GCSE

Edexcel GCSE in Additional Science
In Your Element

(Concept approach)

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Support material

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Acknowledgements

This specification has been produced by Edexcel on the basis of consultation with teachers, examiners, consultants and other interested parties. Edexcel recognises and values all those who contributed their time and expertise to the development of GCSE specifications.

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Topic 6: In Your Element

Introduction

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1 This booklet contains a concept-driven scheme of work for the Edexcel GCSE Additional Science Unit C2 Topic 6: In Your Element.

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 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)
   - *Control 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 6: In Your Element

LESSON 1 — Explaining the properties of metals							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.1 C2 6.3	Unit 9E Reactions of metals and metal compounds. Unit 7G Particle model of solids, liquids and gases.	To appreciate the structure of metals at the atomic level, to understand why metals have certain properties and to know that alloying with other metals can modify those properties. (This will lead on to 'The number of outer electrons in an element determines its position in the periodic table and its reactivity'. See lesson 3.)	Remind students about their work in KS3, ie all metals are good conductors. Ask the students why this is the case by considering properties such as malleability, hardness and high melting/boiling points, and asking why. Aim to arrive at the conventional understanding of the structure of metals, ie close packed, crystalline structures. Explain the principle of alloying at the atomic level. State how alloying can change physical properties. Explore the percentage composition (ratios) of different metals in alloys.	Ball bearings in tray to simulate metal structure. Data tables showing the melting and boiling points of selected metals and non-metals. Show examples of common alloys and the elements from which they are made. Give the students the names and properties of the more common alloys, eg bronze, brass, constantan, alnico, duralumin, cupro-nickel, etc. Insert smaller or larger spheres into ball bearing tray to simulate alloying.	Describe and explain the physical properties of metals including conductivity, malleability, hardness and high melting/boiling points. Describe and explain how alloying can change the properties of metals.	C: 1.1 2.1	No relevant safety issues.
Homework: Get the students to look up the percentage composition of the alloys mentioned in the lesson. Compare the properties of these alloys with the properties of the elements from which they are made. Give the uses of the alloys investigated.							

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LESSON 2 — Elements, and what they are made of							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.4 C2 6.5 C2 6.6	Unit 8E Atoms and elements. Unit 7G Particle model of solids, liquids and gases.	Remind students of the work covered in C1a topic 5, and extend the ideas to the history of the periodic table. (This will lead on to 'The number of outer electrons in an element determines its position in the periodic table and its reactivity'. See lesson 3.)	Show the students a large periodic table and ask them what they think it shows. Focus the students' attention on the creativity of either Dobereiner, Mendeleev, or Newlands in constructing the table. Ask the students what they think elements are made of, and then ask what they think atoms are made of. Give the students information on the relative masses of protons, neutrons and electrons. Explain the terms atomic number, mass number and relative atomic mass. Explain that the order of elements in the periodic table is due to the atomic number, not the relative atomic mass of the element.	Show the students a DVD or video on the history of the periodic table. (There are a number available commercially, eg Multimedia Science School.) Textbooks or other literature showing the work of, eg John Dalton, JJ Thomson, Ernest Rutherford, Niels Bohr and John Newlands.	Identify an example of creative insight in the history of the discovery of the elements or periodic table. Recall the relative charges of and relative masses of protons, neutrons and electrons. Explain the terms atomic number, mass number and relative atomic mass.	C: 1.1 2.1	No relevant safety issues.
Homework: Ask the students to select one of the scientists discussed in the lesson, and to research their contributions to the structure of the atom and the construction of the periodic table. Produce at least one side of A4 to explain the contributions made.							

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LESSON 3 — Placing elements in the periodic table							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.2 C2 6.7 C2 6.15	Unit 8E Atoms and elements. Unit 7G The particle model of solids, liquids and gases.	Remind students of the work they did in C1a topic 5. The number of outer electrons in an element determines its position in the periodic table and its reactivity.	Ask the students to fill in the given table by marking with crosses the number of electrons in each of the shells. (Maximum two in first, maximum eight in second, maximum eight in third.) Ask them also to fill in the number of protons and neutrons for each element. Discuss the patterns seen in the way that the electrons are arranged, and state that each element has its own unique number of protons (atomic number). (See lesson 7 for isotopes.) Make the link between the number of outer electrons and the group number in which the elements are in the periodic table.	Present the students with an outline of the short form of the periodic table (elements 1–20 only), with concentric rings drawn on. See also 'Multimedia Science School — How electrons are arranged in atoms'. Useful websites include: www.chemicool.com www.periodic.lanl.gov www.chemsoc.org www.chemicalelements.com	Describe the structure of an atom as a nucleus containing protons, neutrons and electrons surrounded by orbiting electrons arranged in shells. Explain that all atoms of a given element contain the same number of protons and that this number is unique to that element and is its atomic number. Describe the connection between the number of outer electrons and the position of an element in the periodic table.	C2.1	No relevant safety issues.
Homework: a) Get the students to complete some prepared sentences (with gaps in) such as those on pages 85, 88 and 90 of Nelson Modular Science Book 1. (ISBN 0748762469) b) Research information on the transition metals by visiting one of these websites: www.chemicalelements.com/index.html, or www.webelements.com/webelements/scholar. Draw up a table showing number of protons and electrons — listing anything interesting you find. Tell the class about your findings next lesson.							

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LESSON 4 — Ions and ionic bonding							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.8 C2 6.9 C2 6.10	Unit 8E Atoms and elements. Unit 7G Particle model of solids, liquids and gases.	The importance of electrons in ionic and metallic bonding.	Class experiment: Demonstrate the existence of charged particles (ions) by passing a current through an ionic solution, and observing the movement and colour changes. Explain observations in terms of ions. Draw the structure of sodium and chlorine ions (see lesson 3) and explain how sodium chloride is formed: by the transfer of an outer electron from sodium to chlorine. Extend this idea to other ionic compounds. Predict the formation of ions from the formulae of ionic compounds.	See RSC Classic Chemistry no 34 pages 87-88 (ISBN 0854049193) for electrolysis of potassium manganate (VII). Or: Place some copper chromate solution in a U tube. Insert long carbon electrodes and pass a high current (dc) for several minutes. (Blue colour moves to cathode, yellow colour moves to anode.) See http://chemistry.slss.ie/downloads/ch_pr_ionicmovement.pdf for details. See Multimedia Science School — Ionic bonding.	Recall that an ion is an atom or group of atoms with a positive or negative charge. Explain that ionic bonds can be made by the transfer of electrons to form positive and negative ions. Describe the formation of sodium ions (Na^+) and chloride ions (Cl^-) and hence predict the formation of ions in other ionic compounds, from their atoms.	WO2.2	Remember to wash hands after using chemicals. Do not touch potassium manganate (VII) crystals.
Homework: Give the students the formulae of some other ionic compounds and ask them to draw diagrams showing electron transfer and the charges on the ions formed.							

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LESSON 5 — Ions and giant structures							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.11 C2 6.12	Unit 8E Atoms and elements. Unit 7G The particle model of solids, liquids and gases. Unit 7H Solutions.	The process of electrolysis.	Given the charges on the ions from groups 1, 2, 6, and 7, together with the charges on compound ions such as NH_4^+, CO_3^{2-}, SO_4^{2-}, etc, work out the formulae of some ionic compounds. Explain what is meant by the term 'giant ionic structure', discussing the regular crystal shape (look at NaCl with a hand lens), its high melting point (try to melt some in a Pyrex™ tube), and its electrical conductivity when in solution.	Large ionic model of sodium chloride. Demonstration ammeter connected via electrodes to a large beaker of distilled water. Show little or no current flows, then add a small amount of salt. Stir to dissolve and then observe. Hand lenses, salt and Pyrex™ test tubes.	Predict the formula of ionic compounds, given the charges on the ions. Describe and explain the physical properties of giant ionic structures eg sodium chloride; their regular crystal shape high melting and boiling points and ability to conduct when molten or in solution.	C1.1	Take care with Bunsen burners when heating test tubes.
Homework: Summarise the properties of giant ionic substances, and explain them in terms of the forces between the particles.							

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LESSON 6 — The electrolysis of a molten salt, and substances in solution							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.13 C2 6.14	Unit 8E Atoms and elements. Unit 7G Particle model of solids, liquids and gases. Unit 7H Solutions.	The process of electrolysis.	Higher tier students only: Demonstrate the electrolysis of molten lead bromide, showing that a current is flowing by lighting up a bulb (when all the solid is molten). Test for bromine at the anode (by colour) and examine the bead of lead (when cooled) which forms at the cathode. Test the lead by writing on paper and check the electrical conductivity. Write electron half equations for the reactions at the electrodes. Class practical (an opportunity for the assessment of practical skills): Electrolyse some solutions (including HCl, and $CuCl_2$ [if possible]) and explain observations in terms of the movement of ions towards oppositely charged electrodes.	Molten lead bromide in a crucible, carbon electrodes, 6V bulb and holder, and DC power pack. See RSC Classic Chemistry Demonstrations No 85. See Multimedia Science School: Electrolysis of copper chloride. Nuffield electrolysis cells or similar. Power packs with dc supply. Various binary compounds in solution. See RSC Classic Chemistry experiments no 82 Page 210-211.	Predict the products of electrolysis of a given binary salt, and write balanced half equations for the electrode reactions. Recall that electrolysis is the movement of ions towards oppositely charged electrodes.	WO: 1.1 1.2	Only to be done as a teacher demonstration in a fume cupboard. (Bromine fumes are poisonous). Take care not to spill solutions. Wash hands afterwards. Refer to relevant hazcards.
Homework: Higher tier students: Explain why sodium chloride could not be used for the demonstration, and lead bromide was used instead. Write electron half equations for the electrolysis of NaCl (aq), and other binary salts. Foundation tier students: Draw a diagram of the electrolysis equipment you used and label it. Summarise the results you obtained at each electrode, from the solutions tested, and state any patterns you can see.							

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LESSON 7 — Isotopes							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.16 C2 6.17	Unit 8E Atoms and elements. Unit 7G The particle model of solids, liquids and gases.	The existence of isotopes and their relationship to relative atomic mass.	Look at a detailed copy of the periodic table showing exact atomic masses. Ask the students why they are not whole numbers. Using chlorine as an example, state that three out of every four atoms have atomic mass 35, but the fourth has two extra neutrons, and so has an atomic mass of 37. The figure of 35.5 on their chart is an average of the masses of these atoms. Discuss the idea of 'heavy hydrogen'. Higher tier students only: Extend this idea to the other elements. Calculate the relative atomic mass from the relative masses and abundance of the isotopes of some elements.	Teacher's version of a large periodic table, giving exact atomic masses. Suitable data for isotopic abundances can be found in the Nuffield Chemistry Data book.	Explain the existence of isotopes. Calculate the relative atomic mass of an element from the relative masses and abundance of its isotopes.	N1.1	
Homework: Look up isotopes in your textbook, or use the internet. List the names and the uses of all those you can find.							

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LESSON 8 — Explaining the reactions of alkali metals							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.18 C2 6.21	Unit 8E Atoms and elements. Unit 7G The particle model of solids, liquids and gases.	The number of outer electrons in an element determines its position in the periodic table and its reactivity.	Show the students freshly cut samples of lithium, sodium and potassium. Show that their physical properties are similar. Allow each to react, in turn, with a fresh sample of water containing some universal indicator solution. Ignite a small sample of each metal in turn, and allow to react with chlorine in gas jars. Write equations for the reactions seen. Explain the similarity in the reactions of the alkali metals in terms of their electronic configurations. Higher tier students should relate the ease of reactivity to the number of electrons in the outermost shell of the elements.	Alkali metals. Sharp knife, filter paper (to remove oil) and container of water. Combustion spoons and prepared gas jars of chlorine. A demonstration or video could be used to show the reactivity of the alkali metals with water eg RSC Classical demonstrations 72 and 76.	Explain that reactions of an element depend upon the arrangement of electrons in the outer shell of its atoms. Explain the trends in the reactivity of the alkali metals and halogens in terms of their electronic configuration.		Do not allow students to use sodium or potassium. Use only small pieces of metals. Refer to relevant hazcards. Igniting of metals and burning in chlorine is best done as a teacher demonstration in a fume cupboard. (Chlorine is poisonous.)
Homework: a) Why didn't your teacher show you the reactions of rubidium and caesium? Based on what you know, predict what would happen when these two metals react with water and with chlorine. b) Why has francium yet to be isolated as an element?							

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LESSON 9 — Reactivity of the halogens							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.21	Unit 8E Atoms and elements. Unit 7G The particle model of solids, liquids and gases.	The number of outer electrons in an element determines its position in the periodic table and its reactivity.	Remind students of the reactions of the alkali metals with chlorine (lesson 8). Show the reactions of the halogens with hot steel wool. Show chlorine's reaction with Dutch metal. Pass some chlorine into solutions of KCl, KBr and KI. Add a few drops of bromine to fresh KCl, KBr and KI solutions. Repeat with iodine. Explain the trends in reactivity of the halogens in terms of their electronic configuration. Write equations for all reactions observed.	Gas jars of chlorine, bromine and iodine. Steel wool. Dutch metal. Solutions of potassium chloride, bromide and iodide. Chlorine gas generator ($KMnO_4$ and conc. HCl) with delivery tube. See Multimedia Science School — First Impressions of the Halogens.	Explain the trends in reactivity of the alkali metals and halogens in terms of their electron configuration.		Take great care with all halogens. Do not spill bromine! Use small amounts only. These reactions are to be carried out only in a fume cupboard. Refer to CLEAPSS Hazcard before using bromine.
Homework: Read about the halogens in your textbook. Write up the experiments you have seen in your exercise book. Write balanced equations wherever possible. Why are the 'halogens' so called?							

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LESSON 10 — The noble gases							
Spec. code	**Links and concept building from KS3**	**Learning objectives**	**Teaching activities**	**Resources**	**Learning outcomes**	**Key skills**	**Safety issues**
C2 6.19 C2 6.20 C2 6.22	Unit 8E Atoms and elements. Unit 7G The particle model of solids, liquids and gases.	The number of outer electrons in an element determines its position in the periodic table and its reactivity.	Show a video or DVD of the noble gases. Discuss their lack of reactivity in terms of their electron arrangements. (All have full outer orbits.) Get the students to prepare a chart listing the first 20 elements, and either drawing each of their electron structures, or writing them in the form 2, 8, 1. Note that chemical equations should be used wherever possible throughout this unit. Students should be familiar with state symbols.	Suitable video or DVD showing the properties of the noble gases. Chart showing the first 20 elements.	Explain the lack of reactivity of the noble gases in terms of the electron configuration of their atoms. Write down the electronic configurations of the first 20 elements in the periodic table, given the atomic numbers, either as electron shell diagrams or in the form eg 2, 8, 1. Represent chemical equations in this unit by word equations, write balanced equations; use state symbols (s), (l), (g) and (aq).		No relevant safety issues.
Homework: Revise the material covered in this topic for your end-of-unit test.							

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