Oxford Cambridge and RSA

Monday 19 May 2025 – Morning

GCSE (9–1) Combined Science B (Twenty First Century Science)

J260/06 Chemistry (Higher Tier)

Time allowed: 1 hour 45 minutes

H

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

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

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 **95**.
- 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 **24** pages.

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

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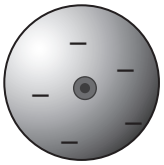
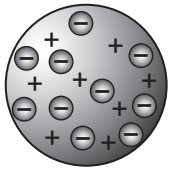
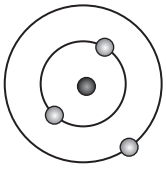
1 In the 1800s, Dalton did experiments to help produce a model for the atom.

(a) Later discoveries led to scientists suggesting new models for the atom.

Draw lines to connect each **discovery** with the **model** it led to.

Discovery	**Model**
Electrons are discovered.	
Electrons are in shells.	
Nucleus is discovered.	

[2]

(b) The modern model of the atom consists of electrons, neutrons and protons.

Which statements about the modern model of the atom are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
Neutrons have a charge of 0.		
Protons and electrons are in the nucleus.		
Protons and electrons have a relative charge of –1.		
Protons and neutrons have a relative mass of 1.		

[3]

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(c) The diameter of an atom is 1×10^{-10} m and the diameter of a nucleus is 1.7×10^{-15} m.

Estimate how many times bigger the atom is compared to the nucleus.

Number of times bigger = ... **[2]**

(d) The atomic number and mass number can be used to find the number of protons, neutrons and electrons in an atom.

The table shows information about an argon atom and a potassium atom.

Complete the table.

	Argon atom	**Potassium atom**
Atomic number	18	.....
Mass number	40	.....
Number of electrons	.....	19
Number of neutrons	.....	20
Number of protons	.....	19

[4]

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2 Zinc is extracted from its ore by separating the zinc compounds from the waste rock and then converting the zinc compounds into zinc.

(a) A company wants to extract 5.5 kg of zinc from an ore which contains 8.5% zinc.

Calculate the mass of ore needed.

Use the equation: percentage of zinc in ore = $\frac{\text{mass of zinc} \times 100}{\text{mass of ore}}$

Give your answer to **3** significant figures.

Mass of ore = ... kg **[4]**

(b) The zinc compounds are heated strongly to produce zinc oxide.
The zinc oxide is then heated with carbon to produce zinc and carbon monoxide.

$ZnO + C \rightarrow Zn + CO$

Explain which substance is oxidised and which is reduced in this reaction.

Oxidised .....

.....

Reduced .....

.....
[2]

(c) Many metals cannot be extracted using carbon.

Explain why zinc can be extracted using carbon but aluminium **cannot**.

Zinc .....

.....

Aluminium .....

.....
[2]

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3 Drinking water in the UK can be obtained from rivers. Rivers are a type of surface water.

(a) Surface water contains impurities. The table shows some stages of the treatment to make surface water more suitable for drinking.

(i) Complete the table to show which impurities are removed and how these impurities are removed at each stage shown.

Stage	**Impurities removed**	**How the impurities are removed**
Screening (pass the water through a wide mesh)	Leaves, branches, rubbish.	.....
Filtration (pass the water through a bed of sand)	Soil	.....
Disinfection (add chlorine to the water)	.....	.....

[4]

(ii) Suggest why the water after these stages is still **not** considered scientifically pure.

.....

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

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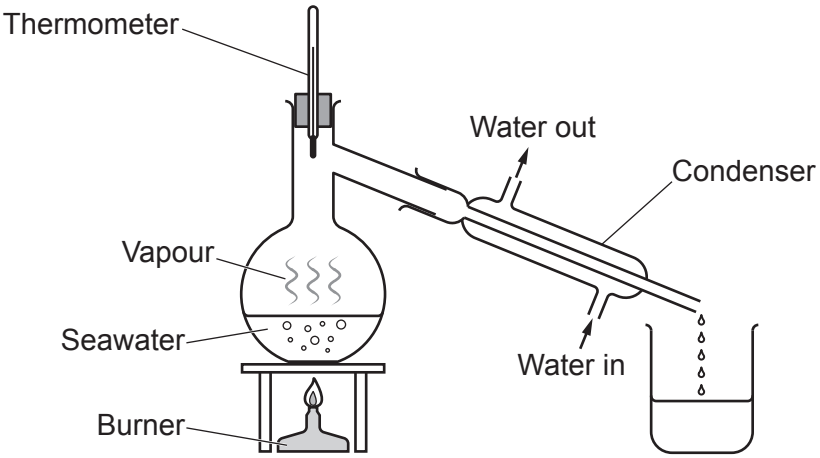
(b) Some countries get their drinking water from seawater. Seawater contains dissolved salts such as sodium chloride.

Distillation can be used to obtain drinking water from seawater.

The diagram shows how distillation is used in a laboratory.



Describe how distillation separates the dissolved salts from the water.

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

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(c) Different countries choose different ways to produce drinking water.

The table gives information about two countries.

	Country A	**Country B**
Amounts of surface water	Unlimited	Limited
Amounts of seawater	Unlimited	Unlimited
Climate	Warm and wet	Hot and dry
Mean hours of sunshine per year	1700	3000
Cost of energy	High	Low
Main method of producing drinking water	From surface water	Distillation of seawater

(i) The cost of energy is generally lower in countries which can use solar power.

Suggest why this means the cost of energy is lower in Country **B**.

Use the table.

.....

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

(ii) Explain why country **A** chooses to use surface water to produce their drinking water.

You should refer to water availability and energy use in your answer.

.....

.....

.....

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

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4 Many hydrocarbons are used as fuels. They burn in a large supply of air to form carbon dioxide and water.

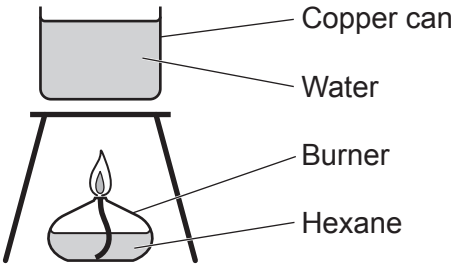
(a) Complete the balanced symbol equation when hexane burns in air.

..... C_6H_{14} + ... O_2 → ..... CO_2 + ... H_2O

[2]

(b) A scientist does an experiment to find the change in thermal energy of the water when 1 mole of hexane burns in air.

They use this apparatus:



They measure:

- the mass of water in the copper can
- the mass of hexane burned
- the temperature change of the water.

Describe how they do the experiment, including all equipment needed for the measurements.

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..... **[4]**

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DO NOT WRITE ON THIS PAGE
Turn over for the next question

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(c) The table shows their results.

Mass of hexane burned (g)	0.75
Temperature change of water (°C)	12.5
Mass of water in copper can (g)	500

(i) Calculate the change in thermal energy of the water.

Use the equation:

Change in thermal energy (kJ) = 4.2 × mass of water (kg) × temperature change (°C)

Change in thermal energy = ... kJ **[3]**

(ii) The mass of 1 mole of a substance is its relative formula mass in grams.

Calculate the mass of 1 mole of hexane, C_6H_{14}.

Use the Data Sheet.

Mass of 1 mole of hexane = ... g **[2]**

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(iii) Calculate the change in thermal energy of the water when 1 mole of hexane burns.

Use the table and your answers to **(c)(i)** and **(c)(ii)**.

Change in thermal energy = ... kJ **[3]**

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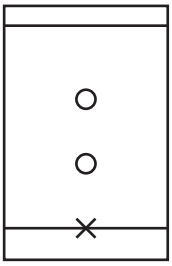
5 A scientist is testing the purity of **solid** samples.

(a) The scientist decides to use paper chromatography to test the samples.

The diagram shows the results for one of the samples.



(i)* Describe how the scientist uses chromatography to test the samples for purity and how they can identify the substances in the samples using R_f values.

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

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(ii) The scientist says that the results show that the sample is impure.

Explain why they are **correct**.

.....

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

(iii) The scientist wants to increase the distance between the spots on the chromatogram.

How can the method be adapted to increase the distance between the spots?

Tick (✓) **one** box.

Add a locating agent. ☐

Leave the paper in the solvent for longer. ☐

Use more solid. ☐

Use more solvent. ☐

[1]

(b) What **other** method could the scientist use to check the purity of the solid samples?

.....

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

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6 The elements in Group 7 of the periodic table are called the halogens.

(a) The table shows some of the properties of the halogens.

	Formula	Boiling point (°C)	Colour and state at room temperature and pressure	Reaction with hydrogen
Fluorine	F_2	–188	Yellow gas	Explodes in cold and dark.
Chlorine	Cl_2	–35	Green gas	Explodes with flame or in sunlight.
Bromine	Br_2	59	Red liquid	
Iodine	I_2	184	Grey solid	Slow when heated strongly.

(i) Explain why the halogens all form molecules containing two identical atoms.

Use ideas about electrons and bonding.

.....

.....

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.....

.....

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

(ii) Predict the reaction of bromine with hydrogen.

.....

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

(iii) Explain the trend in boiling points shown in the table.

Use ideas about energy and forces.

.....

.....

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.....

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

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(b) Halogens react with metals to form metal halides.

Complete the table to show the ions present and the formulae of some metal halides.

Metal halide	**Ions present**	**Formula**
Sodium iodide	Na^+ and I^-	NaI
Magnesium chloride	Mg^{2+} and Cl^-	.....
Iron bromide	..... and	$FeBr_3$

[2]

(c) Chlorine gas reacts with aqueous potassium iodide to form a solution of iodine and potassium chloride.

$Cl_2 + 2KI \rightarrow I_2 + 2KCl$

(i) In the reaction, chlorine reacts with iodide ions to form chloride ions and iodine.

Write the balanced ionic equation for the reaction.

Include state symbols.

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

(ii) The table shows what happens when some halogens are added to aqueous solutions of metal halides.

Complete the table.

Use the Data Sheet.

Halogen	**Metal halide**	**Result**
Chlorine	Potassium iodide	Iodine and potassium chloride formed
Iodine	Potassium chloride	No reaction
Bromine	Potassium iodide	.....
Bromine	Potassium chloride	.....

[2]

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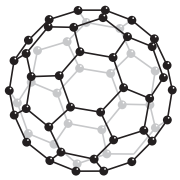
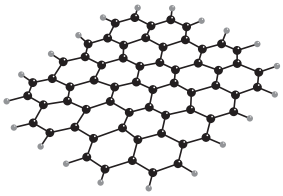
7 Nanoparticles are tiny particles with many important uses.

(a) Fullerene and graphene are nanoparticles made from carbon.

The diagrams show their structures.



Fullerene



Graphene

(i) State **two** similarities and **two** differences between the structures.

Similarity 1 .....

.....

Similarity 2 .....

.....

Difference 1 .....

.....

Difference 2 .....

.....

[4]

(ii) Explain why graphene is a very good conductor of electricity.

.....

.....

.....

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

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(b) The table shows the sizes of some particles.

Particle	Size (m)
A	1.6×10^{-7}
B	1.5×10^{-8}
C	3.9×10^{-9}
D	2.7×10^{-10}
E	3.3×10^{-10}
F	3.7×10^{-11}

(i) Which **two** particles are the **same** order of magnitude?

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

(ii) Nanoparticles are between 1×10^{-9} and 1×10^{-7} m in size.

Which **two** particles could be nanoparticles?

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

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8 Zinc reacts with sulfuric acid to produce a salt and hydrogen.

(a) Describe the test to identify hydrogen.

Test .....

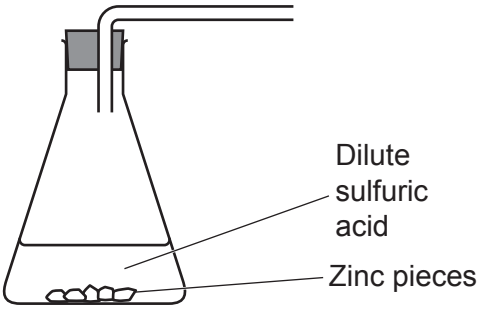
Positive result .....
[2]

(b) A student does an experiment to investigate the effect of adding a catalyst on the rate of reaction between zinc and sulfuric acid.

This is the method:

- Add zinc pieces to dilute sulfuric acid.
- Measure the volume of hydrogen produced at regular time intervals.
- Repeat the experiment with the catalyst added to the zinc pieces and dilute sulfuric acid.

The diagram shows some of the apparatus used.



(i) The student decides to use a gas syringe to collect and measure the volume of hydrogen.

Describe **other** apparatus they could use to collect and measure the volume of hydrogen.

.....

.....

.....

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

(ii) The student keeps the temperature and the concentration of the acid the same for the two experiments.

Identify **two** other factors which should be kept constant.

1 .....

2 .....
[2]

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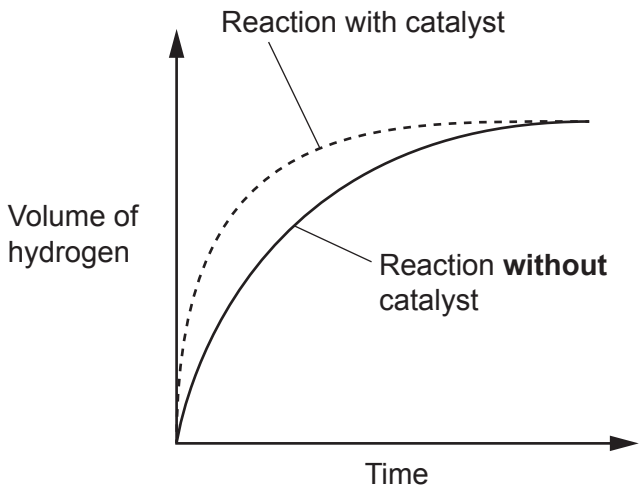
(c) The student sketches their results on a graph as shown.



Explain how the shape of the lines on the graph show that the reaction has been catalysed.

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.....

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

(d) Explain why increasing the temperature of the sulfuric acid increases the rate of the reaction.

Use ideas about particles.

.....

.....

.....

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

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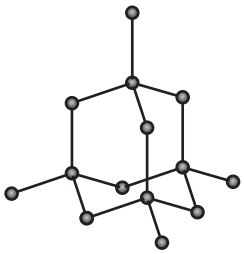
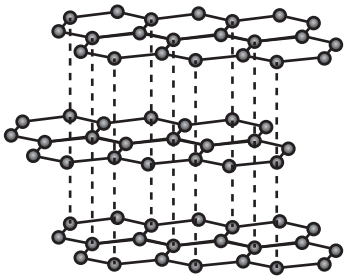
9 The table gives some information about diamond and graphite.

	Diamond	**Graphite**
Structure		
Type of bonds		Covalent
Arrangement of atoms		Each carbon bonded to 3 others. 2-dimensional layers.
Melting point	Very high	Very high
Hardness	Hard	Soft and slippery
Electrical conductivity	None	Good

(a) Describe the type of bonds and the arrangement of atoms in diamond.

Type of bonds .....

Arrangement of atoms .....

.....

.....

[3]

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(b) Explain why diamond is hard but graphite is soft and slippery.

Use ideas about structure and bonding.

.....

.....

.....

.....

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.....

.....

..... **[4]**

(c) Explain why the melting point of diamond is very high.

.....

.....

.....

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

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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