GCSE ADDITIONAL SCIENCE CHEMISTRY
Higher Tier Unit Chemistry C2

Wednesday 15 June 2016 Afternoon Time allowed: 1 hour

Materials
For this paper you must have:
• a ruler
• the Chemistry Data Sheet (enclosed).
You may use a calculator.

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 60.
• You are expected to use a calculator where appropriate.
• You are reminded of the need for good English and clear presentation in your answers.
• Question 2(d) should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
• In all calculations, show clearly how you work out your answer.
1 This question is about temperature changes.

1 (a) A student investigated the temperature change when 8 g of sodium nitrate dissolves in 50 cm$^3$ of water.

Figure 1 shows the apparatus the student used.

![Figure 1](image)

The student did the experiment five times. Table 1 shows the results.

Table 1

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Decrease in temperature of water in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>3</td>
<td>7.2</td>
</tr>
<tr>
<td>4</td>
<td>5.6</td>
</tr>
<tr>
<td>5</td>
<td>5.8</td>
</tr>
</tbody>
</table>
1 (a) (i) Calculate the mean decrease in temperature. Do not use the anomalous result in your calculation. 

Mean decrease in temperature = _____________ °C

1 (a) (ii) Suggest one change in the apparatus in Figure 1 which would improve the accuracy of the results. Give a reason for your answer.

Question 1 continues on the next page
The student investigated the temperature change when different masses of sodium carbonate were added to 50 cm³ of water at 20 °C.

Table 2 shows the results.

<table>
<thead>
<tr>
<th>Mass of sodium carbonate in g</th>
<th>Final temperature of solution in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>21.5</td>
</tr>
<tr>
<td>4.0</td>
<td>23.0</td>
</tr>
<tr>
<td>6.0</td>
<td>24.5</td>
</tr>
<tr>
<td>8.0</td>
<td>26.0</td>
</tr>
<tr>
<td>10.0</td>
<td>26.6</td>
</tr>
<tr>
<td>12.0</td>
<td>26.6</td>
</tr>
<tr>
<td>14.0</td>
<td>26.6</td>
</tr>
</tbody>
</table>

Describe the relationship between the mass of sodium carbonate added and the final temperature of the solution.

Use values from Table 2 in your answer.

[3 marks]
This question is about ammonia and fertilisers.

2 (a) Ammonia is produced by a reversible reaction.

The equation for the reaction is:

\[ \text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 \]

Complete the sentence.

The forward reaction is exothermic, so the reverse reaction is ____________________ .

2 (b) Calculate the percentage by mass of nitrogen in ammonia (\(\text{NH}_3\)).

Relative atomic masses (\(A_r\)): H = 1; N = 14

You must show how you work out your answer.

[3 marks]

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Percentage by mass of nitrogen = ____________________ %
2 (c) A neutral solution can be produced when ammonia reacts with an acid.

2 (c) (i) Give the pH of a neutral solution. [1 mark]

\[ \text{pH } \] ______________

2 (c) (ii) Which of these ionic equations shows a neutralisation reaction? [1 mark]

Tick (\(\checkmark\)) one box.

\[ \text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} \] \(\square\)

\[ \text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_4\text{OH} \] \(\square\)

\[ \text{H}^+ + \text{Cl}^- \rightarrow \text{HCl} \] \(\square\)

\[ \text{H}^+ + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ \] \(\square\)

2 (c) (iii) Name the salt produced when ammonia reacts with hydrochloric acid. [1 mark]

_______________________________________

Question 2 continues on the next page
2 (d) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Farmers use ammonium nitrate as a fertiliser for crops.

Rainwater dissolves ammonium nitrate in the soil.

Some of the dissolved ammonium nitrate runs off into rivers and lakes.

**Figure 2** shows three graphs A, B and C. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

**Figure 2**

**Graph A**

Crop yield in kg per hectare

Mass of ammonium nitrate in kg per hectare

**Graph B**

Profit in £ per hectare

Mass of ammonium nitrate in kg per hectare

**Graph C**

Mass of ammonium nitrate running off in kg per hectare

Mass of ammonium nitrate in kg per hectare
Suggest how much ammonium nitrate farmers should use per hectare.
Give reasons for your answer.
Use information from graphs A, B and C.

[6 marks]

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Turn over for the next question
3 This question is about atoms, molecules and nanoparticles.

3 (a) Different atoms have different numbers of sub-atomic particles.

3 (a) (i) An oxygen atom can be represented as $^{16}_8 O$

Explain why the mass number of this atom is 16.

You should refer to the numbers of sub-atomic particles in the nucleus of the atom. [2 marks]

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3 (a) (ii) Explain why $^{12}_6 C$ and $^{14}_6 C$ are isotopes of carbon.

You should refer to the numbers of sub-atomic particles in the nucleus of each isotope. [3 marks]

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3 (b) Hydrogen atoms and oxygen atoms chemically combine to produce water molecules.

3 (b) (i) Complete Figure 3 to show the arrangement of the outer shell electrons of the hydrogen and oxygen atoms in a molecule of water.

Use dots (●) or crosses (×) to represent the electrons. [2 marks]

![Figure 3](image)

3 (b) (ii) Name the type of bonding in a molecule of water. [1 mark]

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3 (b) (iii) Why does pure water **not** conduct electricity? [1 mark]

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3 (c) Nanoparticles of cobalt oxide can be used as catalysts in the production of hydrogen from water.

3 (c) (i) How does the size of a nanoparticle compare with the size of an atom? [1 mark]

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3 (c) (ii) Suggest one reason why 1 g of cobalt oxide nanoparticles is a better catalyst than 1 g of cobalt oxide powder. [1 mark]

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Turn over
A student investigated the effect of temperature on the rate of a reaction. **Figure 4** shows an experiment.

The student:
- put sodium thiosulfate solution into a conical flask
- heated the sodium thiosulfate solution to the required temperature
- put the flask on a cross drawn on a piece of paper
- added dilute hydrochloric acid and started a stopclock
- stopped the stopclock when the cross could no longer be seen
- repeated the experiment at different temperatures.

The equation for the reaction is:

\[
\text{Na}_2\text{S}_2\text{O}_3(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{g}) + \text{S(s)}
\]

<table>
<thead>
<tr>
<th>sodium thiosulfate</th>
<th>hydrochloric acid</th>
<th>sodium chloride</th>
<th>water</th>
<th>sulfur dioxide</th>
<th>sulfur</th>
</tr>
</thead>
</table>

**Figure 4**

Add dilute acid and start timing

Sodium thiosulfate solution

A cross drawn on paper

Cloudy solution

Before reaction

After reaction
4 (a) Explain why the solution goes cloudy. [2 marks]

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4 (b) Give two variables the student must control to make the investigation a fair test. [2 marks]

1  ________________________________________________________________________________
2  ________________________________________________________________________________

4 (c) State the effect that increasing the temperature of the sodium thiosulfate solution has
on the rate of the reaction. Explain this effect in terms of particles and collisions. [4 marks]

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4 (d) Suggest how the student should change the method to investigate the rate of
reaction at 5 °C. [1 mark]

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Turn over ➤
This question is about magnesium and magnesium chloride.

(a) Magnesium chloride contains magnesium ions (Mg\(^{2+}\)) and chloride ions (Cl\(^-\)).

Describe, in terms of electrons, what happens when a magnesium atom reacts with chlorine atoms to produce magnesium chloride.

[4 marks]
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(b) Magnesium chloride can be electrolysed. **Figure 5** shows two experiments for electrolysing magnesium chloride.

**Figure 5**

**Experiment 1**
- d.c. power supply
- Positive electrode
- Negative electrode
- Heat
- Molten magnesium chloride

**Experiment 2**
- d.c. power supply
- Positive electrode
- Negative electrode
- Magnesium chloride dissolved in water
5 (b) (i) Explain why magnesium chloride must be molten or dissolved in water to be electrolysed.  

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5 (b) (ii) Explain how magnesium is produced at the negative electrode in Experiment 1.  

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5 (b) (iii) In Experiment 2 a gas is produced at the negative electrode.  
Name the gas produced at the negative electrode.  

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5 (b) (iv) Suggest why magnesium is not produced at the negative electrode in Experiment 2.  

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Question 5 continues on the next page
5 (b) (v) Complete and balance the half equation for the reaction at the positive electrode. [1 mark]

\[ \underline{\text{____ Cl}^-} \rightarrow \text{Cl}_2 + \underline{\text{____}} \]

5 (c) Magnesium is a metal. Explain why metals can be bent and shaped. [2 marks]

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This question is about the properties and uses of materials. Use your knowledge of structure and bonding to answer the questions.

6 (a) Explain how copper conducts electricity. [2 marks]

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6 (b) Explain why diamond is hard. [2 marks]

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6 (c) Explain why thermosetting polymers are better than thermosoftening polymers for saucepan handles. [2 marks]

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END OF QUESTIONS
There are no questions printed on this page