

## Scheme of work – Cambridge IGCSE<sup>®</sup> Chemistry (US) 0439

### Unit 7: Covalent bonding

#### Recommended prior knowledge

Basic knowledge of atomic structure, ionic bonding and the layout of the Periodic Table.

#### Context

This unit builds on Unit 2 and 6. The concepts of this unit will be revisited in Unit 9.

#### Outline

This unit starts by looking at covalent bonding in simple molecules and comparing their properties to those of ionic compounds. Giant covalent structures are introduced and their key features explored. Opportunity for students, in groups, to make models of these giant structures. This unit is cross-referenced to assessment objectives A1–4, B1–5, C1–3 and Units 2 and 6.

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

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
3.2(b)	Describe the formation of single covalent bonds in H <sub>2</sub> , Cl <sub>2</sub> , H <sub>2</sub> O, CH <sub>4</sub> and HC/ as the sharing of pairs of electrons leading to the noble gas configuration	Use overlapping circles to show where the bonding electrons are. Students should distinguish the origin of the electrons by dots and crosses.  Students can use mini-whiteboards to draw electron diagrams as a class activity.	Notes on covalent bonding in some of these molecules: <a href="http://www.docbrown.info/page04/4_72bond3.htm">www.docbrown.info/page04/4_72bond3.htm</a> Link does not work
3.2(b) (S)	<b>Describe the electron arrangement in more complex covalent molecules such as N<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>, CH<sub>3</sub>OH and CO<sub>2</sub></b>	As above examples.  Extension – some complicated examples like AsCl <sub>3</sub> , SO <sub>3</sub> , PCl <sub>5</sub> and BF <sub>3</sub> and example.	

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3.2(b)	Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds	<p>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.</p> <p>For advanced students, sugar can be given as an additional example to show that some simple covalent compounds are soluble in water.</p> <p>A database could be set up for a range of compounds of all bonding types with fields for each property.</p> <p>More advanced students could be asked to design questions based on the properties which would produce lists of compounds with a particular bonding type.</p>	
3.2(c)	Describe the giant covalent structures of graphite and diamond	<p>Ball and spoke models will be useful here.</p> <p>Emphasise key features in their structures:</p> <ul style="list-style-type: none"> <li>• Graphite: <ul style="list-style-type: none"> <li>○ Each carbon attached to three other carbon atoms;</li> <li>○ Hexagonal ring layered lattice structure;</li> <li>○ Delocalised electrons within each layer;</li> <li>○ Weak intermolecular forces between the layers.</li> </ul> </li> <li>• Diamond: <ul style="list-style-type: none"> <li>○ Each carbon forms four covalent bonds with other carbon atoms;</li> <li>○ Each carbon has a tetrahedral arrangement;</li> <li>○ All electrons are localised in covalent bonds.</li> </ul> </li> </ul>	<p>Good interactive site on giant covalent bonding: <a href="http://www.avogadro.co.uk/structure/chemstruc/network/g-molecular.htm">www.avogadro.co.uk/structure/chemstruc/network/g-molecular.htm</a></p>

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3.2(c)	Relate their structures to the use of graphite as a lubricant and of diamond in cutting	<p>Relate the above key features to the properties of graphite and diamond – high melting/boiling point, conductivity, hardness.</p> <p>Discuss the importance of the one-directional strength of graphite to its use as to reinforce fishing rods, sports rackets and modern polymer based materials such as those used to build aircraft.</p>	
<b>3.3(c) (S)</b>	<b>Describe the macromolecular structure of silicon(IV) oxide (silicon dioxide)</b>	<p>Ball and spoke models will be useful here.</p> <p>Note the similarities and differences between SiO<sub>2</sub> and diamond.</p>	<p>Practical activity to compare the differences between SiO<sub>2</sub> and CO<sub>2</sub>:  <a href="http://www.schools.longman.co.uk/gcsechemistry/worksh eets/index.html">www.schools.longman.co.uk/gcsechemistry/worksh eets/index.html</a></p>
<b>3.3(c) (S)</b>	<b>Describe the similarity in properties between diamond and silicon(IV) oxide, related to their structures</b>	<p>Emphasise the key features in SiO<sub>2</sub>:</p> <ul style="list-style-type: none"> <li>• tetrahedral arrangement of silicon atoms</li> <li>• an oxygen atom between each pair of silicon atoms</li> <li>• each silicon forms four covalent bonds to other oxygen atoms</li> <li>• each oxygen forms two covalent bonds to other silicon atoms</li> </ul>	<p><a href="http://www.chemguide.co.uk/atoms/structures/giantcov.html">www.chemguide.co.uk/atoms/structures/giantcov.html</a></p>