GCSE

Edexcel GCSE in Additional Science
Synthesis

(Concept approach)

June 2006

Support material

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Topic 5: Synthesis

Introduction

1 This booklet contains a concept-driven scheme of work and some suggested activities for the Edexcel GCSE in Additional Science Unit C2 topic 5: Synthesis.

2 Two schemes of work are available for each topic in separate booklets. One of these booklets contains a scheme of work that is concept-driven ie scientific ideas are presented before their applications are explored. The other booklet contains a scheme of work that is context-driven ie applications of science are presented before the scientific principles used in these applications are explored.

3 Booklets for each GCSE in Additional Science topic are provided free of charge to centres who are offering the Edexcel GCSE suite of Science qualifications via the secure area of the Edexcel website (www.edexcel.org.uk).

4 Although Edexcel owns the copyright for the booklets, they are provided in Word format so that Edexcel centres may customise the schemes if required.

5 Each lesson is designed to last for 50 minutes although the total teaching time is not stated in the specification; teachers may adjust the schemes of work to accommodate the time available in individual centres.

6 Centres are responsible for the overall risk assessment of experimental work undertaken by students.

7 Attention is drawn to the need for safe practice when students carry out laboratory experiments or observe demonstrations. Particular attention is drawn to the possible hazards associated with electrical equipment, the handling of micro-organisms and ionising radiation. Strict aseptic conditions should be used when undertaking practical work. Reference must be made to COSHH regulations and any specific local education authority restrictions.

Relevant advice can be obtained from the following publications:

- *CLEAPSS Laboratory Handbook* (available from CLEAPSS School Science Service, website www.cleapss.org.uk)
- C*ontrol of Substances Hazardous to Health Regulations* (HSE, 2005) ISBN 0717629813
- *Hazcards* (2004 update available from CLEAPSS School Science Service)
- *Topics in Safety, Third Edition* (ASE January 2001) ISBN 0863573169

Scheme of work for Topic 5: Synthesis

LESSON 1 — The basics of organic chemistry							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.7 C2 5.5 C2 5.6	8E Atoms and elements. 8F Compounds and mixtures.	Organic chemicals are based on the element carbon and mainly originate from living things.	Set fire to small pieces of several foods. Compare what is left behind afterwards. State that the black substance is carbon, and is common to all foods. Trace the sources of the foods to living things and make the connection that carbon is present in living things. State that the reason carbon appears to be everywhere is its ability to link with other carbon atoms to form long chains. This is the basis of organic chemistry. Show simple molecular models, and draw diagrams of their structures or get students to make molecular models of methane, ethane, and propane. State that these are the first three alkanes with general formula C_nH_{2n+2}. Show simple molecular models, and draw diagrams of their structures. State that these are the first two alkenes with general formula C_nH_{2n}.	Bunsen burner and heat proof mat. Several foodstuffs. Demonstration molecular model kit.	Relate the ability of carbon to form four bonds to the large number of carbon compounds, which are the basis of life. Recall the formulae of methane, ethane, propane, butane and draw the structures of their molecules. Recall the formulae of ethene and propene, and draw the structures of their molecules.		Use a safety screen. Take care with the Bunsen burner.

Homework:

a) Issue a pre-prepared worksheet with molecular diagrams of the three alkanes, and the first two alkenes, but in random order. Ask students to name them.

b) Ask the students to write out the molecular formulae of C_5H_{10}, C_5H_{12}, C_8H_{18}, C_4H_8, C_6H_{14}, etc, and to classify the compounds as alkanes or alkenes.

Scheme of work for Topic 5: Synthesis

LESSON 2 — A cracking lesson

Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
C2 5.1 C2 5.2 C2 5.3 C2 5.4 C2 5.8 C2 5.13	7F Simple chemical reactions. 8F Compounds and mixtures. 9H Using Chemistry.	Many new chemicals are made from oil.	This is a class practical session, suitable for the assessment of students' practical skills (following instructions). Draw a possible structural formula for medicinal paraffin – a long chain of hydrocarbon. Allow the students to crack the paraffin. Connect a glass delivery tube to Pyrex boiling tubes containing mineral wool, broken porcelain pot, and some medicinal paraffin, and lead into a container of water. Heat the boiling tube strongly and collect the ethene formed (by water displacement) in an inverted test tube. Aim to collect four stoppered tubes per group. Allow the students to smell the ethene, and also to light it with a splint. The reaction is an example of 'cracking' – an important process. Add some bromine water to a test tube of cyclohexane and shake, to decolourise the bromine water. Describe how ethene reacts with water to make ethanol (Higher-tier students only).	RSC 'Cracking Hydrocarbons' No 96 pages 247-248. Bromine water. Cyclohexane. Test tubes.	Investigate cracking within the laboratory. Explain that cracking involves the breaking down of larger hydrocarbon molecules into smaller, more useful ones. Recall that when alkanes are cracked, mixtures of alkanes and alkenes are formed. Explain that alkanes are saturated hydrocarbons, containing single covalent bonds, that alkenes are unsaturated hydrocarbons containing double covalent bonds. Describe how bromine water is used to distinguish between alkanes and alkenes. Explain how ethene can be reacted with water to make ethanol.	PS: □2.2 WO: □1.1 □1.2 □2.1	Ensure that apparatus is gas tight before heating. Care with Bunsen burner. If prepared from bromine liquid – take great care!

Homework: Research the industrial cracking of crude oil. Explain the process and draw a diagram. If possible, write chemical equations to help with the explanation.

Scheme of work for Topic 5: Synthesis

LESSON 3 — Introduction to polymers							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.14 C2 5.16	7F Simple chemical reactions. 8F Compounds and mixtures. 9H Using chemistry.	Polymers are large molecules which can be formed by a combination of many smaller molecules.	Remind students of ethene's molecular structure. Write the equation for the reaction of bromine water with ethene (see Lesson 2). Use a model to show how molecules of ethene can combine to form polyethene. Replace one of the hydrogen atoms in the ethene monomer, and show how the polymer polychloroethene (PVC) is made. Get the students to make some slime balls from PVA and borax. Demonstration or class practical: Heat a selection of small plastic objects in hot water. Those that deform are thermoplastics, those which retain their shape are thermosetting plastics.	Demonstration, and student versions of molecular model kits. Long string of 'poppit' beads to simulate the polymer. PVA, borax, food colouring. See recipe on: www.chemsoc.org/exemplarchem/entries/2004/keele_bridgewood/funpolymerslime.htm or in RSC experiments 77 Page 195 A mixture of thermosetting plastics and thermoplastics in a beaker of very hot water (include an empty yoghurt pot).	Recall that polymers are large molecules which can be formed by a combination of many smaller molecules. Explain the differences and similarities in properties between thermosetting and thermoplastics in terms of their structure.	WO: □1.2	Take care not to knock the beaker over.
Homework: Research a selection of common plastics to find out which are thermoplastics, and which are thermosetting plastics. Research the process of 'vulcanisation' as used in tyre manufacture. Students could use a diagram to help them explain what is happening.							

LESSON 4 — Formation and uses of polymers							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.18 C2 5.15 C2 5.19 C2 5.20 C2 5.21	7F Simple chemical reactions. 8F Compounds and mixtures. 9G Environmental chemistry. 9H Using chemistry.	Polymers are large molecules that can be formed by a combination of many smaller molecules. Disposing of some plastics is an environmental problem.	Remind students of the principles of polymerization. Give students the structural formula for polyphenylethene (polystyrene) and ask them to draw (and name) the monomer. Repeat with other monomer/polymer pairs such as propene/polypropene. Give the students the properties of two different polymers (A and B). Get them to suggest uses based on the properties. Get the students to find out how the properties of a plastic can be altered, eg by changing starting materials, the conditions of the reaction, and the use of additives (plasticisers, preservatives and cross-linking). Discuss the issue of non-biodegradability, and the breakdown of some plastics to form toxic products.	See RSC Classic Chemistry experiments 75 and 95. Demonstration molecular model kit may be useful. Pre- researched properties of two different polymers. Access to the internet may be required. Selection of supermarket plastic bags.	Explain how addition polymers are formed from unsaturated monomers. Draw a section of an addition polymer given the monomer and vice versa. Predict uses of polymers given appropriate information about properties. Explain how the properties of a plastic can be altered and relate this to their structure and bonding. Discuss the problems of disposing of some plastics, including non-biodegradability and breakdown to toxic products.	ICT: □1.1	See notes on pages 189 and 245 of the RSC book.
Homework: Students could find out: a) why milk crates are made of high density polyethene, b why electrical wire insulation is made of polychloroethene c) why electrical plugs and sockets are made of cross-linked polymers d) the meaning of ‘u’ in uPVC as used in new window frames.							

LESSON 5 — It's all fat, but does it make you fat?							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.9 C2 5.10 C2 5.11 C2 5.12	8F Compounds and mixtures. 9H Using chemistry. 7F Simple chemical reactions.	Polymers are large molecules which can be formed by a combination of many smaller molecules.	Get the students to make a list on the board of all the products they can see in the laboratory which are made from oil. (If you wish you could divide the class into teams and make it into a game.) Get the students to add the names of other materials not normally found in the room. Discuss what might happen when oil supplies begin to run out. Remind students of the term 'unsaturated' (see Lesson 2) and get them to find out the meaning of the terms 'polyunsaturated' and 'monounsaturated'. You may wish to test for unsaturation by shaking with bromine water. (Fat is unsaturated if bromine becomes colourless.) Get the students to research the manufacture of margarine.	Assorted plastic laboratory objects made from oil. Selection of other (non- laboratory based) oil products. Tub of margarine which has the label 'high in polyunsaturates', olive oil, dairy products. Access to the internet may be required. (See www.medicinalfoodnews.com/vol01/issue7/sat_fat.htm)	Discuss how modern society depends on oil and predict the consequence when supplies begin to run out. Explain why some vegetable oils are referred to as polyunsaturated or monounsaturated. Explain why polyunsaturated oils are far less viscous that saturated ones. Describe how vegetable oil can be hydrogenated to form hydrogenated vegetable oil and what this is used for in the food industry.	ICT: □1.1 WO: □1.2	Take care if making bromine water from bromine. Refer to CLEAPSS hazcard.

Homework: The students could be asked to:

a) write out the meaning of the words 'saturated', 'monounsaturated' and 'polyunsaturated'
b) summarise how margarine is manufactured using their research from the lesson
c) discuss the health issues associated with saturated fats, and find out why some animal products are best avoided.

LESSON 6 — Making new chemicals safely							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2.5.22 C2 5.17 C2 5.23	7F Simple chemical reactions. 9H Using chemistry.	Raw materials are converted into new and useful chemicals by chemical reactions.	You may wish to introduce the lesson by using one of the Alice Hamilton case studies from the RSC. Briefly discuss how new chemicals are tested for toxicity to humans. Discuss chemical equations in terms of reactants and products. Get the students to appreciate the steps taken by research chemists when synthesising new substances. Give the students information about the reactants in an unfamiliar reaction, and ask them to predict the products that may be formed, using their knowledge of a similar reaction.	RSC 'Health Safety and Risk' ISBN 0854049592 Useful website: www.chemsoc.org/ networks/learnnet/ ideas-evidence.htm. You might also access www.chemicalindustryarc hives.org/ factfiction for information.	Discuss the issue of toxicity to humans in how chemists synthesise new substances. Understand that chemists use information about known reactions to make new chemicals and predict the products of a reaction given the reactants and products of similar reactions. Use information about a given reaction to predict the new product of a similar reaction.	ICT: □1.1	

Homework:

a) Give the students information about the reactants in an unfamiliar reaction, and ask them to predict the products that may be formed, using their knowledge of a similar reaction.
b) Students could do internet research to find out how chemists use information about known reactions to make new chemicals and summarise their findings.
c) Read about the other two Alice Hamilton case studies and answer the questions that follow them.

LESSON 7 — Synthesis in action							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.25 C2 5.26	7F Simple chemical reactions. 9H Using chemistry.	Raw materials are converted into new and useful chemicals by chemical reactions.	Tell students that in excess of 100, 000 new molecules are made every year. To find out which are most effective, scientists use combinatorial chemistry, which enables thousands of molecules to be tested at the same time. Tests are carried out on silicon chips rather than in test tubes. Scientists also use computer modelling to make predictions. Calculate the number of possible products from a staged synthesis experiment involving no more than four stages, given appropriate data.	Access to the internet may be required. Useful websites include: www.bls.gov/oco/ ocos047.htm www.genetics.gsk.com/ role.htm Teacher support sheet 5.7: Synthesising new products.	Describe how stage methods of synthesis are used in drug development to speed up discovery of effective substances. Calculate the number of possible products from a staged synthesis experiment involving no more than four stages, given appropriate data.	ICT: □1.1	
Homework: Summarise the stages of drug development, describing how combinatorial chemistry is used to test thousands of molecules at the same time. (See www.combichemistry.com/ or www.louisville.edu/a-s/chemistry/peptide/combichem.html for useful information on combinatorial chemistry.)							

Scheme of work for Topic 5: Synthesis

LESSON 8 — Introduction to chemical calculations							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.27 C2 5.31 C2 5.28	8F Compounds and mixtures. 7F Simple chemical reactions. 9H Using chemistry.	The amount of reactant needed to get a desired quantity of product can be calculated.	Show students how to calculate relative formula masses, starting with simple binary compounds, leading on to more complex compounds. Remind students (or tell them) about the use of state symbols when writing balanced equations. Use word and/or symbol equations, depending on the ability of the teaching group. Students could be given a graded list of unbalanced equations, and asked to balance them and insert state symbols. See www.chemsheets.co.uk for some suggestions. A list of chemical equations should include calculations of masses of both reactants and product. Higher- tier students only: Show students how chemical equations may be used to calculate masses of reactants and products of chemical reactions.	Periodic table showing relative atomic masses. Calculator. Graded list of exemplars. See www.chemsheets.co.uk	Calculate relative formula mass from relative atomic masses. Represent chemical equations by word equations; write balanced equations; use state symbols (s), (l), (g) and (aq). Use chemical equations to calculate masses of reactants and products.	N: □2.2 □2.1 □2.2 □2.3	
Homework: Students should be given further practice in doing calculations from the lesson. There are several possibilities at www.chemsheets.co.uk							

Scheme of work for Topic 5: Synthesis

LESSON 9 — Using chemical equations

Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
C2 5.30 C2 5.31 C2 5.24	7F Simple chemical reactions. 9H Using chemistry.	The amount of reactant needed to get a desired quantity of product can be calculated. The theoretical yield often differs from the actual yield and this has financial implications.	Based on Lesson 8, the students could be given the equation: $2Mg + O_2 \rightarrow 2MgO$ and asked to calculate the total mass of magnesium oxide which should be formed from a known mass of magnesium ribbon. They could then carry out the task, and compare theoretical yield with the actual yield. Apply the concepts learned to industrial situations and mention the need for high atom economy. Higher — tier students only: Give the students experimental data and ask then to calculate the percentage atom economy of some reactions. As an example, refer to developments in the production of ibuprofen, where the atom economy rose from 40% in mid 1980s to 77% in the mid 1990s.	Magnesium ribbon, crucibles and lids, direct reading balances, tongs, heating apparatus. See experiment sheet 5.9: The atom economy of a reaction. A useful website to introduce the idea of atom economy is: www.uyseg.org/greener_industry/pages/atom/1atom_yield.htm	Understand that reactions with high atom economy are important for sustainable development as they prevent waste. Represent chemical equations by word equations; write balanced equations; use state symbols (s), (l), (g) and (aq). Use the formula: $\frac{\text{Mass of useful product}}{\text{Total mass of product}} \times 100\%$ to calculate the 'atom economy' of a reaction.	N: □2.1 □2.2 □2.3 WO: □1.2	Take care with burning magnesium, and hot crucibles. Do not look directly at the burning magnesium.

Homework: Students should be given further practice in doing calculations from the lesson.
(See www.combichemistry.com/, or www.louisville.edu/a-s/chemistry/peptide/combichem.html for useful information on combinatorial chemistry, and www.uyseg.org/greener_industry/pages/atom/1atom_yield.htm for an introduction to atom economy.)

LESSON 10 — Calculating formulae and percentage yields							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 5.32 C2 5.29	9H Using chemistry.	The amount of reactant needed to get a desired quantity of product can be calculated. The theoretical yield often differs from the actual yield and this has financial implications.	Give the students a series of calculations, involving reacting masses of elements and show them how to calculate empirical formulae of compounds. Higher -tier students only: give the students questions to calculate both theoretical and actual percentage yields of chemical reactions. Discuss the financial implications of chemical reactions where the actual yield is low.	A prepared list of chemical calculations. See www.chemsheets.co.uk for some suggestions. A prepared list of chemical calculations on actual and theoretical percentage yields. For an introduction, search in Google for 'Percentage yield in chemical reactions'. (There are several web sites to choose from.)	Calculate the formulae of simple compounds from reacting masses and understand that these are empirical. Calculate theoretical and percentage yields of reactions.	N: □2.1 □2.2 □2.3	
Homework: Students could revise the material learned in this topic in preparation for a unit test.							

Teacher support sheet 5.7: Synthesising new products

Introduction

This sheet discusses the synthesis of new products by a staged approach or by using a combinatorial approach (or a combination of both). The aim of using these approaches to synthesis is to produce more products that could be active using an atomic economy approach. This enhances the speed of discovery and sustainable development in producing less waste.

Staged synthesis

The examples below are straightforward addition reactions where there is one product at each stage. Staged synthesis when dealing with large biomechanicals (eg proteins) can also include a number of products at each stage and therefore a greater chance of producing active products.

Here is a straightforward addition reaction using symbols:

$$A \xrightarrow{+B} AB \xrightarrow{+C} ABC \xrightarrow{+D} ABCD$$

Three stages yields three products

Here is a reaction where more than one product is produced at two stages:

$$A \xrightarrow{+B} AB \xrightarrow{+C} ABC + AC + BC \xrightarrow{+D} ABCD + ABD + BCD + CD + ACD$$

Three stages yields nine products.

Alternatively – one stage:

$A \longrightarrow ABCD$ One stage (direct) produces one product.

Examples

1 $CH_2CH_2 \longrightarrow CH_3CH_3 \longrightarrow CH_3CH_2Cl \longrightarrow CH_3CH_2OH$

Three stages yields three products.

$CH_2CH_2 \longrightarrow CH_3CH_2OH$

One stage (direct) produces one product.

2 $NH_3 \longrightarrow NH_4Cl \longrightarrow NH_4OH \longrightarrow (NH_4)_2SO_4$

Three stages yields three products.

$NH_3 \longrightarrow (NH_4)SO_4$

One stage (direct) yields one product.

Teacher support sheet 5.7: Synthesising new products

Combinatorial theory

Combinational theory involves the reactions of classes (groups) of reactants that react together under the same reactions' conditions and therefore produce larger numbers of products.

This can be combined with a staged synthesis to produce an even greater number of products provided they can be separated by modern separation techniques.

Example 1

The synthesis of halogeno alkanes and halogens under the same reaction conditions.

Using symbols and examples:

Reactants A and B: two reactants from one class or group, eg halogens (chlorine and bromine).
Reactants C alkene: ethene.

	A	B	Possible mixture
C	AC	BC	ABC

This produces three possible products: chloroethane, bromoethane and a possible mixture – chloro bromo ethane.

Example 2

Reactants A and B – two halogens, eg chlorine and bromine.
Reactants C and D which are both alkenes – ethene and propene.

	C	D	Possible mixtures
A	AC	AD	ABC
B	BC	BD	ABD

This produces six possible products from four reactants in a one stage process: chloro ethane, chloro propane, bromo ethane, bromo propane, chloro bromo ethane, chloro bromo propane.

Experiment 5.9: The atom economy of a reaction

What you will learn from this experiment

You will learn how to carry out a simulation activity on the atom economy of a reaction.

What you will know when you finish this experiment

1 The atom economy of a reaction is ideally 100%.

2 In reality the atom economy is rarely 100%.

3 How to calculate the atom economy in this simulation.

Introduction

When a chemical reaction takes place, ideally all of the atoms in the reactants combine to form the products. Such a reaction has 100% atom economy.

In reality this often does not happen. Sometimes not all of the atoms of the reactants combine to form new products. In this case the atom economy is less than 100%.

This experiment simulates the idea of a reaction where the atom economy is less than 100%.

In the reaction:

$$2Mg + O_2 \longrightarrow 2MgO$$

the atom economy should be 100% because all of the atoms in the reactants are used in making the products. Experimental error, however, often means that the yield is often less than 100%, because some magnesium oxide is lost to the air. How good is your atom economy in this reaction?

In theory, 48 g of magnesium should produce 80g of magnesium oxide. (Why is this?)

So 1 g of magnesium should produce 1.667 g of magnesium oxide. (This is the theoretical yield.)

What you do

1 Weigh a clean crucible and lid call this **W1**.

2 Remove the oxide layer from a length of magnesium ribbon, using fine sandpaper. Coil up the magnesium (not too tightly!) and add to the crucible.

3 Weigh the crucible, lid and magnesium – call this **W2**.

4 Place the crucible, lid and magnesium on a pipe clay triangle, on top of a tripod. Put on your safety glasses.

5 With a Bunsen burner, carefully heat the crucible strongly, to enable the magnesium to react with the oxygen in the crucible. From time to time, use tongs to lift the lid a little bit to allow more oxygen into the crucible. You will know when the magnesium reacts, because it will flare up and give out a bright light. Do not look directly at the light.

6 Try not to let too much of the white smoke escape – this is the magnesium oxide.

7 Stop heating when the magnesium no longer flares up.

8 Allow the crucible to cool for 10 minutes or so, and then reweigh it, not forgetting the lid. Call this **W3**.

Working out the results:

1 The mass of magnesium you used is **W2 – W1** g

2 The mass of magnesium oxide formed is **W3 – W1** g

Experiment 5.9: The atom economy of a reaction

Calculation

Use your results to calculate the theoretical yield, and compare with your actual yield. How good was your atom economy?

Suggestions for further work/homework

Look up this website:

www.uyseg.org/greener_industry/pages/atom/1 atom _yield.htm

Explain how this simulation is different from the actual interpretation for the calculation of atom economy, which is:

$$\text{atom economy} = \frac{\text{mass of useful product}}{\text{total mass of product}} \times 100\ \%$$

Experiment 5.9: The atom economy of a reaction

Notes for technicians and teachers

Previous skills, knowledge and understanding required

1 The ability to read a direct reading balance to at least two decimal places.

2 The ability to follow instructions, manipulate the equipment and work safely in the laboratory.

3 The ability to perform simple calculations.

Equipment and chemicals required

1 A length of magnesium ribbon (approximately 15 cm).

2 Fine grade sandpaper.

3 One crucible and lid.

4 A pipe clay triangle (to support the crucible) on a tripod.

5 Bunsen burner and tongs.

6 Access to direct reading balance (preferably to at least two decimal places).

7 Safety glasses.

Delivery strategies

- This is a fairly simple experiment, though some students will need help with the calculations, which follow the practical work.
- Students could work in pairs for this task, but it is an opportunity to assess individual practical skills, if you have sufficient equipment.
- Discuss the reason for the sanding down of the magnesium before starting. (To remove the oxide layer which may already be present on the surface of the magnesium.)
- Discuss the reason why the magnesium should not be coiled too tightly. (To allow oxygen from the air to react with all of the magnesium.)
- Discuss the reason why the lid needs raising carefully from time to time during the heating process. (To allow more oxygen into the crucible.)
- Discuss the reason why it is important to take care not to allow smoke to escape. (This is magnesium oxide. Obviously if too much is lost to the air the 'atom economy' of the reaction will be reduced.)

Health and safety issues

- When magnesium burns, it gives out an intense white light. Students should be discouraged from looking directly at it.
- The equipment does get extremely hot – there is a risk to students if they do not follow instructions carefully.
- The hot crucible must be allowed to cool thoroughly after heating, before re-weighing it, to minimise the risk of burns.

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