Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Secondary Education
January 2009

ADDITIONAL SCIENCE
Unit Chemistry C2

CHY2H

H

CHEMISTRY
Unit Chemistry C2

Higher Tier

Thursday 15 January 2009 1.30 pm to 2.15 pm

For this paper you must have:
- 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. 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		4	
2		5	
3		6	
		7	
		8	
		9	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 Iron is an essential part of the human diet. Iron(II) sulfate is sometimes added to white bread flour to provide some of the iron in a person's diet.

1 (a) The formula of iron(II) sulfate is $FeSO_4$

Calculate the relative formula mass (M_r) of $FeSO_4$

Relative atomic masses: O = 16; S = 32; Fe = 56.

.....

.....

The relative formula mass (M_r) = ... *(2 marks)*

1 (b) What is the mass of one mole of iron(II) sulfate? Remember to give the unit.

.....

(1 mark)

1 (c) What mass of iron(II) sulfate would be needed to provide 28 grams of iron? Remember to give the unit.

.....

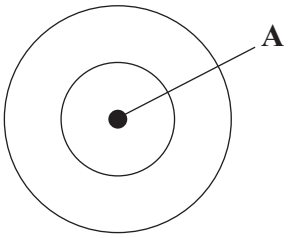
(1 mark)

4

2 This question is about oxygen atoms. The periodic table on the Data Sheet may help you to answer this question.

2 (a) (i) Oxygen atoms have 8 electrons.

Complete the diagram to represent the arrangement of electrons in an oxygen atom.
Use crosses (×) to represent the electrons.



(1 mark)

2 (a) (ii) Name the part of the oxygen atom that is labelled **A** on the diagram.

.....

(1 mark)

2 (b) Two isotopes of oxygen are oxygen-16 and oxygen-18.

$^{16}_{8}O$ $^{18}_{8}O$

oxygen-16 **oxygen-18**

Explain, in terms of particles, how the nucleus of an oxygen-18 atom is different from the nucleus of an oxygen-16 atom.

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(2 marks)

4

3 Read the information below and then answer the questions that follow.

It was once thought that organic compounds could be made only in living organisms. The living organisms were assumed to have a special life force. This life force allowed them to make organic compounds.

Urea is an organic compound produced in animals. It is found in urine. In 1828, Friedrich Wöhler made urea from chemicals which were not obtained from living things.

Other famous scientists still believed in the idea of a life force. Wöhler made another organic compound in 1845. Most scientists then stopped believing that a life force was needed to make organic compounds.

3 (a) How did Wöhler prove that a life force is **not** needed to make organic compounds?

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(1 mark)

3 (b) Suggest why in 1828 most scientists continued to believe that a life force was needed to produce an organic compound.

.....

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(1 mark)

3 (c) Suggest why in 1845 most scientists stopped believing that a life force was needed to make an organic compound.

.....

.....

(1 mark)

3 (d) Some scientists repeated Wöhler's experiment.

These scientists used lead nitrate as one of their starting materials.

Lead nitrate solution can be made by reacting lead with an acid.

3 (d) (i) Give the name of this acid. .....

(1 mark)

3 (d) (ii) State how solid lead nitrate can be obtained from lead nitrate solution.

.....

.....

(1 mark)

3 (e) The equations below show two methods of making urea.

Method 1 (Wöhler's method)

$$Pb(NO_3)_2 + 2KCNO + 2NH_3 + 2H_2O \rightarrow 2KNO_3 + Pb(OH)_2 + 2(NH_2)_2CO$$

urea

Method 2 (The modern industrial method)

$$2NH_3 + CO_2 \rightarrow (NH_2)_2CO + H_2O$$

urea

Method **2** has a higher atom economy than method **1**.

Use information from the equations to explain why.

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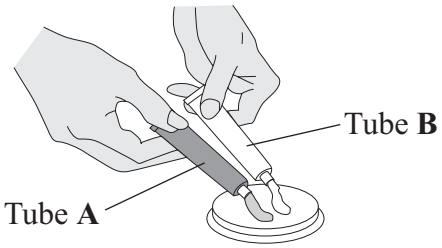
(2 marks)

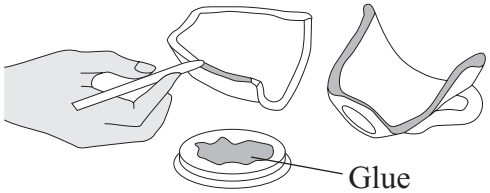
7

4 The following steps show how to use a type of glue.

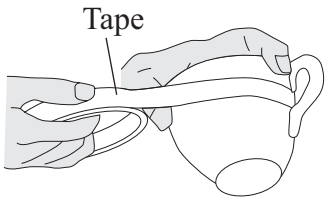
Step 1 Measure out equal amounts of the liquids from tubes **A** and **B**.



Step 2 Mix the liquids to make the glue.
Put a thin layer of the glue onto each of the surfaces to be joined.



Step 3 Assemble the pieces to be joined and then hold them together with tape.



Step 4 Leave the glue to set.

4 (a) When liquids **A** and **B** are mixed a chemical reaction takes place.

4 (a) (i) This reaction is exothermic.

State how the temperature of the mixture will change as the glue is mixed.

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(1 mark)

4 (a) (ii) When the glue sets it forms a giant covalent structure.

Explain why substances with giant covalent structures have high melting points.

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(2 marks)

4 (b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

Explain, in terms of particles, why increasing the temperature changes the rate of the reaction which causes the glue to set.

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(2 marks)

5

5 Read the article and then answer the questions.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air.

'Nanocoated' tennis balls have a *nanosize* layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly.

5 (a) What is the meaning of *nanosize*?

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(1 mark)

5 (b) Suggest why using 'nanocoated' tennis balls would be good for the environment.

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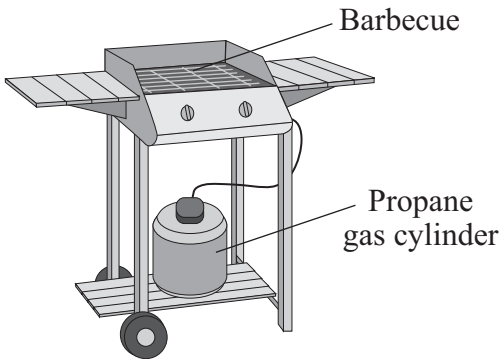
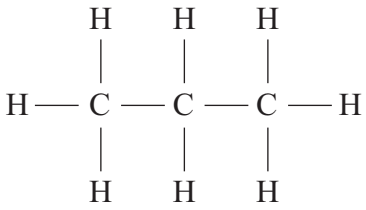
(2 marks)

3

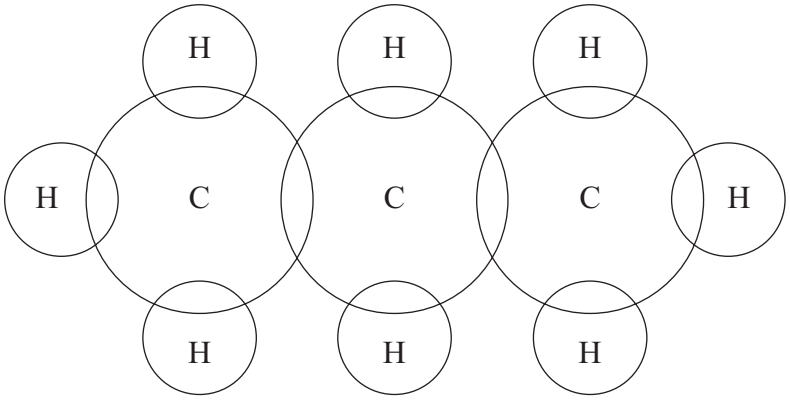
6 This barbecue burns propane gas.



The structure of propane is shown below.



6 (a) Complete the diagram to show how the outer energy level (shell) electrons of hydrogen and carbon are arranged in a molecule of propane.

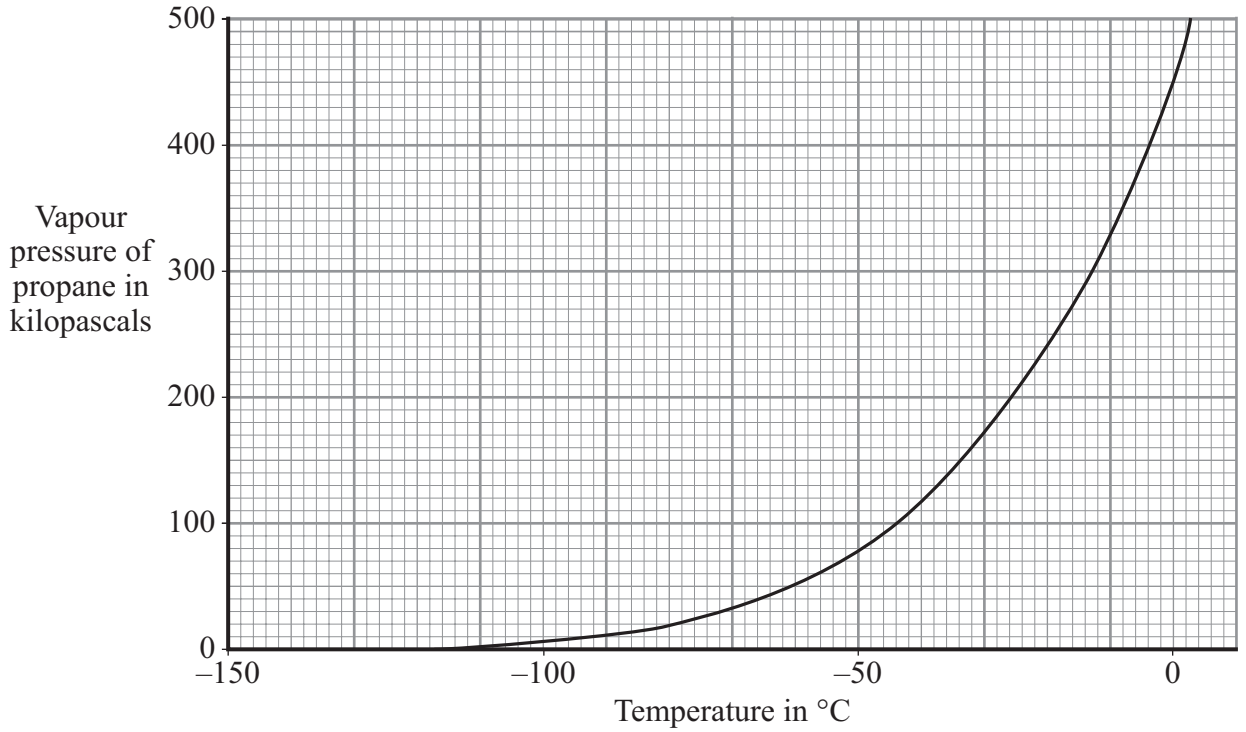


(1 mark)

Question 6 continues on the next page

6 (b) The graph shows how the vapour pressure of propane changes with temperature.

The vapour pressure of a liquid is the pressure of the vapour above the liquid.



6 (b) (i) Describe, as fully as you can, how the vapour pressure of propane changes with temperature.

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(2 marks)

6 (b) (ii) The boiling point of a liquid is the temperature at which its vapour pressure is equal to the air pressure above the liquid.

Use the graph to find the boiling point of propane when the air pressure is 100 kilopascals.

Boiling point ..... °C

(1 mark)

6 (c) Explain, in terms of molecules, why propane has a low boiling point.

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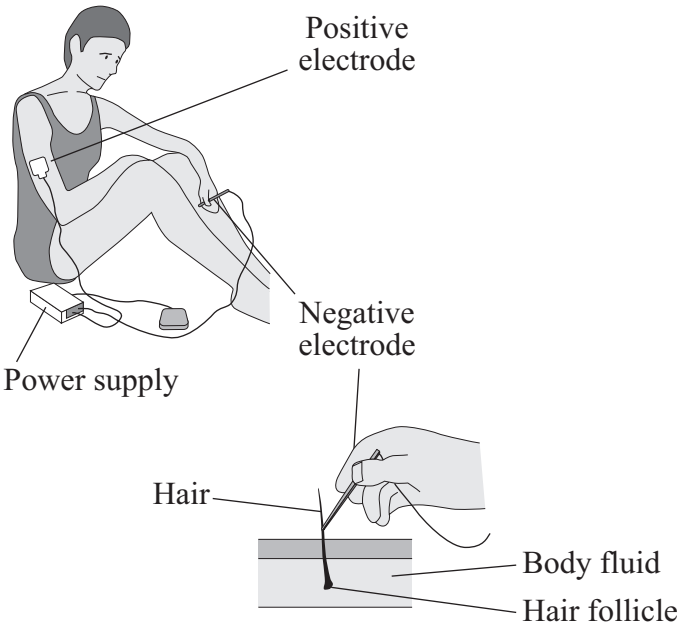
(2 marks)

6

Turn over for the next question

7 Electrolysis can be used to remove unwanted hair from the skin.



The hair is first coated with a layer of gel containing ions in solution.

The positive electrode is connected by a patch to the skin.

The negative electrode is connected to the hair. Electricity flows through the gel and causes electrolysis of the body fluid around the hair follicle.

7 (a) Metal wires conduct electricity to the electrodes.

Explain how metals conduct electricity.

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(2 marks)

7 (b) Explain why the gel containing ions in solution can conduct electricity.

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(1 mark)

7 (c) The body fluid is a solution that contains sodium chloride. The electricity causes the electrolysis of a small amount of this solution.

This solution contains hydrogen ions that move to the negative electrode.

7 (c) (i) The half equation represents the reaction at the negative electrode.

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

Explain why this reaction is a reduction.

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.....

(1 mark)

7 (c) (ii) As a result of the electrolysis of sodium chloride solution, an alkali forms which kills the hair follicle.

What is the name of this alkali? .....

(1 mark)

7 (c) (iii) Complete the half equation for the reaction at the positive electrode.

$$Cl^- \rightarrow Cl_2$$

(1 mark)

6

Turn over for the next question

8 Aspirin tablets have important medical uses.

A student carried out an experiment to make aspirin. The method is given below.

1. Weigh 2.00 g of salicylic acid.
2. Add 4 cm^3 of ethanoic anhydride (an excess).
3. Add 5 drops of concentrated sulfuric acid.
4. Warm the mixture for 15 minutes.
5. Add ice cold water to remove the excess ethanoic anhydride.
6. Cool the mixture until a precipitate of aspirin is formed.
7. Collect the precipitate and wash it with cold water.
8. The precipitate of aspirin is dried and weighed.

8 (a) The equation for this reaction is shown below.

$$\underset{\text{salicylic acid}}{C_7H_6O_3} + C_4H_6O_3 \rightarrow \underset{\text{aspirin}}{C_9H_8O_4} + CH_3COOH$$

Calculate the maximum mass of aspirin that could be made from 2.00 g of salicylic acid.

The relative formula mass (M_r) of salicylic acid, $C_7H_6O_3$, is 138

The relative formula mass (M_r) of aspirin, $C_9H_8O_4$, is 180

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.....

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.....

Maximum mass of aspirin = ... g

(2 marks)

8 (b) The student made 1.10 g of aspirin from 2.00 g of salicylic acid.

Calculate the percentage yield of aspirin for this experiment.

(If you did not answer part (a), assume that the maximum mass of aspirin that can be made from 2.00 g of salicylic acid is 2.50 g. This is **not** the correct answer to part (a).)

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Percentage yield of aspirin = ... %

(2 marks)

8 (c) Suggest **one** possible reason why this method does **not** give the maximum amount of aspirin.

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(1 mark)

8 (d) Concentrated sulfuric acid is a catalyst in this reaction.

Suggest how the use of a catalyst might reduce costs in the industrial production of aspirin.

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(1 mark)

6

Turn over for the next question

9 Methanol is a fuel that is used in some racing cars instead of petrol.

Methanol can be made from carbon monoxide and hydrogen. The equation for this reaction is shown below.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

9 (a) A high pressure (between 50 and 100 atmospheres) is used in this process.

Explain why the highest equilibrium yield of methanol is obtained at high pressure.

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(1 mark)

9 (b) The temperature used in this process is about 250 °C.

It has been stated that, 'the use of this temperature is a compromise between the equilibrium yield of product and the rate of reaction'.

Explain this statement.

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(3 marks)

4

END OF QUESTIONS

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