GCSE (9–1) Chemistry A (Gateway Science)
J248/03 Paper 3 (Higher Tier)
Sample Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 45 minutes

You must have:
• the Data Sheet
You may use:
• a scientific or graphical calculator
• a ruler

INSTRUCTIONS
• Use black ink. You may use an HB pencil for graphs and diagrams.
• Complete the boxes above with your name, centre number and candidate number.
• Answer all the questions.
• Write your answer to each question in the space provided.
• Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
• Do not write in the bar codes.

INFORMATION
• The total mark for this paper is 90.
• The marks for each question are shown in brackets [ ].
• Quality of extended response will be assessed in questions marked with an asterisk (*).
• This document consists of 28 pages.
2

SECTION A

Answer all the questions.

You should spend a maximum of 30 minutes on this section.

1  Tim is separating the colours in a sample of black ink using paper chromatography. He puts a spot of black ink onto filter paper. He dips the filter paper into ethanol in a beaker.

What is the name given to ethanol in this experiment?

A  gas phase  
B  mobile phase  
C  solid phase  
D  stationary phase  

Your answer

2  Look at Tim’s chromatogram.

What is the R_f value of the green spot? Use a ruler to help you.

A  0.17  
B  0.42  
C  0.83  
D  1.00  

Your answer
3  What is the best description of the particles in a liquid?

<table>
<thead>
<tr>
<th>Distance between particles</th>
<th>Movement of particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  close together</td>
<td>in continuous random motion</td>
</tr>
<tr>
<td>B  close together</td>
<td>vibrating about a fixed point</td>
</tr>
<tr>
<td>C  far apart</td>
<td>in continuous random motion</td>
</tr>
<tr>
<td>D  far apart</td>
<td>vibrating about a fixed point</td>
</tr>
</tbody>
</table>

Your answer  

[1]

4  The molecular formula of decene is C\textsubscript{10}H\textsubscript{20}.

What is the empirical formula of decene?

A  CH\textsubscript{2}       
B  C\textsubscript{2}H\textsubscript{4}  
C  C\textsubscript{5}H\textsubscript{10}  
D  C\textsubscript{20}H\textsubscript{40}  

Your answer  

[1]
5 Hardeep does some experiments with acids and alkalis.
He measures the pH of a sample of acid and a sample of alkali.
He adds magnesium metal to a sample of the acid and to a sample of the alkali.
What results should Hardeep expect?

<table>
<thead>
<tr>
<th>Results for acid experiments</th>
<th>Results for alkali experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A pH below 7 no reaction with magnesium</td>
<td>pH above 7 magnesium fizzes</td>
</tr>
<tr>
<td>B pH below 7 magnesium fizzes</td>
<td>pH above 7 no reaction with magnesium</td>
</tr>
<tr>
<td>C pH above 7 magnesium fizzes</td>
<td>pH above 7 no reaction with magnesium</td>
</tr>
<tr>
<td>D pH above 7 no reaction with magnesium</td>
<td>pH below 7 magnesium fizzes</td>
</tr>
</tbody>
</table>

Your answer [1]

6 Rosa tests some compounds to find out if they conduct electricity.
Which row in the table shows the correct results for each compound?

<table>
<thead>
<tr>
<th>Solid ionic compound</th>
<th>Ionic compound dissolved in water</th>
<th>Molten ionic compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>A conducts</td>
<td>does not conduct</td>
<td>conducts</td>
</tr>
<tr>
<td>B conducts</td>
<td>conducts</td>
<td>conducts</td>
</tr>
<tr>
<td>C conduct</td>
<td>conducts</td>
<td>does not conduct</td>
</tr>
<tr>
<td>D does not conduct</td>
<td>conducts</td>
<td>conducts</td>
</tr>
</tbody>
</table>

Your answer [1]
7 What is the approximate size of an atom?

A $3 \times 10^{-1}$ metres
B $3 \times 10^5$ metres
C $3 \times 10^9$ metres
D $3 \times 10^{-13}$ metres

Your answer

8 During the electrolysis of molten potassium chloride, what is made at the cathode?

A chlorine
B hydrogen
C potassium
D potassium hydroxide

Your answer

9 Crude oil can be separated in the laboratory into fractions which have different boiling points.

Look at the table. It shows possible relationships between:
- boiling point
- number of carbon atoms in the molecule
- size of intermolecular forces.

Which letter represents the correct relationship between the boiling point, number of carbon atoms and size of intermolecular forces?

<table>
<thead>
<tr>
<th>Boiling point</th>
<th>Number of carbon atoms in the molecule</th>
<th>Size of intermolecular forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>high</td>
<td>more than 50</td>
</tr>
<tr>
<td>B</td>
<td>low</td>
<td>more than 50</td>
</tr>
<tr>
<td>C</td>
<td>high</td>
<td>less than 20</td>
</tr>
<tr>
<td>D</td>
<td>low</td>
<td>less than 20</td>
</tr>
</tbody>
</table>

Your answer
10 Which of these shows the balanced symbol equation for the reaction between potassium and chlorine to make potassium chloride?

A \[ \text{K} + \text{Cl}_2 \rightarrow \text{KCl}_2 \]
B \[ \text{P} + \text{Cl}_2 \rightarrow \text{PCl}_2 \]
C \[ 2\text{K} + \text{Cl}_2 \rightarrow 2\text{KCl} \]
D \[ 2\text{P} + \text{Cl}_2 \rightarrow 2\text{PCl} \]

Your answer [ ]

11 Look at the diagrams.

Which diagram shows a solid with the largest surface area to volume ratio?

A

B

C

D

Your answer [ ]
12 Ann neutralises nitric acid with potassium hydroxide solution.

Which of these shows the ionic equation for neutralisation?

A \[ \text{HNO}_3 \quad + \quad \text{KOH} \quad \rightarrow \quad \text{KNO}_3 \quad + \quad \text{H}_2\text{O} \]

B \[ \text{H}^+ \quad + \quad \text{OH}^- \quad \rightarrow \quad \text{H}_2\text{O} \]

C \[ \text{NO}_3^- \quad + \quad \text{K}^+ \quad \rightarrow \quad \text{KNO}_3 \]

D \[ \text{H}^+ \quad + \quad \text{NO}_3^- \quad \rightarrow \quad \text{HNO}_3 \]

Your answer [ ]

13 A student investigates some acids.

She has a solution of hydrochloric acid of concentration 0.01mol/dm³.

This solution has a pH of 2.

She increases the concentration of hydrochloric acid from 0.01mol/dm³ to 0.1mol/dm³.

What is the pH of this new solution?

A 0

B 1

C 3

D 12

Your answer [ ]

14 Which of these is the best explanation of what is meant by a strong acid?

A There is a large amount of acid and a small amount of water.

B There is a small amount of acid and a large amount of water.

C The acid is completely ionised in solution in water.

D The acid is partially ionised in solution in water.

Your answer [ ]
Look at the diagram.

It shows how the reaction between hydrochloric acid and marble chips (calcium carbonate) can be monitored.

The reading on the balance decreases during the reaction.

Which of these statements is the best explanation?

A. Acid escapes from the flask.
B. A gas called hydrogen is made which leaves the flask.
C. A gas called carbon dioxide is made which leaves the flask.
D. The temperature in the laboratory changes.

Your answer [ ]
10  

SECTION B  

Answer all the questions.

16 Look at the table. It shows information about some atoms and ions.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Atomic number</th>
<th>Mass number</th>
<th>Number of protons</th>
<th>Number of neutrons</th>
<th>Number of electrons</th>
<th>Electronic structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
<td>23</td>
<td>11</td>
<td>...........</td>
<td>11</td>
<td>2.8.1</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>19</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>...........</td>
</tr>
<tr>
<td>C</td>
<td>...........</td>
<td>37</td>
<td>17</td>
<td>...........</td>
<td>17</td>
<td>2.8.7</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>27</td>
<td>...........</td>
<td>...........</td>
<td>10</td>
<td>2.8</td>
</tr>
</tbody>
</table>

(a) Complete the table. [4]

(b) Particle A is a metal atom, particle D is an ion. Explain why.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [2]

(c) Particle C has the electronic structure 2.8.7. What does this tell you about the position of particle C in the Periodic Table? Explain your answer.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [4]
(d) Complete the table below to give information about protons, neutrons and electrons.

<table>
<thead>
<tr>
<th></th>
<th>Charge</th>
<th>Mass in atomic mass units</th>
</tr>
</thead>
<tbody>
<tr>
<td>proton</td>
<td>..........</td>
<td>1</td>
</tr>
<tr>
<td>neutron</td>
<td>..........</td>
<td>..........</td>
</tr>
<tr>
<td>electron</td>
<td>negative</td>
<td>..........</td>
</tr>
</tbody>
</table>

(e) Rutherford was a scientist who helped to develop the atomic model.

State how Rutherford's work contributed to the development of the atomic model.

.............................................................................................................................................
............................................................................................................................................. [1]
(a) The diagrams show the structures of two forms of carbon.

Graphite is a good conductor of electricity.

Diamond does not conduct electricity.

Use ideas about structure and bonding in diamond and graphite to explain these observations.

(b) Carbon can form many thousands of different compounds.

Two examples are shown below.

Why can carbon form many thousands of different compounds?

………………………………………………………………………………………………………

……………………………………………………………………………………………….. [1]
(c) Ethanol contains carbon.

Look at some information about ethanol.

**Melting point** = -114°C

**Boiling point** = 78°C

Predict the state of ethanol at 25°C. How can you tell?
Look at the energy profile for a reaction.

(a) What can you deduce about this reaction?

Include the quantities A and B and a full explanation.

.................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................................. [4]
(b) Look at the equation.

\[
\begin{array}{c}
\text{methane} & \text{oxygen} & \rightarrow & \text{carbon} & \text{dioxide} & \text{water} \\
\text{H} \quad \text{H} \quad \text{C} - \text{H} & \text{O} = \text{O} & \rightarrow & \text{O} = \text{C} & \text{O} & \text{H} \quad \text{H} \\
\text{H} & \text{H} & & & & \\
\end{array}
\]

The table shows the bond energies of the bonds involved.

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-H</td>
<td>435</td>
</tr>
<tr>
<td>O=O</td>
<td>498</td>
</tr>
<tr>
<td>C=O</td>
<td>805</td>
</tr>
<tr>
<td>O-H</td>
<td>464</td>
</tr>
</tbody>
</table>

(i) What type of energy change happens when bonds are broken and when bonds are made?

Bonds broken ......................................

Bonds made ....................................... [2]

(ii) Calculate the energy change for this reaction.

\[\text{Energy change} = \text{………………...} \text{kJ/mol} \] [3]
(c) When propane reacts with oxygen, energy is given out.

Propane gives out 50 kJ/g.

A propane burner is used to boil 200 g of water to make a cup of tea.

The initial temperature of the water is 15°C.

How many grams of propane are needed to heat this water?

Use the following equation:

\[
\text{Energy transferred in } \text{J} = 4.2 \text{ J/g°C} \times \text{mass of water in g} \times \text{temperature change in °C}
\]

Amount of propane = ……………………………. g

[5]

19. Irenka reacts an element, X, with oxygen, O₂.

There is one product. It is the oxide of X i.e. X oxide.

4.86 g of X reacts with 3.20 g of oxygen to make 8.06 g of X oxide.

(a) (i) Calculate the number of moles of X, oxygen and X oxide involved in the reaction.

(The relative atomic mass of X is 24.3 and the relative formula mass of oxygen, O₂, is 32.0 and of X oxide is 40.3.)

Number of moles of X = ……………………………

Number of moles of O₂ = ……………………………

Number of moles of X oxide = ……………………………

[3]

(ii) Use your answers to write the balanced symbol equation for the reaction between X and oxygen to make X oxide.

…………………………………………………………………………………………

[2]
(b) Look at the equation.

It shows the reaction between sodium hydroxide and dilute sulfuric acid.

\[
\text{2NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}
\]

sodium + sulfuric acid \rightarrow sodium sulfate + water

Calculate the mass of sodium hydroxide needed to make 30.0 g of sodium sulfate.

Give your answer to three significant figures.

\[
\text{Mass of sodium hydroxide} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots g \quad [3]
\]
A student is separating a mixture of three substances, **A**, **B** and **C**.

Look at the table. It gives information about these substances.

<table>
<thead>
<tr>
<th>Substance</th>
<th>State at room temperature</th>
<th>Melting point (°C)</th>
<th>Boiling point (°C)</th>
<th>Solubility in water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>liquid</td>
<td>0</td>
<td>100</td>
<td>soluble</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>liquid</td>
<td>-117</td>
<td>78</td>
<td>soluble</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>solid</td>
<td>1535</td>
<td>2750</td>
<td>insoluble</td>
</tr>
</tbody>
</table>

**A** and **B** mix together completely.

(a)* Suggest how the student can separate the mixture to get pure samples of substances **A**, **B** and **C**.

Explain in detail how each method works.
(b) The student has separated a pure sample of substance B from the mixture.

Suggest how the student can check that the sample of substance B is pure.

...........................................................................................................................................................................
...........................................................................................................................................................................
...........................................................................................................................................................................
.................................................................................................................................................................................. [2]
21 Zinc nitrate can be made by reacting zinc oxide with nitric acid, HNO₃.

(a) Write a balanced symbol equation for this reaction.

……………………………………………………………………………………………………………………………... [2]

(b) Paul suggests this method for preparing zinc nitrate.

1. Measure 50cm³ of dilute nitric acid into a beaker.
2. Add one spatulaful of zinc oxide.
3. Heat the mixture until crystals of zinc nitrate are made.

Paul’s method will not make a pure dry sample of zinc nitrate.

What improvements should Paul make to the method to make sure that:
- the reaction is complete
- the zinc nitrate can be separated from the nitric acid and the zinc oxide?

Explain your answer.

……………………………………………………………………………………………………………………………... [4]

(c) Describe why this reaction is a neutralisation reaction.

…………………………………………………………………………………………………………………………………………………... [2]
Magnesium burns in oxygen to make magnesium oxide.

The reaction involves both oxidation and reduction.

\[ 2\text{Mg(s)} + \text{O}_2(\text{g}) \rightarrow 2\text{MgO(s)} \]

\[ \text{magnesium} + \text{oxygen} \rightarrow \text{magnesium oxide} \]

(a) **Complete** the sentence.

During this reaction, the oxidising agent is ………………………. …….. and the reducing agent is ……………………………………. . [1]

(b) Magnesium has an atomic number of 12.

Calculate the mean mass of an atom of magnesium. Quote your answer to three significant figures.

(Avogadro constant = \(6.02 \times 10^{23}\) atoms per mole)

Mean mass ……………………… g [2]
Meena electrolyses copper sulfate using copper electrodes.

Look at the diagram. It shows the apparatus she uses.

She investigates the change in mass at each electrode before and after the electrolysis.

Look at Meena’s method.

1. Using a balance, measure the mass of the copper cathode and copper anode.
2. Set up the apparatus and run the electrolysis for 30 seconds.
3. Remove the copper cathode and the copper anode and immediately place them on the balance and measure their masses again.

(a) What improvements could you make to Meena’s experiment?

Explain your answers.
(b) Meena finds that

- the cathode gains mass
- the anode loses mass.

Explain these observations in terms of the reactions at each electrode.
Look at the diagrams.
They show the structures of two compounds.

(a) Sodium chloride has a melting point of 801°C.
Use the structure of sodium chloride to explain why.
...........................................................................................................................................
...........................................................................................................................................
........................................................................................................................................... [2]

(b) Water has a low melting point and boiling point.
Explain why.
...........................................................................................................................................
...........................................................................................................................................
........................................................................................................................................... [2]
(c) Magnesium oxide has a similar structure to sodium chloride.

Draw 'dot and cross' diagrams to show the ionic bonding in magnesium oxide.

You should include the charges on the ions.

The electronic structure of magnesium is 2.8.2.

The electronic structure of oxygen is 2.6.
A student adds calcium to dilute hydrochloric acid. The mixture begins to fizz.

Write a balanced symbol equation for this reaction.

………………………………………………………………………………………………………….  [2]
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PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: scoris assessor Online Training; OCR Essential Guide to Marking.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the required number of practice responses (“scripts”) and the required number of standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.
5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. ‘can’t do’, ‘don’t know’)
   - OR if there is a mark (e.g. a dash, a question mark) which isn’t an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris comments box is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. Do not use the comments box for any other reason.

   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
10. For answers marked by levels of response:

   Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates’ answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a ‘best-fit’ approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Once the level is located, award the higher or lower mark:

   **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
   **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

   **In summary:**

   The skills and science content determines the level.
   The communication statement determines the mark within a level.

   

SPECIMEN
11. Annotations

<table>
<thead>
<tr>
<th>Annotation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DO NOT ALLOW</strong></td>
<td>Answers which are not worthy of credit</td>
</tr>
<tr>
<td><strong>IGNORE</strong></td>
<td>Statements which are irrelevant</td>
</tr>
<tr>
<td><strong>ALLOW</strong></td>
<td>Answers that can be accepted</td>
</tr>
<tr>
<td>()</td>
<td>Words which are not essential to gain credit</td>
</tr>
<tr>
<td>___</td>
<td>Underlined words must be present in answer to score a mark</td>
</tr>
<tr>
<td><strong>ECF</strong></td>
<td>Error carried forward</td>
</tr>
<tr>
<td><strong>AW</strong></td>
<td>Alternative wording</td>
</tr>
<tr>
<td><strong>ORA</strong></td>
<td>Or reverse argument</td>
</tr>
</tbody>
</table>
12. **Subject-specific Marking Instructions**

**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet *Instructions for Examiners*. If you are examining for the first time, please read carefully *Appendix 5 Introduction to Script Marking: Notes for New Examiners*.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.
The breakdown of Assessment Objectives for GCSE (9–1) in Chemistry A:

<table>
<thead>
<tr>
<th>Assessment Objective</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AO1</strong></td>
<td>Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.</td>
</tr>
<tr>
<td>AO1.1</td>
<td>Demonstrate knowledge and understanding of scientific ideas.</td>
</tr>
<tr>
<td>AO1.2</td>
<td>Demonstrate knowledge and understanding of scientific techniques and procedures.</td>
</tr>
<tr>
<td><strong>AO2</strong></td>
<td>Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.</td>
</tr>
<tr>
<td>AO2.1</td>
<td>Apply knowledge and understanding of scientific ideas.</td>
</tr>
<tr>
<td>AO2.2</td>
<td>Apply knowledge and understanding of scientific enquiry, techniques and procedures.</td>
</tr>
<tr>
<td><strong>AO3</strong></td>
<td>Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.</td>
</tr>
<tr>
<td>AO3.1</td>
<td>Analyse information and ideas to interpret and evaluate.</td>
</tr>
<tr>
<td>AO3.1a</td>
<td>Analyse information and ideas to interpret.</td>
</tr>
<tr>
<td>AO3.1b</td>
<td>Analyse information and ideas to evaluate.</td>
</tr>
<tr>
<td>AO3.2</td>
<td>Analyse information and ideas to make judgements and draw conclusions.</td>
</tr>
<tr>
<td>AO3.2a</td>
<td>Analyse information and ideas to make judgements.</td>
</tr>
<tr>
<td>AO3.2b</td>
<td>Analyse information and ideas to draw conclusions.</td>
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<tr>
<td>AO3.3</td>
<td>Analyse information and ideas to develop and improve experimental procedures.</td>
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<tr>
<td>AO3.3a</td>
<td>Analyse information and ideas to develop experimental procedures.</td>
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<tr>
<td>AO3.3b</td>
<td>Analyse information and ideas to improve experimental procedures.</td>
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<tr>
<td>Question</td>
<td>Answer</td>
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<tr>
<td>1</td>
<td>B</td>
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<tr>
<td>2</td>
<td>C</td>
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<tr>
<td>3</td>
<td>A</td>
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<td>4</td>
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<td>14</td>
<td>C</td>
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<td>15</td>
<td>C</td>
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<td>Question</td>
<td>Answer</td>
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<tr>
<td>16 (a)</td>
<td>Particle</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>D</td>
</tr>
<tr>
<td>(b)</td>
<td>particle A – one electron in outer shell or energy level (1)</td>
</tr>
<tr>
<td></td>
<td>particle D – has more protons than electrons (1)</td>
</tr>
<tr>
<td>(c)</td>
<td>group 7 (1) as 7 electrons in outer shell (1) period 3 (1) as 3 shells occupied (1)</td>
</tr>
<tr>
<td>(d)</td>
<td>Charge</td>
</tr>
<tr>
<td></td>
<td>proton</td>
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<tr>
<td></td>
<td>neutron</td>
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<tr>
<td></td>
<td>electron</td>
</tr>
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<td></td>
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<tr>
<td>(e)</td>
<td>idea of the nuclear atom (1)</td>
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<td>Question</td>
<td>Answer</td>
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<td>------------------------------------------------------------------------</td>
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<tr>
<td>17 (a)</td>
<td><strong>graphite</strong> – has a layered structure (1) electrons can move / electrons between layers or delocalised (1) <strong>diamond</strong> – no free electrons or ions (1)</td>
</tr>
<tr>
<td>(b)</td>
<td>it can bond to itself (and make chains and rings) (1)</td>
</tr>
<tr>
<td>(c)</td>
<td>liquid (1) liquid above -114°C and does not boil until 78°C (1)</td>
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<td>Question</td>
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<tr>
<td>18 (a)</td>
<td>any four from: reaction is exothermic (1) as reactants have more energy than products (1) A is the activation energy (1) activation energy is the amount of energy supplied to get the reaction started (1) B is the energy change for the reaction (1) the value of B is negative (1)</td>
</tr>
<tr>
<td>(b) (i)</td>
<td>bonds broken – endothermic (1) bonds made – exothermic (1)</td>
</tr>
<tr>
<td>(ii)</td>
<td>energy needed to break bonds = 2736 (kJ) (1) energy released when new bonds form = 3466 (kJ) (1) energy change for a reaction = 730 (kJ) given out / - 730 (kJ) (1)</td>
</tr>
<tr>
<td>(c)</td>
<td>energy transferred = 4.2 x 200 x (100 – 15) (1) = 71400 J (1) Mass of fuel needed to boil water (g) = energy needed to boil water (J) / energy per gram 50 kJ = 50000 J (1) = 71400 / 50000 (1) = 1.43 g (1)</td>
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<tr>
<td>Question</td>
<td>Answer</td>
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<tr>
<td>19 (a) (i)</td>
<td>no of moles of X = 0.2 (1) no of moles of oxygen = 0.1 (1) no of moles of X oxide = 0.2 (1)</td>
</tr>
<tr>
<td>19 (a) (ii)</td>
<td>$2X + O_2 \rightarrow 2XO$ (2) formulae (1) balancing (1)</td>
</tr>
<tr>
<td>(b)</td>
<td>16.9 (g) scores (3) <strong>but if answer incorrect then</strong> RFM of NaOH = 40.0 and RFM of Na$_2$SO$_4$ = 142.1 (1) idea that 2 moles of NaOH react to produce 1 mole of Na$_2$SO$_4$ (1)</td>
</tr>
<tr>
<td>Question</td>
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| 20 (a)*  | Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. | 6 | 2 x 1.2 2 x 2.2 2 x 3.3a | AO1.2: Knowledge of process of fractional distillation  
- Use fractional distillation to separate substance A from substance B.  
- Substance B will come off first as it has lowest boiling point.  
- Stronger forces between molecules in substance A / ora.  

AO2.2: Apply knowledge of process of fractional distillation  
- Fractional distillation works as substances A and B have different boiling points.  
- As substance C is insoluble in water.  
- Because there are differing forces of attraction between the molecules.  

AO3.3a: Analyse information in the table to develop experimental procedure  
- Heat mixture to boil off substances A and B leaving pure C.  
- Filter mixture to remove substance C.  
- Substance C can be washed with water and dried. |

Level 3 (5–6 marks)  
Suggestion would enable pure samples of all three components to be obtained in the correct sequence with clear explanations of why the methods work.  
There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.  

Level 2 (3–4 marks)  
Suggestion would enable pure samples of two of the components of the mixture to be obtained with an attempt at an explanation.  
There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.  

Level 1 (1–2 marks)  
Suggestion would enable a pure sample of one of the components to be obtained.  
The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.  

0 marks  
No response or no response worthy of credit.
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
<th>AO element</th>
<th>Guidance</th>
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</table>
| **(b)** | measure its melting point or boiling point (1) if pure melting point or boiling point will be sharp / if impure melting point is lowered / if impure boiling point is elevated (1) | 2 | 1.2 2.1 | balancing mark is conditional on correct formulae
| **21 (a)** | $\text{ZnO} + 2\text{HNO}_3 \rightarrow \text{Zn(NO}_3)_2 + \text{H}_2\text{O}$ correct formulae (1) balancing (1) | 2 | 2.2 | balancing mark is conditional on correct formulae
| | ALLOW any correct multiple e.g. $2\text{ZnO} + 4\text{HNO}_3 \rightarrow 2\text{Zn(NO}_3)_2 + 2\text{H}_2\text{O}$ (2) | | | ALLOW $\Rightarrow$ or $\Leftrightarrow$ or $\leftrightarrow$ for arrow
| | DO NOT ALLOW ‘and’ or & for + | | | ALLOW one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $\text{ZnO} + 2\text{HNO}_3 \rightarrow \text{Zn(NO}_3)_2 + \text{H}_2$ |
| **(b)** | Any four from: idea that an excess of zinc oxide must be added (1) so reaction is complete / all nitric acid is reacted (1) filter off excess zinc oxide (1) evaporate off some of the water (1) allow to crystallise (1) | 4 | 3.3b | |
| **(c)** | reaction between nitric acid (HNO$_3$), an acid and zinc oxide (ZnO), a base (1) to make zinc nitrate (Zn(NO$_3$)$_2$, a salt and water (only) (1) | 2 | 1.1 | Only award marks if reactions and products are named in the answer
<p>| | ALLOW the use of just chemical formulae | | | |</p>
<table>
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<tr>
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<th>Marks</th>
<th>AO element</th>
<th>Guidance</th>
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<tbody>
<tr>
<td>22 (a)</td>
<td>The oxidising agent is <strong>oxygen</strong> and the reducing agent is <strong>magnesium</strong> (1)</td>
<td>1</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>
| (b)      | 24.3 / $6.022 \times 10^{23}$ (1) 
4.04 x $10^{-23}$ (1) | 2     | 2.1        | 1 mark for 4.03520425 x $10^{-23}$ or correctly rounded up but not to 3 sig. fig. |
| 23 (a)   | electrolysis needs to run for longer than 30 seconds (1) 
otherwise insufficient change at electrodes (1) 
after electrolysis anode and cathode need to be washed (1) and then dried (1) before measuring the mass | 4     | 2 x 3.2a   
2 x 3.3b |          |
| (b)      | copper is deposited at the cathode (1) 
copper anode dissolves / copper ions produced at anode (1) | 2     | 1.2        | **ALLOW** higher level answers in terms of half equations 
e.g. at cathode Cu$^{2+}$ +2e$^{-}$ → Cu (1) 
e.g. at anode Cu → Cu$^{2+}$ + 2e$^{-}$ / Cu - 2e$^{-}$ → Cu$^{2+}$ (1) |
<table>
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<th>Guidance</th>
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<tbody>
<tr>
<td>24 (a)</td>
<td>strong electrostatic force of attraction between ions (1) must be broken to melt sodium chloride (1)</td>
<td>2</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>weak intermolecular forces / weak forces between molecules (1) easily broken (1)</td>
<td>2</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>electronic structure of magnesium ion (1) electronic structure of oxide ion (1) charges correct on both ions (1)</td>
<td>3</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>(\text{Ca} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2)</td>
<td>2</td>
<td>1.2</td>
<td>1 mark for both correct reactants 1 mark for both correct products</td>
</tr>
</tbody>
</table>