OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

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Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS

CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Friday 5 January 2024 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do **not** write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

Answer **all** questions in the spaces provided.

Do not write outside the box

0 1 Gallium (Ga) is a metal.

0 1 . 1 Describe the bonding in solid gallium.

[2 marks]

Gallium forms $GaCl_3$ molecules.

0 1 . 2 Write an equation for the formation of $GaCl_3$ from its elements.

[1 mark]

0 1 . 3 Draw the shape of a molecule of $GaCl_3$

Include any lone pairs of electrons, if any, that influence the shape.

Name the shape of the $GaCl_3$ molecule.

[2 marks]

Shape

Name of shape _____

Do not write outside the box

0 1 . 4 A molecule of $GaCl_3$ reacts with a chloride ion to form a $GaCl_4^-$ ion.

During this reaction a bond is formed.

Name the type of bond formed.

Describe how this bond is formed.

[2 marks]

Type of bond _____

How bond is formed _____

_____

_____

0 1 . 5 What is the difference, if any, between the Cl–Ga–Cl bond angle in $GaCl_3$ and in $GaCl_4^-$?

Tick (✓) **one** box.

[1 mark]

The bond angle is bigger in $GaCl_3$ ☐

The bond angle is the same ☐

The bond angle is smaller in $GaCl_3$ ☐

8

Turn over for the next question

Do not write outside the box

0 2 This question is about reactions involving halide ions.

0 2 . 1 Give a reagent that could be used to distinguish between separate samples of aqueous potassium fluoride and aqueous potassium chloride.

Describe what you would observe for each solution.

[3 marks]

Reagent _____

Observation with aqueous potassium fluoride _____

_____

Observation with aqueous potassium chloride _____

_____

Aqueous bromine reacts with aqueous sulfur dioxide to form hydrobromic acid (HBr).

0 2 . 2 Write a half-equation for the reaction of bromine to form bromide ions.

[1 mark]

_____

0 2 . 3 Write a half-equation for the reaction of an aqueous solution of sulfur dioxide to form hydrogen ions and sulfate(VI) ions.

[1 mark]

_____

0 2 . 4 Use your answers to Question **02.2** and Question **02.3** to deduce an overall equation for the reaction of bromine and aqueous sulfur dioxide to form hydrobromic acid.

[1 mark]

_____

0 2 . 5 Identify the reducing agent in this reaction.

[1 mark]

_____

Do not write outside the box

0 2 . 6 Chlorine gas is bubbled into an aqueous solution of potassium iodide.

Give **one** observation.

Write an equation for this reaction.

[2 marks]

Observation _____

_____

Equation

_____

9

Turn over for the next question

Do not write outside the box

0 3 Time of flight (TOF) mass spectrometry is used to determine accurate relative atomic masses.

0 3 . 1 Define relative atomic mass.

[2 marks]

A sample of germanium (Ge) is ionised by electron impact.

0 3 . 2 Write an equation, including state symbols, for this ionisation.

[1 mark]

Do not write outside the box

0 3 . 3 In a TOF mass spectrometer, some germanium ions are accelerated to a kinetic energy (*KE*) of 9.616×10^{-13} J

One germanium ion takes 3.739×10^{-7} s to travel along a 1.500 m flight tube.

$$KE = \frac{mv^2}{2}$$

m = mass of the ion / kg
v = velocity of ion / m s^{-1}

Calculate the mass, in g, of one mole of these germanium ions.

Use your answer to deduce the mass number of this germanium ion.

The Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1}

[5 marks]

Mass of one mole of germanium ions _____ g

Mass number _____

0 3 . 4 Explain why the atomic radius of ^{76}Ge is the same as the atomic radius of ^{74}Ge

[1 mark]

_____

_____

9

Turn over for the next question

Do not write outside the box

0 4 This question is about compounds containing carbon.

0 4 . 1 Deduce the formula of silicon carbide.

[1 mark]

0 4 . 2 The C–F bond is polar.

Explain why CF_4 is a non-polar molecule.

[2 marks]

0 4 . 3 Ethane (C_2H_6) reacts with fluorine to form CF_4

$C_2H_6(g) + 7\,F_2(g) \rightarrow 2\,CF_4(g) + 6\,HF(g) \qquad \Delta H^{\ominus} = -2889\ kJ\ mol^{-1}$

Table 1 gives some values of standard enthalpies of formation, $\Delta_f H^{\ominus}$

Table 1

Substance	$C_2H_6(g)$	$F_2(g)$	$HF(g)$
$\Delta_f H^{\ominus}$ / kJ mol^{-1}	−85	0	−269

Use the standard enthalpy change of the reaction and the data in **Table 1** to calculate the standard enthalpy of formation, in kJ mol^{-1}, of $CF_4(g)$

[3 marks]

Standard enthalpy of formation of $CF_4(g)$ _____ kJ mol^{-1}

Do not write outside the box

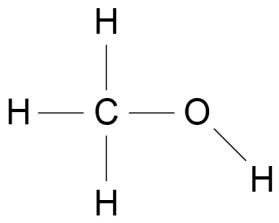
0 4 . 4 Methanol (CH_3OH) dissolves in water.

Name the strongest type of interaction between a molecule of methanol and a molecule of water.

Complete the diagram to show how one molecule of methanol interacts with one molecule of water.
Include all lone pairs and partial charges in your diagram.

[4 marks]

Name _____



10

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0 5 This question is about a titration experiment.

0 5 . 1 A student does a titration to identify a metal, **M**.
The student dissolves 2.43 g of the metal hydroxide, **M**$(OH)_2$, in distilled water to make 250 cm^3 of an aqueous solution.

A 25.0 cm^3 sample of this **M**$(OH)_2$ solution is titrated with 0.104 mol dm^{-3} hydrochloric acid.

The mean titre is 27.30 cm^3

The equation for the reaction is

$$\mathbf{M}(OH)_2 + 2\,HCl \rightarrow \mathbf{M}Cl_2 + 2\,H_2O$$

Calculate the relative atomic mass of **M**.

Give your answer to 1 decimal place.

Identify **M**.

[6 marks]

Relative atomic mass of **M** _____

Identity of **M** _____

Do not write outside the box

The student makes the solution of the metal hydroxide in Question **05.1** as follows.

Step 1 Weighs out the solid metal hydroxide and records the mass to 2 decimal places

Step 2 Transfers the solid to a beaker

Step 3 Dissolves the solid in distilled water

Step 4 Transfers the solution, with washings from the beaker, to a suitable piece of equipment

Step 5 Makes up the volume of solution with distilled water to exactly 250 cm^3

0 5 . 2 Describe what the student must do to make sure they know the exact mass of the solid metal hydroxide in **Step 1**.

[1 mark]

0 5 . 3 Name a suitable piece of equipment the student would use in **Step 4**.

[1 mark]

0 5 . 4 Describe how the student would make the solution up to exactly 250 cm^3 in **Step 5**.

[1 mark]

Question 5 continues on the next page

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0 5 . 5 **Table 2** shows the results of the experiment.

Table 2

	Rough	**1**	**2**	**3**
Final reading / cm^3	29.20	29.55	29.35	30.95
Initial reading / cm^3	1.50	2.20	1.85	3.70
Titre / cm^3	27.70	27.35	27.50	27.25

Explain why the mean titre used in the calculation in Question **05.1** is 27.30 cm^3

[1 mark]

0 5 . 6 Distilled water is used to wash down the sides of the conical flask near the end of the titration.

Give **one** reason why this washing is done.

Give **one** reason why distilled water is used.

[2 marks]

Reason for washing down the sides of the flask

Reason why distilled water is used

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Turn over for the next question

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0 6 This question is about the elements in Group 2, from Mg to Ba, and their compounds.

0 6 . 1 State why the atomic radius of barium is larger than the atomic radius of calcium.

[1 mark]

0 6 . 2 Strontium reacts with hydrochloric acid.

When 0.123 g of strontium is added to hydrochloric acid, a gas is produced.

Write an equation for the reaction of strontium with hydrochloric acid.

Calculate the volume, in cm^3, of the gas produced at 101 kPa and 25 °C
Give your answer to 3 significant figures.

The gas constant, R = 8.31 J K^{-1} mol^{-1}

[6 marks]

Equation _____

Volume _____ cm^3

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Two Group 2 metals, **Y** and **Z**, form chlorides $\mathbf{Y}Cl_2$ and $\mathbf{Z}Cl_2$
A student does some test tube reactions with solutions of $\mathbf{Y}Cl_2$ and $\mathbf{Z}Cl_2$
The observations are shown in **Table 3**.

Table 3

	Addition of potassium hydroxide solution	**Addition of potassium sulfate solution**
$\mathbf{Y}Cl_2$	Colourless solution	White precipitate
$\mathbf{Z}Cl_2$	White precipitate	Colourless solution

0 6 . 3 Identify metal **Y** and metal **Z**.

[2 marks]

Metal **Y** _____ Metal **Z** _____

0 6 . 4 Write equations to show the formation of each of the white precipitates.

If you were unable to identify the metals **Y** and **Z**, you should use $\mathbf{Y}Cl_2$ and $\mathbf{Z}Cl_2$ in your equations.

[2 marks]

Equation 1

_____

Equation 2

_____

0 6 . 5 A student dissolves 2.53 g of calcium chloride in water at 20.0 °C in a plastic cup. 50.0 cm^3 of solution are formed and the temperature of the solution rises to 25.4 °C

Calculate a value for the enthalpy change, in kJ mol^{-1}, when calcium chloride dissolves in water.

Specific heat capacity of the solution is 4.18 J g^{-1} K^{-1}
Assume that the density of the solution is 1.00 g cm^{-3}

[3 marks]

Enthalpy change _____ kJ mol^{-1}

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Turn over ►

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0 7 This question is about physical properties of elements in Period 3.

0 7 . 1 Identify the element in Period 3 with the lowest melting point.

[1 mark]

0 7 . 2 State the meaning of electronegativity.

[1 mark]

0 7 . 3 Suggest why the electronegativity of the elements in Period 3 increases from sodium to chlorine.

[2 marks]

0 7 . 4 **Table 4** shows successive ionisation energies of an element in Period 3.

Table 4

Ionisation number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ionisation energy / kJ mol^{-1}	1060	1900	2920	4960	6280	21 200	25 900	30 500

Identify this element.

[1 mark]

Do not write outside the box

0 7 . 5 Write an equation, including state symbols, to show the process that occurs when the **second** ionisation energy of sodium is measured.

[1 mark]

0 7 . 6 Explain why sodium has a higher **second** ionisation energy than magnesium.

[2 marks]

8

END OF QUESTIONS

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