

HOW TO ESCAPE

5 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 5 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

Part 1. Name it.

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

The liquid that passes through the filter paper.

The solid left behind in 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 Stop heating when crystals form on a cold glass rod dipped into the solution.

4 Filter off the crystals and pat them dry between filter papers.

6 Heat the copper(II) sulfate solution in an evaporating basin to boil off some of the water.

8 Leave the solution to cool so that crystals grow.

ORDER → → →

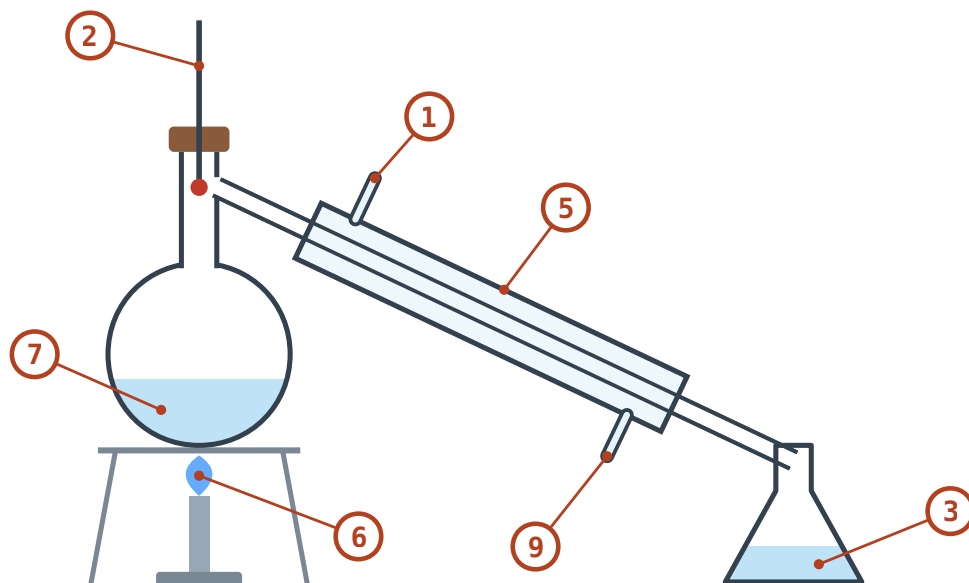
Door code = the Part 1 numbers, then the step numbers in order.

DOOR
CODE

KEY
DIGIT

Part 1. Read the rig.

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



Which number labels the **distillate**?

Which number labels the **condenser**?

Part 2. Fractional distillation.

A mixture of these liquids is fractionally distilled. In what order do they collect?

Label	Liquid	Boiling point / °C
8	Water	100
1	Methanol	65
5	Ethanol	78

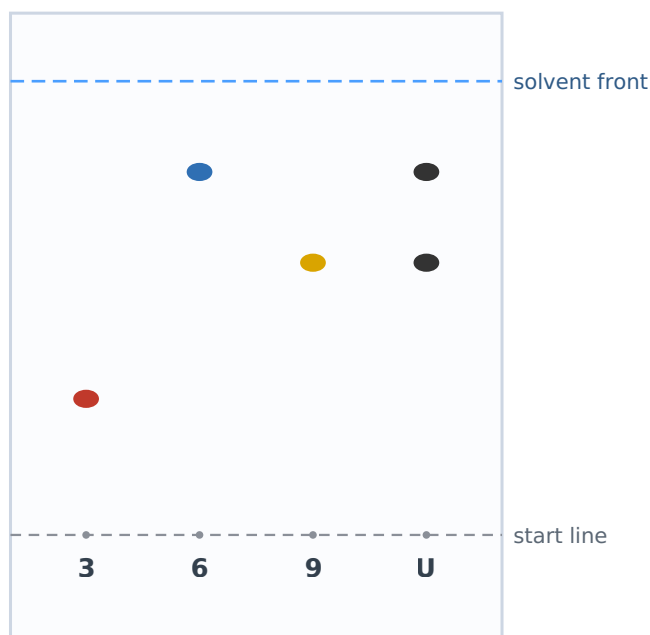
ORDER → →

Door code = the Part 1 numbers, then the labels in the order they collect.

DOOR
CODE

KEY
DIGIT

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.



Part 1. R_f values.

R_f = distance moved by the spot $\div$ distance moved by the solvent. Round $R_f \times 10$ to a whole number.

R_f of dye **3**, multiplied by 10

R_f of dye **9**, multiplied by 10

Part 2. What is in ink U?

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

Door code = the Part 1 answers, then the Part 2 lanes.

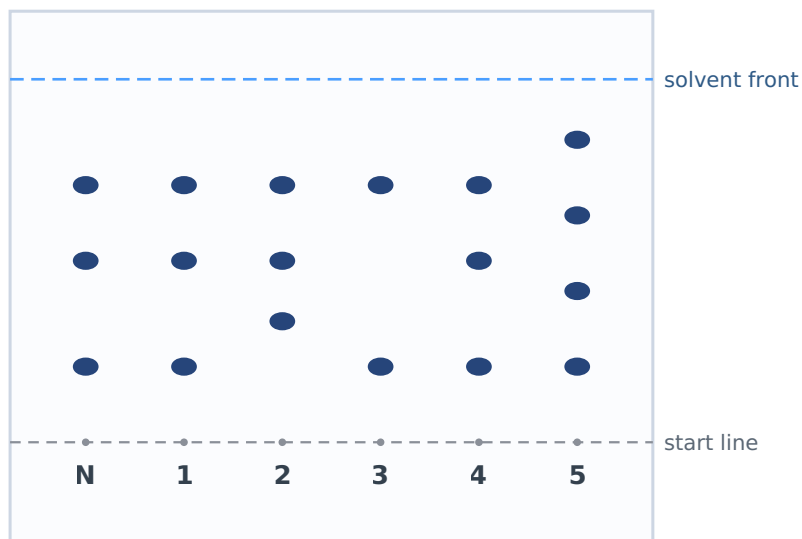
DOOR
CODE

KEY
DIGIT

CASE FILE. Last night someone broke into the prep room and swapped the exam paper for a forgery. Five people had keys. Use all 3 pieces of evidence to name the one person who matches **every** clue.

No.	Suspect	Pen	Boots	Drinks bottle
1	Mr Ashworth groundsman	pen 1	chalk dust	methanol
2	Ms Bello lab technician	pen 2	sand dust	water
3	Mr Carver PE teacher	pen 3	iron filings dust	propanone
4	Dr Doyle design teacher	pen 4	chalk dust	water
5	Mrs Evans bursar	pen 5	copper(II) oxide dust	ethanol

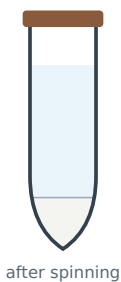
E1 THE NOTE: ink chromatography



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



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 white. It fizzes with dilute acid and the gas turns limewater milky.**

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 100 °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

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

Door code = the matching pens, then the evidence IDs in order (E2 and E3), then the culprit's number.

DOOR
CODE

KEY
DIGIT

Each clue gives only a **type** of element. Exactly one element of that type is hidden in the grid. **Find it**, then write the **first letter** of each element. Enter them in order 1 to 4 for the code.

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

1. A Group 1 metal
2. A Group 2 metal
3. A transition metal
4. A Group 7 element (a halogen)

CODE 1 2 3 4

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

MASTER OVERRIDE

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

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DOOR 1 DOOR 2 DOOR 3 DOOR 4 DOOR 5

Enter codes at: fourthschem.com/escaperooms/separation

HOW TO ESCAPE

6 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 6 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

Part 1. Name it.

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

The solid left behind in the filter paper.

The liquid that a solid dissolves in.

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. **1 of them is a trap:** leave it out.

6 Heat the copper(II) sulfate solution in an evaporating basin to boil off some of the water.

1 Keep heating until all of the water has gone.

8 Leave the solution to cool so that crystals grow.

2 Stop heating when crystals form on a cold glass rod dipped into the solution.

4 Filter off the crystals and pat them dry between filter papers.

ORDER → → →

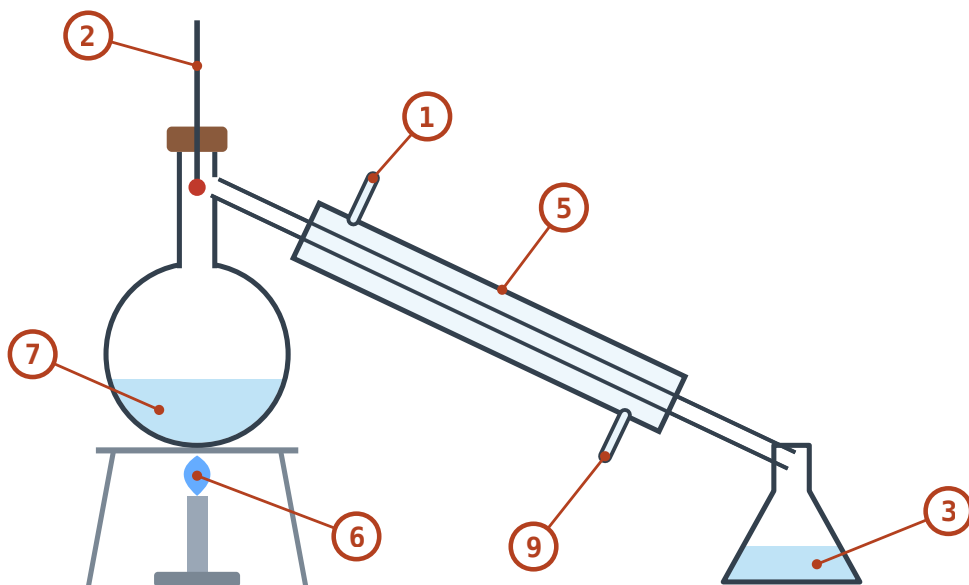
Door code = the Part 1 numbers, then the step numbers in order.

DOOR
CODE

KEY
DIGIT

Part 1. Read the rig.

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



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

Which number labels the **distillate**? ☐

Which number labels the **condenser**? ☐

Part 2. Common error.

Where should the bulb of the thermometer be? ☐

- 1 Level with the side arm, where the vapour leaves.
- 2 Touching the bottom of the flask.
- 3 In the collected distillate.

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

DOOR
CODE

KEY
DIGIT

Part 1. Collection order.

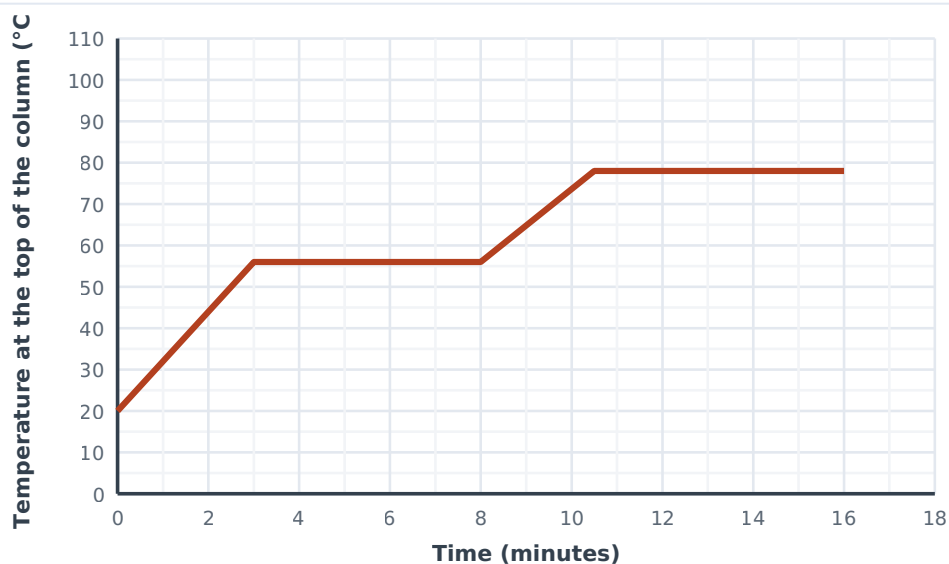
This mixture is fractionally distilled. Write the labels of the liquids in the order they collect. Leave out anything that never distils.

Label	Substance	Boiling point / °C
6	Water	100
2	Ethanol	78
9	Methanol	65
4	Propanone	56

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.



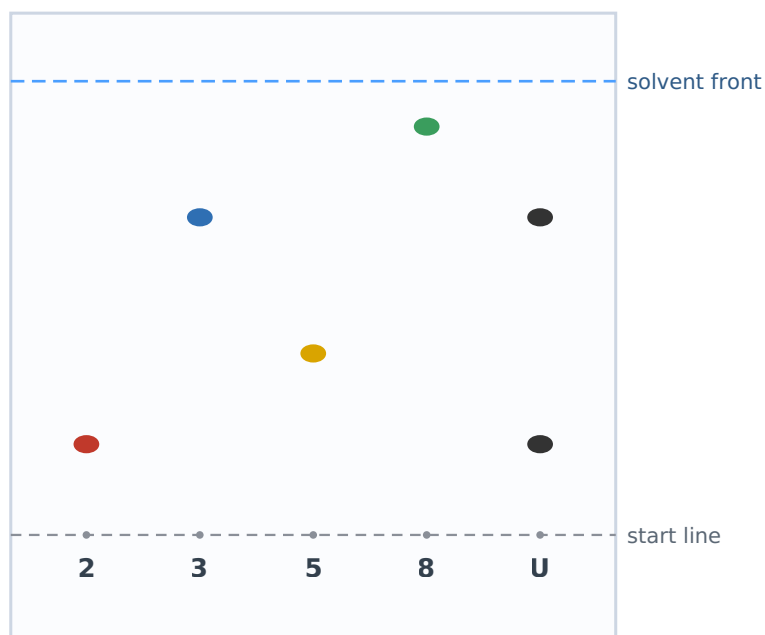
First liquid, then second liquid

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

DOOR
CODE

KEY
DIGIT

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.



Part 1. R_f values.

R_f = distance moved by the spot $\div$ distance moved by the solvent. Round $R_f \times 10$ to a whole number.

R_f of dye **2**, multiplied by 10

R_f of dye **5**, multiplied by 10

R_f of dye **8**, 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 Drew the start line in felt tip pen.
- 2 Covered the beaker with a lid while the solvent rose.
- 3 Let each spot dry before adding more, to keep the spots small.
- 4 Put in so much solvent that it covered the start line.
- 5 Marked the solvent front as soon as the paper came out.
- 6 Measured every distance from the bottom edge of the paper.

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

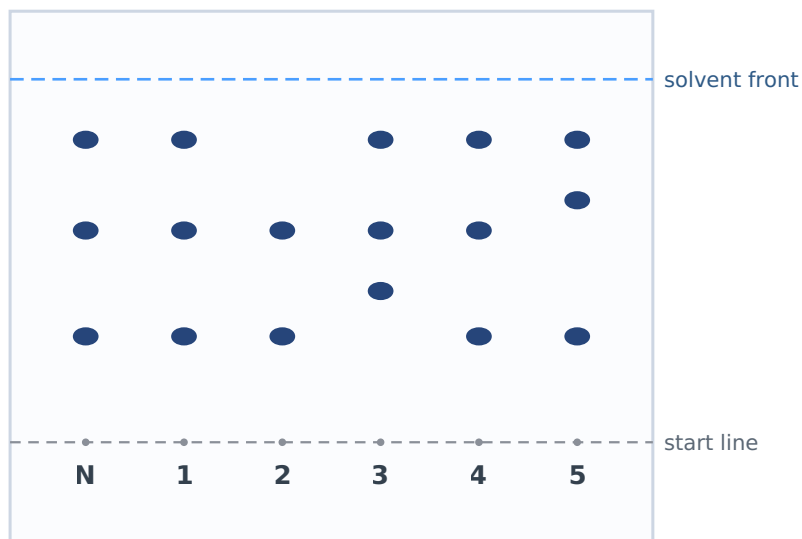
DOOR
CODE

KEY
DIGIT

CASE FILE. Last night someone broke into the prep room and swapped the exam paper for a forgery. Five people had keys. Use all 4 pieces of evidence to name the one person who matches **every** clue.

No.	Suspect	Pen	Boots	Drinks bottle	Desk drawer
1	Mr Ashworth groundsman	pen 1	copper(II) oxide dust	methanol	sucrose (sugar)
2	Ms Bello lab technician	pen 2	copper(II) oxide dust	water	benzoic acid
3	Mr Carver PE teacher	pen 3	sand dust	methanol	sodium chloride (salt)
4	Dr Doyle design teacher	pen 4	copper(II) oxide dust	methanol	citric acid
5	Mrs Evans bursar	pen 5	chalk dust	ethanol	sucrose (sugar)

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



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 black. It does not fizz with acid and is not magnetic. It dissolves in warm dilute acid to give a blue solution.**

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 65 °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 186 °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

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

Door code = the matching pens, then the evidence IDs in order (E2 to E4), then the culprit's number.

DOOR
CODE

KEY
DIGIT

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.

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

1. A Group 1 metal
2. A Group 2 metal
3. A transition metal
4. A Group 7 element (a halogen)

CODE

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

MASTER OVERRIDE

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

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

Enter codes at: fourthschem.com/escaperooms/separation

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

Part 1. Name it.

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

The solid that dissolves.

A solution that cannot dissolve any more solid at that temperature.

The liquid that passes through the filter paper.

The solid left behind in 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.

1 Keep heating until all of the water has gone.

8 Leave the solution to cool so that crystals grow.

2 Stop heating when crystals form on a cold glass rod dipped into the solution.

9 Dry the crystals by heating them strongly in a Bunsen flame.

4 Filter off the crystals and pat them dry between filter papers.

6 Heat the copper(II) sulfate solution in an evaporating basin to boil off some of the water.

ORDER → → →

Part 3. Explain it.

Why do you stop heating before the basin is dry?

- 1 So crystals grow slowly as it cools, giving bigger, well formed crystals, and the hot solution does not spit.
- 2 To stop the basin cracking.
- 3 Because some water must be left to dissolve the crystals.

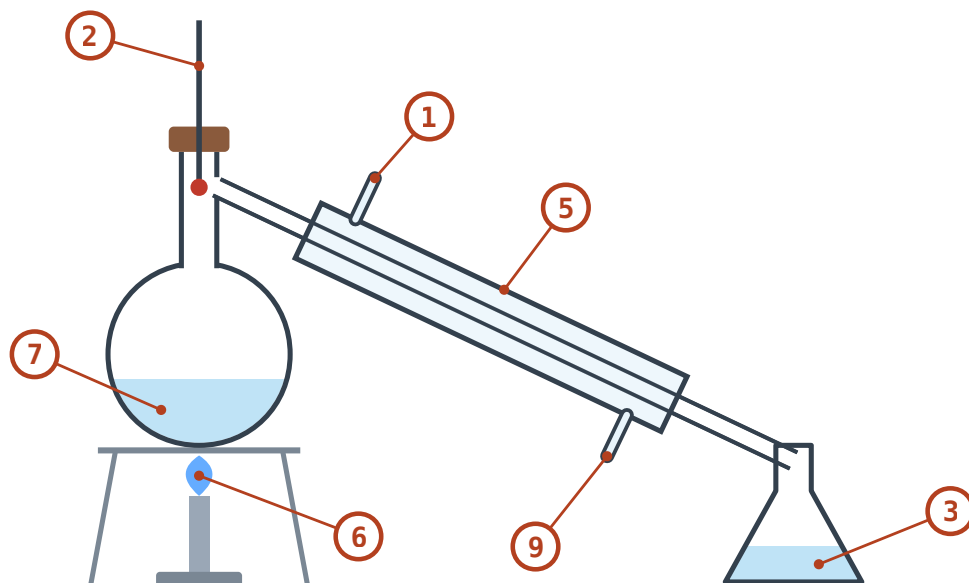
Door code = the Part 1 numbers, then the step numbers in order, then your Part 3 choice.

DOOR
CODE

KEY
DIGIT

Part 1. Read the rig.

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



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

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

Which number labels the **condenser**?

Part 2. Common error.

Where should the bulb of the thermometer be?

- 1 Level with the side arm, where the vapour leaves.
- 2 Touching the bottom of the flask.
- 3 In the collected distillate.

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

Part 1. Collection order.

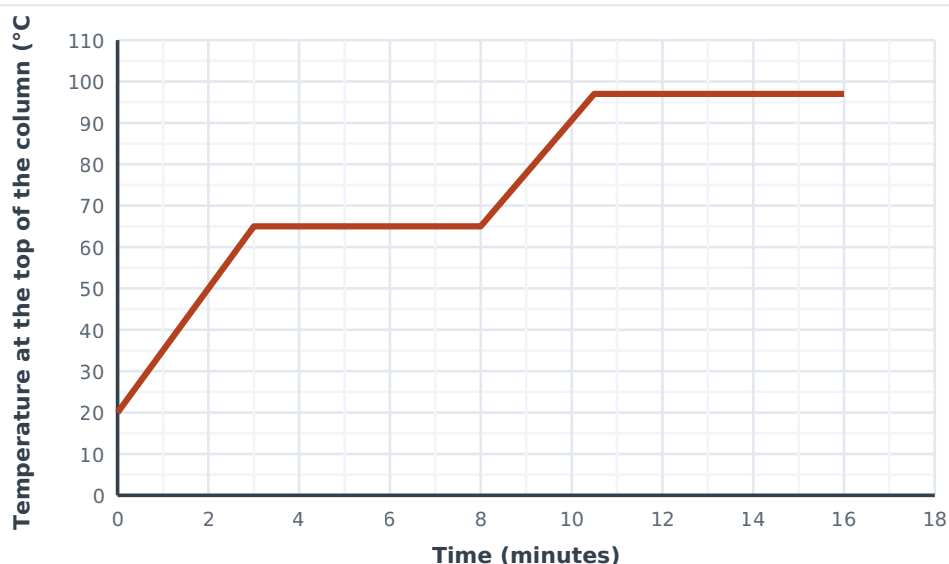
This mixture is fractionally distilled. Write the labels of the liquids in the order they collect. Leave out anything that never distils.

Label	Substance	Boiling point / °C
3	Methanol	65
8	Propan-1-ol	97
1	Copper(II) sulfate (dissolved)	does not boil off
5	Ethanol	78
2	Propanone	56

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?

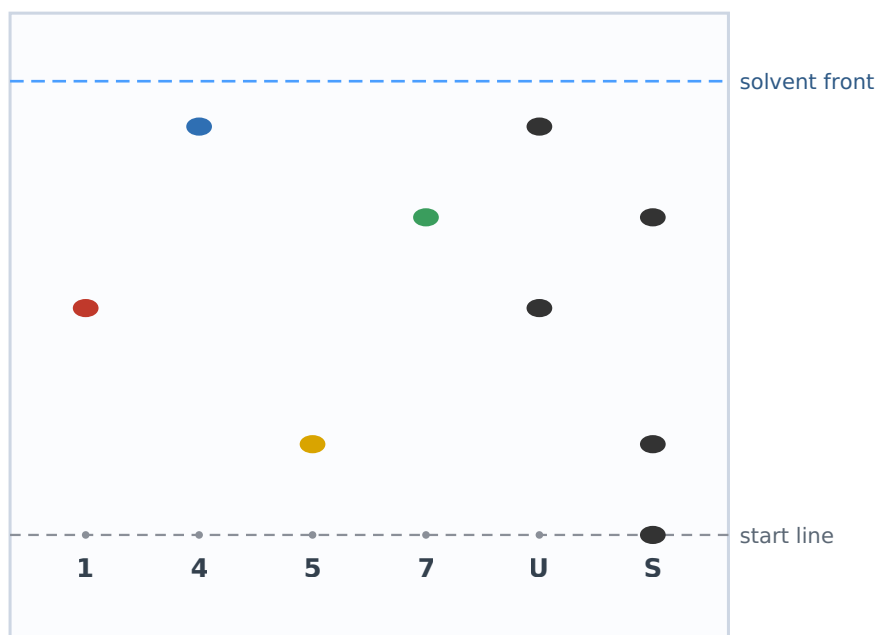
- 1 It stops the flask from boiling over.
- 2 It cools the vapour so it turns back into liquid.
- 3 Vapour condenses and boils again many times up the column, so only the lowest boiling liquid reaches the top.

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

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 $\div$ distance moved by the solvent. Round $R_f \times 10$ to a whole number.

R_f of dye **1**, multiplied by 10

R_f of dye **4**, multiplied by 10

R_f of dye **7**, 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 Marked the solvent front as soon as the paper came out.

2 Put in so much solvent that it covered the start line.

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

4 Drew the start line in felt tip pen.

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

6 Drew the start line in pencil.

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

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. Sucrose (pure melts at 186 °C) melts between 176 and 182 °C.

☐

Q. Naphthalene (pure melts at 80 °C) melts sharply at 80 °C.

☐

R. Stearic acid (pure melts at 69 °C) starts to melt at 62 °C and is fully melted by 66 °C.

☐

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

☐

Part 2. Pick the technique.

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

1 Paper chromatography

2 Crystallisation

4 Fractional distillation

6 Using a magnet

7 Filtration

9 Simple distillation

Remove sand from a mixture of sand and salt water.

☐

Get pure water from ink.

☐

Pull iron filings out of sulfur powder.

☐

Get salt crystals from salt water.

☐

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

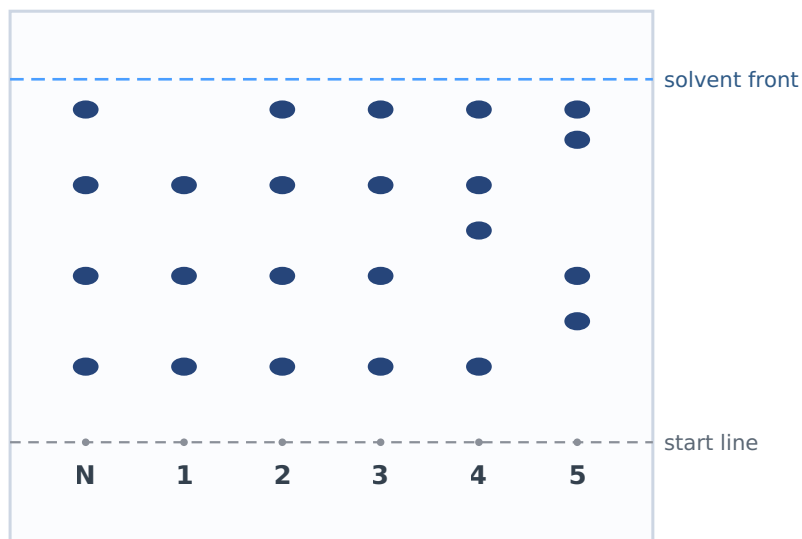
DOOR
CODE

KEY
DIGIT

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	iron filings dust	ethanol	sodium chloride (salt)	Nocturne
2	Ms Bello lab technician	pen 2	chalk dust	methanol	sodium chloride (salt)	Aurora
3	Mr Carver PE teacher	pen 3	chalk dust	methanol	sodium chloride (salt)	Lumen
4	Dr Doyle design teacher	pen 4	copper(II) oxide dust	methanol	sucrose (sugar)	Aurora
5	Mrs Evans bursar	pen 5	chalk dust	water	citric acid	Velvet

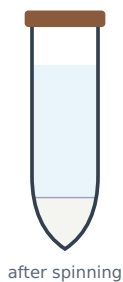
E1 THE NOTE: ink chromatography



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



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 white. It fizzes with dilute acid and the gas turns limewater milky.**

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 65 °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

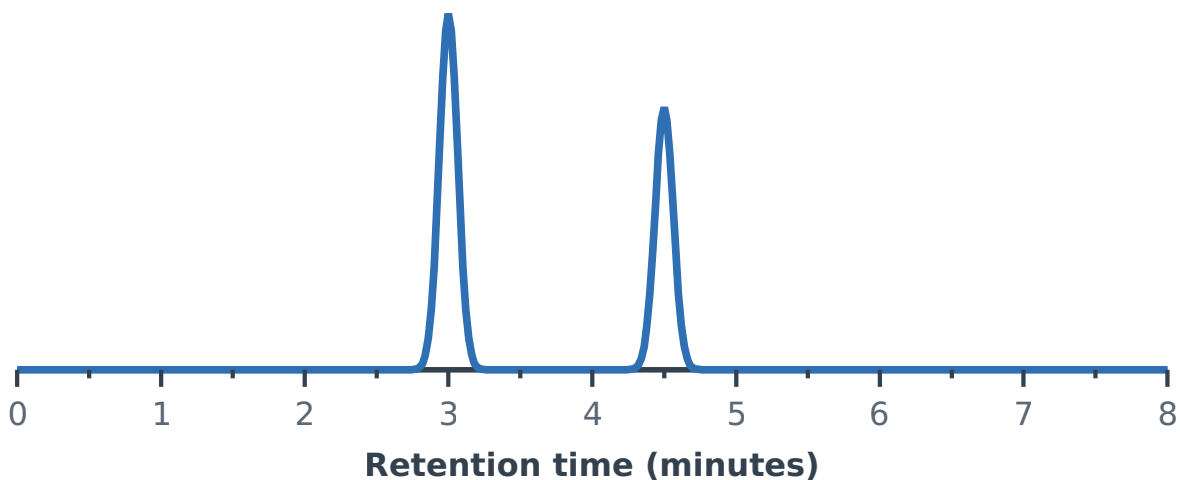
White powder spilt on the desk would not melt at all, even at 300 °C.

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.

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

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

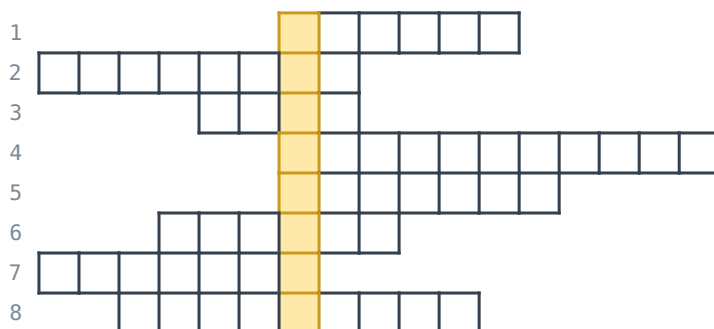
CODE

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

Optional command challenges for teams who have escaped. Crack any of them and enter the answer on the escape screen. No calculators needed.

1 Solvent Showdown

The same three dyes were run in three solvents. These are their R_f values.

No.	Solvent	Dye X	Dye Y	Dye Z
1	Propanone	0.10	0.45	0.85
2	Water	0.55	0.55	0.30
3	Ethanol	0.20	0.00	0.70

Best solvent for separating all three ☐

Solvent where one dye did not move ☐

Solvent where two dyes would look like one spot ☐

3 Purity Check

pure = 1 · impure = 2. Impure samples melt **lower** and over a **range**.

1. Naphthalene (pure melts at 80 °C) melts sharply at 80 °C. ☐

2. Stearic acid (pure melts at 69 °C) melts between 61 and 66 °C. ☐

3. Ice made from sea water (pure ice melts at 0 °C) melts between -3 and -1 °C. ☐

4. Sucrose (pure melts at 186 °C) melts sharply at 186 °C. ☐

2 Liquid Air

Air is cooled until it is a liquid, then warmed slowly in a fractionating column. Each gas boils off at its own boiling point.

Label	Gas	Boiling point / °C
7	Argon	-186
9	Krypton	-153
2	Nitrogen	-196
4	Oxygen	-183

In what order do they boil off?

ORDER ☐ → ☐ → ☐ → ☐

4 Route Planner

A flask holds **sand, iron filings, ethanol and water**. Get all four back, separately.

8 Using a magnet

1 Filtration

6 Fractional distillation

3 Simple distillation

5 Crystallisation

9 Chromatography

Some techniques are decoys. Choose the ones you need, in order.

ORDER ☐ → ☐ → ☐