OXFORD

INTERNATIONAL
AQA EXAMINATIONS

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

Friday 6 January 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	

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

Do not write outside the box

0 1 This question is about some reactions of halide ions.

A student adds a few drops of acidified silver nitrate solution to a few drops of a solution of a potassium halide.
A cream precipitate forms.

0 1 . 1 State why the silver nitrate solution is acidified.

Identify an acid that can be used.

[2 marks]

Why acidified _____

_____

Identity of acid _____

0 1 . 2 Identify the cream precipitate.

[1 mark]

_____

0 1 . 3 Give a further reagent that the student could add to confirm the identity of the halide ion in the precipitate.

State what the student would observe.

[2 marks]

Test _____

Observation _____

Do not write outside the box

The student adds a few drops of concentrated sulfuric acid to some solid sodium iodide.
Hydrogen sulfide and iodine are formed.

0 1 . 4 Write a half equation to show the formation of hydrogen sulfide from sulfuric acid.

[1 mark]

0 1 . 5 Write a half equation to show the formation of iodine from iodide ions.

[1 mark]

0 1 . 6 Use your answers to Questions **01.4** and **01.5** to write an overall ionic equation for the reaction between concentrated sulfuric acid and iodide ions.

[1 mark]

0 1 . 7 State the role of concentrated sulfuric acid in this reaction.

[1 mark]

0 1 . 8 When concentrated sulfuric acid is added to solid sodium fluoride, steamy fumes form.

Write an equation for this reaction.

Explain why sodium fluoride reacts differently from sodium iodide with sulfuric acid.

[2 marks]

Equation

Explanation

11

Turn over ►

Do not write outside the box

0 2 This question is about copper.

0 2 . 1 State the full electron configuration of a copper atom.

[1 mark]

0 2 . 2 A sample of copper contains only two isotopes, ^{63}Cu and ^{65}Cu
The sample of copper has a relative atomic mass of 63.8

Calculate the percentage abundance of ^{65}Cu in the sample.

[2 marks]

Abundance of ^{65}Cu _____ %

A sample of copper is ionised by electron impact in a time of flight (TOF) mass spectrometer.

0 2 . 3 Write an equation, including state symbols, to show how the copper atoms are ionised by electron impact.

[1 mark]

Do not write outside the box

0 2 . 4 Complete **Table 1** to show the number of neutrons and electrons in a $^{65}Cu^{+}$ ion.

Use the Periodic Table on the Chemistry Data Sheet.

[1 mark]

Table 1

	Number of neutrons	**Number of electrons**
$^{65}Cu^{+}$		

0 2 . 5 Calculate the time taken for a $^{65}Cu^{+}$ ion with kinetic energy of 2.75×10^{-16} J to travel along a flight tube of length 80 cm
Give your answer to 3 significant figures.

The Avogadro Constant, $L = 6.02 \times 10^{23}$ mol^{-1}

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

KE = kinetic energy / J
m = mass / kg
v = velocity / m s^{-1}

[4 marks]

Time _____ s

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 How does the time of flight of the $^{63}Cu^{+}$ ion compare to the time of flight of the $^{65}Cu^{+}$ ion?

Tick (✓) **one** box.

[1 mark]

$^{63}Cu^{+}$ has a longer time of flight than $^{65}Cu^{+}$ ☐

$^{63}Cu^{+}$ has the same time of flight as $^{65}Cu^{+}$ ☐

$^{63}Cu^{+}$ has a shorter time of flight than $^{65}Cu^{+}$ ☐

10

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Turn over for the next question

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0 3 This question is about compounds that contain atoms of the element hydrogen.

0 3 . 1 Draw a diagram to show the strongest type of interaction between a molecule of ammonia and a molecule of water.

Include all lone pairs and partial charges in your diagram.

[3 marks]

0 3 . 2 Ammonia reacts with aluminium chloride to form the compound H_3NAlCl_3

Draw the structure of H_3NAlCl_3
Show each covalent bond as a line (–) and each co-ordinate bond as an arrow (→).

[2 marks]

0 3 . 3 Sodium amide ($NaNH_2$) contains the amide ion, NH_2^-

Draw the shape of the amide ion, NH_2^-
Include any lone pairs that influence the shape.

State the bond angle.

[2 marks]

Shape

Bond angle _____

Do not write outside the box

0 3 . 4 Balance the equation for the combustion of sodium amide in oxygen.

[1 mark]

$$\_\_\_\_NaNH_2 + 7\,O_2 \rightarrow \_\_\_\_Na_2O + \_\_\_\_NO_2 + \_\_\_\_H_2O$$

0 3 . 5 The boiling points of hydrogen sulfide and hydrogen are shown in **Table 2**.

Table 2

Substance	Boiling point / K
Hydrogen sulfide	212
Hydrogen	20

Explain the difference in boiling points.

[3 marks]

11

Turn over for the next question

0 4 A student determines the concentration of some hydrochloric acid in a titration using a 0.150 mol dm^{-3} standard solution of sodium carbonate.

$$Na_2CO_3(aq) + 2\,HCl(aq) \rightarrow 2\,NaCl(aq) + CO_2(g) + H_2O(l)$$

Method

Step 1 Rinse a pipette with the sodium carbonate solution.
Transfer 25.0 cm^3 of the sodium carbonate solution into a conical flask and add methyl orange indicator.

Step 2 Rinse a burette with hydrochloric acid and then fill the burette with hydrochloric acid.

Step 3 Add the hydrochloric acid from the burette to the conical flask until the indicator changes colour.

Step 4 Repeat the titration until sufficient results are obtained.

Table 3 shows the titration results.

Table 3

	1	**2**	**3**	**4**
Final volume of HCl / cm^3	32.30	48.35	36.45	36.40
Initial volume of HCl / cm^3	0.00	17.25	5.10	5.20
Titre / cm^3	32.30	31.10	31.35	31.20

Do not write outside the box

0 4 . 1 Select appropriate results and use them to calculate the mean titre.

[1 mark]

_____ cm^3

0 4 . 2 Use your answer to Question **04.1** and the equation for the reaction to calculate the concentration of the hydrochloric acid.

[3 marks]

Concentration _____ mol dm^{-3}

The standard sodium carbonate solution is prepared as follows.

A known mass of sodium carbonate is weighed and put in a beaker.
The solid is dissolved in water and the solution transferred to a 250 cm^3 volumetric flask. Distilled water is added to make 250 cm^3 of solution.

0 4 . 3 Calculate the mass, in g, of Na_2CO_3 needed to make 250 cm^3 of 0.150 mol dm^{-3} sodium carbonate solution.

[2 marks]

_____ g

Do not write outside the box

0 4 . 4 State two ways that the student could make sure that the mass of sodium carbonate in the volumetric flask is known exactly.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 5 In **Steps 1** and **2**, the pipette and burette are rinsed before use.

State why they are rinsed before use.

[1 mark]

_____

_____

_____

0 4 . 6 In **Step 3**, the student adds hydrochloric acid from the burette to the conical flask until the indicator changes colour.

State what the student should do in this step to ensure an accurate titre.

[1 mark]

_____

_____

_____

0 4 . 7 The student wants to get a pure solution of sodium chloride using this reaction. Suggest how this can be done.

[2 marks]

_____

_____

_____

_____

_____

Do not write outside the box

0 4 . 8 In a different experiment, a student reacts solid sodium carbonate with an excess of hydrochloric acid and collects the carbon dioxide formed.

$$Na_2CO_3(s) + 2\,HCl(aq) \rightarrow 2\,NaCl(aq) + CO_2(g) + H_2O(l)$$

Calculate the amount, in moles, of sodium carbonate needed to form 95.0 cm^3 of carbon dioxide, measured at 298 K and 101 kPa

Give your answer to 3 significant figures.

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

[3 marks]

Amount _____ mol

15

Turn over for the next question

Do not write outside the box

0 5 This question is about energetics.

0 5 . 1 State Hess's law.

[1 mark]

0 5 . 2 Manganese can be extracted from Mn_2O_3 by reaction with carbon monoxide at high temperatures.

$$Mn_2O_3(s) + 3\,CO(g) \rightarrow 2\,Mn(s) + 3\,CO_2(g) \qquad \Delta H^{\ominus} = +122 \text{ kJ mol}^{-1}$$

Table 4 shows some standard enthalpy of formation data.

Table 4

	$Mn_2O_3(s)$	**Mn(s)**	**$CO_2(g)$**
Standard enthalpy of formation / kJ mol^{-1}	−971	0	−394

Use the data in **Table 4** and the enthalpy change for the reaction to calculate a value for the standard enthalpy of formation, in kJ mol^{-1}, for carbon monoxide.

[3 marks]

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

0 5 . 3 State why the standard enthalpy of formation of Mn(s) is zero.

[1 mark]

Do not write outside the box

0 5 . 4 Write an equation, including state symbols, for the reaction that has an enthalpy change equal to the standard enthalpy of formation for CO(g)

Suggest why it is difficult to measure the standard enthalpy of formation of carbon monoxide.

[2 marks]

Equation

Suggestion

0 5 . 5 Carbon monoxide (C≡O) reacts with hydrogen to form methane.

$$CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g) \quad \Delta H = -206 \text{ kJ mol}^{-1}$$

Table 5 shows some bond enthalpy values.

Table 5

Bond	C≡O	H–H	O–H
Bond enthalpy / kJ mol^{-1}	1070	436	464

Use the equation and **Table 5** to calculate a value for the bond enthalpy of the C–H bond in methane.

[3 marks]

Bond enthalpy _____ kJ mol^{-1}

0 5 . 6 Suggest why the data book value for the bond enthalpy of the C–H bond is different from your answer to Question **05.5**.

[1 mark]

11

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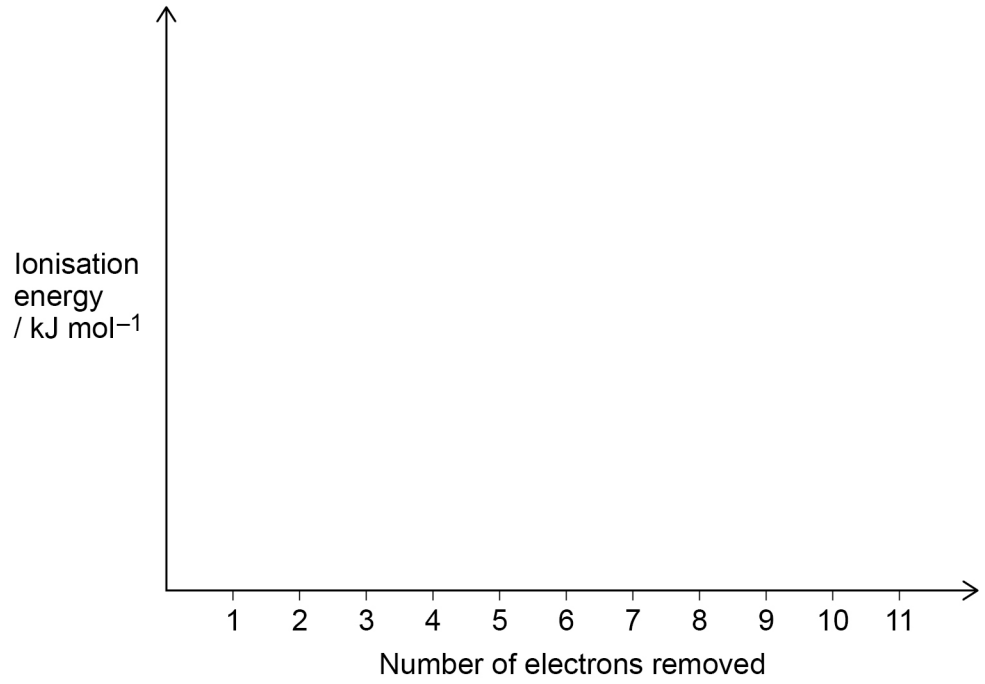
0 6 This question is about the elements in Period 3.

0 6 . 1 On the axes, sketch a graph to show the successive ionisation energies of sodium.



[2 marks]

0 6 . 2 Explain, in terms of structure and bonding, why the melting point of magnesium is higher than the melting point of sodium.

[2 marks]

Do not write outside the box

Magnesium can be used in the extraction of titanium.

0 6 . 3 Write an equation to show how magnesium is used to extract titanium from titanium(IV) chloride**.**

[1 mark]

0 6 . 4 After the extraction of titanium in Question **06.3**, the unreacted magnesium can be removed using an aqueous solution of sulfuric acid to form magnesium sulfate.
The titanium does not react with the acid.

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

State why magnesium sulfate can be separated easily from titanium.

[2 marks]

Equation

Why separated easily

0 6 . 5 The melting point of titanium chloride is 214 K
The melting point of sodium chloride is 1074 K

Which of the following shows the correct type of bonding in each compound?

Tick **one** (✓) box.

[1 mark]

Titanium(IV) chloride	**Sodium chloride**	**Tick** (✓)
ionic	covalent	
ionic	ionic	
covalent	ionic	

0 6 . 6 Identify the element in Period 3 that has the highest melting point.

[1 mark]

Do not write outside the box

0 6 . 7 Identify the element in Period 3, from sodium to chlorine, that has the largest atomic radius.

[1 mark]

Table 6 shows the electronegativity values of some Period 3 elements.

Table 6

	Si	P	S	Cl
Electronegativity	1.9	2.2	2.6	3.2

0 6 . 8 State the meaning of electronegativity.

[1 mark]

0 6 . 9 Use the data in **Table 6** to suggest the formula of the compound with the most polar bonds formed by two of these elements.

[1 mark]

12

END OF QUESTIONS

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