SCHOLAR Lesson Outline

curriculum for excellence

subject: Chemistry

Title: Unit 1 -Topic 8 - Intermolecular Bonding

level: CfE Higher

Activity type	classroom ☑ homework ☑ independent learning ☑ other ☐
Activity objectives(s)	At the end of this topic, you should know that: • All molecular elements and compounds and monatomic elements condense and freeze at sufficiently low temperatures. For this to occur, some attractive forces must exist between the molecules or discrete atoms. • Any 'intermolecular' forces acting between molecules are known as van der Waals' forces. • There are several different types of van der Waals' forces such as London dispersion forces and permanent dipole: permanent dipole interactions, which include hydrogen bonding. • London dispersion forces are forces of attraction that can operate between all atoms and molecules. • These forces are much weaker than all other types of bonding. • They are formed as a result of electrostatic attraction between temporary dipoles and induced dipoles caused by movement of electrons in atoms and molecules. • The strength of London dispersion forces is related to the number of electrons within an atom or molecule. • A molecule is described as polar if it has a permanent dipole. • The spatial arrangement of polar covalent bonds can result in a molecule being polar. • Permanent dipole-permanent dipole interactions are additional electrostatic forces of attraction between polar molecules. • Permanent dipole-permanent dipole interactions are stronger than London dispersion forces for molecules with similar numbers of electrons. • Bonds consisting of a hydrogen atom bonded to an atom of a strongly electronegative element such fluorine, oxygen or nitrogen are highly polar. • Hydrogen bonds are electrostatic forces of attraction between molecules which contain these highly polar bonds. • A hydrogen bond is stronger than other forms of permanent dipole-permanent dipole interaction but weaker than a covalent bond. • Melting points, boiling points and viscosity can all be rationalised in terms of the nature and strength of the intermolecular forces which exist between molecules. • By considering the polarity and number of electrons present in molecules, it is possible to make qualitative predictions of the strength of the intermolecular forces. • The melting and boiling points of polar substances are higher than the melting and boiling points of non-polar substances with similar numbers of electrons. • The anomalous boiling points of ammonia, water and hydrogen fluoride are a result of hydrogen bonding. • Boiling points, melting points, viscosity and solubility/miscibility in water are properties of substances which are affected by hydrogen bonding. • Hydrogen bonding between molecules in ice results in an expanded structure which causes the density of ice to be less than that of water at low temperatures.
Activity resources(s)	Students will need access to the internet and their SCHOLAR login details. Students will need access to a data book.
Delivery mode	teacher led ☑ student led ☑
Collaboration type	individual ☑ pairs ☐ groups ☑

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Task description	Computer task Get pupils to navigate to the correct topic - Higher (CfE) Chemistry Unit 1 Topic 1.8 - Intermolecular Forces. Navigate through the topic and complete the end of topic test for homework. Students should be familiar with how to use their data books to source periodicity information. • The relationship between the strength of London forces and the number of electrons can be shown by plotting the melting or boiling points for the noble gases or for the halogens — information available from websites such as Web Elements. • A practical demonstration of the polarity of molecules is provided by experiments in which liquids are deflected by a static charge. Classic experiments would include allowing learners to experiment with the use of charged rods to deflect a stream of polar liquid flowing from a burette, but there are also more unusual variations such as the deflection of syrup by a charged balloon. • The effect of the polarity of a molecule on the strength of intermolecular forces can be illustrated by comparing molecules with similar numbers of electrons but differing polarity, for example bromine and iodine monochloride. (Br2, 70 electrons, non-polar, mp –7 ºC) (ICl, 70 electrons, polar, mp +27 ºC) • Water can be placed into sealed glass bottles and frozen, demonstrating the formation of the hydrogen bonded lattice structure which causes the anomalously large volume for frozen water. • Hydrogen bonding is also responsible for the surface tension of water can be demonstrated using classic experiments such as the floating needle on the surface of a glass of water, or adding coins to a wine glass full of water to demonstrate the level rising above the rim of the glass. • Hydrogen bonding is at the heart of ‘hydrogel’ materials. Examples of which are easily obtained from disposable nappies (see Inspirational Chemistry, Vicky Wong, Royal Society of Chemistry, 2006, pp. 115–120). Teachers may wish to outline the role of hydrogen bonding in maintaining the shape of DNA molecules and proteins. Learners could explore the Fold It website to explore how hydrogen bonds maintain the shape adopted by proteins. • The anomalous density of ice can be demonstrated by showing that wax beads sink when dropped into molten wax in contrast to ice, which floats on water. An alternative experiment from the RSC involves placing ice cubes into vegetable oil. The ice cube floats, but on melting the liquid water descends through the oil to form a layer at the bottom of the vessel. Coloured ice can be used to enhance the visual effect. • In an investigative variation, a glass containing a layer of oil on water is placed in the freezer to see what happens. The effects of intermolecular forces on Viscosity of a variety of liquids can be shown by up filling burettes with different liquids, leaving an air bubble at the top, inverting the burettes and seeing which air bubbles more most quickly. The solubilities/miscibilities of a variety of substances can be investigated to prove the rule "like dissolves like". Focus on definitions of "Intermolecular", "Intramolecular", "Van der Waals' Forces", "Polar Covalent Bond","Hydrogen Bonding", "Dipole", "Permanent Dipole Interactions", "London Dispersion Forces" and "Viscosity". Also focus on the ability of students to describe why each of these trends arises. Whole class You may wish to give feedback to students on their progress. Display a report of the exercise. Card sorts can be a good way of checking students understanding of the concepts covered in this topic.

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Differentiation (Alternative use)	With an able group of students,you may wish to set this as a homework task to review the topic when you have completed it. With weaker students, you may wish to carry this out as an in class activity so you can answer any questions they may have as they attempt the exercise.
Hints & Tips	This task is best done in pairs or individually. Go round the class and get students to explain their answers. Focus not only on identifying the type of intermolecular force present in a substance but also explaining how these occur and how they affect physical properties of the substance such as boiling point. It is a good idea to get students to show you their score when they finish the exercise. If they do not get full marks you can send them back to have another try while the rest of the class finish off. Some teachers like to generate a report while students are logged in so that they can be shown what the teacher can see. This will highlight progress and any pupils who are just clicking reveal, as full marks can only be achieved by entering correct answers. There is online training available to help you learn how to do this. When you are logged in you will see a course called Succeed with SCHOLAR. Unit 1 Topic 7 introduces you to the reporting system. Choose some questions for students to try from the textbook / past paper questions in advance so faster pupils can move onto these. Questions in the end of topic test give extra practice.
Notes	Pupils will need access to a data book. The SCHOLAR section of this material should take approx 30 minutes.