

## Separation and purification

1. The results obtained from a chromatogram are shown.

	distance travelled / cm
solvent	5.0
substance X	3.0
substance Y	2.5

$\frac{3}{5} = 0.6$   
 $\frac{2.5}{5} = 0.5$

Which row gives the  $R_f$  values of substance X and substance Y?

	$R_f$ (X)	$R_f$ (Y)
<b>A</b>	0.5	0.6
<b>B</b>	0.6	0.5
<b>C</b>	1.6	2.0
<b>D</b>	2.0	1.6

2. A student carried out paper chromatography on a mixture of amino acids.

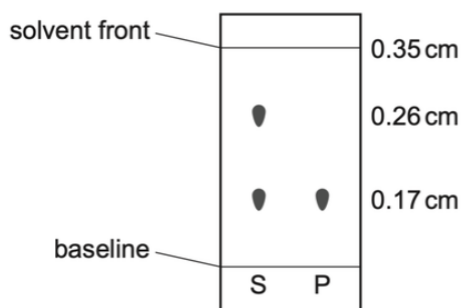
The student sprayed the dried chromatogram with a locating agent.

What is the function of the locating agent?

- A** to dissolve the amino acids  
**B** to form coloured spots with the amino acids  
**C** to preserve the amino acids  
**D** to stop the amino acids reacting

3. The painkiller paracetamol is synthesised from 4-aminophenol.

Chromatography was carried out on an impure sample of paracetamol. The results are shown (not drawn to scale).



key  
 S = impure sample of paracetamol  
 P = pure paracetamol

$\frac{0.17}{0.35}$

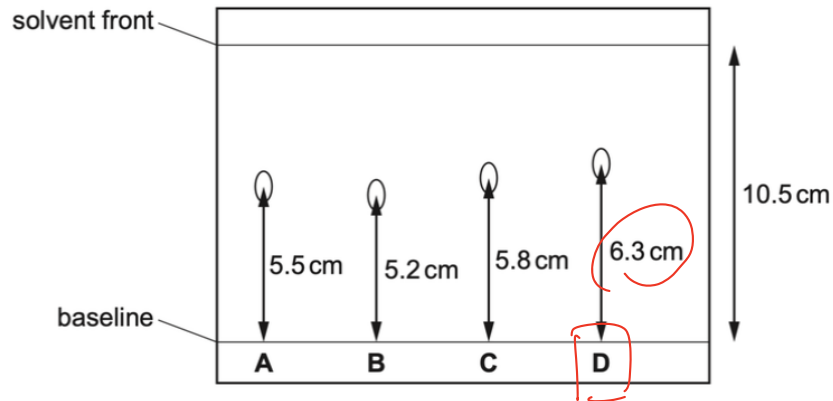
The sample of paracetamol was contaminated with 4-aminophenol only.

What is the  $R_f$  value of 4-aminophenol?

- A** 0.49      **B** 0.65      **C** 0.74      **D** 1.35

4. A chromatogram obtained from the chromatography of four substances is shown.

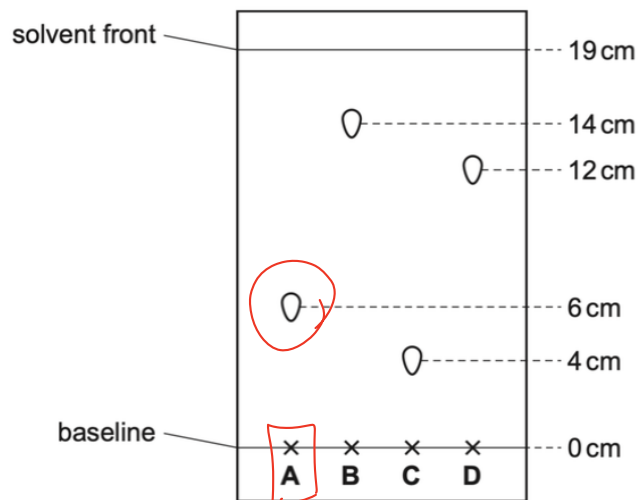
Which substance has an  $R_f$  value of 0.6?



$$10.5 \times 0.6 =$$

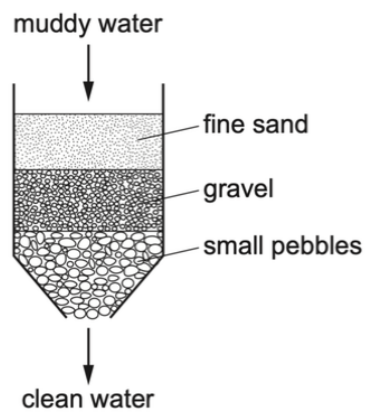
5. The diagram shows a chromatogram of four substances.

Which substance has an  $R_f$  value of approximately 0.32?



$$19 \times 0.32 = 6.08$$

6. The diagram shows how muddy water can be purified.



Which process for purifying the muddy water is shown?

A crystallisation

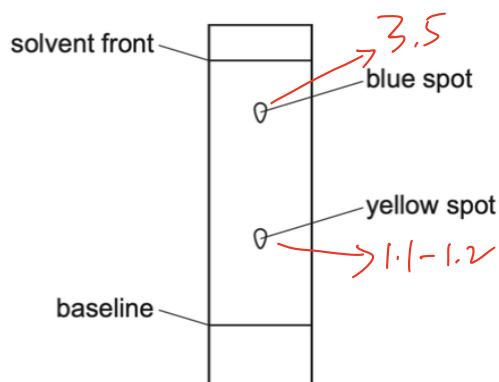
B distillation

C filtration

D solvent extraction

7. A student used chromatography to analyse a green food colouring.

The chromatogram obtained is shown.



$$\frac{1.2}{3.5} = 0.34$$

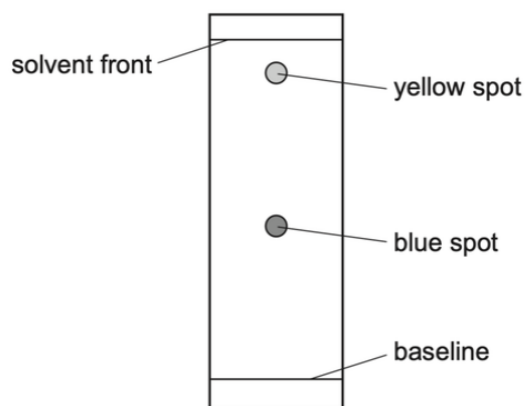
The table lists some yellow food dyes and their  $R_f$  values.

Which yellow food dye does the green food colouring contain?

	yellow food dye	$R_f$ value
<b>A</b>	Quinolene Yellow	0.48
<b>B</b>	Sunset Yellow	0.32
<b>C</b>	tartrazine	0.69
<b>D</b>	Yellow 2G	0.82

8. A sample of a green food colouring was separated into its component colours using paper chromatography.

The results obtained are shown.



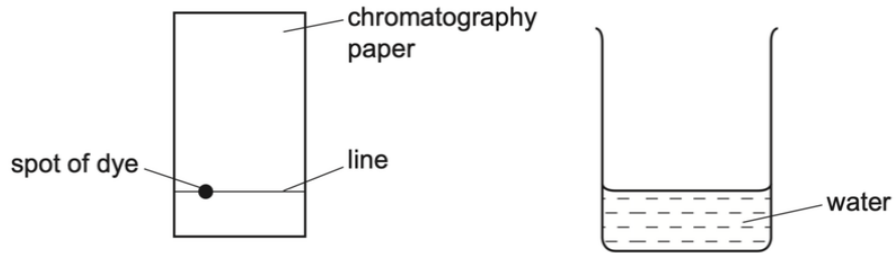
What is the  $R_f$  value of the blue spot?

- A** 0.45      **B** 0.90      **C** 1.10      **D** 2.20
- Handwritten red annotations: A circle around 'A', a red arrow pointing to '0.45', and a red line striking through 'C' and 'D'.

9. A sample of a dye is investigated by chromatography.

A line is drawn across a piece of chromatography paper and a spot of the dye is placed on it.

The paper is placed in water.

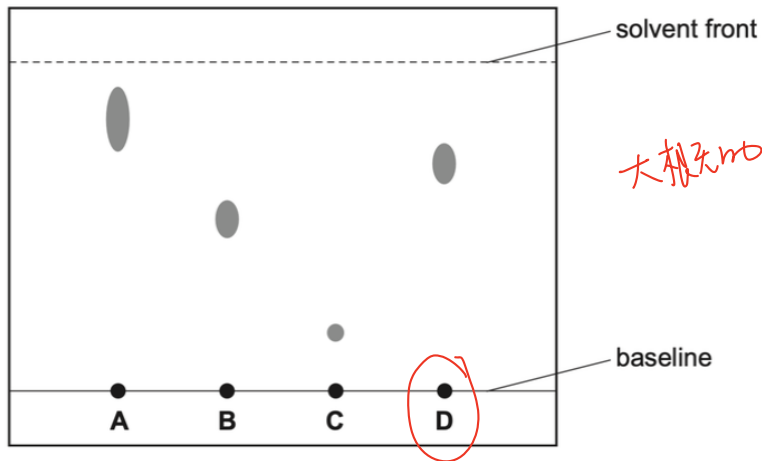


Which row is correct?

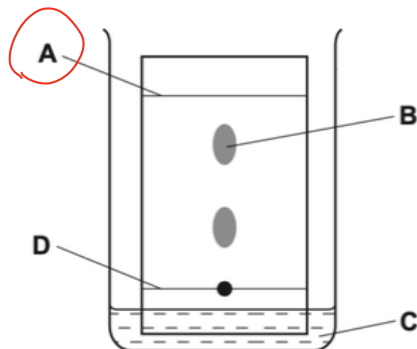
	what is used to draw the line	position of spot
<b>A</b>	ink	above the level of the water
<b>B</b>	ink	below the level of the water
<b>C</b>	pencil ✓	above the level of the water ✓
<b>D</b>	pencil ✓	below the level of the water

10. The paper chromatogram below was obtained from four different dyes.

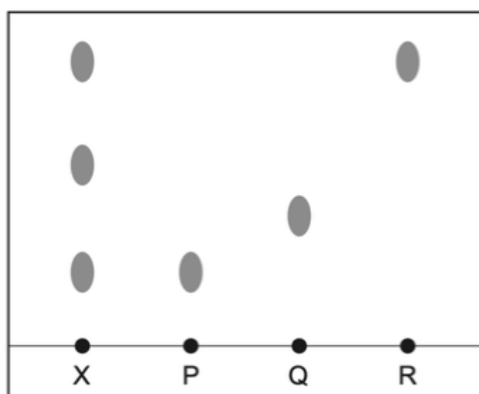
Which dye has an  $R_f$  value of 0.7?



11. In the chromatography experiment shown, which label represents the solvent front?



12. X is a mixture of colourless compounds. The diagram shows a chromatogram of X and of three pure compounds, P, Q and R.



Which statement is **not** correct?

A A locating agent was used to develop the chromatogram of X. ✓

B P and R could be present in X. ✓

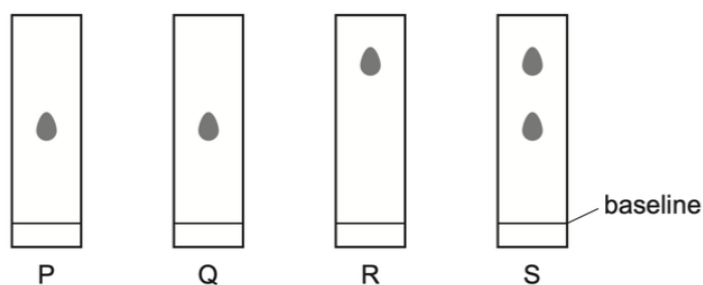
C P and R have different solubilities in the solvent. ✓

D Q has a greater  $R_f$  value than R. ✗

13. Chromatography experiments are carried out on four substances, P, Q, R and S.

The same solvent is used in each experiment.

The resulting chromatograms are shown below.



Which statement is **not** correct?

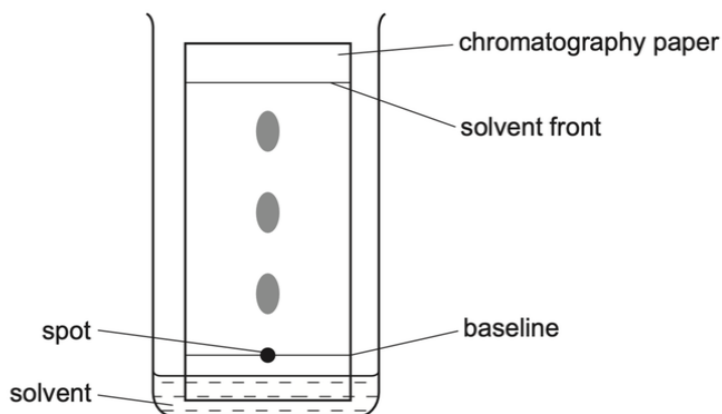
A P and Q are pure substances. ✓

B P and R are different substances. ✓

C R and S are pure substances. ✗

D S is a mixture of substances. ✓

14. The diagram shows the apparatus used to separate the different components of a mixture by chromatography.



Which statement about this experiment is correct?

- A A locating agent is used to find the position of the solvent front.
- B** The components to be separated must be soluble in the solvent.
- C The baseline on which the spot of the mixture is placed is drawn in ink.
- D The  $R_f$  value is calculated by  $\frac{\text{the distance travelled by the solvent front}}{\text{the distance travelled by the component}}$
15. Information about the solubility of four solids, P, Q, R and S, is given in the table.

	P	Q	R	S
solubility in water	dissolves	insoluble	insoluble	dissolves

A student attempted to separate mixtures of these solids using the following method.

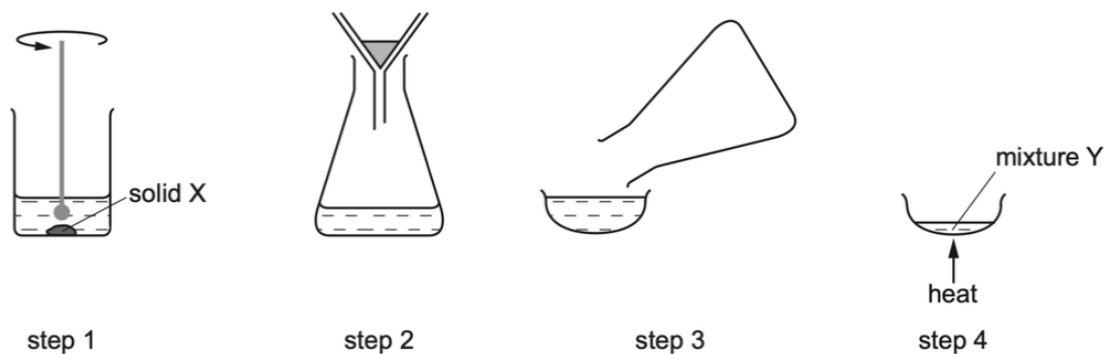
- 1 Add the mixture to a beaker of water and stir.
- 2 Filter the mixture.
- 3 Crystallise one of the solids from the filtrate.

Which of the following mixtures could **not** be separated by this method?

- A a mixture of P and R
- B a mixture of Q and P
- C** a mixture of Q and R
- D a mixture of R and S
16. A sample contains a mixture of powdered limestone (calcium carbonate), sugar and wax.
- What is the correct way to obtain a pure sample of sugar?
- A Dissolve the mixture in dilute hydrochloric acid, filter and wash the residue.
- B Dissolve the mixture in hexane, filter and evaporate the filtrate.
- C** Dissolve the mixture in water, filter and evaporate the filtrate.
- D Dissolve the mixture in water, filter and wash the residue.

17. A solid X is purified in five steps.

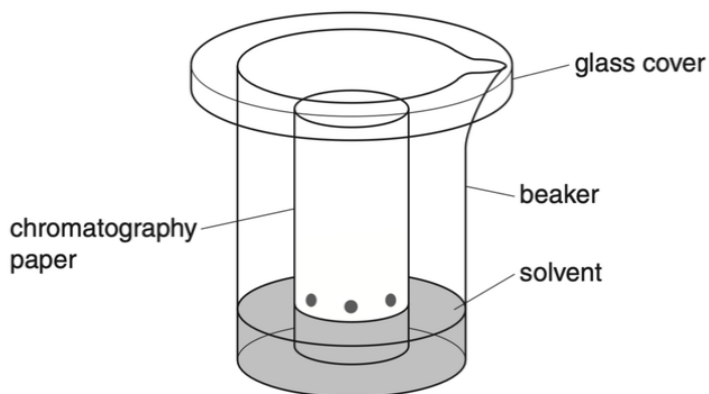
The first four steps of the purification are shown in the diagram.



In **step 5**, how is a pure sample of solid X obtained from mixture Y?

- A dissolving
- B distillation
- C evaporating**
- D filtering

18. Amino acids are colourless and can be separated and identified by chromatography.

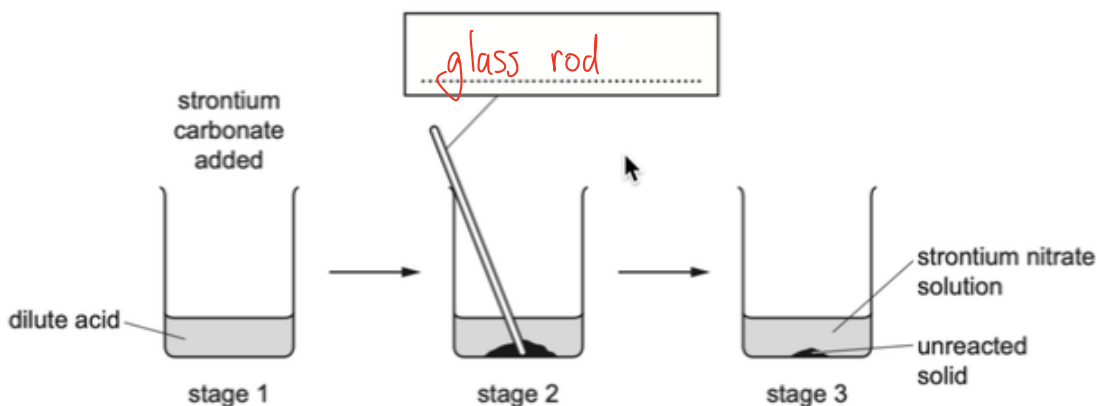


What additional apparatus is required to identify the amino acids present in a mixture?

- A a locating agent
- B a ruler
- C a ruler and a locating agent**
- D neither a ruler or a locating agent

19. A student prepared strontium nitrate crystals.

The diagram shows some of the stages in this preparation.



(a) (i) Complete the box to identify the apparatus. [1]

(ii) What is used to add the strontium carbonate to the acid in stage 1? [1]

..... spatula .....

(iii) Name the dilute acid used. [1]

..... nitric acid .....

(iv) Give one expected observation in stage 2. [1]

..... bubble .....

(b) Why is heat **not** necessary in stage 2? [1]

..... the reaction can happen under room temp. .....

(c) Which of the reactants is in excess? Explain your answer. [2]

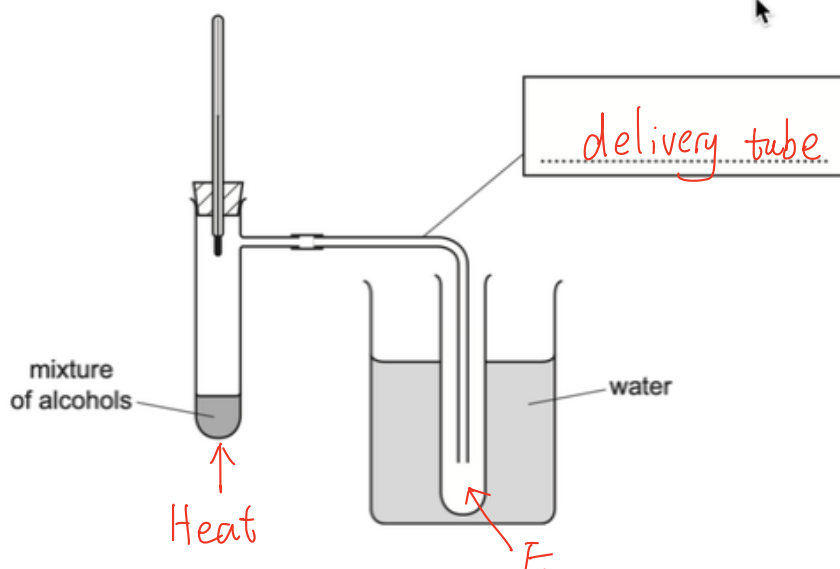
..... Strontium carbonate  
..... it is insoluble in water and can be removed after reaction .....

(d) Describe how crystals of strontium nitrate could be obtained from the mixture in stage 3. [3]

..... Heat to crystallization point  
..... Cooling down  
..... crystals will be formed .....



20. A mixture of alcohols can be separated by fractional distillation. The apparatus shown was used to separate ethanol from the mixture.



- (a) (i) Complete the box to identify the apparatus. [1]  
 (ii) Indicate with an arrow where heat is applied. [1]

(b) What is the purpose of the water?  
 to condensed the vapor  
 [2]

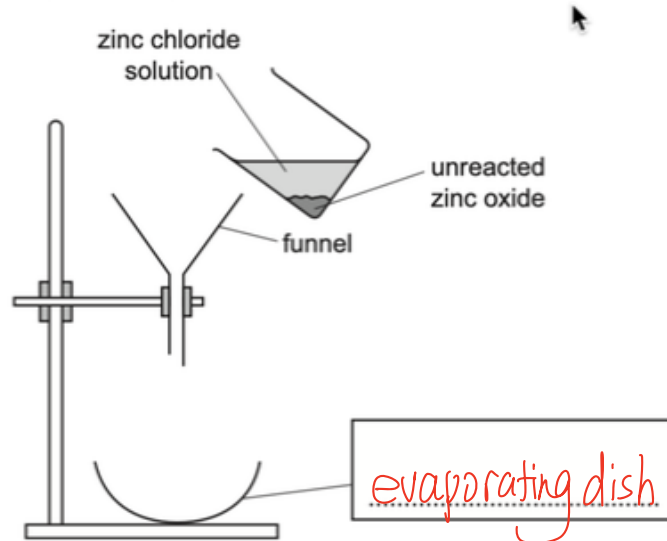
(c) Why is the thermometer bulb placed as shown and **not** in the mixture of alcohols?  
 to measure the b.p. of alcohol  
 [1]

(d) Use the letter **E** to indicate on the diagram where ethanol would collect. [1]

(e) (i) Suggest a simple chemical test to show that the liquid collected is ethanol and **not** water.  
 ethanol can burn [1]

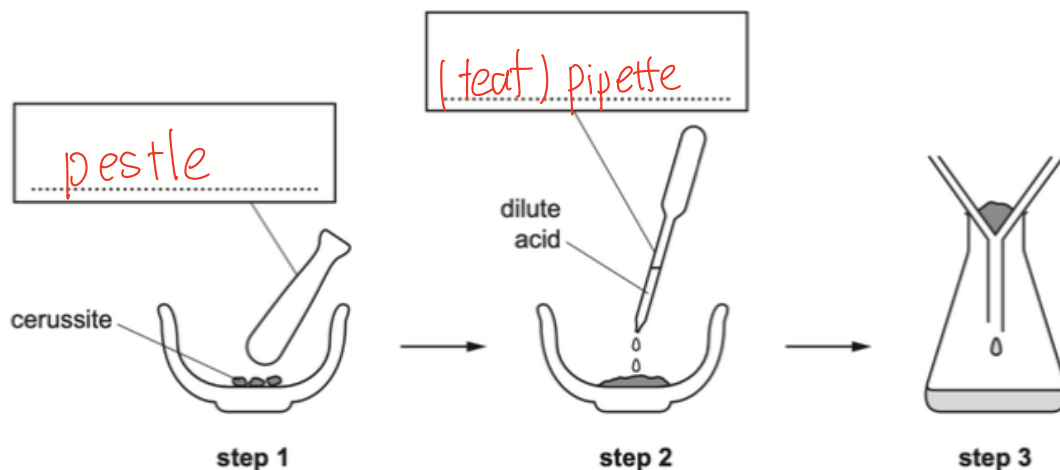
(ii) Give a physical test to identify pure ethanol.  
 measure m.p. and b.p. [1]

21. A student reacted dilute hydrochloric acid with zinc oxide to prepare zinc chloride solution. The diagram shows part of the procedure.



- (a) Complete the box to name the apparatus. [1]
- (b) Which of the reactants was in excess?  
..... zinc oxide ..... [1]
- (c) (i) Name the separation process this apparatus is used for.  
..... Filtration ..... [1]
- (ii) Suggest why this apparatus would **not** work.  
..... no filter paper ..... [1]
- (d) Describe how crystals of zinc chloride could be obtained from the zinc chloride solution.  
..... Heat to crystallization point .....  
..... Cooling down .....  
..... crystals will be formed ..... [3]

22. Cerussite is a lead ore which contains lead(II) carbonate. A student obtained a solution of lead(II) nitrate from cerussite using the apparatus shown.



(a) Complete the boxes to name the apparatus. [2]

(b) Why was the cerussite crushed in step 1?

to increase surface area to make it dissolve faster [1]

(c) Name the dilute acid used in step 2.

nitric acid [1]

(d) What is the general name given to an insoluble solid left on a filter paper after filtration?

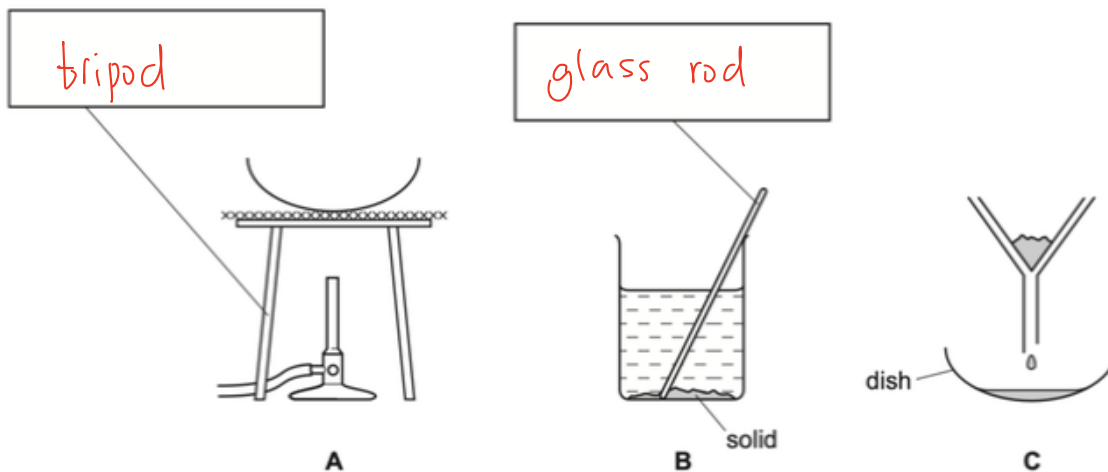
residue [1]

(e) Suggest how a sample of lead could be obtained from the solution of lead(II) nitrate.

add a more reactive metal (eg: Zn)  
lead can be replaced.  
Residue can be collected by filtration

[2]

23. The diagrams show the apparatus used to obtain crystals of calcium chloride from a mixture of solid calcium chloride and solid calcium carbonate. Calcium chloride is soluble in water and calcium carbonate is insoluble in water.



(a) Complete the boxes to name the apparatus. [2]

(b) (i) Write down the order in which the apparatus should be used in this experiment.

..... B C A ..... [1]

(ii) Name the separation process in C.

..... filtration ..... [1]

(c) (i) What has been added to the mixture in B?

..... water ..... [1]

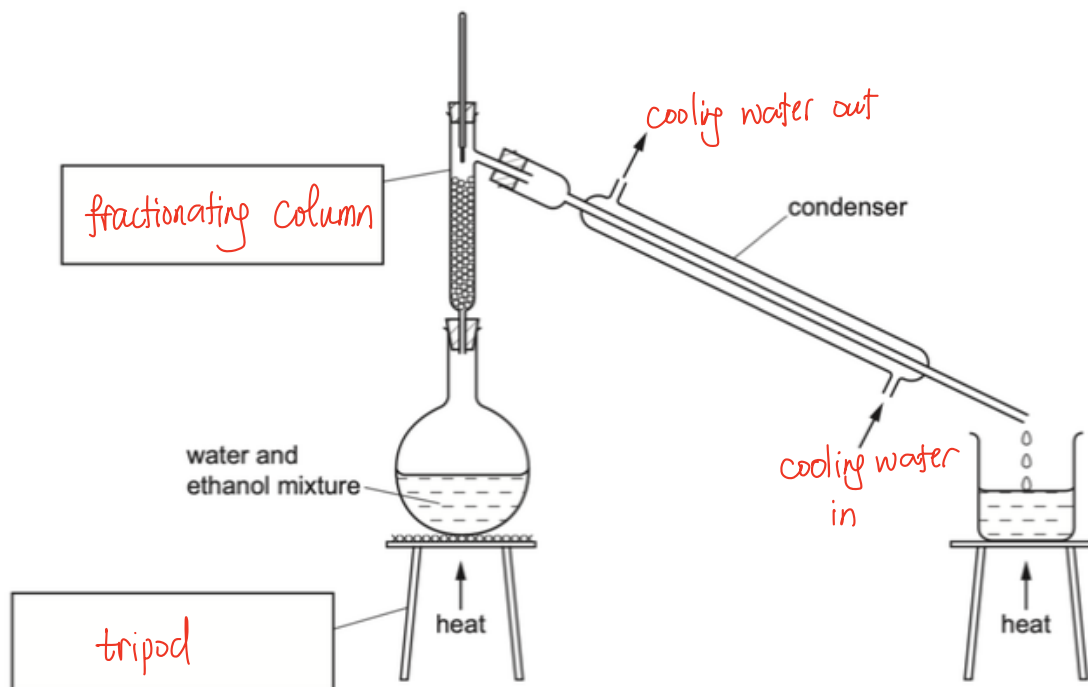
(ii) What is the general name given to the liquid in the dish in C?

..... filtrate ..... [1]

(d) How would you know when to stop heating the dish in A?

..... solid appeared on edge of glass rod ..... [1]

24. The diagram shows the apparatus used to separate a mixture of water, boiling point  $100^{\circ}\text{C}$ , and ethanol, boiling point  $78^{\circ}\text{C}$ .



(a) Complete the boxes to name the apparatus. [2]

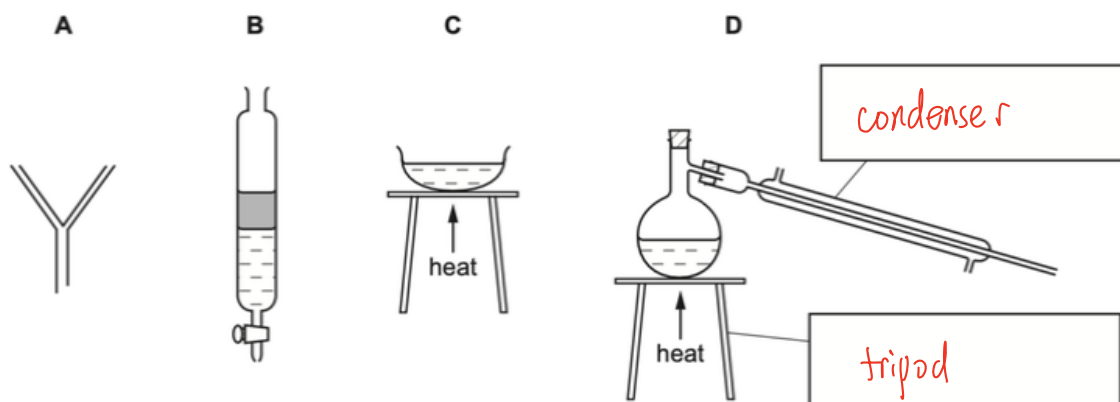
(b) Label the arrows on the condenser. [1]

(c) Identify **one** mistake in the apparatus.  
 ..... No necessary to heat beaker ..... [1]

(d) Which liquid would collect first? Explain your answer.  
 ..... ethanol .....  
 ..... ethanol has lower b.p. .... [2]

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture?  
 ..... ethanol is flammable ..... [1]

25. This question is about the separation of mixtures.  
The diagram shows four sets of apparatus that can be used to separate mixtures.



(a) Complete the boxes to name the apparatus. [2]

(b) The table shows four different mixtures.

Complete the table to show which set of apparatus should be used to obtain the substance listed. The first one has been completed for you. Each set of apparatus can be used once, more than once or not at all.

mixture	to obtain	use apparatus
petroleum and water	petroleum	<b>B</b>
sodium chloride dissolved in water	sodium chloride crystals	..... <b>C</b> .....
sodium chloride dissolved in water	water	..... <b>D</b> .....
insoluble silver chloride and water	silver chloride	..... <b>A</b> .....

[3]

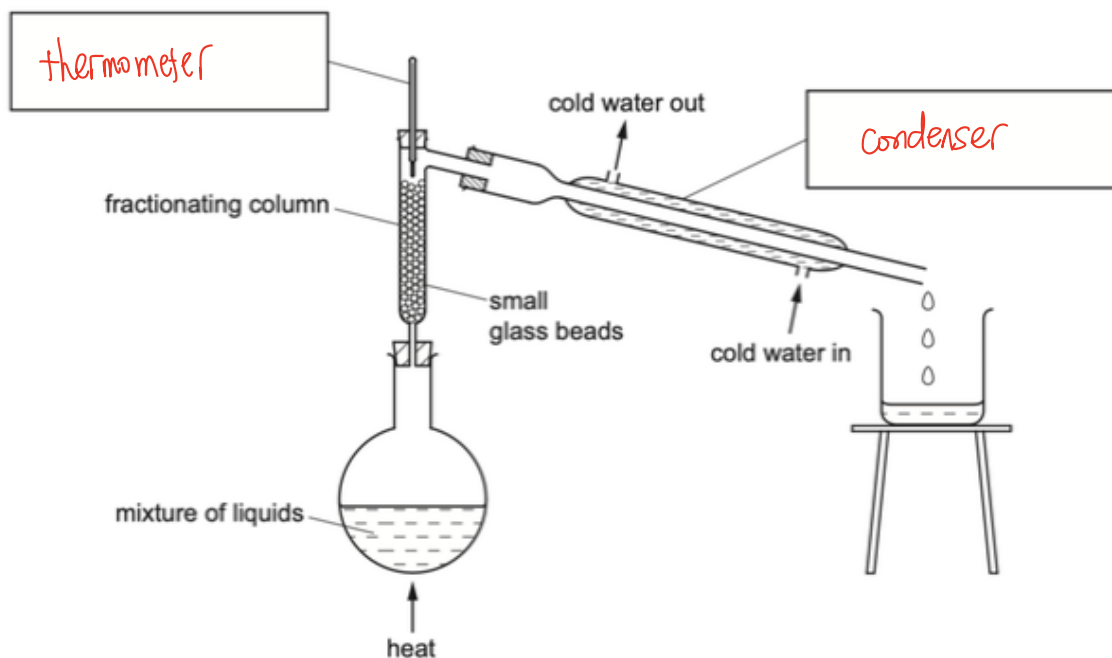
(c) Put a ring around the separation method that should be used to separate a mixture of coloured dyes.

centrifugation    chromatography    condensation    evaporation

[1]

26. A teacher separated a mixture of two liquids using the apparatus shown. The liquids were:

- ethanoic acid, boiling point  $118^{\circ}\text{C}$ ,
- chloroethanoic acid, boiling point  $190^{\circ}\text{C}$ .



(a) Complete the boxes to label the pieces of apparatus used. [2]

(b) (i) Which liquid would be collected first? Explain why.

ethanoic acid  
it has lower b.p. [2]

(ii) How would the teacher know when all of this liquid had been collected?

reading on thermometer is above than  $118^{\circ}\text{C}$  [1]

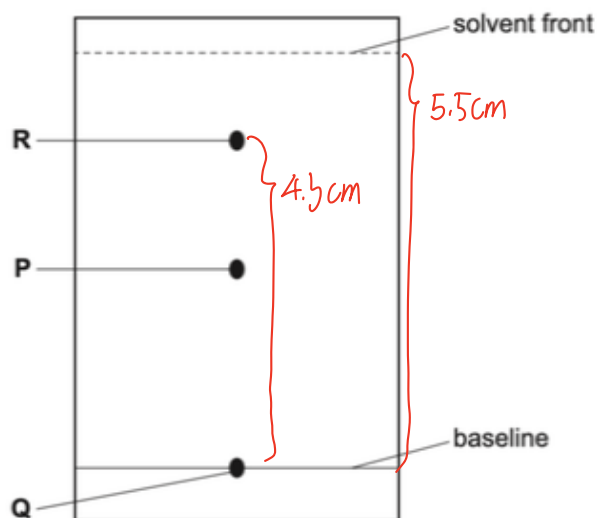
(c) Suggest why small glass beads are used in the fractionating column instead of large glass beads.

large surface area [1]

(d) Give a test to show that the liquids are acidic.

test ..... litmus .....  
result ..... red ..... [2]

27. A mixture of three compounds, P, Q and R, was separated using a piece of paper.



(a) Name this method of separation.

..... chromatography ..... [1]

(b) What could have been used to apply the mixture onto the paper?

..... (heat) pipette / capillary tube ..... [1]

(c) Suggest a possible solvent that could be used for this separation.

..... water ..... [1]

(d) Suggest why compound Q remained on the baseline.

..... Q is insoluble ..... [1]

(e)  $R_f$  values are used to identify compounds.

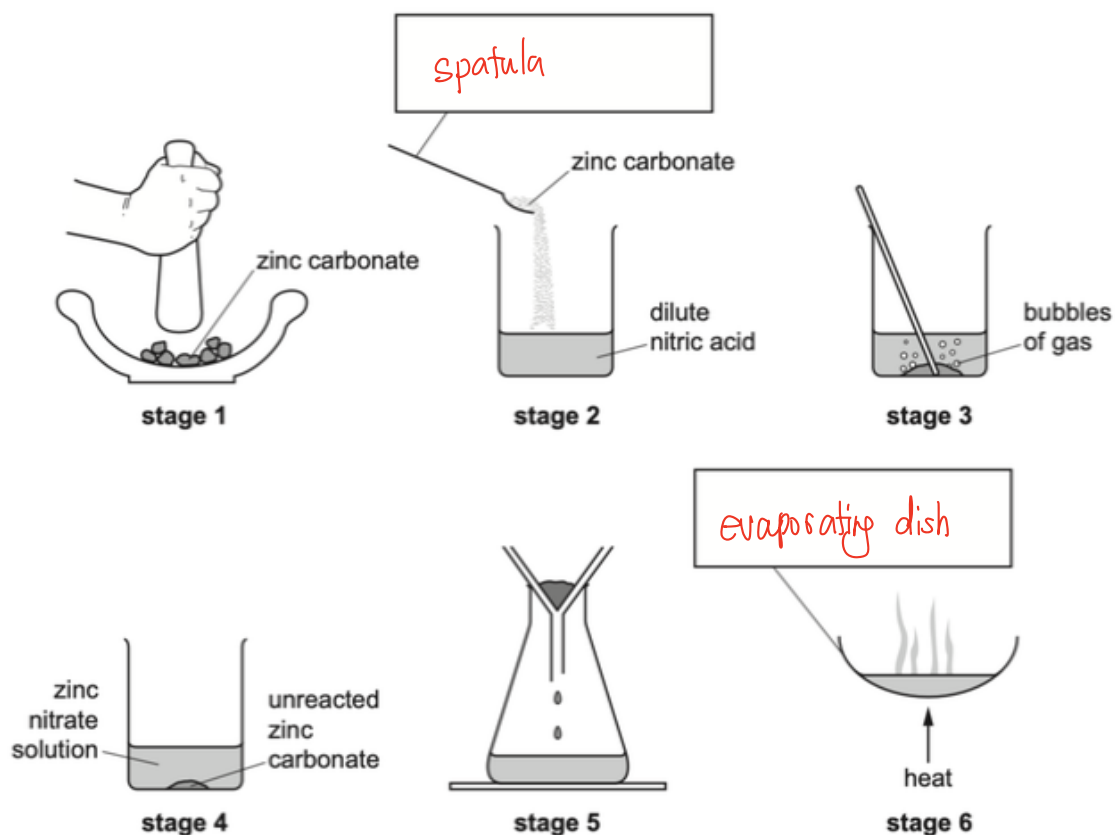
$$R_f = \frac{\text{distance travelled by compound}}{\text{distance travelled by the solvent}}$$

Use the diagram to work out the  $R_f$  value of compound R.

.....  $\frac{4.5}{5.5} = 0.78$  ..... [2]



28. The diagrams show the stages in the preparation of zinc nitrate crystals from lumps of zinc carbonate.



(a) Complete the boxes to show the apparatus used. [2]

(b) Use the diagrams to write a list of instructions for the stages of this preparation.

(i) stages 1, 2, 3 and 4

crush zinc carbonate into powder  
 add zinc carbonate into nitric acid and stir  
 when no more bubbles produced, reaction is complete. [3]

(ii) stage 5

filtration [1]

(iii) stage 6

evaporate filtrate to crystallisation point  
 cool down, and crystal will be collected [2]