# Scheme of work

## Combined Science: Trilogy - Foundation

## 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 Combined Science: Trilogy specification (8464). It has been updated from the draft version to reflect the changes made in the accredited specification. These changes are also reflected in the learning outcomes, opportunities to develop skills with some additions to the resources.

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.

#### 5.6.1 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.  MS 1a, 1c, 1d, 4a, 4b, 4c, 4d, 4e | 1 | Record the results and plot a graph of results of CO2 volume of gas against time.  Describe the difference between g/s and cm3/s and when you would each of these units.  Calculate the mean rate of a reaction using the quantity of CaCO3 used and the time taken to fully react.  Compare this to the mean rate of reaction calculated by using the quantity of CO2 formed and the time taken.  Use the graph to determine the mean rate of reaction by drawing tangents to the curves and using the slope of the tangent as a measure of the rate of reaction. | Demonstrate the iodine clock reaction:  [Nuffield Foundation – Iodine Clock Reaction](http://www.nuffieldfoundation.org/practical-chemistry/iodine-clock-reaction)  Students can react CaCO3 with dilute HCl and measure the volume of CO2 produced against time. | [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |

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| 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. | 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 | Using both words and pictures to illustrate, describe the effect on the rate of reaction of the following factors:   * concentration * pressure * surface area * temperature * catalyst. | **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. | 2 | Recall particle theory (and refer to kinetic theory from physics).  Define the term activation energy.  Describe, in terms of collision theory, the effects on rates of reaction of changes in the size of pieces of a reacting solid in terms of surface area to volume ratio.  Describe the effects of changing conditions on the rate of a reaction.  Draw diagrams of particles colliding to show how changes in temperature affect the rate of a reaction.  Draw diagrams of particles colliding to show how changes in concentration affect the rate of a reaction.  Draw diagrams of particles colliding to show how changes in pressure affect the rate of a reaction. | Students can investigate the effect of surface area: [Nuffield Foundation – Rates and Rhubarb](http://www.nuffieldfoundation.org/practical-chemistry/rates-and-rhubarb)  Students can investigate the rate of reaction when large and small marble chips are reacted with hydrochloric acid.  Students can investigate the effect of temperature on reaction rate:  Students can investigate the effect of concentration of HCl on reaction with magnesium ribbon. | 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: | 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.  Explain catalytic action in terms of activation energy.  Students do not need to knowthe names of catalysts other than those specified in the subject content. | 1 | Define a catalyst.  Describe the effect of using a catalyst on the activation energy of a reaction.  Draw a reaction profile for a catalysed reaction.  Describe advantages of using catalysts in industrial reactions, eg reducing costs, reusable, reduce energy use and reduce pollution (ie catalytic converters). | Students can investigate the rate of hydrogen production during a catalysis of the reaction between zinc and sulphuric acid: [Nuffield Foundation – Catalysis reaction](http://www.nuffieldfoundation.org/practical-chemistry/catalysis-reaction-between-zinc-and-sulfuric-acid)  Research uses of catalysts in the home and industry (links with biological catalysts such as enzymes). | 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: |  | 1 | Describe what is meant by a reversible reaction.  Compare the difference between ⇌ reactions and 🡪 reactions.  Describe the changes that take place when temperature is changed during the diffusion of ammonia and hydrogen chloride. For example:  *heat*    *cool* | Demonstrate an irreversible reaction such as combustion of an organic compound.  Students can perform a reversible experiment involving hydrated or anhydrous copper sulfate: [Nuffield Foundation – Reversible reaction involving hydrated copper(II) sulfate](http://www.nuffieldfoundation.org/practical-chemistry/reversible-reaction-involving-hydrated-copperii-sulfate-and%C2%A0its-anhydrous-form)  Demonstrate how direction of reversible reactions can be influenced by temperature: [Nuffield Foundation – Diffusion of ammonia and hydrogen chloride gases](http://www.nuffieldfoundation.org/practical-chemistry/diffusion-gases-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: | . | 1 | Recall definition of exothermic and endothermic.  Describe how the temperature changes between hydrated and anhydrous copper sulfate. For example: | Demonstrate a spontaneous exothermic reaction: [Nuffield Foundation | Spontaneous exothermic reaction](http://www.nuffieldfoundation.org/practical-chemistry/spontaneous-exothermic-reaction)  Investigate the temperature changes for hydrated copper  sulfate (blue) and anhydrous  copper sulfate (white) + water  [Nuffield Foundation – Reversible reaction involving hydrated copper(II) sulfate](http://www.nuffieldfoundation.org/practical-chemistry/reversible-reaction-involving-hydrated-copperii-sulfate-and%C2%A0its-anhydrous-form) | 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 | 1 | Define the term equilibrium.  Students can illustrate how dynamic equilibrium is reached in a closed system (for example reactants are converted to products and products are converted to reactants at an equal and constant rate). | Demonstrate equilibrium in cobalt in aqueous solutions:  [Nuffield Foundation – Equilibrium between two coloured cobalt species](http://www.nuffieldfoundation.org/practical-chemistry/equilibrium-between-two-coloured-cobalt-species-aqueous-solution)  Students can examine physical equilibrium when iodine crystals sublime in a closed system (gas jar with lid) with a demo of an open system (no lid). | Video clip  YouTube:  [What is Dynamic Equilibrium?](https://www.youtube.com/watch?v=wlD_ImYQAgQ&list=PL75xKSrnq-rJ9j8qIxGL0va__xxM8LEkf) |