

London, dipole and hydrogen bond attractions between molecules

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

Name: _____ Date: _____ Class: _____

Why does ethanol feel colder than butanol on your skin? In this lab you measure the cooling caused by four evaporating liquids and use the data to compare the strength of their intermolecular forces.

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

Aim

To compare how quickly four liquids evaporate by measuring the temperature fall on a thermometer, and to link the result to intermolecular forces.

Equipment

- Thermometer or temperature probe (to 0.5 °C)
- Four small beakers containing 10 cm³ each of propanone, ethanol, propan-1-ol and butan-1-ol
- Filter paper strips and elastic bands
- Stopclock
- Safety goggles

Safety

Safety

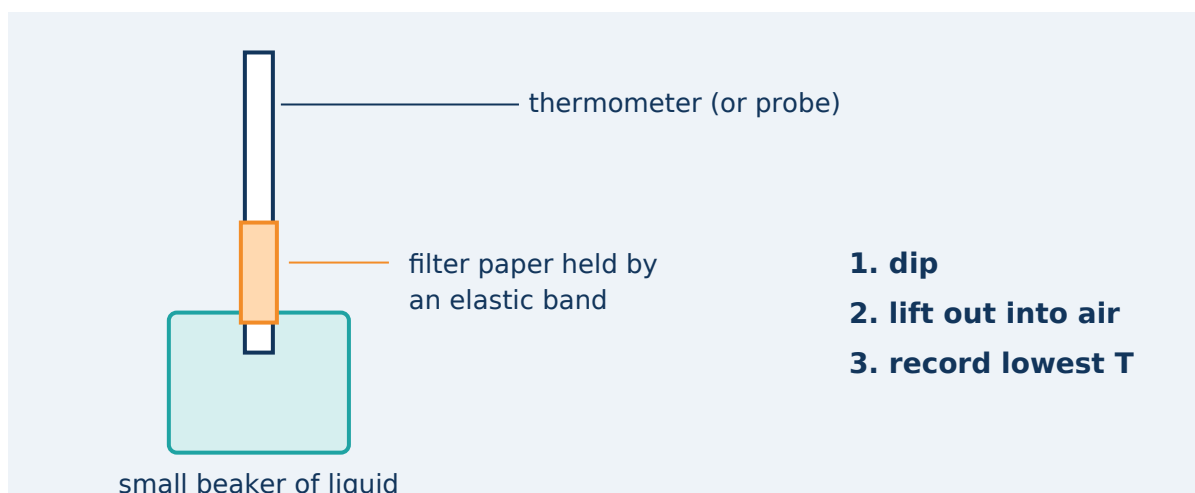
All four liquids are flammable and their vapours are harmful: no flames, work in a well-ventilated room, keep lids on the beakers when not in use and wear goggles. Dispose of the wet paper as directed by your teacher.

Method

1. Wrap a strip of filter paper round the bulb of the thermometer and secure it with an elastic band.
2. Record the room temperature with the dry thermometer.
3. Dip the covered bulb into the first liquid for 30 seconds.
4. Take it out, hold it in still air and read the temperature every 15 seconds for 3 minutes.

Note the lowest temperature.

5. Use a fresh paper strip and repeat for each liquid.



The paper-wrapped thermometer is dipped in a liquid and the lowest temperature reached as it evaporates is recorded.

Results

Wanjiru in Nairobi recorded these results (thermometer reading $\pm 0.5^\circ\text{C}$). Boiling points are from a data book.

Liquid	Boiling point / $^\circ\text{C}$	Starting temperature / $^\circ\text{C}$	Lowest temperature / $^\circ\text{C}$
Propanone	56	21.0	5.0
Ethanol	78	21.0	10.5
Propan-1-ol	97	21.0	16.0
Butan-1-ol	117	21.0	18.5

Analysis questions

Question 1 Temperature falls

Calculate the fall in temperature for each liquid.

Question 2 Pattern in the data

Describe the relationship between boiling point and temperature fall.

Question 3 Why evaporation cools

Explain why the thermometer cools when a liquid evaporates from the paper.

Question 4 Propan-1-ol and ethanol

Both are alcohols that form hydrogen bonds. Explain why propan-1-ol cools the thermometer less than ethanol.

Question 5 Propanone

Propanone cannot form hydrogen bonds yet shows the biggest fall. Explain.

Question 6 Uncertainty

The thermometer reading has an uncertainty of ± 0.5 °C. Calculate the uncertainty in a temperature fall and the percentage uncertainty for butan-1-ol.

Question 7 Fair test

State three variables to control.

Question 8 Improvement

Suggest one way to make the results more reliable.