# Scheme of work

## Combined Science: Trilogy

## Chemistry – The rate and extent of chemical change

This resource provides guidance for teaching The rate and extent of chemical change topic from our new GCSE in Combined Science: Trilogy (Chemistry) 8464. It has been updated from the draft version to reflect the changes made in the accredited specification. Changes have been made to 5.6.1.2, 5.6.1.3 and 5.6.1.4 and minor amendments to each of the other sections.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 5.6 The rate and extent of chemical change

#### 5.6.1 Rate of reaction

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
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| 5.6.1.1 | The rate of a chemical reaction can be found by measuring the quantity of a reactant used or the quantity of product formed over time:    or      The quantity of reactant or product can be measured by the mass in grams, by a volume in cm3 or by an amount in moles.  The units of rate of reaction may be given as g/s, cm3/s or mol/s. | Calculate the mean rate of a reaction from given information about the quantity of a reactant used or the quantity of a product formed and the time taken.  Draw and interpret graphs showing the quantity of product formed or quantity of reactant used up against time.  Draw tangents to the curves on these graphs and use the slope of the tangent as a measure of the rate of reaction.  (HT only) Calculate the gradient of a tangent to the curve on these graphs as a measure of rate of reaction at a specific time.  MS 1a, 1c, 1d, 4a, 4b, 4c, 4d, 4e | 2 | Use graphical data to explain each part of the graph ie:   * initially rate is fast * slows down * reaction completes.   Extended writing: write instructions to another student how to calculate the mean rate of reaction.  Explain what is meant by the units:   * g/s * cm3/s * mol/s. | React CaCO3 with dilute HCl and measure the volume of CO2 evolved against time.  Record the results and plot a graph of results of volume of gas against time.  Use the results and graph to determine the mean rate of reaction.  A similar reaction can be done with magnesium and hydrochloric acid. | [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 5.6.1.2 | Factors which affect the rates of chemical reactions include: the concentrations of reactants in solution, the pressure of reacting gases, the surface area of solid reactants, the temperature and the presence of catalysts. | Be able to recall how changing these factors affects the rate of chemical reactions.  WS 2.1, 2.2, 2.3, 2.4, 2.6, 2.7  MS 1a, 1c, 1d, 2a, 2b, 4a, 4b, 4c, 4d, 4e | 2 | Extended writing: explain the effect on the rate of reaction of the following factors:   * concentration * pressure * surface area * temperature * catalyst.   Use graphs of data obtained from concentration reactions to explain what occurs as the reaction proceeds. | **Required practical 11:**  investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced **and** a method involving a change in colour or turbidity.  This should be an investigation involving developing a hypothesis.  AT skills covered by this practical activity: 1, 3, 5 and 6.  This topic offers opportunities for practical work and investigations in addition to required practical 11, by changing temperature and surface area of reactants and use of catalysts. | Video clips:  [BBC Bitesize Rates of reactions](http://www.bbc.co.uk/education/clips/zrdvcdm)  YouTube:  [Rates of reaction](https://www.youtube.com/watch?v=ExHV_cFWYSM) |
| 5.6.1.3 | Collision theory explains how various factors affect rates of reactions. According to this theory, chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. The minimum amount of energy that particles must have to react is called the activation energy.  Increasing the concentration of reactants in solution, the pressure of reacting gases, and the surface area of solid reactants increases the frequency of collisions and so increases the rate of reaction.  Increasing the temperature increases the frequency of collisions and makes the collisions more energetic, and so increases the rate of reaction. | Predict and explain using collision theory the effects of changing conditions of concentration, pressure and temperature on the rate of a reaction.  Predict and explain the effects of changes in the size of pieces of a reacting solid in terms of surface area to volume ratio.  Use simple ideas about proportionality when using collision theory to explain the effect of a factor on the rate of a reaction.  WS 1.2  MS 1c, 5c | 1 | Describe collision theory.  Use collision theory to explain the change in rate of reaction in terms of particle behaviour for:   * concentration * pressure * surface area * temperature * catalyst. |  | Video clips  YouTube:  [Collision theory 1](https://www.youtube.com/watch?v=SbapBWjDA74)  [Collision theory 2](https://www.youtube.com/watch?v=8ZhhqALrfxQ)  [Rates of reaction](https://www.youtube.com/watch?v=ExHV_cFWYSM)  BBC Bitesize  [Collision theory and how to speed up rates of reaction](http://www.bbc.co.uk/education/clips/zptkq6f) |
| 5.6.1.4 | Catalysts change the rate of chemical reactions but are not used up during the reaction. Different reactions need different catalysts. Enzymes act as catalysts in biological systems.  Catalysts increase the rate of reaction by providing a different pathway for the reaction that has lower activation energy.  A reaction profile for a catalysed reaction can be drawn in the following form: | Be able to identify catalysts in reactions from their effect on the rate of reaction and because they are not included in the chemical equation for the reaction.  Be able to explain catalytic action in terms of activation energy.  *Students do not need to know the names of catalysts other than those specified in the subject content.* | 1 | Define the term activation energy.  Identify advantages of using catalysts in industrial reactions eg reducing costs.  Explain the effect of using a catalyst on the activation energy. | Research different catalysts and their uses in industry.  Research catalytic converters.  An opportunity to investigate the catalytic effect of adding different metal salts to a reaction such as the decomposition of hydrogen peroxide.  AT 5 | Video clip  YouTube:  [What are catalysts?](https://www.youtube.com/watch?v=m_9bpZep1QM) |

#### 5.6.2 Reversible reactions and dynamic equilibrium

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| --- | --- | --- | --- | --- | --- | --- |
| 5.6.2.1 | In some chemical reactions, the products of the reaction can react to produce the original reactants. Such reactions are called reversible reactions and are represented:    The direction of reversible reactions can be changed by changing the conditions.  For example: |  | 0.5 | Explain what is meant by a reversible reaction.  Explain the difference between:  reactions  and  🡪 reactions. | Practical: hydrate or dehydrate copper sulfate. Write a balanced equation for the reaction and describe the full process.  Heat ammonium chloride in a test tube. Use mineral wool to support a piece of damp pH paper half way up the tube and observe the colour change. Interpret the results (blue then red) in terms of the thermal decomposition of the ammonium chloride into ammonia and hydrogen chloride. | Video clips:  [BBC Bitesize Reversible reactions](http://www.bbc.co.uk/education/guides/z7qfr82/video)  YouTube:  [What are Reversible Reactions?](https://www.youtube.com/watch?v=br8lKynV1Hc) |
| 5.6.2.2 | If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction. The same amount of energy is transferred in each case. For example: |  | 0.5 | Recall definition of:   * exothermic * endothermic.   Describe the effects of temperature on the reversible reaction. | Investigate the temperature changes for: | Video clips:  [BBC Bitesize Endothermic and exothermic reactions](http://www.bbc.co.uk/education/clips/zy886sg)  YouTube:  [Exothermic and Endothermic Reactions](https://www.youtube.com/watch?v=yvyHVA1Ww_M) |
| 5.6.2.3 | When a reversible reaction occurs in apparatus which prevents the escape of reactants and products, equilibrium is reached when the forward and reverse reactions occur at exactly the same rate. | WS 1.2 | 0.5 | Explain the term equilibrium and given suitable examples of when it can occur. | Research examples of equilibrium reactions in industry. | Video clip  YouTube:  [What is Dynamic Equilibrium?](https://www.youtube.com/watch?v=wlD_ImYQAgQ&list=PL75xKSrnq-rJ9j8qIxGL0va__xxM8LEkf) |
| 5.6.2.4  (HT only) | The relative amounts of all the reactants and products at equilibrium depend on the conditions of the reaction.  If a system is at equilibrium and a change is made to any of the conditions, then the system responds to counteract the change.  The effects of changing conditions on a system at equilibrium can be predicted using Le Chatelier’s Principle. | Be able to make qualitative predictions about the effect of changes on systems at equilibrium when given appropriate information. | 1 | Describe Le Chatelier’s principle.  Explain the effects on equilibrium of changing conditions using suitable examples.  Research the work of Le Chatelier or the life of Fritz Haber. Highlight the moral ambiguity of Haber’s work. |  | Video clips  YouTube:  [Le Chatelier’s Principle Part 1](https://www.youtube.com/watch?v=7zuUV455zFs)  [BBC Bitesize Formation of ammonia using the Haber Process](http://www.bbc.co.uk/education/clips/zdtkq6f)  YouTube:  [What is the Haber Process?](https://www.youtube.com/watch?v=NWhZ77Qm5y4) |
| 5.6.2.5  (HT only) | If the concentration of one of the reactants or products is changed, the system is no longer at equilibrium and the concentrations of all the substances will change until equilibrium is reached again.  If the concentration of a reactant is increased, more products will be formed until equilibrium is reached again.  If the concentration of a product is decreased, more reactants will react until equilibrium is reached again. | Be able to interpret appropriate given data to predict the effect of a change in concentration of a reactant or product on given reactions at equilibrium. | 0.5 | Use data to predict the effect of concentration on equilibrium. Justify answers. |  | See video clips for 4.6.2.4 |
| 5.6.2.6  (HT only) | If the temperature of a system at equilibrium is increased:   * the relative amount of products at equilibrium increases for an endothermic reaction * the relative amount of products at equilibrium decreases for an exothermic reaction.   If the temperature of a system at equilibrium is decreased:   * the relative amount of products at equilibrium decreases for an endothermic reaction * the relative amount of products at equilibrium increases for an exothermic reaction. | Be able to interpret appropriate given data to predict the effect of a change in temperature on given reactions at equilibrium. | 0.5 | Use data to predict the effect of temperature on equilibrium. Justify answers. |  | Video clip  YouTube:  [Le Chatelier’s Principle Part 2](https://www.youtube.com/watch?v=XhQ02egUs5Y) |
| 5.6.2.7  (HT only) | For gaseous reactions at equilibrium:   * an increase in pressure causes the equilibrium position to shift towards the side with the smaller number of molecules as shown by the symbol equation for that reaction * a decrease in pressure causes the equilibrium position to shift towards the side with the larger number of molecules as shown by the symbol equation for that reaction. | Be able to interpret appropriate given data to predict the effect of pressure changes on given reactions at equilibrium. | 0.5 | Use data to predict the effect of pressure on equilibrium. Justify answers. |  | See video clips for 4.6.2.4 |