OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS

CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Wednesday 8 May 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	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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

0 1 This question is about zinc.

0 1 . 1 Complete the electron configuration for an atom of zinc.

[1 mark]

$1s^2$ _____

0 1 . 2 State the number of full 3d orbitals in an ion of Zn^{2+}

[1 mark]

_____

0 1 . 3 An atom of a different element has two more protons and three more neutrons than an atom of ^{65}Zn

Give the symbol and the mass number of this atom.

[2 marks]

_____

0 1 . 4 State why zinc is a good conductor of electricity.

[1 mark]

_____

_____

_____

A sample of zinc contains three isotopes, ^{64}Zn, ^{66}Zn and ^{68}Zn

0 1 . 5 Explain why these isotopes have the same chemical reactions.

[1 mark]

_____

_____

_____

Question 1 continues on the next page

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0 1 . 6 The sample is ionised by electron impact and then analysed using time of flight (TOF) mass spectrometry.

The ions are accelerated to a kinetic energy (*KE*) of 1.25×10^{-16} J
They travel down a 0.650 m flight tube.

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

m = mass / kg
v = velocity / ms^{-1}

Calculate the mass, in kg, of a $^{64}Zn^+$ ion.

Calculate the time, in s, for a $^{64}Zn^+$ ion to travel through the flight tube.

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

[4 marks]

Mass of a $^{64}Zn^+$ ion _____ kg

Time to travel through the flight tube _____ s

Do not write outside the box

0 1 . 7 **Table 1** shows the data from the mass spectrum of the sample of zinc.

Table 1

$\frac{m}{z}$	**Relative intensity**
64	2.8
66	1.6
68	1.0

Calculate the relative atomic mass (A_r) of zinc.
Give your answer to 1 decimal place.

[2 marks]

A_r _____

12

Turn over for the next question

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0 2 Sodium hydrogencarbonate reacts with sulfuric acid.

$$2\,NaHCO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2\,H_2O(l) + 2\,CO_2(g)$$

A student analyses some impure sodium hydrogencarbonate in a titration experiment. The impurity is unreactive.

Step 1 The student weighs a 2.21 g sample of impure sodium hydrogencarbonate and dissolves the solid in distilled water in a beaker.

Step 2 The student transfers the solution, with washings, to a 100 cm^3 volumetric flask and makes up to the mark with distilled water.

Step 3 The student transfers 25.0 cm^3 of the solution into a conical flask using a pipette.

Step 4 The student adds a few drops of an indicator to the conical flask and adds 0.100 mol dm^{-3} sulfuric acid from a burette until the indicator changes colour.

Step 5 The student repeats **Steps 3** and **4** twice.

Table 2 shows the results of the titrations.

Table 2

	1	**2**	**3**
Final volume / cm^3	35.40	40.25	37.65
Initial volume / cm^3	3.00	8.00	5.45
Titre / cm^3	32.40	32.25	32.20

0 2 . 1 Use suitable values from **Table 2** to calculate the mean titre.

[1 mark]

Mean titre _____ cm^3

Do not write outside the box

0 2 . 2 Use your answer to Question **02.1** to calculate the percentage, by mass, of sodium hydrogencarbonate in the sample.
Give your answer to 3 significant figures.

[5 marks]

_____ %

0 2 . 3 Describe a method to determine the accurately known mass of solid added to the beaker in **Step 1**.

[2 marks]

_____

_____

_____

_____

_____

_____

0 2 . 4 State why the student used a conical flask rather than a beaker for the titration in **Step 4**.

[1 mark]

_____

_____

Question 2 continues on the next page

Do not write outside the box

0 2 . 5 Sodium sulfate is a solid with a high melting point.

Explain why the melting point of sodium sulfate is high.

[2 marks]

_____

_____

_____

_____

_____

0 2 . 6 At high temperatures sodium sulfate reacts with carbon to form sodium sulfide and carbon dioxide.

$$Na_2SO_4(s) + 2C(s) \rightarrow Na_2S(s) + 2CO_2(g)$$

3.28 g of sodium sulfate are reacted with an excess of carbon.
4850 cm^3 of carbon dioxide are formed at a pressure of 100 kPa

Calculate the temperature, in °C, of the carbon dioxide.

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

[6 marks]

_____ °C

17

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0 3 This question is about Period 2 elements.

0 3 . 1 **Table 3** shows the first ionisation energies of some Period 2 elements.

Table 3

Element	**First ionisation energy / kJ mol^{-1}**
Lithium	519
Beryllium	900
Boron	To be predicted
Carbon	1088
Nitrogen	1402

Predict the value of the first ionisation energy of boron.

Explain your answer in terms of atomic structure.

[3 marks]

First ionisation energy of boron _____ kJ mol^{-1}

Explanation _____

_____

_____

_____

Question 3 continues on the next page

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0 3 . 2 **Table 4** shows the electronegativity values for some of the elements in Period 2.

Table 4

	Li	Be	B	C	N	O	F
Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0

Suggest why electronegativity values increase across Period 2.

[2 marks]

_____

_____

_____

_____

0 3 . 3 Draw the shape of a molecule of boron trifluoride, BF_3
Include any lone pairs, if any, that influence the shape.

Explain why a molecule of boron trifluoride is non-polar, although a B—F bond is polar.

[3 marks]

Shape

Explanation _____

_____

_____

_____

_____

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0 3 . 4 A boron trifluoride molecule reacts with a fluoride ion to form a BF_4^- ion.

Name the type of bond formed when BF_3 reacts with a fluoride ion.

Explain how this bond is formed.

[2 marks]

Name of bond _____

Explanation _____

_____

_____

_____

_____

_____

10

Turn over for the next question

Do not write outside the box

0 4 This question is about the standard enthalpy of combustion of propanone, CH_3COCH_3

$$CH_3COCH_3(l) + 4\,O_2(g) \rightarrow 3\,CO_2(g) + 3\,H_2O(l)$$

0 4 . 1 Define standard enthalpy of combustion.

[2 marks]

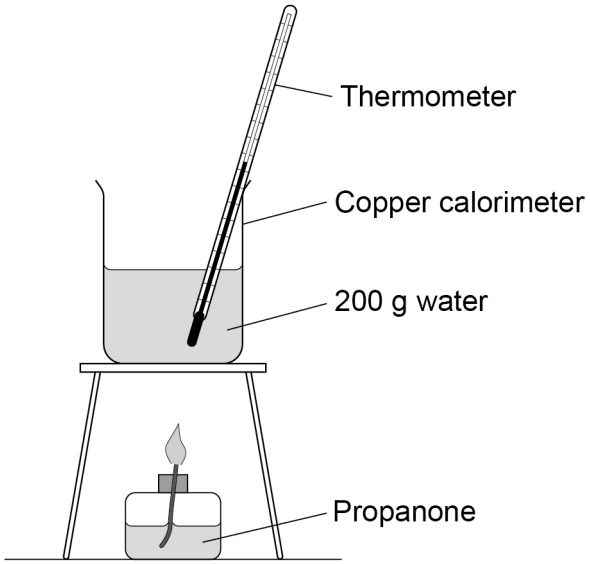
_____

_____

_____

_____

0 4 . 2 In a calorimetry experiment, 1.027 g of propanone are burned in oxygen. The heat given out is used to increase the temperature of 200 g of water from 19 °C to 42 °C



Calculate a value, in kJ mol^{-1}, for the enthalpy of combustion of propanone.
The specific heat capacity of water is 4.18 J K^{-1} g^{-1}

[4 marks]

Enthalpy of combustion _____ kJ mol^{-1}

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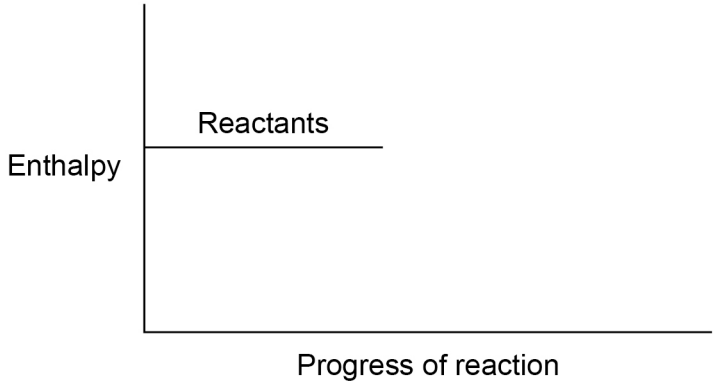
0 4 . 3 Complete the enthalpy level diagram for the combustion of propanone.

[1 mark]



0 4 . 4 Suggest why a copper calorimeter is used rather than a glass beaker.

[1 mark]

In a data book, the value for the enthalpy of combustion for propanone is –1792 kJ mol^{-1}

0 4 . 5 Give one reason, other than heat loss, why the value obtained in Question **04.2** is different from the value given in the data book.

[1 mark]

Question 4 continues on the next page

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0 4 . 6 The standard enthalpy of combustion of propanone can be used to calculate the standard enthalpy of formation of propanone.

The equation for the standard enthalpy of formation of propanone is

$$3\,C(s) + 3\,H_2(g) + \frac{1}{2}O_2(g) \longrightarrow CH_3COCH_3(l)$$

Table 5 shows some standard enthalpy of combustion data.

Table 5

	C(s)	**H_2(g)**	**CH_3COCH_3(l)**
$\Delta_c H^{\ominus}$ / kJ mol^{-1}	–394	–286	–1792

Use the data in **Table 5** to calculate the standard enthalpy of formation, in kJ mol^{-1}, of propanone.

[2 marks]

Standard enthalpy of formation _____ kJ mol^{-1}

11

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Turn over for the next question

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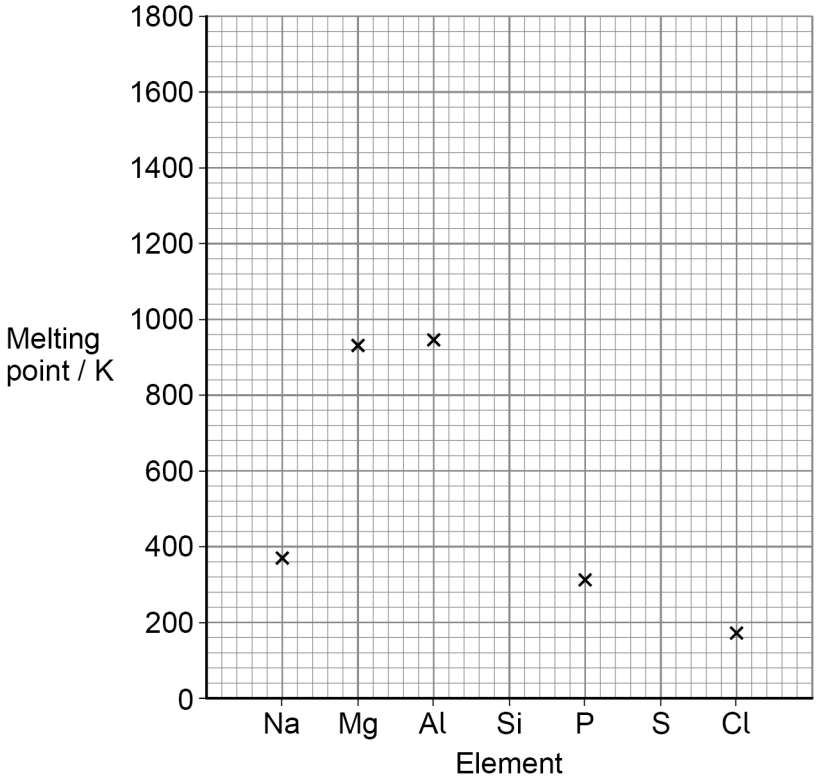
0 5 This question is about the Period 3 elements, sodium to chlorine, and their compounds.

0 5 . 1 **Figure 1** shows the melting points of some of the elements in Period 3.

Figure 1



Draw crosses on **Figure 1** to mark the melting points for silicon **and** sulfur.

[2 marks]

0 5 . 2 In terms of structure and bonding, explain why magnesium has a higher melting point than sodium.

[2 marks]

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0 5 . 3 In terms of structure and bonding, explain why phosphorus has a higher melting point than chlorine.

[2 marks]

_____

_____

_____

_____

0 5 . 4 Which of these elements has the largest atomic radius?

Tick (✓) **one** box.

[1 mark]

sodium ☐

silicon ☐

sulfur ☐

0 5 . 5 Chlorine reacts with cold, dilute aqueous sodium hydroxide.

Write an equation for the reaction.

[1 mark]

_____

0 5 . 6 Chlorine reacts with an aqueous sodium halide to form a black solid in a dark brown solution.

Identify the sodium halide.

Write an ionic equation for the reaction.

[2 marks]

Identity of sodium halide _____

Ionic equation

_____

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0 5 . 7 Sodium chloride dissolves in water to form a colourless solution.

A student adds dilute acid and another reagent to show that the colourless solution contains chloride ions.

Give the formula of this other reagent.

Give one observation the student would make.

[2 marks]

Formula of reagent _____

Observation _____

0 5 . 8 Solid sodium bromide reacts with concentrated sulfuric acid in a redox reaction.

Write an equation for this reaction.

State **one** observation.

[2 marks]

Equation

_____

Observation _____

14

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0 6 This question is about redox reactions containing manganese compounds. MnO_2 reacts, in acidic conditions, with iodide ions to form iodine.

0 6 . 1 Write a half-equation to show the conversion of iodide ions into iodine.

[1 mark]

_____

0 6 . 2 Write a half-equation to show the conversion of MnO_2, in acidic conditions, into Mn^{2+}

[1 mark]

_____

0 6 . 3 Write an overall ionic equation for the reaction of MnO_2, in acidic conditions, with iodide ions.

[1 mark]

_____

MnO_4^{2-} reacts, in acidic conditions, as shown in the equation.

$$3\,MnO_4^{2-} + 4\,H^+ \rightarrow 2\,MnO_4^- + MnO_2 + 2\,H_2O$$

0 6 . 4 Give the oxidation state of manganese in MnO_4^{2-} **and** in MnO_4^-

[1 mark]

Oxidation state of Mn in MnO_4^{2-} _____

Oxidation state of Mn in MnO_4^- _____

Question 6 continues on the next page

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0 6 . 5 In the extraction of manganese from Mn_3O_4, aluminium acts as a reducing agent and forms Al_2O_3

State, in terms of electrons, the meaning of reducing agent.

Write an equation for the overall reaction.

[2 marks]

Meaning of reducing agent _____

_____

Equation

_____

6

END OF QUESTIONS

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