

London, dipole and hydrogen bond attractions between molecules

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Marks are given for naming the correct force and for linking it to the boiling point. Answers that say covalent bonds break on boiling lose the relevant mark. Accept equivalent wording.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB S2.2

Question 1 Boiling bromine (2 marks)

London forces are broken. The Br-Br covalent bond is within the molecule and is far stronger, so the molecules remain intact as Br₂.

Marking: 1 for London forces; 1 for covalent bonds not broken.

Question 2 Krypton and argon (3 marks)

Krypton has more electrons (36 against 18), so its electron cloud is larger and more easily distorted. Instantaneous dipoles are larger, so the **London forces are stronger** and more energy is needed to separate the atoms.

Marking: 1 for more electrons; 1 for larger instantaneous dipoles; 1 for stronger forces needing more energy.

Question 3 Alkanes and alcohols (4 marks)

- a. Alcohols boil **higher** than alkanes with the same number of carbons.
- b. Alcohols have O-H groups and form hydrogen bonds, which are stronger than the London forces between alkane molecules.
- c. As the chain lengthens the London forces become a larger part of the total attraction, so the contribution of hydrogen bonding becomes relatively smaller.

Marking: (a) 1; (b) 1 for hydrogen bonding, 1 for stronger than London; (c) 1.

Question 4 Propanol and methoxyethane (2 marks)

Propan-1-ol has an O-H group and forms **hydrogen bonds**. Methoxyethane has no H bonded to oxygen and only dipole-dipole and London forces, which are weaker.

Marking: 1 for hydrogen bonds in propan-1-ol; 1 for none in methoxyethane.

Question 5 Hydrogen bond in water (2 marks)

The hydrogen atom of one molecule is $\delta+$ because oxygen is highly electronegative. It is attracted to a **lone pair on the oxygen of a neighbouring molecule**, with the three atoms in a nearly straight line.

Marking: 1 for $\delta+$ H bonded to O; 1 for attraction to a lone pair on a neighbour.

Question 6 Energy to vaporise water (2 marks)

$n = 36.0 \div 18.0 = 2.00$ mol. Energy = $2.00 \times 40.7 =$ **81.4 kJ**.

Marking: 1 for n; 1 for the energy with unit.

Question 7 Why ice floats (3 marks)

In ice each water molecule forms four hydrogen bonds in a regular open lattice. The hydrogen bonds hold the molecules at fixed distances and leave empty spaces. In the liquid the molecules are closer together on average, so ice is **less dense**.

Marking: 1 for four hydrogen bonds; 1 for open lattice or spaces; 1 for molecules further apart than in the liquid.

Question 8 Pentane and butan-1-ol (2 marks)

Pentane has only London forces. Butan-1-ol also forms **hydrogen bonds**, which are much stronger, so more energy is needed to separate its molecules.

Marking: 1 for London only in pentane; 1 for hydrogen bonds in butan-1-ol.