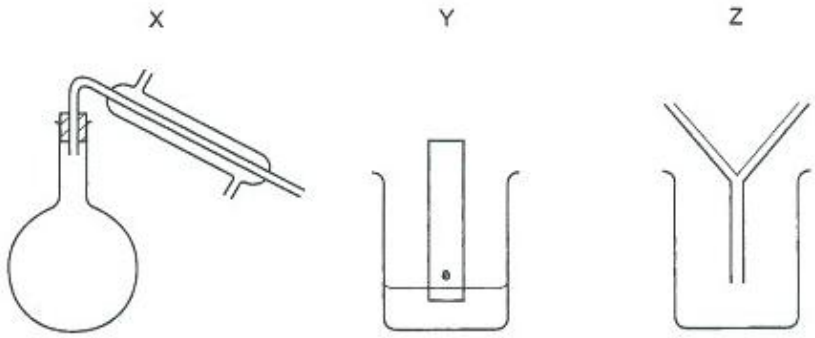
Topic 1 Experimental Design, Methods of Purification and Analysis and Identification of Gases

PAPER 3

MULTIPLE-CHOICE QUESTIONS

For each question, there are four possible answers. Choose the one you consider correct and record your choice (A, B, C or D) in the brackets provided.

1. The diagrams show three methods of separation.



What are the three methods called? (2011/P3/Q1)

	X	Y	Z
A	chromatography	distillation	filtration
B	distillation	chromatography	filtration
C	distillation	filtration	chromatography
D	filtration	chromatography	distillation

( )

2. A student wishes to add exactly 13.2 cm^3 of acid to exactly 25.0 cm^3 of an alkali as part of an experiment.

Which apparatus should the student use to measure these volumes? (2011/P3/Q2)

	acid	alkali
A	pipette	burette
B	burette	measuring cylinder
C	burette	pipette
D	measuring cylinder	pipette

( )

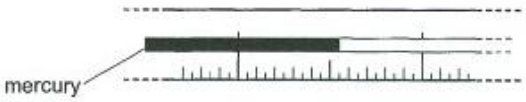
3. Sea water contains dissolved sodium chloride.

Which method is used to obtain pure water from sea water? (2012/P3/Q1)

A chromatography
B distillation
C evaporation
D filtration

( )

4. The boiling point of liquid X is lower than that of water.
The student places a thermometer in boiling liquid X.
The diagram represents part of the stem of this thermometer, without numbers.

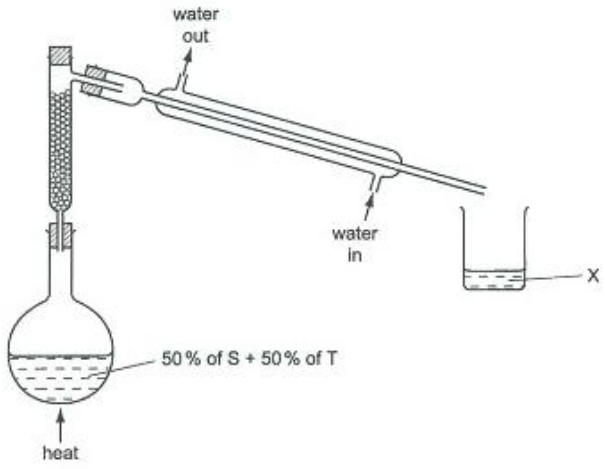


What is the boiling point of liquid X? (2012/P3/Q2 / 2016/P3/Q1)

A 75.5 °C
B 84.5° C
C 104.5° C
D 105.5° C

( )

5. A mixture contains equal volumes of two liquids.
Liquid S has a boiling point of 80°C. Liquid T has a boiling point of 54°C.
The mixture is heated in the apparatus shown below.

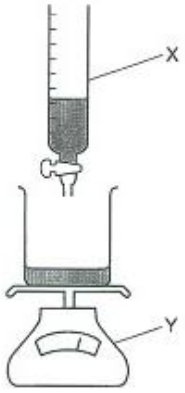


What is the initial composition of X? (2013/P3/Q1)

A 100% S
B 50% S and 50% T
C 10% S and 90% T
D 100% T

( )

6. A student sets up the following apparatus for an experiment.

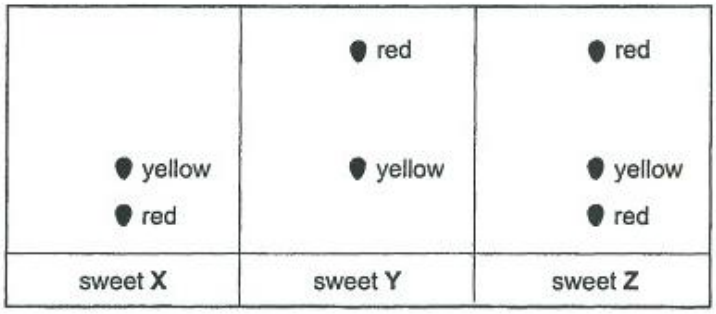


What are X and Y? (2013/P3/Q2)

	X	Y
A	balance	burette
B	burette	pipette
C	burette	balance
D	pipette	balance

( )

7. The diagram shows a chromatogram obtained from the colouring of three different sweets, **X**, **Y** and **Z**.



How many different **red** dyes are present in the sweets? (2014/P3/Q1)

A 1 **B** 2
C 3 **D** 4

( )

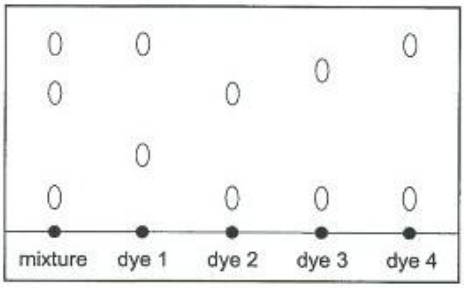
8. Which row describes the test for oxygen? (2014/P3/Q2)

	test	observation
A	glowing splint	relights
B	limewater	white precipitate forms
C	red litmus	turns blue
D	lighted splint	flame goes out

( )

9. A mixture of coloured dyes is compared with other dyes using chromatography.

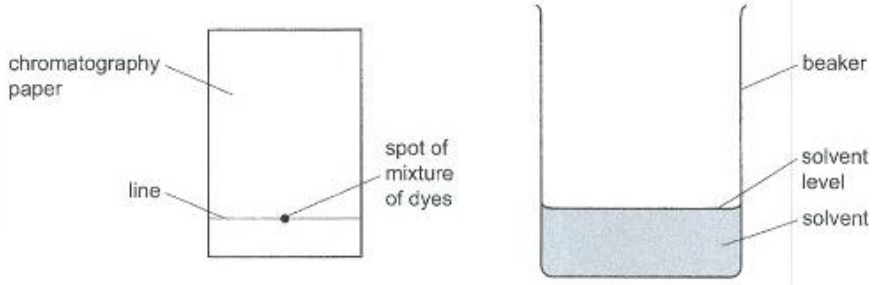
The chromatogram is shown below.



Which dyes are present in the mixture? (2015/P3/Q2)

A 1 and 3 **B** 2 and 3
C 2 and 4 **D** 2 only ( )

10. An experiment is carried out to separate a mixture of two dyes.
A line is drawn on a piece of chromatography paper and a spot of the mixture of dyes is placed on it.
The paper is dipped into a solvent and left for several minutes.



Which statement about this experiment is correct? (2016/P3/Q2)

A The dyes must have different boiling points.
B The dyes must have different solubilities in the solvent.
C The line on the paper must be drawn in ink.
D The paper must be placed with the line below the level of the solvent. ( )

11. The table shows the melting points of four different substances.
Which substance is a pure solid at a temperature of 20°C? (2017/P3/Q1)

	melting point / °C
A	32
B	25 to 28
C	–20 to –30
D	–35

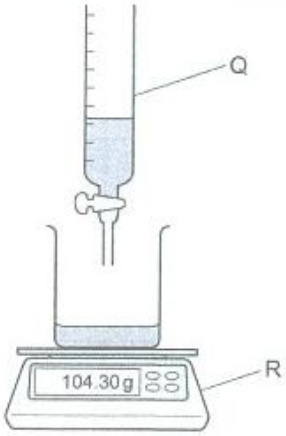
( )

12. A student wishes to add exactly 13.2 cm^3 of acid to exactly 25.0 cm^3 of an alkali.
Which apparatus should the student use to measure these volumes? (2017/P3/Q2)

	acid	alkali
A	burette	measuring cylinder
B	burette	pipette
C	measuring cylinder	pipette
D	pipette	burette

( )

13. A student sets up the following apparatus for an experiment.



What are Q and R? (2018/P3/Q1)

	Q	R
A	balance	burette
B	burette	balance
C	burette	pipette
D	pipette	balance

( )

14. A student makes some crystals.
What does the student check to test the purity of the crystals? (2018/P3/Q2)

A the melting point of the crystals
B the shape of the crystals
C the size of the crystals
D the solubility of the crystals in water ( )

15. Mixture 1 contains sand and water.
Mixture 2 contains salt and water.
Which method of separation could be used to obtain each of the required products from each mixture? (2018/P3/Q4)

	mixture 1		mixture 2	
	to obtain sand	to obtain water	to obtain salt	to obtain water
A	crystallisation	distillation	filtration	filtration
B	crystallisation	filtration	filtration	distillation
C	filtration	distillation	crystallisation	filtration
D	filtration	filtration	crystallisation	distillation

( )

16. A student is given a mixture of three substances P, Q and R.
The table shows some of the properties of P, Q and R.

substance	state	solubility in water	solubility in ethanol
P	solid	yes	no
Q	liquid	no	yes
R	solid	no	no

Which method describes how a pure sample of substance Q can be separated from the original mixture? (2019/P3/Q2)

A add ethanol, filter, distil the filtrate
B add ethanol, filter, add water to residue, filter
C add water, filter, dry the residue
D add water, filter, add ethanol to residue, filter ( )

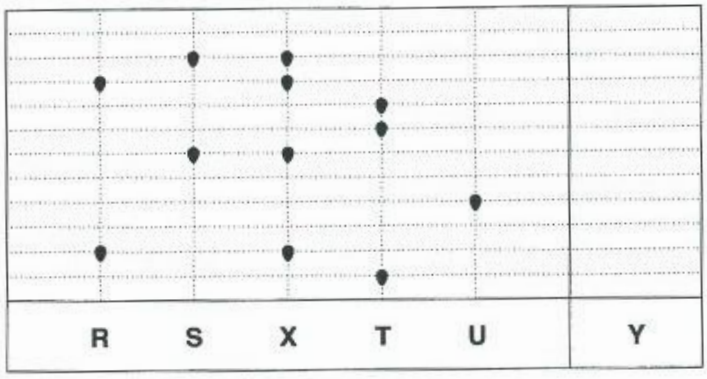
PAPER 4

STRUCTURED QUESTIONS

Section A

Answer the following questions.

1. Ink X is analysed using chromatography by comparing its chromatogram with those for dyes **R**, **S**, **T** and **U**.



(a) Which dye does **X** contain? [1]

(b) What does the chromatogram tell you about dye **U**? [1]

(c) On the diagram above, sketch the chromatogram for ink **Y** which only contains the dyes **R** and **T**. [1]

(2012/P4/Q3)

2. The following is part of a label found on a bottle of mineral water.
The label shows the ions present in the mineral water.

TYPICAL ANALYSIS

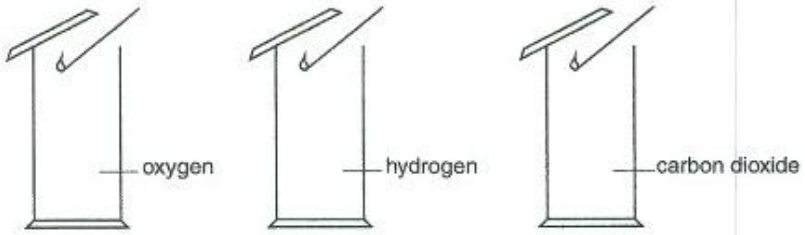
ions	mg/dm^3
bicarbonate (HCO_3^-)	225.0
calcium (Ca^{2+})	55.0
chloride (Cl^-)	9.0
magnesium (Mg^{2+})	15.0
nitrate (NO_3^-)	3.5
potassium (K^+)	0.5
sodium (Na^+)	5.0
sulfate (SO_4^{2-})	9.0

dry residue at 180 °C	210.0 mg/dm^3
pH	8.0

State how the dry residue is obtained from the mineral water. [1]

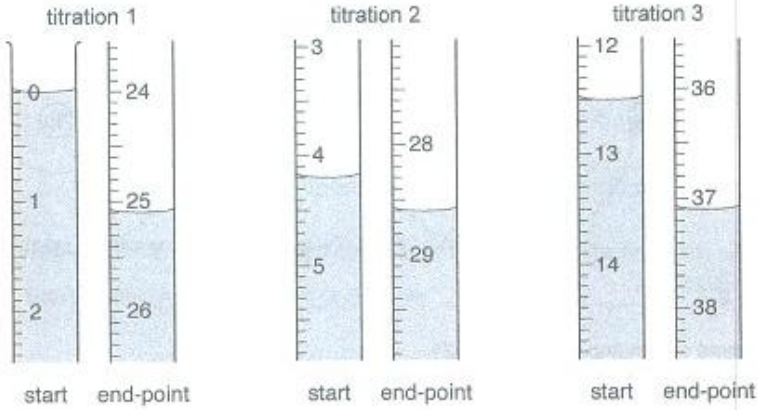
(2013/P4/Q2d)

3. Burning splints are placed into three gas jars as shown in the diagram.



State what you would observe in each case. [3]
(2015/P4/Q1)

4. In a titration experiment, a liquid is added from a burette. A total of three titrations are performed.
The diagrams show the positions of the liquid at the start of each titration, and at each end-point.



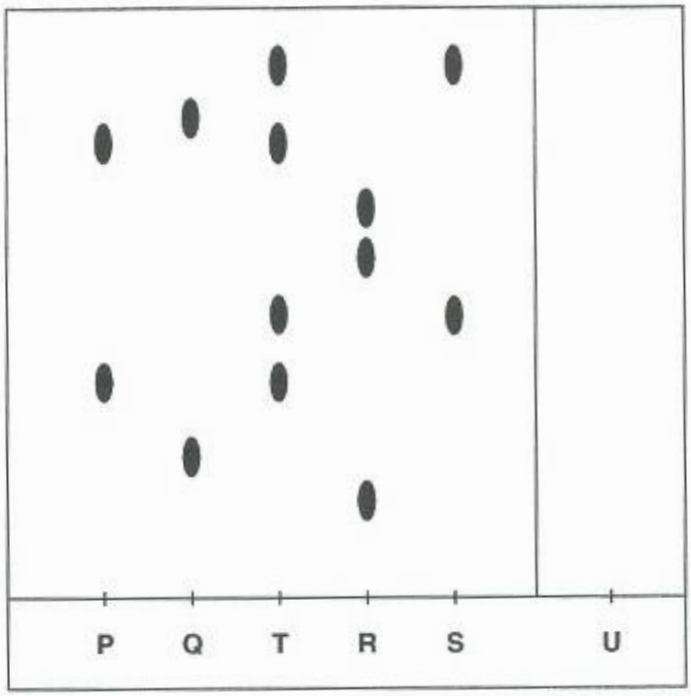
(a) Complete the results table.

titration number	1	2	3
final burette reading/cm³	25.10	28.60	
initial burette reading/cm³	0.00	4.20	
volume of liquid added/cm³	25.10	24.40	

[1]

(b) Explain why it is good practice to repeat a titration several times. [1]
(2016/P4/Q4)

5. (a) A water soluble dye, **T**, is analysed using paper chromatography. On the same chromatography paper, the pattern produced by dye **T** is compared with those of four other dyes **P**, **Q**, **R** and **S**.

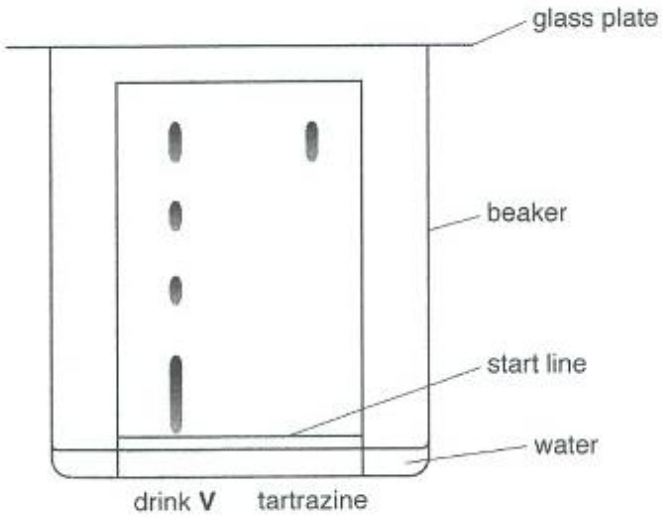


(i) Dye **T** is prepared by mixing two of the dyes **P**, **Q**, **R** and **S**. Identify the **two** dyes. [1]

(ii) A dye, **U**, is prepared by mixing together dyes **P** and **R**. On the diagram, draw the pattern produced by dye **U**. [1]

(b) Tartrazine is an orange dye that can be added to bottled drinks to make them look more appealing.
A food inspector uses paper chromatography to test a bottle of drink **V**.
The inspector first prepares a concentrated solution of drink **V**.
A drop of concentrated drink **V** and a drop of tartrazine solution are placed on a piece of chromatography paper.
The paper is then placed in a beaker of water.

The chromatogram obtained is shown.



(i) Describe how the inspector can prepare a concentrated solution of drink **V**. [1]
(ii) State **three** conclusions that can be made from the chromatogram. [3]
(2018/P4/Q3)

Section B
Answer the following questions.

1. (a) A student carries out an experiment to study the reaction between hydrochloric acid and magnesium.

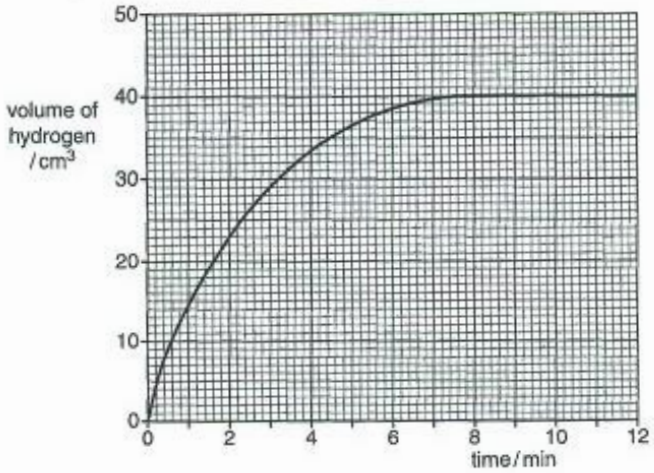
The word equation for the reaction is shown below.

magnesium + hydrochloric acid ⟶ magnesium chloride + hydrogen

The hydrogen produced in this experiment is collected in a gas syringe.

Its volume is measured at one minute intervals.

The results obtained from this experiment are plotted. The graph is shown below.



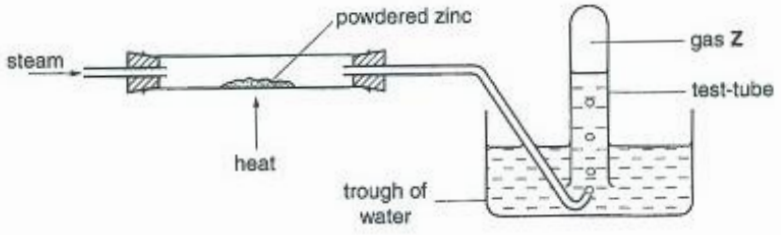
(i) What is the volume of hydrogen collected after 3 minutes? [1]

(ii) After how many minutes does the reaction stop? [1]

(b) Describe how crystals of magnesium chloride can be obtained from the resulting solution. [2]

(2012/P4/Q4b)

2. The apparatus shown below can be used to study the reaction between zinc and steam.



(a) Name gas Z. [1]

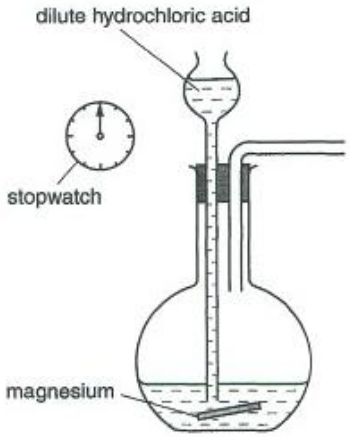
(b) Describe a test to identify gas Z. [2]

(2013/P4/Q6ai, ii)

3. Magnesium metal reacts with dilute hydrochloric acid to produce the gas hydrogen.

A student added an **excess** of hydrochloric acid to magnesium in the apparatus shown below.

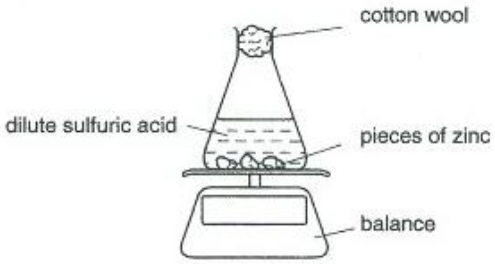
The gas given off was collected and the total volume of gas was measured every minute.



Complete the diagram to show the apparatus the student would use to collect the gas and measure the total volume of the gas. [1]

(2014/P4/Q6c)

4. A student uses the apparatus below to study the reaction between dilute sulfuric acid and an excess of zinc.



The equation for the reaction is

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

(a) Suggest why the total mass of the flask and its contents decreases with time. [1]

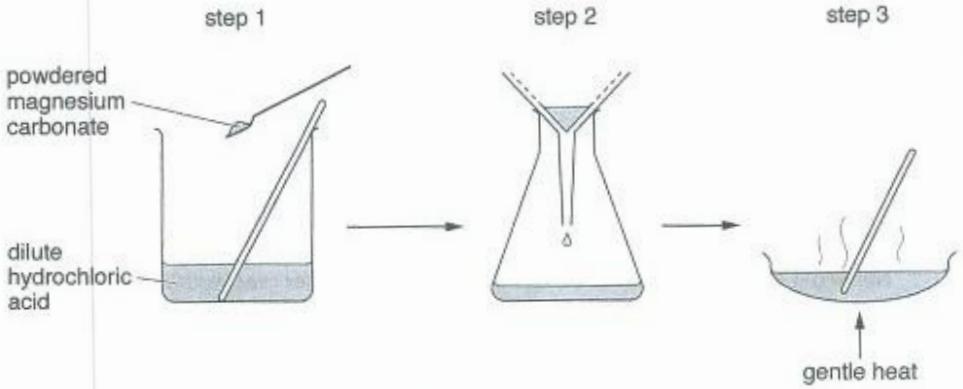
(b) Suggest why an excess of zinc is used. [1]

(c) Explain how the student can obtain crystals of zinc sulfate from the contents of the flask. [2]

(2015/P4/Q5b)

5. Crystals of the salt magnesium chloride, $MgCl_2$, can be made by reacting dilute hydrochloric acid, HCl, with an excess of powdered magnesium carbonate, $MgCO_3$.

The diagram shows the first three steps used to prepare crystals of this salt.



(a) (i) Name the process being used in step 2 and the process being used in step 3. [1]
(ii) Explain why step 3 is carried out. [1]

(b) The liquid from step 3 is allowed to stand for some time to allow crystals to grow. Describe the next two steps needed in order to produce a sample of dry magnesium chloride crystals. [2]

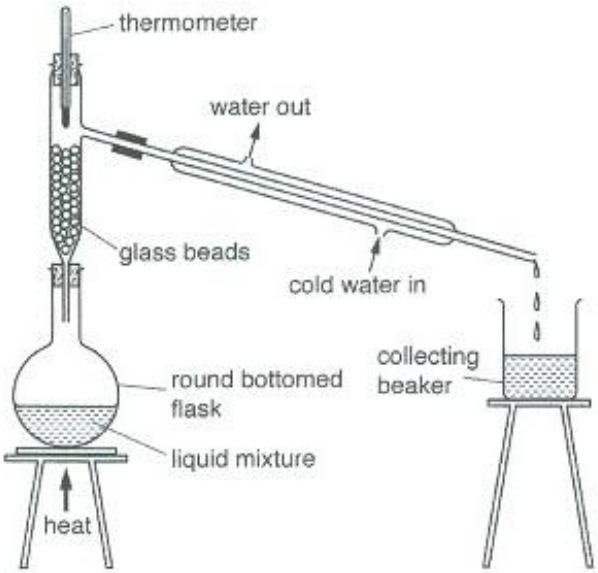
(c) During step 1, a gas is given off.
Name the gas and describe a positive test to identify the gas. [1]

(2016/P4/Q6a, b, ci)

6. The table shows some of the properties of the first seven members of the alkane homologous series.

name	formula	boiling point /°C	physical state at 20°C
methane	CH_4	–164	gas
ethane	C_2H_6	–89	gas
propane	C_3H_8	–42	gas
butane	C_4H_{10}	0	gas
pentane	C_5H_{12}	36	
hexane	C_6H_{14}	69	liquid
heptane	C_7H_{16}	98	liquid

Octane follows heptane in the alkane homologous series.
A mixture of heptane and octane can be separated using the apparatus shown.



(a) Name this method of separation. [1]
(b) Which of the two alkanes will collect in the beaker first? Explain your answer. [1]
(2018/P4/Q6ci, ii)