Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Secondary Education
June 2008

ADDITIONAL SCIENCE
Unit Chemistry C2

CHY2H

H

CHEMISTRY
Unit Chemistry C2

Higher Tier

Thursday 5 June 2008 9.00 am to 9.45 am

For this paper you must have:
- 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. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 45.
- The marks for questions are shown in brackets.
- 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.

For Examiner's Use			
Question	Mark	Question	Mark
1		3	
2		4	
		5	
		6	
		7	
		8	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.

Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2.

1 (a) Calculate the relative formula mass (M_r) of SnF_2.
Relative atomic masses: F = 19; Sn = 119

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Relative formula mass (M_r) = ...
(2 marks)

1 (b) Calculate the percentage by mass of fluorine in SnF_2.

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Percentage by mass of fluorine = ... %
(2 marks)

1 (c) A tube of toothpaste contains 1.2 g of SnF_2.

Calculate the mass of fluorine in this tube of toothpaste.

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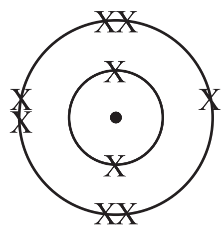
Mass of fluorine = ... g

(1 mark)

1 (d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion, F^-.

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(2 marks)

7

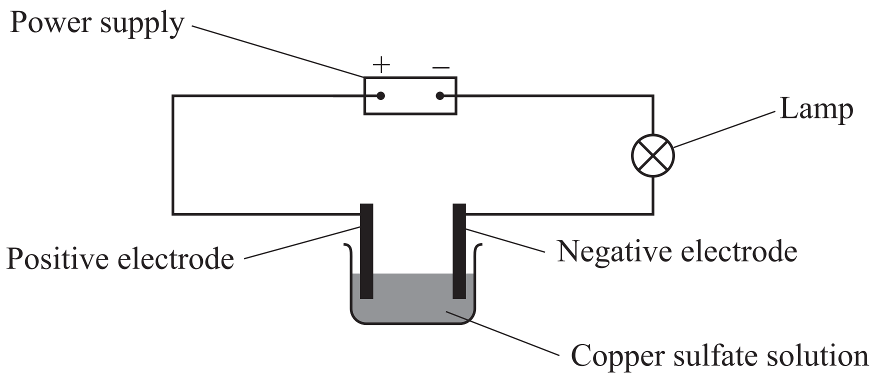
Turn over for the next question

Turn over ▶

2 A student investigated the electrolysis of copper sulfate solution.
The student's method is shown in the box.

Two clean pieces of copper were weighed. One piece was used as the positive electrode and the other piece was used as the negative electrode.

The circuit was set up as shown in the diagram.



After the electrolysis, the pieces of copper were:

- washed with distilled water
- washed with propanone (a liquid with a lower boiling point than water)
- allowed to dry
- weighed.

2 (a) Explain why the electrode would dry faster when washed with propanone instead of water.

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(1 mark)

2 (b) The student's results are given in the table.

	Positive electrode	**Negative electrode**
mass of electrode before electrolysis, in grams	16.41	15.46
mass of electrode after electrolysis, in grams	16.10	15.75

The mass of the positive electrode decreased by 0.31 g.

2 (b) (i) What is the change in mass of the negative electrode? .... g

(1 mark)

2 (b) (ii) The mass lost by the positive electrode should equal the mass gained by the negative electrode.

Suggest **two** reasons why the results were **not** as expected.

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(2 marks)

2 (c) Describe and explain how electrolysis is used to make pure copper from a lump of impure copper.

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(4 marks)

8

Turn over for the next question

3 Copper sulfate ($CuSO_4$) is a salt that has many uses.

An aqueous solution of copper sulfate can be made by reacting copper oxide (CuO) with an acid.

3 (a) (i) Name this acid. ....

(1 mark)

3 (a) (ii) Write a balanced symbol equation, including state symbols, for this reaction.

....

(2 marks)

3 (b) Copper oxide reacts much faster with acid at 40 ºC than at 20 ºC.

Explain why in terms of particles.

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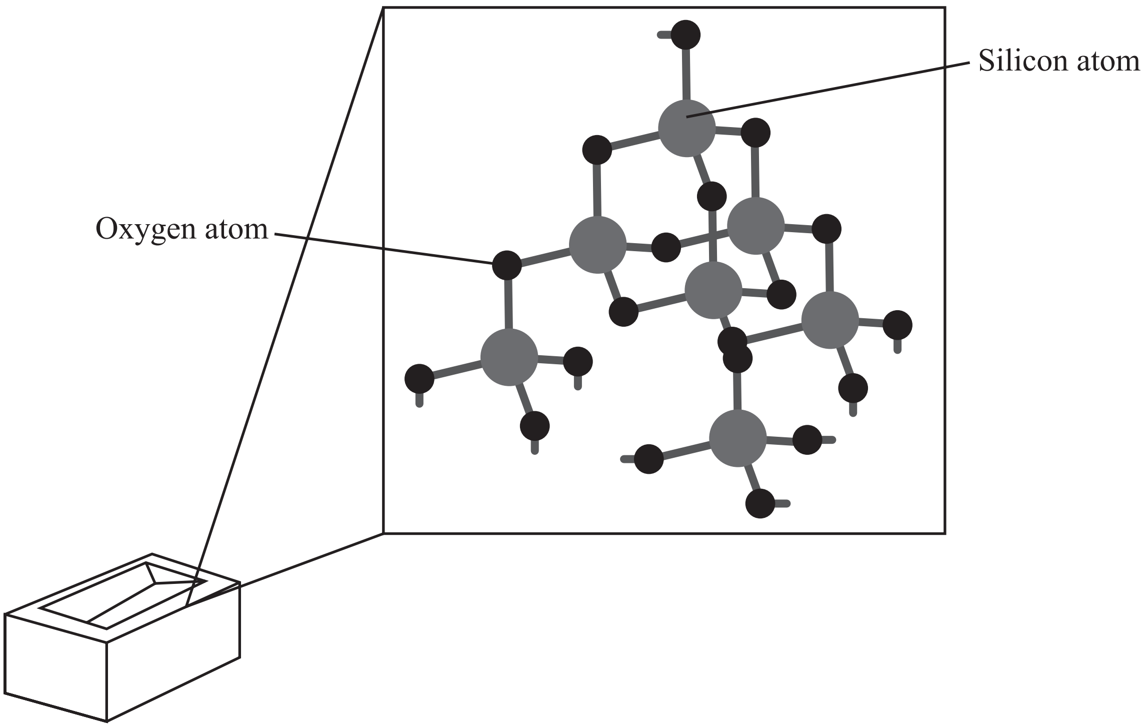
(2 marks)

5

4 Bricks made from silica (silicon dioxide) are used to line furnaces that operate at high temperatures.

Part of the structure of silica is shown in the diagram.



Suggest and explain why silica is used to make bricks for high-temperature furnaces.
In your answer, you should refer to the structure of, and bonding in, silica.

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(4 marks)

4

Turn over ▶

Areas outside the box will not be scanned for marking

5 Cosmetic powders were widely used in ancient Egypt.

Cosmetic powders that may have been used in face paints have been analysed. These powders contained compounds that are rare in nature. The compounds must have been made by the ancient Egyptians using chemical reactions.

5 (a) One of these compounds is called phosgenite.
Analysis of this compound shows that it contains:

76.0% lead (Pb) 13.0% chlorine (Cl) 2.2% carbon (C) 8.8% oxygen (O)

Calculate the empirical formula of this compound.

To gain full marks you must show all your working.

Relative atomic masses: C = 12 ; O = 16 ; Cl = 35.5 ; Pb = 207

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(4 marks)

5 (b) Another compound that the ancient Egyptians used is laurionite.

The reaction used to make laurionite can be represented by this equation:

$PbO(s) + NaCl(aq) + H_2O(1) \rightarrow PbOHCl(s) + NaOH(aq)$

(PbOHCl(s): laurionite)

5 (b) (i) Explain why the pH of the solution increases as the reaction takes place.

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(1 mark)

5 (b) (ii) How could laurionite be separated from the other product when the reaction is complete?

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(1 mark)

6

Turn over ▶

6 Read the article about the use of nanoparticles in sun creams.

Sun creams

Many sun creams use nanoparticles. These sun creams are very good at absorbing radiation, especially ultraviolet radiation. Owing to the particle size, the sun creams spread more easily, cover better and save money because you use less. The new sun creams are also transparent, unlike traditional sun creams which are white. The use of nanoparticles is so successful that they are now used in more than 300 sun cream products.

Some sun creams contain nanoparticles of titanium oxide. Normal-sized particles of titanium oxide are safe to put on the skin. For this reason some chemical companies have assumed that nanoparticles of titanium oxide are also safe without doing further testing.

It is thought that nanoparticles can pass through the skin and travel around the body more easily than normal-sized particles. It is also thought that nanoparticles might be toxic to some types of cell, such as skin, bone, brain and liver cells.

6 (a) Explain why nanoparticles pass through the skin and travel around the body more easily than normal-sized particles of titanium oxide.

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(2 marks)

6 (b) Explain why sun creams containing nanoparticles should be tested further.

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(1 mark)

6 (c) Suggest why some companies that make sun creams might not want to do more tests.

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(2 marks)

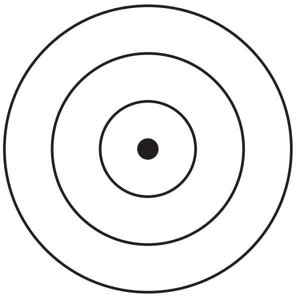
5

Areas outside the box will not be scanned for marking

7 Aluminium is a useful metal.

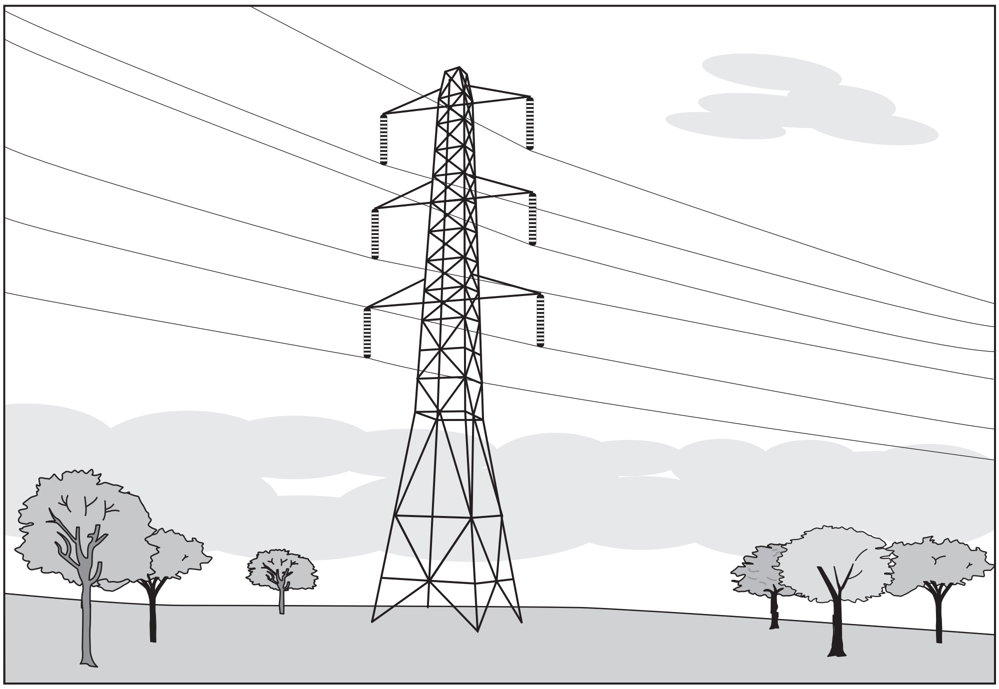
7 (a) The atomic number (proton number) of aluminium is 13.

Complete the diagram to show the electronic structure of an aluminium atom.
Use crosses (x) to represent the electrons.



(1 mark)

7 (b) Aluminium is used as the electrical conductor for overhead power cables.



Explain why metals are good conductors of electricity.

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(2 marks)

3

Turn over ▶

Areas outside the box will not be scanned for marking

8 Epoxyethane has the formula C_2H_4O. It is used to make antifreeze and some types of plastic.

When choosing a method of making a chemical, it is important to consider:

- the percentage yield
- the atom economy.

Epoxyethane can be made from ethene by two different methods. The overall equation for each method is shown below.

Method 1

$$\underset{\text{ethene}}{C_2H_4} + Cl_2 + Ca(OH)_2 \rightarrow \underset{\text{epoxyethane}}{C_2H_4O} + CaCl_2 + H_2O$$

Method 2

$$\underset{\text{ethene}}{2C_2H_4(g)} + O_2(g) \xrightleftharpoons{\text{catalyst}} \underset{\text{epoxyethane}}{2C_2H_4O(g)}$$

8 (a) The table gives the relative formula masses (M_r) of the reactants and products for **Method 1**.

Formula of reactant or product	**Relative formula mass (*M*r)**
H_2O	18
C_2H_4	28
C_2H_4O	44
Cl_2	71
$Ca(OH)_2$	74
$CaCl_2$	111

The percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{Total } M_r \text{ of all reactants added together}} \times 100\%$$

The percentage atom economy for **Method 2** is 100%.

8 (a) Calculate the percentage atom economy for **Method 1**.

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(2 marks)

8 (b) **Method 2** has the higher atom economy.

Suggest why this is an advantage.

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(2 marks)

8 (c) State and explain how an increase in pressure would affect the equilibrium yield of epoxyethane using **Method 2**.

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(2 marks)

8 (d) One problem with **Method 2** is that ethene can also react with oxygen to make carbon dioxide and water.

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

How might this reaction affect the percentage yield of epoxyethane?

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(1 mark)

7

END OF QUESTIONS

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Data Sheet

1. Reactivity Series of Metals

Potassium	most reactive
Sodium	↑
Calcium	
Magnesium	
Aluminium	
Carbon	
Zinc	
Iron	
Tin	
Lead	
Hydrogen	
Copper	
Silver	
Gold	↓
Platinum	least reactive

(elements in italics, though non-metals, have been included for comparison)

2. Formulae of Some Common Ions

Positive ions

Name	Formula
Hydrogen	H^{+}
Sodium	Na^{+}
Silver	Ag^{+}
Potassium	K^{+}
Lithium	Li^{+}
Ammonium	NH_4^{+}
Barium	Ba^{2+}
Calcium	Ca^{2+}
Copper(II)	Cu^{2+}
Magnesium	Mg^{2+}
Zinc	Zn^{2+}
Lead	Pb^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Aluminium	Al^{3+}

Negative ions

Name	Formula
Chloride	Cl^{-}
Bromide	Br^{-}
Fluoride	F^{-}
Iodide	I^{-}
Hydroxide	OH^{-}
Nitrate	NO_3^{-}
Oxide	O^{2-}
Sulfide	S^{2-}
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}

Turn over ▶

3. The Periodic Table of Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Cu and **Cl** have not been rounded to the nearest whole number.