1 A student wants to find out if the green colouring in grass is a mixture of dyes.

He uses a solvent to dissolve the green colouring from some grass.

He then separates the solution of the green colouring from the remaining grass.

(a) Which of these methods is used to separate the solution of the green colouring from the remaining grass?

(1)

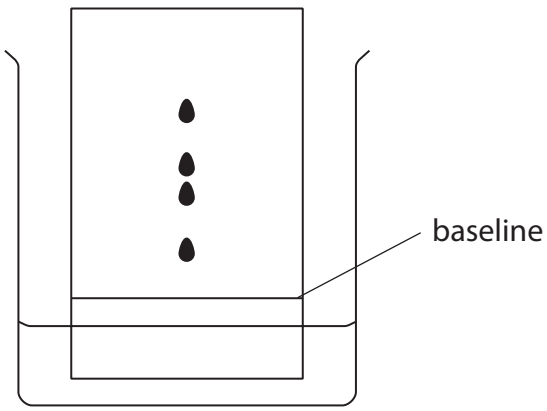
☒ **A** boiling

☒ **B** condensation

☒ **C** evaporation

☒ **D** filtration

(b) The student uses a dropping pipette to place a drop of the green solution onto a piece of chromatography paper and produces a chromatogram.
The diagram shows his results.



(i) Add three more labels to the diagram to show

- the solvent
- the chromatography paper
- the original position of the spot of the green solution

(3)

(ii) Explain how many different dyes are present in the green colouring.

(1)

.....

.....

.....

(Total for Question 1 = 5 marks)

2 Techniques used in the separation of mixtures include

A crystallisation

B filtration

C fractional distillation

D simple distillation

For each separation, select the most suitable technique, A, B, C or D, used to obtain the first named substance from the mixture.

Each letter may be used once, more than once or not at all.

(a) Pure water from sea water

(1)

.....

(b) Ethanol from a mixture of ethanol and water

(1)

.....

(c) Calcium carbonate from a mixture of calcium carbonate and water

(1)

.....

(d) $CuSO_4.5H_2O(s)$ from $CuSO_4(aq)$

(1)

.....

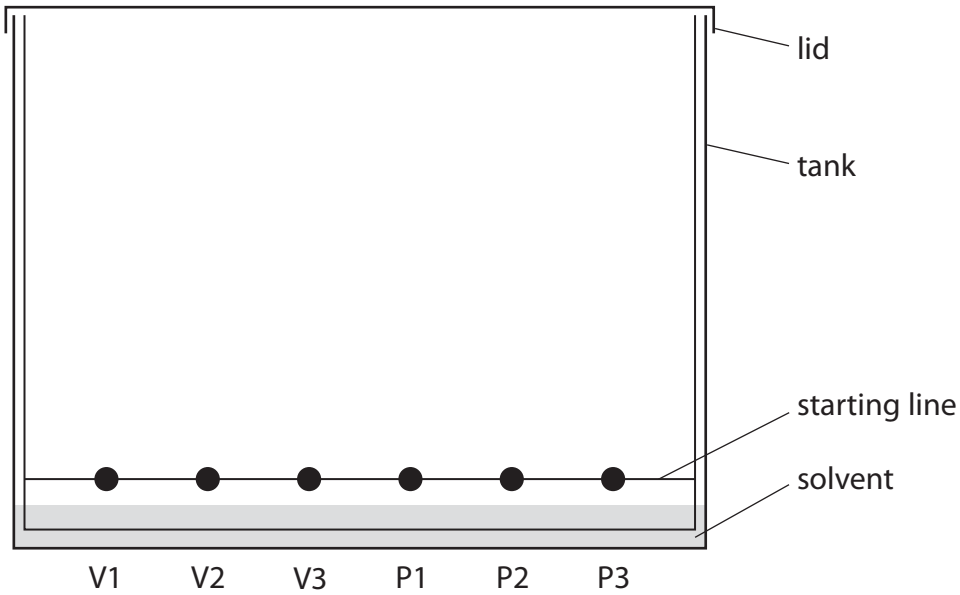
(Total for Question 2 = 4 marks)

3 A student investigates the pigments found in some vegetables and fruit.

She obtains some coloured vegetable and fruit extracts from carrots, tomatoes and sweet potatoes.

She places a spot of each extract on chromatography paper, along with spots of the three pigments beta-carotene, chlorophyll and lycopene.

Her teacher provides a solvent containing volatile, flammable organic compounds for the experiment. The diagram shows the apparatus at the start of the experiment.



Key to vegetable and fruit extracts and pigments

V1 = carrots	V2 = tomatoes	V3 = sweet potatoes
P1 = beta-carotene	P2 = chlorophyll	P3 = lycopene

(a) (i) Explain why it is important for the solvent level to be below the spots.

(1)

.....

.....

(ii) State two potential problems that are prevented by fitting the tank with a lid.

(2)

1 .....

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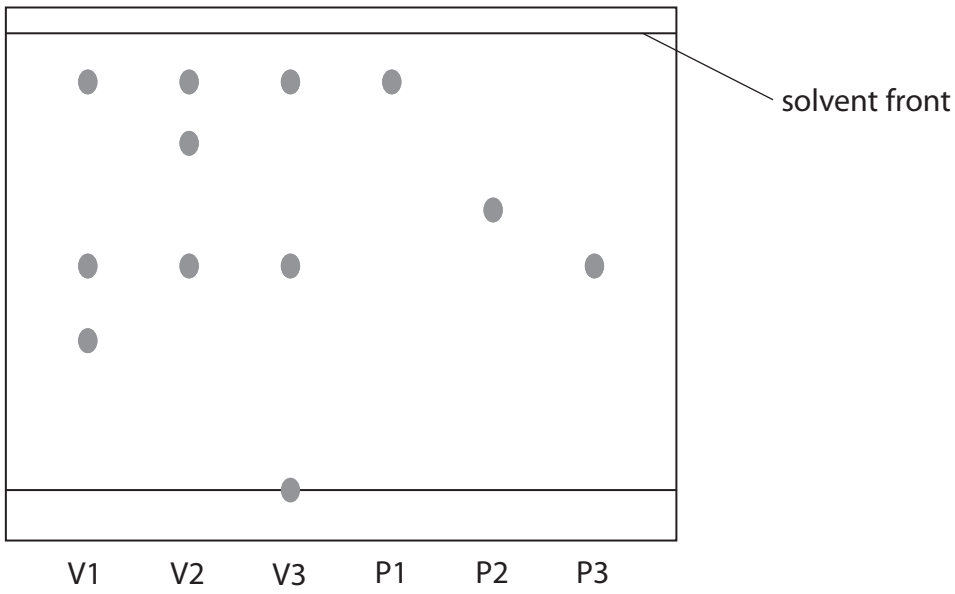
2 .....

.....

(b) The diagram shows the chromatogram at the end of the experiment.



Key to vegetable and fruit extracts and pigments

V1 = carrots	V2 = tomatoes	V3 = sweet potatoes
P1 = beta-carotene	P2 = chlorophyll	P3 = lycopene

Which three of the statements A, B, C, D and E are supported by the chromatogram?

Place a cross in three boxes to indicate your choice.

(3)

A Chlorophyll is **not** present in carrots, sweet potatoes or tomatoes. ☐

B Beta-carotene is present in carrots but **not** present in tomatoes. ☐

C Both beta-carotene and lycopene are present in sweet potatoes. ☐

D Lycopene is present in tomatoes but **not** present in carrots. ☐

E Both carrots and tomatoes contain a pigment **other than** beta-carotene, chlorophyll and lycopene. ☐

(c) One of the pigments present in the vegetable extracts is not shown in the chromatogram. It appears as a very faint spot 1.3 cm above the starting line.

Calculate its R_f value using the expression

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

(2)

$R_f =$ .....

(d) Suggest a reason why there is a spot on the starting line in the chromatogram for sweet potatoes.

(1)

.....

.....

(Total for Question 3 = 9 marks)

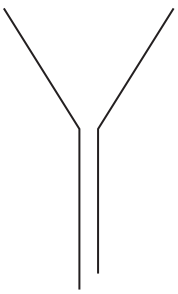
4 A student adds dilute sulfuric acid to a beaker containing calcium chloride solution. He obtains a mixture containing a precipitate of calcium sulfate in a solution of hydrochloric acid.

(a) Complete the equation for this reaction by inserting state symbols.

(1)

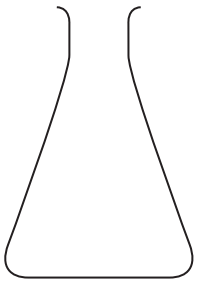
$$CaCl_2(\ldots\ldots) + H_2SO_4(\ldots\ldots) \rightarrow CaSO_4(\ldots\ldots) + 2HCl(\ldots\ldots)$$

(b) The student uses this apparatus to separate the mixture into a residue and a filtrate.



filter funnel

folded filter paper



conical flask

Draw a diagram to show how he should assemble the apparatus for the filtration.

(2)

(c) The student carries out a flame test on the filtrate he obtains and observes a brick-red colour.

(i) Identify the ion responsible for this colour.

(1)

.....

(ii) Suggest why this ion is present in the filtrate.

(1)

.....

.....

(d) The student tests the filtrate for chloride ions by adding silver nitrate solution.

(i) State what he would observe in this test.

(1)

.....

.....

(ii) State the name of the substance responsible for this observation.

(1)

.....

(iii) He reads in a textbook that dilute nitric acid should be added before the silver nitrate solution in the test.

Suggest why the student does **not** need to add dilute nitric acid in the test.

(1)

.....

.....

(e) The calcium sulfate residue he obtains is impure because it contains some hydrochloric acid.

Describe how he can obtain a pure dry sample of calcium sulfate from this residue.

(2)

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.....

.....

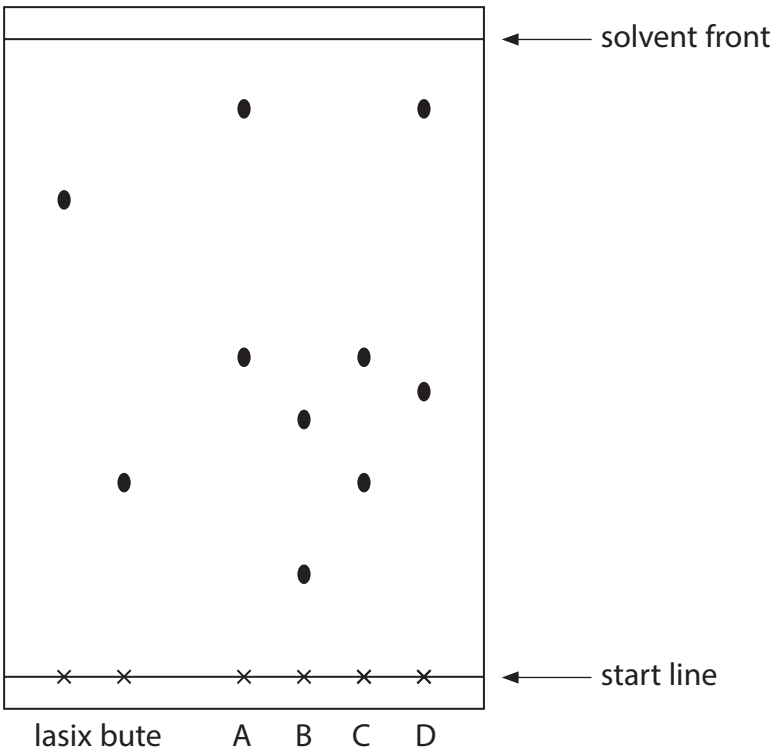
.....

(Total for Question 4 = 10 marks)

5 Illegal drugs are sometimes used to affect the performance of racehorses.
These drugs can be detected in horse urine using chromatography.

- a concentrated sample of urine from each horse is spotted onto the start line of a sheet of chromatography paper
- known illegal drugs are also spotted onto the same paper
- ethanol is used as the solvent

The chromatogram shows urine samples, A, B, C and D, and the two illegal drugs lasix and bute.



(a) Explain which urine sample contains an illegal drug.

(2)

(b) What is the meaning of the term **solvent**?

(1)

.....

.....

(c) The results for known drugs are given as R_f values.

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

Calculate the R_f value for lasix.

(2)

R_f value for lasix =.....

(d) Suggest how the solubility of the drug in the solvent affects the distance travelled by the substance.

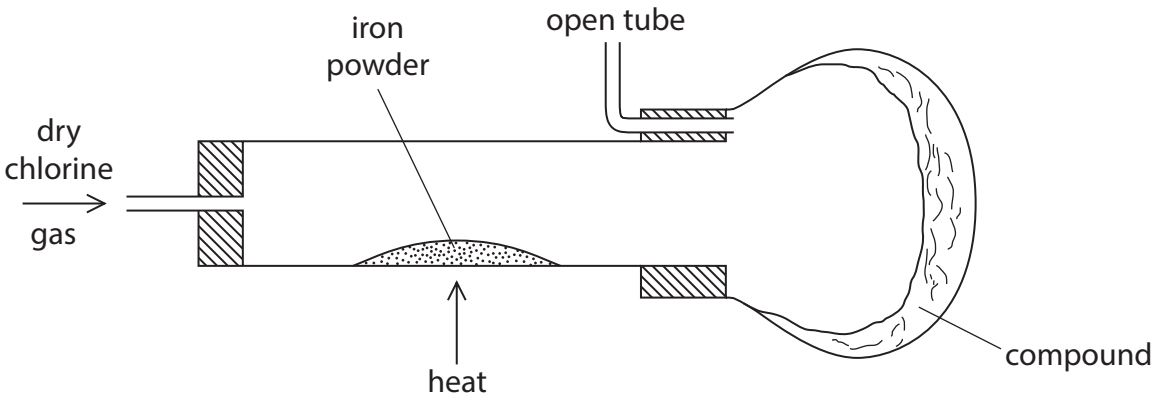
(1)

.....

.....

(Total for Question 5 = 6 marks)

6 The diagram shows the apparatus used to form a compound containing iron and chlorine.



(a) (i) State the colour of chlorine gas.

(1)

.....

(ii) Suggest why it is necessary to have an open tube fitted to the apparatus.

(1)

.....

.....

(iii) For safety reasons, this reaction should be carried out in a fume cupboard.

Explain why this is necessary.

(1)

.....

.....

(b) A mass of 2.800 g of iron reacts with 5.325 g of chlorine.

(i) Calculate the empirical formula of the compound formed.

(3)

empirical formula = ...

(ii) Suggest a name for this compound.

(1)

.....

(c) When chlorine gas is bubbled into aqueous sodium hydroxide, a mixture of bleach (NaClO), sodium chloride and water is formed.

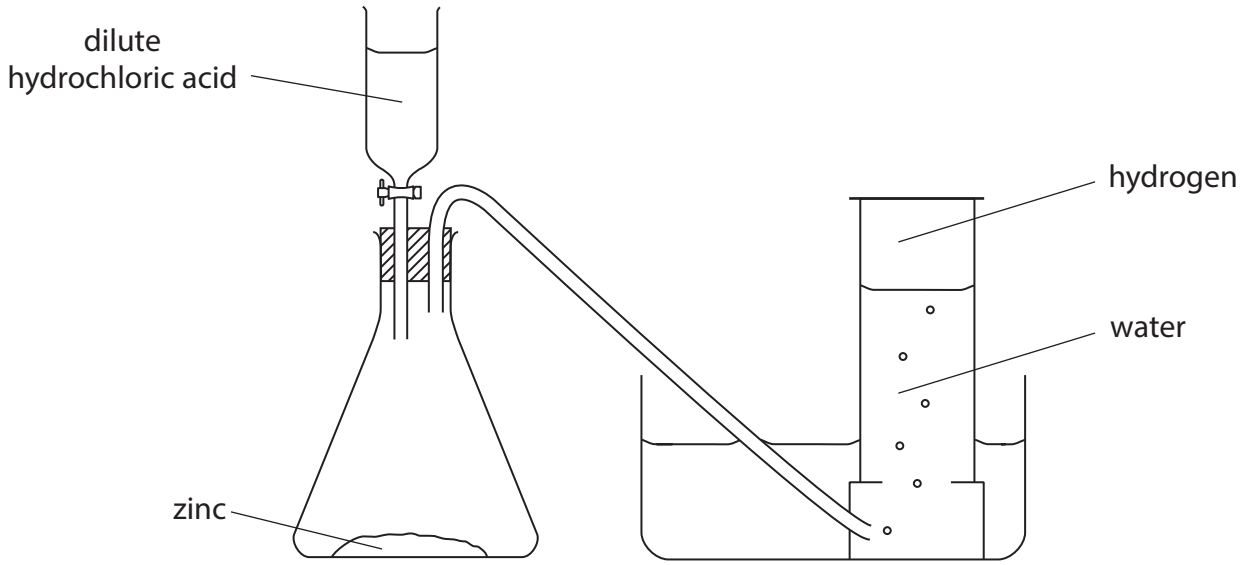
Write a chemical equation for this reaction.

(2)

.....

(Total for Question 6 = 9 marks)

7 This apparatus can be used to prepare a sample of hydrogen.



(a) Write a chemical equation for the reaction between zinc and hydrochloric acid.

Include state symbols.

(2)

.....

(b) State two observations you would make when hydrochloric acid reacts with zinc in the conical flask.

(2)

1 .....

.....

2 .....

.....

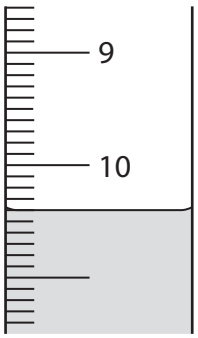
(c) A student carries out two experiments to find the volume of dilute hydrochloric acid required to completely react with 0.5 g of zinc powder.

Experiment 1

She fills a burette to the 0.00 cm^3 mark with dilute hydrochloric acid.

She places 0.5 g of zinc powder into a conical flask and then slowly adds the acid to the zinc until the reaction is complete.

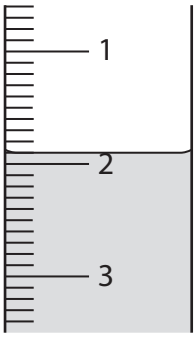
The diagram shows the final reading on the burette.



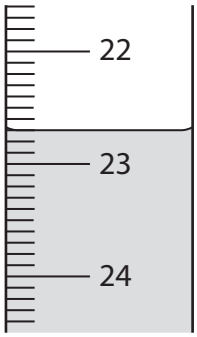
Experiment 2

She then repeats the experiment with 0.5 g of zinc powder from the same source, but with a different sample of dilute hydrochloric acid.

The diagram shows the initial and final burette readings for this experiment.



initial reading



final reading

(i) Use the burette readings to complete the table, recording the volumes to the nearest 0.05 cm^3.

(3)

	Experiment 1	**Experiment 2**
final burette reading in cm^3		
initial burette reading in cm^3		
volume in cm^3 of acid added		

(ii) The concentration of the acid in experiment 1 was 0.74 mol/dm^3.

Explain how the concentration of the acid in experiment 2 can be calculated.

(2)

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(Total for Question 7 = 9 marks)