

**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****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



First name

Last name

Centre  
numberCandidate  
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**

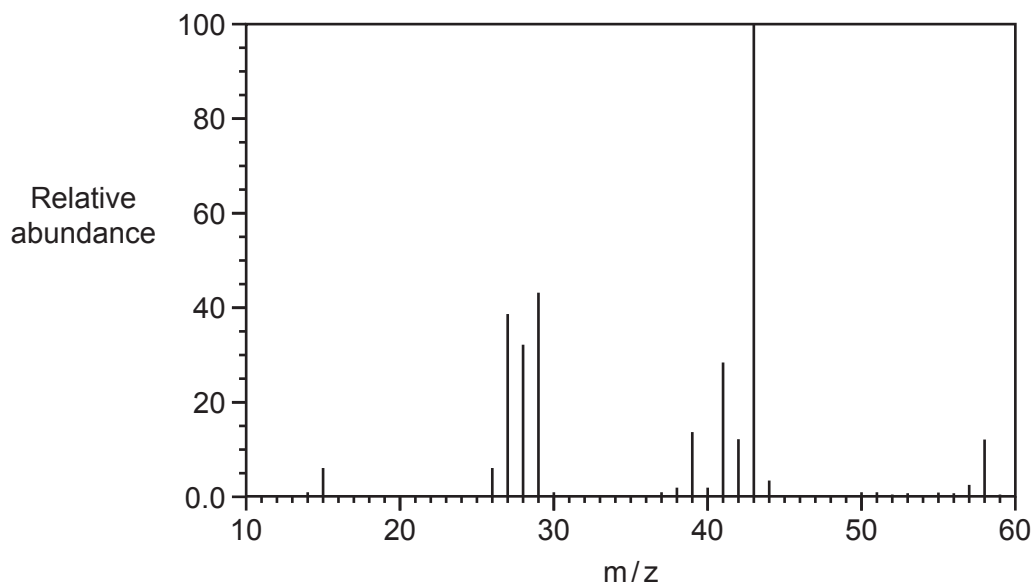
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets [ ].
- Quality of extended responses will be assessed in questions marked with an asterisk (\*).
- This document consists of **28** pages.

2  
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 <sup>3</sup> )	Ions formed
A	98	0.97	A <sup>+</sup>
B	-101	0.0032	B <sup>-</sup>
C	1535	7.9	C <sup>2+</sup> , C <sup>3+</sup>
D	660	2.7	D <sup>3+</sup>

Which element is a transition element?

Your answer

[1]

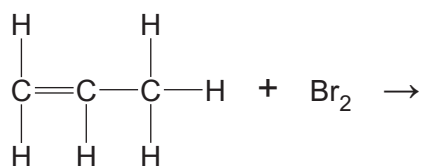
3 Which statement is true for a reversible reaction when it is at dynamic equilibrium?

- 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<sub>2</sub>H<sub>3</sub>Br
- B C<sub>3</sub>H<sub>5</sub>Br<sub>2</sub>
- C C<sub>2</sub>H<sub>3</sub>Br
- D C<sub>3</sub>H<sub>6</sub>Br<sub>2</sub>

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.

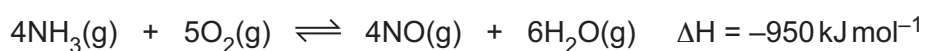
Polymer	Cost (£ per kg)	Tensile strength (MPa)	Melting point (°C)	Maximum useable temperature (°C)
A	0.74	15	120	85
B	1.20	78	254	70
C	0.92	35	176	160
D	1.42	42	156	160

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

Your answer

[1]

7 Look at the equation for a reversible reaction.



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

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

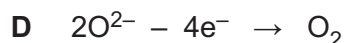
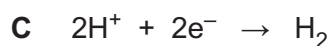
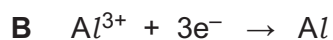
- A Decreasing the pressure and decreasing the temperature.
- B Increasing the pressure and decreasing the temperature.
- C Increasing the pressure and increasing the temperature.
- D Increasing the pressure and using a catalyst.

Your answer

[1]

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

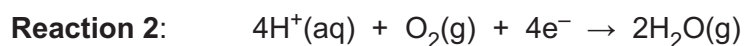
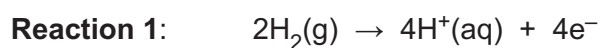
Which equation shows the reaction at the **anode** in this electrolysis?



Your answer

[1]

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



	Reaction 1	Reaction 2
<b>A</b>	Oxidation because electrons are gained	Reduction because electrons are lost
<b>B</b>	Reduction because electrons are gained	Reduction because electrons are gained
<b>C</b>	Oxidation because electrons are lost	Reduction because electrons are gained
<b>D</b>	Oxidation because electrons are lost	Oxidation because electrons are lost

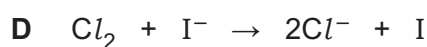
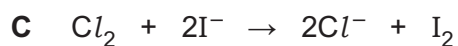
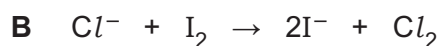
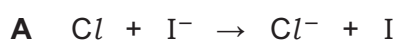
Which row of the table, **A**, **B**, **C** or **D**, is correct about reactions **1** and **2**?

Your answer

[1]

10 Chlorine can displace iodine from iodide ions.

Which equation represents this reaction?



Your answer

[1]

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

- A  $20 \text{ cm}^3$
- B  $200 \text{ cm}^3$
- C  $500 \text{ cm}^3$
- D  $600 \text{ cm}^3$

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.

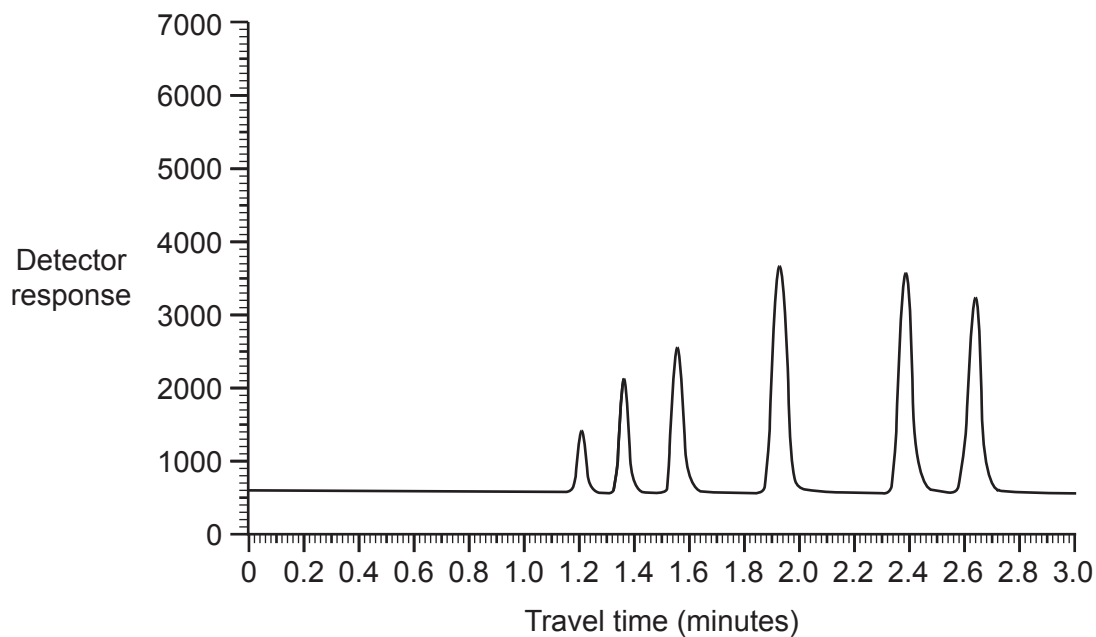
Which statement explains why?

- 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 % difference =  $100 \times \frac{(\text{student's value in } ^\circ\text{C}) - 85^\circ\text{C}}{85^\circ\text{C}}$ .

B % difference =  $100 \times \frac{85^\circ\text{C} - (\text{student's value in } ^\circ\text{C})}{85^\circ\text{C}}$ .

C % difference =  $\frac{(\text{student's value in } ^\circ\text{C}) - 85^\circ\text{C}}{85^\circ\text{C}}$ .

D % difference =  $\frac{85^\circ\text{C} - (\text{student's value in } ^\circ\text{C})}{85^\circ\text{C}}$ .

Your answer

[1]

SECTION B

Answer **all** the questions.

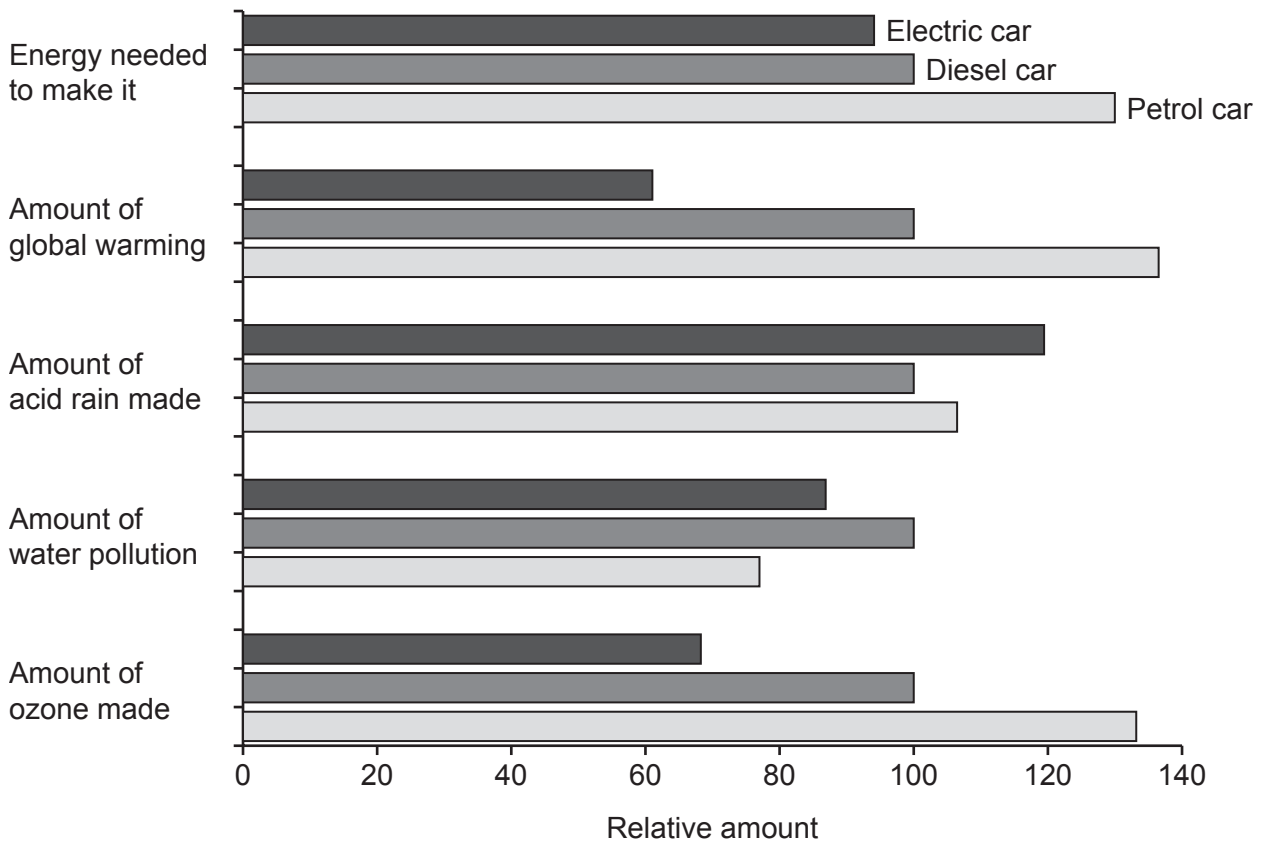
16 This question is about life-cycle assessment.

(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.

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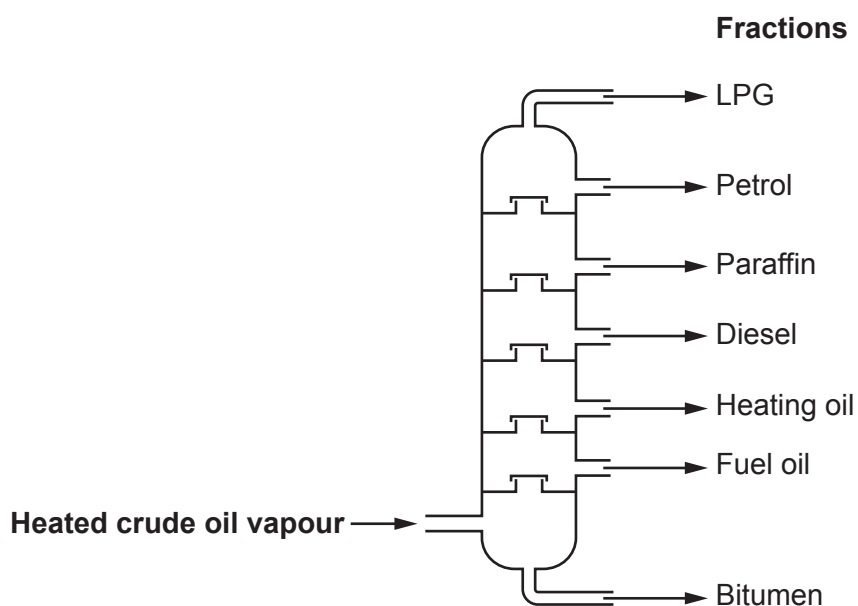
.....

[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)
<b>A</b>	-2
<b>B</b>	125
<b>C</b>	216
<b>D</b>	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
<b>Refuelling time (minutes)</b>	360	4
<b>Cost of refuelling (£)</b>	3.20	4.20
<b>CO<sub>2</sub> emitted (kg)</b>	48	36
<b>Mass of car (kg)</b>	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.

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

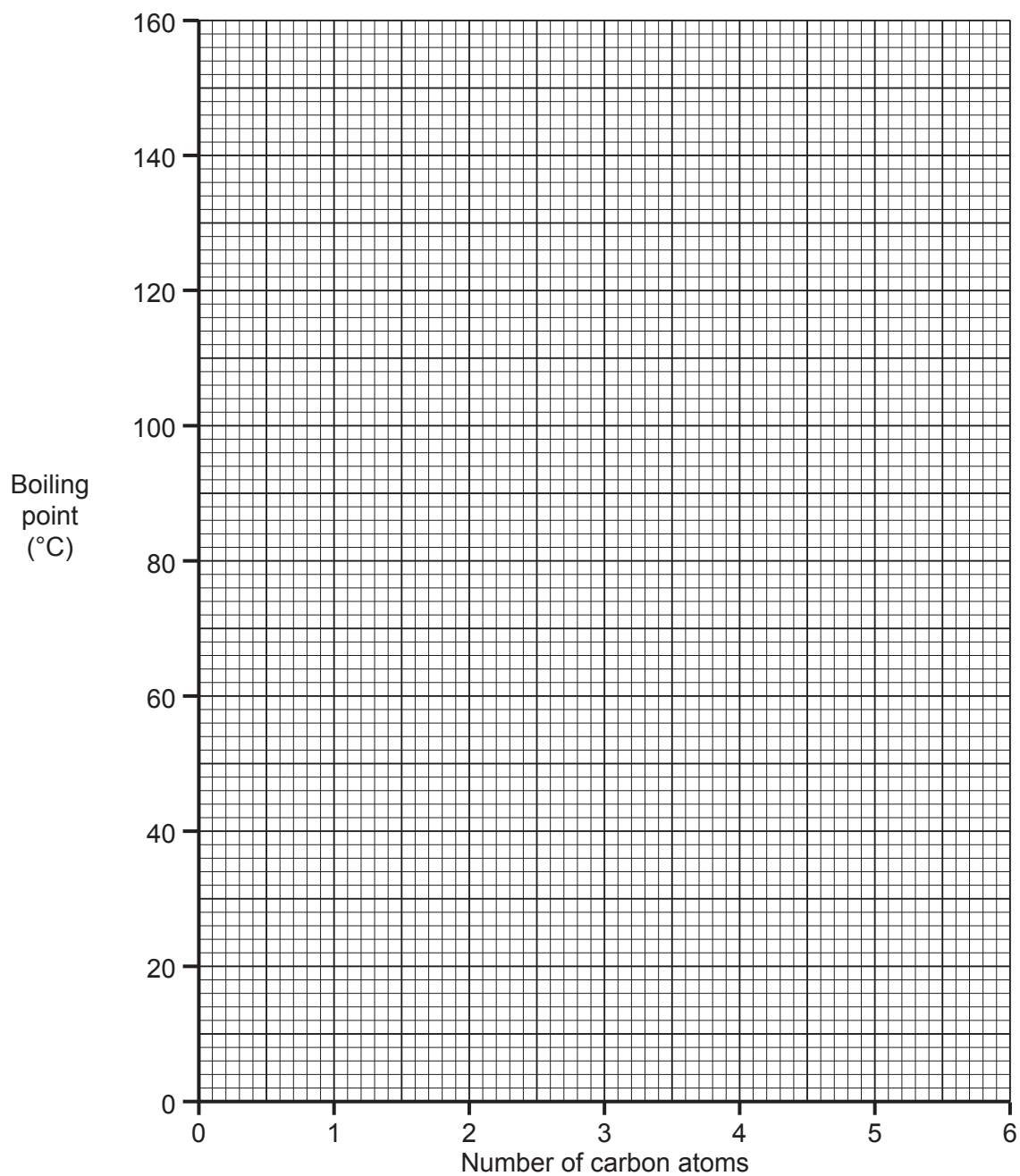
13  
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17 A student is using the internet to find out about alcohols. The student finds the following information.

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]

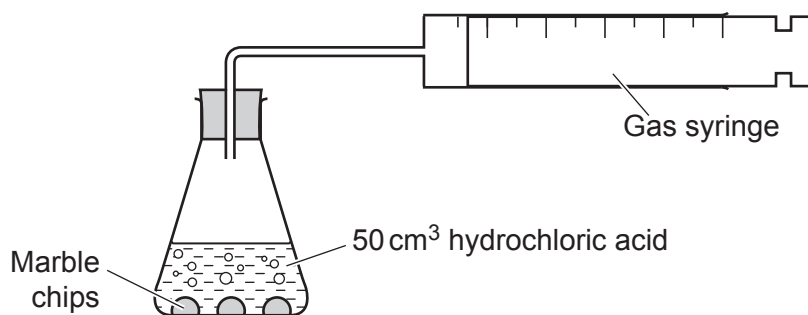
18 A student investigates the reaction between marble chips,  $\text{CaCO}_3$ , and hydrochloric acid.

Calcium chloride,  $\text{CaCl}_2$ , carbon dioxide and water are made.

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

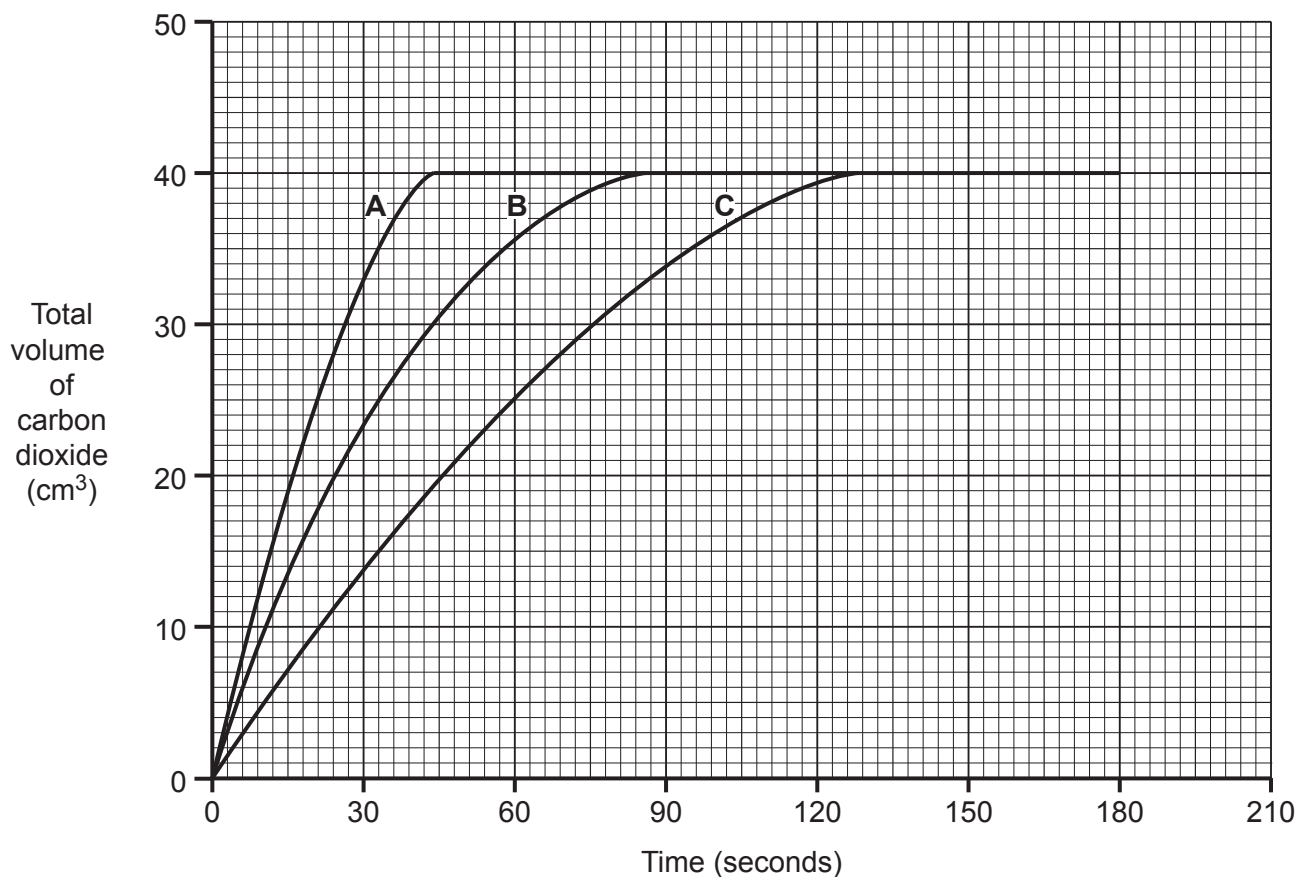
..... [2]

(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.

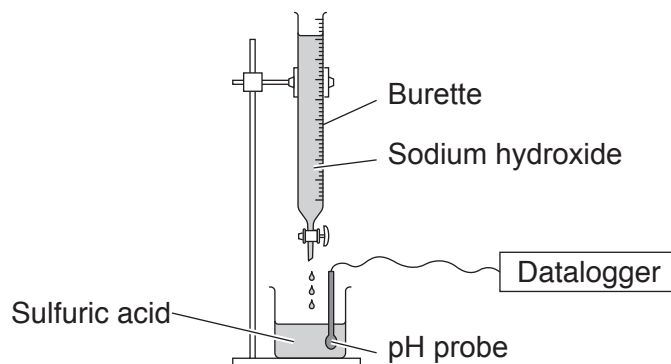
Answer = ..... cm<sup>3</sup>/s [3]







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



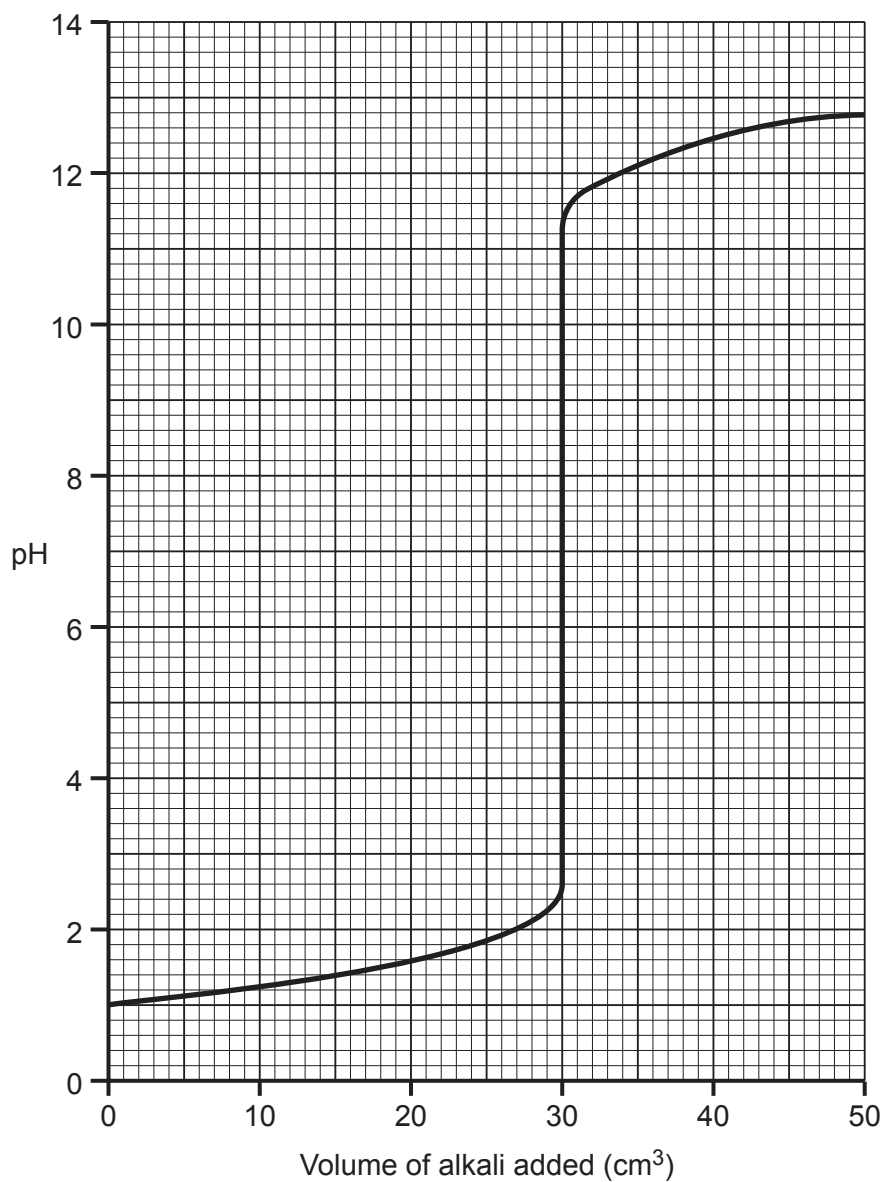
Sodium hydroxide solution is slowly added to the beaker of dilute sulfuric acid.

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<sup>3</sup> of alkali has been added?

Answer = ..... [1]

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

Answer = ..... cm<sup>3</sup> [1]

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

This time she uses:

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

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

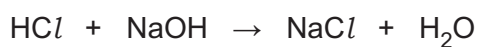
Titration number	1	2	3	4
Final burette reading (cm <sup>3</sup> )	26.9	27.6	27.0	28.2
Initial burette reading (cm <sup>3</sup> )	0.5	2.5	1.2	3.2
Titre (volume of alkali used) (cm <sup>3</sup> )	26.4	25.1	25.8	25.0

(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, HCl, and sodium hydroxide, NaOH.



Calculate the concentration of hydrochloric acid in mol/dm<sup>3</sup>.

Use the average titre, in cm<sup>3</sup>, from titration numbers **2** and **4**.

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

Answer = ..... mol/dm<sup>3</sup> [4]

21 (a) A student dissolves 0.6 g of zinc sulfate in 250 cm<sup>3</sup> of water.

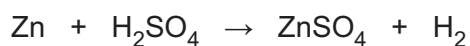
(i) Calculate the volume of the water in dm<sup>3</sup>.

Answer = ..... dm<sup>3</sup> [1]

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

Answer = ..... g/dm<sup>3</sup> [1]

(b) Zinc reacts with sulfuric acid. Zinc sulfate and hydrogen gas, H<sub>2</sub>, are made.



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

Answer = ..... mol [2]

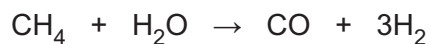
(ii) Use your answer to part (b)(i) to calculate the **volume** of hydrogen gas produced at room temperature and pressure.

One mole of any gas occupies 24 dm<sup>3</sup> at room temperature and pressure.

Answer = ..... dm<sup>3</sup> [2]



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



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

Hydrogen can also be produced by the decomposition of ammonia.

This reaction requires a catalyst.



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

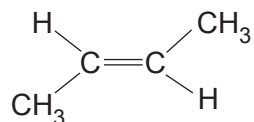
Give your answer to **3** significant figures.

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]

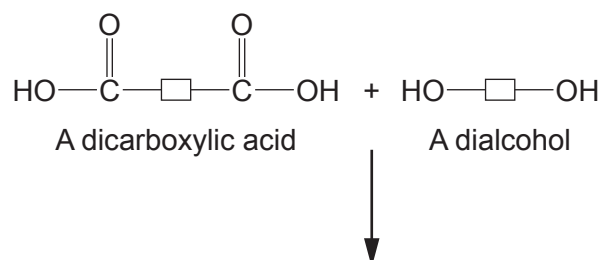
(e) Polyesters are polymers made by **condensation polymerisation**.

- (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.

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.....

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..... [3]

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

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..... [3]

**END OF QUESTION PAPER**



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