

Forces between particles and what they decide

AP Chemistry · Lab

Name: _____ Date: _____ Class: _____

Evaporation takes energy from the liquid, so a wet thermometer bulb cools. If intermolecular forces really control how easily molecules escape, three liquids should give different temperature drops. This lab uses simple equipment to test that idea and to see why water behaves differently from its energy data.

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

Aim

To compare the strength of intermolecular forces in water, ethanol and propanone by measuring the cooling caused by evaporation.

Equipment

- alcohol-in-glass or digital thermometer (resolution 0.1 °C)
- cotton wool and elastic band
- 3 small beakers with water, ethanol and propanone (10 mL each)
- pipette or dropper
- stopwatch
- small fan on a low setting

Safety

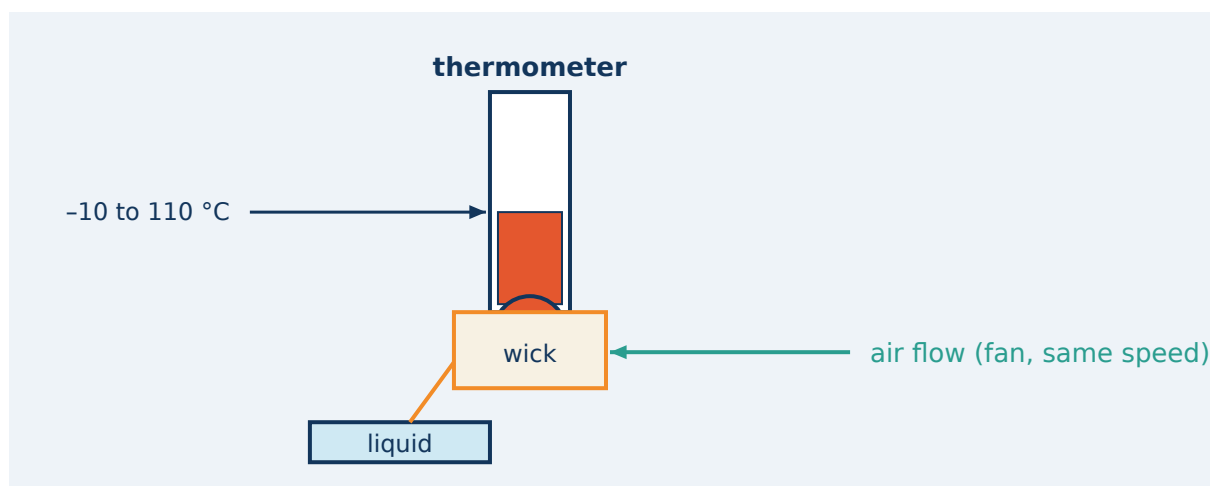
Safety

Ethanol and propanone are highly flammable: no flames or hot surfaces nearby. Work in a ventilated room, wear goggles and keep the bottles closed when not in use. Do not breathe the vapour.

Method

1. Wrap a small piece of cotton wool around the thermometer bulb and fix it with the band.
2. Record the room temperature with the dry thermometer for one minute.
3. Add 1.0 mL of the first liquid onto the cotton wool using the pipette.
4. Start the fan and the stopwatch; record the temperature every 15 s for 3 minutes.
5. Note the minimum temperature reached. Dry and replace the cotton wool.
6. Repeat for the other two liquids, starting each when the thermometer is back at room

temperature.



Evaporative cooling set-up.

Results

Sample data from a school lab, room temperature 22.0 °C:

Liquid	Lowest temperature (°C)	ΔT (°C)	Time to lowest (s)	ΔH_{vap} (kJ/mol)
Water	18.8	3.2	150	40.7
Ethanol	12.9	9.1	90	38.6
Propanone	8.2	13.8	60	31.3

Analysis questions

Question 1 Calculate the temperature drops

Check that the ΔT values in the table are correct. Show one calculation.

Question 2 Rank the liquids

Rank the three liquids from the largest to the smallest cooling.

Question 3 Link the order to forces

Name the strongest intermolecular force in each liquid and explain how the order of cooling relates to it.

Question 4 Why water cools least

Water has the largest ΔH_{vap} . Explain why it still gives the smallest drop.

Question 5 Rate of cooling

Using the first 15 s data of propanone, 22.0 to 19.4 °C, calculate the average rate of cooling in °C/s.

Question 6 Control of variables

Name three variables you controlled and explain why each matters.

Question 7 Uncertainty

The thermometer reads to ± 0.1 °C. Calculate the uncertainty in ΔT for water and its percentage.

Question 8 Improvement

Suggest one improvement and say what it would achieve.