CHEMISTRY LOCKDOWN

SEPARATION PROTOCOL

MELTDOWN

SET A

Critical. Traps armed. Final code reversed.

HOW TO ESCAPE

7 doors. The first one is a real practical: your teacher watches you work. The last one is a crime to solve.

1. Work every part of a door on this pack and build its code.
2. Type the code into the terminal to open the door.
3. Write down the key digit it gives you.
4. Combine all 7 key digits into the master override and escape.

TEAM NAME _____

TERMINAL _____

🔒 DOOR 1 THE PRACTICAL

SAND AND WATER

Your first lock is real. Separate the **sand** from the **water** in your beaker by filtration. Your teacher watches your whole team and judges you against every point below.

1. Goggles on from start to finish.
2. Standing up the whole time. Stools tucked in, bags and coats off the bench.
3. Equipment laid out before you start: beaker of mixture, filter funnel in a conical flask, filter paper, glass rod, wash bottle.
4. Filter paper folded into a cone and wetted so it sits snugly in the funnel.
5. Mixture stirred, then poured slowly down a glass rod.
6. Liquid never rises above the top edge of the filter paper.
7. Sand rinsed with a little distilled water from the wash bottle.
8. Filtrate is clear: no sand got through.
9. Spills wiped up at once. Bench clean, equipment back where it started.
10. Efficient: jobs shared out and finished inside the time your teacher sets.

GREEN SLIP
Every point met. The door opens.

AMBER SLIP
Sloppy. The door opens, then two **best practice** detour doors.

RED SLIP
Unsafe or a mess. The door opens, then three **lab safety** detour doors.

Type the five digit code from your slip into the terminal. Amber and red teams also get a detour sheet with their slip.

DOOR CODE ☐☐☐☐☐ KEY DIGIT ☐

🔒 DOOR 2 FILTRATION AND CRYSTALLISATION

NAME IT, GROW IT

Part 1. Name it.

Match each description to its word. residue = 1 · filtrate = 2 · solvent = 3 · solute = 4 · saturated = 5

- A solution that cannot dissolve any more solid at that temperature. ☐
- The solid left behind in the filter paper. ☐
- The solid that dissolves. ☐
- The liquid that passes through the filter paper. ☐

Part 2. Grow the crystals.

These steps make copper(II) sulfate crystals from its solution. Put the right steps in order. **2 of them are traps**: leave them out.

- **7** Stop heating when crystals form on a cold glass rod dipped into the solution.
- **4** Dry the crystals by heating them strongly in a Bunsen flame.
- **1** Leave the solution to cool so that crystals grow.
- **3** Heat the copper(II) sulfate solution in an evaporating basin to boil off some of the water.
- **9** Keep heating until all of the water has gone.
- **5** Filter off the crystals and pat them dry between filter papers.

ORDER ☐ → ☐ → ☐ → ☐

Part 3. Explain it.

Why do you stop heating before the basin is dry? ☐

1. To save gas.
2. So crystals grow slowly as it cools, giving bigger, well formed crystals, and the hot solution does not spit.
3. Because the salt would melt.

Door code = the Part 1 numbers, then the step numbers in order, then your Part 3 choice.

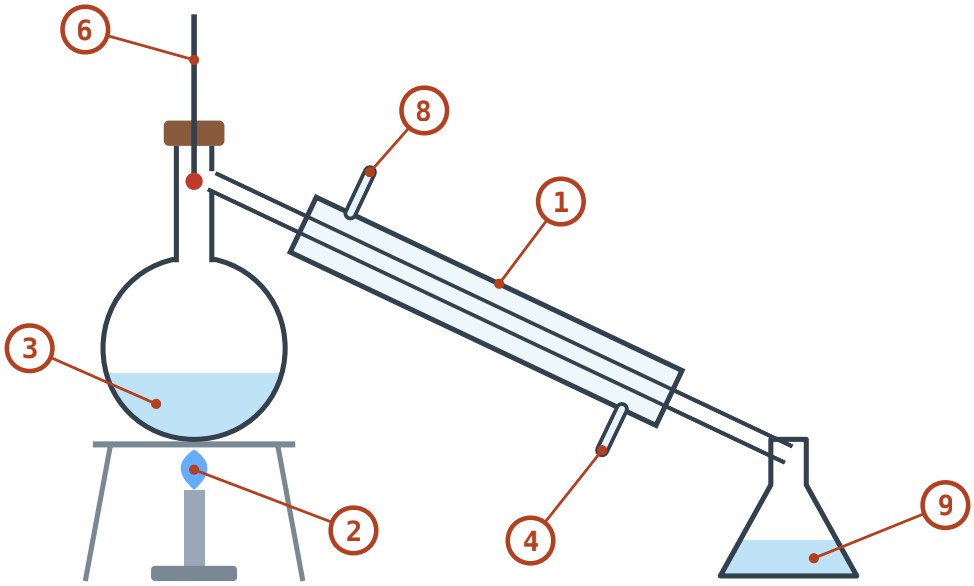
DOOR CODE ☐☐☐☐☐☐☐☐☐ KEY DIGIT ☐

🔒 DOOR 3 SIMPLE DISTILLATION

READ THE RIG

Part 1. Read the rig.

Salty water is being separated by **simple distillation**.



Which number shows where **cold water goes in**? ☐

Which number shows where **water comes out**? ☐

Which number labels the **distillate**? ☐

Part 2. Common error.

Where should the bulb of the thermometer be? ☐

1 In the boiling liquid.

2 Level with the side arm, where the vapour leaves.

3 Inside the condenser.

While pure water is collecting, what does the thermometer read, in °C? ☐☐☐

Door code = the Part 1 numbers, then your Part 2 choice, then the temperature.

DOOR CODE ☐☐☐☐☐☐☐ KEY DIGIT ☐

🔒 DOOR 4 FRACTIONAL DISTILLATION

ORDER AND GRAPH

Part 1. Collection order.

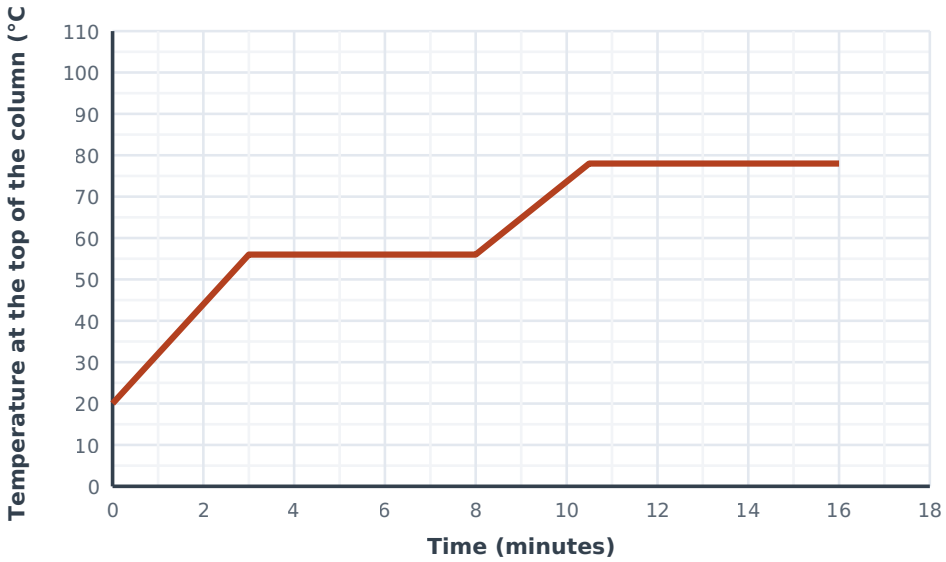
This mixture is fractionally distilled. Write the labels of the liquids in the order they collect. Leave out anything that never distils.

Label	Substance	Boiling point / °C
7	Propan-1-ol	97
2	Ethanol	78
9	Water	100
4	Propanone	56
6	Sodium chloride (dissolved)	does not boil off

ORDER ☐ → ☐ → ☐ → ☐

Part 2. Read the column.

A different mixture of **two** liquids from the table was fractionally distilled. The graph shows the temperature at the top of the column. Which liquid came over **first**, and which **second**? Write their labels.



First liquid, then second liquid ☐☐

Part 3. Explain it.

Why is a fractionating column needed for this kind of mixture? ☐

1 It cools the vapour so it turns back into liquid.

2 Vapour condenses and boils again many times up the column, so only the lowest boiling liquid reaches the top.

3 It stops the flask from boiling over.

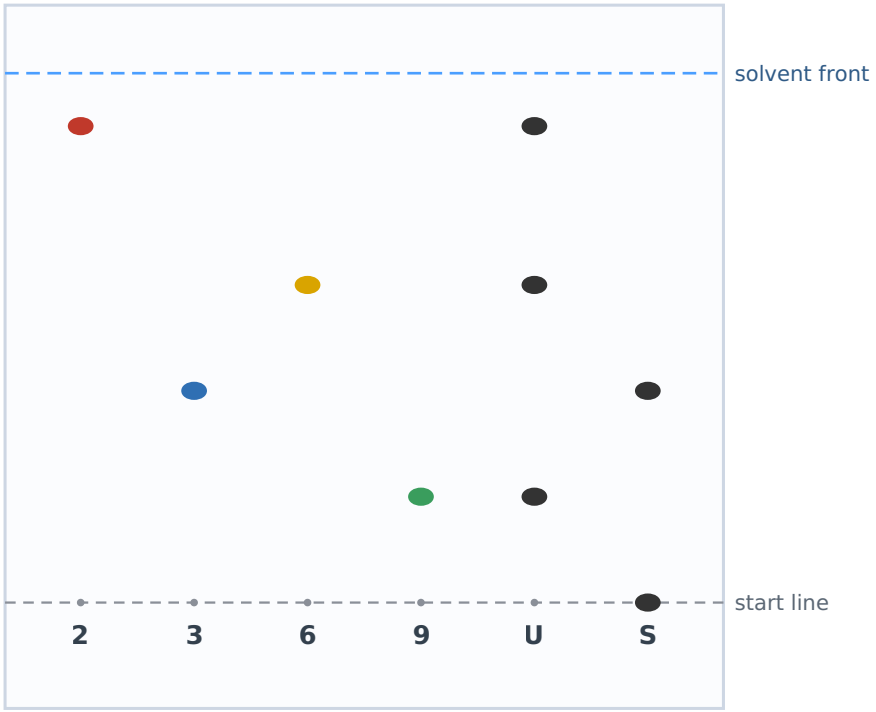
Door code = the Part 1 labels, then the two Part 2 labels, then your Part 3 choice. The flat parts of the graph are where a liquid is boiling off.

DOOR CODE ☐☐☐☐☐☐☐ KEY DIGIT ☐

🔒 DOOR 5 CHROMATOGRAPHY

MEASURE IT

This chromatogram is printed **to scale**. You need a **ruler**. Measure from the start line to the **centre** of each spot, and from the start line to the solvent front. Numbered lanes are single dyes. Lane **U** is an unknown ink, and lane **S** is a sample from a crime scene.



Part 1. R_f values.

R_f = distance moved by the spot ÷ distance moved by the solvent. Round R_f × 10 to a whole number.

R_f of dye **2**, multiplied by 10 ☐

R_f of dye **3**, multiplied by 10 ☐

R_f of dye **6**, multiplied by 10 ☐

Part 2. What is in ink U?

Write the lane numbers of the dyes in U, smallest first ☐☐☐

Part 3. Spot the mistakes.

Another student wrote up their method. **3** of these are mistakes. Write their numbers, smallest first.

1 Let each spot dry before adding more, to keep the spots small.

2 Left the paper in until the solvent ran off the top.

3 Drew the start line in pencil.

4 Measured every distance from the bottom edge of the paper.

5 Covered the beaker with a lid while the solvent rose.

6 Drew the start line in felt tip pen.

Part 4. How many lanes on this plate hold a **mixture**?

Door code = the Part 1 answers, then the Part 2 lanes, then the mistake numbers, then the Part 4 count.

DOOR CODE

KEY DIGIT

🔒 DOOR 6 PURITY AND TECHNIQUE

PURE OR NOT

Part 1. Pure or not?

A pure substance melts at one exact temperature. An impure one melts **lower** and over a **range**.

pure = 1 · impure = 2

P. Benzoic acid (pure melts at 122 °C) melts sharply at 122 °C. ☐

Q. Citric acid (pure melts at 153 °C) starts to melt at 141 °C and is fully melted by 148 °C. ☐

R. Ice (pure melts at 0 °C) melts sharply at 0 °C. ☐

S. Aspirin (pure melts at 136 °C) melts between 128 and 133 °C. ☐

Part 2. Pick the technique.

Choose the best single technique for each job. Some techniques are not needed.

1 Simple distillation	**2** Using a magnet
3 Filtration	**5** Paper chromatography
6 Crystallisation	**8** Fractional distillation

Get pure water from sea water. ☐

Separate the dyes in a food colouring. ☐

Get ethanol out of a mixture of ethanol and water. ☐

Get copper(II) sulfate crystals from its solution. ☐

Door code = the Part 1 digits, then the Part 2 technique numbers, in order.

DOOR CODE ☐☐☐☐☐☐☐☐ KEY DIGIT ☐

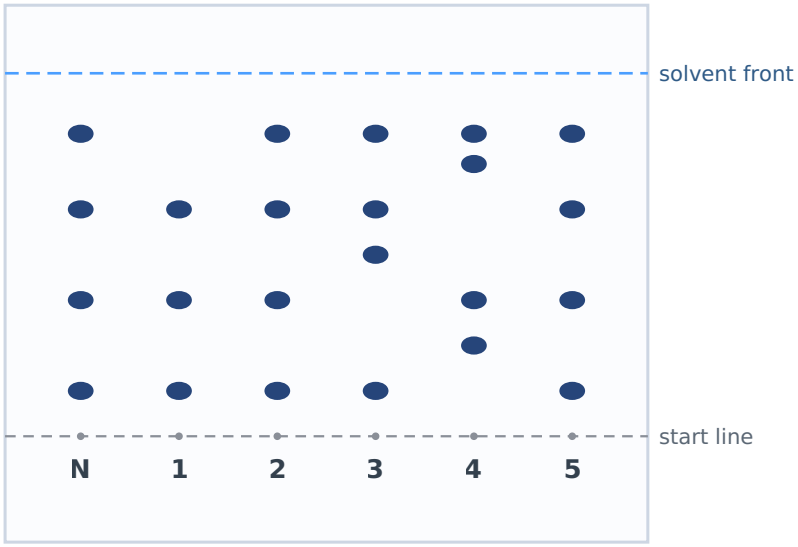
🔒 DOOR 7 THE CASE

FORENSIC BOSS

CASE FILE. Last night someone broke into the prep room and swapped the exam paper for a forgery. Five people had keys. Use all 5 pieces of evidence to name the one person who matches **every** clue.

No.	Suspect	Pen	Boots	Drinks bottle	Desk drawer	Perfume
1	**Mr Ashworth** groundsman	pen 1	chalk dust	ethanol	sodium chloride (salt)	Velvet
2	**Ms Bello** lab technician	pen 2	sand dust	ethanol	benzoic acid	Lumen
3	**Mr Carver** PE teacher	pen 3	iron filings dust	water	benzoic acid	Aurora
4	**Dr Doyle** design teacher	pen 4	sand dust	propanone	citric acid	Nocturne
5	**Mrs Evans** bursar	pen 5	sand dust	ethanol	benzoic acid	Velvet

E1 THE NOTE: ink chromatography



The forged note's ink (lane **N**) was run beside every suspect's pen (lanes numbered by pen). A pen matches only if **every** spot lines up.

Pens that match the note, smallest first ☐☐

E2 THE FOOTPRINT: centrifuge

after spinning

Mud from a footprint was shaken with water. The particles were too fine to filter, so the tube was **spun in a centrifuge**: the denser solid is forced to the bottom and the liquid can be poured off.

Tests on the solid: **It is pale yellow. It does not fizz with acid, is not magnetic and does not dissolve.**

ID	Solid	Colour	Test result
1	Chalk	white	Fizzes with dilute acid. The gas turns limewater milky.
2	Iron filings	dark grey	Pulled out by a magnet.
3	Sand	pale yellow	No fizz with acid. Not magnetic. Does not dissolve.
4	Copper(II) oxide	black	Dissolves in warm dilute acid to give a blue solution.

ID of the solid ☐

E3 THE FLASK: distillation

A flask of clear liquid left at the scene was distilled. The thermometer stayed steady at 78 °C the whole time it was collecting.

ID	Liquid	Boiling point / °C
5	Propanone	56
6	Ethanol	78
7	Water	100
8	Methanol	65

ID of the liquid ☐

E4 THE POWDER: melting point

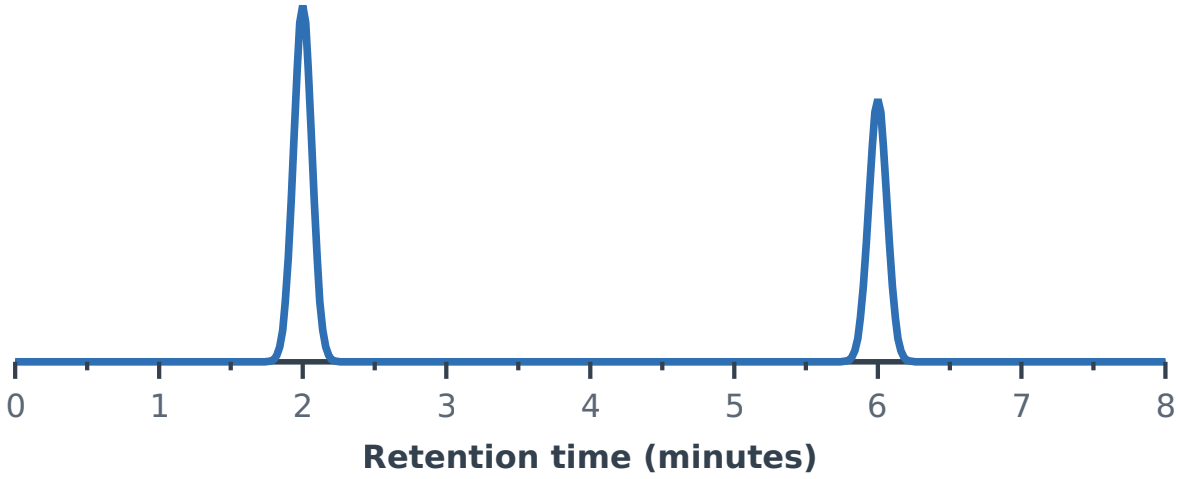
White powder spilt on the desk melted sharply at 122 °C.

ID	Substance	Melting point / °C
1	Benzoic acid	122
2	Citric acid	153
3	Sucrose (sugar)	186
4	Sodium chloride (salt)	801

ID of the powder ☐

E5 THE SCENT: gas chromatography

A swab of the note went through a **gas chromatograph**: each compound comes out of the column at its own **retention time**, just as each dye has its own R_f. Match the peaks to a perfume.



ID	Perfume	Retention times / minutes
1	Nocturne	2.0 and 4.5
2	Lumen	3.0 and 6.0
3	Velvet	2.0 and 6.0
4	Aurora	3.0 and 4.5

ID of the perfume

THE CULPRIT. Number of the only suspect who matches every clue

Door code = the matching pens, then the evidence IDs in order (E2 to E5), then the culprit's number.

DOOR CODE

KEY DIGIT

BONUS OVERRIDE VAULT

WORD SEARCH

Each clue gives only a **type** of element. Exactly one element of that type is hidden in the grid. **Find it**, then write the **chemical symbol** of each element (find iron, write **Fe**). Enter them in order 1 to 4 for the code.

Q	G	B	C	G	G	Y	O	U	V	V	B	G
M	S	F	X	V	O	T	Q	W	L	W	I	J
A	E	T	L	D	Q	Y	C	O	L	N	R	K
C	T	N	R	O	Z	F	A	O	Q	O	U	F
Z	T	U	I	O	S	B	G	N	C	U	B	Q
X	H	J	Y	T	N	B	D	L	E	J	I	H
C	Y	H	X	M	A	T	W	V	P	V	D	Q
J	Z	L	O	J	M	T	I	V	I	Z	I	Z
J	B	H	W	Q	V	V	S	U	V	Y	U	J
X	P	S	L	I	E	L	A	A	M	V	M	Z
G	C	Y	F	J	Y	J	K	O	C	S	Z	K
E	J	G	K	X	Z	M	G	K	Q	P	G	L
M	S	Q	O	G	S	X	C	O	B	A	L	T

1. An alkali metal
2. An alkaline earth metal
3. A transition metal
4. A halogen

CODE

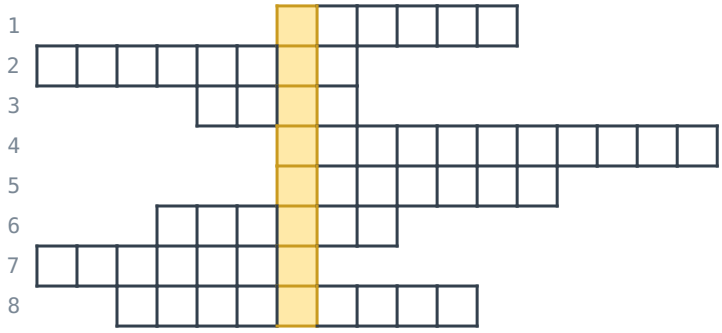
1	2	3	4

The clue only tells you the group. The grid tells you which element it is.

BONUS II OVERRIDE VAULT

CROSSWORD

Solve the clues, one letter per box. The **shaded column**, top to bottom, spells the vault password.



1. Holds the filter paper (6)
2. Iron filings are this, so a magnet can pull them out (8)
3. Crystallisation gets this back from sea water (4)
4. Measures the temperature of the vapour at the side arm (11)
5. The solid left behind in the filter paper (7)
6. Pour off a liquid gently, leaving the solid behind (6)
7. The liquid that carries dyes up chromatography paper (7)
8. Cools vapour back into a liquid (9)

Every answer crosses the shaded column at one letter.

PASSWORD

MASTER OVERRIDE

Every door green? Write your key digits in order, then enter the master code to escape.

DOOR 1	DOOR 2	DOOR 3	DOOR 4	DOOR 5	DOOR 6	DOOR 7

MELTDOWN OVERRIDE: enter your key digits REVERSED, last door first.

Enter codes at: **fourthschem.com/escaperooms/separation**