

3 Bonding in Carbon Compounds

You need to be able to explain the properties of alkanes and alkenes in terms of the bonding of their molecules. You may need to revise the work you did in Year 11 on bonding. Again, the main ideas are summarised below.

Intramolecular Forces (Forces within a Molecule)

Covalent bonds are attractive forces between atoms of non-metals formed by **sharing** one or more pairs of electrons. Covalent bonds occur **within molecules** of elements (e.g. H_2 , N_2) and compounds (e.g. CO_2 , H_2O , NH_3). Covalent bonds can be **single** (1 pair of shared electrons), **double** (2 pairs of shared electrons) or **triple** (3 pairs of shared electrons).

Covalent bonds can be **polar** (atoms sharing electrons are different, e.g. in HCl) or **non-polar** (atoms sharing electrons are identical, e.g. in H_2). The atom that attracts the electron(s) more strongly is said to be more electronegative.

Molecules can be polar or non-polar depending on whether their bonds are polar or non-polar, and also on their shape. Remember, a molecule can have polar bonds and be non-polar if the bonds cancel out so that there is no net dipole.

Intermolecular Forces (Forces between Molecules)

Intermolecular forces determine the physical properties (e.g. boiling and melting points) of covalent molecular substances. There are three main types of intermolecular forces: dispersion forces, dipole-dipole forces and hydrogen bonds.

Dispersion forces are very weak, induced, temporary forces of attraction, which exist between all molecules due to constantly moving electron clouds.

Dipole-dipole forces are permanent electrostatic attractions between positive and negative ends of polar molecules caused by uneven distribution of electrons within the molecule.

Hydrogen bonds are strong attractive forces between a hydrogen atom and an atom of fluorine, oxygen or nitrogen in a nearby molecule.

For You To Do

1. Explain in terms of bonding why small molecule hydrocarbons such as methane have low melting points and are volatile.
2. Explain the meaning of the following types of bonds:
 - (a) covalent bond

- (b) polar bond
 - (c) non-polar bond
 - (d) hydrogen bond
 - (e) dispersion force
3. Explain how a substance with polar bonds can form a non-polar molecule.
 4. Identify whether intermolecular or intramolecular bonds are more important in determining the melting and boiling points of a covalent compound. Justify your answer.
 5. Identify the type of bonding present in each of the following compounds as ionic or covalent:
 - (a) sodium chloride
 - (b) water
 - (c) ammonia
 - (d) dilute hydrochloric acid
 - (e) hydrogen chloride
 - (f) sodium hydroxide
 6. Identify from the list below:
 - (a) those substances which contain any polar bonds
 - (b) those substances which have polar molecules. hydrogen, chlorine, water, methane, hydrogen chloride, ethanol, ethane
 7. The following table shows the boiling points of the alkanes C_1 to C_5 .

Table 3.1 Alkanes

Alkane	Number of carbon atoms	Boiling point ($^{\circ}C$)
Methane	1	-163.9
Ethane	2	-88.5
Propane	3	-42
Butane	4	-0.4
Pentane	5	36.2

- (a) Graph this information.
 - (b) Outline the relationship between boiling point and number of carbon atoms in the alkane molecule.
 - (c) Account for this relationship in terms of bonding.
8. Check your knowledge with this quick quiz.
 - (a) What do we call the attractive forces between hydrogen atoms and atoms of fluorine, oxygen or nitrogen in a nearby molecule?
 - (b) Name the intermolecular force present in all covalent substances.
 - (c) Identify the type of bond formed by uneven sharing of electrons.
 - (d) How many electrons are shared in a double bond?
 - (e) Do covalent bonds occur between or within molecules?