

Predicting molecular shape, bond angles and polarity

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

The model answers treat deflection above 0.5 cm as evidence of polarity. Remember that this is a qualitative test, so link the results to shape and dipoles, and comment on the uncertainty.

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

Question 1 Mean for water

Mean = $(1.4 + 1.5 + 1.6) \div 3 = \mathbf{1.5\text{ cm}}$. Range = $1.6 - 1.4 = 0.2\text{ cm}$, so the result is $1.5 \pm 0.1\text{ cm}$.

Question 2 Classifying the liquids

Water (1.5), propanone (1.60) and ethanol (1.10) are above 0.5 cm: **polar**. Hexane (0.03) and cyclohexane (0.03) are below: **non-polar**.

Question 3 Why a polar stream is deflected

Each polar molecule has a $\delta+$ end and a $\delta-$ end. A charged rod attracts the end of opposite charge more strongly than it repels the near end, because it is closer. The molecules turn so that the opposite charge faces the rod, and the stream **is attracted toward it**.

Question 4 Shape of water

Oxygen has two bonding pairs and two lone pairs, so the molecule is **bent** (about 104.5°). The O-H bonds are polar (3.4 against 2.2) and, because of the bend, their dipoles do not cancel, giving a net dipole toward oxygen.

Question 5 Hexane

The C-H bonds have a very small difference in electronegativity (0.4), and the molecule has no atoms that are much more electronegative. Any small dipoles are spread over the chain and nearly cancel, so the net dipole is about zero and the stream is **not deflected**.

Question 6 Ethanol compared with water

Ethanol has a non-polar ethyl group that contributes little to the dipole, and its stream differs from water in viscosity and surface tension. With only three trials and a $\pm 0.1\text{ cm}$ spread, **only a rough ranking** (polar above non-polar) is justified, not a precise one.

Question 7 Controlling variables

Same burette tap opening (flow rate), same distance of the rod from the stream and height below the tap, same charging of the rod (same number of rubs) and the same temperature.

Question 8 Improvement

Fix the rod in a clamp at a measured distance and photograph the stream against a ruler, so the deflection is read from the image instead of by eye.