

London, dipole and hydrogen bond attractions between molecules

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab answers

The model answers link each temperature fall to the forces between molecules. Mention hydrogen bonds, dipole-dipole forces and London forces by name, and comment on the uncertainty of the thermometer.

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

Question 1 Temperature falls

Propanone: $21.0 - 5.0 = \mathbf{16.0\text{ }^{\circ}\text{C}}$. Ethanol: $21.0 - 10.5 = \mathbf{10.5\text{ }^{\circ}\text{C}}$. Propan-1-ol: $21.0 - 16.0 = \mathbf{5.0\text{ }^{\circ}\text{C}}$. Butan-1-ol: $21.0 - 18.5 = \mathbf{2.5\text{ }^{\circ}\text{C}}$.

Question 2 Pattern in the data

The **higher the boiling point, the smaller the temperature fall**. Liquids with weaker intermolecular forces evaporate faster and cool the bulb more.

Question 3 Why evaporation cools

The molecules with the highest kinetic energy escape from the surface, because they can overcome the intermolecular forces. The mean kinetic energy of the remaining liquid falls, so its temperature falls, and heat flows from the thermometer into the liquid. The thermometer **cools**.

Question 4 Propan-1-ol and ethanol

Both form hydrogen bonds. Propan-1-ol has more electrons (32 against 26), so its London forces are stronger, it evaporates more slowly, and the fall is **smaller** (5.0 against 10.5 °C).

Question 5 Propanone

Propanone has only dipole-dipole and London forces, which are weaker than hydrogen bonds. Its molecules escape easily, so it evaporates quickly and cools the thermometer most: **16.0 °C**.

Question 6 Uncertainty

Fall = start – lowest, so the uncertainties add: $0.5 + 0.5 = \mathbf{\pm 1.0\text{ }^{\circ}\text{C}}$. For butan-1-ol: $1.0 \div 2.5 \times 100 = \mathbf{40\text{ \%}}$.

Question 7 Fair test

Same volume of liquid, same size of paper, same dipping time, and the same airflow and room temperature.

Question 8 Improvement

Use a temperature probe with a data logger and repeat each liquid three times, then take the mean, so that the smallest fall (butan-1-ol) is measured with a lower percentage uncertainty.