OCR
Oxford Cambridge and RSA

H

GCSE (9–1) Chemistry A (Gateway Science)

J248/04 Paper 4, C4–C6 and C7 (Higher Tier)

Wednesday 13 June 2018 – Morning

Time allowed: 1 hour 45 minutes

7024559824

You must have:
- a ruler (cm/mm)
- the Data Sheet (for GCSE Chemistry A (inserted))

You may use:
- a scientific or graphical calculator
- an HB pencil

J248004

First name									
Last name									
Centre number						Candidate number				

INSTRUCTIONS
- The data sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

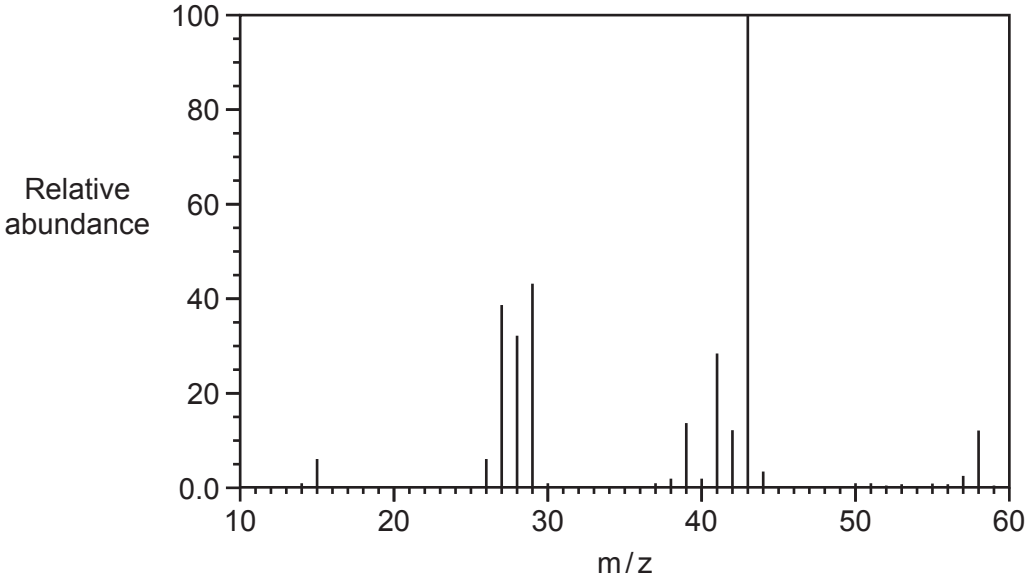
INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **28** pages.

SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

1 Look at the mass spectrum of a carbon compound.



Which carbon compound is the mass spectrum from?

A C_2H_2

B $C_2H_5^+$

C $C_3H_7^+$

D C_4H_{10}

Your answer ☐ **[1]**

2 Look at the data about four elements.

Element	Melting point (°C)	Density (g/cm^3)	Ions formed
A	98	0.97	A^+
B	–101	0.0032	B^-
C	1535	7.9	C^{2+}, C^{3+}
D	660	2.7	D^{3+}

Which element is a transition element?

Your answer ☐ **[1]**

3 Which statement is true for a reversible reaction when it is at dynamic equilibrium?

A The concentration of the products is increasing.

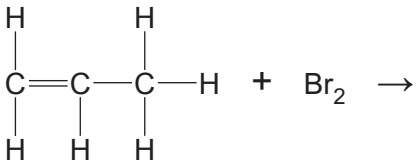
B The rate of the backward reaction is greater than the rate of the forward reaction.

C The rate of the forward reaction is equal to the rate of the backward reaction.

D The rate of the forward reaction is greater than the rate of the backward reaction.

Your answer ☐ **[1]**

4 What is the formula of the product in this equation?



A C_2H_3Br

B $C_3H_5Br_2$

C C_2H_3Br

D $C_3H_6Br_2$

Your answer ☐ **[1]**

5 The following statements describe one possible theory for how the Earth's atmosphere evolved.

The statements are not in the correct order.

1	Formation of water
2	Carbon cycle now keeps the composition of the atmosphere almost constant
3	Atmosphere of ammonia and carbon dioxide
4	Increase in oxygen and nitrogen levels
5	Photosynthetic organisms began to make oxygen
6	Degassing from the Earth's crust

What is the correct order for the sentences?

A 3, 5, 4, 6, 1, 2

B 3, 6, 5, 4, 1, 2

C 6, 1, 3, 5, 4, 2

D 6, 3, 1, 5, 4, 2

Your answer ☐ **[1]**

6 Look at the information about four different polymers.

Polymer	Cost (£ per kg)	Tensile strength (MPa)	Melting point (°C)	Maximum useable temperature (°C)
A	0.74	15	120	85
B	1.20	78	254	70
C	0.92	35	176	160
D	1.42	42	156	160

Which polymer would be best for making a plastic washing up bowl?

Your answer ☐ **[1]**

7 Look at the equation for a reversible reaction.

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \quad \Delta H = -950\,kJ\,mol^{-1}$

The reversible reaction forms a dynamic equilibrium in a sealed container.

Which of the following would move the position of equilibrium to the **right**?

A Decreasing the pressure and decreasing the temperature.

B Increasing the pressure and decreasing the temperature.

C Increasing the pressure and increasing the temperature.

D Increasing the pressure and using a catalyst.

Your answer ☐ **[1]**

8 Aluminium is extracted by the electrolysis of molten aluminium oxide, Al_2O_3.

Which equation shows the reaction at the **anode** in this electrolysis?

A $4OH^- - 4e^- \rightarrow O_2 + 2H_2O$

B $Al^{3+} + 3e^- \rightarrow Al$

C $2H^+ + 2e^- \rightarrow H_2$

D $2O^{2-} - 4e^- \rightarrow O_2$

Your answer ☐ **[1]**

9 Look at the equations for the reactions that happen at each side of a hydrogen-oxygen fuel cell.

Reaction 1: $2H_2(g) \rightarrow 4H^+(aq) + 4e^-$

Reaction 2: $4H^+(aq) + O_2(g) + 4e^- \rightarrow 2H_2O(g)$

	Reaction 1	Reaction 2
A	Oxidation because electrons are gained	Reduction because electrons are lost
B	Reduction because electrons are gained	Reduction because electrons are gained
C	Oxidation because electrons are lost	Reduction because electrons are gained
D	Oxidation because electrons are lost	Oxidation because electrons are lost

Which row of the table, **A**, **B**, **C** or **D**, is correct about reactions **1** and **2**?

Your answer ☐ **[1]**

10 Chlorine can displace iodine from iodide ions.

Which equation represents this reaction?

A $Cl + I^- \rightarrow Cl^- + I$

B $Cl^- + I_2 \rightarrow 2I^- + Cl_2$

C $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$

D $Cl_2 + I^- \rightarrow 2Cl^- + I$

Your answer ☐ **[1]**

11 How much 0.2 mol / dm^3 hydrochloric acid solution could you make from 100 cm^3 of 1.0 mol / dm^3 hydrochloric acid?

A 20 cm^3

B 200 cm^3

C 500 cm^3

D 600 cm^3

Your answer ☐ **[1]**

12 Which one of the following is an **advantage** of phytoextraction?

A A high concentration of a metal can be obtained from a low grade ore.

B Bacteria are used to dissolve metals instead of chemical solutions.

C Better crops of plants are harvested.

D Phytoextraction is a quick process and is not affected by poor weather.

Your answer ☐ **[1]**

13 Group 1 elements get more reactive down the group.

Which statement explains why?

A The outer electron is closer to the nucleus and lost more easily.

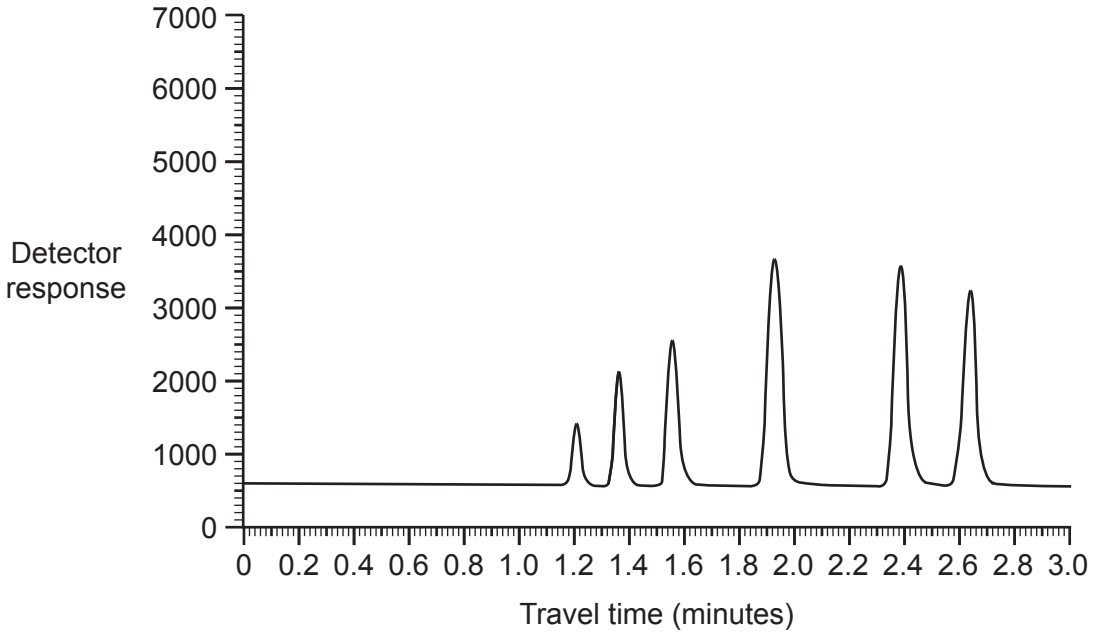
B The outer electron is further from the nucleus and lost more easily.

C There is less shielding from the inner electrons.

D There is more attraction between the nucleus and the outer electron down the group.

Your answer ☐ **[1]**

14 A gas chromatogram is a chart that represents different substances in a mixture.



Which of the following statements about a gas chromatogram is **not** correct?

A A gas chromatogram can detect very small amounts of substances.

B One compound produces several peaks.

C The area of each peak shows the relative amount of each substance.

D The retention time is different for different substances.

Your answer ☐ **[1]**

15 A student wants to test the purity of a liquid by testing its boiling point.

The actual boiling point of the pure liquid is 85 °C.

Which equation represents the percentage (%) difference between the student's value and the actual value?

A $\%\ \text{difference} = 100 \times \dfrac{(\text{student's value in °C}) - 85\,°\text{C}}{85\,°\text{C}}$.

B $\%\ \text{difference} = 100 \times \dfrac{85\,°\text{C} - (\text{student's value in °C})}{85\,°\text{C}}$.

C $\%\ \text{difference} = \dfrac{(\text{student's value in ºC}) - 85\,°\text{C}}{85\,°\text{C}}$.

D $\%\ \text{difference} = \dfrac{85\,°\text{C} - (\text{student's value in °C})}{85\,°\text{C}}$.

Your answer ☐ **[1]**

SECTION B

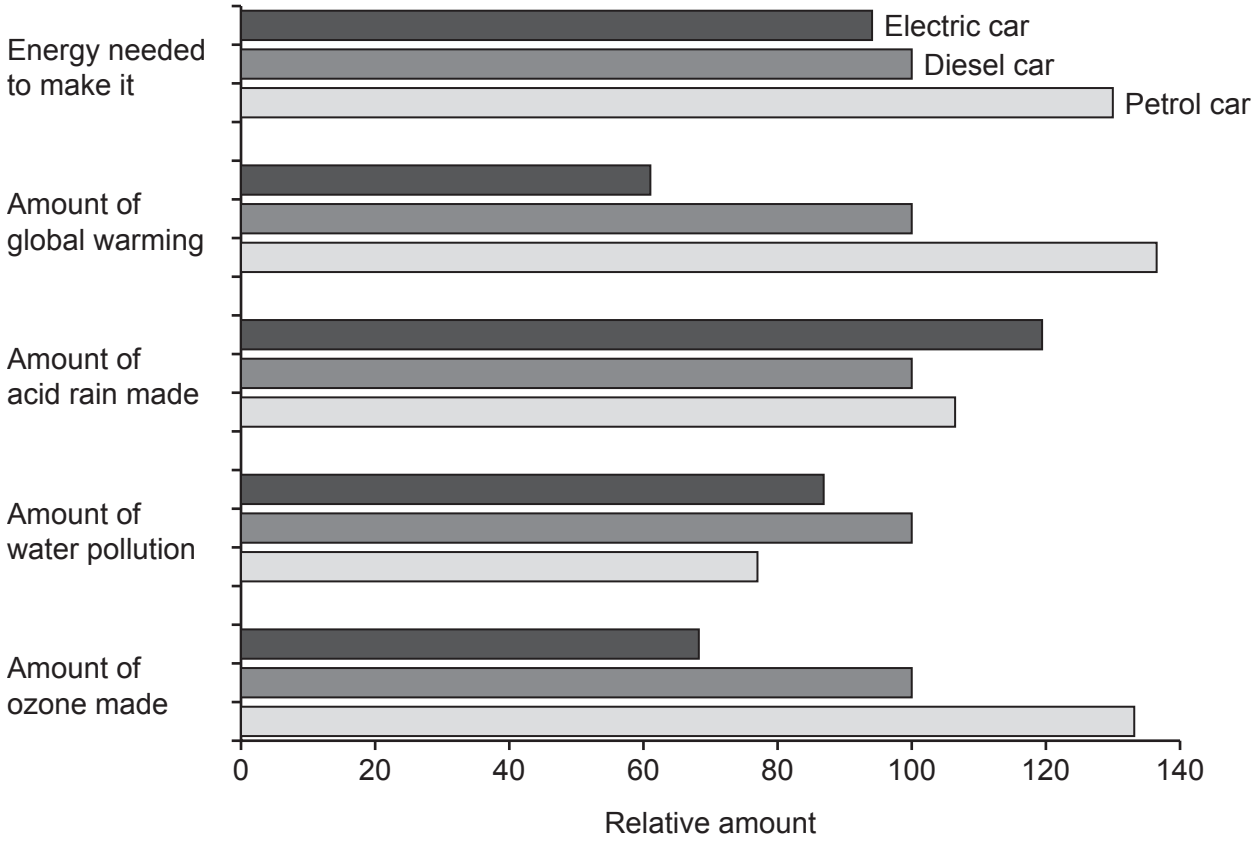
Answer **all** the questions.

16 This question is about life-cycle assessment.

(a) A car company is developing three new cars:
- A petrol car
- A diesel car
- An electric car.

They do a life-cycle assessment of each car.

Look at the information about the life-cycle assessment of each car.



The company decides to manufacture and sell the electric car.

Explain why they make this choice.

Use the information from the life-cycle assessment to help you.

.....

.....

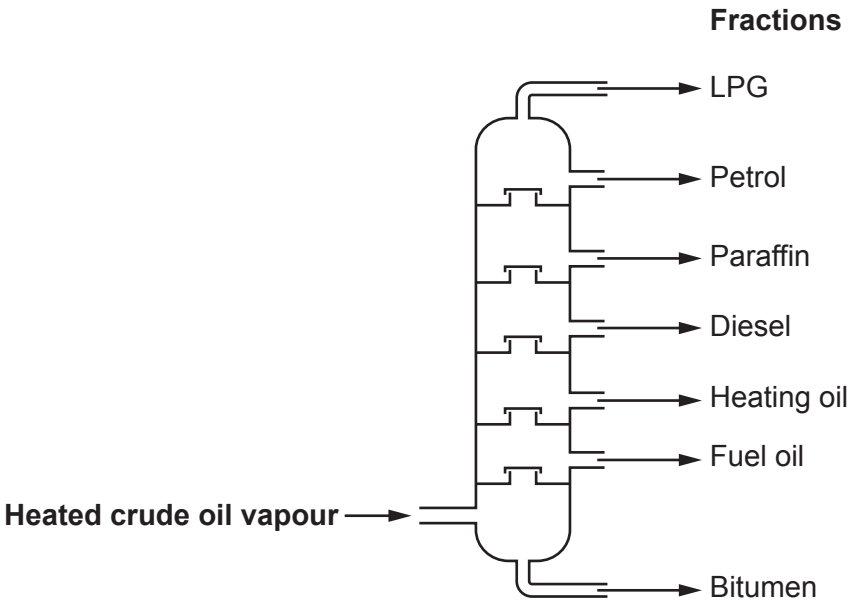
.....

..... **[3]**

(b) The fuels for the petrol and diesel cars are made from crude oil.

Crude oil is separated into different parts by **fractional distillation**.

The diagram shows a fractionating column.



Explain why crude oil **vapour** can be separated by fractional distillation.

.....

.....

.....

.....

..... **[3]**

(c) The table shows the boiling points of molecules present in different crude oil fractions.

Molecule	Boiling point (°C)
A	–2
B	125
C	216
D	502

Which molecule, **A**, **B**, **C** or **D** is in the **LPG fraction**?

Explain your decision.

.....

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

(d) Car manufacturers are developing cars that are powered by hydrogen/oxygen fuel cells.

The table shows some information about a 200 km journey using an electric car and a car using a fuel cell.

Feature	Electric	Fuel cell
Refuelling time (minutes)	360	4
Cost of refuelling (£)	3.20	4.20
CO_2 emitted (kg)	48	36
Mass of car (kg)	1550	1200

Evaluate the **advantages** and **disadvantages** of using a car powered by a fuel cell, rather than an electric car for the 200 km journey.

.....

.....

.....

.....

..... **[3]**

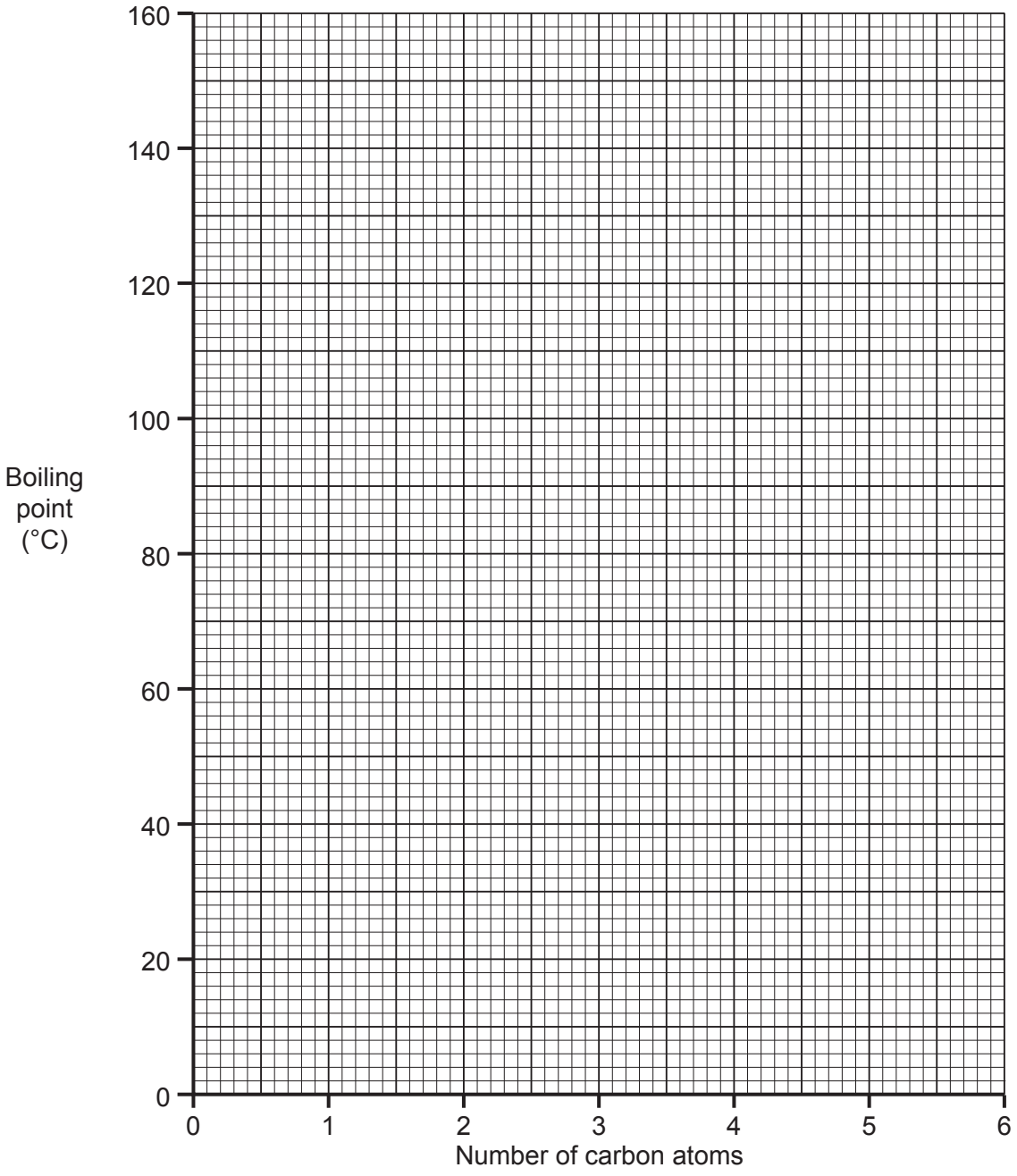
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

17 A student is using the internet to find out about alcohols. The student finds the following information.

Name	Number of carbon atoms	Boiling point (°C)
Methanol	1	65
Ethanol	2	79
Propanol	3	97
Pentanol	5	138
Hexanol	6	156

(a) Plot a graph of the boiling points of the alcohols on the grid. Draw a line of best fit.



[3]

(b) (i) The student could not find a value for the boiling point of butanol, C_4H_9OH.

Use the graph to estimate the boiling point of butanol.

Answer = ... °C **[1]**

(ii) Draw the **displayed formula** of butanol, C_4H_9OH.

[1]

(c) The alcohols all react in a similar way because they all contain the same **functional group**.

What is the functional group in an **alcohol** molecule?

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

(d) Ethanol, C_2H_5OH, can be oxidised to **ethanoic acid** using potassium manganate(VII).

What is the formula of ethanoic acid?

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

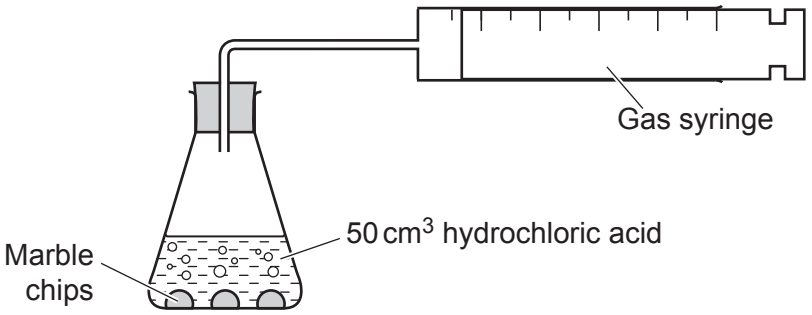
18 A student investigates the reaction between marble chips, $CaCO_3$, and hydrochloric acid.

Calcium chloride, $CaCl_2$, carbon dioxide and water are made.

(a) Write a **balanced symbol** equation for the reaction.

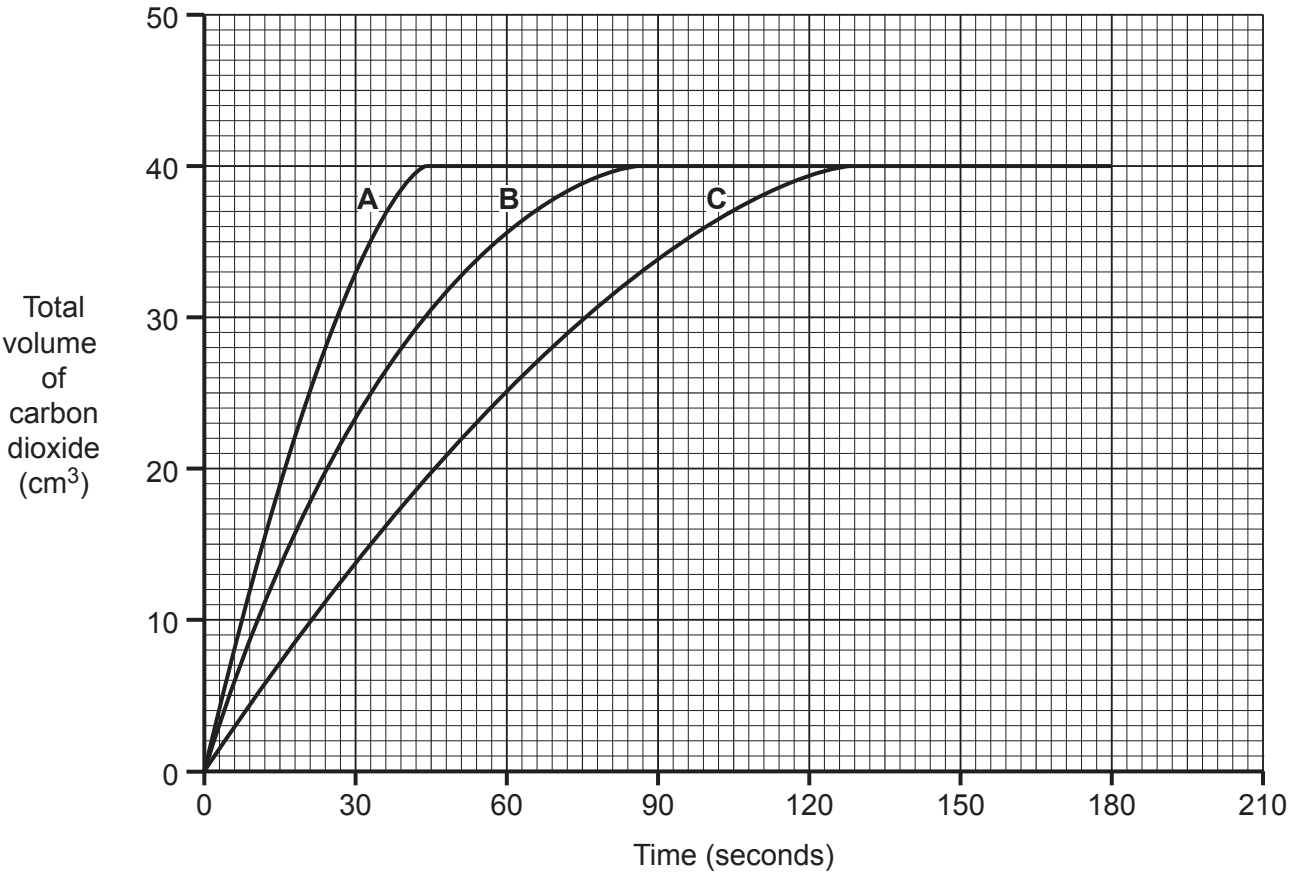
..... **[2]**

(b) The student does three experiments, **A**, **B** and **C**.



In each experiment she uses a different size of marble chip. She uses the same mass of marble in each experiment. She also uses the same concentration of acid.

Look at the graph of her results.



(i) Look at the line for experiment **B** on the graph.

When is the rate of reaction **greatest**?

Choose your answer from the list.

0 – 30 seconds

30 – 60 seconds

60 – 90 seconds

90 – 120 seconds

Answer = ... seconds **[1]**

(ii) Look at the line for experiment **C**.

Calculate the **rate of reaction** during the first 45 seconds.

Give your answer to **2** significant figures.

Answer = ... cm^3/s **[3]**

(c) The rate of reaction between marble and hydrochloric acid can be decreased by:

- Using a more dilute solution of hydrochloric acid
- Cooling the acid.

Explain how each of these methods make the reaction slower.

Use ideas about collisions between particles.

.....

.....

.....

.....

.....

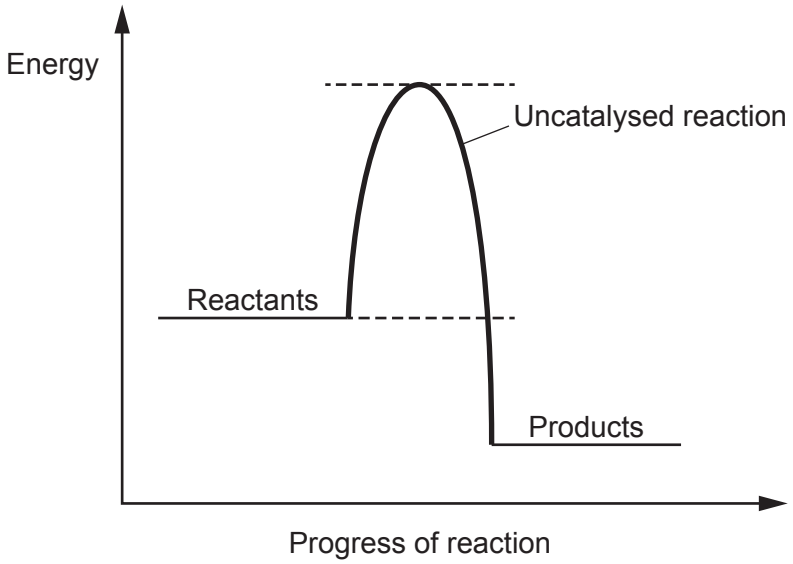
.....

.....

..... **[4]**

(d) A catalyst can be used to increase the rate of a reaction.

Look at the energy profile diagram for a reaction **without** a catalyst.



Complete the energy profile diagram to show

(i) The reaction profile for the reaction with a catalyst. **[1]**

(ii) Label the **activation energy** for the reaction **with** a catalyst. **[1]**

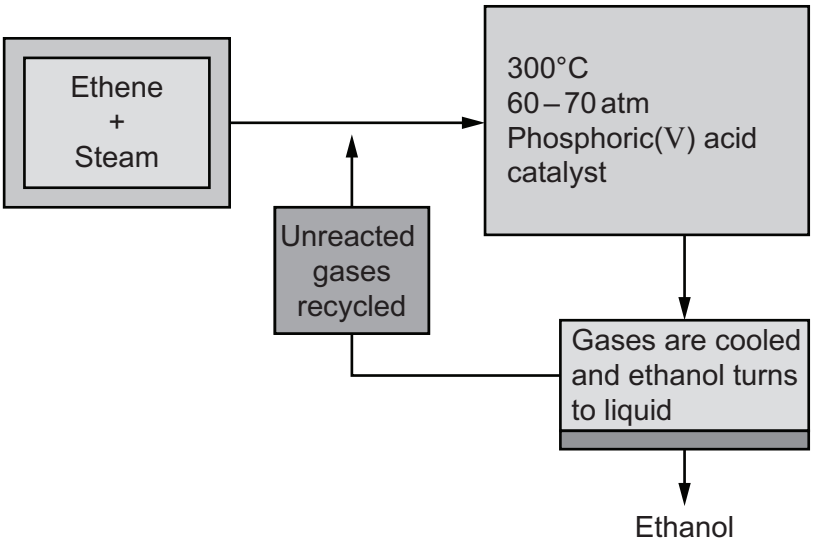
19* Ethanol is manufactured by reacting ethene, C_2H_4, with steam.

The reaction is reversible and occurs in a closed system.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45\,kJ\,mol^{-1}$$

Only 5% of the ethene is converted into ethanol at each pass through the reactor.

By removing the ethanol from the equilibrium mixture and recycling the ethene, it is possible to achieve an overall 95% conversion.



Explain why the conditions used for the process are chosen.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

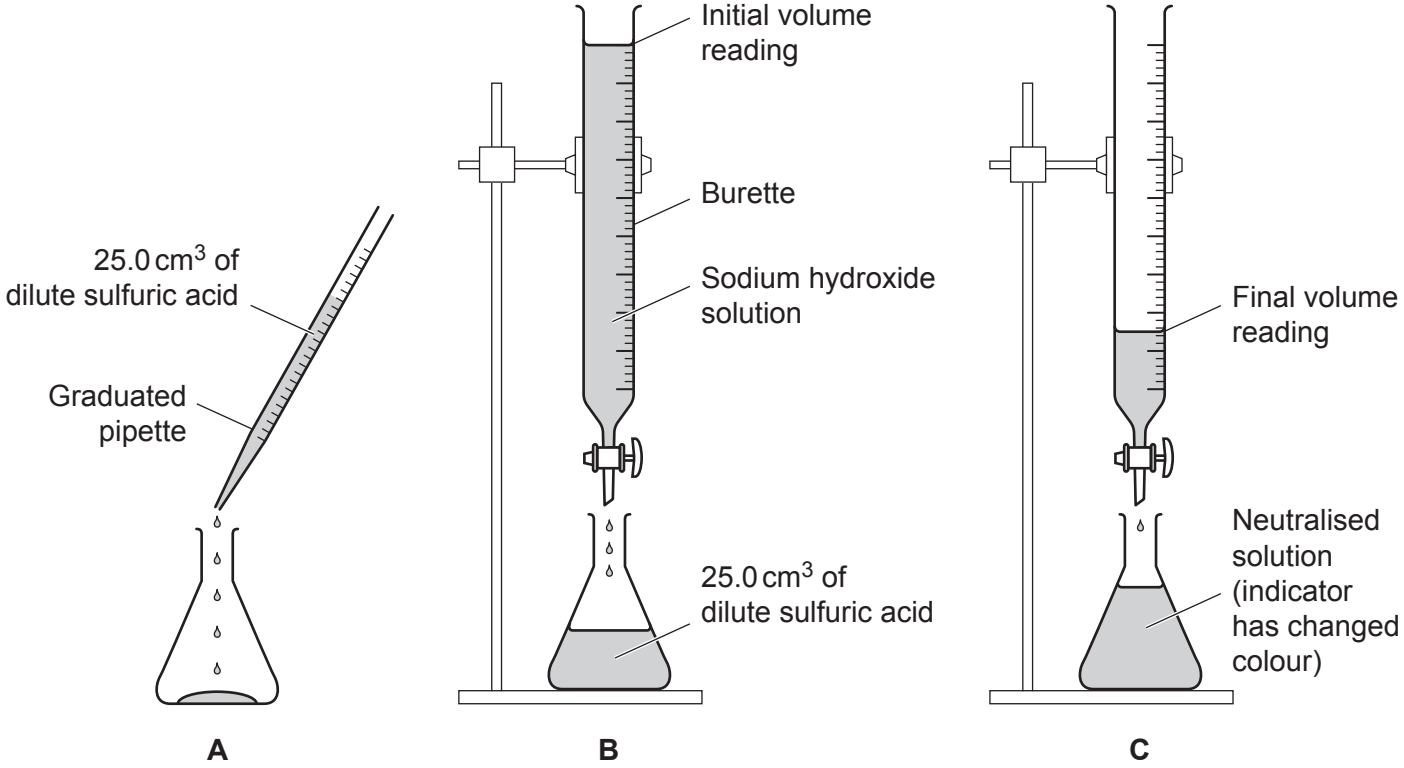
.....

..... **[6]**

20 Student **A** does a titration with an acid and an alkali.

He uses dilute sulfuric acid, sodium hydroxide solution and an indicator solution.

The diagram shows the apparatus he uses.



The student adds sodium hydroxide solution from the burette to the sulfuric acid until the indicator changes colour.

He then adds a few more drops of sodium hydroxide to be certain the sulfuric acid is neutralised.

He takes the final volume reading on the burette to find out how much acid reacts with 25.0 cm^3 of sodium hydroxide solution.

(a) Describe and explain how the student could improve his experiment to get a more accurate value.

.....

.....

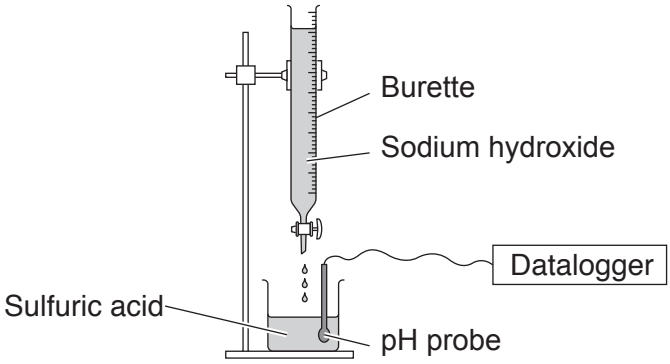
.....

.....

.....

..... **[4]**

(b) Student **B** does a titration.



Sodium hydroxide solution is slowly added to the beaker of dilute sulfuric acid.

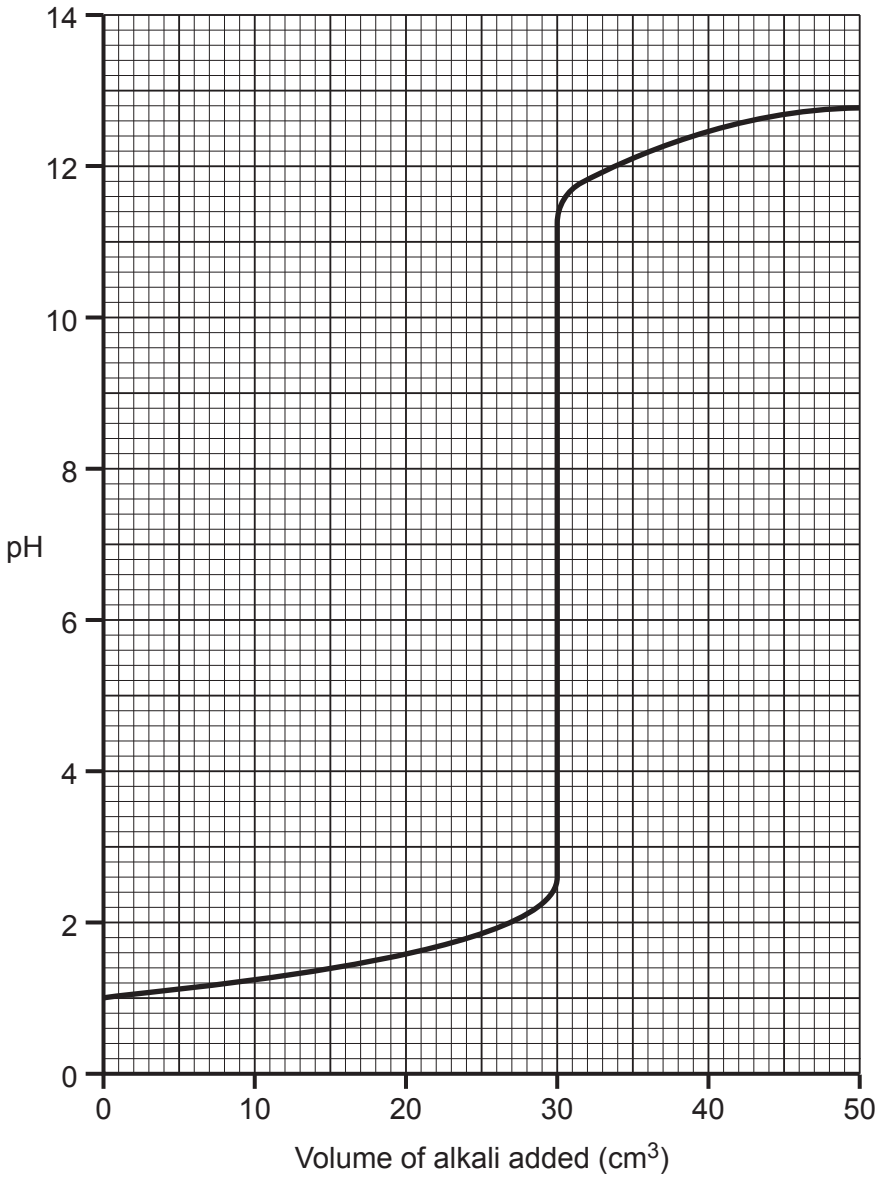
The pH probe is connected to a datalogger.

Suggest how student **B**'s method is better than student **A**'s.

.....

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

(c) Look at the display from the datalogger.



(i) What is the pH value when 15 cm^3 of alkali has been added?

Answer = ... **[1]**

(ii) What volume of alkali is needed to exactly neutralise the sulfuric acid?

Answer = ... cm^3 **[1]**

(d) Student **B** does another experiment.

This time she uses:

- 20.0 cm^3 of dilute hydrochloric acid in the beaker
- sodium hydroxide solution of concentration 0.200 mol/dm^3 in the burette.

Look at student **B**'s results.

Titration number	**1**	**2**	**3**	**4**
Final burette reading (cm^3)	26.9	27.6	27.0	28.2
Initial burette reading (cm^3)	0.5	2.5	1.2	3.2
Titre (volume of alkali used) (cm^3)	26.4	25.1	25.8	25.0

(i) Student **B** decides to only use the results from titration numbers **2** and **4**.

Explain why.

.....

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

(ii) Look at the equation for the reaction between hydrochloric acid, HC*l*, and sodium hydroxide, NaOH.

$HCl + NaOH \rightarrow NaCl + H_2O$

Calculate the concentration of hydrochloric acid in mol/dm^3.

Use the average titre, in cm^3, from titration numbers **2** and **4**.

Give your answer to **2** significant figures.

Answer = ... mol/dm^3 **[4]**

21 **(a)** A student dissolves 0.6 g of zinc sulfate in 250 cm^3 of water.

(i) Calculate the volume of the water in dm^3.

Answer = ... dm^3 **[1]**

(ii) Use your answer to part **(a)(i)** to help you calculate the concentration of the zinc sulfate in g/dm^3.

Answer = ... g/dm^3 **[1]**

(b) Zinc reacts with sulfuric acid. Zinc sulfate and hydrogen gas, H_2, are made.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

(i) Calculate the amount of **hydrogen gas**, in mol, that could be made from 3.27 g of **zinc**.

Answer = ... mol **[2]**

(ii) Use your answer to part **(b)(i)** to calculate the **volume** of hydrogen gas produced at room temperature and pressure.

One mole of any gas occupies 24 dm^3 at room temperature and pressure.

Answer = ... dm^3 **[2]**

(c) Hydrogen can be made by reacting methane with steam.

$CH_4 + H_2O \rightarrow CO + 3H_2$

The **atom economy** for this process is 17.6%.

Hydrogen can also be produced by the decomposition of ammonia.

This reaction requires a catalyst.

$2NH_3 \rightarrow N_2 + 3H_2$

(i) Calculate the atom economy for the production of hydrogen from ammonia.

Give your answer to **3** significant figures.

Answer = ... % **[3]**

(ii) Suggest other factors, apart from atom economy, that must be considered when deciding which reaction pathway to choose for the manufacture of hydrogen.

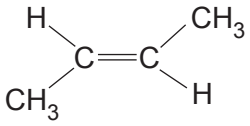
.....

.....

.....

..... **[3]**

22 Look at the displayed formula of the monomer butene.



(a) What feature of butene molecules allows them to act as monomers?

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

(b) Butene is an alkene.

What is the **general formula** for an alkene?

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

(c) Butene undergoes **addition polymerisation** to form poly(butene).

Write the **displayed formulae**, for poly(butene).

[2]

(d) DNA molecules are polymers made from four different monomers.

What are the monomers in DNA called?

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

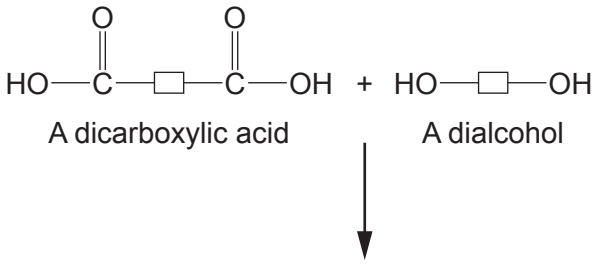
(e) Polyesters are polymers made by **condensation polymerisation**.

(i) What is the minimum number of **functional groups** that a monomer must have to form a condensation polymer?

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

(ii) Polyesters are made from a carboxylic acid and an alcohol.

Complete the block diagram to show the formation of a polyester.



[2]

(iii) What is the **formula** of the molecule that is eliminated in the reaction to form a polyester?

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

(f) Nylon is another polymer formed in a condensation polymerisation reaction.

Nylon can be made from hexanedioyl dichloride and hexane-1,6-diamine.

Both chemicals are highly corrosive.

A solvent is needed which is highly flammable.

(i) Describe how to make nylon in a laboratory.

.....

.....

.....

.....

.....

..... **[3]**

(ii) Describe and explain **three** precautions needed to control the hazards in this experiment.

.....

.....

.....

..... **[3]**

END OF QUESTION PAPER