Suggested teaching program

Chapter 4: Chemical reactions

Time allocation: 5–6 weeks

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| Context and overview |
| In year 10, students investigate the different types of chemical reactions which are used to produce a range of products and which occur at different rates. |
| Syllabus outcomes addressed |
| • Different types of chemical reactions are used to produce a range of products and can occur at different rates (ACSSU187)  • Scientific understanding, including models and theories, is contestable and are refined over time through a process of review by the scientific community ACSHE157  • Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries ACSHE158  • People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities ACSHE160  • The values and needs of contemporary society can influence the focus of scientific research ACSHE228  • Formulate questions or hypotheses that can be investigated scientifically ACSIS164  • Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods ACSIS165  • Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data ACSIS166  • Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies ACSIS169  • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence ACSIS170  • Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data ACSIS171  • Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems ACSIS172  • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations ACSIS174 |

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| Achievement standards |
| Students explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They investigate how chemistry can be used to produce a range of useful substances such as fuels, metals and pharmaceuticals. Students predict the products of different types of simple chemical reactions using word or symbol equations and they investigate the effect of a range of factors, such as temperature and catalysts, on the rate of chemical reactions.  Students design questions that can be investigated using a range of inquiry skills. They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trends in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence. They evaluate others’ methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences. |

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| Student book section | AC Syllabus links | Suggested indicators of learning and understanding | Suggested teaching and learning activities | Resources |
| 4.1 Synthesis and decomposition  reactions can be represented  by equations  (pages 89–91) | Science Understanding  ACSSU187  Science as a Human Endeavour  ACSHE191  ACSHE158  ACSHE160  ACSHE228  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • recognise the difference between a synthesis and decomposition reaction  • explain that heat and electricity and sometimes needed in decomposition reactions  • write, balance and assign states to simple synthesis and decomposition reaction equations. | What if?  Students investigate the application of a battery (electric current) to a chemical reaction and determine the effect that different voltages will have on the outcome of the experiment.  These experiments are excellent demos if time within the classroom is limited.  Experiment 4.1A  Direct Synthesis with a POP.  Students produce water using a direct synthesis reaction. They then relate this knowledge to synthesis and decomposition reactions and can use the results to identify this as:  Acid + Metal 🡪 Salt + Hydrogen Gas OR  A single displacement reaction  NB: technically this is both synthesis and decomposition as the acid decomposes to synthesise the salt and gas.  Experiment 4.1B  Decomposing a Carbonate:  Students use heat to decompose copper(II) carbonate and produce copper oxide and carbon dioxide. They can build upon this experiment further to design a test which will determine that carbon dioxide was produced (use a lit match, as carbon dioxide extinguishes fire).  Experiment 4.1C  Electrolysis:  Students use electricity to produce copper metal from copper(II) sulfate and determine that they have conducted a decomposition reaction. This can be seen as the copper will form on one electrode.  A good extension is to ask students whether copper has formed on the positive or negative electrode and explain why. Copper will form on the negative electrode as copper ions are positive. | Oxford Science 10 resources  • What if? Page 89  • Check your learning, page 91  • Experiment 4.1A, page 200  • Experiment 4.1B, page 201  • Experiment 4.1C, page 202  Additional resources  Phet balancing chemical equations simulation provides a visual animation and simulation to demonstrate the law of conservation of mass.  <https://phet.colorado.edu/en/simulation/balancing-chemical-equations> |
| 4.2 Acid reactions depend on strength and concentration  (pages 92–93) | Science Understanding  ACSSU187  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • determine the difference between an acid and a base including key features and properties  • identify a neutralisation reactions and explain why it is named this way  • write, balance and assign states to neutralisation reactions  • identify acid reactions and their products  • write, balance and assign states to reactions of acids with:  –metal oxides  –metal carbonates  • explain the difference between acid strength and concentration. | Experiment 4.2  Acid Titrations:  Students compare the reactions of a strong acid (hydrochloric acid), and a weak acid (ethanoic acid – common name acetic acid) by titrating them against a strong base.  This experiment demonstrates the difference between strength and concentration. Students should come to the conclusion that an equal volume is required to neutralise the same concentration of acid, regardless of the strength of the acid.  Note: this will help students to answer question 5 on page 93. | Oxford Science 10 resources  • Check your learning, page 93  • Experiment 4.2, page 203  Additional resources  Phet Acid Base simulation provides a visual animation and simulation to allow students to visualise strong vs weak acids and bases:  <https://phet.colorado.edu/en/simulation/acid-base-solutions>  And concentration:  <https://phet.colorado.edu/en/simulation/concentration> |
| 4.3 The solubility rules predict the formation of precipitates  (pages 94–95) | Science Understanding  ACSSU187  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • identify precipitation reactions and explain why it is named this way  • define the state ‘aqueous’ as a chemical which is dissolved in water  • write, balance and assign states to precipitation reactions  • determine whether a chemical is solid (s) or aqueous (aq) based on solubility rules  • explain the importance of precipitation reactions. | Experiment 4.3  Precipitation reactions:  Students determine which compounds form precipitates and write equations for the reactions occurring.  As a pre-lab activity, get students to write the balanced chemical equations of each reaction and determine whether reactants and products are soluble (aq) or insoluble (s). This will form a hypothesis for each reaction. It also gives them practice in developing chemical formulae, balancing and assigning states using the solubility table.  An alternative to placing this in a plastic pocket sleeve is to get your lab tech to laminate the table which can be used in future years. | Oxford Science 10 resources  • Check your learning, page 95  • Experiment 4.3, page 204 |
| 4.4 Combustion reactions between hydrocarbons and oxygen produce carbon dioxide, water and energy  (pages 96–97) | Science Understanding  ACSSU187  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • define the terms oxidation, combustion and hydrocarbon  • write, balance and assign states to oxidation reactions with:  –metals  –non-metals  • write, balance and assign states to combustion reactions with hydrocarbons  • explain the effect of limiting the amount of oxygen in hydrocarbon combustion reactions  • identify common chemical fuels and their relation to hydrocarbons  • explain “carbon economy” making reference to real world science. | Experiment 4.4  Combustion of wire wool:  Students observe the oxidation of wire wool. Students determine the balanced chemical equation, including states, for the reaction, then apply this to the law of conservation of mass and exothermic/endothermic reactions. | Oxford Science 10 resources  • Check your learning, page 97  • Experiment 4.4, page 205 |
| 4.5 Polymers are long chains of monomers  (pages 98–99) | Science Understanding  ACSSU187  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • define the terms monomer, polymer, cross-linked, thermosetting and thermoplastic  • explain the properties of polymers based on their structures  • determine whether polymers are thermoplastic or thermosetting based on their properties and determine where this knowledge may be useful around the home/ real world  • explain the formation of polymers and relate the name of a polymer to the name of its monomer units. | Experiment 4.5  Polymerisation of casein:  Students use milk and ethanoic acid to form casein plastic: polymers of casein monomers. Casein is a protein found in mammalian milk products.  A version of this experiment is located within the Year 8 student book to create casein glue. This is an excellent activity for any teacher who would like to incorporate STEM into the classroom as it incorporates chemical engineering.  Thermoplastic polymer can also be purchased at science supply stores to demonstrate to students, or get them to play with. This is excellent at demonstrating the mold-ability of the plastic when it is warm and only needs to be placed in hot water. When cold, the plastic becomes hard. | Oxford Science 10 resources  • Check your learning, page 99  • Experiment 4.5, page 206  Additional resources  Crash Course Chemistry: Polymers – a good, if somewhat fast, summary of common polymers and their monomers. It can get a little advanced, but the first 5–6 minutes is great.  <https://www.youtube.com/watch?v=rHxxLYzJ8Sw> |
| 4.6 Temperature, concentration, surface area and stirring affect reaction rate  (pages 100–103) | Science Understanding  ACSSU187  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • define collision theory and identify how this relates to the rate of a chemical reaction  • identify the key elements required for molecules to collide and result in a successful reaction which forms products  • explain how to increase the rate of a chemical reaction using collision theory for:  –surface area  –concentration  –temperature  –stirring. | Experiment 4.6A  The effect of temperature on reaction rate:  Students investigate the effect of temperature on reaction rate.  Experiment 4.6B  Factors affecting reaction rate:  Students investigate the rates of a reaction between hydrochloric acid and calcium carbonate. This experiment determines the effect of surface area on the rate of a chemical reaction.  The inquiry aspect of Experiment 4.6B is an excellent way of assessing science inquiry skills. Set students the challenge of writing this as a scientific poster in preparation for VCE Sciences. | Oxford Science 10 resources  • Check your learning, page 103  • Experiment 4.6A, page 207  • Experiment 4.6B, page 208  Additional resources  YouTube Video  “How to speed up chemical reactions (and get a date) – Aaron Sams”  <https://www.youtube.com/watch?v=OttRV5ykP7A>  Phet Reactions and Rates simulation provides a visual animation and simulation to allow students to visualise collision theory as well as the effect of temperature and concentration  <https://phet.colorado.edu/en/simulation/legacy/reactions-and-rates> |
| 4.7 Catalysts increase the rate of a reaction  (pages 104–105) | Science Understanding  ACSSU187  Science Inquiry Skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • define what a catalyst is and how it can increase the rate of a chemical reaction  • explain the two types of catalysts and give examples  • explain real world examples of reactions which require catalysts and determine whether they are beneficial to society. | Experiment 4.7  Using a catalyst:  Students investigate the effect of adding a catalyst to a reaction. The reaction used in this experiment is the decomposition of hydrogen peroxide:  2 H2O2 (aq) 🡪 2 H2O (l) + O2 (g)  This experiment can be performed on a grander scale using the foam column/’elephant’s toothpaste’ experiment. If you are unable to perform this in class, there are many YouTube videos which demonstrate this. | **Oxford Science 10 resources**  • Check your learning, page 105  • Experiment 4.7, page 209  Additional resources  YouTube Video  Elephant's Toothpaste Geyser With Science Bob on Jimmy Kimmel  <https://www.youtube.com/watch?v=p1eG2y2mn54>  There are many more videos similar to this one online. |
| 4.8 Green chemistry reduces the impact of chemicals on the environment  (pages 106–107) | Science Understanding  ACSSU186  Science as a Human Endeavour  ACSHE192  ACSHE194  ACSHE230  Science Inquiry Skills  ACSIS204  ACSIS205  ACSIS208 | By the end of this unit, students should be able to:  • define what green chemistry is and why it is beneficial to the environment/ society  • explain the negative cost of:  –low-impact chemicals  –pesticides and herbicides  –heavy metals  –solvent-based paints and why they are no longer used  • determine how people (particularly themselves), as citizens, can utilise the principals of green chemistry to reduce their carbon footprint. | Activity:  Green chemistry provides teachers with a great opportunity to get students reading scientific journals and articles. Not only will this improve reading skills but it will expand their vocabulary. Get students to find articles, summarise them and present to the class on the Principals of Green Chemistry and its application within their lives. | Oxford Science 10 resources  • Extend your understanding, page 107 |
| 4 Review  (pages 108–109) | Science Understanding  ACSSU186  Science as a Human Endeavour  ACSHE191  ACSHE192  ACSHE194  ACSHE230  Science Inquiry Skills  ACSIS208 | By the end of this unit, students should be able to:  • define all Key words listed on page 110  • identify, write, balance and assign states to chemical reactions:  –synthesis  –decomposition  –acid  –precipitation  –combustion  –polymers  • explain chemical rates of reaction and the factors which affect them  • explain how catalysts can affect a chemical rate of reaction  • define green chemistry and explain how this benefits society  • identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic. | Revision activities  • Students could play celebrity heads with the Key words list  • Students can make dominoes with Key words on one end and definitions/diagrams/examples on the other end  • Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter  • Peer teaching: students can work in groups to reteach the content of the unit to the class for the purpose of revision. Each group could be allocated a double-page to summarise. | Oxford Science 10 resources  • Review questions, pages 108–109  • Research topics, page 109  • Key words list, page 110 |