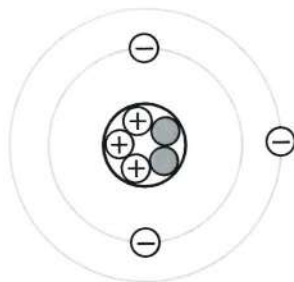


Answer ALL questions. Write your answers in the spaces provided.

- 1 The diagram shows the structure of an atom.



- (a) Name the central part of an atom.

(1)

nucleus

- (b) Name the positively charged particles in an atom.

(1)

proton

- (c) State how the diagram shows that this atom is neutral.

(1)

Atom has an equal number of protons and electrons

- (d) Give the mass number of this atom.

(1)

5

- (e) Give the name of the element containing this atom.
Use the Periodic Table to help you.

(1)

Lithium

(Total for Question 1 = 5 marks)

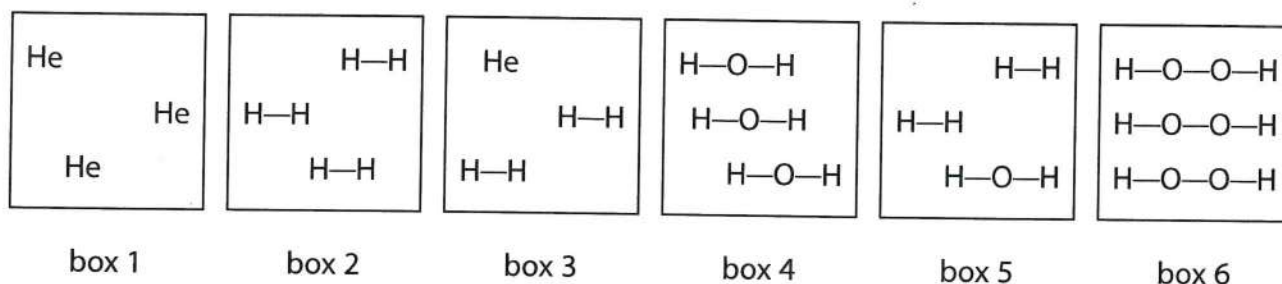
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2 Substances can be classified as elements, compounds or mixtures.

(a) Each of the boxes in the diagram represents either an element, a compound or a mixture.



(i) Explain which **two** boxes represent an element.

(2)

• 1 and 2

• Both boxes only contain one type of atom

(ii) Explain which **two** boxes represent a mixture.

(2)

• 3 and 5

• Both boxes contain 2 different molecules

(b) The list gives the names of some methods used in the separation of mixtures:

- chromatography
- crystallisation
- distillation
- filtration

Use names from the list to choose a suitable method for each separation.

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

(i) Separating water from sodium chloride solution.

(1)

simple distillation

(ii) Separating the blue dye from a mixture of blue and red dyes.

(1)

chromatography

(iii) Separating potassium nitrate from potassium nitrate solution.

(1)

crystallisation

(Total for Question 2 = 7 marks)

- 3 Ammonium chloride decomposes in a reversible reaction. The equation for this reaction is



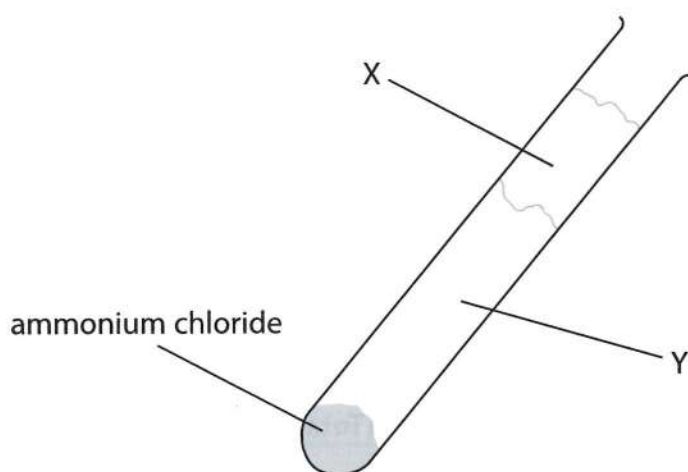
- (a) State how the equation shows that the reaction is reversible.

(1)

There is a reversible arrow.

- (b) Some ammonium chloride is heated gently in a test tube.

The diagram shows the test tube after it has been heated gently for a short time.



- (i) Identify solid **X** and the two gases formed in region **Y** of the test tube.

(2)

Solid **X** ammonium chloride

Gases in region **Y** ammonia and hydrogen chloride

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(ii) Which change of state occurs in the test tube during heating?

(1)

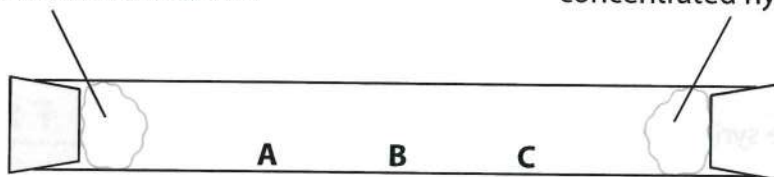
- ☐ A condensing
- ☐ B evaporating
- ☐ C melting
- ☒ D subliming

(c) An experiment involving ammonium chloride can be used to show the process of diffusion.

The diagram shows the apparatus at the start of the experiment.

cotton wool soaked in
concentrated ammonia solution

cotton wool soaked in
concentrated hydrochloric acid



At the end of the experiment, a white solid forms in the test tube.

Explain which position, A, B or C, shows where the white solid forms.

(3)

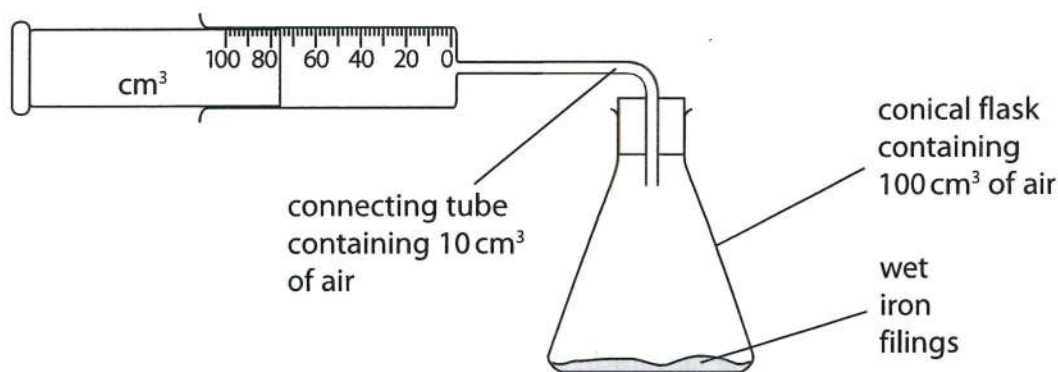
• C

• ammonia molecules have a smaller Mr than hydrogen chloride molecules

• so ammonia molecules travel further in the same time

(Total for Question 3 = 7 marks)

- 4 The percentage by volume of oxygen in air can be found by using the rusting of iron.
- A student sets up this apparatus to measure the volume of oxygen in a sample of air.

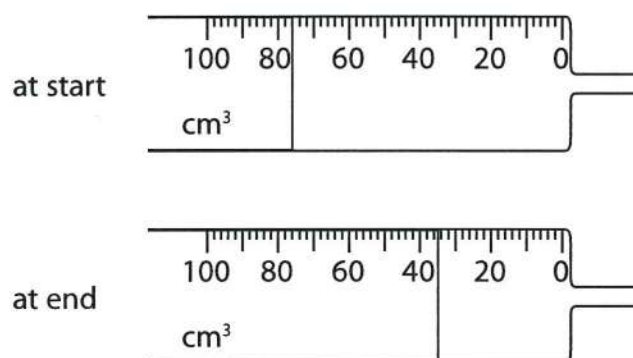


An excess of wet iron filings is used.

At the start of each experiment, the reading on the syringe is recorded and the apparatus is then left for a week so that the reaction is complete.

The reading on the syringe is then recorded again.

- (a) The diagram shows the readings in one experiment.



Complete the table to show:

- the syringe reading at the end of this experiment
- the volume of oxygen used in the experiment.

syringe reading at start / cm ³	76
syringe reading at end / cm ³	35
volume of oxygen used / cm ³	41

(b) The table shows the results recorded by a different student in her experiment.

volume of air in conical flask / cm ³	100
volume of air in connecting tube / cm ³	10
original volume of air in syringe / cm ³	80
final volume of air in syringe / cm ³	43

Calculate the percentage of oxygen in air using these results.

$$\text{volume of oxygen used} = 80 - 43 = 37 \quad (3)$$

$$\text{initial volume} = 100 + 10 + 80 = 190$$

$$\frac{37}{190} \times 100 = 19.47$$

$$\text{percentage of oxygen} = 19.5 \%$$

(c) The table shows some possible causes of anomalous results in this experiment.

Use terms from the box to complete the table, showing possible causes and their effects on the volume of oxygen used in this experiment.

decreased increased no effect

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

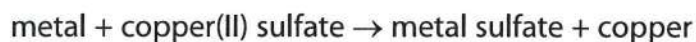
(3)

Possible cause	Effect on volume of oxygen used
wet iron filings not in excess	decreased
apparatus left for 1 hour instead of 1 week	decreased
apparatus left in a warmer place for 1 week	no effect

(Total for Question 4 = 8 marks)

5 A metal is added to copper(II) sulfate solution.

A displacement reaction only occurs if the metal added is more reactive than copper.



Displacement reactions are exothermic. The more reactive the metal added, the greater the temperature rise.

A student uses the following method in an experiment to compare the reactivities of different metals:

- pour some copper(II) sulfate solution into a boiling tube and record its temperature using a thermometer
- add some metal to the tube and stir with the thermometer
- record the maximum temperature of the contents of the tube.

He repeats the method using the same amount, in moles, of different metals.

- (a) To make the experiment valid, he starts with the copper(II) sulfate solution and the added metal at the same temperature.

State **two** other variables that must be controlled if the experiment is to be valid.

(2)

1 *concentration of copper (II) sulfate solution*

2 *volume of copper (II) sulfate solution*

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- (b) Another student uses the same method three times for each of the metals **E**, **F**, **G** and **H**. The table shows her results for these metals.

Metal	Temperature increase / °C			Mean temperature increase / °C
	1	2	3	
E	7.0	4.0	8.0	7.5
F	0.0	0.0	0.0	0.0
G	6.0	5.0	5.4	5.5
H	5.5	11.0	12.0	11.5

- (i) The student calculates the mean temperature increase for metals **E** and **F**. She does not include anomalous values in her calculations.

Calculate the mean temperature increase for metals **G** and **H**, ignoring any anomalous values. Write your answers in the table.

(2)

- (ii) Explain which metal is the most reactive.

(2)

H, because this metal caused the biggest temperature increase

- (iii) Explain which metal is less reactive than copper.

(2)

F, because this metal did not cause a temperature increase.

(Total for Question 5 = 8 marks)

6 This question is about the elements in Group 1 of the Periodic Table and their reactions with water.

(a) State why sodium and potassium are in Group 1 of the Periodic Table.

(1)

The atoms of both elements have 1 electron in their outer shells

(b) A reaction occurs when a small piece of sodium is added to a large volume of water in a trough.

(i) Give **two** observations that you would make during this reaction.

(2)

1 sodium moves around on the water

2 bubbles are produced

(ii) After the reaction has finished, a few drops of universal indicator are added to the solution in the trough.

Explain the final colour of the universal indicator.

(2)

- final colour is blue / purple
- since the solution produced is sodium hydroxide which is alkaline

(iii) What is the most likely pH value of the solution in the trough after the reaction is complete?

(1)

- ☐ A 2
- ☐ B 5
- ☐ C 8
- ☒ D 12

(c) Give the name of a Group 1 metal that is less reactive than sodium.

(1)

lithium

(d) A small piece of potassium is added to a large volume of water in a trough.

Give **one** observation that is made when potassium is added to water that is **not** made when sodium is added to water.

(1)

potassium catches fire

(e) Complete the equation for the reaction of rubidium with water.
State symbols are not required.

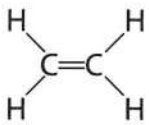
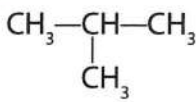
(1)



(Total for Question 6 = 9 marks)

7 This question is about hydrocarbons.

(a) The table shows the formulae of some hydrocarbons.

A CH_4	B 	C $\text{CH}_3-\text{CH}_2-\text{CH}_3$
D 	E $\text{CH}_3\text{CH}=\text{CH}_2$	F $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

(i) Give the letters that represent hydrocarbons with the general formula C_nH_{2n}

(1)

B and E

(ii) State why **B** is the only hydrocarbon shown as a displayed formula.

(1)

B shows all atoms and all bonds

(iii) Explain which **two** letters represent isomers.

(3)

• D and F

• They have the same molecular formula

• but have a different structural formula

(iv) How many of the hydrocarbons are members of the homologous series of alkanes?

(1)

4

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(b) Many hydrocarbons are used as fuels. There are problems associated with this use.

(i) Explain how the combustion of a hydrocarbon can lead to the formation of a poisonous gas.

(2)

- Incomplete combustion of a hydrocarbon
- leads to the formation of carbon monoxide

(ii) State why this gas is poisonous to humans.

(1)

Reduces capacity of blood to transport oxygen

(c) Fuels used in cars often have sulfur compounds removed.

Explain how the combustion of these fuels in car engines still leads to the formation of acid rain.

(4)

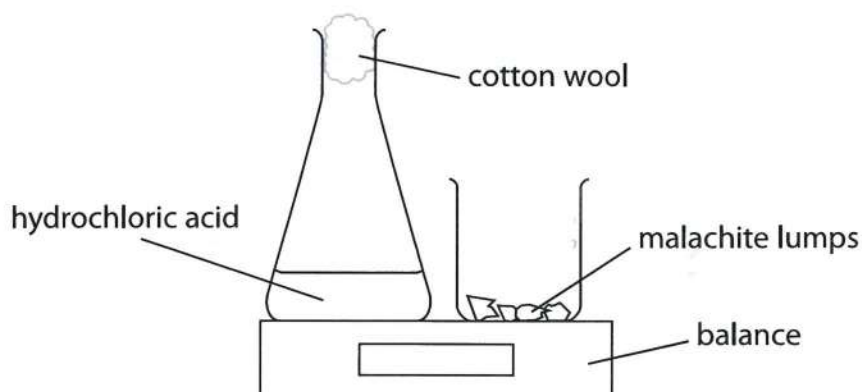
- Nitrogen and oxygen in the air react
- at high temperatures e.g. car engines
- which produces nitrogen oxides
- NO_x then reacts with water in the atmosphere to create nitric acid

(Total for Question 7 = 13 marks)

- 8 The copper(II) carbonate in the mineral, malachite, reacts with hydrochloric acid according to this equation.



Some students investigate the effect of changing the concentration of acid on the rate of this reaction. The diagram shows the apparatus they use.



This is the method they use:

- set the balance to zero
- add an excess of malachite lumps to the conical flask and replace the cotton wool
- start a timer and record the balance reading after one minute.

The experiment is repeated using different concentrations of hydrochloric acid. The mass and number of malachite lumps are kept the same in each experiment.

- (a) The table shows the results obtained in one series of experiments.

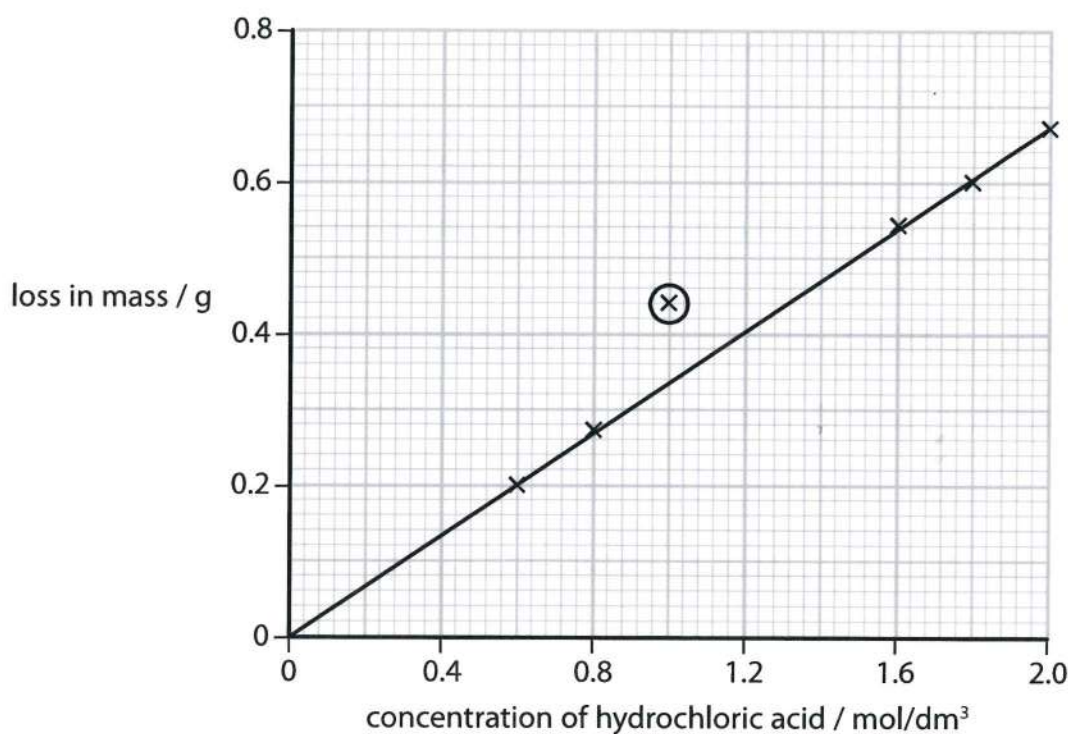
concentration of hydrochloric acid / mol/dm^3	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	-0.20	-0.27	-0.44	-0.54	-0.60	-0.67

State why the balance readings have negative values.

(1)

One product of the reaction is CO_2 gas and so escapes from the flask.

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

Balance reading was recorded too late

(ii) State the relationship shown by the graph.

(1)

loss in mass is directly proportional to concentration of hydrochloric acid

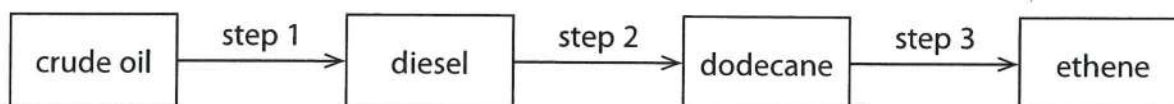
(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

- particles are closer together
- so particles have more frequent collisions

(Total for Question 8 = 5 marks)

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

- crude oil is heated until it becomes a vapour
- Vapours enter the lower part of fractionating column
- There is a temperature gradient up the column, where the column is cooler at the top and hotter at the bottom
- Vapours rise up the column until they condense
- Diesel fraction is removed

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

- Dodecane contains carbon and hydrogen atoms only
- Dodecane contains only single bonds

(c) Which of these formulae is that of an alkane?

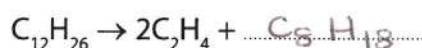
(1)



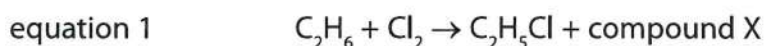
(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)



(e) Alkanes and alkenes both react with halogens, but in different ways. The equations for two examples of these different reactions are shown.



(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light

(ii) Deduce the formula of compound X.

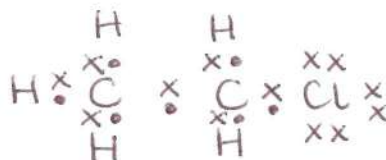
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

substitution

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ A colourless to orange
☐ B colourless to green
☐ C green to colourless
☒ D orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

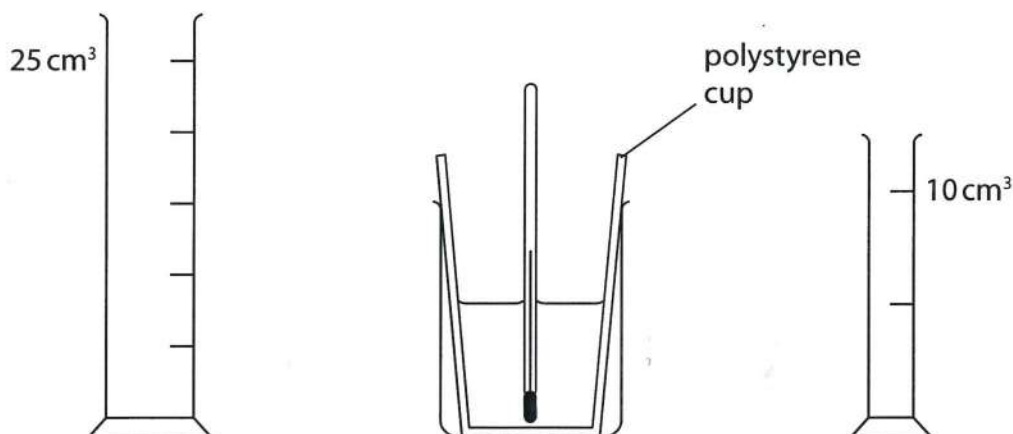
(3)

C	H	Br	O
25.9	5.0	57.6	11.5
<u>12</u>	<u>1</u>	<u>80</u>	<u>16</u>
2.16	5.0	0.72	0.72
<u>0.72</u>	<u>0.72</u>	<u>0.72</u>	<u>0.72</u>
3	7	1	1

empirical formula = C_3H_7BrO

(Total for Question 9 = 19 marks)

- 10 When aqueous solutions of potassium hydroxide and nitric acid are mixed together, an exothermic reaction occurs. The diagram shows the apparatus used in an experiment to measure the temperature increase.



This is the student's method;

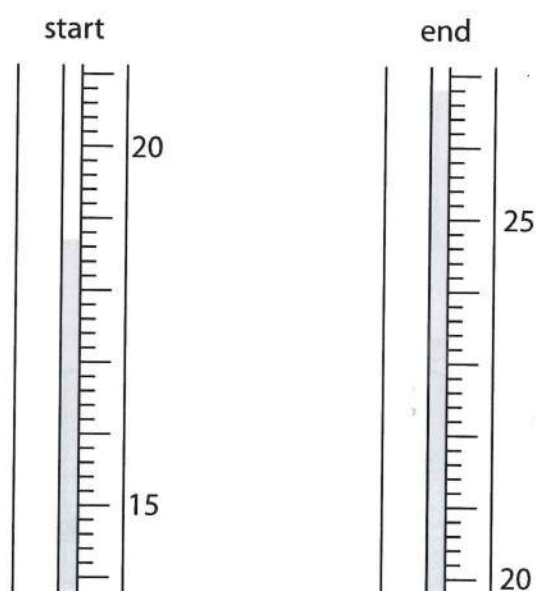
- use the larger measuring cylinder to add 25 cm^3 of aqueous potassium hydroxide to the polystyrene cup
- record the steady temperature
- use the smaller measuring cylinder to add 5 cm^3 of dilute nitric acid to the cup, stir the mixture with the thermometer
- record the highest temperature of the mixture
- continue adding further 5 cm^3 portions of dilute nitric acid to the cup, stirring and recording the temperature, until a total volume of 35 cm^3 has been added.

- (a) A teacher advises the student to use a 50 cm^3 burette instead of the 10 cm^3 measuring cylinder.

Suggest **two** reasons why it would be better to use a burette instead of a measuring cylinder to add the acid in this experiment.

1. *graduations are more precise*
2. *avoids refilling the measuring cylinder*

- (b) The diagram shows the thermometer readings at the start and at the end of one experiment.



Complete the table to show:

- the thermometer reading at the start of the experiment
- the temperature rise in the experiment.

(2)

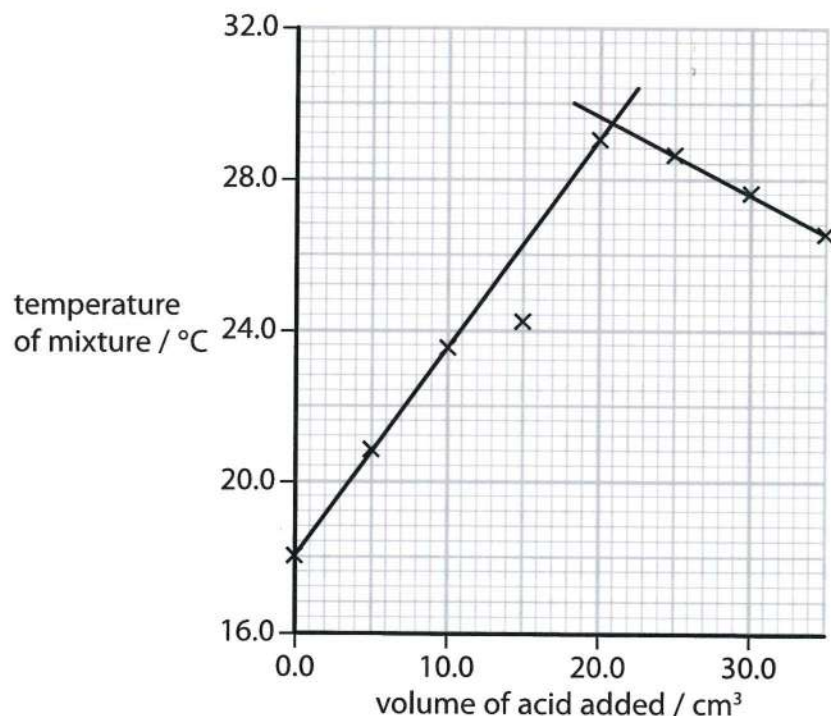
thermometer reading at end / °C	26.8
thermometer reading at start / °C	18.7
thermometer rise / °C	8.1

- (c) Another student uses the same method, adding the dilute nitric acid from a burette.

The table shows his results.

volume of acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0
temperature of mixture / $^{\circ}\text{C}$	18.0	20.8	23.5	24.2	29.0	28.6	27.6	26.5

This is the student's graph.



The point where the lines cross represents complete neutralisation.

- (i) Identify the maximum temperature reached during the experiment.

(1)

maximum temperature = 29.5 $^{\circ}\text{C}$

- (ii) Identify the volume of dilute nitric acid that exactly neutralises the 25 cm^3 of aqueous potassium hydroxide.

(1)

volume = 20.8 cm^3

(d) Another student records these results.

volume of aqueous potassium hydroxide = 20.0 cm³

starting temperature of aqueous potassium hydroxide = 18.5 °C

maximum temperature of mixture = 30.0 °C

volume of dilute nitric acid = 20.0 cm³

Calculate the heat energy released in this experiment.

$$c = 4.2 \text{ J/g/}^\circ\text{C}$$

mass of 1 cm³ of mixture = 1 g

$$\text{total volume} = 20 + 20 = 40 \text{ cm}^3 \quad (4)$$

$$m = 40 \text{ g}$$

$$\Delta T = 30 - 18.5$$

$$= 11.5$$

$$Q = mc\Delta T$$

$$= 40 \times 4.2 \times 11.5$$

$$= 1932$$

$$\text{heat energy} = 1932 \text{ J}$$

(e) In another experiment, the heat energy released is 1600 J when 0.040 mol of potassium hydroxide is neutralised.

Calculate the value of ΔH , in kJ/mol, for the neutralisation of potassium hydroxide.

(2)

$$\Delta H = \frac{Q}{\text{mol}} = \frac{1600}{0.04}$$

$$= 40000 \text{ J/mol}$$

$$\text{J} \rightarrow \text{kJ} \quad (\div 1000)$$

- 40 kJ/mol as exothermic reaction

$$\Delta H = -40 \text{ kJ/mol}$$

(Total for Question 10 = 12 marks)

11 Many different salts can be prepared from acids.

(a) The table shows the reactants used in two salt preparations.

Complete the table to show the name of the salt formed and the other product(s) in each case.

(4)

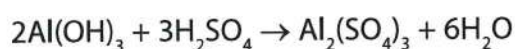
MASH

CAWS
CoD

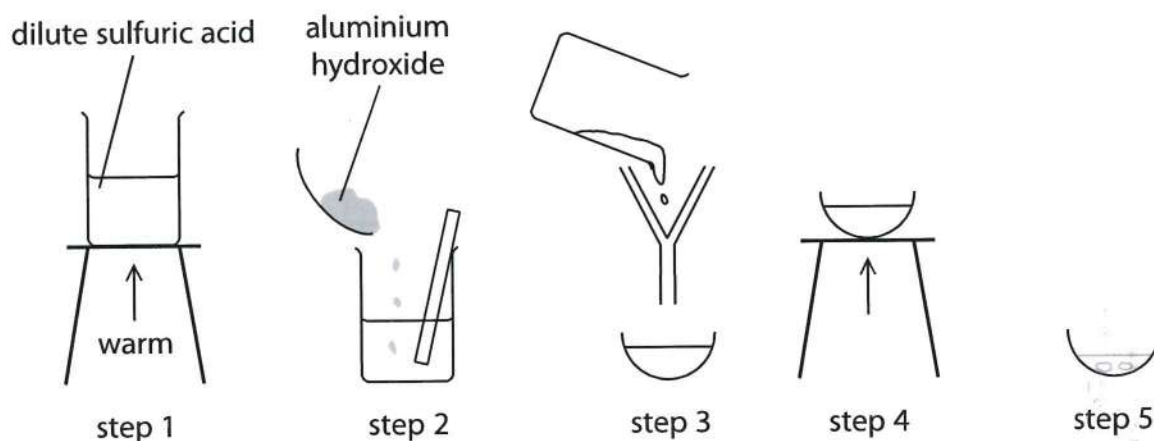
Reactants	Name of salt formed	Other product(s)
zinc + hydrochloric acid	zinc chloride	hydrogen
calcium carbonate + nitric acid	calcium nitrate	water + carbon dioxide

(b) A student uses the reaction between aluminium hydroxide and dilute sulfuric acid to prepare a pure, dry sample of aluminium sulfate crystals.

The equation for the reaction used to prepare this salt is



The diagram shows the steps in the student's method.



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(i) State **two** ways to make sure that all the acid is reacted in step 2.

(2)

1 Use excess aluminium hydroxide

2 Stir the mixture

(ii) State the purpose of filtration in step 3.

(1)

To remove unreacted aluminium hydroxide

(iii) In step 5, the basin is left to cool to room temperature to allow crystals of aluminium sulfate to form.

State **one** method of drying these crystals.

(1)

leave in a warm place

(c) The student records this information about the reagents she uses in her preparation.

mass of aluminium hydroxide = 3.9 g

amount of sulfuric acid = 0.090 mol

Determine which reagent is in excess, making use of this information and the equation in part (b).

$$M_r(\text{Al}(\text{OH})_3) = 27 + (3 \times 17) = 78$$

(3)

$$\text{mol} = \frac{\text{mass}}{M_r} = \frac{3.9}{78} = 0.05 \text{ mol}$$

$$0.09 \text{ mol } \text{H}_2\text{SO}_4 > 0.05 \text{ mol } \text{Al}(\text{OH})_3$$

so H_2SO_4 is in excess

reagent used in excess = H_2SO_4

- (d) Another student prepares 0.25 mol of aluminium sulfate. The formula of aluminium sulfate is $\text{Al}_2(\text{SO}_4)_3$

Calculate the mass of aluminium sulfate prepared.

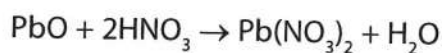
$$\text{Mr}(\text{Al}_2(\text{SO}_4)_3) = (27 \times 2) + (32 \times 3) + (16 \times 12) \quad (3)$$
$$= 342$$

$$\text{mass} = \text{Mr} \times \text{mol}$$

$$= 342 \times 0.25 = 85.5$$

$$\text{mass} = 85.5 \text{ g}$$

- (e) The equation for another reaction used to prepare a sample of a salt is



In one experiment, the amount of lead(II) oxide used was 0.75 mol and the amount of nitric acid used was 1.5 mol. At the end of the experiment, the mass of lead(II) nitrate obtained was 209 g.

Calculate the percentage yield of lead(II) nitrate in this experiment.

[M_r of lead(II) nitrate = 331]

$$\text{mol} = \frac{\text{mass}}{\text{Mr}} \quad (3)$$

$$\text{mol}(\text{Pb}(\text{NO}_3)_2) = \frac{209}{331} = 0.631 \text{ mol}$$

$$\frac{0.631}{0.75} \times 100 = 84\%$$

$$\text{percentage yield} = 84\%$$

(Total for Question 11 = 17 marks)

TOTAL FOR PAPER = 110 MARKS