| Centre Number | | | | | | Candidate Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surname | | | | | | | | | | |
| Other Names | | | | | | | | | | |
| Candidate Signature | | | | | | | | | | |

| For Examiner's Use | |
|---|---|
| Examiner's Initials | |
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
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| 6 | |
| 7 | |
| TOTAL | |

AQA

General Certificate of Secondary Education
Higher Tier
January 2012

# Additional Science
**Unit Chemistry C2**

**CHY2H**

**H**

# Chemistry
**Unit Chemistry C2**

**Written Paper**

**Thursday 26 January 2012 9.00 am to 9.45 am**

**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. 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.

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

**1** Read the information.

> Alumina is a white solid. In 1800, scientists thought that alumina contained an undiscovered metal. We now call this metal aluminium. At that time, scientists could not extract the aluminium from alumina.
>
> In 1825, Christian Oersted, a Danish scientist, did experiments with alumina.
>
> **Step 1** He reacted a mixture of hot alumina and carbon with chlorine to form aluminium chloride. The reaction is very endothermic.
>
> **Step 2** The aluminium chloride was reacted with potassium. He was left with potassium chloride and tiny particles of aluminium metal.
>
> Other scientists were **not** able to obtain the same results using his experiment and his work was not accepted at that time.
>
> In 1827, Friedrich Wöhler, a German chemist, made some changes to Oersted's experiment. He obtained a lump of aluminium. He tested the aluminium and recorded its properties.

**1 (a)** Suggest why scientists in 1800 could not extract aluminium from alumina.

.....

.....

*(1 mark)*

**1 (b)** Oersted's experiment in 1825 was **not** thought to be reliable.

Explain why.

.....

.....

*(1 mark)*

**1 (c)** Why must the reaction in **Step 1** be heated to make it work?

.....

.....

*(1 mark)*

**1 (d)** Complete the word equation for the reaction in **Step 2**.

aluminium chloride + potassium → ..... + .....

*(1 mark)*

**1 (e)** Suggest how Wöhler was able to prove that he had made a new metal.

.....

.....

.....

.....

*(2 marks)*

6

**Turn over for the next question**

**2** Some students investigated magnesium oxide.

**2 (a)** Magnesium oxide has the formula MgO.

**2 (a) (i)** Calculate the relative formula mass ($M_r$) of magnesium oxide.

Relative atomic masses: O = 16; Mg = 24.

.....

.....

Relative formula mass = .....

*(2 marks)*

**2 (a) (ii)** Calculate the percentage by mass of magnesium in magnesium oxide.

.....

.....

Percentage by mass of magnesium in magnesium oxide = .....%

*(2 marks)*

**2 (a) (iii)** Calculate the mass of magnesium needed to make 25 g of magnesium oxide.

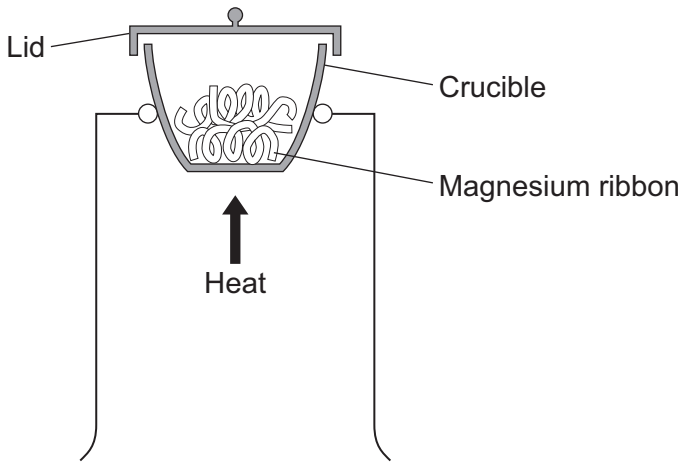
.....

Mass of magnesium = ..... g

*(1 mark)*

**2 (b)** The students calculated that if they used 0.12 g of magnesium they should make 0.20 g of magnesium oxide.

They did this experiment to find out if this was correct.



- The students weighed 0.12 g of magnesium ribbon into a crucible.
- They heated the magnesium ribbon.
- They lifted the lid of the crucible slightly from time to time to allow air into the crucible.
- The students tried to avoid lifting the lid too much in case some of the magnesium oxide escaped.
- When all of the magnesium appeared to have reacted, the students weighed the magnesium oxide produced.

The results of the experiment are shown below.

| | |
|---|---|
| Mass of magnesium used in grams | 0.12 |
| Mass of magnesium oxide produced in grams | 0.18 |

**2 (b) (i)** The mass of magnesium oxide produced was lower than the students had calculated. They thought that this was caused by experimental error.

Suggest **two** experimental errors that the students had made.

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.....

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*(2 marks)*

**2 (b) (ii)** The students only did the experiment once.

Give **two** reasons why they should have repeated the experiment.

.....

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.....

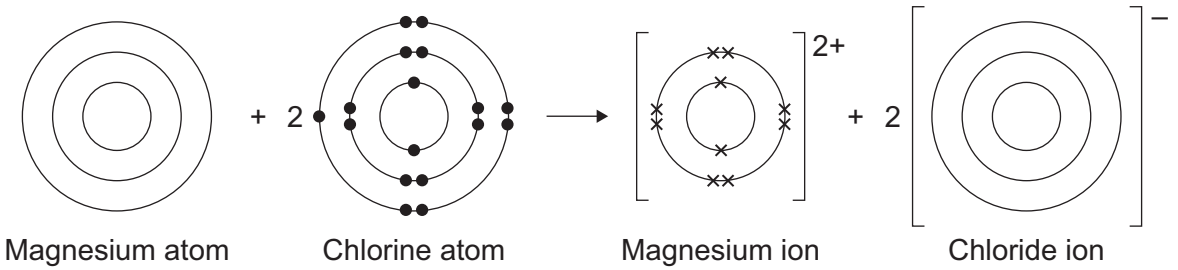
.....

*(2 marks)*

**9**

**3** Magnesium reacts with chlorine to make the ionic compound called magnesium chloride.

**3 (a)** Complete the diagram by adding the electronic structures of the magnesium atom and the chloride ion.




Magnesium atom Chlorine atom Magnesium ion Chloride ion

*(2 marks)*

**3 (b)** Magnesium metal can be extracted from sea water.
Sea water contains magnesium chloride, $MgCl_2$

**3 (b) (i)** Calcium hydroxide, $Ca(OH)_2$, is added to the sea water.
Magnesium hydroxide, $Mg(OH)_2$, is produced.

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

Name a method that could be used to separate magnesium hydroxide from the solution.

.....

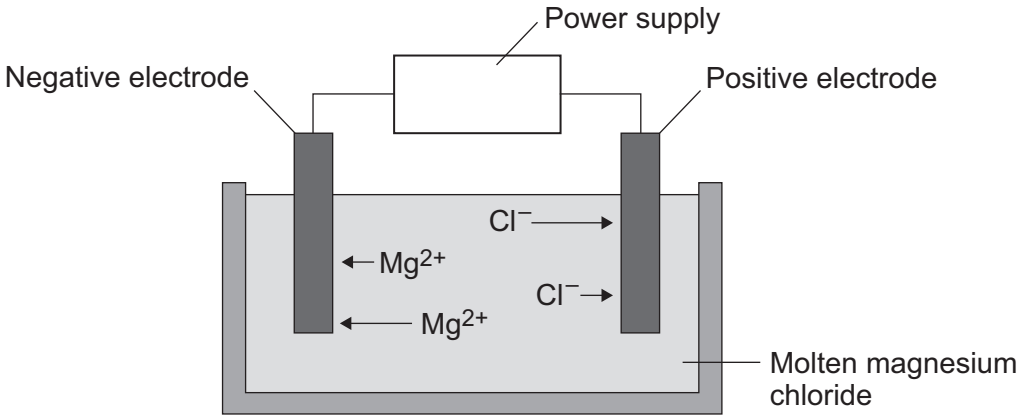
*(1 mark)*

**3 (b) (ii)** An acid is then added to the magnesium hydroxide to make magnesium chloride.

Name this acid. .....

*(1 mark)*

**3 (c)** Electrolysis is used to extract magnesium metal from magnesium chloride.




**3 (c) (i)** Why must the magnesium chloride be molten?

.....

.....

*(1 mark)*

**3 (c) (ii)** The equation shows the reaction that takes place at the positive electrode.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Why is this reaction an oxidation reaction?

.....

*(1 mark)*

**3 (c) (iii)** Complete the equation for the reaction at the negative electrode.

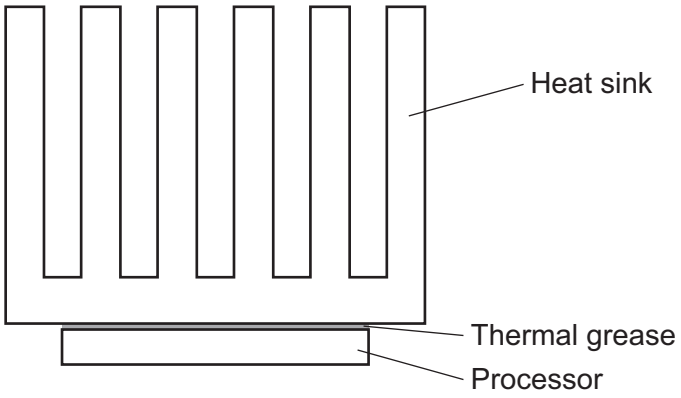
$$Mg^{2+} \rightarrow Mg$$

*(1 mark)*

7

**Turn over for the next question**

**4** The diagram shows how a heat sink is placed on top of a processor in a computer. The heat sink is a large piece of metal which conducts heat away from the processor. If the processor gets too hot it may be damaged.




**4 (a) (i)** Describe the structure of a metal.

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*(3 marks)*

**4 (a) (ii)** Why are metals very good conductors of heat?

.....

.....

*(1 mark)*

**4 (b)** When viewed under a microscope, it can be seen that the surfaces of the processor and the heat sink that are in contact are not flat.
There are lots of tiny gaps between the two surfaces.
The gaps contain air, which does not conduct heat very well.
Thermal grease is used to fill the gaps between the processor and the heat sink to improve the transfer of heat from the processor to the heat sink.

One type of thermal grease contains nanosized particles of silver.
The manufacturer claims that the nanosized particles help to transfer heat better than normal sized particles.

**4 (b) (i)** How are nanosized particles different from normal sized particles?

.....

.....

*(1 mark)*

**4 (b) (ii)** Suggest **one** reason why nanosized particles of silver might help to transfer heat better than normal sized particles.

.....

.....

*(1 mark)*

6

**Turn over for the next question**

**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

**5** The picture shows a painting which was painted in a cave in France about 17 000 years ago.

One of the pigments in this painting contains:

70 % of iron (Fe) and 30 % of oxygen (O)

Calculate the simplest (empirical) formula of this substance.

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

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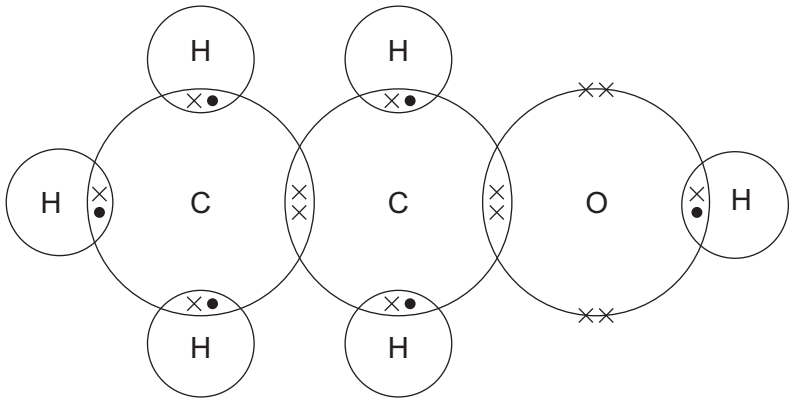
*(4 marks)*

4

**Turn over for the next question**

**6** Ethanol, $C_2H_5OH$, is used as a solvent.

**6 (a)** The diagram represents the arrangement of electrons in a molecule of ethanol.

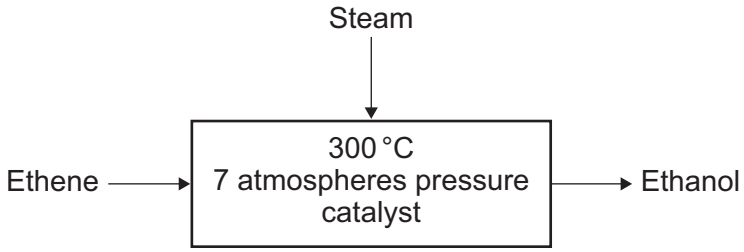



State the type of bonding between the atoms in an ethanol molecule.

.....

*(1 mark)*

**6 (b)** Ethanol can be made by the reaction of ethene with steam.




The equation for this reaction is shown below.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The forward reaction is exothermic.

**6 (b) (i)** Why does an increase in pressure increase the yield of ethanol at equilibrium?

.....

.....

.....

*(1 mark)*

**6 (b) (ii)** Why does an increase in temperature decrease the yield of ethanol at equilibrium?

.....

.....

*(1 mark)*

**6 (c)** As the pressure increases, the rate of reaction increases.

Explain why.

.....

.....

.....

.....

*(2 marks)*

**6 (d)** Ethanol has a low boiling point and evaporates easily.

Explain why.

.....

.....

.....

.....

*(2 marks)*

7

**Turn over for the next question**

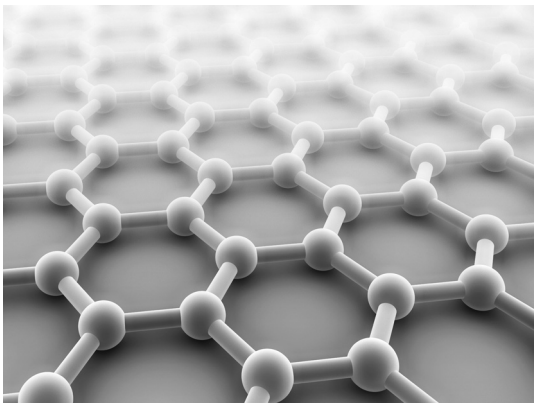
**7** Scientists have recently developed a method to produce large sheets of a substance called graphene.
Graphene is made from carbon and is a single layer of graphite just one atom thick.

The properties of graphene include:

- it conducts electricity
- it is transparent since it is only one atom thick
- it is strong and durable.

These properties make it suitable to overlay a monitor screen to make it a touchscreen.

The photograph below shows the structure of graphene.



Source: photograph © PASIEKA / Science Photo Library

Use your knowledge of the bonding in graphite and the photograph of the structure to help you to explain, as fully as you can:

**7 (a) (i)** why graphene is strong;

.....

.....

.....

.....

.....

.....

*(3 marks)*

**7 (a) (ii)** why graphene conducts electricity.

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*(2 marks)*

**7 (b)** Suggest why a sheet of graphite which has a large number of carbon layers would not be suitable for the touchscreen.

.....

.....

*(1 mark)*

6

**END OF QUESTIONS**

**There are no questions printed on this page**

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**ANSWER IN THE SPACES PROVIDED**

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