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By the end of this unit, the Learner should know about intermolecular forces and their effect on the physical properties of organic molecules.

LESSON:

COVALENT BONDING AND INTERMOLECULAR FORCES

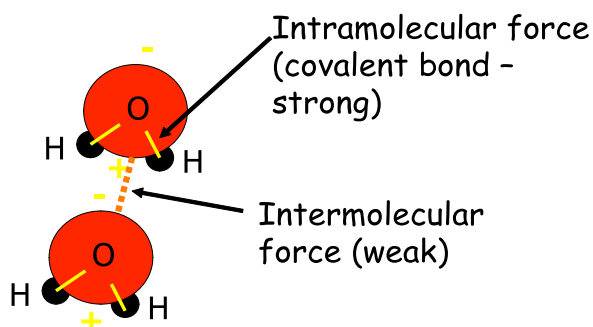
COVALENT BONDS

- ∞ Covalent bonds occur between two non metals
- ∞ Electronegativity difference of 0 non polar covalent
- ∞ Electronegativity difference of 0,1 – 1,6 polar covalent
- ∞ Electrons are shared in a covalent bond
- ∞ Forming a Chlorine molecule
 - Each atom has 7 $\bar{e}$ in the outer energy level.
 - The only way that each can achieve the octet structure, is for a pair of $\bar{e}$'s to be shared equally between them:
 - Each F atom now shares 1 $\bar{e}$ with the other therefore each has the noble gas electron structure.



INTERMOLECULAR FORCES

- ∞ Weak electrostatic forces (Coulombic forces)
- ∞ Holds together molecules (covalently bonded units)
- ∞ Between non polar molecules – London forces or instantaneous dipoles
- ∞ Between polar covalent molecules – dipole dipole van der Waals forces. Dipole-dipole is an attraction between slightly positive and slightly negative sides (poles) of the molecule.
- ∞ Hydrogen bonding between NOF (Nitrogen, Oxygen and Fluorine) bonded to hydrogen.



PHYSICAL PROPERTIES

Molecules are held together by intermolecular forces. In order to separate these molecules from each other requires energy. The stronger the intermolecular forces, the more energy that is required to separate or break these bonds. This will lead to a higher melting point, boiling point, etc

Boiling and melting points

As the strength of the intermolecular forces increase, the boiling point and melting point will increase. Thus, molecules where there are hydrogen bonds present, will have a higher melting point and boiling point than those molecules where there are weaker London forces or Van der Waals forces present.

Vapour pressure

Vapour pressure is the amount of pressure that the gaseous molecules exert above the surface of the liquid phase. The vapour pressure will decrease as the size of the molecule increases (chain length).

Vapour pressure is an indication that there are weak intermolecular forces present in the liquid phase.

Viscosity

A liquid that has a low viscosity will be able to flow more easily. Thus, where hydrogen bonds are present, there will be a much higher degree of viscosity. The opposite is true for the weak Van der Waals forces. Viscosity will also increase as the length of the carbon chain increases.

Density

The density of organic molecules will increase as the length of the chain increases.

Surface area

As the surface area of the molecule decreases, there will be lower boiling and melting points as the intermolecular forces will be weaker.

Phases

As you go down a group, either alkanes, alkenes etc, as the chain length increases, the melting and boiling points will increase. The smaller molecules will then be gases at room temperature and the longer chain lengths will be liquids or solids at room temperature.

REVIEW QUESTIONS:

The first six members of the alkanes occur as gases and liquids at normal temperatures. Alkanes are currently our most important fuels, but the use of alcohols as renewable energy source is becoming more and more important. Alcohols are liquids that might be a solution to the energy crisis.

- 1 Which chemical property of alkanes and alcohols make them suitable to be used as fuels? (2)
- 2 The table shows the boiling points of the first six alkanes and the first six alcohols.

Alkane	Boiling point (°C)	Alcohol	Boiling point (°C)
methane	- 164	methanol	65
ethane	- 89	ethanol	79
propane	- 42	1-propanol	97
butane	- 0,5	1-butanol	117
pentane	36	1-pentanol	138
hexane	69	1-hexanol	156

- Draw a graph of boiling points versus number of carbon atoms for the first six ALCOHOLS. Choose 50 °C and 1 carbon atom as origin and use an appropriate scale. Plot the points and draw the best curve through the points. (5)
- 3 What trend in boiling point can be observed from the graph? (2)
 - 4 Provide a reason for the trend mentioned in QUESTION 6.3 by referring to the type of intermolecular forces. (2)
 - 5 Explain, referring to the type of intermolecular forces, why the boiling points of alcohols are higher than the boiling points of alkanes. (2)
 - 6 People are always cautioned to keep liquids such as petrol (a mixture of alkanes) out of reach of children. Use the boiling points of alkanes and justify this precaution. (2)