Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Secondary Education
Higher Tier
June 2010

Chemistry

CHY3H

Unit Chemistry C3

H

Wednesday 26 May 2010 9.00 am to 9.45 am

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

You may use a calculator.

Time allowed
- 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- 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.

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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.

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(2 marks)

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

Use the information in the table to explain why.

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(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.

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(2 marks)

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

State **one** way these ions can be removed.

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(1 mark)

6

Turn over for the next question

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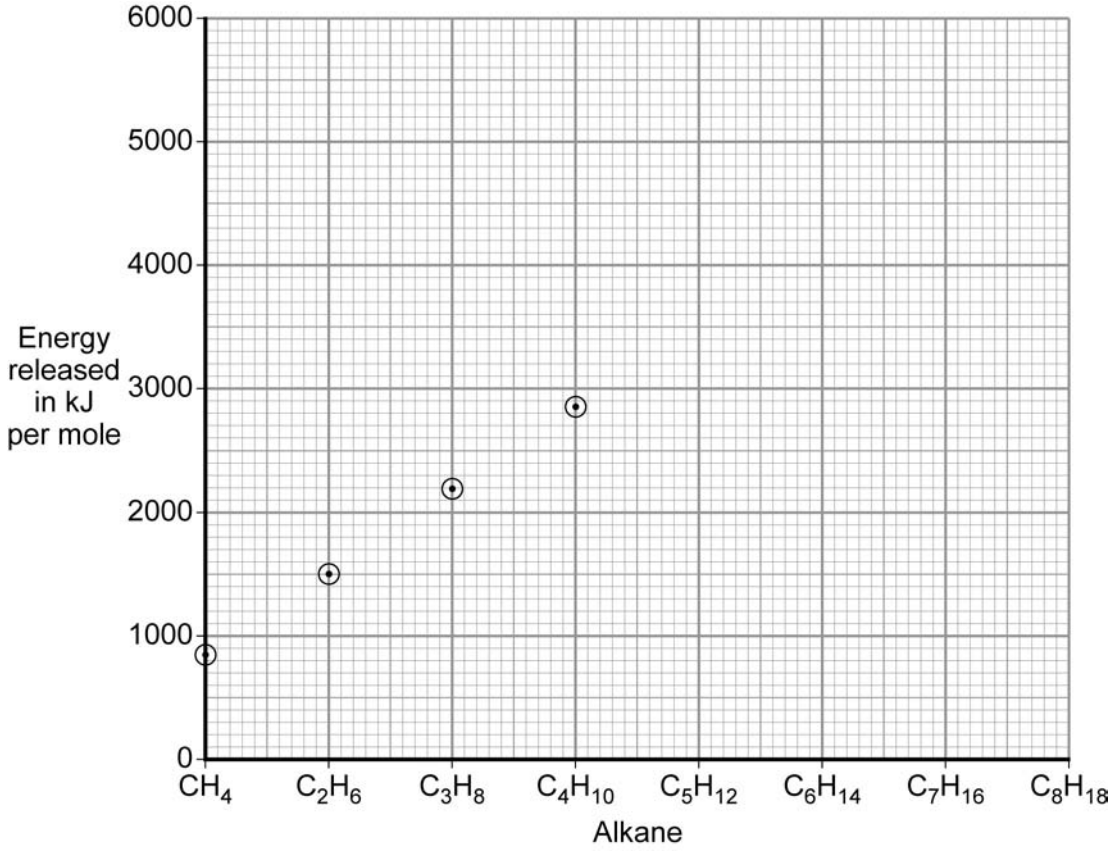
2 (a) Alkanes are important hydrocarbon fuels. They have the general formula C_nH_{2n+2}

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.

Energy released = ... kJ
(1 mark)

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

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(1 mark)

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.

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(2 marks)

Question 2 continues on the next page

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

			Combustion products			
Fuel	**Type**	**Heat released in kJ per g**	**CO_2**	**SO_2**	**H_2O**	**Type of flame**
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."

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(2 marks)

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

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(2 marks)

9

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Turn over for the next question

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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.

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(3 marks)

3 (a) (ii) Complete **and** balance the equation for the reaction of sodium with water.

.....Na + ...H_2O → ..... + H_2

(2 marks)

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

Explain why in terms of electronic structure.

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(3 marks)

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

Give **two** of these different properties of transition elements.

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2 .....

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(2 marks)

10

Turn over for the next question

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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+}

Test .....

.....

Result .....

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(2 marks)

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

Test .....

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Result .....

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(2 marks)

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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.

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

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.

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

$$2AgNO_3\ (aq) + Na_2CO_3\ (aq) \rightarrow \underset{\text{white}}{Ag_2CO_3\ (s)} + 2NaNO_3\ (aq)$$

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

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(2 marks)

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.

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(1 mark)

7

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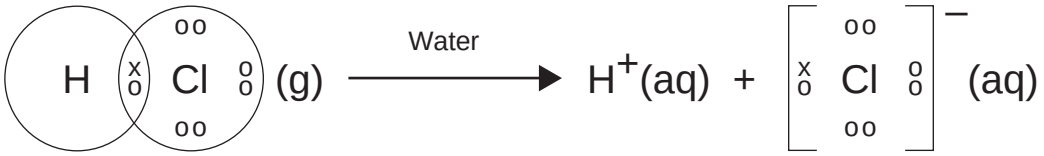
5 In 1884 Svante Arrhenius put forward ideas to explain acid-base behaviour. It was many years before his ideas were accepted. In 1903 he was awarded the Nobel Prize for Chemistry.

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:



Explain why

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

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(2 marks)

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

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

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

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(2 marks)

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

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(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?

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(1 mark)

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

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(1 mark)

7

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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.

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(2 marks)

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

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(1 mark)

3

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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.

You must show your working to gain full marks.

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The empirical formula of this hydrocarbon is .....

(3 marks)

3

END OF QUESTIONS

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