OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

OXFORD AQA INTERNATIONAL AS

CHEMISTRY (9620)

Unit 1 Inorganic 1 and Physical 1

Thursday 18 January 2018 06:00 GMT Time allowed: 1 hour 30 minutes

A

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.
- 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	
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4	
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6	
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TOTAL	

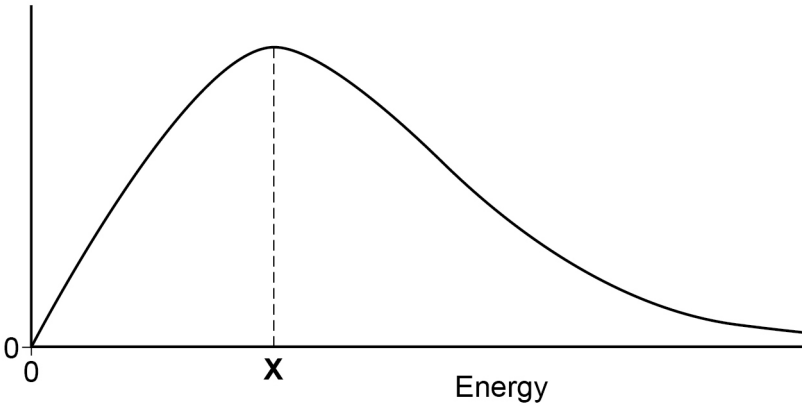
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Answer **all** questions in the spaces provided.

0 1 This question is about kinetics.

Figure 1 shows the Maxwell–Boltzmann distribution of molecular energies in a sample of gas at temperature *T*.

Figure 1



0 1 . 1 One of the axes in **Figure 1** is labelled.

Label the other axis.

[1 mark]

0 1 . 2 Which of the following describes the energy value represented by the letter **X** in **Figure 1**?

Tick (✓) **one** box.

[1 mark]

The total energy of the sample of gas ☐

The minimum energy needed for a reaction to occur ☐

The most probable energy of the particles ☐

The average energy of the particles ☐

Do not write outside the box

0 1 . 3 The pressure of the original sample of gas is halved at temperature *T*.

State the effect, if any, of the change on the value of **X**.

[1 mark]

0 1 . 4 Draw a curve on **Figure 1** for the distribution of molecular energies in this sample of gas at a **lower** temperature.

[2 marks]

0 1 . 5 Catalysts play an important role in many reactions.

State the meaning of the term **catalyst**.

[1 mark]

Question 1 continues on the next page

Do not write outside the box

0 1 . 6 State and explain, using the collision theory, the effect on the rate of a reaction between two gases of:

- decreasing the overall pressure, without changing the temperature
- increasing the temperature, without changing the overall pressure.

[4 marks]

Decreasing the overall pressure _____

Explanation _____

_____

_____

_____

Increasing the temperature _____

Explanation _____

_____

_____

_____

10

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0 2 This question is about compounds of nitrogen.

0 2 . 1 A reaction between N_2O_4 and N_2H_4 has been used to propel rockets.
The only products of the reaction are water and nitrogen.

Write an equation for this reaction.

[1 mark]

0 2 . 2 Give the oxidation state of nitrogen in N_2O_4 and the oxidation state of nitrogen in N_2H_4

Give a reason why the reaction in Question **02.1** is classified as redox.

[3 marks]

Oxidation state of N in N_2O_4 _____

Oxidation state of N in N_2H_4 _____

Reason _____

_____

_____

_____

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 The following equilibrium is established between the gases N_2O_4 and NO_2

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = 58 \text{ kJ mol}^{-1}$$

Give **two** features of a reaction at equilibrium.

[2 marks]

Feature 1

Feature 2

0 2 . 4 N_2O_4 is a colourless gas and NO_2 is a brown gas.
When the equilibrium mixture in Question **02.3** is heated at constant pressure, the colour of the mixture becomes darker.

Explain, with reference to Le Chatelier's principle, why the mixture becomes darker.

[2 marks]

Do not write outside the box

0 2 . 5 When the pressure of the mixture in Question **02.3** is increased at constant temperature, the colour of the new equilibrium mixture is paler.

Explain, with reference to Le Chatelier's principle, why the colour of the new equilibrium mixture is paler.

[2 marks]

10

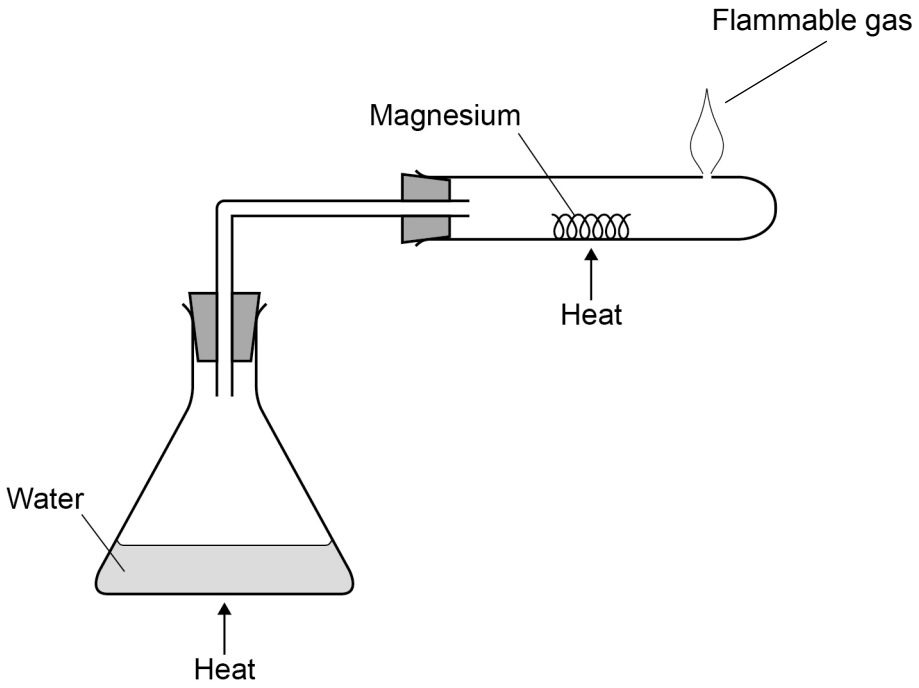
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0 3 This question is about some compounds of Group 2 metals.

0 3 . 1 **Figure 2** shows how magnesium can be reacted with steam.

Figure 2



A solid and a flammable gas are formed in this reaction.

Identify the gas and write an equation for the combustion of this flammable gas.

[2 marks]

Gas _____

Equation

_____

Do not write outside the box

0 3 . 2 A student suggested that the solid product of the reaction in Question **03.1** was either magnesium oxide or magnesium hydroxide.

Give a reason why the appearance of the solid product **cannot** be used to decide which of these two magnesium compounds was formed.

[1 mark]

0 3 . 3 Magnesium hydroxide is used in medicines to neutralise an excess of hydrochloric acid in the stomach.

Write an equation for this reaction.

[1 mark]

0 3 . 4 A student was given a solution that contained either Mg^{2+} or Sr^{2+} ions.

Describe a test-tube reaction that the student could use to identify the metal ion in the solution.

[2 marks]

6

Turn over for the next question

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0 4 A student was asked to distinguish between solid samples of sodium halides **A**, **B** and **C**.

The student added a few drops of concentrated sulfuric acid to separate samples of **A**, **B** and **C** in a fume cupboard.

Table 1 shows the observations recorded.

Table 1

Sodium halide	Observations
A	yellow solid and misty fumes
B	brown fumes and misty fumes
C	misty fumes

0 4 . 1 Identify the sodium halide in each of **A**, **B** and **C**.

[3 marks]

A _____

B _____

C _____

0 4 . 2 Write an equation to show the formation of the misty fumes from **C**.

You should use the formula NaX to represent **C** in your equation.

[1 mark]

_____

0 4 . 3 A different student said that when concentrated sulfuric acid was added to one of the sodium halides, a gas with the smell of bad eggs would be produced.

Identify the sodium halide that forms a gas with a bad egg smell.

[1 mark]

_____

Do not write outside the box

0 4 . 4 When concentrated sulfuric acid is added to solid sodium bromide, a gas with a choking smell is formed.

Write an equation for this reaction.

[1 mark]

0 4 . 5 Identify the halide ion in **A**, **B** or **C** that is the most powerful reducing agent.

[1 mark]

7

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 5 . 1 Give the meaning of the term **relative atomic mass**.

[2 marks]

0 5 . 2 A sample of nickel was ionised by electron impact in a time of flight (TOF) mass spectrometer to produce Ni^+ ions. The relative abundance of each isotope is shown in **Table 2**.

Table 2

m/z	58	60	62
Relative abundance	19	8	3

Calculate the relative atomic mass of nickel in the sample.

Give your answer to one decimal place.

[2 marks]

Relative atomic mass _____

Question 5 continues on the next page

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0 5 . 3 State why the inside of a TOF mass spectrometer is operated under vacuum.

[1 mark]

0 5 . 4 Complete the electron configuration of the $^{58}Ni^{+}$ ion.

[1 mark]

$1s^2$ _____

0 5 . 5 Calculate the mass, in kg, of a $^{58}Ni^{+}$ ion.

Give your answer to three significant figures.

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

[1 mark]

Mass _____ kg

Do not write outside the box

0 5 . 6 A $^{58}Ni^{+}$ ion travels down the flight tube of a TOF mass spectrometer with constant kinetic energy.
The flight tube is 1.80 m long and the $^{58}Ni^{+}$ ion takes 5.82×10^{-7} s to reach the detector.

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

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

where KE = kinetic energy (J)
m = mass (kg)
v = velocity (m s^{-1})
d = length of the flight tube (m)
t = time (s)

Use your answer to Question **05.5** to calculate the kinetic energy, in J, of the $^{58}Ni^{+}$ ion as it travels down the flight tube.

(If you were unable to answer Question **05.5**, you should use the value 7.37×10^{-25} kg. This is **not** the correct answer.)

Give your answer to three significant figures.

[3 marks]

Kinetic energy _____ J

10

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0 6 This question is about calcium nitrate.

0 6 . 1 When 4.38 g of calcium nitrate are heated strongly at 550 °C and 100 kPa, complete decomposition occurs as shown.

$$2Ca(NO_3)_2(s) \rightarrow 2CaO(s) + 4NO_2(g) + O_2(g)$$

Calculate the volume, in m^3, of the gaseous products.
Give your answer to three significant figures.

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

[5 marks]

Volume _____ m^3

Do not write outside the box

0 6 . 2 Suggest why it is difficult to prepare a pure sample of nitrogen dioxide by this method.

[1 mark]

0 6 . 3 Calcium nitrate can be prepared from calcium phosphate.

Balance the equation.

[1 mark]

____$Ca_3(PO_4)_2(s)$ + ____$HNO_3(aq)$ → ____$H_3PO_4(aq)$ + ____$Ca(NO_3)_2(aq)$

0 6 . 4 Calculate the concentration of calcium nitrate in the solution formed when 0.21 g of powdered calcium carbonate are added to 25.0 cm^3 nitric acid of concentration 0.50 mol dm^{-3}

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + CO_2(g) + H_2O(l)$$

[3 marks]

Concentration _____ mol dm^{-3}

10

Turn over for the next question

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0 7 This question is about the elements in Period 2 of the Periodic Table.

0 7 . 1 Identify the element in Period 2 that has the highest electronegativity value.

[1 mark]

0 7 . 2 Identify the element in Period 2 that has the highest first ionisation energy.

Explain your answer.

[3 marks]

Element

Explanation

0 7 . 3 Write an equation, including state symbols, to show the process that occurs when the first ionisation energy of oxygen is measured.

[1 mark]

Do not write outside the box

0 7 . 4 Identify the element in Period 2 that has the highest melting point.

Explain your answer.

[3 marks]

Element _____

Explanation _____

_____

_____

_____

_____

0 7 . 5 Draw the shape of a tetrafluoromethane molecule (CF_4) and the shape of a chlorine trifluoride molecule (ClF_3).

Include any lone pairs of electrons that influence the shape.

Name the shape of the CF_4 molecule.

[3 marks]

Shape of CF_4

Shape of ClF_3

Name of shape of CF_4 _____

Question 7 continues on the next page

Do not write outside the box

0 7 . 6 Explain why the boiling point of CF_4 is very low.

[2 marks]

0 7 . 7 A compound, which contains carbon, chlorine and fluorine only, has a relative molecular mass (M_r) of 204.0

Elemental analysis shows that the compound contained 69.6% chlorine and 18.6% fluorine by mass.

Calculate the molecular formula of this compound.

[4 marks]

Molecular formula _____

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END OF QUESTIONS

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