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

Monday 6 January 2025 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	

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

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0 1 This question is about atomic structure.

0 1 . 1 **Table 1** shows the relative charge of a proton and the relative mass of an electron.

Complete **Table 1**.

[2 marks]

Table 1

	Proton	**Electron**	**Neutron**
Relative charge	+1		
Relative mass		1	

0 1 . 2 An atom has two more protons and two more neutrons than an atom of ^{30}Si
Give the symbol of the atom, including mass number.

[1 mark]

0 1 . 3 Complete the electron configuration for a S atom and for a V^{2+} ion.

[2 marks]

S [Ne] _____

V^{2+} [Ar] _____

0 1 . 4 In terms of sub-atomic particles, explain how isotopes of an element differ.
State why these isotopes have the same chemical reactions.

[2 marks]

How isotopes differ _____

_____

Why same chemical reactions _____

_____

7

Turn over ►

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0 2 This question is about carbon monoxide.

0 2 . 1 State the type of crystal structure of solid carbon monoxide.

[1 mark]

0 2 . 2 Carbon monoxide is formed in a reaction from ethene (C_2H_4).

$$C_2H_4(g) + 2O_2(g) \rightarrow 2CO(g) + 2H_2O(g) \quad \Delta H^{\ominus} = -758 \text{ kJ mol}^{-1}$$

Table 2 shows some standard enthalpy of formation data.

Table 2

	$C_2H_4(g)$	**$H_2O(g)$**
$\Delta_f H^{\ominus}$ / kJ mol^{-1}	+52	−242

State Hess's Law.

Use Hess's Law and the data in **Table 2** to calculate the standard enthalpy of formation, in kJ mol^{-1}, of carbon monoxide.

[4 marks]

Hess's Law

Calculation

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

Do not write outside the box

0 2 . 3 Carbon monoxide burns in oxygen to form carbon dioxide.

$$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g) \quad \Delta H^{\ominus} = -283 \text{ kJ mol}^{-1}$$

The bond enthalpy for O═O is 496 kJ mol^{-1}
The mean bond enthalpy for C═O in carbon dioxide is 804 kJ mol^{-1}

Calculate the bond enthalpy, in kJ mol^{-1}, for the bond between the carbon atom and the oxygen atom in carbon monoxide.

[2 marks]

Bond enthalpy _____ kJ mol^{-1}

0 2 . 4 Suggest why the value for O═O is **not** given as a mean bond enthalpy.

[1 mark]

_____

_____

0 2 . 5 The boiling point of carbon monoxide is 82 K

Explain why the boiling point of carbon monoxide is low.

[2 marks]

_____

_____

_____

_____

10

Turn over ►

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0 3 This question is about how time of flight (TOF) mass spectrometry is used to analyse a sample of platinum (Pt).

0 3 . 1 Write an equation, including state symbols, to show how platinum atoms are ionised by electron impact in a TOF mass spectrometer.

[1 mark]

After ionisation, the platinum ions are accelerated.

0 3 . 2 State how the ions are accelerated in a mass spectrometer.

[1 mark]

0 3 . 3 All the platinum ions have the same charge.

What common property do the accelerated ions have?

Tick (✓) **one** box.

[1 mark]

Same *m/z* ratio ☐

Same speed ☐

Same kinetic energy ☐

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0 3 . 4 In the TOF mass spectrometer $^{195}Pt^{+}$ ions have a kinetic energy of 1.54×10^{-14} J
The ions take 4.87×10^{-6} s to travel along the flight tube.

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

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

KE = kinetic energy of the ion / J
m = mass of the ion / kg
v = speed / m s^{-1}

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

[4 marks]

Length of flight tube _____ m

0 3 . 5 The relative atomic mass of Pt in this sample is different from the relative atomic mass given on the Chemistry Data Sheet.

Suggest why there is a difference.

[1 mark]

_____

_____

8

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0 4 **Table 3** shows the electronegativity values of some atoms.

Table 3

	Hydrogen	Carbon	Nitrogen	Oxygen	Fluorine	Arsenic
Electronegativity	2.1	2.5	3.0	3.5	4.0	2.0

0 4 . 1 Explain why the electronegativity of oxygen is greater than the electronegativity of nitrogen.

[2 marks]

0 4 . 2 Give the formula of the compound that contains the least polar bonds that can be formed from two of the elements in **Table 3**.

[1 mark]

0 4 . 3 Explain why the CF_4 molecule is non-polar even though the C–F bond is polar.

[1 mark]

Do not write outside the box

0 4 . 4 Draw the shape of the BrF_4^- ion.
Include any lone pairs of electrons that influence the shape.

Name the shape of the BrF_4^- ion.

Deduce the bond angle in the BrF_4^- ion.

[3 marks]

Shape

Name of shape _____

Bond angle _____

7

Turn over for the next question

Do not write outside the box

0 5 The identity of the unknown metal (**Q**) in the metal carbonate ($\mathbf{Q}_2CO_3$) can be determined by titration of an aqueous solution of the metal carbonate with nitric acid.

$$\mathbf{Q}_2CO_3(aq) + 2\,HNO_3(aq) \rightarrow 2\,\mathbf{Q}NO_3(aq) + CO_2(g) + H_2O(l)$$

- 2.03 g of $\mathbf{Q}_2CO_3$ are dissolved in distilled water and the solution made up to 250 cm^3 in a volumetric flask.
- 25.0 cm^3 samples of this solution are titrated with 0.100 mol dm^{-3} nitric acid using methyl orange as indicator.

Table 4 shows the results of the titrations.

Table 4

	1	**2**	**3**	**4**
Final burette reading / cm^3	32.15	29.55	31.75	31.00
Initial burette reading / cm^3	0.00	0.15	2.50	1.55
Titre / cm^3	32.15	29.40	29.25	29.45

0 5 . 1 State why the mean titre, to be used in the calculation, is 29.43 cm^3

[1 mark]

0 5 . 2 Use the mean titre in Question **05.1** and the information given to identify metal **Q**.

[6 marks]

Identity of **Q** _____

Do not write outside the box

A student uses this method to prepare a solution of known concentration of $\mathbf{Q}_2CO_3$

a) Weigh a bottle containing a sample of $\mathbf{Q}_2CO_3$, tip some $\mathbf{Q}_2CO_3$ solid into a beaker and reweigh the bottle.

b) Add some distilled water to the beaker and dissolve the $\mathbf{Q}_2CO_3$

c) Pour the solution into a volumetric flask and make up to 250 cm^3 with distilled water.

d) Put a stopper in the flask.

There are **two** mistakes in the student's method.

0 5 . 3 Identify the **two** mistakes.

State the problem caused by each mistake.

[4 marks]

Mistake 1 _____

Problem caused _____

_____

Mistake 2 _____

Problem caused _____

_____

0 5 . 4 When the student transfers the solution into the volumetric flask, in step c), a few drops of solution are poured on to the bench.
The student continues to make the solution up to 250 cm^3 with distilled water.

How does this affect the titre?

Tick (✓) **one** box.

[1 mark]

The titre would be bigger. ☐

The titre would be unchanged. ☐

The titre would be smaller. ☐

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0 6 This question is about the chemistry of Group 2 and Group 7 elements.

0 6 . 1 A piece of barium is added to some water.

State **two** observations.

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

[3 marks]

Observation 1 _____

Observation 2 _____

Equation

_____

0 6 . 2 A solution of barium chloride is added to a solution of sodium sulfate.

Describe what is observed.

Write an ionic equation for the reaction.

[2 marks]

Observation _____

Equation

_____

0 6 . 3 Chlorine dissolves in water to give a pale green solution.

Give the formula of the species that causes the solution to be pale green.

Write an equation for the reaction of chlorine with water in the absence of sunlight.

[2 marks]

Formula of species _____

Equation

_____

Do not write outside the box

0 6 . 4 Give a reagent and an observation that can be used to confirm the presence of chloride ions in aqueous solution.

[2 marks]

Reagent _____

Observation _____

0 6 . 5 Concentrated sulfuric acid is added to solid sodium chloride.

Describe what is observed.

Write an equation for the reaction.

State the role of the sulfuric acid.

[3 marks]

Observation _____

Equation

_____

Role of sulfuric acid _____

0 6 . 6 Solid sodium iodide reacts with concentrated sulfuric acid to produce a gas that smells of bad eggs.

Give the formula of this gas.

Write an ionic equation to show how iodide ions react with concentrated sulfuric acid to form this gas.

State the role of the iodide ion in this reaction.

[3 marks]

Formula of gas _____

Ionic equation

_____

Role of iodide ion _____

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0 7 This question is about manganese and manganese compounds.

0 7 . 1 Manganese is a metal with a high melting point.

Explain, in terms of structure and bonding, why manganese has a high melting point.

[2 marks]

MnO_4^{2-} ions react, in acidic solution, to form MnO_2 and MnO_4^- ions.

0 7 . 2 State the oxidation state of Mn in MnO_4^{2-}

[1 mark]

0 7 . 3 Write a half-equation for the reaction of MnO_4^{2-} ions, in acidic solution, to form MnO_2

[1 mark]

0 7 . 4 Write a half-equation for the reaction of MnO_4^{2-} ions to form MnO_4^- ions.

[1 mark]

0 7 . 5 Use your answers to Questions **07.3** and **07.4** to write an equation for the reaction of MnO_4^{2-} ions, in acidic solution, to form MnO_2 and MnO_4^- ions.

[1 mark]

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0 7 . 6 Solid $KMnO_4$ decomposes when heated.

$$2\,KMnO_4(s) \rightarrow K_2MnO_4(s) + MnO_2(s) + O_2(g)$$

Calculate the mass, in g, of $KMnO_4$ that decomposes to form 750 cm^3 of O_2 measured at 240 °C and 100 kPa

Give your answer to 3 significant figures.

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

[5 marks]

Mass _____ g

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END OF QUESTIONS

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