

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL AS CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Thursday 6 January 2022 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.

0 1

This question is about some elements in Period 3.

Table 1 shows data about some elements in Period 3.

Table 1

Element	First ionisation energy / kJ mol^{-1}	Atomic radius / nm
magnesium	736	–
aluminium	577	–
silicon	786	0.117
phosphorus	1060	0.110
sulfur	1000	0.104

0 1 . 1

Explain why the first ionisation energy of aluminium is less than the first ionisation energy of magnesium.

[2 marks]

0 1 . 2

Explain why the first ionisation energy of sulfur is less than the first ionisation energy of phosphorus.

[2 marks]



0 1 . 3 Identify the element in Period 3 that has the highest **third** ionisation energy.

[1 mark]

0 1 . 4 Explain the decrease in atomic radius of the elements silicon, phosphorus and sulfur.

[2 marks]

7

Turn over for the next question

Turn over ►



0 2

This question is about fluorine and its compounds.

0 2 . 1

State the meaning of the term electronegativity.

[1 mark]

0 2 . 2Draw the shape of a SeF_2 molecule and of a SeF_4 molecule.

Include any lone pairs of electrons that affect the shapes of the molecules.

[2 marks]

SeF_2	SeF_4

0 2 . 3Van der Waals' forces exist between molecules of SeF_2

Explain how these forces arise.

[3 marks]



0 2 . 4 Explain how a lone pair of electrons in a molecule of NF_3 affects the bond angle in the molecule.

[2 marks]

0 2 . 5 Boron reacts with fluorine to form the compound BF_3
Boron is solid at 298 K

Write an equation, including state symbols, for the reaction that has an enthalpy change equal to the standard enthalpy of formation for $\text{BF}_3(\text{g})$

[1 mark]

0 2 . 6 BF_3 molecules are trigonal planar.

A molecule of BF_3 reacts with a fluoride ion to form a BF_4^- ion.

State the bond angle in the BF_3 molecule.

Describe how the bond between a BF_3 molecule and a fluoride ion is formed.

[2 marks]

Bond angle in BF_3 _____

How bond is formed _____

Question 2 continues on the next page

Turn over ►



Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

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0 3

This question is about magnesium.

0 3 . 1

Give the full electron configuration of magnesium.

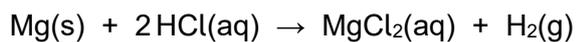
[1 mark]**0 3 . 2**

Magnesium is used in the extraction of titanium metal from titanium(IV) chloride.

Write an equation for this reaction.

[1 mark]**0 3 . 3**

A sample of magnesium reacts completely with an excess of hydrochloric acid to form hydrogen.

At 298 K and 101 kPa, the hydrogen formed has a volume of 149 cm³Calculate the mass, in g, of the sample of magnesium.
Give your answer to 3 significant figures.The gas constant, $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ **[4 marks]**

Mass _____ g



0 3 . 4

Calculate the minimum volume, in dm^3 , of $0.500 \text{ mol dm}^{-3}$ hydrochloric acid needed to react completely with all the sample of magnesium.

[2 marks]Volume _____ dm^3

0 3 . 5

Magnesium reacts slowly with cold water to form magnesium hydroxide.

State **one** use of magnesium hydroxide.

[1 mark]

0 3 . 6

Magnesium hydroxide decomposes on heating to form magnesium oxide.

Deduce an equation for the reaction.

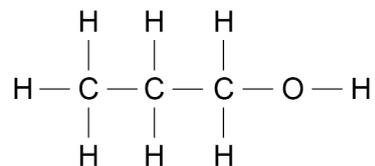
[1 mark]

10**Turn over for the next question****Turn over ►**

0 4

This question is about energetics.

Propan-1-ol has the structure



Propan-1-ol burns according to the equation

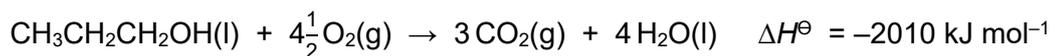


Table 2 shows some standard enthalpies of formation, $\Delta_f H^\ominus$

Table 2

	$\Delta_f H^\ominus / \text{kJ mol}^{-1}$
$\text{CO}_2(\text{g})$	-394
$\text{H}_2\text{O}(\text{l})$	-286

0 4 . 1

Use the data in **Table 2** to calculate a value, in kJ mol^{-1} , for the enthalpy of formation of $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{l})$

[2 marks]

Enthalpy of formation _____ kJ mol^{-1}



0 4 . 2 Table 3 shows some bond enthalpy data.

Table 3

Bond	Bond enthalpy / kJ mol^{-1}
C–C	348
C–H	412
C–O	360
O–H	463
O=O	496
C=O	805

Use the data in **Table 3** to calculate a value, in kJ mol^{-1} , for the enthalpy of combustion of $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{g})$

[2 marks]

Enthalpy of combustion _____ kJ mol^{-1}

0 4 . 3 Suggest **two** reasons why the value for enthalpy of combustion of propan-1-ol calculated in Question **04.2** is different from the value used in Question **04.1**.

[2 marks]

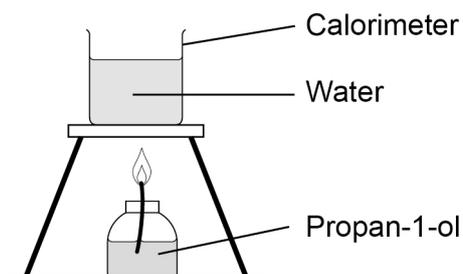
Reason 1 _____

Reason 2 _____

Turn over ►



0 4 . 4 A sample of propan-1-ol ($M_r = 60.0$) is burned to heat 250 g of water in a calorimeter.



The temperature of the water rises from 296 K to 319 K

Calculate the mass, in g, of propan-1-ol used in this experiment.

You may assume that all the heat energy from the flame is used to heat the water.

The specific heat capacity of water = $4.18 \text{ J K}^{-1} \text{ g}^{-1}$

$\Delta_c H^\ominus$ for propan-1-ol = $-2010 \text{ kJ mol}^{-1}$

[3 marks]

mass _____ g

9



0 5 Bromine is an oxidising agent.

0 5 . 1 State, in terms of electrons, the meaning of oxidising agent.

[1 mark]

In aqueous solution, bromine oxidises SO_2 to SO_4^{2-} ions.

0 5 . 2 Write a half-equation for the oxidation of aqueous SO_2 to SO_4^{2-} ions.

[1 mark]

0 5 . 3 Write an equation for the reaction of bromine with aqueous SO_2

Explain, using oxidation states, how bromine oxidises SO_2 to SO_4^{2-} ions.

[3 marks]

Equation

Explanation

0 5 . 4 A few drops of aqueous bromine are added to a test tube that contains some sodium iodide solution.

State the colour change observed in the test tube.

Write an equation for this reaction.

[2 marks]

Colour change

Equation

7

Turn over ►



0 6

This question is about argon.

0 6 . 1

Give the meaning of the term mass number.

[1 mark]

0 6 . 2

The most abundant isotope of argon has mass number = 40
The most abundant isotope of potassium has mass number = 39

Justify why argon is placed before potassium in the Periodic Table.
Do **not** refer to the chemical properties of the elements in your answer.

[2 marks]

0 6 . 3

A sample of argon is analysed in a time of flight (TOF) mass spectrometer.
The first stage is ionisation of the argon atoms by electron impact.

Write an equation, including state symbols, for this ionisation.

[1 mark]



0 6 . 4

In the TOF mass spectrometer an $^{40}\text{Ar}^+$ ion takes 2.00×10^{-4} seconds to travel along a flight tube of length 1.25 m

The time of flight of an ion is shown by the equation

$$t = d \sqrt{\frac{m}{2 KE}}$$

m = mass / kg

d = length of flight tube / m

t = time of flight / s

KE = kinetic energy / J

Calculate the mass, in kg, of an $^{40}\text{Ar}^+$ ion.

Calculate the kinetic energy, in J, of the $^{40}\text{Ar}^+$ ion.

Give your answers to 3 significant figures.

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

[3 marks]

Mass of $^{40}\text{Ar}^+$ _____ kg

Kinetic energy _____ J

Turn over ►



0 6 . 5

A sample of argon that contains ^{38}Ar and ^{40}Ar is analysed using a TOF mass spectrometer.
The sample is ionised using electron impact.

Which statement is correct?

Tick (✓) **one** box.

[1 mark]

The kinetic energy of the $^{38}\text{Ar}^+$ ion is greater than the $^{40}\text{Ar}^+$ ion.

The kinetic energy of the $^{38}\text{Ar}^+$ ion is the same as the $^{40}\text{Ar}^+$ ion.

The kinetic energy of the $^{38}\text{Ar}^+$ ion is less than the $^{40}\text{Ar}^+$ ion.

0 6 . 6

A different sample of argon has relative atomic mass = 39.964
This sample contains only two isotopes.
The abundance of the ^{40}Ar isotope in the sample is 99.090%

Calculate the mass number of the other isotope of argon in the sample.

[3 marks]

Mass number _____

11



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0 7

Test-tube reactions can be used to distinguish between pairs of colourless solutions.

0 7 . 1

Identify a reagent that can be used to distinguish between aqueous solutions of sodium sulfate and sodium nitrate.

Give the observation that would be made in each case.

[3 marks]

Reagent _____

Observation with sodium sulfate _____

Observation with sodium nitrate _____

0 7 . 2

Identify a reagent that can be used to distinguish between aqueous solutions of potassium carbonate and potassium hydroxide.

Give the observation that would be made in each case.

[3 marks]

Reagent _____

Observation with potassium carbonate _____

Observation with potassium hydroxide _____

0 7 . 3

Describe a test-tube reaction to show that a solution of ammonium chloride contains ammonium ions.

[2 marks]



0 7 . 4

Some acidified silver nitrate is added to separate aqueous solutions of two unknown potassium halides, **P** and **Q**.

A yellow precipitate is seen with **P**.

A colourless solution is seen with **Q**.

Give the formula of an acid that can be used to acidify the silver nitrate solution.

Give the formulas of the potassium halides **P** and **Q**.

[3 marks]

Formula of acid _____

Formula of **P** _____

Formula of **Q** _____

11**END OF QUESTIONS**

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2 4



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