Oxford Cambridge and RSA

# Monday 19 May 2025 – Morning

## GCSE (9–1) Combined Science A (Gateway Science)

**J250/09** Chemistry (Higher Tier)

**Time allowed: 1 hour 10 minutes**

**H**

**You must have:**
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science A (Chemistry) (inside this document)

**You can use:**
- a scientific or graphical calculator
- an HB pencil

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 **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

**ADVICE**
- Read each question carefully before you start your answer.

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## Section A

You should spend a **maximum** of **20 minutes** on this section.

Write your answer to each question in the box provided.

**1** Which statement describes a **pure** substance?

**A** A mixture of substances which melts at a single temperature.

**B** A mixture of substances which melts over a range of temperatures.

**C** One substance which melts at a single temperature.

**D** One substance which melts over a range of temperatures.

Your answer ☐ **[1]**

**2** Which row describes the **nucleus** of an atom?

| | **Charge** | **Mass** |
|---|---|---|
| **A** | positive | contains little of the mass of the atom |
| **B** | positive | contains most of the mass of the atom |
| **C** | negative | contains little of the mass of the atom |
| **D** | neutral | contains most of the mass of the atom |

Your answer ☐ **[1]**

**3** Which substance is made from rings of carbon atoms?

**A** Carbon monoxide

**B** Copper carbonate

**C** Graphene

**D** Poly(ethene)

Your answer ☐ **[1]**

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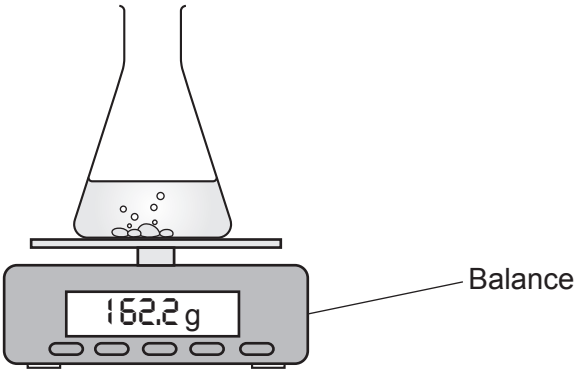
**4** The diagram shows a chemical reaction.




During the reaction the mass on the balance **decreases**.

Which state symbol describes the **product** that causes the mass to decrease?

**A** aq

**B** g

**C** l

**D** s

Your answer ☐ **[1]**

**5** Which statement about how Mendeleev arranged his version of the Periodic Table is **incorrect**?

**A** He arranged elements in order of atomic number.

**B** He arranged elements with similar properties in groups.

**C** He left gaps for undiscovered elements.

**D** He swapped the order of pairs of some elements.

Your answer ☐ **[1]**

**6** Which of these is a **cation**?

**A** $Cl^-$

**B** He

**C** $I_2$

**D** $Na^+$

Your answer ☐ **[1]**

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**7** A student performs a chromatography experiment on a mixture of dyes.

The solvent moves 8.0 cm up the chromatography paper.

The $R_f$ value for one dye is 0.60.

What distance does this dye move up the chromatography paper?

**A** 4.0 cm

**B** 4.8 cm

**C** 6.0 cm

**D** 7.2 cm

Your answer ☐ **[1]**

**8** The reaction of iron, Fe, with copper ions, $Cu^{2+}$, can be written as two half equations.

$Fe \longrightarrow Fe^{2+} + 2e^-$

$Cu^{2+} + 2e^- \longrightarrow Cu$

Which species is **oxidised**?

**A** Cu

**B** Fe

**C** $Cu^{2+}$

**D** $Fe^{2+}$

Your answer ☐ **[1]**

**9** The particle model is used to describe changes of state.

Which statement about the particle model is **correct**?

**A** It takes into account the forces between particles.

**B** It takes into account the size of the particles.

**C** It takes into account the space between the particles.

**D** It represents the particles as inelastic spheres.

Your answer ☐ **[1]**

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**10** How many grams of NaOH are found in 50 $cm^3$ of a 4 g / $dm^3$ solution of NaOH(aq)?

**A** 0.08 g

**B** 0.2 g

**C** 2 g

**D** 80 g

Your answer ☐ **[1]**

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## Section B

**11** A student investigates the reaction of magnesium carbonate and dilute sulfuric acid.

**(a)** The student wants to measure the pH of the dilute sulfuric acid.

**(i)** Suggest the pH of dilute sulfuric acid.

..... **[1]**

**(ii)** Name an indicator that the student could use to measure the pH of dilute sulfuric acid.

State the colour of the indicator after it has been added to the dilute sulfuric acid.

Name of indicator .....

Colour .....
**[2]**

**(iii)** Name a piece of equipment the student could use to measure the pH more accurately.

..... **[1]**

**(b)** When magnesium carbonate reacts with dilute sulfuric acid, it forms a salt, water and carbon dioxide.

What is the name of the salt?

..... **[1]**

**(c)** The student adds an **excess** of magnesium carbonate to dilute sulfuric acid until **no more of it reacts**.

magnesium carbonate(s) + sulfuric acid(aq) → salt(aq) + water(l) + carbon dioxide(g)

Magnesium carbonate is a white powder that is insoluble in water.

A colourless solution of the salt is formed.

Describe **two** observations the student would see as the reaction is happening.

1 .....

.....

2 .....

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

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**(d)** The student separates the salt from the solution formed at the end of the reaction.

| |
|---|
| **Step 1:** They remove the excess magnesium carbonate. |
| **Step 2:** They remove the water from the salt solution. |

State the names of the separation techniques used in Step 1 and Step 2.

Step 1 .....

Step 2 .....
**[2]**

**(e)** The student measures the mass of the salt obtained when different masses of magnesium carbonate are added to the same volume of dilute sulfuric acid.

The table shows their results.

| Mass of magnesium carbonate (g) | Mass of the salt (g) |
|---|---|
| 1.0 | 1.4 |
| 2.0 | 2.9 |
| 3.0 | 4.3 |
| 4.0 | 5.7 |
| 5.0 | 7.1 |
| 6.0 | 7.1 |
| 7.0 | 7.1 |

**(i)** Describe the relationship between the mass of magnesium carbonate and the mass of the salt.

.....

.....

.....

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

**(ii)** A student thinks that when 6.0 g of magnesium carbonate has been added it is in excess.

Explain why the student is **correct**.

.....

..... **[1]**

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**12** Atoms are made from the sub-atomic particles protons, neutrons and electrons.

**(a)** **Table 12.1** shows the relative mass and relative charge of the three sub-atomic particles.

Complete **Table 12.1** by writing the name of a sub-atomic particle in each space.

**Table 12.1**

| Sub-Atomic particle | Relative mass | Relative charge |
|---|---|---|
| ..... | 0.0005 | –1 |
| ..... | 1 | 0 |
| ..... | 1 | +1 |

**[2]**

**(b)** An atom of phosphorus has an atomic number of 15 and a mass number of 31.

Calculate the number of protons, neutrons and electrons in this atom of phosphorus.

Number of protons = .....

Number of neutrons = .....

Number of electrons = .....

**[2]**

**(c)** Phosphorus reacts with oxygen to form an oxide called phosphorus trioxide.

Phosphorus trioxide has the molecular formula $P_4O_6$.

**(i)** What is the empirical formula of phosphorus trioxide?

Tick (✓) **one** box.

PO ☐

$P_2O_3$ ☐

$P_4O_6$ ☐

**[1]**

**(ii)** Complete the **balanced symbol** equation for the reaction of phosphorus trioxide with water.

$$P_4O_6 + \text{.....}H_2O \rightarrow \text{.....}H_3PO_3$$

**[2]**

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**(iii)** **Table 12.2** shows the melting point and boiling point of phosphorus trioxide.

**Table 12.2**

| Melting point (°C) | Boiling point (°C) |
|---|---|
| 24 | 173 |

In the box draw the particle arrangement for phosphorus trioxide at 100 °C.

Use ◯ to represent each particle.

**[1]**

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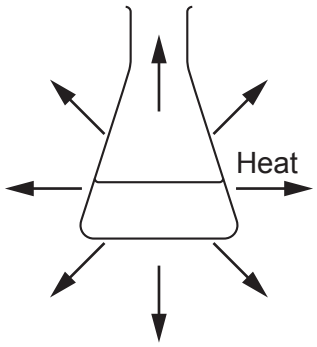
**13*** The boxes show three pieces of information about a reaction.

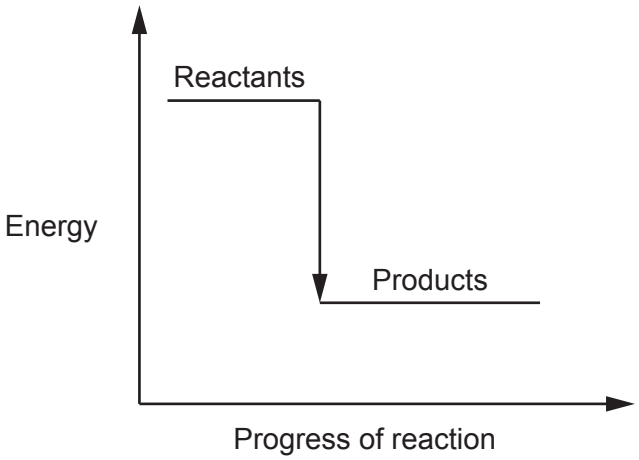
**1**




**2**

| Temperature at start of reaction (°C) | Final temperature of reaction (°C) |
|---|---|
| 20 | 42 |

**3**

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State whether the reaction is exothermic or endothermic.

Explain your answer using information from each box.

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..... **[6]**

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**14** The properties of materials depend on their structure and bonding.

**(a)** The table shows some information about four materials.

| Material | Appearance at room temperature | Melting point (°C) | Does it dissolve in water? | Does it conduct heat? | Does it conduct electricity? | Does it react with acids? |
|---|---|---|---|---|---|---|
| **A** | a grey-black solid | 3600 | no | yes | yes | no |
| **B** | a flexible white solid | 166 | no | no | no | no |
| **C** | a silver-grey solid | 1538 | no | yes | yes | yes |
| **D** | a white solid | 770 | yes | no | when molten | no |

Draw **four** lines to connect each **material** with its correct **structure**.

**Material**

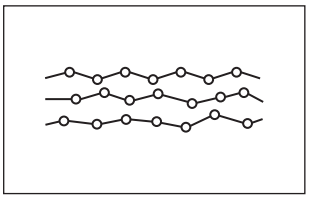
**A**

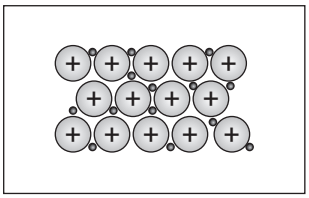
**B**

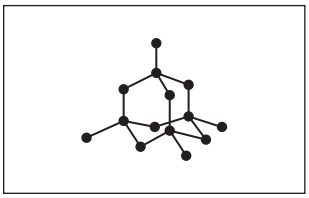
**C**

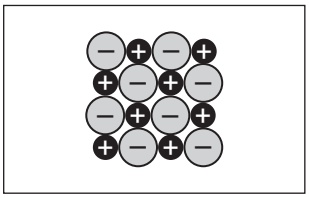
**D**

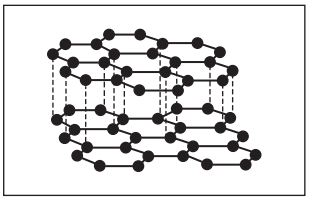
**Structure**











**[4]**

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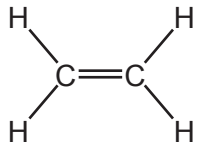
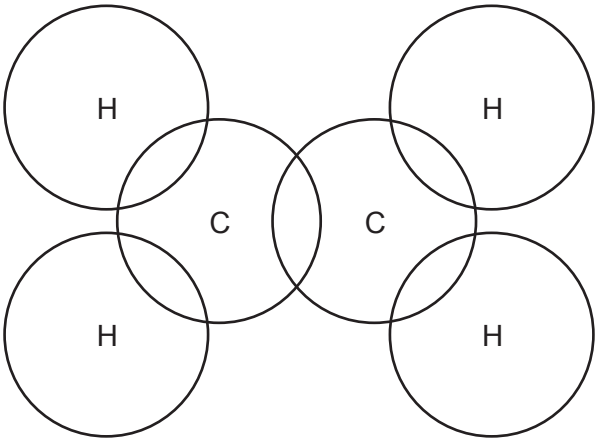
**(b)** Ethene, $C_2H_4$, has this structure.




**(i)** Complete the dot and cross diagram for a molecule of ethene.

Only show the outer shell electrons.




**[2]**

**(ii)** Explain why ethene has a low boiling point.

Use ideas about structure and bonding.

.....

.....

.....

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

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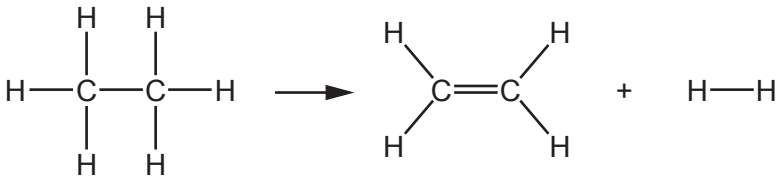
**(c)** The equation shows how ethene can be produced.



The table shows some bond energies.

| Bond | Bond energy (kJ / mol) |
|---|---|
| C–C | 347 |
| C–H | 413 |
| C=C | 612 |
| H–H | 436 |

**(i)** Calculate the total energy transferred to **break** all the bonds in the reactant.

Energy transferred to break all the bonds = ..... kJ / mol **[1]**

**(ii)** Calculate the total energy transferred to **make** all the bonds in the products.

Energy transferred when all the bonds are made = ..... kJ / mol **[1]**

**(iii)** Use your answers to parts **(i)** and **(ii)** to calculate the energy change for the reaction.

Energy change = ..... kJ / mol **[1]**

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**15** Sodium hydroxide, NaOH, and calcium hydroxide, $Ca(OH)_2$, are ionic compounds that dissolve in water to form alkaline solutions.

**(a)** Why are solutions of sodium hydroxide and calcium hydroxide called alkalis?

..... **[1]**

**(b)** Explain why the formula of sodium hydroxide is NaOH but the formula of calcium hydroxide is $Ca(OH)_2$.

.....

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..... **[3]**

**(c)** The electrolysis of a sodium hydroxide solution produces hydrogen at the cathode rather than sodium.

Explain why.

.....

.....

.....

.....

.....

..... **[3]**

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**(d)** When carbon dioxide is bubbled through a calcium hydroxide solution it turns cloudy white.

This is the equation for the reaction.

$$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$$

**(i)** Which chemical in the equation turns the solution cloudy white?

..... **[1]**

**(ii)** What is the alternative name for the calcium hydroxide solution?

..... **[1]**

**(iii)** The calcium hydroxide solution contains 0.038 g of calcium hydroxide.

Calculate the maximum mass of carbon dioxide that can react with the calcium hydroxide solution.

Give your answer to **2** significant figures.

Relative atomic mass ($A_r$): H = 1.0 C = 12.0 O = 16.0 Ca = 40.1

Mass of carbon dioxide = ..... g **[4]**

**END OF QUESTION PAPER**

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## EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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