

Topic 4: Bonding (12.5 hours)

4.1 Ionic bonding

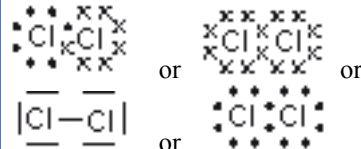
2 hours

	Assessment statement	Obj	Teacher's notes
4.1.1	Describe the ionic bond as the electrostatic attraction between oppositely charged ions.	2	
4.1.2	Describe how ions can be formed as a result of electron transfer.	2	
4.1.3	Deduce which ions will be formed when elements in groups 1, 2 and 3 lose electrons.	3	
4.1.4	Deduce which ions will be formed when elements in groups 5, 6 and 7 gain electrons.	3	
4.1.5	State that transition elements can form more than one ion.	1	Include examples such as Fe^{2+} and Fe^{3+} .
4.1.6	Predict whether a compound of two elements would be ionic from the position of the elements in the periodic table or from their electronegativity values.	3	
4.1.7	State the formula of common polyatomic ions formed by non-metals in periods 2 and 3.	1	Examples include NO_3^- , OH^- , SO_4^{2-} , CO_3^{2-} , PO_4^{3-} , NH_4^+ , HCO_3^- .
4.1.8	Describe the lattice structure of ionic compounds.	2	Students should be able to describe the structure of sodium chloride as an example of an ionic lattice.

4.2 Covalent bonding

6 hours

	Assessment statement	Obj	Teacher's notes
4.2.1	Describe the covalent bond as the electrostatic attraction between a pair of electrons and positively charged nuclei.	2	Single and multiple bonds should be considered. Examples should include O_2 , N_2 , CO_2 , HCN , C_2H_4 (ethene) and C_2H_2 (ethyne).
4.2.2	Describe how the covalent bond is	2	Dative covalent bonds are required.

	formed as a result of electron sharing.		Examples include CO, NH ₄ ⁺ and H ₃ O ⁺ .
4.2.3	Deduce the Lewis (electron dot) structures of molecules and ions for up to four electron pairs on each atom.	3	<p>A pair of electrons can be represented by dots, crosses, a combination of dots and crosses or by a line. For example, chlorine can be shown as:</p>  <p>Note: Cl-Cl is not a Lewis structure.</p>
4.2.4	State and explain the relationship between the number of bonds, bond length and bond strength.	3	<p>The comparison should include the bond lengths and bond strengths of:</p> <ul style="list-style-type: none"> two carbon atoms joined by single, double and triple bonds the carbon atom and the two oxygen atoms in the carboxyl group of a carboxylic acid.
4.2.5	Predict whether a compound of two elements would be covalent from the position of the elements in the periodic table or from their electronegativity values.	3	
4.2.6	Predict the relative polarity of bonds from electronegativity values	3	Aim 7: Simulations may be used here.
4.2.7	Predict the shape and bond angles for species with four, three and two negative charge centres on the central atom using the valence shell electron pair repulsion theory (VSEPR).	3	<p>Examples should include CH₄, NH₃, H₂O, NH₄⁺, H₃O⁺, BF₃, C₂H₄, SO₂, C₂H₂ and CO₂.</p> <p>Aim 7: Simulations are available to study the three-dimensional structures of these and the structures in 4.2.9 and 4.2.10.</p>
4.2.8	Predict whether or not a molecule is polar from its molecular shape and bond polarities.	3	
4.2.9	Describe and compare the structure and bonding in the three allotropes of carbon (diamond, graphite and C ₆₀ fullerene).	3	
4.2.10	Describe the structure of and bonding in silicon and silicon dioxide.	2	

4.3 Intermolecular forces

2 hours

	Assessment statement	Obj	Teacher's notes
4.3.1	Describe the types of intermolecular forces (attractions between molecules that have temporary dipoles, permanent dipoles or hydrogen bonding) and explain how they arise from the structural features of molecules.	3	The term van der Waals' forces can be used to describe the interaction between non-polar molecules.
4.3.2	Describe and explain how intermolecular forces affect the boiling points of substances.	3	The presence of hydrogen bonding can be illustrated by comparing: <ul style="list-style-type: none">• HF and HCl• H₂O and H₂S• NH₃ and PH₃• CH₃OCH₃ and CH₃CH₂OH• CH₃CH₂CH₃, CH₃CHO and CH₃CH₂OH.

4.4 Metallic bonding

0.5 hour

	Assessment statement	Obj	Teacher's notes
4.4.1	Describe the metallic bond as the electrostatic attraction between a lattice of positive ions and delocalized electrons.	2	
4.4.2	Explain the electrical conductivity and malleability of metals.	3	Aim 8: Students should appreciate the economic importance of these properties and the impact that the large-scale production of iron and other metals has made on the world.

4.5 Physical properties

2 hours

	Assessment statement	Obj	Teacher's notes
4.5.1	Compare and explain the properties of substances resulting from different types of bonding.	3	Examples should include melting and boiling points, volatility, electrical conductivity and solubility in non-polar and polar solvents.