# Scheme of work

## Combined Science: Trilogy - Foundation

## Chemistry – Chemical changes

This resource provides guidance for teaching the Chemical changes topic from our new 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 and opportunities to develop skills.

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.

### 5.4 Chemical changes

#### 5.4.1 Reactivity of metals

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes** *What most students 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*  |
| --- | --- | --- | --- | --- | --- | --- |
| 5.4.1.1 | Metals react with oxygen to produce metal oxides. The reactions are oxidation reactions because the metals gain oxygen. | Explain reduction and oxidation in terms of loss or gain of oxygen. | 1 | Define the following terms:* oxidation
* reduction.

Write word equations for the reactions of metals with oxygen to produce metal oxides. | Demonstrate a variety of different metals (manganese, magnesium, calcium, aluminium) as described by the Royal Society of Chemistry (RSC):[RSC – Reacting metals with oxygen](http://www.rsc.org/learn-chemistry/resource/download/res00000705/cmp00000783/pdf) | [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 5.4.1.2 | When metals react with other substances the metal atoms form positive ions. The reactivity of a metal is related to its tendency to form positive ions. Metals can be arranged in order of their reactivity in a reactivity series. The metals potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper can be put in order of their reactivity from their reactions with water and dilute acids. The non-metals hydrogen and carbon are often included in the reactivity series.A more reactive metal can displace a less reactive metal from a compound. | The reactions of metals with water and acids are limited to room temperature and do not include reactions with steam.Recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids, where appropriate, to place these metals in order of reactivity.Explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion.Deduce an order of reactivity of metals based on experimental results. | 1 | Recapping KS3, ask students to describe the reactions of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water. Construct a reactivity series of these metals. Draw the atomic structure of the metal and ions formed following the reaction.Draw a flow diagram to illustrate what the particles are doing during a thermite reaction.Write word equations for the reactions. | Demonstrate the reactivity of the alkali metals in water.Students can investigate the reactivity of magnesium, zinc, iron and copper in warm water. Demonstrate the thermite reaction. Demonstrate the reaction between zinc powder and copper oxide. [Nuffield Foundation – Reaction between zinc and copper oxide](http://www.nuffieldfoundation.org/print/2991) Investigate the displacement reactions of Mg, Zn, Fe, and Cu with copper(II) sulfate, zinc sulfate, iron sulfate and magnesium sulfate. [Nuffield Foundation –Displacement reactions between metals and their salts](http://www.nuffieldfoundation.org/print/3034) | Video clips:[BBC Bitesize Alkali metals and their reactions to air and water](http://www.bbc.co.uk/education/clips/zychyrd) [BBC Bitesize How sodium reacts with water](http://www.bbc.co.uk/education/clips/zxkn34j) |
| 5.4.1.3 | Unreactive metals such as gold are found in the Earth as the metal itself but most metals are found as compounds that require chemical reactions to extract the metal. Metals less reactive than carbon can be extracted from their oxides by reduction with carbon. Reduction involves the loss of oxygen. | Knowledge and understanding are limited to the reduction of oxides using carbon.Knowledge of the details of processes used in the extraction of metals is not required. Interpret or evaluate specific metal extraction processes when given appropriate information.Identify the substances which are oxidised or reduced in terms of gain or loss of oxygen.WS 1.4, 4.1 | 1 | Construct a timeline showing how discovery of the metal relates to reactivity.Write an equation to describe the reactions.Describe which of the substances are oxidised or reduced in terms of gain or loss of oxygen. | Students extract copper from copper(II) carbonate as described by the RSC. [Nuffield Foundation - Extracting metals from rocks](http://www.nuffieldfoundation.org/print/2931) Students reduce iron(III) oxide with carbon on a match head to produce iron [Nuffield Foundation – Extraction of iron on a match head](http://www.nuffieldfoundation.org/print/2977)  |  |

#### 5.4.2 Reactions of acids

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes** *What most students 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*  |
| --- | --- | --- | --- | --- | --- | --- |
| 5.4.2.1 | Acids react with some metals to produce salts and hydrogen. | Knowledge of reactions limited to those of magnesium, zinc and iron with hydrochloric and sulfuric acids.  | 1 | Recap KS3 by giving students a selection of different metals and acid and ask them to write word equations for the reactions.Describe the test for hydrogen. | Investigate the reactions of the magnesium, zinc, iron and copper with sulfuric acid.[Nuffield Foundation – Metals and acids](http://www.nuffieldfoundation.org/print/3015) Test the gas produced.  |  |
| 5.4.2.2 | Acids are neutralised by alkalis (eg soluble metal hydroxides) and bases (eg insoluble metal hydroxides and metal oxides) to produce salts and water, and by metal carbonates to produce salts, water and carbon dioxide.The particular salt produced in any reaction between an acid and a base or alkali depends on:* the acid used (hydrochloric acid produces chlorides, nitric acid produces nitrates, sulfuric acid produces sulfates)
* the positive ions in the base, alkali or carbonate.
 | Predict products from given reactants.Use the formulae of common ions to deduce the formulae of salts. | 1 | Recap KS3 by asking students to match the acid used with the suffix of salt produced.Write word equations for the reactions. | Investigate the following reactions:acid + alkali (ie HCl plus NaOH)acid + insoluble metal oxides (ie copper oxide plus sulfuric acid)acid + metal carbonates (ie calcium, copper, zinc carbonates) | Students can develop a jigsaw that can help link products from different reactants and peer assess each other.Video clips:[BBC Bitesize Acids and alkalis](http://www.bbc.co.uk/education/clips/zfgtfg8) [BBC Bitesize Neutralisation](https://www.youtube.com/watch?v=_cB2vSaalXg) [BBC Bitesize How neutralisation is used in diving apparatus](http://www.bbc.co.uk/education/clips/zpq34wx)  |
| 5.4.2.3 | Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates.The solid is added to the acid until it no more reacts and the excess solid is filtered off to produce a solution of the salt.Salt solutions can be crystallised to produce solid salts. | Describe how to make pure, dry samples of named soluble salts from information provided.WS 2.3, 2.4 | 2 | Ask students to come up with their own definitions of soluble and insoluble using words or diagrams.Recall table salt as an ionic compound made up of two ions, positive and negative. Students can draw a diagram to show that table salt, when dissolved in water it breaks in to anions and cations.Describe what is meant by a soluble salt and write out the equation for NaCl solution.Describe the method used to make a pure, dry sample of a soluble salt.Describe why reactants are often used in excess. | **Required practical 8:**Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.AT skills covered by this practical activity: 2, 3, 4 and 6 |  |
| 5.4.2.4 | Acids produce hydrogen ions (H+) in aqueous solutions.Aqueous solutions of alkalis contain hydroxide ions (OH–).The pH scale, from 0 to 14, is a measure of the acidity or alkalinity of a solution, and can be measured using universal indicator or a pH probe.A solution with pH 7 is neutral. Aqueous solutions of acids have pH values of less than 7 and aqueous solutions of alkalis have pH values greater than 7.In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water. This reaction can be represented by the equation:H+ (aq) + OH– (aq)$ \rightarrow $ H2O (l) | Describe the use of universal indicator or a wide range indicator to measure the approximate pH of a solution.Use the pH scale to identify acidic or alkaline solutions.WS 1.2, 2.6, 4.1 | 1 | Recap KS3 by asking students to define the following terms: acid, base, alkali, neutral in their own words.Recall the pH numbers for the acidic, neutral and alkaline solutions and link to the colours of universal indicator.Describe the use of universal indicator to measure the approximate pH of different solutions.Write the word equation for the neutralisation of an acid and an alkali.Students can draw diagrams to show the H+ and OH– ions in acid alkali reactions using the equation: I:\Amy\Import specs\GCSE Chemistry\Images\Chem spec 21.jpgGive students a range of different acids and alkali formula and ask them to predict the outcomes using the equation above. Compare the different treatments for a wasp sting (alkaline) and a bee sting (acidic). | Use the pH scale to identify a range of different acidic, neutral or alkaline solutions (lemon juice, lemonade, baking powder, laundry powder, tap water).Use spotting tiles with drops of dilute UI solution in the wells. Add citric acid solution and sodium carbonate solution in varying droplet amounts to produce a range of different colours on the tiles. | Video clips:[BBC Bitesize Acidic, alkaline or neutral](http://www.bbc.co.uk/education/clips/zcswmp3) YouTube: [What are Indicators and how do we use them?](https://www.youtube.com/watch?v=xYQlvTblgCY)   |

### 5.4.3 Electrolysis

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes** *What most students 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*  |
| --- | --- | --- | --- | --- | --- | --- |
| 5.4.3.1 | When an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes.Passing an electric current through electrolytes causes the ions to move to the electrodes. Positively charged ions move to the negative electrode (the cathode), and negatively charged ions move to the positive electrode (the anode). Ions are discharged at the electrodes producing elements. This process is called electrolysis. |  | 1 | Define the term electrolyte.Describe how an electric current can pass through an ionic compound. | Carry out the electrolysis of brine using the RSC method:[Nuffield foundation – Colourful electrolysis](http://www.nuffieldfoundation.org/print/3054) Role play the movement of ions to the positive and negative electrodes. |  |
| 5.4.3.2 | When a simple ionic compound (eg lead bromide) is electrolysed in the molten state using inert electrodes, the metal (lead) is produced at the cathode and the non-metal (bromine) is produced at the anode. | Predict the products of the electrolysis of binary ionic compounds in the molten state. | 1 | Students can make a model of the electrolysis process to show the journey to the cathode and anodes. | Demo the electrolysis of lead bromide. [Nuffield Foundation – Electrolysing molten lead (II) bromide](http://www.nuffieldfoundation.org/print/3055)  | Video clip:YouTube: [Electrolysis of Molten Compounds](https://www.youtube.com/watch?v=87K8QsMl8nc) |
| 5.4.3.3 | Metals can be extracted from molten compounds using electrolysis. Electrolysis is used if the metal is too reactive to be extracted by reduction with carbon or if the metal reacts with carbon. Large amounts of energy are used in the extraction process to melt the compounds and to produce the electrical current.Aluminium is manufactured by the electrolysis of a molten mixture of aluminium oxide and cryolite using carbon as the positive electrode (anode). | Explain why a mixture is used as the electrolyte.Explain why the positive electrode must be continually replaced.WS 1.4, 4.1 | 1 | Recall the reactivity series.Give reasons why some metals have to be extracted by electrolysis.Write balanced equations for the reactions that occur at both electrodes.Draw a cartoon strip to describe how aluminium is extracted from its ore, including what happens at the anode and cathode. Students can produce a paper model of the process using cut out electrodes and electrons. | Students can extract zinc from zinc iodide using electrolysis.[Nuffield Foundation – Reaction of zinc with iodine](http://www.nuffieldfoundation.org/print/2986) Research how aluminium is extracted from its ore.[Science aid.co.uk – Extraction of Aluminium](http://scienceaid.co.uk/chemistry/applied/aluminium.html)[Bitesize – Aluminium extraction](http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/electrolysis/electrolysisrev3.shtml) [Bitesize – Iron and aluminium](http://www.bbc.co.uk/education/guides/zfsk7ty/revision) |  |
| 5.4.3.4 | The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved.At the negative electrode (cathode), hydrogen is produced if the metal is more reactive than hydrogen.At the positive electrode (anode), oxygen is produced unless the solution contains halide ions when the halogen is produced. This happens because in the aqueous solution water molecules break down producing hydrogen ions and hydroxide ions that are discharged. | Be able to predict the products of the electrolysis of aqueous solutions containing a single ionic compound.WS 2.1, 2.2, 2.3, 2.4, 2.6 | 2 | Define the term aqueous.Describe how an aqueous solution is electrolysed.Explain why the following atoms could be produced:* hydrogen
* oxygen
 | **Required practical 9:** Investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.AT skills covered by this practical activity: 3 and 7. |  |