

1. Kate makes a solution of zinc chloride by reacting solid zinc carbonate with dilute hydrochloric acid.

She adds too much solid zinc carbonate to the reaction mixture.

She needs to remove the excess solid.

What separation technique should she use?

Put a **ring** around the correct answer.

crystallisation

filtration

distillation

evaporation

[1]

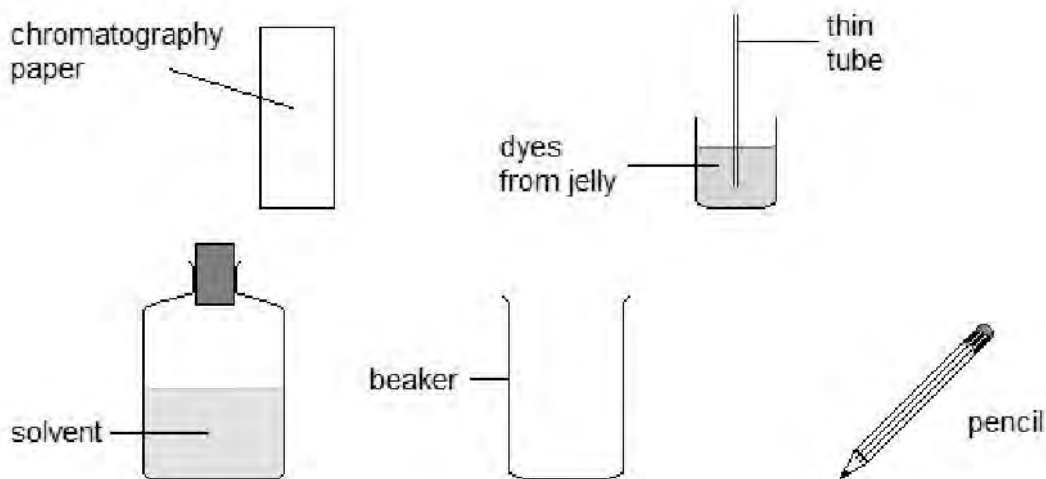
2(a). Eve works in a laboratory where food dyes are tested.

Some dyes are banned because they are known to be harmful.

Eve is going to test a jelly that will be exported to the USA.

Eve prepares a chromatogram of the jelly.

The diagrams show some apparatus she uses.



(i) Calculate how much sodium chloride she needs to use to make 250 cm^3 of the solvent.

0.2 % of the mass of the solvent is sodium chloride.

Assume 1 cm^3 of solvent has a mass of 1 g.

amount of sodium chloride _____ g [2]

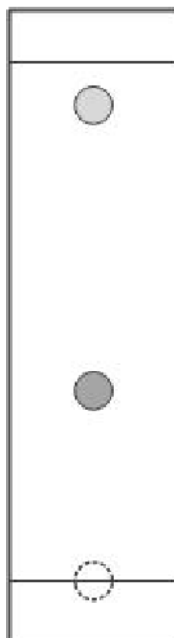
(ii) Describe how Eve should set up her chromatogram of the jelly. You may use a diagram in your answer.

[4]

(b). * Below is a table of the Rf values of dyes banned in the USA.

Food dye	Rf value in 0.2% sodium chloride solution
Yellow 5	0.71
Blue 2	0.37
Yellow 6	0.52
Red 3	0.10

Eve's finished chromatogram is shown below.



Explain the conclusions Eve can make about the jelly. Include what she could do to increase the confidence in her conclusions.

[6]

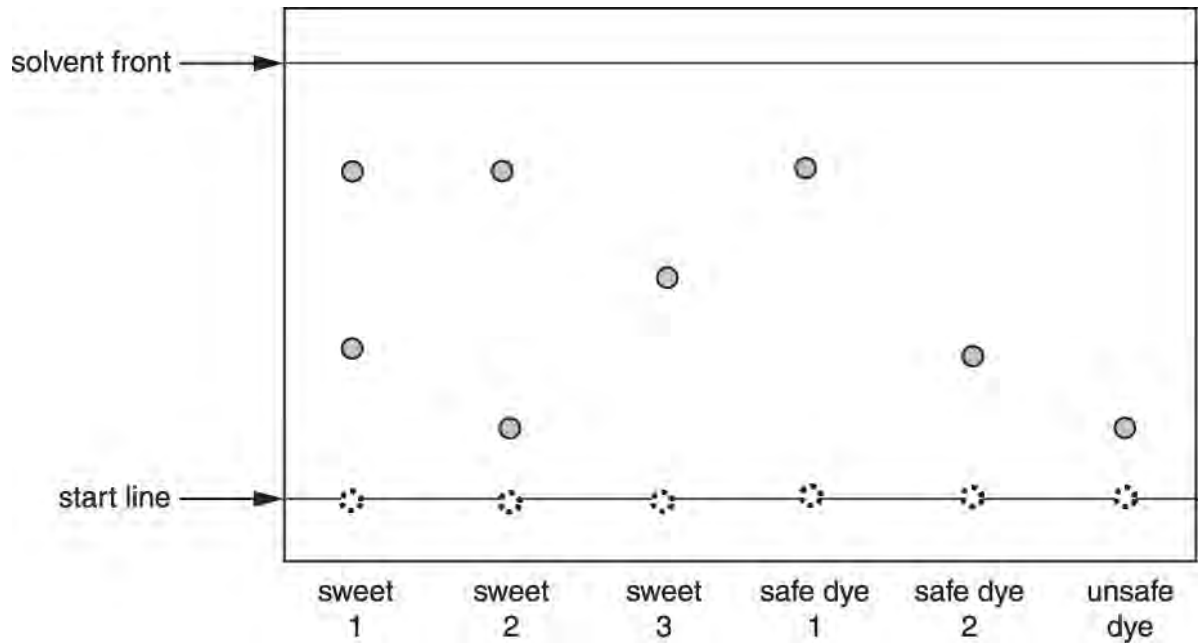
3. Alex uses chromatography to check that the food dyes used in some sweets are safe.

He tests three sweets against three known reference dyes.

Two of the references are known safe dyes.

One reference is a known unsafe dye.

Here is the chromatogram showing his results.



Alex's job is to decide whether or not the sweets contain only safe dyes or if they might contain any unsafe dyes.

What conclusions can you make about the safety of the sweets and the dyes that the sweets contain?

Use the results of the chromatogram to explain your answer.



The quality of written communication will be assessed in your answer.

[6]

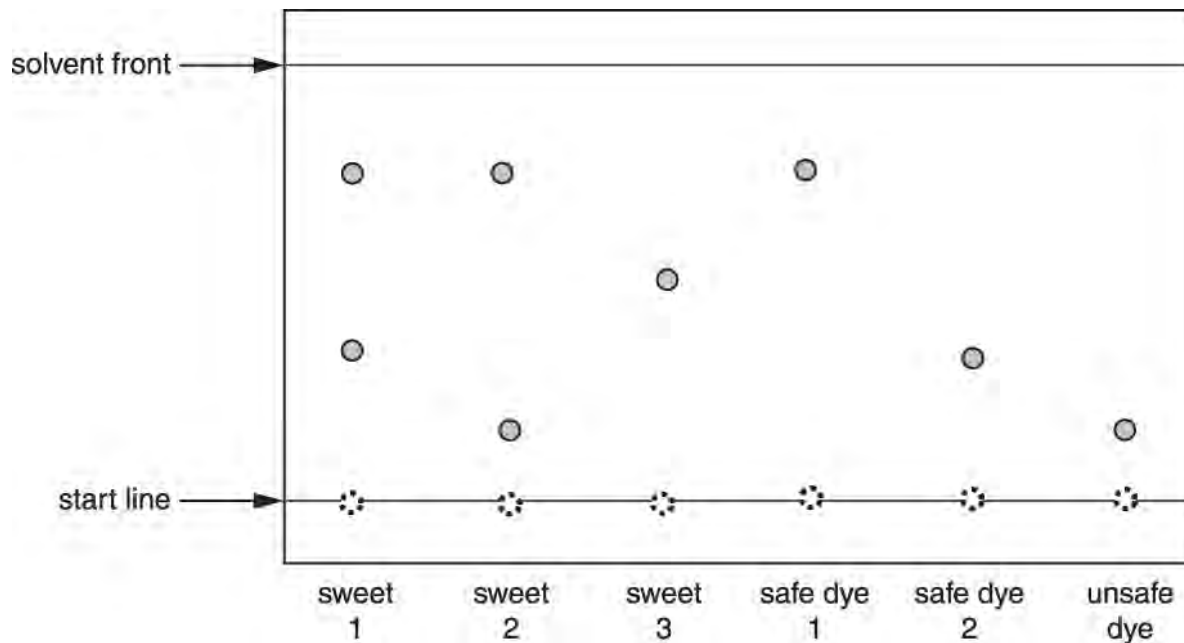
4(a). Alex uses chromatography to check that the food dyes used in some sweets are safe.

He tests three sweets against three known reference dyes.

Two of the references are known safe dyes.

One reference is a known unsafe dye.

Here is the chromatogram showing his results.



Alex decides to calculate the R_f of safe dye 1.

What measurements does he need to make from the chromatogram to use in his calculation?

[2]

(b). Alex also uses chromatography to identify the **flavourings** used in sweets.

At the end of his experiment he sprays his chromatogram with a locating agent.

Why does he need to do this?

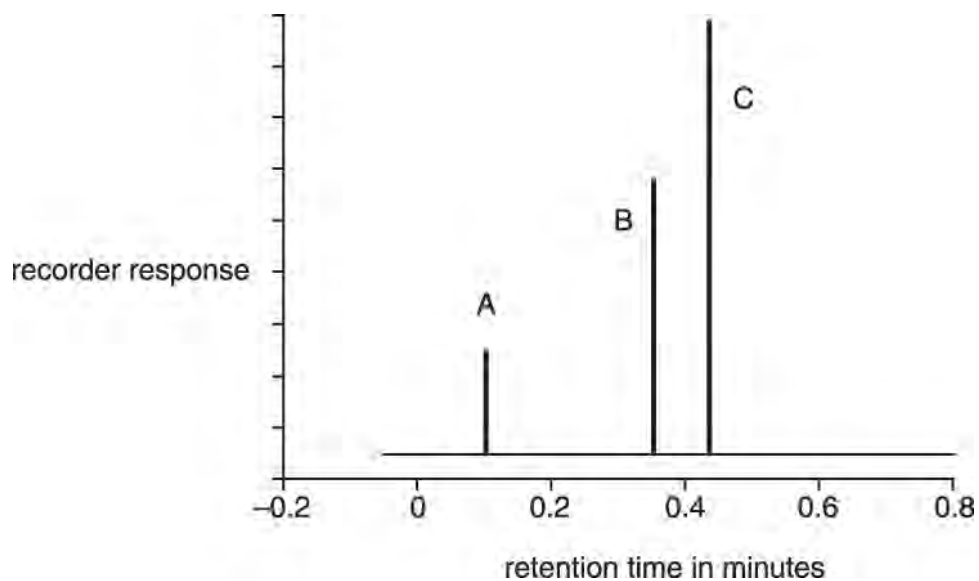
Put a tick (✓) in the box next to the correct answer.

- To separate the spots.
- To remove the solvent.
- To see the spots.
- To speed up the movement of the solvent.

[1]

(c). Alex decides to use a chromatography machine to analyse the dyes from a different type of sweet.

This is the printout he gets.



(i) The printout shows that three dyes have been used in the sweet.

Alex thinks that there is more of dye C in the sweet than either dye A or dye B.

How does the printout show that he is right?

Put a tick (✓) in the box next to the correct answer.

Dye C has the highest peak.

Dye C has the longest retention time.

There is more than 0.4 g of dye C in the sweet.

Dyes A and B both have retention times below 0.4 minutes.

[1]

(ii) Alex says that the chromatography printout gives both **qualitative** and **quantitative** information about the dyes used in the sweet.

Explain why this is true.

[2]

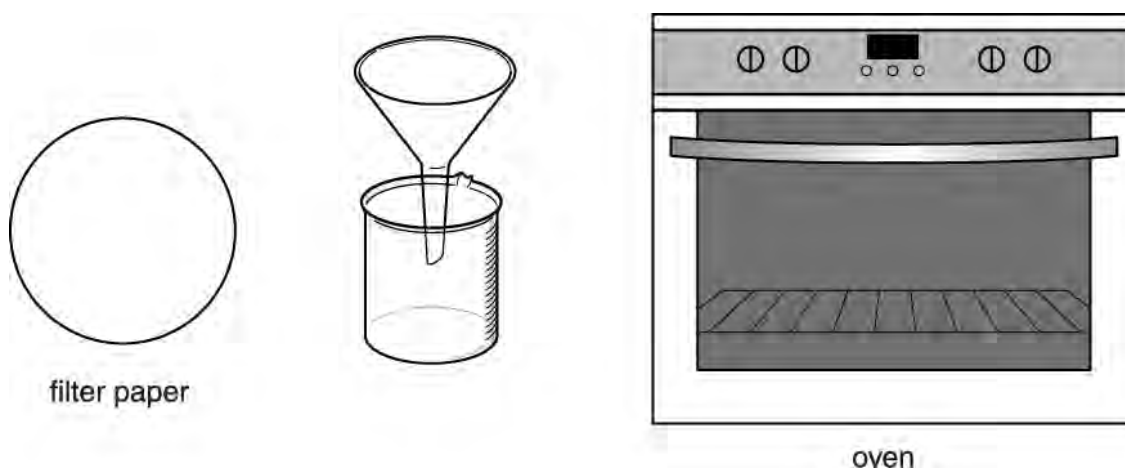
5. Silver chloride is a salt that is used to make lenses that darken in bright light.



In the reaction, silver chloride forms as a precipitate.

Terry wants to make a pure, dry sample of silver chloride from the reaction mixture.

The diagram shows the apparatus he uses.



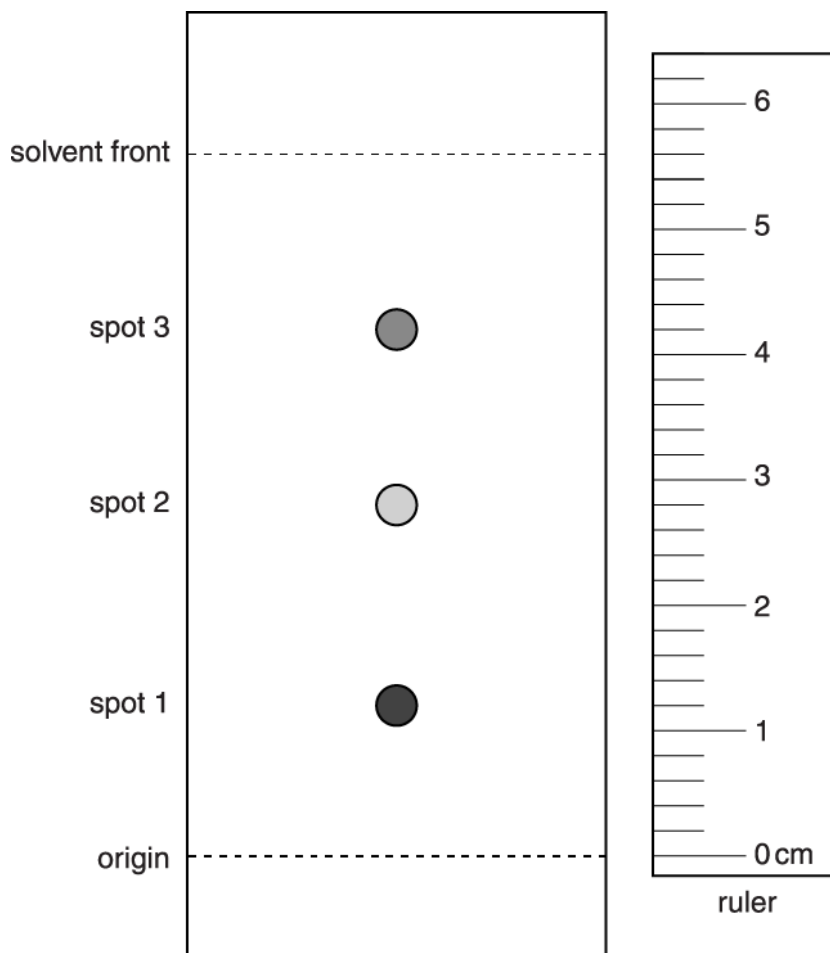
Describe how Terry should use this apparatus to make a pure, dry sample of silver chloride.

6(a). Peter is testing the food colourings in soft drinks made by different companies.

He wants to find out if any of these drinks contain banned food colourings.

Peter uses chromatography.

Here is a diagram of the chromatogram from soft drink A.



Use the ruler on the diagram.

Work out the Rf value for **spot 3** on this chromatogram.

Use the formula in the box.

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

Show your working.

Rf value for spot 3 = [2]

(b). Peter tests five soft drinks.

Write your Rf value for spot 3 of soft drink A in the table with the others.

Soft drink	Rf value spot 1	Rf value spot 2	Rf value spot 3
A	0.21	0.50	
B	0.38	0.65	0.72
C	0.38	0.72	0.88
D	0.29	0.65	0.82
E	0.38	0.44	0.65

Peter does a chromatogram of the a banned food colouring.

He finds that it gives two spots, with Rf values 0.38 and 0.65.

Which of the soft drinks contain the banned food colouring?

answer [2]

(c). Peter does another chromatogram of the banned food colouring.

This time he uses alcohol instead of water as the solvent.

The table shows his results.

Solvent	Rf values for spots
water	0.38 and 0.65
alcohol	0.25 and 0.90

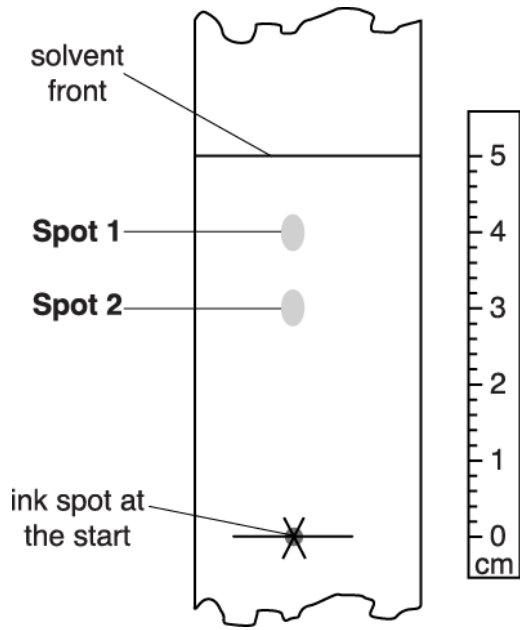
He writes this conclusion.

Both of the dyes in the food colouring move further when alcohol is used.

Do you think Peter's conclusion is correct? Explain your reasoning.

[2]

7(a). Ben uses paper chromatography to analyse the ink from his pen. He puts the bottom of the paper in water and leaves it for a few hours. The diagram shows his result.



Explain why there are two spots, and why Spot 1 is higher than Spot 2.



The quality of written communication will be assessed in your answer.

[6]

(b). Use this formula to calculate the *Rf* value for Spot 1.

$$Rf = \frac{\text{distance travelled by spot}}{\text{distance travelled by solvent}}$$

Show your working.

Rf for Spot 1 = [2]

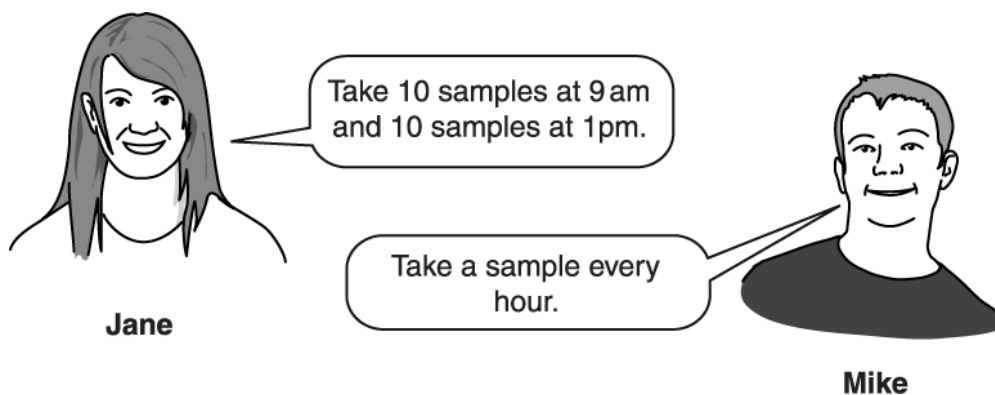
(c). Sometimes when scientists do chromatography they have to use locating agents.

Explain why.

..... [2]

(d). A factory makes ink. The ink is made continuously throughout the day.

Chromatography is used to test samples of the ink.



Explain who has the best approach.

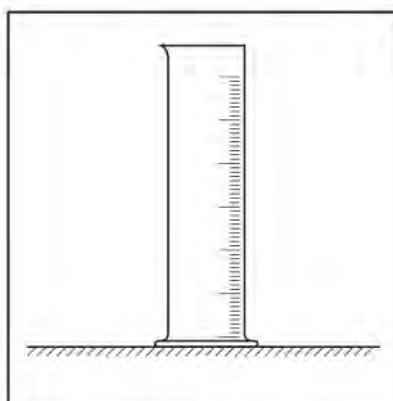
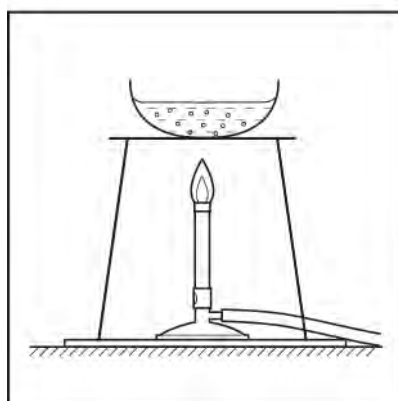
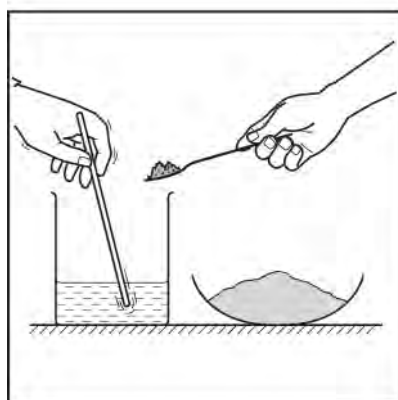
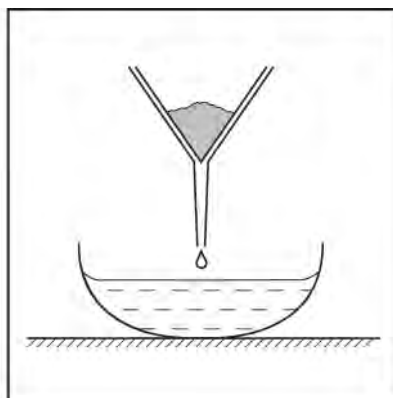
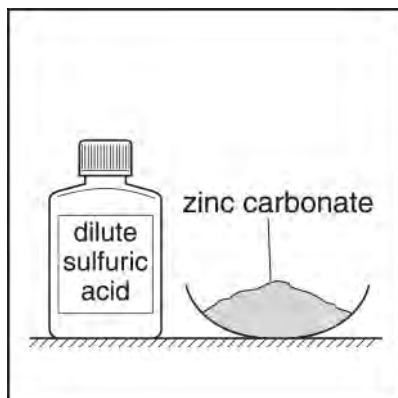
..... [3]

8(a). Jak makes some zinc sulfate crystals from solid zinc carbonate and dilute sulfuric acid.

He starts with 20 cm³ of dilute sulfuric acid.

The diagrams below show some of the apparatus and chemicals he uses.

They are not in the order that Jak uses them.



Describe how Jak uses the apparatus and chemicals shown in the diagrams to make some clean, dry crystals of

zinc sulfate.



The quality of written communication will be assessed in your answer.

[6]

(b). Jak makes more zinc sulfate crystals by a different method.

This time he reacts the acid with zinc instead of with zinc carbonate.

He notices that a gas is made in each reaction.

Draw straight lines to connect each reaction with the correct gas.

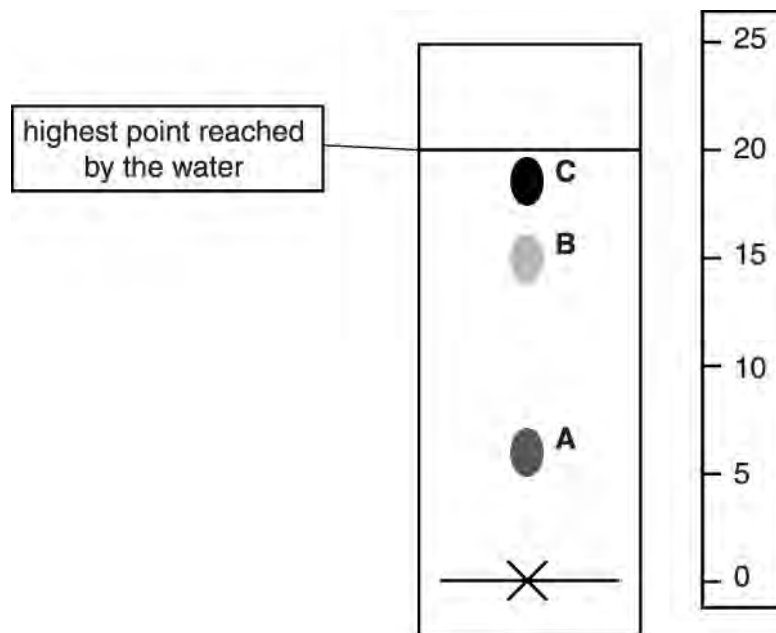
reaction	gas
sulfuric acid + zinc carbonate	carbon dioxide
sulfuric acid + zinc	nitrogen
	hydrogen
	oxygen
	sulfur dioxide

[2]

9(a). Alex does a chromatography experiment using the ink from her pen.

She makes an ink dot on the paper, and then puts the bottom of the paper into a dish of water.

She gets this pattern.



(i) How many colours are in the ink?

answer [1]

(ii) Alex knows that the different colours all dissolve in water.

Which colour dissolves in water the best?

Explain your answer.

.....
..... [2]

(iii) Use the formula to calculate the Rf value for colour B.

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

Show your working.

Rf = [2]

(b). Alex tries out the ink from a different pen.

She knows that the ink contains two colours.

She gets this result when she runs the chromatogram with water.



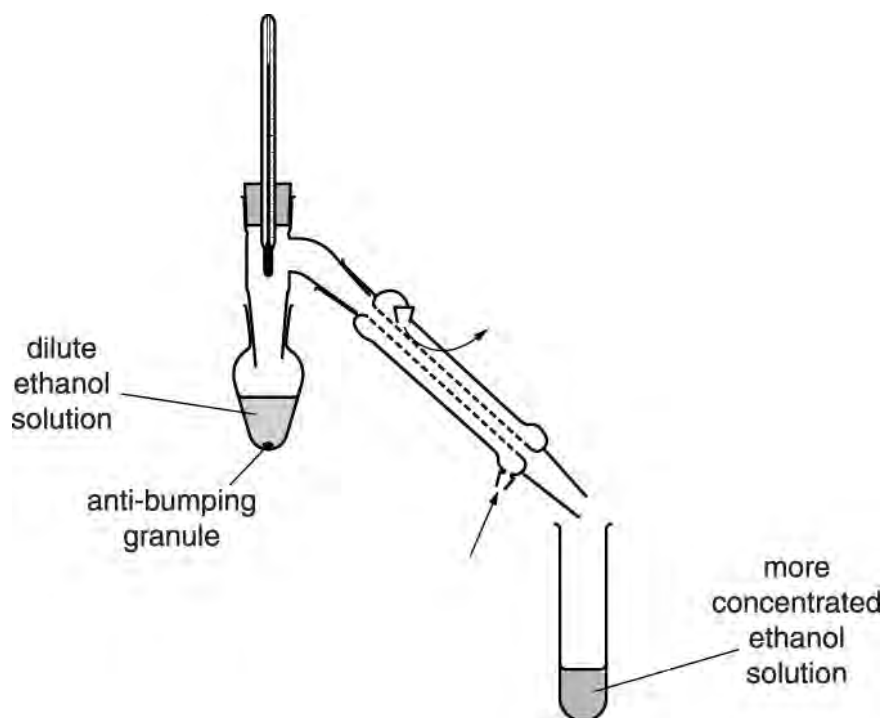
(i) Suggest why no spots appear higher up the paper.

.....
.....
..... [2]

(ii) How could she change her experiment to make the two colours show up?

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

10. Kate and William have a dilute ethanol solution. They decide to make their solution more concentrated. They use this apparatus.



Describe how they use this equipment to make their dilute ethanol solution more concentrated, and why it works.



The quality of written communication will be assessed in your answer.

11. Mauritius is a country of small islands surrounded by sea.
There is almost no fresh water in Mauritius.
A distillation process is used to produce fresh water.

Statements A–G describe some **correct** and some **incorrect** stages in the distillation process.

A	Cold water is used to cool the steam.
B	Water evaporates.
C	Water condenses.
D	Water is heated.
E	Seawater is taken from the sea.
F	Water is sent through pipes to homes.
G	Salt is filtered out from the seawater.

Put the **correct** statements in the correct order.

The first and last have been done for you.

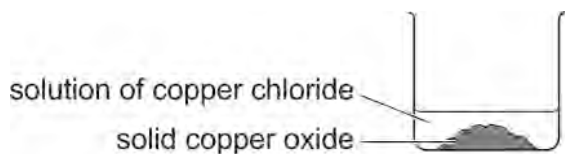
E					F
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[2]

12.

Amir adds 8 g of solid copper oxide to a small amount of dilute hydrochloric acid in a beaker. Some of the copper oxide does not react.

He now has a mixture which contains a solution of copper chloride and some solid copper oxide.



(i) Amir uses different techniques to separate solid copper oxide and to obtain crystals of copper chloride from the mixture.

Draw lines from each **substance** to the correct **technique**.

Substance	Technique
<input type="text"/>	<input type="text" value="Distillation"/>
<input type="text" value="Solid copper oxide"/>	<input type="text" value="Evaporation"/>
<input type="text" value="Copper chloride crystals"/>	<input type="text" value="Filtration"/>
<input type="text"/>	<input type="text" value="Titration"/>

[2]

(ii) Amir's percentage yield for this experiment is very low.

Suggest a reason why.

----- [1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			filtration ✓	1	
			Total	1	
2	a	i	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.5 (g) award 2 marks</p> <p>mass of solvent = $1 \times 250 = 250$ ✓</p> <p>mass of NaCl = $250 \times 0.2 \div 100 = 0.5$ (g) ✓</p>	2	
		ii	<p>draw start line with pencil ✓</p> <p>put a dot of dye on start line ✓</p> <p>add sodium chloride / solvent to beaker / put paper into solvent ✓</p> <p>make sure solvent is below level of dot ✓</p>	4	all points may be scored from a clearly labelled diagram

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
b	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>Level 3 (5–6 marks)</p> <p><i>Shows correct understanding of output of the chromatogram and calculates correctly the Rf of some of the spots, including linking the Rf values to the table of food dyes.</i></p> <p>And</p> <p><i>makes correct conclusions about the jelly</i></p> <p>And</p> <p><i>Suggests improvements to increase confidence in the result.</i></p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i></p> <p>Level 2 (3–4 marks)</p> <p><i>Shows correct understanding of output of the chromatogram and calculates correctly the Rf of some of the spots, including linking the Rf values to the table of food dyes.</i></p> <p>And</p> <p><i>makes some conclusions about the jelly or suggests improvements. There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks)</p> <p><i>Shows correct understanding of output of the chromatogram and attempts to calculate the Rf of a spot but incorrectly (shows knowledge of the formula)</i></p> <p><i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i></p>	6	<p>Indicative scientific points may include</p> <p>AO3.2b: making conclusions about the dye dyes by comparing results with table of Rf values</p> <p>For example</p> <ul style="list-style-type: none"> • one spot possibly a safe dye • one spot banned dye • cannot be exported to USA <p>AO2.2: directly linking spots Rf values</p> <p>For example</p> <ul style="list-style-type: none"> • calculates the Rf of dyes: 0.37 / 0.92 • compares spots with table <p>AO1.2: understanding of the output from a chromatogram</p> <p>For example</p> <ul style="list-style-type: none"> • jelly contains 2 dyes • shows how to calculate RF value <p>AO3.3b: making improvement to increase confidence</p> <p>For example</p> <ul style="list-style-type: none"> • use a different solvent • suggest a different method • look at a more extensive Rf table to identify other dye and check for safety

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			0 marks No response or no response worthy of credit.		
			Total	12	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
3	<p>[Level 3] Makes statements about the safety of all three sweets AND makes conclusions about the dyes in all three sweets. Quality of written communication does not impede communication of the science at this level.</p> <p style="text-align: right;">(5 – 6 marks)</p> <p>[Level 2] Makes statements about the safety of at least two sweets OR makes conclusions about the dyes in two sweets. Quality of written communication partly impedes communication of the science at this level.</p> <p style="text-align: right;">(3 – 4 marks)</p> <p>[Level 1] Makes a correct statement about the safety of one of the sweets OR dyes in one of the sweets. Quality of written communication impedes communication of the science at this level.</p> <p style="text-align: right;">(1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit.</p> <p style="text-align: right;">(0 marks)</p>	6	<p>This question is targeted at grades up to C</p> <p>Indicative scientific points may include: Dyes in the sweets</p> <ul style="list-style-type: none"> • sweet 1 contains 2 (safe) dyes • sweet 2 contains 2 dyes/safe dye 1 and unsafe dye • sweet 1 and 2 contain one dye that is the same in both sweets • sweet 3 contains one dye • sweet 3 contains an unknown dye/can't tell <p>Safety of the sweets</p> <ul style="list-style-type: none"> • sweet 1 contains (only) safe dyes / is safe • sweet 2 also contains the unsafe dye / is unsafe • sweet 3 may be unsafe / need more information <p>Ignore 'makes spots' look for references to dyes or colours.</p> <p>Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.</p> <p>Examiner's Comments</p> <p>Questions in the past have asked students to calculate <i>R_f</i> values or identify the contents of simple chromatograms in short questions. Candidates typically answer such questions well. In this case, they were asked to discuss conclusions about the safety of some sweets based on the dyes they contain. Candidates found this very difficult. Firstly, candidates did not always identify the dyes in the sweets. Secondly, many were unsure whether sweet 2 was safe or not, as it included both a safe and an unsafe dye. Candidates did not typically realise that it would not be possible to judge the safety of sweet 3 as it contains an unidentified dye.</p>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	6	
4	a		distance travelled by spot; (1) distance travelled by solvent; (1)	2	Examiner's Comments The measurements to make to calculate Rf were not well expressed. Many discussed measuring the position of the dyes from the solvent front, rather than the start line. Few candidates stated clearly 'from the start line to...'.
	b		To see the spots (box 3)	1	Examiner's Comments Just under half of the candidates knew the function of a locating agent. The other distractors were all popular choices.
	c	i	Dye C has the highest peak (box 1)	1	Examiner's Comments Candidates were unsure whether the quantity of dye was represented by the height of the peak or by the retention time.
		ii	(qualitative because) can show which dyes are used; (1) (quantitative because) can show how much of each dye is used; (1)	2	Allow (1) only for '(quantitative because) shows how many dyes are used.' Ignore statements about retention time or recorder response. 'shows which dyes are used and how much' = (2) Examiner's Comments Most candidates did not know what 'quantitative' and 'qualitative' meant. A few said that the data gives information about 'what is in the sweet and how much'.
			Total	6	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
5		<p>filter paper goes into funnel;</p> <p>filter off solid / idea that solid or silver chloride is in filter paper/washing of solid;</p> <p>solid is dried (in oven);</p>	3	<p>Check diagram for indication of MP1 and/or 2</p> <p>Do not allow MP3 if oven is used before filtration/filtration not mentioned.</p> <p>Allow filter paper into oven to dry</p> <p>Examiner's Comments</p> <p>Many omitted to answer and few gave good descriptions of the experiment. Few knew the term 'funnel' and many thought that the solution which ended up in the beaker was to be put in the oven to get AgCl.</p>
		Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
6	a	<p>measurements 4.2 and 5.6 from the diagram (1) Rf value for spot 2 = $4.2/5.6 = 0.75$ (1)</p>	2	<p>allow +/- 0.2 for each value allow 2 marks for 0.75 without working allow ecf for correct calculation from ONE incorrect measurement for 2nd mark</p> <p>Examiner's Comments</p> <p>Most candidates were able to use the ruler given to measure the distances moved by the spot and by the solvent and then to calculate the Rf value by substituting into the formula. A few were confused by the scale, thinking that each graduation was 0.1cm instead of 0.2cm and others did not realise that the solvent front showed the distance travelled by the solvent.</p>
	b	B (1) and E (1)	2	<p>Examiner's Comments</p> <p>Stronger candidates were able to identify both soft drinks that contained the banned food colouring and most could identify at least one correctly, showing that they understood that both spots must be present in the drink for it to contain the banned colour. A small number quoted spots or values instead of identifying the drinks.</p>
	c	<p>no / partly correct (no mark) one dye moves less far / only one moves further (1)</p> <p>identifies first spot as the one that travels less far / identifies second spot as the only one that travels further (1)</p>	2	<p>allow only one Rf value is higher</p> <p>allow references to appropriate Rf values to identify the spot but must refer to distance travelled</p> <p>Examiner's Comments</p> <p>The relationship between Rf value and distance moved by the dye was much less well understood although there were some good responses that explained that the lower R_f value of the first spot in alcohol compared to water meant that it had travelled less far. A significant number thought that the dyes had moved further in alcohol because the difference between the two spots in alcohol was greater than between the two spots in water.</p>

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			Total
6			

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
7	a	<p>Level 3 Explains in terms of solubility. <i>Quality of written communication does not impede communication of the science at this level.</i></p> <p style="text-align: right;">(5 ? 6 marks)</p> <p>Level 2 Describes a simple mechanism for chromatography. <i>Quality of written communication partly impedes communication of the science at this level.</i></p> <p style="text-align: right;">(3 ? 4 marks)</p> <p>Level 1 Makes a correct statement about the chromatogram. <i>Quality of written communication impedes communication of the science at this level.</i></p> <p style="text-align: right;">(1 ? 2 marks)</p> <p>Level 0 <i>Insufficient or irrelevant science. Answer not worthy of credit.</i></p> <p style="text-align: right;">(0 marks)</p>	6	<p>This question is targeted at grades up to C</p> <p>Indicative scientific points may include:</p> <p>Solubilities</p> <ul style="list-style-type: none"> • spots / ink have different solubilities (in water) / dissolve more or less in water • spots 'stick' to the paper by different amounts <p>Level 2:</p> <ul style="list-style-type: none"> • move at different speeds • move different amounts • water carries the ink / spots • water moves up the paper • correct reference to the mobile phase <p>Level 1:</p> <ul style="list-style-type: none"> • ink contains two colours / inks / components • chromatography is a separation technique <p>Ignore : more or less amounts of ink in each spot idea</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>This level of response question asked for two aspects to be discussed; why there are two spots and why spot 1 is higher. It is important that candidates take a moment to make sure that they will address both parts of the question before they begin to write. Most knew that water or a mobile phase carries or moves the spots. A common misconception was that the distance moved depends on either the concentration of the ink or its relative mass. Fewer candidates clearly explained that the two spots come from different components or colours in the ink. The best answers made reference to the distance moved in terms of the solubility of the inks</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
				in the water. Some also discussed the affinity or attraction of the inks to the paper or stationary phase.
	b	0.8 (2) Shows 5 or 4 (allow 4 ? 4.3) in working (1)	2	Allow range of 0.8 ? 0.86 Ignore units If incorrect, shows suitable working (1) Examiner's Comments Almost all candidates correctly measured the distances on the chromatogram and correctly calculated the Rf for Spot 1. Those who did not usually gained one mark for at least one correct measurement from the chromatogram.
	c	spots are colourless / cannot be seen / invisible; locating agent makes the spots coloured / locating agent reacts with the spots;	2	Do not allow idea that spots are not on the paper / lost Ignore disappear Ignore 'locate' or 'find' the spots Allow correct example of a locating agent e.g UV Examiner's Comments Although some knew that sometimes spots cannot be seen, in general the function of a locating agent was not well known. Common answers which were not enough to gain credit included repeating the question, 'to locate the spots' or to imply that the spots needed 'to be found'.

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	d	<p>Any three points from</p> <p>idea of reproducibility / reliability;</p> <p>Jane does repeats / Jane can take an average / Mike does not do repeats;</p> <p>Jane takes representative sample;</p> <p>Jane samples only short amount of time / should be longer / Mike samples throughout the day;</p> <p>Mike equally spaced through the day / continuous sampling;</p> <p>Mike picks up a change straightaway / Jane does not pick up a change straightaway;</p> <p>Mike takes more samples overall;</p>	3	<p>Ignore Mike can take averages</p> <p>Examiner's Comments</p> <p>Most candidates gave at least one point to justify the approaches of Jane and Mike. There were three marks for this question. Candidates need to consider the number of marks when they make their answer to make sure that they make three clear points to gain all three marks.</p>
		Total	13	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
8	a	<p>[Level 3] Describes a workable method to make crystals which is mostly in the correct sequence. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Describes a method to make crystals with some in the correct sequence. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Gives some basic ideas about how to use the apparatus to make crystals. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to E</p> <p>Indicative scientific points may include: basic ideas</p> <ul style="list-style-type: none"> • acid in beaker • add carbonate to acid • stir • filter • heat / boil <p>possible additional details</p> <ul style="list-style-type: none"> • measure acid in measuring cylinder • add excess zinc carbonate • add more carbonate when fizzing stops / when reaction stops / when no more dissolves • filter off unreacted carbonate • heat to evaporate water • evaporate only some of the water • cool to crystallise / leave to crystallise • dry crystals in oven <p>idea of sequence</p> <ul style="list-style-type: none"> • measuring • mixing • filtering • evaporation • drying <p>Ignore numbers on diagram unless linked to descriptions in text.</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>There were some very good descriptions of the method to produce crystals for 7(a), with candidates choosing the correct sequence for the various steps of the process. Many did not realise that excess zinc carbonate should be added and so consequently either missed out the filtration or used it later in the process to</p>

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					separate out the crystals. Others did not understand that the solution needed to be heated to allow the solution to become more concentrated by evaporation, thinking that the heating was to speed up the reaction between the carbonate and the acid. A few did not relate the given diagrams to the required method and just described what was happening in each diagram in the order given.
	b	 zinc carbonate ? carbon dioxide (1) zinc ? hydrogen (1)	2	Examiner's Comments Some candidates recalled the gases produced when an acid reacts with a carbonate and with a metal. Others struggled to recall these and sulfur dioxide was commonly linked with the reaction between sulfuric acid and a metal.
			Total	8	

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9	a	i	3	1	<p>Examiner's Comments</p> <p>Almost all candidates were able to interpret the diagram and understood that there were three colours in the original sample, but they were less secure about the most soluble colour. Good responses came from candidates who had experienced the experiment and they clearly explained that the most soluble sample moved highest up the paper. The most common misconception was for candidates to think that C was the most soluble because it was darkest, or that B was most soluble because it was lightest.</p>
		ii	C, goes further (up the paper)	2	<p>Any other choice made scores zero for the question. Accept carried further by water</p> <p>Examiner's Comments</p> <p>Almost all candidates were able to interpret the diagram and understood that there were three colours in the original sample, but they were less secure about the most soluble colour. Good responses came from candidates who had experienced the experiment and they clearly explained that the most soluble sample moved highest up the paper. The most common misconception was for candidates to think that C was the most soluble because it was darkest, or that B was most soluble because it was lightest.</p>
		iii	0.75 = 2 15 divided by 20 = 1	2	<p>Examiner's Comments</p> <p>There were a number of candidates who successfully achieved full marks in this question. However, frequently candidates had used randomly selected numbers to try and calculate the Rf value (values that were not given in the diagram). In some cases, the candidates had correctly used the correct numbers, but had incorrectly substituted them into the formula given in the rubric.</p>

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	b	i	Insoluble [in water] = 2 not carried [by water] = 1	2	<p>Allow it is permanent marker for 1 mark</p> <p>Examiner's Comments</p> <p>The best responses to this question were those where the candidates had used scientific vocabulary such as "insoluble", "solvent" and "solute." It was a common misconception that Alex didn't use enough pen, or that the spots had moved, just not much even though the diagram does not support this.</p>
		ii	Idea of a different solvent e.g. ethanol	1	<p>Examiner's Comments</p> <p>Misconceptions meant that few candidates were able to explain that a different solvent was required. Candidates had completed experiments on chromatography, but many described that spots would have been observed had the paper been sprayed with a special dye, and therefore not appreciating that pen wouldn't be very useful if it was invisible.</p>
			Total	8	

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10	<p>[Level 3] Gives operational points AND theoretical points which describe the distillation including a reference to BPt difference [from water]. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Gives operational points AND theoretical points which describe the distillation. OR Makes reference to BPt and operational OR theoretical points. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Gives indicative points which describe the distillation. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to C CHECK FOR INFORMATION ON THE DIAGRAM Indicative operational points may include:</p> <ul style="list-style-type: none"> • boil / heat [the dilute ethanol] • antibumping granules control the boiling • condenser used • [condenser] is cold / cooled / water flows through • use of thermometer • keep the liquid that collects around the boiling temperature of the alcohol • stop when temp too high <p>Indicative theoretical points may include:</p> <ul style="list-style-type: none"> • boiling points different • boiling point of alcohol lower than water • gas / vapour / evaporation (ethanol) • vapour contains both alcohol and water • [vapour] richer in alcohol • [Vapour] condenses / turns to liquid [in the condenser] • vapour contains increasing amounts of water as distillation proceeds <p>If answer includes incorrect points (e.g. BPt of ethanol higher than water) then consider quality of communication to be impeded at level 2 and 3.</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>Candidates lacked understanding of this process. Where marks were achieved, it was usually for simple operational points such as heating the solution and using a thermometer to monitor temperature. Some candidates were able to explain that there was evaporation and condensation. However, marks were sometimes lost</p>

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					because candidates were confused about which liquid was evaporated, when in fact <i>both</i> will evaporate, but the vapour is richer in ethanol. For six marks to be achieved, the question required candidates to describe the process simply, explain what happens to the liquids, and refer to the different boiling points of the liquids.
			Total	6	
11			DBAC	2 (AO 2 × 1.2)	G is left out ✓ others in correct order ✓ Examiner's Comments Although almost all candidates attempted this item, many did not correctly sequence all the steps in distillation. The most common error was to start by filtering in the expectation that this might remove salt from the seawater.
			Total	2	
12		i	solid copper oxide → filtration ✓ copper chloride crystals → evaporation ✓	2 (AO 1.2)	
		ii	not all copper oxide reacted / used up / copper oxide left at the end / not enough acid used ✓	1 (AO 2.2)	Examiner's Comments Despite the mention of a "small amount" of acid and the statement in the question stem that "some copper oxide does not react" few candidates could explain why the theoretical yield could not be achieved.
			Total	3	