OXFORD

INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

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

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I declare this is my own work.

INTERNATIONAL AS
CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Wednesday 10 May 2023 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	
TOTAL	

Do not write outside the box

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

0 1 This question is about atoms and ions.

0 1 . 1 **Table 1** shows some information about an atom and an ion for two different isotopes of bromine.

Complete **Table 1**.

[2 marks]

Table 1

Atom or ion	Number of electrons	Number of protons	Number of neutrons
^{79}Br	35		
	36		46

0 1 . 2 State how many times heavier a proton is than an electron.

[1 mark]

_____

0 1 . 3 State the maximum number of electrons in one orbital.

[1 mark]

_____

0 1 . 4 Complete the electron configuration for a Cu atom and for a Mn^{2+} ion.

[2 marks]

Cu atom [Ar] _____

Mn^{2+} ion [Ar] _____

6

Do not write outside the box

0 2 A sample of lead contains atoms of three isotopes, ^{206}Pb, ^{207}Pb and ^{208}Pb
The sample is analysed using a time of flight (TOF) mass spectrometer.

0 2 . 1 State why all isotopes of lead have the same chemical properties.

[1 mark]

0 2 . 2 In the TOF mass spectrometer the atoms in the sample are ionised by electron impact.

Give **one** reason why the atoms must be ionised.

[1 mark]

0 2 . 3 Explain why $^{208}Pb^{+}$ has a longer time of flight than $^{206}Pb^{+}$

[2 marks]

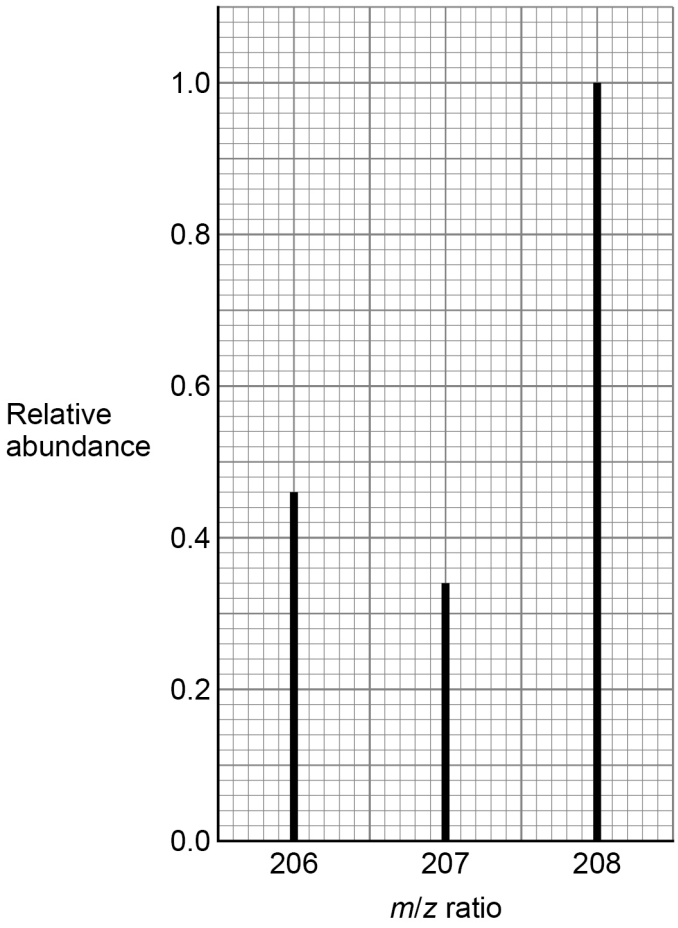
0 2 . 4 Suggest why there must be no air inside a mass spectrometer.

[1 mark]

Do not write outside the box

0 2 . 5 **Figure 1** shows the mass spectrum of this sample of lead.

Figure 1



Use **Figure 1** to calculate the relative atomic mass of this sample of lead.
Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass _____

Do not write outside the box

0 2 . 6 A $^{207}Pb^{+}$ ion takes 7.460×10^{-6} s to travel along the flight tube.
The kinetic energy of the ion is 1.565×10^{-14} J

Calculate the length, in m, of the flight tube.

$$KE = \frac{1}{2} mv^2$$

$$v = \frac{d}{t}$$

KE = kinetic energy of the ion / J
m = mass of the ion / kg
v = velocity / m s^{-1}
d = length of flight tube / m
t = time of flight / s

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

[4 marks]

Length of flight tube _____ m

12

Do not write outside the box

0 3 This question is about magnesium and some reactions of magnesium.

0 3 . 1 Define standard enthalpy of formation.

[2 marks]

Table 2 shows some standard enthalpy of formation data.

Table 2

	$TiCl_4(g)$	$Mg(l)$	$MgCl_2(s)$	$Ti(s)$
$\Delta_f H^\ominus$ / kJ mol^{-1}	–720	+9	–642	0

0 3 . 2 State why the value for the standard enthalpy of formation of Mg(l) is **not** zero.

[1 mark]

Titanium can be obtained by reacting titanium(IV) chloride with magnesium.

$$TiCl_4(g) + 2\,Mg(l) \rightarrow Ti(s) + 2\,MgCl_2(s)$$

0 3 . 3 Use data from **Table 2** to calculate a value, in kJ mol^{-1}, for the standard enthalpy change for this reaction.

[2 marks]

Standard enthalpy change _____ kJ mol^{-1}

Do not write outside the box

0 3 . 4 State the role of magnesium in this reaction.

[1 mark]

_____

_____

Magnesium reacts with acids.

0 3 . 5 Write an equation for the reaction of magnesium with sulfuric acid.

[1 mark]

_____

0 3 . 6 Give a reagent that can be added to the products of the reaction in Question **03.5** to test for the anion present.

State what is observed.

[2 marks]

Reagent _____

Observation _____

_____

Question 3 continues on the next page

Do not write outside the box

Magnesium can displace copper from copper(II) sulfate solution.

$$Mg(s) + CuSO_4(aq) \rightarrow Cu(s) + MgSO_4(aq)$$

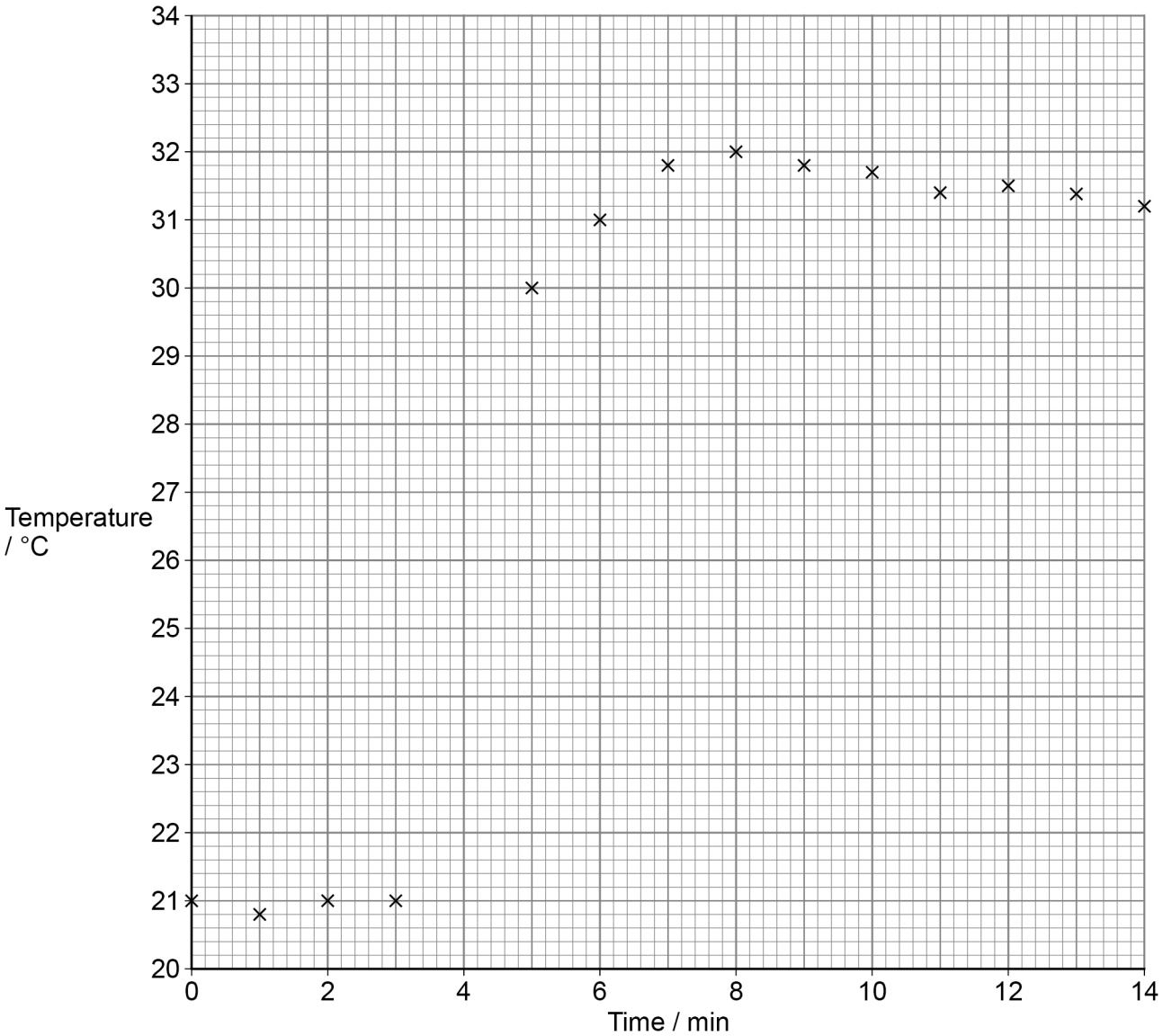
A student pours 25.0 cm^3 of 0.25 mol dm^{-3} copper(II) sulfate solution into a plastic cup and records the temperature of the solution every minute for 3 minutes.

At the fourth minute the student adds 0.5 g (an excess) of magnesium powder and stirs the mixture but does not take the temperature.

The student then records the temperature of the mixture at every minute from the fifth minute.

Figure 2 shows the student's measurements.

Figure 2



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0 3 . 7 Draw **two** appropriate best-fit lines on **Figure 2**.

Use these lines to determine the temperature change for the reaction at the time of mixing.

[3 marks]

Temperature change _____ °C

0 3 . 8 Use your answer to Question **03.7** to calculate the enthalpy change, in kJ mol^{-1}, for the reaction of magnesium with copper(II) sulfate solution.

You should assume that all of the heat energy is used to warm the solution.

The specific heat capacity of the solution is 4.18 J K^{-1} g^{-1}
The density of the solution is 1.0 g cm^{-3}

(If you could not answer Question **03.7** you should use the value 8.5 °C
This is **not** the correct value.)

[4 marks]

Enthalpy change _____ kJ mol^{-1}

16

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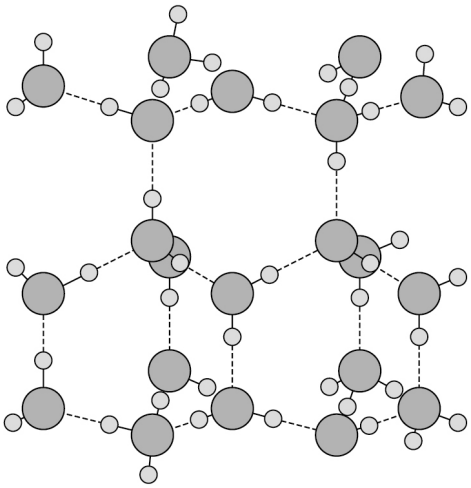
0 4 Water can exist as a solid, a liquid or a gas.

Figure 3 shows the arrangement of water molecules in ice.

Figure 3



0 4 . 1 Name the strongest intermolecular force in ice.

[1 mark]

_____

0 4 . 2 Use **Figure 3** to explain why ice is less dense than liquid water at 0 °C

[1 mark]

_____

_____

_____

Do not write outside the box

0 4 . 3 Germanium(II) chloride reacts with warm water to form germanium(II) oxide and hydrochloric acid.

$$GeCl_2(s) + H_2O(l) \rightarrow GeO(s) + 2\,HCl(aq)$$

2.18 g of germanium(II) chloride are added to water to form 250 cm^3 of solution.

Calculate the concentration, in mol dm^{-3}, of hydrochloric acid formed.
Give your answer to 3 significant figures.

[4 marks]

Concentration _____ mol dm^{-3}

0 4 . 4 Iron reacts with steam.

$$3\,Fe(s) + 4\,H_2O(g) \rightarrow Fe_3O_4(s) + 4\,H_2(g)$$

Calculate the minimum volume, in m^3, of steam at 450 °C and 100 kPa needed to react completely with 0.559 mol of iron.

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

[4 marks]

Volume _____ m^3

10

Do not write outside the box

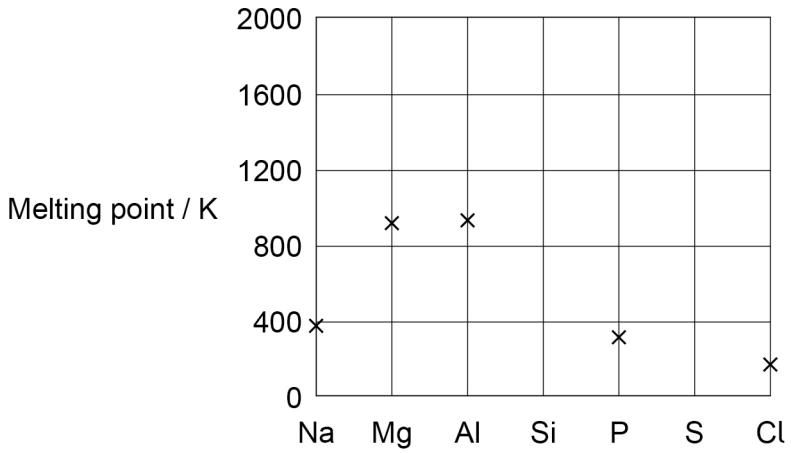
0 5 This question is about elements in Period 3.

0 5 . 1 State why aluminium conducts electricity.

[1 mark]

0 5 . 2 **Figure 4** shows the melting points of some elements in Period 3.

Figure 4



Draw crosses on **Figure 4** to mark the melting points for silicon and sulfur.

[2 marks]

0 5 . 3 Write an equation, including state symbols, for the process that occurs when the first ionisation energy of sulfur is measured.

[1 mark]

0 5 . 4 Explain why the first ionisation energy of sulfur is lower than the first ionisation energy of phosphorus.

[2 marks]

Do not write outside the box

0 5 . 5 Which Period 3 element has the highest **second** ionisation energy?

Tick (✓) **one** box.

[1 mark]

Argon ☐

Magnesium ☐

Sodium ☐

0 5 . 6 Draw the shape of the SCl_2 molecule.
Include any lone pairs that influence the shape.

Name the shape of the SCl_2 molecule.

[2 marks]

Shape

Name of shape _____

9

Do not write outside the box

0 6 This question is about the halogens and their compounds.

0 6 . 1 Van der Waals' forces exist between halogen molecules.

Explain how these forces arise.

[3 marks]

0 6 . 2 State and explain the trend in boiling points of the halogens from fluorine to iodine.

[3 marks]

Trend

Explanation

0 6 . 3 An important use of chlorine is in the treatment of drinking water supplies.

State why chlorine is added to drinking water supplies.

[1 mark]

Do not write outside the box

Aqueous solutions of unknown halogens X_2, Y_2 and Z_2 are added to aqueous solutions of sodium halides.

Table 3 shows the colours of the final solutions.

Table 3

Aqueous halogen	Final colour with NaCl(aq)	Final colour with NaBr(aq)	Final colour with NaI(aq)
X_2	orange	orange	brown
Y_2	pale green	orange	brown
Z_2	brown	brown	brown

0 6 . 4 Use **Table 3** to deduce the **decreasing** oxidising ability of the unknown halogens.

Tick (✓) **one** box.

[1 mark]

Y_2 Z_2 X_2 ☐

Y_2 X_2 Z_2 ☐

Z_2 X_2 Y_2 ☐

0 6 . 5 Write an equation for the reaction between Y_2 and aqueous sodium bromide.

[1 mark]

_____

0 6 . 6 Chlorine can be made by reacting $KMnO_4$ with concentrated HCl

The equation for the reaction is

$$2\,KMnO_4 + 16\,HCl \rightarrow 2\,KCl + 2\,MnCl_2 + 8\,H_2O + 5\,Cl_2$$

Use oxidation numbers to show that this is a redox reaction.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

0 6 . 7 Give a reagent that can be used to show that hydrochloric acid contains chloride ions.

State what is observed.

Write an ionic equation, including state symbols, for the reaction.

[3 marks]

Reagent _____

Observation _____

Ionic equation _____

Solid sodium halides react with concentrated sulfuric acid.

0 6 . 8 Write an equation for the reaction of solid sodium fluoride with concentrated sulfuric acid.

State the role of sulfuric acid in the reaction.

[2 marks]

Equation

_____

Role _____

0 6 . 9 Solid sodium iodide reacts with concentrated sulfuric acid to form the gas hydrogen sulfide that smells of bad eggs.

Write an equation for this reaction.

[1 mark]

_____

17

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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