GCSE
SCIENCE A, SCIENCE B, CHEMISTRY
UNIT C1 – Example 2
4461, 4462, 4421

Scheme of Work

Introduction

This Outline Scheme of Work is one of a number of schemes prepared by practising teachers for the new AQA GCSE Sciences suite. It is hoped that other teachers will find them helpful as the basis for the fully detailed schemes prepared for teaching from September 2006. Each outline scheme covers one unit (B1, B2, B3, C1, C2, C3, P1, P2, P3) and for some units more than one outline scheme is available. This is because there are different, equally valid ways of approaching the teaching of the specifications and a single scheme would not show the range of possible approaches.

The AQA specifications are designed to be used with a wide range of resources, so this scheme does not assume the availability of any particular printed or electronic publications, or any special equipment. Teachers are enabled to use existing resources, including their own, together with resources specially purchased for the new specifications.

The outline scheme is arranged under the section headings of the relevant specification, for example, *12.1/11.1 How do rocks provide building materials?* The content in the section is further subdivided with a brief statement given of the coverage of each subdivision, together with activities that relate to that content and an indication of the number of hours it is suggested are needed to deliver that part of the content.

Opportunities to deliver 'How Science Works' and to use ICT are highlighted using the same icons as used in the specifications.

 This identifies parts of the content which lend themselves to extended investigative work of the type needed to explore Sections 10.3–10.7 of the specifications. These sections are about obtaining valid and reliable scientific evidence.

 This identifies parts of the content which lend themselves to activities which allow Sections 10.2 and 10.8–10.9 to be considered. These sections are about using scientific evidence, for example, how scientific evidence can contribute to decision making and how scientific evidence is limited.

 This identifies where there are opportunities to use ICT sources and tools in teaching the specifications.

UNIT 1

Total hours: 6 — 11.1/12.1 How do rocks provide building materials?

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Basic atomic theory: • Structure of atom • Arrangement of periodic table • Symbols and formulae • Equations and balancing.		• Bookwork and quiz for the names/symbols of the more common elements. • Homework – formulae and names of the more common chemicals met in this section. • Counting atoms and masses – balanced equations leading to law of conservation of mass.	Colour in periodic table to show metals/non-metals Note that elements with similar properties occur in the same group. Only need to have basic model of atom – more detail comes later. Emphasise that atoms combine by exchanging (losing and gaining) or by sharing electrons.
• to consider and evaluate the environmental, social and economic effects of exploiting limestone and producing building materials from it.		Internet search – find out about: • limestone quarries • lime kilns • uses of limestone • pros and cons of setting up a quarry	Quarries provide a useful source material, though they may be an eyesore and there are environmental considerations as well. Lime kilns have been used for centuries – how has their design changed over this time?

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• to evaluate the developments in using limestone, cement, concrete and glass as building materials, and their advantages and disadvantages over other materials.		Internet search – find out about: • how cement, concrete and glass are made • advantages and disadvantages of the above.	Cement and concrete have been known for centuries. The Romans even developed a concrete that could set under water. Many ancient Roman buildings/structures made of concrete are still standing today.
		Practical – make cardboard tubes by putting thin card around a boiling tube. Remove tube. Make mixtures and leave to harden. Test about 1 week later by hanging weights on the horizontal cylinder.	Try these mixtures of sand and cement to make mortar – 3:1, 4:1 and 5:1. (3:1 is strong but brittle) Aggregate (small rocks):sand:cement = 4:2:1 = concrete. Different groups could try different mixtures to see who makes the best one. They could also try out their own possible mixture.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Thermal decomposition of $CaCO_3$ Thermal decomposition of other carbonates The ‘Limestone Cycle’		Students can heat a small piece of marble on a gauze. Heat from the top. Make sure it glows. Heat for about 10 mins. When cool put into a dry test-tube and seal with a tight rubber bung. While cooling students can heat $CuCO_3$ and $MgCO_3$ and test gas evolved with limewater (take care to prevent suckback). The following lesson add a ***few*** drops of water to the quicklime. Observe that it heats up (exothermic reaction), expands and breaks up (compare with an unheated piece of limestone which acts like it’s ‘dead’). Dissolve in water, filter and bubble CO_2 through the resultant solution to prove limewater has been made.	The light seen is ‘limelight’. Pieces of limestone were heated with gas jets in Victorian theatres to provide light for the stage. Quicklime is so called because the word ‘quick’ means ‘alive’ – as in quicksand. Emphasise the cycle that they have just done as the cloudiness of the limewater is due to insoluble $CaCO_3$. Emphasise: • thermal decomposition • soluble and insoluble • precipitate • dissolving • filtering Safety – goggles to protect eyes at all times. Limewater has a pH of about 10. Take care to prevent suckback – remove the delivery tube from the limewater before the source of heat is removed. If breathing out through the limewater then put limewater in a small conical flask - less chance of splashing.

Total hours: 6	11.2/12.2 How do rocks provide metals and how are metals used?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
What are ores? Why are they useful? What are the implications of their extraction and use? What are the major uses of the metals extracted from their ore? Name some ores (with formulae) and the metal that is extracted.		Internet search to answer the questions in the topic outline.	Copper rich ores are becoming scarce. It's becoming more expensive (due to energy considerations) to extract certain metals (aluminium, titanium) so there is a need for recycling (though this can have some drawbacks). Some metals are unreactive and can be found as the pure metal in the ground.
Iron is extracted from the blast furnace. Properties of pig iron, pure iron and steels.		Bookwork/internet search/worksheets to emphasise information required. Internet search on the discovery of stainless steel by Harry Brearley in 1913 (shows the need for keeping of good notes/data). Search -"Harry Brearley" + "stainless steel". This can be done as part of the previous internet search.	Details of blast furnace not needed at this stage. Emphasise reactivity of metals that means reduction of oxide with carbon is viable.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Carbon reduction of some metal oxides can be used to extract those metals that are less reactive than carbon.		Heat a range of metal oxides and powdered carbon together (e.g. ZnO, CuO, Al_2O_3, MgO). Test for the production of CO_2 as proof that reduction has happened. Observe carefully the residue in the tube. Look for evidence of metal.	Care – prevent suckback by removing delivery tube from limewater before removing the source of heat
Alloys and their uses. Reason for alloying copper, gold and aluminium.		Compare malleability of pure metals with their alloys – simple bending by hand will do. Students can think about the need for a 'fair test' – compare thickness of materials, possible ways to quantify the force needed to make the metal bend etc. Wrap copper wire round two cylindrical pieces of wood. Mark out a distance of say 5cm and pull apart. Look at ends under a microscope/hand lens. Measure new distance. Hold copper wire between thumb and forefinger of both hands and twist round. The wire eventually snaps – this is called 'work hardening'. Compare appearance under microscope with stretched wire.	Homework – investigate the 'carat' measurement of gold's purity. Why do we not use 24 carat gold for wedding rings? What are 'smart alloys' and how are they made? The wire thins out as it is stretched. Compare with info about pure iron previously met. Wire shears because crystal structure is not complete – there are 'holes'. The twisting moves adjacent atoms into these holes. The effect is that the holes 'move'. When they all line up the metal shears. Addition of *measured* amounts of carbon to iron prevents this as the carbon fills the holes. Too much carbon and the crystal structure is further deformed and the iron becomes weak.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Transition metals and their position in the periodic table. Basic properties. linked to their uses.		Basic properties linked to their uses. Look at heat and electrical conduction, malleability, strength.	Links with next lesson's work about copper
Extraction, properties and uses of copper.		Cost of extraction of copper linked to energy costs. Low grade ores increasingly being investigated. There are environmental problems associated with this.	Possible internet research on siting of copper extraction facilities, and problems associated with low grade ores.
Properties and uses of titanium and aluminium.		Compare densities of iron, copper, aluminium, titanium and their alloys (including duralumin). Note that low density alloys have other uses when compared to high density alloys/metals. Duralumin is an alloy widely used for aircraft bodies.	Emphasise need for recycling as resources on our planet are limited.

Total hours: 5 or 6	11.3/12.3 How do we get fuels from crude oil?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Properties of mixtures		Investigate properties of iron, sulfur and an iron/sulfur mixture. Individual properties (magnetism and solubility in organic solvents) are maintained in the mixture. Use basic distillation to give water from a coloured solution (e.g. copper sulfate) – basic distillation (2-step process: evaporation followed by condensation).	Care with organic solvents – heat by means of a water bath to prevent ignition of vapours. Heat gently in a conical flask (clamp flask in place to prevent it falling over). Use delivery tube to deliver steam/vapour to a boiling tube in a beaker of cold water. Care with steam – possibility of burns. Test water with cobalt chloride paper (proves presence, not purity)
What's in crude oil and how can it be separated?		Describe components of crude oil and how the separation can occur. Use molecular models to show the first 4 alkanes. Demonstrate fractional distillation of crude oil	Emphasise *hydrocarbon, saturated, alkane*. Also emphasise that the fractions are not pure. They are still mixtures, but they are more useful than the bigger mixture that is crude oil. Use a crude oil substitute to demonstrate this in a fume cupboard. Show that lower boiling fractions are easier to ignite – link in with their size.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Burning of fuels		Students burn a candle. Above candle is inverted glass funnel leading through limewater to water pump. Proof of fuels releasing CO_2 when they are burnt. Teacher demonstration of burning of sulfur in gas jar of pure oxygen to get SO_2. Test with UI solution to show it's an acidic gas. Students put cold water in beaker and *for a few seconds* put a lit Bunsen burner underneath (small flame – 2cm – air hole half open). Condensation quickly appears on outside of beaker. Proof that burning fuels release water vapour. Reminder that burning fuels sometimes releases solid particles (soot). Safety flame on Bunsen or candle can show this if put under a beaker with water in it.	Compare time taken for limewater to go cloudy with one running with just air going through it (students will be aware of presence of CO_2 in air and could argue that's what's turning the limewater cloudy). Care – SO_2 is a major asthma trigger. Vent excess gas out through a fume cupboard. Emphasise: • fuels aren't pure (hence presence of sulfur) • component elements in fuels react with oxygen from the air • burning fuels in a limited supply of air releases poisonous carbon monoxide, hence the need for adequate ventilation for gas fires (be sensitive to the fact that they may know someone who has died because of this).
Pollution problems caused by burning fuels and to evaluate developments in the production and uses of better fuels, for example ethanol and hydrogen.		Internet research on acid rain, global warming, global dimming. Removal of sulfur from fuels and sulfur dioxide from waste gases of power stations. Are there better fuels out there for us to use?	See Physics 1 Section 11.4 for The Carbon Dioxide debate

Total hours: 3	11.4/12.4 How are polymers and ethanol made from oil?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Cracking		Teacher demonstration of cracking. Rocksill/mineral wool soaked in liquid paraffin. Pass hot vapours over heated aluminium oxide or hot unglazed pottery. Collect gases produced. It takes a while to make the ethene, so collect lots of test tubes. The gas can be seen burning if the room is darkened. Test for unsaturated hydrocarbons – yellow/brown bromine water is discoloured	Another example of thermal decomposition. Use atomic/molecular models to show the double covalent bond between the carbons in ethene and propene. Draw structures of the two molecules. Cracking produces the extra petrol we need. We use more petrol than we get from just fractional distillation.
Uses of alkenes		Internet research to find out about: • ethanol from ethene c/f ethanol from sugar – advantages and disadvantages • making (addition) polymers such as poly(ethene) and poly(propene) • the varied and many uses of polymers • problems associated with disposal of polymers – need for recycling • poly(ethenol) and its uses as ingredient in PVA glues etc. • is burning of crude oil the best use of it or is it best used to make useful chemicals?	Emphasise that polymers have many and varied uses. Note that poly(ethene), for example, is longer than the alkanes present in crude oil and this is what makes it useful. Note the major uses of: • poly(ethene) – carrier bags, drinks bottles • poly(propene) – milk crates, 'rope', washing up bowls

Total hours: 5	11.5/12.5 How can plant oils be used?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Where do vegetable oils come from? How are they extracted?		Internet research on the extraction and uses of vegetable oils. • evaluate the effects of using vegetable oils in foods and the impacts on diet and health • evaluate the benefits, drawbacks and risks of using vegetable oils to produce fuels.	
Making oils and making emulsions.		Pupils could try extracting their own oils from olives. Then they could investigate what makes the best emulsion, using varying proportions of oil, water, vinegar. Also look at a range of emulsions – salad dressing, paint, ice creams etc.	• CARE IF DOING PRACTICAL – ground nut oil comes from 'peanuts'. Advised that this is NOT used. Students may be allergic to it. If any trace is left behind in the lab other students may be exposed to it as well.
Which spread is the best?		Internet research to find out about cis and trans unsaturated fats, and their health advantages/disadvantages. How is margarine made? What are the advantages of it over butter?	Pupils can test a range of so-called healthy and unhealthy spreads. They are testing for the presence of unsaturation with either bromine or iodine.

What colours are present in sweets?		Use of chromatography to test the colouring in some sweets. Are the colours single substances? How can we make we are testing each sweet in the same way?	Sweets with a coloured coating work best. The coating can be applied to strips of chromatography paper and then these are placed in separate boiling tubes for the appropriate length of time.
Food additives		Internet research on how scientists find out about the colouring in some foodstuffs. What illegal food colourings might be used? Why are they illegal? What are the common additives used in food to improve appearance, taste and shelf life? What are the benefits, drawbacks and risks involved in using food additives?	All ingredients in food must be listed in order of quantity on the food label. What else is on the label that helps inform us of whether it is a ‘healthy option’? What are the common E numbers and what chemicals are they? Note that many labels on products other than food list *aqua* as the main ingredient. Make sure the students know that this is water.

Total hours: 6		11.6/12.6 What are the changes in the Earth and the atmosphere?	
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Earth's structure and the history of our understanding of it.		Internet research – what is the Earth's internal structure like? How did we used to think mountains were made? Who was Alfred Wegener and what was his theory? What is the current theory of crustal movement (continental drift)? What causes this movement and what effects does it have on the Earth's surface?	Bishop Usher (in the late 1600s) estimated the creation of the Earth as happening on the evening of Oct 22nd 4004 BC. In the 1800s there was an obvious discrepancy and split between science and religion (there are some creationists still around today).
Why can't we predict earthquakes and volcanic eruptions?		Internet research – find dates of major earthquakes in Turkey. Work out the difference between successive dates. Is there a pattern? Do the same for eruptions of Mount Etna or Vesuvius. Why is it impossible to accurately predict when an earthquake or an eruption will happen? Some of this information can be found in recent textbooks written for the previous AQA syllabus.	It becomes obvious that there is no real pattern, but a general prediction can be made. Also why do people live in these areas - land might be cheap, there might not be any other available land. Also in volcanic regions the soil is more fertile, as well as the fact that some people make a living from collecting and selling sulfur (brimstone).

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
What's in the air?		Demonstrate that about one-fifth of the air is oxygen gas (Exelo apparatus can be used to show it's actually 21%). Use water pump and limewater to prove existence of CO_2 in air. It takes a long time because there's so little of it. Ice in a beaker can show presence of water vapour (test with cobalt chloride paper – as seen in Section 11.3).	We know that basic amounts haven't changed much over the last millennia or so because we can look at trapped air samples in ice cores from the Poles. This is our proof that the amount of CO_2 has been gradually increasing over the last few centuries.
The Noble Gases		Put filament bulb in old fashioned upright table lamp. Carefully use a hacksaw to saw off the glass envelope (which contains argon). Plug in and switch on in a darkened room. The tungsten filament flares up for about 1 second and is then gone. Use EHT supply and neon discharge tube to demonstrate neon lights. A very distinctive red light is seen. Use helium canister to fill balloon and watch it float up to the ceiling.	Care with broken glass and EHT supply (no bare leads). If demonstrating helium producing a squeaky voice breathe in from a balloon and not directly from the canister. Much helium is leaking into outer space and the world stocks are slowly diminishing.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
What was the Earth's atmosphere like in the early stages?		Basic information about Earth's early atmosphere and how it resembled present day Mars and Venus. Photosynthesis produced the oxygen that we have today (links back to KS3 information as well as Biology 2). Internet search – look for other theories about what has happened/is happening to the Earth's atmosphere.	Surface temperatures on Venus are very high. Scientists think this may be due to a runaway greenhouse effect. Is the same thing likely to happen on the Earth?
What happened to all the carbon dioxide?		Link back to the thermal decomposition of marble proving that CO_2 is incorporated into some rocks. Many scientists (though not all) accept that the levels of CO_2 in the air are rising as we release carbon that was locked up as fossil fuels for millions of years. Internet search – what are the arguments for and against the theory that increased levels of CO_2 are causing global warming.	Another chance to emphasise the carbon dioxide debate.