Collins

AQA

GCSE

Chemistry

H

SET A – Paper 1 Higher Tier

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Materials

Time allowed: 1 hour 45 minutes

For this paper you must have:

- a ruler
- a calculator
- the Periodic Table (found at the end of the paper).

Instructions

- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering question 10.1 you need to make sure that your answer:
  – is clear, logical, sensibly structured
  – fully meets the requirements of the question
  – shows that each separate point or step supports the overall answer.

Advice

- In all calculations, show clearly how you work out your answer.

Name: .....

01.1 Which of the substances below have high melting points **and** can conduct electricity when molten?

Tick **two** boxes.

- Sodium chloride ☐
- Silicon dioxide ☐
- Sulfur dioxide ☐
- Scandium ☐
- Sulfur ☐

[1 mark]

01.2 Which of the following substances have weak intermolecular forces?

Tick **three** boxes.

- Carbon dioxide ☐
- Methane ☐
- Graphite ☐
- Graphene ☐
- Diamond ☐
- Oxygen ☐

[1 mark]

01.3 Calcium fluoride is used in the manufacture of windows and lenses.

Explain how calcium fluoride is formed from atoms of calcium and fluorine.

Use a dot and cross diagram in your explanation.

[4 marks]

01.4 As well as a dot and cross diagram, a three-dimensional diagram can be used to represent calcium fluoride.

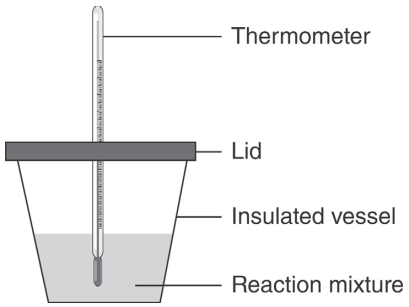
Suggest one limitation of using a dot and cross diagram and one limitation of using a three-dimensional diagram.

[2 marks]

02 Some students investigated the temperature change during the neutralisation of sodium hydroxide and hydrochloric acid.

The students used the apparatus in **Figure 2.1** to collect the data.

Figure 2.1



The students carried out eight experiments.

In each experiment, they added a volume of 2 mol/dm^3 sodium hydroxide to a fixed volume and concentration of hydrochloric acid.

The volumes of 2 mol/dm^3 sodium hydroxide added and the temperatures recorded are shown in **Table 2.1**

Table 2.1

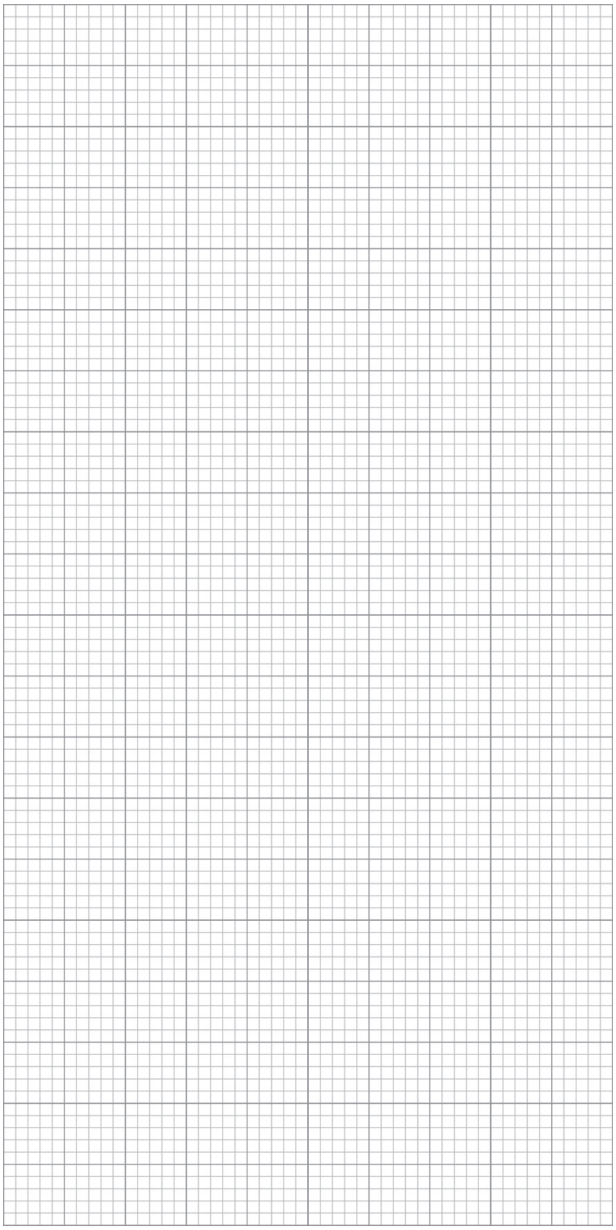
Volume of NaOH (cm^3)	Temperature (°C)
5	25.80
10	26.40
15	27.00
20	27.60
25	27.40
30	27.20
35	27.00
40	26.80

02.1 Name a suitable material to make the insulating material and the lid in **Figure 2.1**

.....

[1 mark]

02.2 Using a suitable scale on your axes, plot **all** the points from **Table 2.1**



[4 marks]

Question 2 continues on the next page

02.3 Draw two straight lines of best fit on the graph to show how the temperature changes as the volume increases.

[2 marks]

02.4 The **point of neutralisation** occurs at the highest temperature rise.

What is the volume of sodium hydroxide at the point of neutralisation?

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

02.5 Write an **ionic equation** for the neutralisation reaction.

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

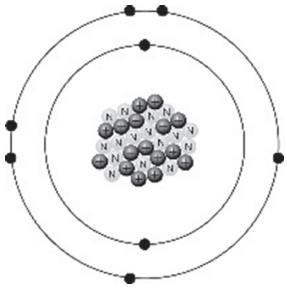
02.6 Draw **one** line from each volume of sodium hydroxide added to the acid to the acid's expected pH range.

Volume of sodium hydroxide (cm^3)	pH range
	0–2
10	2–4
25	4–6
40	6–8
15	8–10
	10–12

[4 marks]

03.1 Which diagram represents the correct atomic structure for oxygen?

Tick **one** box.



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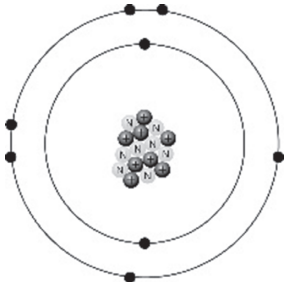

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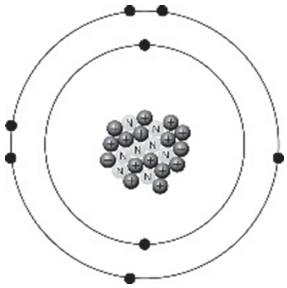


☐

[1 mark]

03.2 Draw the electronic structure of the **oxide ion**.

[2 marks]

Question 3 continues on the next page

03.3 Which statement about the sizes of the atoms and the nucleus is true?

Tick **one** box.

The radius of an atom is about 10 nm ☐

The radius of a nucleus is about 10 nm ☐

The radius of an atom is about 0.1 nm ☐

The radius of a nucleus is about 0.1 nm ☐ **[1 mark]**

03.4 Which **two** statements about isotopes are true?

Tick **two** boxes.

Isotopes have the same physical properties. ☐

Isotopes contain the same number of protons. ☐

Isotopes contain the same number if neutrons. ☐

Isotopes contain the same number of electrons. ☐ **[2 marks]**

03.5 Oxygen has three isotopes:

$^{16}_{8}O$ $^{17}_{8}O$ $^{18}_{8}O$

Describe the **similarities** and **differences** between the three isotopes of oxygen.

.....

.....

.....

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

03.6 **Table 3.1** shows the percentage of each isotope in a sample of oxygen.

Table 3.1

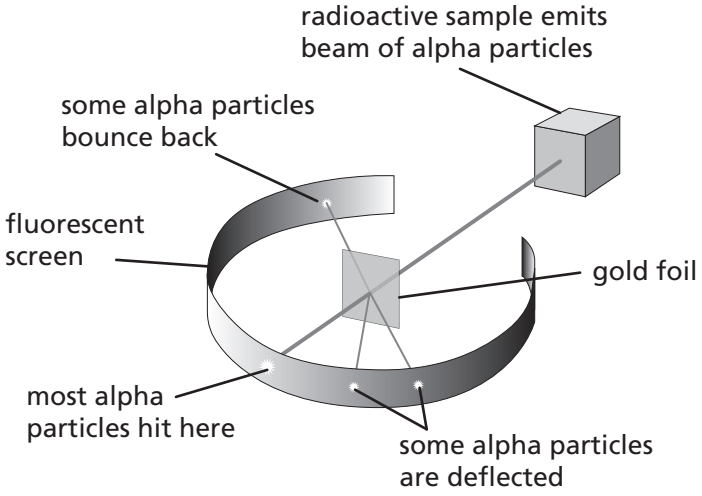
Percentage	Isotope
70	$^{16}_{8}O$
25	$^{17}_{8}O$
5	$^{18}_{8}O$

Calculate the relative atomic mass of oxygen in the sample.

Give your answer to 4 significant figures.

[3 marks]

04 Scientists used to think that atoms were like 'plum puddings'. An experiment using positively charged alpha particles and gold foil changed scientists' ideas.



1. Scientists thought the alpha particles would pass straight through the gold foil.

2. Alpha particles were fired at a sheet of gold foil.

3. Some alpha particles did go straight through the gold foil; others were deflected.

04.1 Which **two** statements about Rutherford's experiment **provided evidence** for the nuclear model of the atom?

Tick **two** boxes.

The beam produced is deflected by an electric field. ☐

Alpha particles were fired at a thin piece of gold foil. ☐

A high voltage was applied to produce a beam. ☐

Flashes of light were observed when particles hit a screen. ☐ **[2 marks]**

04.2 Describe the evidence collected through this experiment.

Explain how the evidence led to new conclusions about the structure of the atom.

.....

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.....

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

05 A student is given four unknown metals and a bottle of nitric acid.

05.1 Describe an experiment she could carry out to determine the relative reactivity of the metals.

In your description:

- Describe any observations or measurements she should make.
- Explain how she would make the investigation a fair test.
- Explain how her results would lead to any conclusions.

[4 marks]

05.2 Write a **balanced** symbol equation for the reaction of aluminium with nitric acid.

[2 marks]

05.3 Calculate the number of moles of hydrogen molecules produced if a total of 72 cm^3 of hydrogen is produced.

[2 marks]

06 Acids react with insoluble solid substances to make useful soluble salts.

06.1 Iron(III) nitrate is a soluble salt which can be used as a catalyst.

The balanced symbol equation to make iron(III) nitrate from iron(III) oxide is:

$$Fe_2O_3 + 6HNO_3 \longrightarrow 2Fe(NO_3)_3 + 3H_2O$$

Calculate the number of particles of HNO_3 needed to react completely with 1 mole of Fe_2O_3

Write your answer in Standard Form.

.....

.....

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

06.2 The concentration of HNO_3 used is 2 mol/dm^3

Calculate the number of moles of HNO_3 present in 25 cm^3 of solution.

.....

.....

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

06.3 Calculate the mass of HNO_3 present in this 25 cm^3 of solution.

M_r of HNO_3 = 63

.....

.....

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

06.4 The percentage atom economy for a reaction is given by:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula mass of all reactants from equation}} \times 100$$

Calculate the atom economy for the reaction in question 06.1

Reactive formula masses: $Fe_2O_3 = 160$; $HNO_3 = 63$; $H_2O = 18$

Give your answer to 2 significant figures.

[3 marks]

06.5 Iron(III) nitrate can also be made by reacting iron with nitric acid.

This gives a higher atom economy.

Write the **balanced** symbol equation for this reaction.

[2 marks]

Question 6 continues on the next page

06.6 A chemist wants to produce a solution containing 200 kg of iron(III) nitrate using this reaction:

$$Fe_2O_3 + 6HNO_3 \longrightarrow 2Fe(NO_3)_3 + 3H_2O$$

How much Fe_2O_3 would he need?

Show your working.

Give your answer in tonnes, to 3 significant figures. (1 tonne = 1 000 000 g)

Answer: ..... tonnes **[4 marks]**

06.7 Calculate the volume of 2 mol/dm^3 HNO_3 needed to make 200 kg of iron(III) nitrate.

Give your answer in dm^3

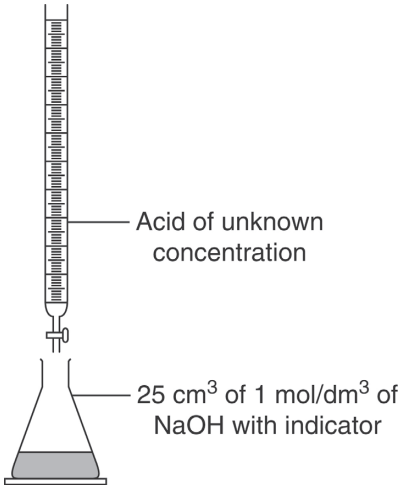
Give your answer to 3 significant figures.

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

07 Hydrochloric acid of unknown concentration is presented to a student.

To determine the concentration of the acid, they will carry out an acid–base titration, using the equipment shown in **Figure 7.1**

Figure 7.1



07.1 Describe how the titration is carried out.

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.....

.....

.....

.....

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

Question 7 continues on the next page

07.2 Show the calculation the student should perform to find the concentration.

[3 marks]

07.3 What could the student do to have greater confidence in the analysis?

[1 mark]

08.1 What is the name of the ion responsible for the pH value of an acid?

.....

[1 mark]

08.2 Two different acids, Acid A and Acid B, were reacted with calcium carbonate.

The volumes and concentrations of the acids used were the same.

The mass of calcium carbonate used (0.05 g) was the same in each reaction.

With Acid A, the volume of carbon dioxide produced after 2 minutes was 11 cm^3

With Acid B, the volume of carbon dioxide produced after 2 minutes was 2 cm^3

What might account for the differences in these results?

.....

.....

.....

.....

[2 marks]

08.3 What is the volume of one mole of any gas at room temperature and pressure?

.....

[1 mark]

Question 8 continues on the next page

08.4 Calculate the number of moles of carbon dioxide produced after 2 minutes with **Acid A.**

Give your answer in Standard Form to 3 significant figures.

Moles with Acid A: .....

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

08.5 The pH of Acid A has a value of 2

If the concentration of the acid is increased by a factor of 10, what will the pH become?

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

08.6 If the concentration of Acid B is increased by a factor of 10, would it produce the same change in the pH value?

Explain your answer.

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

09 A piece of magnesium is placed in a solution of copper(II) sulfate.

09.1 Describe what you would observe.

[2 marks]

09.2 Which species has been oxidised?

Use an ionic half equation to explain your answer.

[2 marks]

09.3 Write the overall ionic equation for the reaction, including state symbols.

[2 marks]

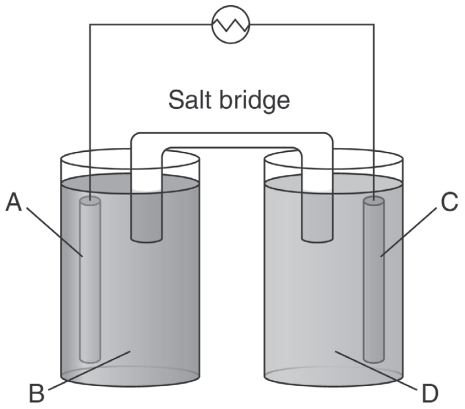
Question 9 continues on the next page

09.4 Electricity can be produced in a cell by:

- placing two different metals each in a solution of its nitrate
- connecting the two metals and solutions, as shown in **Figure 9.1**

By convention, the metal which is most easily **reduced** is drawn on the right-hand side of a diagram of the cell.

Figure 9.1



Design a cell that will produce the highest voltage.

Use your knowledge of the reactivity series to choose metals from this list:

iron; magnesium; tin; zinc; copper; lead; silver

Then complete **Table 9.1** to describe the labels A–D on **Figure 9.1**

Table 9.1

Label on diagram	Description
A	
B	
C	
D	

[4 marks]

09.5 Explain why the cell you designed in 09.4 will produce the highest voltage.

[3 marks]

09.6 Write the overall **balanced** ionic equation for the reaction.

Include the state symbols.

[2 marks]

10.1 Compare the electrolysis of **molten** magnesium chloride with the electrolysis of **aqueous** magnesium chloride.

Explain any differences in the half equations at each electrode.

[6 marks]

END OF QUESTIONS

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Key

Metals

Non-metals

Relative atomic mass — 1
Atomic symbol — H
Name — hydrogen
Atomic/proton number — 1

1	2											3	4	5	6	7	0 or 8
																	4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Uut** ununtrium 113	[289] **Fl** flerovium 114	[289] **Uup** ununpentium 115	[293] **Lv** livermorium 116	[294] **Uus** ununseptium 117	[294] **Uuo** ununoctium 118

*The lanthanides (atomic numbers 58–71) and the actinides (atomic numbers 90–103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.