii follow the same pattern as for atomic radii | Get students to carefully consider the effect of losing or gaining electrons for the outermost shell and whether there are more or less electrons than protons for each ion under consideration |
| Students’ mis-remember formulae of period 3 compounds (e.g. sulfuric acid with sulfurous acid) | Get students to practice writing equations to become use to unfamiliar formulae and make use of the oxidation number concept to check that formulae are correct |
| Students’ mis-remember the equation relating moles, mass and molar mass | Encourage use of units in working out for calculations, drawing attention to molar mass having units of g/mol as indicating mass divided by moles |
| Students confuse the sign of endothermic and exothermic enthalpy changes, and that of corresponding temperature changes | Provide students with simple rules to remember the sign of enthalpy change and the corresponding temperature change (i.e. exothermic = -ve enthalpy change, +ve temperature change; endothermic = +ve enthalpy change, -ve temperature change) |
| Students have the arrows pointing the wrong way round when drawing energy cycles | Practice many different types of energy cycle, particularly using enthalpies of combustion and formation, so students do not simply memorise one example, and draw attention to the change in direction of arrows in each |
| Students confuse the sign of an enthalpy change in calculations when using Hess’s Law | Encourage students to use energy cycles to work out the direction and sign changes when constructing their calculations |
| Students stating that “more collisions” rather than “more frequent collisions” to describe an increase in rate of reaction | Set questions to test student’s ability to clearly and accurately explain the effect of different factors upon rate of reaction |
| Students inaccurately represent features of the Maxwell-Boltzmann distribution curve and its changes when factors are varied | Emphasise how the area does not change but the shape of the distribution curve does  Practice sketching of changes in the curve’s shape, according to differences in temperature and concentration |
| Students have difficulty in predicting or recognising effect on rate for non-standard changes in concentration | Practice many different types of data analysis for rate and concentration changes, so the students become accustomed to non-standard changes (e.g. tripling a concentration will increase the rate nine-fold if the reactant is second order) |
| Students often predict the effect of pressure and temperature change for a given equilibrium incorrectly. | Emphasise that students need to consider the numbers in front of the formulae when using Le Chatelier’s principle, to explain the effects of changing the pressure on a gaseous equilibrium, and the sign of the enthalpy change of reaction to explain the effect of changing temperature. |
| Students think that if concentrations or pressure are changed then so is the value of Kc or Kp | Emphasise that yields of product are changed by changes in concentration or pressure but the equilibrium constant, as the name suggests, remain constant. |
| Students make errors in statements about the effect of catalysts upon equilibrium, distribution curves and reaction profile diagrams | Reinforce the key characteristics of catalysts during the topic of chemical equilibria (i.e. increase rate of reaction, do not change product yield, are not used up, lower the activation energy, etc) in order to explain and deduce effects |
| Students tend to only focus upon the disadvantages of chemical reactions when considering green chemistry | Students should be encouraged to look for positives as well as negatives for every green chemistry principle (e.g. 100% atom economy, exothermic reactions producing heat, etc) |
| Students often count from the wrong end or get the priority of the groups wrong when naming organic compounds | Practice with students naming as many different structures as possible and regularly throughout the teaching of organic chemistry |
| Students repeat a structure for a molecular formula when drawing structural isomers. | Encourage students to look at structures from another perspective or by simply turning the structure round the other way  Naming all structures that have been drawn is often a good way to determine whether a structure has been repeated |
| Students miscount the number of carbon atoms shown in a skeletal formula, and often forget that in skeletal formulae, hydrogens atoms are present even though they are not shown | Reinforce careful counting of the corners of skeletal formulae to determine the number of carbon atoms  Remind students that each line represents a bond and if there are less than 4 then there must be bonds to H atoms at that carbon |
| Students associate that stereoisomerism occurring with all alkenes | Carefully emphasise the conditions required for stereoisomerism i.e. there needs to be different groups/atoms on each carbon of the double bond, and a lack of free rotation about the C═C bond  Practice with students assessing the possibility of stereoisomerism in alkenes throughout the teaching of organic chemistry |
| Students often forget to write down the inorganic product when they write the equations for organic reactions | Ensure that students get plenty of practice in attempting chemical equations as well as just simply predicting the organic product throughout the teaching of organic chemistry |
| Students often draw polymers incorrectly | Develop a strategy with students to draw polymers correctly e.g. draw out the alkene in pencil, with C=C in the centre, draw bonds on each C atom in the double bond pointing up or down, then rub out one of the bonds in the double bond and draw in extension bonds |

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

| Learning Topic | Activities and guidance for unit content delivery | Resources |
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| A: Atomic and electronic structure | | | | | | |
| A1.1 – features of the periodic table and relationship with atomic structure | | | * Whole class teaching and learning – Periodic table and atomic structure * Discuss the Periodic Table, its features and their meanings (groups, periods, blocks, symbols, atomic number, mass number) * Draw / represent subatomic models to show the atomic structure of atoms and ions from different groups and periods (e.g. helium, carbon, fluorine, sodium, calcium) from the information found in the Periodic Table and involve learners in deducing these * Small group / Individual Activity – isotopes and relative atomic mass * Introduce isotopes and relative atomic mass * Task students with determining relative atomic mass from the isotopes and their percentage abundances for an element (e.g. chlorine, magnesium) and to determine percentage abundance of isotopes of an element (e.g. lithium, copper) | | Periodic table (hard copy)  e.g. <https://sciencenotes.org/periodic-table-black-white-wallpaper/>  Royal Society of Chemistry –  Periodic Table (interactive)  <https://www.rsc.org/periodic-table/>  LibreTexts – Chemistry  [2.3: Calculating Atomic Masses - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_201_-_General_Chemistry_I_(Anthony_and_Clark)/Unit_2%3A_The_Structure_of_the_Atom/2.3%3A_Calculating_Atomic_Masses)  Fuse School videos on the atom and periodic table  PhET atom builder and isotope weighing simulations  LibreTexts – Chemistry  [2.3: Calculating Atomic Masses (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT:_CHE_201_-_General_Chemistry_I_(Anthony_and_Clark)/Unit_2:_The_Structure_of_the_Atom/2.3:_Calculating_Atomic_Masses_(Problems))  Problems 2.3.1 – 2.3.5 | |
| A1.2 – electronic structure | | | * Whole class teaching and learning – electronic configuration * Discuss with students their understanding of electronic structure of the elements * Introduce energy levels (shells), subshells and electronic orbitals, and the rules for filling an atom with electrons * Small group or Individual Activity – determining electronic configurations * Show the use of electron-in-boxes diagrams and *s*, *p* and *d* notation to represent electronic configurations for some atoms and ions (e.g. sodium, Na+) * Task students with determining the electronic configuration for selected atoms and ions (up to atomic number 36), using electron-in-boxes diagrams and *spd* notation | | Periodic table (hard copy)  LibreTexts – Chemistry  [3.1: Electron Configurations - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.1%3A_Electron_Configurations)  Crash Course Chemistry videos on the electron, electronic configuration and orbitals  Electron Orbital simulator:  [Electron Orbital Simulator](http://electronorbitalsimulator.com/)  Electron Configuration calculator:  [Wolfram|Alpha Widgets: "Electron Configuration Calculator" - Free Chemistry Widget](https://www.wolframalpha.com/widgets/view.jsp?id=bd4637e2261cbcdda20d9077e61c712f)  Ptable – interactive periodic table  [Periodic Table - Ptable - Electrons - Oxidation states](https://ptable.com/#Electrons/OxidationStates)  electron-in-boxes and *spd* electronic configurations  LibreTexts – Chemistry  [3.1: Electron Configurations (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.1%3A_Electron_Configurations/3.1%3A_Electron_Configurations_(Problems))  Problems 3.1.1 - 3.1.25 | |
| A1.3 – ionisation energy | | | * **Whole class teaching and learning – ionisation energy** * Discuss the ionisation of an atom with students (e.g. whether energy is needed or released, which elements are easy to ionise and which are difficult, etc) * Define first ionisation energy and successive ionisation energy, using a range of different elements (e.g. nitrogen, magnesium, argon)      * Small group / Individual Activity – using successive ionisation energies * Provide students with successive ionisation energy data for an unknown element to analyse, by plotting a graph of log (ionisation energy) vs number of electron removed * Students can present their findings and evidence for the electronic structure of the unknown element * Whole class and individual activity – periodic trends in ionisation energy * Provide students with a graph (or data to plot a graph) of the first ionisation energies of all elements with atomic numbers 1 to 36. * Discuss the trends that can be seen in the graph in terms of factors that have caused an increase or decrease from one element to the next – students should consider the effect of the nuclear charge, shielding, number of electron shells, the subshell an electron is removed from and whether the electron is removed from a pair of electrons. | | Periodic table (hard copy)  Royal Society of Chemistry –  Periodic Table (interactive)  [Periodic Table – Royal Society of Chemistry](https://www.rsc.org/periodic-table/)  <https://www.rsc.org/periodic-table/trends>  first ionisation energy data and trends  WebElements  [WebElements Periodic Table » Periodicity » Ionization energies » Periodic table gallery](https://www.webelements.com/periodicity/ionisation_energy/)  Successive ionisation energy data of the elements  American Association of Chemistry Teachers – classroom resource  [Classroom Resources | Periodic Trends: Ionization Energy, Atomic Radius & Ionic Radius | AACT](https://teachchemistry.org/classroom-resources/periodic-trends-simulation)  Periodic trend simulation to compare first ionisation energy of elements  LibreTexts – Chemistry  [3.3: Trends in Ionization Energy - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.3%3A_Trends_in_Ionization_Energy)  Graph of first ionisation energy  [3.3: Trends in Ionization Energy (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.3%3A_Trends_in_Ionization_Energy/3.3%3A_Trends_in_Ionization_Energy_(Problems))  Problems 3.3.1 - 3.3.5 | |
| B: Bonding and structure | | | | | | |
| B1.1, B1.2, B1.3 and B1.4 – bonding and structure | | | * Whole class teaching and learning – bonding and structure overview * Discuss chemical bonding with students (e.g. how and why it occurs, the type of bonding depending upon the elements, differences between the three main types of bonding) * Present a diagrammatic summary of the three different types of bonding (metallic, ionic and covalent), the structure types (giant and simple), and explain the key properties that characterise each type * Small group / Individual Activity – representing bonding and structure * Provide students with the name or formulae of different elements and compounds to represent the range of bonding and structure types. * Student drawings will include dot-and-cross diagrams and 2D/3D lattice arrangements. Students can also predict typical properties of the substances based upon their diagrams. * Whole class teaching and learning – focus on covalent bonding * Recap covalent bonding and challenge students to draw a dot and cross diagram on a whiteboard, for examples that use single, double, triple and dative covalent bonds. Redraw the student diagrams as displayed structural formulae (stick diagrams). * Discuss which covalent bonds are the longest / shortest and explore the reasons. Extend the discussion with students into how bond length will affect the bond strength and energy required to break the bond. * Present the molecular orbital model, showing how sigma and pi orbitals are formed from the overlap of atomic orbitals, and applying this to the examples that the students have drawn on the whiteboard. * Laboratory Activity – identifying structure and bonding from properties * Task students with the identification a range of unknown substances from their physical properties, including melting point and electrical conductivity – the identification could be a table of data or could be a practical investigation. A key to classifying bonding and structure types (including exceptions) could be provided or students could create one before the task. | | Periodic table (hard copy)  LibreTexts – Chemistry  [10.6: The Solid State of Matter - Chemistry LibreTexts](https://chem.libretexts.org/Bookshelves/General_Chemistry/Chemistry_1e_(OpenSTAX)/10%3A_Liquids_and_Solids/10.06%3A_The_Solid_State_of_Matter)  Problems 10.E.5.9 – 10.E.5.22  [3.4: Molecular and Ionic Compounds - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_201_-_General_Chemistry_I_(Anthony_and_Clark)/Unit_3%3A_Nuclei_Ions_and_Molecules/3.4%3A_Molecular_and_Ionic_Compounds)  Problems 3.4.1 – 3.4.15  American Association of Chemistry Teachers – classroom resource  [Classroom Resources | Ionic & Covalent Bonding | AACT](https://teachchemistry.org/classroom-resources/ionic-covalent-bonding-simulation)  Ionic and covalent bonding simulation  LibreTexts – Chemistry  [4.1: Lewis Dot Diagrams - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_4%3A_Lewis_Structures/4.1%3A_Lewis_Dot_Diagrams)  [4.2: Lewis Structures - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_4%3A_Lewis_Structures/4.2%3A_Lewis_Structures)  Dot and cross diagrams  [4.1: Lewis Dot Diagrams (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_4%3A_Lewis_Structures/4.1%3A_Lewis_Dot_Diagrams/4.1%3A_Lewis_Dot_Diagrams_(Problems))  Problems 4.1.1 – 4.1.3  [4.2: Lewis Structures (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_4%3A_Lewis_Structures/4.2%3A_Lewis_Structures/4.2%3A_Lewis_Structures_(Problems))  Problems 4.2.1 – 4.2.6  3D models of different structures e.g. giant ionic lattice, diamond, graphite  [Inorganic kits – Molymod](https://molymod.com/inorganic-kits/)  ChemTube 3D  [Crystal Structures Section](https://www.chemtube3d.com/category/a-level/crystal-structures/)  3D online structures  LibreTexts – Chemistry  [5.1: Covalent Bond Formation and Strength - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_5%3A_The_Strength_and_Shape_of_Covalent_Bonds/5.1%3A_Covalent_Bond_Formation_and_Strength)  [5.1: Covalent Bond Formation and Strength (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_5%3A_The_Strength_and_Shape_of_Covalent_Bonds/5.1%3A_Covalent_Bond_Formation_and_Strength/5.1%3A_Covalent_Bond_Formation_and_Strength_(Problems))  Problem 5.1.1  [5.3: Valence Bond Theory and Hybrid Orbitals - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_5%3A_The_Strength_and_Shape_of_Covalent_Bonds/5.3%3A_Valence_Bond_Theory_and_Hybrid_Orbitals)  Sigma and pi molecular orbitals  Crash Course Chemistry video on molecular orbitals  [5.3: Valence Bond Theory and Hybrid Orbitals (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_5%3A_The_Strength_and_Shape_of_Covalent_Bonds/5.3%3A_Valence_Bond_Theory_and_Hybrid_Orbitals/5.3%3A_Valence_Bond_Theory_and_Hybrid_Orbitals_(Problems))  Problem 5.3.1 – 5.3.4  Practical Science  [Identification of Unknown Substances: Classifying Metallic, Ionic, or Covalent Compounds – Practical Science](https://practical-science.com/2023/04/05/identification-of-unknown-substances-classifying-metallic-ionic-or-covalent-compounds/) | |
| B1.5 and B1.6 – molecular shape, electronegativity and polarity | * Whole class and individual activity – molecular shape * Introduce the topic of molecular shape by discussing limitations of dot-and-cross diagrams and 2D representations and show what the 3D shape of key molecules would look like. Compile suggestions from learners as to which factors would affect the shape of a molecule. * Provide learners with molecular modelling kits and a list of molecules to make in order to explore shape. Learners can draw the dot-and-cross diagram and 3D model of each molecule. * Summarise the topic by presenting the electron pair repulsion rules and 3D representations of the common molecular shapes with names and bond angles. * Whole class and individual activity – electronegativity and polarity * Introduce the topic of electronegativity by discussing with students whether the pair of electrons in a covalent bond will be shared equally by the two atoms. Compile suggestions from students as to which factors that influence the pull of electrons by an atom. * Define electronegativity and show a periodic table of electronegativity values for the elements. Explain how electronegativity changes down and across the periodic table. * Provide students with covalent bonds to draw dipoles on each atom. Using electronegativity values, learners can place the bonds in order from most polar to least polar or non-polar. * Discuss with students how molecular shape will influence the polarity of the molecule. Provide molecular model kits for students to construct examples of polar and non-polar molecules to illustrate the discussion. | | Periodic table (hard copy)  Molecular modelling kits  (one between two learners)  [Sets – Molymod](https://molymod.com/sets/)  ChemTube 3D  [Shapes of molecules VSEPR Section](https://www.chemtube3d.com/category/a-level/shapes-of-molecules-vsepr/)  3D online structures  Molecular shape chart e.g.  <https://chemistryclinic.co.uk/shapes-of-simple-molecules/>  LibreTexts – Chemistry  [5.2: Molecular Shape - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_5%3A_The_Strength_and_Shape_of_Covalent_Bonds/5.2%3A_Molecular_Shape)  Tables of molecular shape  Fuse School video on shapes of molecules  PhET molecular shape simulation  [5.2: Molecular Shape (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_5%3A_The_Strength_and_Shape_of_Covalent_Bonds/5.2%3A_Molecular_Shape/5.2%3A_Molecular_Shape_(Problems))  Problems 5.2.1 - 5.2.10  Royal Society of Chemistry –  Periodic Table (interactive)  <https://www.rsc.org/periodic-table/trends>  electronegativity trends  LibreTexts – Chemistry  [Unit 6: Molecular Polarity - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_6%3A_Molecular_Polarity)  Table of electronegativity  Crash Course Chemistry and Teacher’s Pet videos on electronegativity and polarity  6.2.1 PhET molecular polarity simulation  Problems 6.1.1 – 6.1.8  Problems 6.2.1 – 6.2.6 | |
| B1.7 and B1.8 - intermolecular forces | * Whole class teaching and learning – intermolecular forces * Introduce the topic of intermolecular forces by discussing with students how type of structure determines state of matter (e.g. why giant structures are solid but simple molecular structures may be solid, liquid or gas). * Present an overview of the three different types of intermolecular force (temporary-induced dipole attraction, permanent dipole – permanent dipole attraction and hydrogen bonding), including how each arises and the effect on physical properties. * Provide students with a range of different molecules to determine the type of intermolecular forces present and predict the order of boiling point. * Peer teaching – properties of water * Task student with researching one specific property of water that is influenced by hydrogen bonding (e.g. melting and boiling points, density as solid and liquid, surface tension, specific heat capacity, etc). * Students will present their research back to the rest of the class, explaining the relevance of hydrogen bonding in the property. * Alternatively, different students could be tasked with presenting research for different substances and their properties as way of reviewing the wider topic of bonding and structure. | | Periodic table (hard copy)  Molecular modelling kits  (one between two learners)  [Sets – Molymod](https://molymod.com/sets/)  3D molecular model of lattice of ice  [Inorganic kits – Molymod](https://molymod.com/inorganic-kits/)  ChemTube 3D  [Ice - water in the solid state](https://www.chemtube3d.com/ss-ice/)  3D online structures  American Association of Chemistry Teachers – classroom resource  [Classroom Resources | Intermolecular Forces | AACT](https://teachchemistry.org/classroom-resources/intermolecular-forces-2020)  Intermolecular forces simulation and quiz  LibreTexts – Chemistry  [6.3: Intermolecular Forces - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_6%3A_Molecular_Polarity/6.3%3A_Intermolecular_Forces)  Graphs and data of boiling / melting point trends of simple molecules  Problems 6.3.1 – 6.3.14  LibreTexts – Chemistry  [7.3: Hydrogen-Bonding and Water - Chemistry LibreTexts](https://chem.libretexts.org/Bookshelves/General_Chemistry/Chem1_(Lower)/07%3A_Solids_and_Liquids/7.03%3A_Hydrogen-Bonding_and_Water) | |
| C: Periodicity | | | | |
| C1.1 – physical properties of Period 3 elements | * Whole class teaching and learning – periodicity * Introduce the topic of periodicity by discussing with students why elements are placed in groups and periods. Students will be familiar with elements in the same group as having similar chemical reactivity and change in physical properties but extend the discussion to consider how chemical and physical properties may change across a period. * Remind students of how atomic radii change down a group of elements (e.g. Group 1) and ask for similar reasoning to explain how the atomic radii will change across Period 3. * Discuss how the radii of positive and negative ions would compare against the original atom and what the trends would be across Period 3. * Paired or Individual activity – trends in physical properties of elements in Period 3 * Provide students with data for physical properties of the Period 3 elements, which should include melting points and electrical conductivity, and ask them to explain the changes in these properties in terms of the bonding and structure of each element. | | Periodic table (hard copy)  e.g. <https://sciencenotes.org/periodic-table-black-white-wallpaper/>  Royal Society of Chemistry –  Periodic Table (interactive)  <https://www.rsc.org/periodic-table/trends>  atomic radius trends  melting point trends  Chemix School periodic table  [Periodic Table Software](https://www.chemix-chemistry-software.com/school/periodic-table.html)  physical property data for elements (including melting point and electrical conductivity)  American Association of Chemistry Teachers – classroom resource  [Classroom Resources | Periodic Trends: Ionization Energy, Atomic Radius & Ionic Radius | AACT](https://teachchemistry.org/classroom-resources/periodic-trends-simulation)  Periodic trend simulation to compare of atomic radii of elements  LibreTexts – Chemistry  [3.2: Trends in Size - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.2%3A_Trends_in_Size)  graphs and data for atomic and ionic radii  [3.2: Trends in Size (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.2%3A_Trends_in_Size/3.2%3A_Trends_in_Size_(Problems))  Problems 3.2.1 - 3.2.10  The Engineering ToolBox  [Electrical Conductivity - Elements and other Materials](https://www.engineeringtoolbox.com/conductors-d_1381.html)  electrical conductivity data  Chemguide  [atomic and physical properties of period 3 elements](https://www.chemguide.co.uk/inorganic/period3/elementsphys.html#top)  notes and problems | |
| C1.2 – oxidation number and redox reactions | * Whole class teaching and learning – oxidation number concept * Introduce the topic of redox by discussing the various meanings of the terms reduction and oxidation, using equations to exemplify the terms. * Discuss the difficulty of identifying which element is reduced and which is oxidised when oxygen of ionic compounds are not involved (e.g. PCl3 + Cl2 à PCl5). Give a presentation on the oxidation number concept and the general rules around assignment of oxidation numbers to elements. * Paired or Individual activity – determining oxidation numbers, half equations and redox equations * Provide students with a series of problems to include: * determining the oxidation numbers of elements in a formula * using oxidation numbers to determine the formula of a compound * constructing reduction and oxidation half equations * constructing and balancing redox equations | | LibreTexts – Chemistry  [Redox menu](https://www.chemguide.co.uk/inorganic/redoxmenu.html#top)  LibreTexts – Chemistry  [Redox Chemistry - Chemistry LibreTexts](https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Electrochemistry/Redox_Chemistry)  reduction and oxidation, oxidation number concept, half equations, redox equations  ChemicalAid calculators  [Oxidation Number Calculator](https://www.chemicalaid.com/tools/oxidationnumber.php?hl=en)  [Redox Reaction Calculator](https://www.chemicalaid.com/tools/redoxreaction.php?hl=en)  tools to determine oxidation numbers and balance redox reaction equations  [11.E: Properties of Reactions (Exercises) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/University_of_Kentucky/CHE_103%3A_Chemistry_for_Allied_Health_(Soult)/11%3A_Properties_of_Reactions/11.E%3A_Properties_of_Reactions_(Exercises))  Problems Q11.1.1 - Q11.1.4  Problems Q11.2.1 - Q11.2.5 | |
| C1.3, C1.4, C1.5, C1.6, C1.7, C1.8, and C1.9 – chemical properties of Period 3 elements and their compounds, uses and predictions | * Laboratory activity – the chemical reactivity of Period 3 elements * Demonstrate (or show internet videos of) the chemical reactivity of some Period 3 elements with oxygen, water and chlorine to students. * Students should make notes on what they observe and construct chemical equations where a reaction has occurred. * The demonstrations could be extended to the products of these reactions, which should be examined for their physical state and properties, and chemical properties by adding them to water and testing the pH of any solution formed. Again, students should make notes on observations, and in particular look for any trends in acid-base behaviour across the period. * Peer teaching – physical and chemical properties of Period 3 compounds and uses * Task students with researching the physical and chemical properties of Period 3 oxides, chlorides and hydroxides / acids. This could supplement the information that students have already gained from the practical demonstration. Students should explain these properties in terms of bonding, structure and chemical equations. * Ask individual students or pairs of students to present to the whole class their research and explanations of the physical and chemical properties of one Period 3 element, its compounds, and their uses. * Select one or two individuals to present their predictions for the properties of a Period 2 or Period 4 element and compounds, based upon their research for Period 3. | | Science Skool videos  [Science Skool - YouTube](https://www.youtube.com/@scienceskool4734/videos)  search the video bank for “oxygen”, “chlorine”, “water” for reactions with period 3 elements  Chemguide  [chemical reactions of period 3 elements](https://www.chemguide.co.uk/inorganic/period3/elementsreact.html#top)  [acid-base behaviour of the period 3 oxides](https://www.chemguide.co.uk/inorganic/period3/oxidesh2o.html#top)  [the period 3 chlorides](https://www.chemguide.co.uk/inorganic/period3/chlorides.html#top)  notes and problems  Chemguide  [Period 3 menu](https://www.chemguide.co.uk/inorganic/period3menu.html#top)  notes and problems  Royal Society of Chemistry –  Periodic Table (interactive)  <https://www.rsc.org/periodic-table/>  uses and properties of elements | |
| D: Physical Chemistry | | | | |
| D1.1 – the mole and quantitative chemistry | * Whole class and individual activity – problems on moles and quantitative chemistry * Give students worksheets at regular points between the following activities to work out molar masses, moles, masses, empirical formulae, stochiometric equations, gas volumes and percentage yields. * Whole class teaching and learning – mole, molar mass and percentage yield * Give a presentation which introduces and defines the mole concept, Avogadro’s number, and molar mass, including its relationship to relative atomic, formula and molecular masses. * Show examples using moles and molar mass to calculate masses of substances (and vice versa). Introduce the ideas of theoretical yield, actual yield and percentage yield, and show a worked example. * Laboratory activity – empirical formulae and stochiometric equations * Students could carry out an experiment to determine the empirical formula of a compound, such as magnesium oxide (by burning magnesium in air) or copper oxide (by reducing copper oxide with methane / hydrogen gas). * Masses before and after should be collected from each learner or pair working together, a graph plotted to average out anomalous data and using this the mole ratio of each element can be determined. From this an empirical formula or stoichiometric equation can be deduced. * Whole class teaching and learning – gas volume and molar volume * Explain the relationship between mole, gas molar volume (24 dm3 at room temperature and pressure) and volume of a gas. * Show a worked example to support the teaching of the relationship. * Set up a demonstration of a reaction which produces a gas (e.g. magnesium and hydrochloric acid to produce hydrogen gas) using apparatus to collect and measure the volume of gas produced. * Show students how the volume of the gas can be predicted from the mass, moles and gas molar volume. | | LibreTexts – Chemistry  [6.11: Exercises - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Anoka-Ramsey_Community_College/Introduction_to_Chemistry/06%3A_Chemical_Composition/6.11%3A_Exercises)  [4.3: Empirical and Molecular Formulas (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_201_-_General_Chemistry_I_(Anthony_and_Clark)/Unit_4%3A_Quantifying_Chemicals/4.3%3A_Empirical_and_Molecular_Formulas_(Problems))  [5.3: Calculating Reaction Yields (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_201_-_General_Chemistry_I_(Anthony_and_Clark)/Unit_5%3A_Transformations_of_Matter/5.3%3A_Calculating_Reaction_Yields_(Problems))  problems on molar mass, moles, etc  Doc Brown  <https://docbrown.info/page04/4_73calcs.htm>  calculation quizzes on quantitative chemistry  Chemguide  [moles](https://www.chemguide.co.uk/14to16/calculations/moles.html#top)  [relative atomic mass and relative formula mass](https://www.chemguide.co.uk/14to16/calculations/relative.html#top)  [calculations from equations involving masses](https://www.chemguide.co.uk/14to16/calculations/mass.html#top)  notes  Chemguide  [empirical formulae](https://www.chemguide.co.uk/14to16/calculations/empirical.html#top)  notes and videos of laboratory experiments  Chemguide  [calculations from equations involving gases](https://www.chemguide.co.uk/14to16/calculations/gases.html#top)  notes  Royal Society of Chemistry  [The volume of 1 mole of hydrogen gas | Experiment | RSC Education](https://edu.rsc.org/experiments/the-volume-of-1-mole-of-hydrogen-gas/452.article)  experiment  Pearson Edexcel A-level core practical  [AS-and-A-level-Chemistry-Core-Practical-1---Molar-Volume-of-a-Gas-(Student,-Teacher,-Technician-Worksheets).pdf](https://qualifications.pearson.com/content/dam/pdf/A%20Level/Chemistry/2015/teaching-and-learning-materials/AS-and-A-level-Chemistry-Core-Practical-1---Molar-Volume-of-a-Gas-(Student,-Teacher,-Technician-Worksheets).pdf)  experiment | |
| D1.2 – chemical kinetics | * Whole class teaching and learning – rate of reaction and collision theory * Use a quiz or question and answer session to found out learners’ prior knowledge of rates of reaction. * Give a presentation that defines chemical kinetics as the study of rate of reaction and covers the main factors that affect rate of reaction. * Use collision theory and activation energy to explain the effect of factors upon rate. This could also be demonstrated using marbles on a tray to show how some factors, such as concentration, temperature and pressure, affect the number of collisions (e.g. changing the number of marbles, their speed or the size of the tray). * Individual activity – concentration-time graph problems * Give students a worksheet of problems to interpret concentration-time graphs. * This should include calculating rate of reactions at different points of a curve, deducing and explaining the effect of changes in concentration, pressure, temperature, surface area and catalysts. * Whole class teaching and learning – Maxwell-Boltzmann distribution curves * Give a presentation which describes and explains the features of the Maxwell-Boltzmann distribution curve. * Use the distribution curve to explain the effects of concentration, temperature and catalyst on rate. * Students should be led through the explanations but involved throughout. For example, students should be able to explain the increase in temperature upon rate and therefore attempt to sketch the shape of the curve, or students should be able to explain the effect of a catalyst and show how this affects the activation energy line. * Whole class and individual activity – rate equation problems * Show students an example of how to determine a rate equation from a table of data where the concentrations of reactants and a catalyst are systematically changed and the initial rate recorded. * Show direct proportion between initial rate and concentration (first order), proportion between initial rate and concentration squared (second order) and constant initial rate, no matter what the concentration is (zero order). * Construct the rate equation and show how to calculate the rate constant and its units. Provide students with a worksheet of different problems using graphs and tables of data that can be analysed to deduce rate equations. * Laboratory activity - determining rate equation, orders of reaction and rate constant * Introduce the concept of the rate equation. * Students will investigate a particular chemical reaction (e.g. the clock reaction between peroxodisulfate and iodide ions) to determine the rate of reaction for different concentrations of the reactants. * Students should use their results to construct graphs to determine the orders of reaction, the rate equation and the rate constant, including its units. | | Chemguide  [Rates of reaction menu](https://www.chemguide.co.uk/physical/basicratesmenu.html#top)  notes  Crash Course Chemistry  [Kinetics: Chemistry's Demolition Derby - Crash Course Chemistry #32 - YouTube](https://www.youtube.com/watch?v=7qOFtL3VEBc)  video  LibreTexts – Chemistry  [14.2: Rates of Chemical Reactions - Chemistry LibreTexts](https://chem.libretexts.org/Courses/University_of_Arkansas_Little_Rock/Chem_1403%3A_General_Chemistry_2/Text/14%3A_Rates_of_Chemical_Reactions/14.02%3A_Rates_of_Chemical_Reactions)  Notes and graphs  Royal Society of Chemistry  [Interpreting rate of reaction graphs | 14-16 years | Lesson plan | RSC Education](https://edu.rsc.org/lesson-plans/interpreting-rate-of-reaction-graphs-14-16-years/95.article)  graphs  Royal Society of Chemistry  [Collision theory and Maxwell–Boltzmann distribution curves | Resource | RSC Education](https://edu.rsc.org/resources/collision-theory-and-maxwell-boltzmann-distribution-curves/4020498.article)  notes and graphs  Chemguide  [Rates of reaction menu](https://www.chemguide.co.uk/physical/basicratesmenu.html#top)  notes and problems  LibreTexts – Chemistry  [12.4: Rate Laws - Chemistry LibreTexts](https://chem.libretexts.org/Bookshelves/General_Chemistry/Chemistry_1e_(OpenSTAX)/12%3A_Kinetics/12.04%3A_Rate_Laws)  Notes and graphs  Chemguide  [orders of reaction and rate equations](https://www.chemguide.co.uk/physical/basicrates/orders.html#top)  notes and problems  Pearson Edexcel A-level core practical  [GCE Science TRP](https://qualifications.pearson.com/content/dam/pdf/A%20Level/Chemistry/2015/teaching-and-learning-materials/A_level_Chemistry_Core_Practical_13b_Clock_Reaction.pdf)  experiment | |
| D1.3 – chemical energetics | * Whole class teaching and learning – chemical energetics basics * Give a presentation of an overview of key terms, definitions and representations - enthalpy change, endothermic and exothermic processes, energy level and reaction profile diagrams, standard conditions, standard enthalpy change, symbols and units. * Show short video clips and ask students to complete an accompanying worksheet. * Individual / Paired activity – identifying and representing enthalpy changes * Give student some exothermic and endothermic reactions, with the enthalpy change values. Ask them to draw labelled reaction profiles, showing the energy position of the reactants and products, the activation energy and Δ*H*. * Give students several reactions and ask them to identify whether Δr*H* for each reaction is Δf*H*, Δc*H* or some other type of standard enthalpy change. * Ask students to write the chemical equations for Δf*H* and Δc*H* of named substances. * Ask students to calculate enthalpy changes from a list of substances and reactions, where the standard enthalpy change, and mass of the reactant or product is given.      * Whole class and individual activity – Hess’s Law and energy cycles * Introduce Hess’s Law of Constant Heat Summation, linking it to the conservation of energy. * Explain how the enthalpy changes of some reactions are difficult to determine experimentally, and how Hess’s Law can be applied to determine a value for such enthalpy changes. * Show the use of energy cycles to determine a value for Δr*H* using Δf*H* and Δc*H* values. * Provide students with problems to determine Δ*H* for given reactions, using energy cycles and appropriate standard enthalpy change data. * Laboratory activity – determining the standard enthalpy change of a reaction * Task students with carrying out different enthalpy change experiments. * They should carry out practical work to determine the standard enthalpy change of a reaction directly (e.g. combustion of an alcohol or alkane) and the enthalpy change of a reaction indirectly (e.g. thermal decomposition of potassium hydrogen carbonate). * Students will need to be shown how to convert temperature change into Δ*H* for reactions performed, and for the indirect enthalpy change determination, how to construct the energy cycle needed. * Calculated values for the enthalpy changes should be collected from each student or pair of students, and the values compared with each other and the actual value. * Review the practical activity in light of the results obtained for all titrations, identifying common errors and suggesting improvements. | | Chemguide  [chemical energetics - an introduction](https://www.chemguide.co.uk/physical/energetics/basic.html#top)  notes and problems  Crash Course Chemistry  [Enthalpy: Crash Course Chemistry #18 - YouTube](https://www.youtube.com/watch?v=SV7U4yAXL5I)  video  Chemguide  [various enthalpy change definitions](https://www.chemguide.co.uk/physical/energetics/definitions.html#top)  notes and problems  Chemguide  [Hess's Law and enthalpy change calculations](https://www.chemguide.co.uk/physical/energetics/sums.html#top)  notes and problems  LibreTexts – Chemistry  [8.3: Enthalpy and Hess’ Law (Problems) - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_201_-_General_Chemistry_I_(Anthony_and_Clark)/Unit_8%3A_Thermochemistry/8.3%3A_Enthalpy_and_Hess%E2%80%99_Law_(Problems))  Problems 8.3.11 – 8.3.13  Chemistorian  [The EASIEST Method For Solving Hess Cycles](https://www.youtube.com/watch?v=DsLDV93-fiE)  video  Royal Society of Chemistry  [Comparing heat energy from burning alcohols | Experiment | RSC Education](https://edu.rsc.org/experiments/comparing-heat-energy-from-burning-alcohols/1733.article)  experiment  Pearson Edexcel A-level core practical  [AS-and-A-level-Chemistry-Core-Practical-8---hess-law--(Student,-Teacher,-Technician-Worksheets).pdf](https://qualifications.pearson.com/content/dam/pdf/A%20Level/Chemistry/2015/teaching-and-learning-materials/AS-and-A-level-Chemistry-Core-Practical-8---hess-law--(Student,-Teacher,-Technician-Worksheets).pdf)  experiment | |
| D1.4 – chemical equilibrium | * Whole class teaching and learning – chemical equilibrium basics and Le Chatelier’s principle * Review what students already know about reversible reactions. Describe the term dynamic equilibrium and introduce its key characteristics. Present analogies for dynamic equilibrium (e.g. a person running up a downwards escalator). * Establish that equilibrium can be affected by changes to the system (concentration, temperature, pressure and presence of a catalyst) and introduce Le Chatelier’s principle. * Illustrate the use of the principle when conditions are altered for a reaction equation in equilibrium. You could show a relevant video and ask students to complete an accompanying worksheet. * Laboratory activity – demonstrations of factors affecting dynamic equilibrium * Demonstrate or allow student to conduct practical experiments to show how changes to conditions affect a system in equilibrium. Some suitable demonstrations include: * an acid–base mixture with an indicator, and additional H+ or OH− ions are added * a solution of Co2+ ions and hydrochloric acid, and the temperature is changed * a gas syringe containing NO2 and N2O4 gases, and the syringe plunger is pushed in or pulled out to change the pressure * Students should record their observations and explain using Le Chatelier’s principle the changes in the position of equilibrium. * Individual activity – interpretation of product yield graphs * Provide students with graphs of product yield vs pressure or temperature for given reaction equations. * Task students with proposing the optimum reaction conditions, justifying their proposals and discussing the possible drawbacks with their suggestion. * Whole class and individual activity – chemical equilibrium problems * Use a presentation to explain the concept of the equilibrium constant, *K*c and *K*p, using a reversible reaction (e.g. the Haber process). * Show how it can be expressed using the stoichiometric equation for a reaction and discuss how its magnitude can determine the position of equilibrium. * Give students a set of chemical reactions/equations and ask them to write expressions for *K*c or *K*p. * Provide worksheets so that students can calculate values of equilibrium constants for reactions from given concentrations or partial pressures, and also to calculate the concentration or partial pressure of a reactant or product where *K* is known. | | Chemguide  [an introduction to chemical equilibria](https://www.chemguide.co.uk/physical/equilibria/introduction.html#top)  [Le Chatelier's Principle](https://www.chemguide.co.uk/physical/equilibria/lechatelier.html#top)  notes and problems  Crash Course Chemistry  [Equilibrium: Crash Course Chemistry #28](https://www.youtube.com/watch?v=g5wNg_dKsYY)  video  LibreTexts – Chemistry  [12: Equilibrium and Le Chatelier's Principle (Experiment) - Chemistry LibreTexts](https://chem.libretexts.org/Ancillary_Materials/Laboratory_Experiments/Wet_Lab_Experiments/General_Chemistry_Labs/Online_Chemistry_Lab_Manual/Chem_10_Experiments/12%3A_Equilibrium_and_Le_Chatelier's_Principle_(Experiment))  Experiments / demonstrations  Royal Society of Chemistry  [The effect of pressure and temperature on equilibrium | Le Chatelier’s principle | Experiment | RSC Education](https://edu.rsc.org/experiments/the-effect-of-pressure-and-temperature-on-equilibrium-le-chateliers-principle/1739.article)  experiment  BBC Bitesize  [Choosing reaction conditions - Higher - Industrial chemical reactions - Higher - GCSE Chemistry (Single Science) Revision - Edexcel - BBC Bitesize](https://www.bbc.co.uk/bitesize/guides/z8npk2p/revision/2)  graph  Chemguide  [equilibrium constants - Kc](https://www.chemguide.co.uk/physical/equilibria/kc.html#top)  [equilibrium constants - Kp](https://www.chemguide.co.uk/physical/equilibria/kp.html#top)  [equilibrium constants and changing conditions](https://www.chemguide.co.uk/physical/equilibria/change.html#top)  notes and problems  LibreTexts – Chemistry  [12: Equilibrium and Le Chatelier's Principle (Experiment) - Chemistry LibreTexts](https://chem.libretexts.org/Ancillary_Materials/Laboratory_Experiments/Wet_Lab_Experiments/General_Chemistry_Labs/Online_Chemistry_Lab_Manual/Chem_10_Experiments/12%3A_Equilibrium_and_Le_Chatelier's_Principle_(Experiment))  Problems – numerical problems 1. – 6. | |
| D1.5 and D1.6 – the chemical industry and green chemistry | * Whole class teaching and learning – understanding the chemical industry * Explain the importance of chemical kinetics, energetics and equilibrium in industrial applications such as the Haber process and the contact process. * You could show suitable videos (e.g. search YouTube for ‘What Is the Haber Process | Reactions | Chemistry | FuseSchool’ or ‘Manufacturing Sulphuric Acid | Reactions | Chemistry | FuseSchool’). * Visit / Guest speaker – managing a chemical industry * Invite a guest speaker from a chemical industry into the class to give a talk on the considerations surrounding the manufacture of a chemical product. * This would ideally focus upon balancing economic or physical chemistry considerations against environmental and green chemistry considerations. * Students should prepare questions to ask the guest speaker but could also be challenged by the guest speaker to weigh up different factors in the running of a chemical manufacturing industry. * Peer teaching – application of green chemistry * Ask pairs or small groups of students to research the application of green chemistry principles in different chemical industries, such as the Haber process and the contact process, and give a presentation on their findings. * Each member of the pair or group could have a different aspect to explore atom economy and waste products; renewable and recycled resources; energy efficiency and catalysis; hazards and safety considerations; end-of-life process for products. | | The Essential Chemical Industry  [Introduction](https://www.essentialchemicalindustry.org/the-chemical-industry.html)  [Industrial processes](https://www.essentialchemicalindustry.org/processes.html)  various topics on industrial processes and manufacture of a range of chemicals  STEM Learning  [STEM Ambassadors](https://www.stem.org.uk/stem-ambassadors)  information on how to source a STEM ambassador  Royal Society of Chemistry  [Chemistry job profiles | RSC Education](https://edu.rsc.org/future-in-chemistry/career-options/job-profiles)  videos  The Essential Chemical Industry  [Green chemistry](https://www.essentialchemicalindustry.org/processes/green-chemistry.html)  [Recycling in the chemical industry](https://www.essentialchemicalindustry.org/processes/recycling-in-the-chemical-industry.html)  the principles of green chemistry and examples  Chemguide  [limiting reagent and atom economy](https://www.chemguide.co.uk/14to16/calculations/othermole.html#top)  notes | |
| E: Organic chemistry | | | | |
| E1.1, E1.2, E1.3 and E1.5 – basics of organic chemistry | * Whole class teaching and learning – organic chemistry basics * Start a discussion with students on why carbon is a unique element and lead into its importance as the basis of organic chemistry and life itself. * Give a presentation on key terminology in organic chemistry that students will need to be familiar with (e.g. hydrocarbons, homologous series and functional group). * This can be illustrated with the alkanes and alkenes, and members of both homologous series can be represented in various types of formulae (i.e. general, molecular, structural, skeletal and 3-dimensional) and topics such as bond angles, bond energy and molecular orbitals can be revisited. * Paired activity – making and drawing organic molecules * Leading on from representations of organic molecules, provide students with molecular modelling kits and ask them to make molecules based upon provided molecular formulae or for homologous series. * Encourage students to draw structural, skeletal and 3-dimensional representations of models that they make. * Whole class and individual activity – naming organic molecules * Give a presentation on the rules of organic chemistry nomenclature, based on IUPAC naming conventions, specifically for alkanes, alkenes, halogenoalkanes and alcohols. * Provide diagrams of structural and skeletal formulae of organic molecules that learners can attempt to name. | | LibreTexts – Chemistry  [1: Introduction - Chemistry LibreTexts](https://chem.libretexts.org/Courses/SUNY_Potsdam/Book%3A_Organic_Chemistry_I_(Walker)/01%3A_Introduction)  [2.1: Combining atomic orbitals, sigma and pi bonding - Chemistry LibreTexts](https://chem.libretexts.org/Courses/SUNY_Potsdam/Book%3A_Organic_Chemistry_I_(Walker)/02%3A_Bonding_and_Molecular_Structure/2.01%3A_Combining_atomic_orbitals%2C_sigma_and_pi_bonding)  organic chemistry basics  Molecular modelling kits  (one between two learners)  [Sets – Molymod](https://molymod.com/sets/)  Chemguide  [How to draw organic molecules](https://www.chemguide.co.uk/basicorg/conventions/draw.html#top)  notes and problems  Chemguide  [Understanding the names of organic compounds](https://www.chemguide.co.uk/basicorg/conventions/names.html#top)  notes and problems | |
| E1.4 and E1.6 – isomerism and physical properties | * Paired activity – making and drawing structural isomers * Provide students with molecular modelling kits and ask them to see how many different structures they can make from a specific molecular formula such as C4H10 or C3H6Cl2. * Discuss the phenomenon of isomerism using the models and arrive at the accepted definition. * Give students more complex molecular formulae to build models for. * Encourage students to draw structural or skeletal formulae of models that they make and name them. * Whole class teaching and learning – physical properties of organic molecules * Start a discussion with students on how they might expect the boiling points of organic molecules in a homologous series, such as the alkanes, to change with increasing molecular mass. * Students should recall how temporary-induced dipole attraction (London dispersion forces) arise and this is a good opportunity to revise this topic. Lead into the difference in boiling point for structural isomers using an example such as the isomers C5H12 and explain the effect of branching. * Whole class and individual activity – stereoisomerism * Ask students to use molecular modelling kits to make different structures from the molecular formula C2H2Br2, and to draw and name these molecules. * They will discover that there are two possible isomers for 1,2-dibromoethene but only one structure for 1,1-dibromoethene. * Use these models to discuss and establish the reasons why two different molecules exist for the same structural isomer, in order to introduce stereoisomerism and the naming conventions to distinguish them. * Give students other molecular formulae to draw and name stereoisomers for. | | Molecular modelling kits  (one between two learners)  [Sets – Molymod](https://molymod.com/sets/)  Chemguide  [structural isomerism](https://www.chemguide.co.uk/basicorg/isomerism/structural.html#top)  notes and problems  Chemguide  [an introduction to alkanes and cycloalkanes](https://www.chemguide.co.uk/organicprops/alkanes/background.html#top)  notes and problems  Molecular modelling kits  (one between two learners)  [Sets – Molymod](https://molymod.com/sets/)  Chemguide  [geometric (cis / trans) isomerism](https://www.chemguide.co.uk/basicorg/isomerism/geometric.html#top)  [E-Z notation for geometric isomerism](https://www.chemguide.co.uk/basicorg/isomerism/ez.html#top)  notes and problems | |
| E1.7 – reactions of organic compounds | * Whole class teaching and learning – organic reaction types * Give a presentation on the different reaction types and provide examples of each i.e. addition, elimination, substitution, oxidation, condensation. * Discuss why certain homologous series tend towards certain reaction types rather than others (e.g. alkanes undergo substitution rather than addition) and the factors that affect reactivity. * Paired activity / individual activity – predicting organic reactions * Set the class a series of problems to solve on different types of organic reaction. This could be done in different ways such as providing the formulae or names of different organic compounds and reaction conditions and asking for the product and reaction type to be predicted. * Alternatively, the starting organic compound and its product could be given, and students could state the reagents and conditions that would need to be used. * A set of flash cards could be created with organic compounds, reagents and conditions, and reaction types, which could be used to in a matching up card game. * Laboratory activity – tests and reactions of functional groups * Students could carry out some simple test tube organic reactions e.g. bromine water, PCl5, acidified potassium dichromate, making an ester. This could be done as a comparison for the four main homologous series (alkane, alkene, alcohol and halogenoalkane), or as an identification exercise for specific functional groups. | | LibreTexts – Chemistry  [6.10: Organic Reactions - Chemistry LibreTexts](https://chem.libretexts.org/Courses/Brevard_College/LNC_216_CHE/06%3A_Organic_Chemistry/6.10%3A_Organic_Reactions)  Notes on main types of organic reaction  Chemguide  [Alkanes Menu](https://www.chemguide.co.uk/organicprops/alkanemenu.html#top)  [Alkenes Menu](https://www.chemguide.co.uk/organicprops/alkenemenu.html#top)  [Halogenoalkanes (haloalkanes) Menu](https://www.chemguide.co.uk/organicprops/haloalkanemenu.html#top)  [Alcohols Menu](https://www.chemguide.co.uk/organicprops/alcoholmenu.html#top)  notes and problems on organic reactions  Royal Society of Chemistry  [Qualitative tests for organic functional groups | practical videos | 16–18 students | Practical | RSC Education](https://edu.rsc.org/practical/qualitative-tests-for-organic-functional-groups-practical-videos-16-18-students/4014327.article)  Practical instructions and video demonstrations of organic chemical tests | |
| E1.8, E1.9 and E1.10 – commercially important organic reactions, benefits, problems and solutions | * Whole class and individual activity – commercially important reactions (cracking, combustion and polymerisation) * Give a presentation on the different reaction types that are commercially important and provide examples of each i.e. cracking, combustion, polymerisation, ethanol manufacture. * Task students with constructing different equations for each of the main reactions. The uses and benefits of the organic products should be highlighted and the problems, particularly for the environment, should be discussed. * Peer teaching – benefits, problems and solutions of organic chemistry * Leading on from the previous whole class activity, task students with researching and presenting to the whole class the benefits and issues for a specific organic compound. * Each student or pair of students could explore a different commercially important organic compound e.g. poly(ethene), ethanol, chlorotrifluoromethane, etc. Part of this research should include solutions to the issue or problem caused by the use of the organic compound. * Guest speaker – commercial reactions and products * The topic provides another good opportunity to invite a guest speaker into the class. * This could be combined with the industrial chemistry / green chemistry talk provided by a professional chemist or scientist. * Equally, an environmentalist or entrepreneur could be invited in to talk about a specific issue and what possible solutions they advocate – these do not necessarily have to be chemical or environmental solutions, and could be social, political or economic answers to an issue. | | Chemguide  [cracking alkanes - thermal and catalytic](https://www.chemguide.co.uk/organicprops/alkanes/cracking.html#top)  [combustion of alkanes and cycloalkanes](https://www.chemguide.co.uk/organicprops/alkanes/oxygen.html#top)  [polymerisation of alkenes](https://www.chemguide.co.uk/organicprops/alkenes/polymerisation.html#top)  [polyesters - terylene and PET](https://www.chemguide.co.uk/organicprops/esters/polyesters.html#top)  [polyamides - nylon and Kevlar](https://www.chemguide.co.uk/organicprops/amides/polyamides.html#top)  [manufacture of alcohols](https://www.chemguide.co.uk/organicprops/alcohols/manufacture.html#top)  notes and problems on commercially important organic reactions  The Essential Chemical Industry  [The Essential Chemical Industry (online)](https://www.essentialchemicalindustry.org/)  basic chemicals and polymers  STEM Learning  [STEM Ambassadors](https://www.stem.org.uk/stem-ambassadors)  information on how to source a STEM ambassador  Royal Society of Chemistry  [Chemistry job profiles | RSC Education](https://edu.rsc.org/future-in-chemistry/career-options/job-profiles)  videos | |

Resources

This section has been created to provide a range of links and resources that are publicly   
available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We’d also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

### Websites

16+ - ABPI Interactive Resources for Schools  
Range of interactive topics across biology, chemistry, and physics  
<https://www.abpischools.org.uk>

Association of Science Education – ASE  
Links to resources, activities, events, and research  
<https://www.ase.org.uk>

CLEAPSS  
Website for health and safety information when handling chemicals and performing experiments  
<https://www.cleapss.org.uk>

ChemGuide  
Notes and problems for chemistry  
<https://www.chemguide.co.uk>

LibreTexts  
Open access to different online textbooks and programs  
<https://chem.libretexts.org>

Nuffield Foundation  
Range of practical chemistry experiments  
<https://www.nuffieldfoundation.org/students-teachers>

PhET Science Simulations  
Interactive science simulations  
<https://phet.colorado.edu>

Resources and Practical Activities for Chemistry – Royal Society of Chemistry  
Resources and practical activities for chemistry  
<https://www.rsc.org/teaching-and-learning>

Science, Technology, Engineering, and Mathematics – STEM Learning  
Resources and activities in science, links with employers and industry  
<https://www.stem.org.uk>

The Essential Chemical Industry  
Case studies on industrial processes  
<https://www.essentialchemicalindustry.org>

### Textbooks

Annets, F., Hartley, J., Hocking, S., Llewellyn, R., Meunier, C., Parmar, C., and Peers, A .,

Pearson BTEC National Applied Science Student Book 1, Pearson Education, 2016 (ISBN 978-1-292-13409-3)

Chapter 1 supports understanding of atomic structure, bonding, periodic trends and

quantitative chemistry.

Annets, F., Hartley, J., Hocking, S., Llewellyn, R., and Meunier, C.,

Pearson BTEC National Applied Science Student Book 2, Pearson Education, 2017 (ISBN 978-1-292-13413-0)

Chapter 1 supports understanding of energetics and organic chemistry.

Chapman, B, Beavon, R and Jarvis, A – Structure, Bonding and Main Group Chemistry, Nelson

Thornes, 2003 (ISBN 9780748776559).

Good overview of the main features of the periodic table, groups, bonding and structure.

Clark, J – Calculations in AS/A Level Chemistry, Longman, 2000 (ISBN 978-0582411270).

This book has many relevant calculations and worked examples.

Fullick, A and McDuell, B – Edexcel AS Chemistry Students’ Book, 1st edition, Longman, 2008,

(ISBN 9781405896351).

Various chapters support understanding of periodicity, kinetics, energetics, equilibria and organic chemistry

Ramsden, E N – A-Level Chemistry, 4th edition (Nelson Thornes, 2000) (ISBN 9780748752997.

In-depth look at atomic theory, bonding and periodicity.

Ramsden, E – Calculations for A-Level Chemistry, Nelson Thornes, 2001 (ISBN 9780748758399).

This book has many relevant calculations and worked examples.

### Pearson paid resources also available

* Pearson Student book
* ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
* Digital Teacher Pack (via ActiveLearn Digital Service)

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