OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL AS

CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Friday 18 January 2019 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	
8	
TOTAL	

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

Do not write outside the box

0 1 This question is about atomic structure.

0 1 . 1 Define the term mass number.

[1 mark]

0 1 . 2 Complete **Table 1** for two of the fundamental particles in an atom.

[2 marks]

Table 1

	Relative mass	**Relative charge**
Neutron		
Electron		

A sample of calcium consists of ^{40}Ca, ^{42}Ca and one other isotope.

0 1 . 3 Predict whether the atomic radius of ^{40}Ca is larger than, smaller than or the same as the atomic radius of ^{42}Ca

Explain your answer.

[2 marks]

Atomic radius of ^{40}Ca compared to ^{42}Ca _____

Explanation _____

Do not write outside the box

0 1 . 4 The relative abundances of two of these calcium isotopes are shown in **Table 2**.

Table 2

Mass number of isotope	40	42
Relative abundance / %	96.80	0.19

Determine the relative abundance of the third calcium isotope.

The sample of calcium has a relative atomic mass of 40.12

Use your answer and the data in **Table 2** to determine the mass number of the third isotope.

Give the mass number to the nearest integer.

[4 marks]

Relative abundance _____

Mass number _____

Question 1 continues on the next page

Do not write outside the box

0 1 . 5 Calculate the mass, in kg, of one atom of ^{42}Ca

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

[1 mark]

Mass _____ kg

0 1 . 6 In a time of flight (TOF) mass spectrometer, a $^{42}Ca^{+}$ ion with a kinetic energy (KE) of 1.164×10^{-13} J takes 9.130×10^{-7} s to reach the detector.

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

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

m = mass / kg
v = velocity / ms^{-1}
d = length of flight tube / m
t = time of flight / s

Use the equations and your answer to question **01.5** to calculate the length, in m, of the flight tube.

Give your answer to **three** significant figures.

(If you could not answer question **01.5** you should assume a mass of 3.08×10^{-25} kg This is **not** the correct answer.)

[3 marks]

Length _____ m

13

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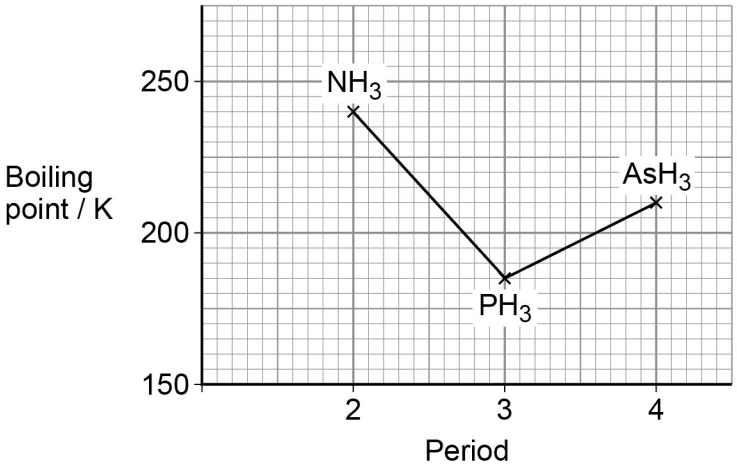
0 2 The boiling points of some of the Group 5 hydrides are shown in **Figure 1**.

Figure 1



0 2 . 1 Explain, in terms of intermolecular forces, why NH_3 has a higher boiling point than PH_3

[3 marks]

0 2 . 2 Explain, in terms of intermolecular forces, why AsH_3 has a higher boiling point than PH_3

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 Draw a diagram to show the shape of the AsH_3 molecule.
Include any lone pairs of electrons that influence the shape.

The electronegativities of As and of H are almost equal.

With reference to your diagram, explain why the AsH_3 molecule is polar.

[2 marks]

Do not write outside the box

0 2 . 4 The equation shows the reaction of one AsH_3 molecule with one H^+ ion.

$$AsH_3 + H^+ \rightarrow AsH_4^+$$

State the type of bond formed between the AsH_3 molecule and the H^+ ion.

Explain how the bond is formed.

[2 marks]

Type of bond _____

How bond is formed _____

_____

_____

0 2 . 5 The reaction of phosphorus with concentrated sodium hydroxide solution produces PH_3

Balance the equation.

[1 mark]

_____ P_4 + _____ NaOH + _____ $H_2O \rightarrow$ _____ NaH_2PO_2 + _____ PH_3

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Turn over for the next question

Do not write outside the box

0 3 . 1 Write an equation, including state symbols, for the reaction for which the energy change is the standard enthalpy of formation of nitric acid, $HNO_3(l)$.

[1 mark]

Some standard enthalpy of formation values ($\Delta_f H^{\ominus}$) are shown in **Table 3**.

Table 3

Substance	$H_2O(l)$	$NO_2(g)$	$O_2(g)$
$\Delta_f H^{\ominus}$ / kJ mol^{-1}	–286	+34	0

0 3 . 2 State why the value for the standard enthalpy of formation of $O_2(g)$ is zero.

[1 mark]

The following equation shows how nitric acid (HNO_3) is formed in the Ostwald Process.

$$2H_2O(l) + 4NO_2(g) + O_2(g) \rightarrow 4HNO_3(l) \qquad \Delta H = -254 \text{ kJ mol}^{-1}$$

0 3 . 3 Use the standard enthalpies of formation in **Table 3** to calculate the standard enthalpy of formation of nitric acid.

[3 marks]

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

Do not write outside the box

0 3 . 4 Give the oxidation state of nitrogen in nitric acid.

Use oxidation states to explain why the reaction in question **03.3** involves the oxidation of nitrogen.

[2 marks]

Oxidation state of nitrogen in nitric acid _____

Explanation _____

_____

_____

7

Turn over for the next question

Do not write outside the box

0 4 When 4.33 g of sodium chlorate(I) are added to an excess of hydrochloric acid, all the sodium chlorate(I) reacts as shown in the equation.

$$NaClO(s) + 2HCl(aq) \rightarrow Cl_2(g) + H_2O(l) + NaCl(aq)$$

0 4 . 1 Calculate the amount, in moles, of sodium chlorate(I) in 4.33 g

[1 mark]

Amount _____ mol

0 4 . 2 Calculate the volume, in dm^3, of chlorine produced at 30 °C and 100 kPa

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

(If you could not answer question **04.1** you should assume a value of 6.24×10^{-2} mol This is **not** the correct answer.)

[4 marks]

Volume _____ dm^3

Do not write outside the box

0 4 . 3 Calculate the volume, in cm^3, of 2.50 mol dm^{-3} hydrochloric acid needed to react exactly with 4.33 g of sodium chlorate(I).

Give your answer to **three** significant figures.

(If you could not answer question **04.1** you should assume a value of 6.24×10^{-2} mol This is **not** the correct answer.)

[2 marks]

Volume _____ cm^3

0 4 . 4 Calculate the percentage atom economy for the formation of sodium chloride in this reaction.

[2 marks]

Atom economy _____ %

0 4 . 5 State how solid sodium chloride can be obtained from the mixture of products.

[1 mark]

_____

0 4 . 6 Suggest **one** precaution a chemist should take when making chlorine gas.

[1 mark]

_____

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Turn over ►

0 5 A student carried out some test-tube reactions on some potassium halides.

The student's description of the experiments is shown. It contains some mistakes.

Experiment 1

Method
Drops of hydrochloric acid and silver nitrate solution were added to potassium bromide solution to test for bromide ions.

Observations
A cream precipitate was formed.
This precipitate was soluble in concentrated aqueous ammonia.

Experiment 2

Method
Drops of concentrated sulfuric acid were added to solid potassium bromide.

Observations
Some yellow solid was seen and a brown gas was given off.

Experiment 3

Method
Drops of chlorine water were added to potassium iodide solution.

Observations
A brown solution was seen.

Do not write outside the box

0 5 . 1 Identify the mistake in the **method** in **Experiment 1**.

Give a reason for your answer.

[2 marks]

Mistake _____

_____

Reason _____

_____

0 5 . 2 Identify the mistake in the **observations** in **Experiment 2**.

Write an equation for the reaction.

[2 marks]

Mistake _____

_____

Equation

_____

0 5 . 3 The method and observations for **Experiment 3** were correct.

Write an equation for the reaction.

[1 mark]

_____

0 5 . 4 In a fourth experiment, a few drops of silver nitrate solution were added to some potassium fluoride solution.

State what the student would observe in this experiment.

[1 mark]

_____

6

Turn over ►

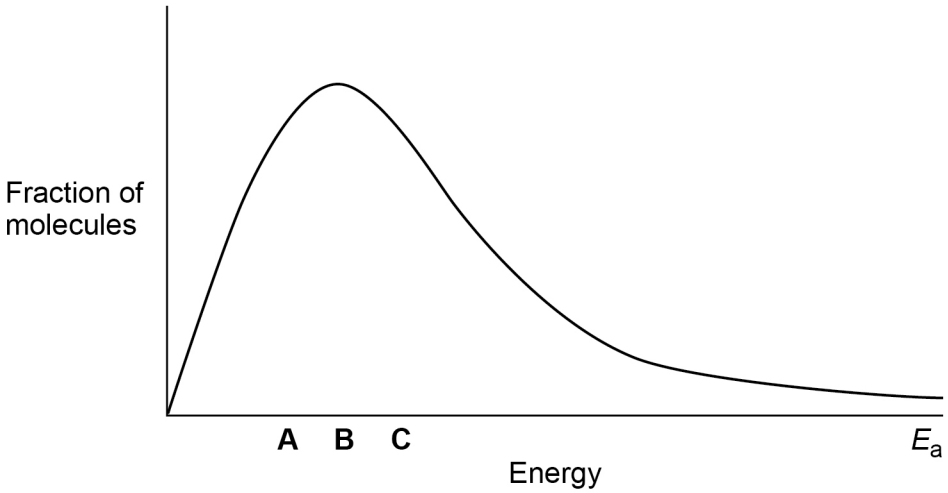
Do not write outside the box

0 6 A flask contains a sample of gas at a constant temperature.

Figure 2 shows the Maxwell-Boltzmann distribution for this gas.

E_a is the activation energy for the decomposition of this gas.

Figure 2



0 6 . 1 Which letter represents the average energy of the molecules?
Tick (✓) **one** box.

[1 mark]

A ☐

B ☐

C ☐

0 6 . 2 Define the term activation energy.

[1 mark]

Do not write outside the box

0 6 . 3 State how the value of E_a for the decomposition of this gas could be altered.

[1 mark]

0 6 . 4 Draw a curve on **Figure 2** to show the distribution of molecular energies in the same sample of gas at a higher temperature.

[2 marks]

0 6 . 5 The volume of the flask was halved.

State and explain the effect of this change on the rate of decomposition of this gas.

[3 marks]

Effect _____

Explanation _____

8

Turn over for the next question

Do not write outside the box

0 7 This question is about the elements in Period 3 of the Periodic Table.

0 7 . 1 Write an equation, including state symbols, for the first ionisation energy of magnesium.

[1 mark]

0 7 . 2 Explain why the first ionisation energy of aluminium is less than the first ionisation energy of magnesium.

[2 marks]

0 7 . 3 Identify the element in Period 3 with the largest atomic radius.

Explain your answer.

[3 marks]

Element

Explanation

Do not write outside the box

0 7 . 4 Silicon has the highest melting point of the elements in Period 3.

Explain this statement in terms of structure and bonding.

[3 marks]

9

Turn over for the next question

Do not write outside the box

0 8 This question is about some reactions of chlorine.

0 8 . 1 A sample of chlorine gas is heated in a sealed tube to a constant temperature.
An equilibrium is established.

$$Cl_2(g) \rightleftharpoons 2Cl(g)$$

Explain why an increase in pressure increases the amount of chlorine molecules in the equilibrium mixture.

[2 marks]

0 8 . 2 When the mixture in question **08.1** is heated to a higher temperature, the equilibrium established contains fewer chlorine molecules.

Deduce the sign of the enthalpy change for this reaction.
Give a reason for your answer.

[2 marks]

Sign of enthalpy change

Reason

0 8 . 3 A student bubbled chlorine gas into cold sodium hydroxide solution.

Write an equation for the reaction that occurs.

Give **one** use for the product that contains chlorine in oxidation state +1

[2 marks]

Equation

Use

END OF QUESTIONS

6

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ANSWER IN THE SPACES PROVIDED

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