Distillation

Student activity • teacher demonstration

YEAR 10 / LESSON 6 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

How can a solvent be collected from a coloured solution?

Observe a teacher-operated simple distillation of water containing a small amount of non-volatile food colouring. Follow evaporation and condensation, and record evidence without assuming a colourless liquid is pure. Then use a diagram to explain fractional distillation of miscible liquids. The fractional-distillation discussion is a model, not an ethanol experiment.

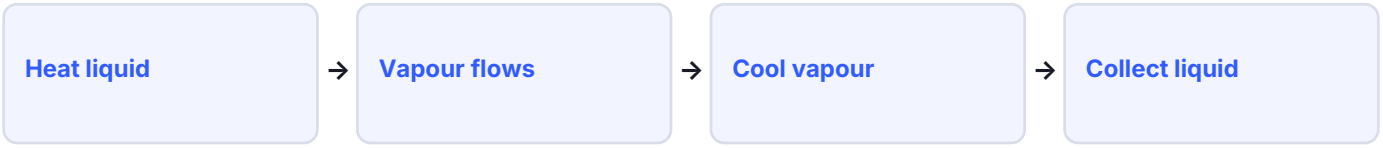
Equipment

- Student booklet, pencil and ruler; eye protection when observing the demonstration
- Teacher demonstration: 100 cm^3 round-bottom flask with 40 cm^3 dilute aqueous food colouring
- Compatible distillation head, thermometer adaptor, thermometer and Liebig condenser
- Open receiver, stands and clamps, secure water tubing and sink drainage
- Suitable controlled electric heater matched to the flask, heatproof mat and anti-bumping granules
- Unheated fractionating column or labelled diagram for explanation; no ethanol required

Teacher demonstration only. Wear eye protection and remain behind the teacher's marked viewing line. Do not touch the heater, glassware, cooling hoses or distillate. The apparatus must stay open to the atmosphere; never seal the receiver. Steam and hot glass can burn. No tasting, smelling or ignition tests. Report leaks immediately and let the teacher stop heating.

Course coverage: 1.10: simple and fractional distillation.

Process map • conceptual, not an apparatus drawing



Use your observed apparatus to explain each stage. This map does not show supports, the heating controls or the condenser cooling-water circuit.

Method and reasoning

Read the whole sequence before starting

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1. Before heating, sketch the teacher's apparatus. Label the flask, thermometer sensing region, condenser water jacket and open receiver. Draw separate arrows for vapour flow and cooling-water flow.

2. Identify where liquid will evaporate and where vapour will condense. Predict whether the colour will travel with the collected liquid; write a reason before observing.

3. Watch the teacher establish a gentle cooling-water flow and then warm the solution electrically. Students do not assemble, heat or adjust the apparatus.

4. Record the initial solution colour, the appearance of the collected liquid and the remaining flask contents. Record a vapour temperature only if the teacher supplies an actual reading with units.

5. After the teacher stops heating, compare prediction and observation. Explain why a colourless distillate alone does not prove that it contains only water.

6. Study the unheated fractionating column or diagram. Explain how repeated condensation and evaporation can enrich the vapour in the more volatile component of a liquid mixture.

7. Use the reference boiling points, ethanol about 78 °C and water about 100 °C at atmospheric pressure, to explain why the first fraction of their mixture is usually ethanol-rich. Do not describe it as guaranteed pure ethanol. These are reference values, not today's readings.

8. Compare simple and fractional distillation. Explain why filtration cannot separate two miscible liquids, and why a fractionating column is unnecessary for this water/non-volatile-dye demonstration.

Cleanup

• Students return worksheets and eye protection as directed. Only the teacher dismantles the apparatus after cooling and manages the retained solution and distillate under school disposal arrangements.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Process	Where to look
Evaporation	Heated liquid in flask
Vapour transfer	Head and inner condenser tube
Condensation	Cooled inner tube
Collection	Receiver open to atmosphere

Reference values at atmospheric pressure: ethanol about 78 °C; water about 100 °C. These are not observed temperatures from this lesson. No ethanol is used in the demonstration.

Evidence	Prediction / explanation	Actual observation
Starting solution		
Collected distillate		
Liquid left in flask		
Vapour temperature (if supplied)		

Sketch the apparatus you observed. Mark vapour and coolant routes separately.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Where do evaporation and condensation occur?

2. Why must the receiver remain open to the atmosphere?

3. Why does cooling water enter the lower condenser connection?

4. What can colourlessness tell you, and what can it not establish?

5. What does a fractionating column add to a distillation setup?

6. Why is the first ethanol/water fraction enriched rather than necessarily pure?