

Forces between particles and what they decide

AP Chemistry · Lab answers

Model answers use the sample data above. Your own readings will differ, but the order of the liquids and the reasoning should match. Always quote numerical answers with units and a sensible number of significant figures.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 3

Question 1 Calculate the temperature drops

$\Delta T = \text{start} - \text{lowest}$. Water: $22.0 - 18.8 = 3.2\text{ }^{\circ}\text{C}$; ethanol: $22.0 - 12.9 = \mathbf{9.1\text{ }^{\circ}\text{C}}$; propanone: $22.0 - 8.2 = 13.8\text{ }^{\circ}\text{C}$. All entries are correct.

Question 2 Rank the liquids

Propanone ($13.8\text{ }^{\circ}\text{C}$) > ethanol ($9.1\text{ }^{\circ}\text{C}$) > water ($3.2\text{ }^{\circ}\text{C}$).

Question 3 Link the order to forces

Water and ethanol: hydrogen bonding; propanone: dipole-dipole. Weaker forces mean more molecules escape per second, so evaporation is faster and the cooling is quicker and larger. **The weaker the forces, the larger the cooling**; water, with the most hydrogen bonds per molecule, cools least.

Question 4 Why water cools least

Cooling depends on energy removed per second = rate of evaporation $\times \Delta H_{\text{vap}}$. Water evaporates much more slowly because its vapour pressure at $22\text{ }^{\circ}\text{C}$ (about 2.6 kPa) is far below that of propanone (about 25 kPa), so the **rate dominates over the larger ΔH_{vap}** .

Question 5 Rate of cooling

Rate = $(22.0 - 19.4) / 15 = 2.6 / 15 = \mathbf{0.17\text{ }^{\circ}\text{C/s}}$.

Question 6 Control of variables

Same volume (1.0 mL) so the same amount evaporates; same air flow so evaporation is not helped more in one run; same starting temperature so the vapour pressure curve starts at the same point. **Without control the comparison is not valid.**

Question 7 Uncertainty

ΔT is a difference of two readings, so the uncertainties add: ± 0.2 °C. Percentage = $0.2 / 3.2 \times 100 = \mathbf{6 \text{ percent}}$; for propanone it is $0.2/13.8 = 1.4$ percent.

Question 8 Improvement

Use a temperature probe with data logging every second, so the true minimum is captured and the rate of cooling can be plotted. **This removes timing error from 15 s readings.**