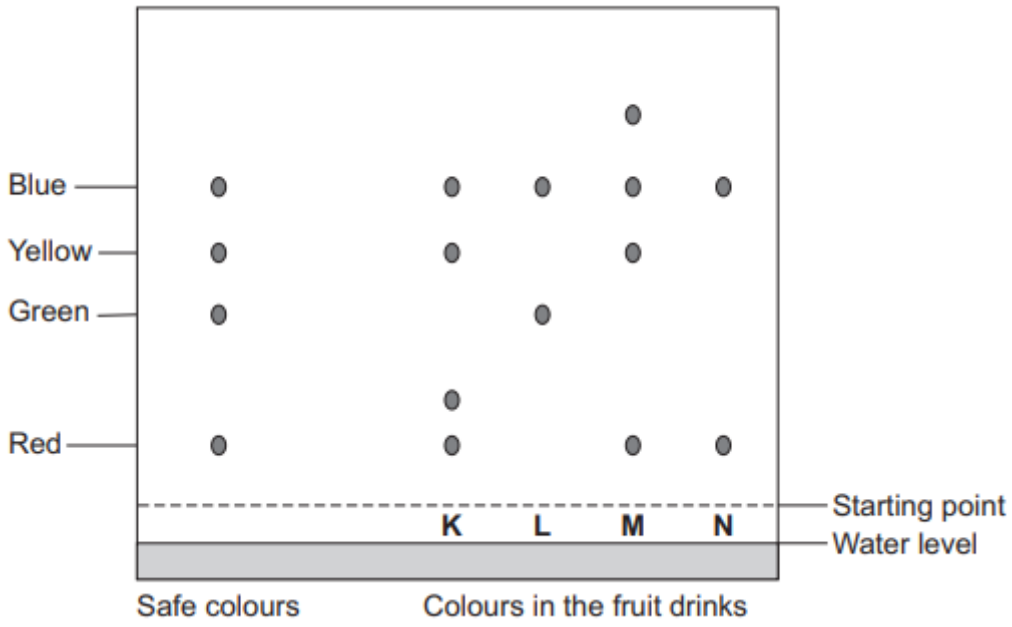
SEPARATION TECHNIQUES 3

Q1. A student investigated the colours in four fruit drinks, K, L, M and N, using chromatography. The solvent used was water.

The results were compared with those of safe colours allowed in fruit drinks.

The results are shown in the chromatogram.



(a) The chromatogram shows that . . .

1 all the fruit drinks contain only two colours.

2 blue, yellow, green and red safe colours are soluble in water.

3 only fruit drink K contains more than two colours.

4 fruit drinks L and N are more dilute than the other fruit drinks.

(1 mark)

(b) The student should investigate fruit drink M more fully because . . .

1 drink M contains four colours.

2 the mixture of colours makes drink M a dark brown colour.

3 people will not buy a fruit drink containing the colours red, yellow and blue.

4 drink M contains a colour that the student has not identified.

(1 mark)

(c) The chromatogram for the four fruit drinks shows that . . .

1 only K is safe to drink.

2 only L and N are safe to drink.

3 only K, L and N are safe to drink.

4 K, L, M and N are safe to drink.

(1 mark)

(d) A test shows that a different fruit drink on sale in the shops contains a colour that could be harmful to some people. What should the manufacturer do immediately?

1 give employees protective gloves when handling this fruit drink

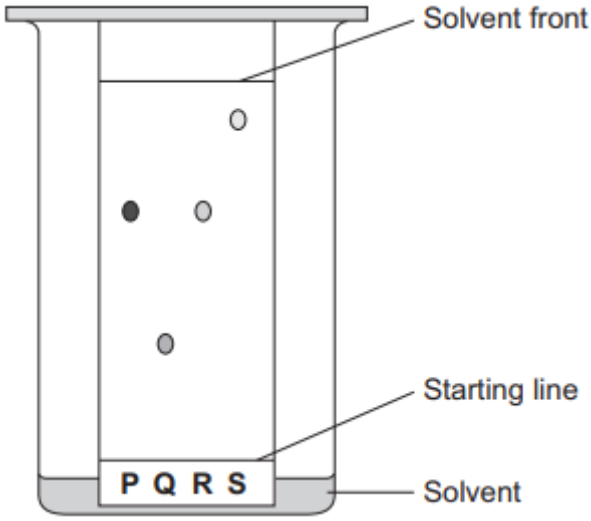
2 replace the colour in the fruit drink with another that is safe

3 stop production of all fruit drinks

4 withdraw the fruit drink from all shops and advise the public not to drink it

(1 mark)

Q2. The diagram shows an investigation using paper chromatography.



As the solvent rises up the paper it moves the colours depending on their attraction for the solvent and the paper.

The greater the attraction of a colour for the solvent and the less the attraction for the paper, the further the colour moves.

An R_f value is defined as:

$$R_f = \frac{\text{distance moved by the colour}}{\text{distance moved by the solvent}}$$

The R_f value for a particular substance is different in different solvents.

(a) In the investigation shown in the diagram, what was the Rf value of colour S?

1 0.0

2 0.5

3 0.7

4 0.9

(1 mark)

The R_f values for the colours, P, Q, R and S, in four different solvents, are shown in the table.

	Solvent			
	Water	**Ethanol**	**Propanone**	**Tetrachloromethane**
Colour P	0.5	0.9	0.7	0.5
Colour Q	0.0	0.8	0.6	0.2
Colour R	0.5	0.7	0.6	0.1
Colour S	0.2	0.6	0.4	0.2

(b) From the information on the diagram and in the table, it is correct to say that . . .

1 colours P and R are the same.

2 colours Q and S are the same.

3 P, Q, R and S are four different colours.

4 chromatography works on any colour.

(1 mark)

(c) Which colour is not soluble in water?

1 P

2 Q

3 R

4 S

(1 mark)

(d) Using the data in the table above, which solvent could be used to separate a mixture of all four colours, P, Q, R and S?

1 water

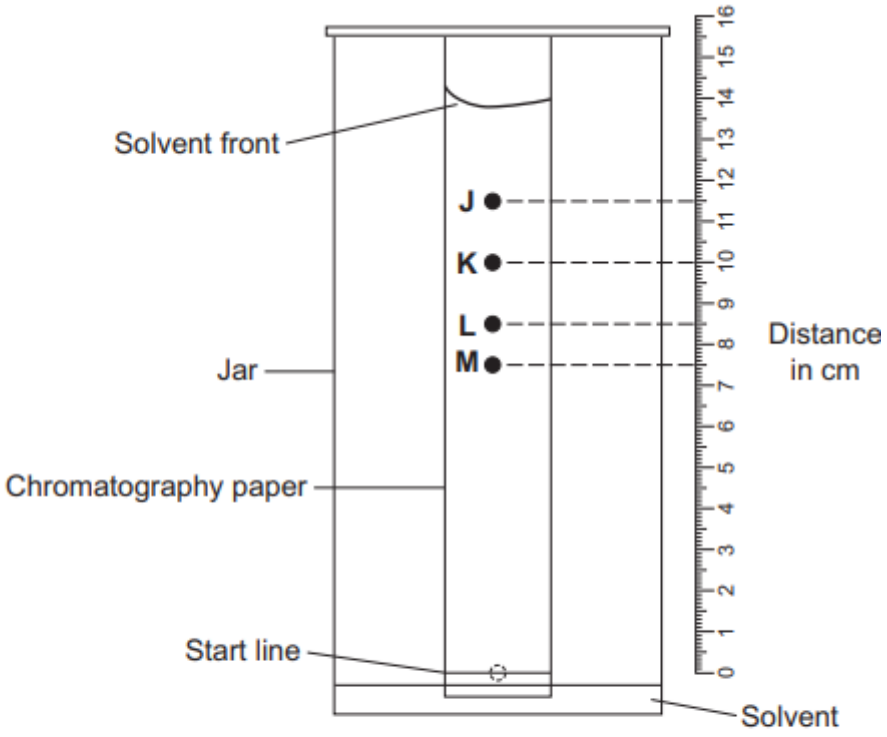
2 ethanol

3 propanone

4 tetrachloromethane

(1 mark)

Q3. The colours from a sweet were dissolved in a solvent. A spot of the solution was put onto some chromatography paper. The paper was then placed in a jar. After a period of time, the colours were separated as shown in the diagram.



$$\text{the } R_f \text{ value for a colour} = \frac{\text{distance moved by the colour}}{\text{distance moved by the solvent}}$$

The substance responsible for a colour can be identified by using its R_f value. This tells you where to look on the chromatogram for this colour.

(a) Amaranth has an R_f value of 0.54. Which of the colours is possibly amaranth?

1 J

2 K

3 L

4 M

(1 mark)

Indigo carmine has an R_f value of 0.58 and amaranth has an R_f value of 0.54.

(b) There must be some doubt about whether a particular spot is indigo carmine or amaranth because . . .

1 the solvent front is not straight.

2 the length of time the chromatography paper was in the solvent is not known.

3 the scale is marked in 10 mm divisions.

4 only colours from one sweet were used.

(1 mark)

(c) The test was done four times for one particular colour. R_f values of 0.51, 0.53, 0.58 and 0.61 were obtained. This data tells us that . . .

1 the colour is amaranth.

2 the colour is indigo carmine.

3 the colour could be indigo carmine or amaranth.

4 the method cannot detect different colours.

(1 mark)

(d) It is recommended that indigo carmine should not be eaten by children. The evidence from this investigation should lead to . . .

1 these sweets being banned.

2 further investigation with additional chemical tests.

3 these sweets being banned for children only.

4 this test being repeated more times.

(1 mark)

Q4. We can get plant oils from crushed plants.

This is a two-stage process.

Stage 1

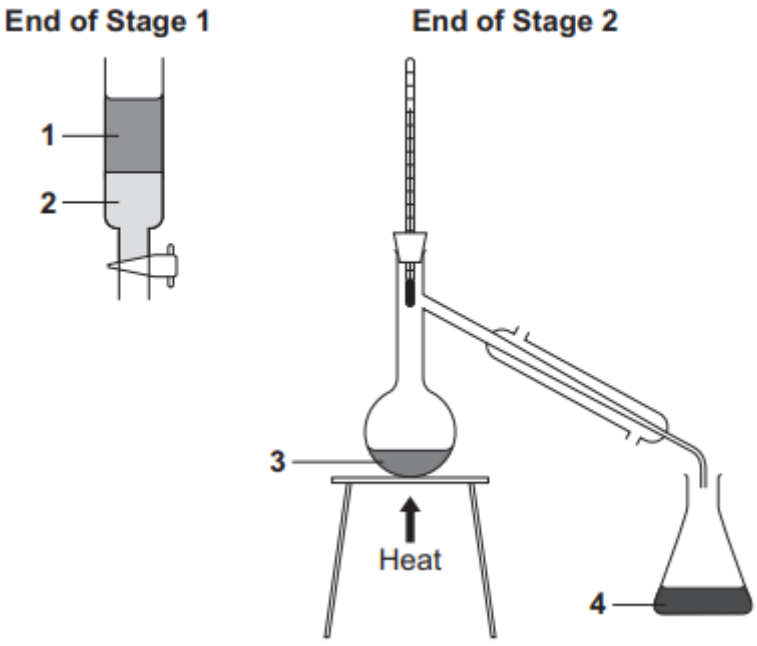
Shake up the crushed mixture with a solvent and water. This separates the oil from the crushed mixture.

- Only the oil dissolves in the solvent.
- The liquids are filtered from the solids.
- The oil and solvent mixture floats on water.

Stage 2

Use simple distillation to separate the oil from the solvent.

- The solvent has a lower boiling point than the oil.



Match words, A, B, C and D, with the labels 1– 4 on the diagrams.

A the oil and solvent mixture

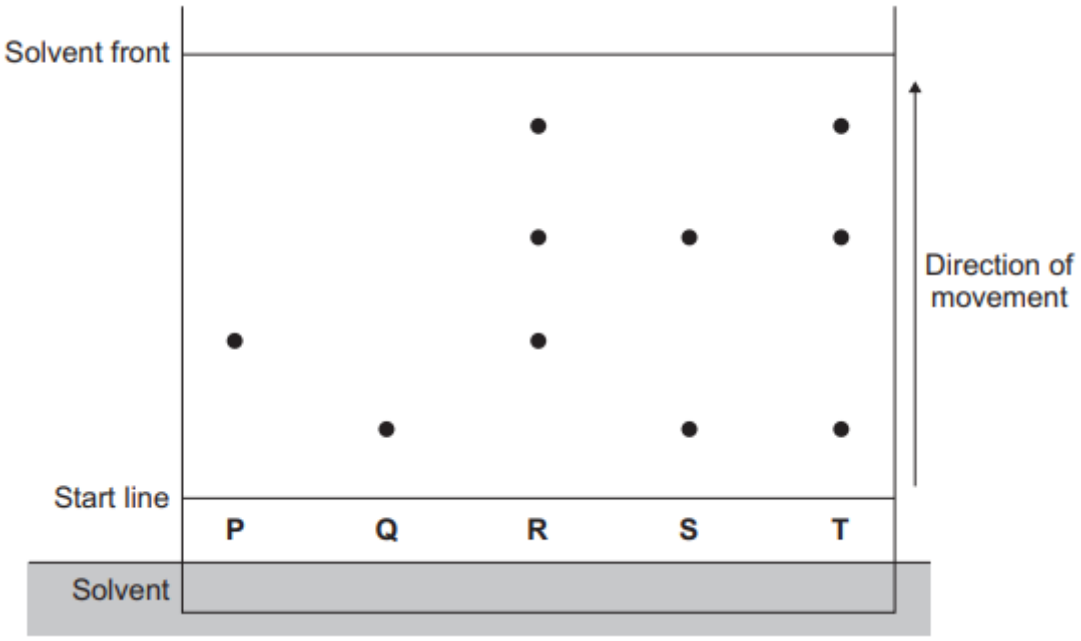
B the plant oil

C the water

D the solvent

(4 marks)

Q5. Chromatography is used to identify and compare five food colourings, P, Q, R, S and T. The five food colourings are used to coat chocolate sweets.



(a) Which food colourings are mixtures of three colours?

1 P and R

2 Q and S

3 R and T

4 S and P

(1 mark)

(b) Food colouring P was analysed and was found to be toxic. Which other food colouring is toxic?

1 Q

2 R

3 S

4 T

(1 mark)

Q6. Diesel is separated from crude oil by fractional distillation.

Describe the steps involved in the fractional distillation of crude oil.

_____

_____

_____

_____

_____

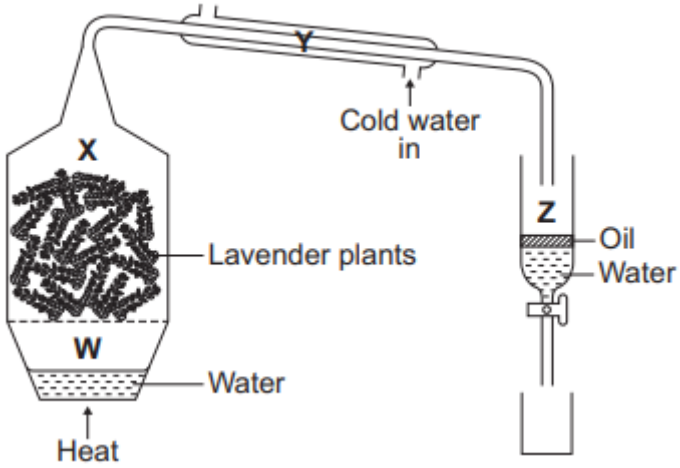
_____

(3 marks)

Q7. This question is about plant oils.

Steam distillation is used to separate oils from plants. The diagram shows some apparatus that can be used to separate oil from lavender plants.

Four parts of the apparatus are labelled W, X, Y and Z.



Describe how lavender oil is separated from the plant material. You need to describe what happens in each of the parts, W, X, Y and Z, of the apparatus.

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_____

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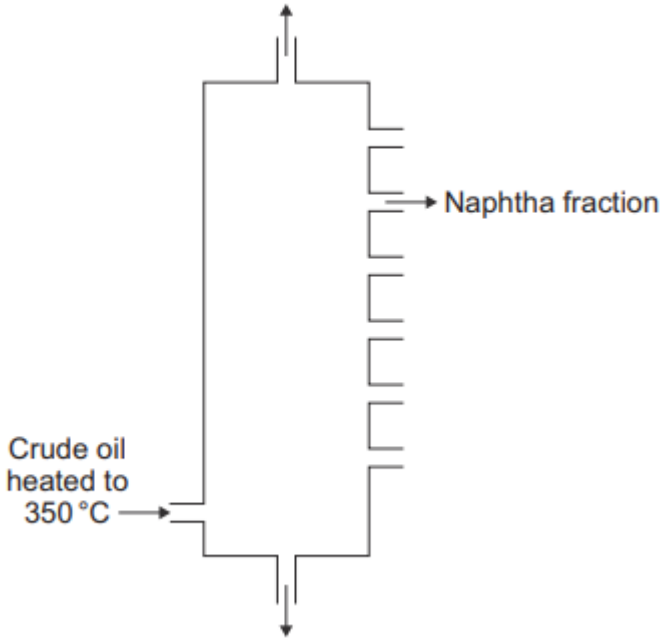
(4 marks)

Q8. Crude oil is used to produce poly(ethene).

Fractional distillation is used to separate crude oil into fractions.



Write a number, 2, 3, 4 or 5, next to each stage so that the description of fractional distillation is in the correct order. Numbers 1 and 6 have been done for you.

Number	Stage
1	The crude oil is heated to 350 °C.
	When a fraction in the vapours cools to its boiling point, the fraction condenses.
	Any liquids flow down to the bottom of the column and the hot vapours rise up the column.
6	The condensed fraction is separated and flows out through a pipe.
	When the hot vapours rise up the column, the vapours cool.
	Most of the compounds in the crude oil evaporate.

(2 marks)

Q9. Green plant cells contain many different coloured pigments.

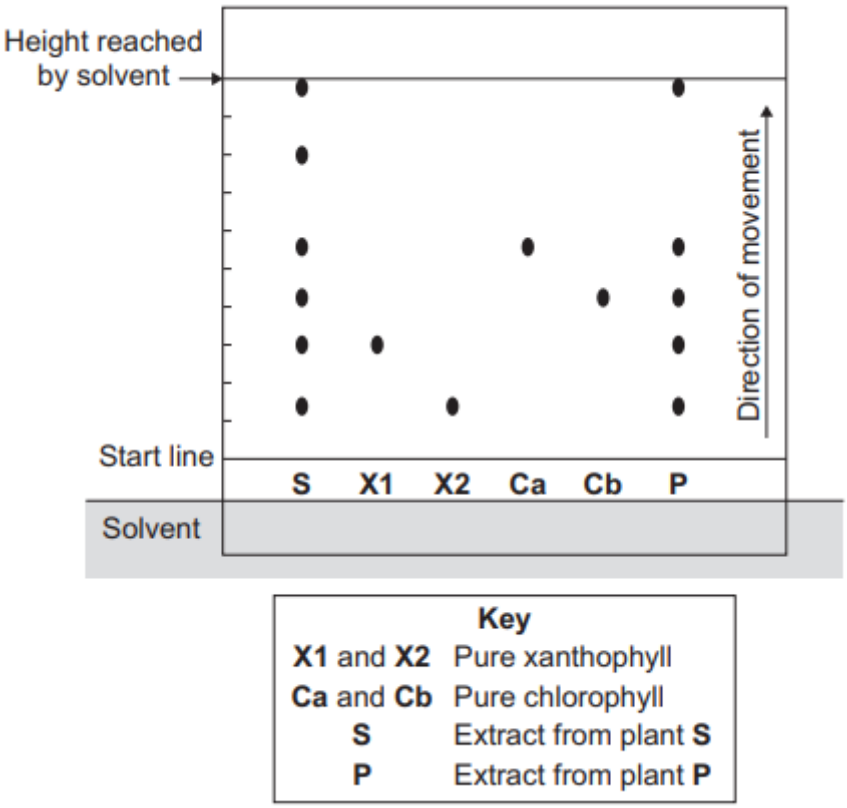
Examples are:

- two types of chlorophyll, **Ca** and **Cb**
- two types of xanthophyll, **X1** and **X2**.

The pigments can be separated by chromatography.

In an experiment, extracts from two plants, P and S, were compared with pure Ca, Cb, X1 and X2 using chromatography.

The diagram shows the results of the experiment.



(a) From this experiment, it is possible to deduce that plant S contains . . .

1 coloured substances not identified by this experiment.

2 four coloured substances.

3 seven coloured substances.

4 the same mixture of coloured substances as plant P.

(1 mark)

(b) From this experiment, it is possible to deduce that plant P . . .

1 contains coloured substances that are soluble in the solvent.

2 contains substances that could be safely used for colouring food.

3 is unhealthy.

4 would look identical to plant S

(1 mark)

$$\text{In chromatography, the } R_f \text{ value} = \frac{\text{distance moved by the substance from the start line}}{\text{distance moved by the solvent from the start line}}$$

(c) What is the R_f value for X1?

1 0.03

2 0.16

3 0.30

4 3.33

(1 mark)

(d) Two other coloured substances found in plants are:

- carotene R_f value 0.98
- phaeophytin R_f value 0.80

From this information we can deduce that the leaves on plant S contain . . .

1 both carotene and phaeophytin.

2 carotene but not phaeophytin.

3 phaeophytin but not carotene.

4 neither carotene nor phaeophytin.

(1 mark)

Total marks (31)