Surname _____

Other Names _____

Centre Number_____

Candidate Number_____

For Examiner's Use

Candidate Signature _____

ASSESSMENT AND QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education
Higher Tier
June 2010

Chemistry

Unit Chemistry C3

CHY3H

Wednesday 26 May 2010 9.00 am

For this paper you must have:
- **a pencil**
- **a ruler**
- **the Data Sheet enclosed.**

You may use a calculator.

TIME ALLOWED
- **45 minutes plus your additional time allowance.**

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

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INSTRUCTIONS

- Use black ink or black ball-point pen.
- Answer ALL questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

INFORMATION

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

ADVICE

- In all calculations, show clearly how you work out your answer.

DO NOT TURN OVER UNTIL TOLD TO DO SO

Answer ALL questions in the spaces provided.

1 **The table gives some information about the composition of three samples of water from wells in the Canary Islands, Crete and Cyprus.**

	MINERAL CONTENT OF WATER IN mg per litre		
IONS	**CANARY ISLANDS**	**CRETE**	**CYPRUS**
Calcium, Ca^{2+}	28	82	18
Magnesium, Mg^{2+}	14	41	13
Sodium, Na^{+}	53	7	22
Chloride, Cl^{-}	7	143	39
Hydrogencarbonate, HCO_3^{-}	281	5	93
Sulfate, SO_4^{2-}	2	14	16

1 (a) **Describe and explain how ions get into these samples of water. [2 marks]**

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1 (b) **The sample of water from Crete is harder than the other two.**

Use the information in the table to explain why. [1 mark]

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1 (c) **People who use hard water can expect higher costs than people who use soft water.**

Explain why. [2 marks]

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1 (d) **Hard water can be made soft by removing the ions that cause hardness.**

State ONE way these ions can be removed. [1 mark]

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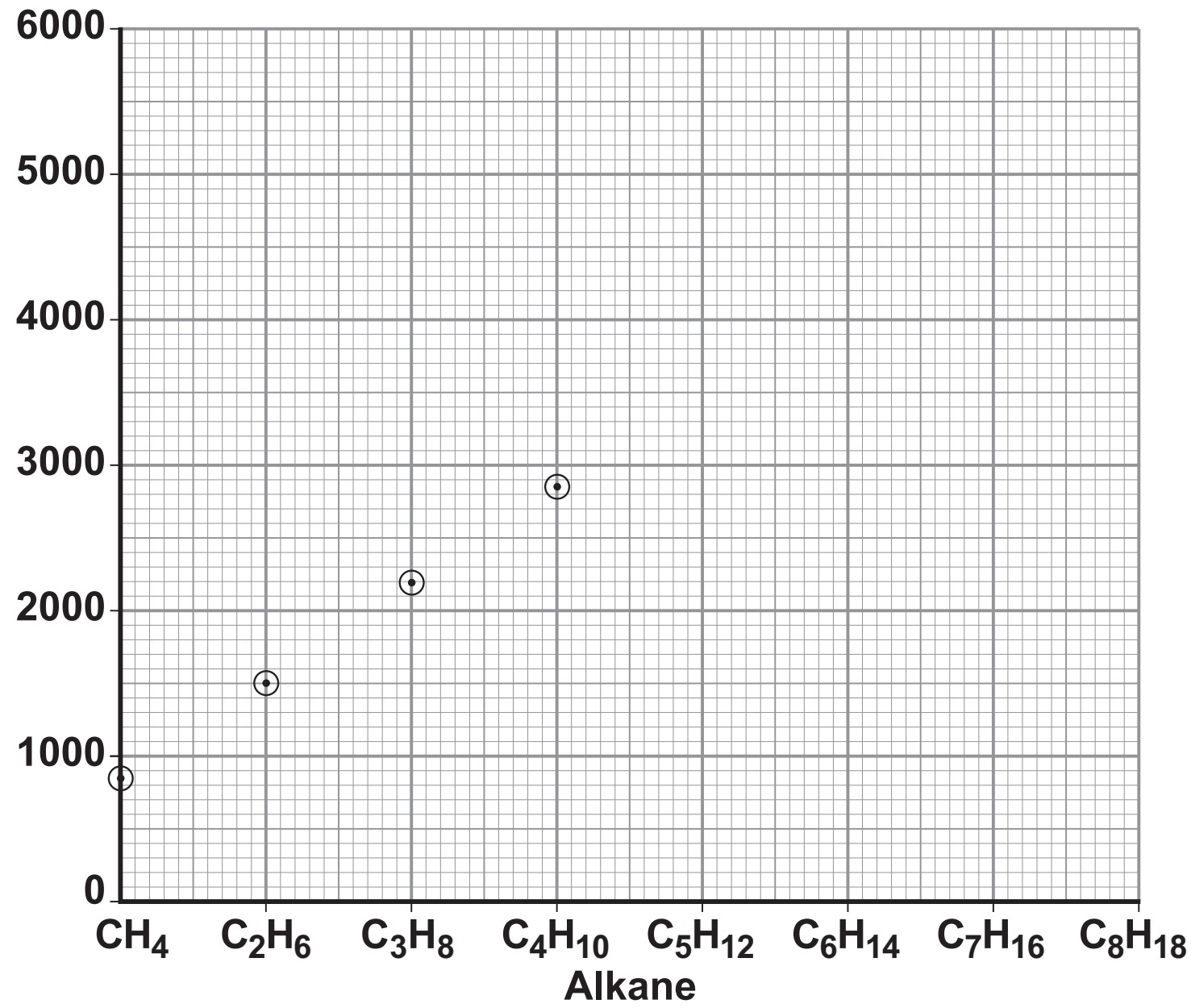
6

2 (a) Alkanes are important hydrocarbon fuels. They have the general formula C_nH_{2n+2}

The points on the graph show the amount of energy released when 1 mole of methane (CH_4), ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) are burned separately.



2 (a) (i) Draw a line through the points and extend your line to the right-hand edge of the graph. [1 mark]

2 (a) (ii) Use the graph to estimate the amount of energy released when 1 mole of octane (C_8H_{18}) is burned. [1 mark]

Energy released = _____ kJ

2 (a) (iii) Suggest why we can make a good estimate for the energy released by 1 mole of pentane (C_5H_{12}). [1 mark]

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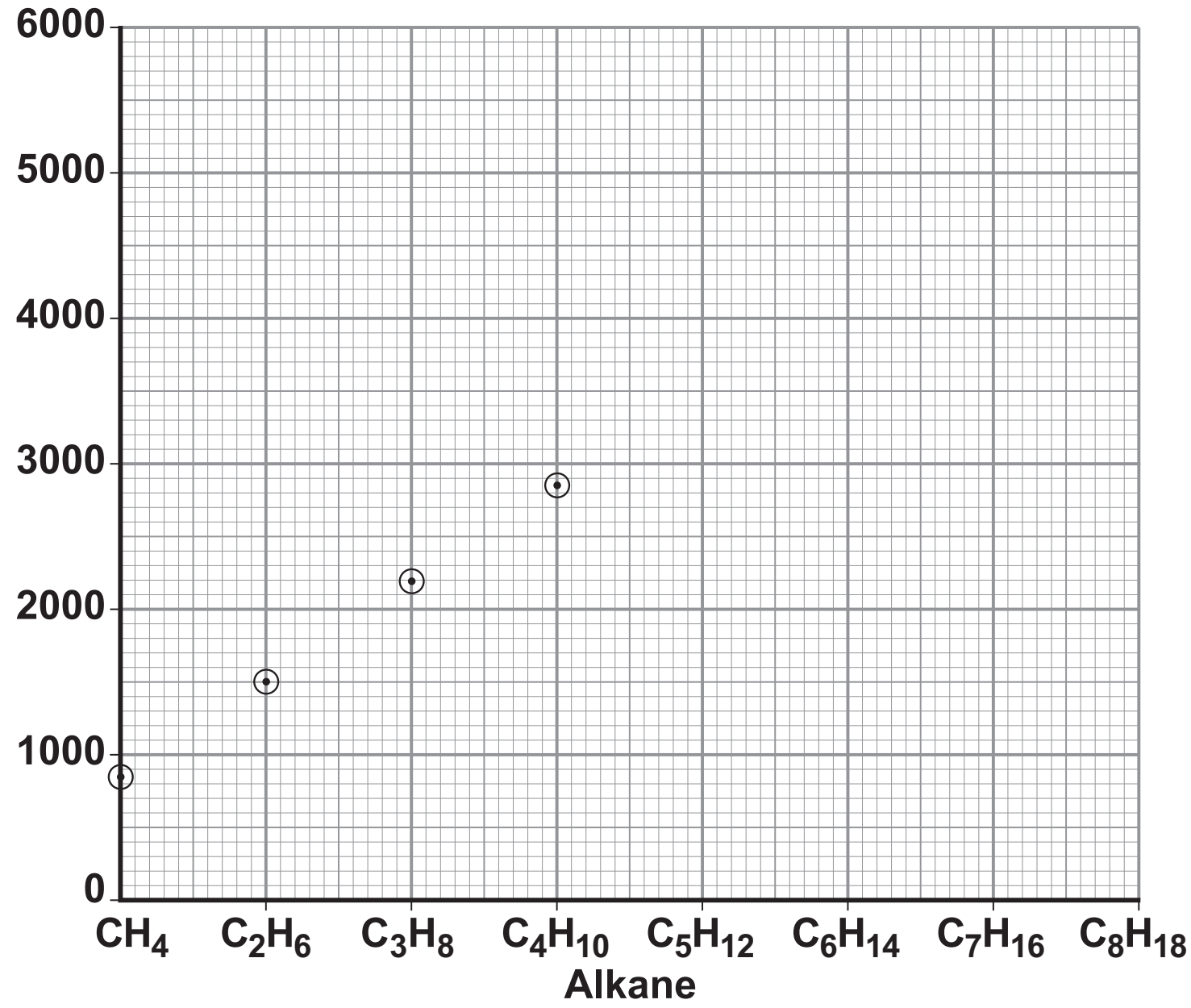
[Question 2 continues on the next page]

The graph is repeated from page 6.



2 (a) (iv) **A student noticed that octane (C_8H_{18}) has twice as many carbon atoms as butane (C_4H_{10}), and made the following prediction:**

"When burned, 1 mole of octane releases twice as much energy as 1 mole of butane."

Use the graph to decide if the student's prediction is correct. You MUST show your working to gain credit. [2 marks]

[Question 2 continues on the next page]

2 (b) **Some information about four fuels is given in the table.**

FUEL	TYPE	HEAT RELEASED IN kJ per g	COMBUSTION PRODUCTS			TYPE OF FLAME
			CO_2	SO_2	H_2O	
Bio-ethanol	Renewable	29	✓		✓	Not smoky
Coal	Non-renewable	31	✓	✓	✓	Smoky
Hydrogen	Renewable	142			✓	Not smoky
Natural gas	Non-renewable	56	✓		✓	Not smoky

From this information a student made two conclusions.

For each conclusion, state if it is correct AND explain your answer.

2 (b) (i) **"Renewable fuels release more heat per gram than non-renewable fuels." [2 marks]**

_____

_____

_____

2 (b) (ii) "Non-renewable fuels are better for the environment than renewable fuels." [2 marks]

9

[Turn over for the next question]

3 (a) **Sodium is a Group 1 element.**

3 (a) (i) **A small piece of sodium is added to some water containing Universal Indicator solution.**

Describe what you would SEE happening. [3 marks]

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3 (a) (ii) **Complete AND balance the equation for the reaction of sodium with water. [2 marks]**

_____Na + _____H_2O $\longrightarrow$ _____ + H_2

3 (b) **Francium is the most reactive element in Group 1.**

Explain why in terms of electronic structure. [3 marks]

[Question 3 continues on the next page]

3 (c) **The transition elements have different properties from the elements in Group 1.**

Give TWO of these different properties of transition elements. [2 marks]

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2 _____

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10

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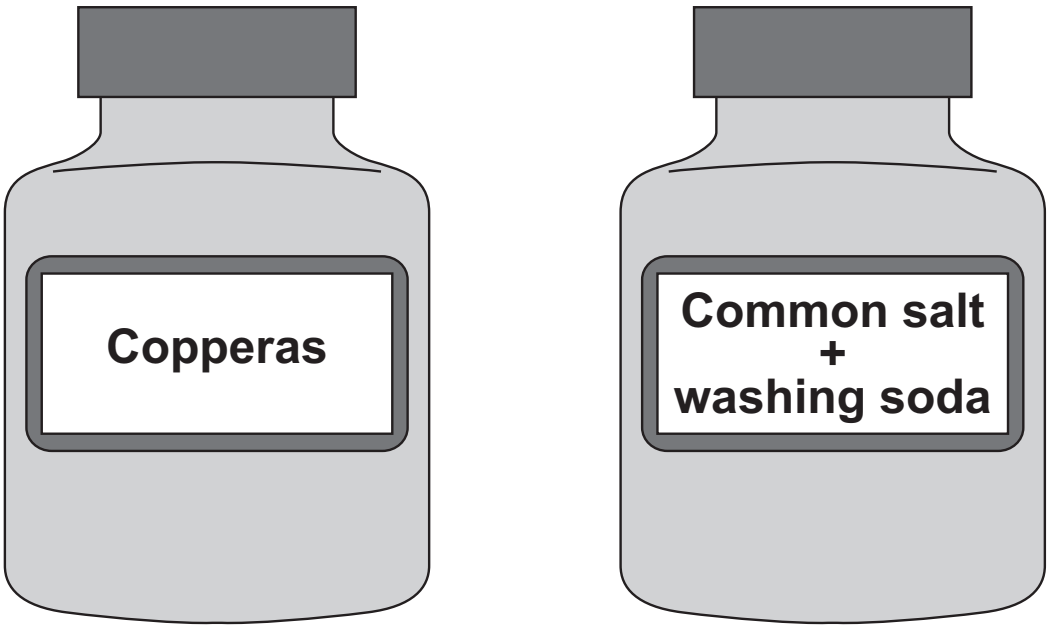
TURN OVER FOR THE NEXT QUESTION

4 **Chemical tests can be used to detect and identify elements and compounds.**

Two jars of chemicals from 1870 are shown.



4 (a) **One jar contains copperas. Copperas was a name used for iron(II) sulfate, $FeSO_4$**
It does not contain any copper!

Describe and give the result of a chemical test to show that a solution of copperas contains:

4 (a) (i) **iron(II) ions, Fe^{2+} [2 marks]**

Test _____

_____

_____

Result _____

_____

_____

4 (a) (ii) sulfate ions, SO_4^{2-} [2 marks]

Test _____

_____

_____

Result_____

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[Question 4 continues on the next page]

4 (b) The other jar contained a mixture of common salt (sodium chloride, NaCl) and washing soda (sodium carbonate, Na_2CO_3).

To show that the mixture contains chloride ions, silver nitrate solution ($AgNO_3$) and nitric acid (HNO_3) are added. A white precipitate is produced.

$$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$$

4 (b) (i) The carbonate ions in the mixture will affect the test for chloride ions.

Use the equations to explain why carbonate ions affect the test for chloride ions AND how nitric acid overcomes this problem. [2 marks]

$$AgCl(s) + HNO_3(aq) \longrightarrow \text{no reaction}$$

$$2AgNO_3(aq) + Na_2CO_3(aq) \longrightarrow Ag_2CO_3(s) + 2NaNO_3(aq)$$

$$Ag_2CO_3(s) + 2HNO_3(aq) \longrightarrow 2AgNO_3(aq) + H_2O(l) + CO_2(g)$$

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4 (b) (ii) Hydrochloric acid (HCl) should NOT be used instead of nitric acid when testing for chloride ions with silver nitrate solution.

Suggest why. [1 mark]

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7

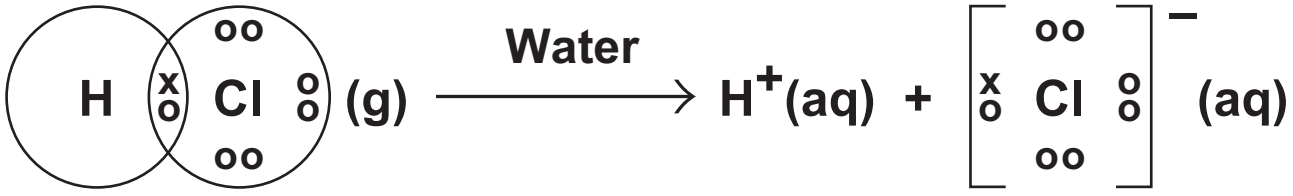
[Turn over for the next question]

5 In 1884 Svante Arrhenius put forward ideas to explain acid-base behaviour. It was many years before his ideas were accepted. In 1903 he was awarded the Nobel Prize for Chemistry.

Use the ideas of Arrhenius to answer parts (a) and (b).

5 (a) Hydrogen chloride solution is called hydrochloric acid. It is made by dissolving hydrogen chloride gas in water.

An equation which represents this reaction is:



hydrogen chloride hydrochloric acid

Explain why [2 marks]

- a solution of hydrogen chloride in water is acidic
- dry hydrogen chloride gas is NOT acidic.

5 (b) The equation below represents the reaction between potassium hydroxide solution and dilute hydrochloric acid:

$$KOH(aq) + HCl(aq) \longrightarrow KCl(aq) + H_2O(l)$$

5 (b) (i) Explain why potassium hydroxide solution, KOH(aq), is a strong alkali. [2 marks]

5 (b) (ii) Explain why potassium chloride solution, KCl(aq), is neutral. [1 mark]

5 (c) **In 1923, Johannes Brønsted and Thomas Lowry extended Arrhenius' ideas on acids and bases. Their ideas were quickly accepted.**

5 (c) (i) **What is Brønsted and Lowry's definition of a base? [1 mark]**

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5 (c) (ii) **Suggest why the ideas of Brønsted and Lowry were accepted more quickly than those of Arrhenius. [1 mark]**

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7

6 Sodium chloride (common salt) can be made from chlorine.

When a student read that chlorine gas is poisonous, the student concluded that sodium chloride must also be poisonous.

6 (a) Use your knowledge of chlorine and sodium chloride to explain why this conclusion is NOT correct. [2 marks]

6 (b) Suggest under what circumstances sodium chloride (common salt) could be harmful. [1 mark]

3

7 **When a known mass of a hydrocarbon was completely burned in oxygen, 17·6 g of carbon dioxide and 7·2 g of water were the only products.**

Relative formula masses (M_r):
CO_2 = 44; H_2O = 18.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answers to calculate the empirical formula of this hydrocarbon.
[3 marks]

You must show your working to gain full marks.

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The empirical formula of this hydrocarbon is

_____

3

END OF QUESTIONS

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For Examiner's Use	
Examiner's Initials	
Question	Mark
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2	
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6	
7	
TOTAL	

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