IGCSE Chemistry: Bonding and Structure

Whole Unit Overview

(Please note: (S) denotes material in the Supplement (Extended syllabus) only)

Learning Outcomes		Suggested Teaching Activities	Resources
1	Describe the states of matter and explain their interconversion in terms of the kinetic particle theory.	Relate the conversions to the motion and arrangement of particles. Use 'particles in boxes' diagrams to represent the three states of matter. Stress the change in the arrangement and movement of the particles when a substance changes state. Relate this to the energy input/ output. Students can be asked to use the theory to explain properties such as behaviour of gases under pressure and liquid flow (opportunity for a 'circus of experiments' here).	(type in a question about particles into): http://www.bbc.co.uk/gcsebitesize
1	Describe and explain diffusion.	Simple examples of diffusion include perfume smells, movement of nitrogen dioxide gas or bromine vapour and coloured inks in water. Air freshener sprayed on a watch glass in the front of the class can be used. The students indicate when the smell has reached them in the room. Tea bags held by a glass rod in beakers of hot and cold water demonstrate the changing rate of diffusion with temperature. In all cases, students should be able to link their observations to the particulate model.	

1	Describe evidence for the movement of particles in gases and liquids. A treatment of Brownian Motion is not required	See above examples.	
1 (S)	Describe dependence of rate of diffusion on molecular mass (treated qualitatively)	Two cotton wool pads, one soaked with conc. hydrochloric acid and the other with conc. ammonia can be placed at either end of a long glass tube sealed with bungs. A white 'smoke' of the precipitated ammonium chloride is seen where the two gases meet.	
3.1	State the relative charges and approximate relative masses of protons, neutrons and electrons.		
3.1	Define proton number and nucleon number.	Proton number is also the atomic number. Nucleon number is also the mass number.	
3.1	Use proton number and the simple structure of atoms to explain the basis of the Periodic table (see syllabus section 9), with special reference to the elements of proton number 1 to 20.	Link this back to Unit 1 - Periodic Table 1.	
3.1	Define isotopes.		

3.1	State the two types of isotopes as being radioactive and non-radioactive.		
3.1	State one medical and one industrial use of radioactive isotopes.	Possible examples include the location of blockages in underground pipes and the use of radioactive iodine in tracing thyroid activity.	http://www.cancerhelp.org.uk/ (general site about cancer only)

6.2	Describe radioactive isotopes, such as ^{235}U as a source of energy.	Possible issues for discussion include ● the long term nature of nuclear energy (sustainable long after coal and oil run out). ● environmental considerations such as the disposal of radioactive waste.	http://www.bnfl.com/
3.1	Describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of valency electrons. (The ideas of the distribution of electrons in s and p orbitals and in d block elements are *not* required.)	Use circles to show the shells up to atomic number 20.	
3.2	Describe the differences between elements, mixtures and compounds, and between metals and non-metals.	Link to Unit 1, Periodic table. The reaction between iron and sulphur can be carried out by students to illustrate the varying properties of the elements, the mixture and the compound.	
3.2	Describe alloys, such as brass, as a mixture of a metal with other elements.	Awareness of the importance of alloys to meet industrial specifications for metals. Link to Section 10.3(a) Unit 1 – Periodic Table 1	
10.1	Identify representations of alloys from diagrams of their structures.		

6.1 (S)	Describe bond breaking as endothermic and bond forming as exothermic.		
3.2 (a)	Describe the formation of ions by electrons loss or gain.	Link this to Electrochemistry and Redox. Emphasize formation of a full shell/noble gas configuration.	
3.2 (a)	Describe the formation of ionic bonds between elements from Groups I and VII.	Concentrate on the attraction of + and – charges and the full outer shells obtained by electron transfer.	
3.2 (a) (S)	Describe the formation of ionic bonds between metallic and non-metallic elements.	Link this to Unit 1 – Periodic Table 1	
3.2 (a) (S)	Describe the lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions.	Ball and spoke models will be useful here.	
3.2 (b)	Describe the formation of single covalent bonds in H_2, Cl_2, H_2O, CH_4 and HCl as the sharing of pairs of electrons leading to the noble gas configuration.	Use overlapping circles to show where the electrons are. Students should distinguish the origin of the electrons by dots and crosses.	Notes on covalent bonding in some of these molecules: http://www.rjclarkson.demon.co.uk/middle/bindinstruct..htm#covalent

3.2 (b) (S)	Describe the electron arrangement in more complex covalent molecules such as N_2, C_2H_4, CH_3OH and CO_2.	Use overlapping circles to show where the electrons are. Students should distinguish the origin of the electrons by dots and crosses.	Notes on covalent bonding in some of these molecules: http://www.rjclarkson.demon.co.uk/middle/bindinstruct..htm#covalent
3.2 (b)	Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds.	Students can be given samples of salt, powdered wax and silver sand as three examples of white solids. They can carry out experiments to identify the bonding in each. For advanced students, sugar can be given as an additional example to show that some simple covalent compounds are soluble in water. A database could be set up for a range of compounds of all bonding types with fields for each property. More advanced students could be asked to design questions based on the properties which would produce lists of compounds with a particular bonding type.	
3.2 (c)	Describe the giant covalent structures of graphite and diamond.	Ball and spoke models will be useful here.	
3.2 (c)	Relate their structures to the use of graphite as a lubricant and of diamond in cutting.	Refer to the bonded/non-bonded nature of the electrons in the two compounds. Discuss the importance of the one-directional strength of graphite to its use as a re-inforcer for fishing rods, sports rackets and modern polymer based materials such as those used to build aircraft.	

3.2 (c) (S)	Describe the macromolecular structure of silicon(IV) oxide (silicon dioxide).	Ball and spoke models will be useful here. Note the similarities between this and diamond.	http://mineral.galleries.com/minerals/silicate/quartz.htm
3.2 (c) (S)	Describe the similarity in properties between diamond and silicon(IV) oxide , related to their structures.		
3.2 (d)	Describe metallic bonding as a lattice of positive ions in a ‘sea of electrons’ and use this to describe the electrical conductivity and malleability of metals.	Emphasize the 'free' electrons in the metallic structure.	