# Scheme of work

## Chemistry – Using resources

This resource provides guidance for teaching the topic Using resources from our new GCSE Chemistry (8462). 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 and apply practical and enquiry skills of most 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.

### 4.10 Using resources

#### 4.10.1. Using the Earth’s resources and obtaining potable water

| **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* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.10.1.1 | Humans use the Earth’s resources to provide warmth, shelter, food and transport.    Natural resources, supplemented by agriculture, provide food, timber, clothing and fuels.  Finite resources from the Earth, oceans and atmosphere are processed to provide energy and materials.  Chemistry plays an important role in improving agricultural and industrial processes to provide new products. It’s also important in sustainable development, which is development that meets the needs of current generations without compromising the ability of future generations to meet their own needs. | State examples of natural products that are supplemented or replaced by agricultural and synthetic products.  Distinguish between finite and renewable resources given appropriate information.  Extract and interpret information about resources from charts, graphs and tables.  Use orders of magnitude to evaluate the significance of data.  WS 3.2  MS 2c, 2h, 4a | 1 | Define the terms:   * finite * renewable.   Explain the differences between the two terms using suitable examples. | Research examples of natural products that are supplemented or replaced by agricultural and synthetic products. |  |
| 4.10.1.2 | Water of appropriate quality is essential for life. For humans, drinking water should have sufficiently low levels of dissolved salts and microbes. Water that is safe to drink is called potable water. Potable water is not pure water in the chemical sense because it contains dissolved substances.  The methods used to produce potable water depend on available supplies of water and local conditions.    In the UK, rain provides water with low levels of dissolved substances (fresh water) that collects in the ground, in lakes and rivers, and most potable water is produced by:   * choosing an appropriate source of fresh water * passing the water through filter beds * sterilising.   Sterilising agents used for potable water include chlorine, ozone or ultra-violet light.  If supplies of fresh water are limited, desalination of salty water or sea water may be required. Desalination can be done by distillation or by processes that use membranes such as reverse osmosis. These processes require large amounts of energy. | Distinguish between potable water and pure water.  Describe the differences in treatment of ground water and salty water.  Give reasons for the steps used to produce potable water.  WS 2.3, 2.4, 2.5, 2.6, 2.7 | 2 | Define the terms:   * potable water * pure water.   Explain the differences between the two terms.  Extended writing: describe the process of desalination.  Extended writing: describe the process of distillation  Extended writing: explain why distillation separates substances.  Grade 9: explain what happens to substances during the process of distillation in terms of intermolecular forces of attraction. | **Required practical 8:**  Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.  AT skills covered by this practical activity: 2, 3 and 4. | Video clip  YouTube:  [UTEC – Potable Water Generator](https://www.youtube.com/watch?v=35yeVwigQcc)  Resources for schools - [Thames Water Tools for Schools](http://www.thameswater.co.uk/about-us/3494.htm)  [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX)  Video clip  YouTube:  [Simple Distillation](https://www.youtube.com/watch?v=x-Bnq6UPdZo) |
| 4.10.1.3 | Urban lifestyles and industrial processes produce large amounts of waste water that require treatment before being released into the environment. Sewage and agricultural waste water require removal of organic matter and harmful microbes. Industrial waste water may require removal of organic matter and harmful chemicals.  Sewage treatment includes:   * screening and grit removal * sedimentation to produce sewage sludge and effluent * anaerobic digestion of sewage sludge * aerobic biological treatment of effluent. | Comment on the relative ease of obtaining potable water from waste, ground and salt water. | 1 |  | Research how water is treated.  Extended writing: detail the methods involved. | Several water companies provide resources for schools regarding sewage treatment, for example: [Anglian Water](http://www.anglianwater.co.uk)  Video clip  YouTube:  [Water and You: The Water Treatment Process](https://www.youtube.com/watch?v=tuYB8nMFxQA) |
| 4.10.1.4  (HT only) | The Earth’s resources of metal ores are limited.  Copper ores are becoming scarce and new ways of extracting copper from low-grade ores include phytomining and bioleaching. These methods avoid traditional mining methods of digging, moving and disposing of large amounts of rock.  Phytomining uses plants to absorb metal compounds. The plants are harvested and then burned to produce ash that contains metal compounds.  Bioleaching uses bacteria to produce leachate solutions that contain metal compounds.  The metal compounds can be processed to obtain the metal. For example, copper can be obtained from solutions of copper compounds by displacement using scrap iron or by electrolysis. | Evaluate alternative biological methods of metal extraction, given appropriate information. | 1 | Extended writing: describe the processes of   * phytomining * bioleaching.   Evaluate the impacts and benefits of biological methods of extracting metal. | Research information for the processes of:   * phytomining * bioleaching.   Include percentage of metal extracted, concentration of global warming gases released, amount of electricity used etc.  Use this data in an evaluation.  It may be possible to model phytomining in the laboratory by watering geraniums with dilute copper sulphate for a period of time. The leaves can be burnt and copper can be extracted from the ash by rinsing in dilute hydrochloric acid and electrolysing the solution. | Video clip  YouTube:  [Bioleaching and Phytomining](https://www.youtube.com/watch?v=XF399zN36LE) |

#### 4.10.2 Life cycle assessment and recycling

| **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* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.10.2.1 | Life Cycle Assessments (LCAs) are carried out to assess the environmental impact of products in each of these stages:   * extracting and processing raw materials * manufacturing and packaging * use and operation during its lifetime * disposal at the end of its useful life, including transport and distribution at each stage.   Use of water, resources, energy sources and production of some wastes can be fairly easily quantified. Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LCA is not a purely objective process.  Selective or abbreviated LCAs can be devised to evaluate a product but these can be misused to reach pre-determined conclusions, eg in support of claims for advertising purposes. | Carry out simple comparative LCAs for shopping bags made from plastic and paper  WS 1.3, 1.4, 1.5  MS 1a, 1c, 1d, 2a, 4a | 1 | Describe what a LCA is using a suitable example.  Use information to interpret the LCA of a given material or product.  Discuss the negative issues relating to LCAs and why caution should be used when using them. | Use the internet to carry out simple comparative LCAs for shopping bags made from plastic and paper.  LCAs should be done as a comparison of the impact on the environment of the stages in the life of a product, and only quantified where data is readily available for energy, water, resources and wastes. |  |
| 4.10.2.2 | The reduction in use, reuse and recycling of materials by end users reduces the use of limited resources, energy consumption, waste and environmental impacts.  Metals, glass, building materials, clay ceramics and most plastics are produced from limited raw materials. Much of the energy used in the processes comes from limited resources. Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts.  Some products, such as glass bottles, can be reused. Glass bottles can be crushed and melted to make different glass products. Other products cannot be reused and so are recycled for a different use  .  Metals can be recycled by melting and recasting or reforming into different products. The amount of separation required for recycling depends on the material and the properties required of the final product. For example, some scrap steel can be added to iron from a blast furnace to reduce the amount of iron that needs to be extracted from iron ore. | Evaluate ways of reducing the use of limited resources, given appropriate information. | 1 | Discuss the issues relating to using limited resources to generate energy.  Extended writing: describe the environmental impacts of obtaining raw materials from the Earth. | Research methods of producing/obtaining metal/glass/building materials/clay ceramics/plastics. Identify in these methods the limited resources that are used to generate the energy.  Research how glass is recycled.  Research how metal is recycled and alternatives for use of scrap metals ie in obtaining iron in a blast furnace. | Video clip  YouTube:  [Recycling Plastics](http://www.youtube.com/watch?v=s5p6Nk3SzcU) |

#### 4.10.3 Using materials

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| --- | --- | --- | --- | --- | --- | --- |
| 4.10.3.1 | Corrosion is the destruction of materials by chemical reactions with substances in the environment. Rusting is an example of corrosion. Both air and water are necessary for iron to rust.  Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating. Aluminium has an oxide coating that protects the metal from further corrosion.  Some coatings are reactive and contain a more reactive metal to provide sacrificial protection, eg zinc is used to galvanise iron.. | Describe experiments and interpret results to show that both air and water are necessary for rusting.  Explain sacrificial protection in terms of relative reactivity.  WS 2.2, 2.7, 3.5 | 2 | Define the following terms using suitable examples:   * corrosion * rusting * sacrificial protection.   Describe how to prevent corrosion using the examples:   * oxide coating on aluminium * zinc on iron * magnesium on steel.   Use suitable examples to explain why corrosion can be prevented using barriers and the role of sacrificial barriers if appropriate to the example used. | Investigate the conditions for rusting of iron nails in test tubes. | Video clips:  [BBC Bitesize Galvanising iron and steel](http://www.bbc.co.uk/education/clips/zjh87ty)    [BBC Bitesize Zinc as sacrificial protection](http://www.bbc.co.uk/education/clips/z6v2hyc)  YouTube:  [Corrosion](https://www.youtube.com/watch?v=TKMgUCq3npg)  [Rust: Prevention and treatment](https://www.youtube.com/watch?v=jQoE_9x37mQ)  [Galvanising and sacrificial protection](https://www.youtube.com/watch?v=HVmqN09PKaA) |
| 4.10.3.2 | Most metals in everyday use are alloys.  Bronze is an alloy of copper and tin. Brass is an alloy of copper and zinc.  Gold used as jewellery is usually an alloy with silver, copper and zinc. The proportion of gold in the alloy is measured in carats, with pure gold being 24 carat. 18 carat gold is 75% gold.  Steels are alloys of iron that contain specific amounts of carbon and other metals. High carbon steel is strong but brittle. Low carbon steel is softer and more easily shaped. Steels containing chromium and nickel (stainless steels) are hard and resistant to corrosion.  Aluminium alloys are low density. | Recall a use of each of the alloys specified  Interpret and evaluate the composition and uses of alloys other than those specified, given appropriate information.  MS 1a, 1c | 1 | Define the terms:   * alloy * high carbon steel * low carbon steel.   Using diagrams, describe the difference between metals and their alloys.  Describe the composition of common alloys and their uses.  State properties of examples of alloys. Explain, in relation to the structure, why these alloys have these properties. | Research the first alloy to include the history of it and its uses.  Model an alloy using different size marbles. Use this model to discuss the properties of alloys.  Research the composition and uses of alloys. Use this information to evaluate the use of the alloys.  The Royal Society of Chemistry has many resources to support teachers in the classroom – including practical guides and instructions:  [RSC Practical-Chemistry](http://www.rsc.org/learn-chemistry/collections/experimentation/practical-chemistry) | Video clips:  [BBC Bitesize Bronze – The first alloy](http://www.bbc.co.uk/education/clips/zxgtfg8)  [BBC Bitesize Superalloys and the jet engine](http://www.bbc.co.uk/education/clips/zt3xn39) |
| 4.10.3.3 | Most of the glass we use is soda-lime glass, made by heating a mixture of sand, sodium carbonate and limestone. Borosilicate glass, made from sand and boron trioxide, melts at higher temperatures than soda-lime glass.  Clay ceramics, including pottery and bricks, are made by shaping wet clay and then heating in a furnace.  The properties of polymers depend on what monomers they are made from and the conditions under which they are made. For example, low density (LD) and high density (HD) poly(ethene) are produced from ethene.  Thermosoftening polymers melt when they are heated. Thermosetting polymers do not melt when they are heated.  Most composites are made of two materials, a matrix or binder surrounding and binding together fibres or fragments of the other material, which is called the reinforcement. | Explain how low density and high density poly(ethene) are both produced from ethene.  Explain the difference between thermosoftening and thermosetting polymers in terms of their structures.    Compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals.  Explain how the properties of materials are related to their uses and select appropriate materials.  WS 1.4, 3.5, 3.8 | 2 | Describe how the following are produced and give uses for each:   * soda-lime glass * borosilicate glass * clay ceramics * low-density poly(ethene) * high density poly(ethene) * composites.   Using diagrams, describe the structure of the following polymers:   * thermosoftening * thermosetting.   Use these diagrams and descriptions to explain why the following happens when heated:   * thermosoftening polymers melt * thermosetting polymers do not melt. | Research the physical properties of:   * soda-lime glass * borosilicate glass * clay ceramics * low-density poly(ethene) * high density poly(ethene) * composites   Use these properties to explain how the materials are related to their use.  Compare the properties of thermosetting and thermosoftening polymers. | More information about glass:  [Pilkington glass website](http://www.pilkington.com/pilkington-information/about+pilkington/education/)  Video clips:  [BBC Bitesize The uses of polymers](http://www.bbc.co.uk/education/clips/zht9jxs)  See also the series ‘How It’s Made’ eg:  [How It's Made Glass Bottles](https://www.youtube.com/watch?v=LUF_5zrFG9c)  Composite materials:  [BBC Bitesize Ceramics Revision Guide](http://www.bbc.co.uk/education/guides/ztxnsbk/revision)  Video clips  YouTube:  [NASA 360 - Composite Materials](https://www.youtube.com/watch?v=tZhH2B-EI1I) (long)  [Graphene: Composite Materials](https://www.youtube.com/watch?v=LTa_ileMJxE)  [How It’s Made Carbon Fibre](https://www.youtube.com/watch?v=ki1aCdkMSeo)  [How to Make an F1 Car: Composites (Part 2)](https://www.youtube.com/watch?v=X6addl525lc) |

#### 4.10.4 The Haber process and the use of NPK fertilisers

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| --- | --- | --- | --- | --- | --- | --- |
| 4.10.4.1 | The Haber process is used to manufacture ammonia, which can be used to produce nitrogen-based fertilisers.    The raw materials for the Haber process are nitrogen and hydrogen.  The purified gases are passed over a catalyst of iron at a high temperature (about 450 °C) and a high pressure (about 200 atmospheres). Some of the hydrogen and nitrogen reacts to form ammonia. The reaction is reversible so some of the ammonia produced breaks down into nitrogen and hydrogen:    On cooling, the ammonia liquefies and is removed. The remaining hydrogen and nitrogen are recycled. | Recall a source for the nitrogen and a source for the hydrogen used in the Haber process.  (HT only) Interpret graphs of reaction conditions versus rate.  (HT only) Apply the principles of dynamic equilibrium to the Haber process.  (HT only) Explain the trade-off between rate of production and position of equilibrium.  (HT only) Explain how the commercially used conditions for the Haber process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate.  WS 3.5, 3.8  MS 1a, 1c | 2 | State where the raw materials in the Haber process come from.  Describe the process for manufacturing ammonia.  Write a balanced symbol equation for the manufacture of ammonia. Use this to describe the reaction in terms of reactants, products, conditions and number of moles.  Recall the following topics:   * dynamic equilibrium * temperature affecting the rate of a reaction * pressure.   Explain how each of these affects the Haber process reaction.  Discuss the effect of the following conditions on the reaction:   * a high temperature * a low temperature * a high pressure * a low pressure * use of a catalyst * no catalyst.   Discuss the pros and cons of these varying conditions.  Explain the trade-off between the rate of the reaction and the position of the equilibrium.  Explain how the conditions used in industry affect the equilibrium position, rate and costs of the reaction. | Research the availability and cost of the raw materials and energy supplies in the Haber process. Explain how these relate to the conditions used for the Haber process in industry. | Video clips  [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&list=PLjE6t_KcL6l55MiKe7xlzecGpu0eWGwx0)  [The Haber Process and its environmental implications](https://www.youtube.com/watch?v=FQunUEaNWCQ&list=PLjE6t_KcL6l55MiKe7xlzecGpu0eWGwx0&index=2)  [Chemistry GCSE Haber Process](https://www.youtube.com/watch?v=OniS3GcC2Io) |
| 4.10.4.2 | Compounds of nitrogen, phosphorus and potassium are used as fertilisers to improve agricultural productivity. NPK fertilisers contain compounds of all three elements.  Industrial production of NPK fertilisers can be achieved using a variety of raw materials in several integrated processes. NPK fertilisers are formulations of various salts containing appropriate percentages of the elements.  Ammonia can be used to manufacture ammonium salts and nitric acid.  Potassium chloride, potassium sulfate and phosphate rock are obtained by mining, but phosphate rock cannot be used directly as a fertiliser.  Phosphate rock is treated with nitric acid or sulfuric acid to produce soluble salts that can be used as fertilisers. | Recall the names of the salts produced when phosphate rock is treated with nitric acid, sulfuric acid and phosphoric acid  Compare the industrial production of fertilisers with laboratory preparations of the same compounds, given appropriate information. | 2 | Extended writing: compare how fertilisers are produced in industry and in the laboratory.  Investigate what was used as fertilizer before the industrial preparation of fertilisers was invented.  Haber’s ambiguous morality could be discussed in the context of his work with fertilisers compared to his work on poison gas in World War I. | Research compositions of NPK and their uses.  Research how fertilisers can be prepared:   * industrially * in a laboratory.   Prepare an ammonium salt by titration eg using aqueous ammonia, dilute sulfuric acid and methyl orange. AT 4. | Video clip  YouTube:  [What are fertilisers?](https://www.youtube.com/watch?v=jJSUN-r3ZXo) |