

Oxford Cambridge and RSA

**Friday 17 May 2024 – Morning**

**GCSE (9–1) Chemistry B (Twenty First Century Science)**

**J258/03 Breadth in Chemistry (Higher Tier)**

**Time allowed: 1 hour 45 minutes**

**You must have:**

- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Chemistry B  
(inside this document)

**You can use:**

- an HB pencil
- a scientific or graphical calculator

**H**

+ . 7 2 5 8 0 3 +

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

Candidate number

First name(s)

Last name

#### INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

#### INFORMATION

- The total mark for this paper is **90**.
- The marks for each question are shown in brackets [ ].
- This document has **24** pages.

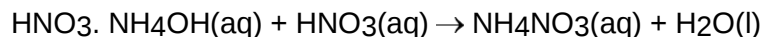
#### ADVICE

- Read each question carefully before you start your answer.

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(c) An example of a synthetic fertiliser is ammonium nitrate,  $\text{NH}_4\text{NO}_3$ .

Ammonium nitrate is produced when ammonium hydroxide,  $\text{NH}_4\text{OH}$ , reacts with nitric acid,



The relative formula masses for the reactants and products are shown in the table.

|                              | $\text{NH}_4\text{OH}$ | $\text{HNO}_3$ | $\text{NH}_4\text{NO}_3$ | $\text{H}_2\text{O}$ |
|------------------------------|------------------------|----------------|--------------------------|----------------------|
| <b>Relative formula mass</b> | 35.0                   | 63.0           | 80.0                     | 18.0                 |

Calculate the atom economy for the formation of  $\text{NH}_4\text{NO}_3$ .

Use the equation:

$$\text{atom economy} = \frac{\text{mass of atoms in desired product}}{100\% \text{ total mass of atoms in reactants}} \times$$

Give your answer to **1** decimal place.

Atom economy = ..... % [4]

8 Fossil fuels are used as energy sources.

(a) Natural gas contains an alkane with the formula CH<sub>4</sub>.

(i) Name this alkane.

..... [1]

(ii) Combustion of natural gas increases the temperature of the surroundings.

Name of the type of reaction that increases the temperature of the surroundings.

..... [1]

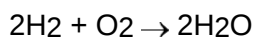
(iii) Incomplete combustion occurs when not enough oxygen is present.

Name **one** pollutant caused by the incomplete combustion of natural gas.

[1]

(b) Hydrogen can also be used as an energy source in a fuel cell.

The balanced symbol equation for the reaction in the hydrogen fuel cell is:



The table shows the bond energies involved in the reaction.

| Bond | Bond energy (kJ) |
|------|------------------|
| O=O  | 498              |
| H—H  | 434              |
| O—H  | 464              |

Calculate:

- the energy needed to break bonds in the reactants
- the energy given out when bonds form in the products
- the overall energy change of the reaction.

Energy needed to break bonds in the reactants = ..... kJ

Energy given out when bonds form in the products = ..... kJ

Overall energy change = ..... kJ

[3]

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The breakdown of Assessment Objectives for GCSE (9-1) in Chemistry B:

|              | <b>Assessment Objective</b>                                                                                                                           |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>AO1</b>   | <b>Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.</b>                                          |
| AO1.1        | Demonstrate knowledge and understanding of scientific ideas.                                                                                          |
| AO1.2        | Demonstrate knowledge and understanding of scientific techniques and procedures.                                                                      |
| <b>AO2</b>   | <b>Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.</b>                                       |
| AO2.1        | Apply knowledge and understanding of scientific ideas.                                                                                                |
| AO2.2        | Apply knowledge and understanding of scientific enquiry, techniques and procedures.                                                                   |
| <b>AO3</b>   | <b>Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.</b> |
| <b>AO3.1</b> | <b>Analyse information and ideas to interpret and evaluate.</b>                                                                                       |
| AO3.1a       | Analyse information and ideas to interpret.                                                                                                           |
| AO3.1b       | Analyse information and ideas to evaluate.                                                                                                            |
| <b>AO3.2</b> | <b>Analyse information and ideas to make judgements and draw conclusions.</b>                                                                         |
| AO3.2a       | Analyse information and ideas to make judgements.                                                                                                     |
| AO3.2b       | Analyse information and ideas to draw conclusions.                                                                                                    |
| <b>AO3.3</b> | <b>Analyse information and ideas to develop and improve experimental procedures.</b>                                                                  |
| AO3.3a       | Analyse information and ideas to develop experimental procedures.                                                                                     |
| AO3.3b       | Analyse information and ideas to improve experimental procedures.                                                                                     |

| Question |     |  | Answer                                                                                                                                   | Marks | AO element                | Guidance                                                                                                                                                                                               |
|----------|-----|--|------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4        | (a) |  | A contains chloride (ions) / $\text{Cl}^-$ (ions) ✓<br>B contains no halide (ions) ✓<br>C contains iodide (ions) / $\text{I}^-$ (ions) ✓ | 3     | 3.2b                      | <b>DO NOT ALLOW</b> contains chlorine ions / iodine ions<br><b>ALLOW</b> no chloride <u>and</u> no bromide <u>and</u> no iodide ions present                                                           |
|          | (b) |  | Silver bromide ✓<br>$\text{AgBr}$ ✓<br>aq and aq ✓                                                                                       | 3     | 1.1<br><br>1.1<br><br>2.1 | <b>DO NOT ALLOW</b> silver bromine<br><b>DO NOT ALLOW</b> 'silver bromide ions'<br><br><b>DO NOT ALLOW</b> numbers added such that equation does not balance<br><b>IGNORE</b> $\text{Ag}^+\text{Br}^-$ |
|          | (c) |  | Contains chloride (ions)/ $\text{Cl}^-$ (ions) / gives (white) precipitate/positive result (with silver nitrate/silver ions) ✓           | 1     | 2.1                       | <b>IGNORE</b> it will react with silver nitrate<br><b>DO NOT ALLOW</b> contains chlorine                                                                                                               |

| Question |     |      | Answer                                                                                                                                               | Marks | AO element | Guidance                                                                                                                                                                                                                                                            |
|----------|-----|------|------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11       | (a) |      |                                                                     | 1     | 1.1        | Judge number by eye<br><br><b>ALLOW</b> particles similar size or smaller<br><b>IGNORE</b> shading/no shading<br>Particles must be single, randomly arranged                                                                                                        |
|          | (b) | (i)  | Strength of acid depends on degree of ionisation/strong acids fully ionise/are more fully ionised ORA ✓                                              | 1     | 1.1        | <b>ALLOW</b> 'how well ionised/ better ionised' etc for degree of ionisation<br><b>ALLOW</b> dissociated for ionised<br><b>IGNORE</b> 'ionised' alone unqualified<br><b>IGNORE</b> references to pH<br><b>IGNORE</b> references to hydrogen ion concentration alone |
|          |     | (ii) | Acid C ✓<br><br>Highest pH/ slowest reaction/longest time to react / pH closest to 7/neutral✓<br><br>so lower <u>concentration</u> of hydrogen ions✓ | 3     | 3.2b       | <b>IGNORE</b> 'it is pH5' unqualified<br><br><b>IGNORE</b> fewer/less hydrogen ions                                                                                                                                                                                 |
|          | (c) | (i)  | (Add a few drops and) <u>colour</u> judged against a chart/pH scale ✓                                                                                | 1     | 1.2        |                                                                                                                                                                                                                                                                     |
|          |     | (ii) | $1.0 \times 10^{-3} \text{ mol dm}^{-3}$ ✓                                                                                                           | 1     | 1.2        |                                                                                                                                                                                                                                                                     |