AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

AS CHEMISTRY

Paper 1 Inorganic and Physical Chemistry

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- 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 80.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Section B	
TOTAL	

Advice

You are advised to spend about 65 minutes on **Section A** and 25 minutes on **Section B**.

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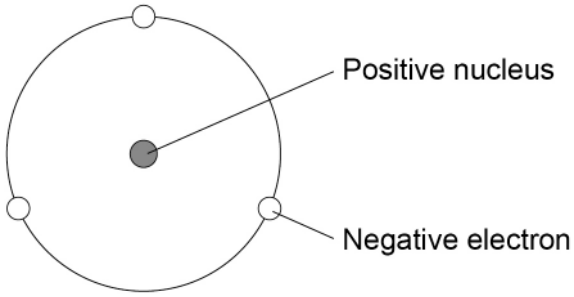
Section A

Answer **all** questions in this section.

0 1 This question is about atomic structure.

0 1 . 1 **Figure 1** is a model proposed by Rutherford to show the structure of an atom.

Figure 1



State **two** features of the current model that are not shown in the Rutherford model.

[2 marks]

Feature 1 of the current model _____

_____

_____

Feature 2 of the current model _____

_____

_____

Do not write outside the box

0 1 . 2 A sample of tin is analysed in a time of flight mass spectrometer.
The sample is ionised by electron impact to form 1+ ions.

Table 1 shows data about the four peaks in this spectrum.

Table 1

m/z	Percentage abundance
112	22.41
114	11.78
117	34.97
120	To be determined

Give the symbol, including mass number, of the ion that reaches the detector first.

Calculate the relative atomic mass of tin in this sample.
Give your answer to 1 decimal place.

[4 marks]

Symbol of ion _____

Relative atomic mass _____

6

Turn over ►

Do not write outside the box

0 2 This question is about magnesium and its compounds.

0 2 . 1 State **one** observation when magnesium reacts with steam.

Give an equation, including state symbols, for this reaction.

[2 marks]

Observation _____

_____

Equation

_____

0 2 . 2 Describe the bonding in magnesium.

[2 marks]

_____

_____

_____

_____

0 2 . 3 Explain, in terms of structure and bonding, why magnesium chloride has a high melting point.

[3 marks]

_____

_____

_____

_____

_____

_____

0 2 . 4 Give **one** medical use for magnesium hydroxide.

[1 mark]

_____

_____

8

Do not write outside the box

0 3 This question is about redox reactions.

0 3 . 1 State, in terms of electrons, the meaning of the term oxidising agent.

[1 mark]

0 3 . 2 $Cr_2O_7^{2-}$ can oxidise SO_3^{2-} in acidic conditions to form Cr^{3+} and SO_4^{2-}

Deduce a half-equation for the oxidation of SO_3^{2-} to SO_4^{2-}

Deduce a half-equation for the reduction of $Cr_2O_7^{2-}$ to Cr^{3+}

Deduce the overall equation for the oxidation of SO_3^{2-} by $Cr_2O_7^{2-}$

[3 marks]

Half-equation for the oxidation of SO_3^{2-} to SO_4^{2-}

Half-equation for the reduction of $Cr_2O_7^{2-}$ to Cr^{3+}

Overall equation

4

Turn over for the next question

Do not write outside the box

0 4 This question is about the identification of ions in unknown solutions.

A student completes a number of test-tube reactions on solutions **A**, **B** and **C**.

Table 2 shows the student's observations.

Table 2

	Test 1	**Test 2**	**Test 3**
	Add $H_2SO_4(aq)$	Warm with NaOH(aq)	Add acidified $AgNO_3(aq)$
A	white precipitate	no visible change	no visible change
B	effervescence	a gas is formed that turns damp red litmus blue	effervescence
C	no visible change	no visible change	off-white precipitate

0 4 . 1 Suggest the identity of the positive ion in solution **A**.

Give the simplest ionic equation for the formation of the white precipitate in **Test 1** for solution **A**.

[2 marks]

Identity of positive ion in **A** _____

Ionic equation

_____

0 4 . 2 Different gases are formed when solution **B** reacts in **Test 1** and in **Test 2**.

Suggest the identity of each gas.

Give the simplest ionic equation for the formation of the gas in **Test 2**.

[2 marks]

Gas formed in **Test 1** _____

Gas formed in **Test 2** _____

Ionic equation for the formation of the gas in **Test 2**

_____

Do not write outside the box

0 4 . 3 The student thinks that solution **C** contains either chloride ions or bromide ions.

Describe a further test, or tests, to show whether solution **C** contains chloride or bromide ions.

[3 marks]

7

Turn over for the next question

Do not write outside the box

0 5 This question is about chlorine.

0 5 . 1 Chlorine has a low boiling point because the forces between the molecules are weak.

Explain how these forces arise between molecules of chlorine.

[3 marks]

0 5 . 2 Give an equation for the reaction of chlorine with water.

Give a reason why chlorine is added to drinking water.

[2 marks]

Equation

Reason

0 5 . 3 Chlorine reacts with cold, aqueous sodium hydroxide in the manufacture of bleach.

Give an equation for this reaction.

[1 mark]

6

Do not write outside the box

0 6 Calcium sulfide reacts with calcium sulfate as shown.

$$CaS + 3\,CaSO_4 \rightarrow 4\,CaO + 4\,SO_2$$

2.50 g of calcium sulfide are heated with 9.85 g of calcium sulfate until there is no further reaction.

Show that calcium sulfate is the limiting reagent in this reaction.

Calculate the mass, in g, of sulfur dioxide formed.

M_r (CaS) = 72.2
M_r ($CaSO_4$) = 136.2

[5 marks]

Mass of sulfur dioxide _____ g

5

Turn over for the next question

Do not write outside the box

0 7 This question is about combustion.

0 7 . 1 State the meaning of the term standard enthalpy of combustion.

[2 marks]

0 7 . 2 A student does an experiment to determine the enthalpy of combustion of propan-1-ol ($CH_3CH_2CH_2OH$, M_r = 60.0).
Combustion of 0.497 g of propan-1-ol increases the temperature of 150 g of water from 21.2 °C to 35.1 °C

Calculate a value, in kJ mol^{-1}, for the enthalpy of combustion of propan-1-ol in this experiment.

The specific heat capacity of water is 4.18 J K^{-1} g^{-1}

[3 marks]

Enthalpy of combustion _____ kJ mol^{-1}

Do not write outside the box

0 7 . 3 The enthalpy of combustion determined experimentally is less exothermic than that calculated using enthalpies of formation.

Give **one** possible reason for this, other than heat loss.

[1 mark]

6

Turn over for the next question

Do not write outside the box

0 8 A student is provided with a 5.60 g sample of ethanoic acid (CH_3COOH) contaminated with sodium ethanoate (CH_3COONa).

The student dissolves the sample in deionised water and makes the volume up to 200 cm^3

The student removes 25.0 cm^3 samples of the solution and titrates them with 0.350 mol dm^{-3} sodium hydroxide solution.

Table 3 shows the results of these titrations.

Table 3

	Rough	**1**	**2**	**3**
Final volume / cm^3	20.85	41.10	20.50	40.80
Initial volume / cm^3	0.00	20.85	0.00	20.50
Titre / cm^3	20.85	20.25	20.50	20.30

0 8 . 1 Use the results in **Table 3** to calculate the mean titre value.

Use the mean titre to calculate the percentage by mass of sodium ethanoate in the original sample.

[6 marks]

Mean titre value _____ cm^3

Do not write outside the box

Percentage by mass _____

0 8 . 2 The student rinses the burette with deionised water before filling with sodium hydroxide solution.

State and explain the effect, if any, that this rinsing will have on the value of the titre.

[2 marks]

_____

_____

_____

_____

8

Turn over for the next question

Do not write outside the box

0 9 Hydrogen can be prepared on an industrial scale using the reversible reaction between methane and steam.

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

The reaction is done at a temperature of 800 °C and a low pressure of 300 kPa in the presence of a nickel catalyst.

Explain, in terms of equilibrium yield and cost, why these conditions are used.

[6 marks]

Do not write outside the box

6

Turn over ►

Do not write outside the box

1 0 Sulfur dioxide reacts with oxygen to form sulfur trioxide.

$$2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g) \qquad \Delta H = -196\,kJ\,mol^{-1}$$

1 0 . 1 Give an expression for the equilibrium constant (K_c) for this reaction.

[1 mark]

K_c

1 0 . 2 A mixture of sulfur dioxide and oxygen is allowed to reach equilibrium in a container of volume 1800 cm^3 at temperature T.

At equilibrium, the mixture contains 0.176 mol of sulfur dioxide and 0.461 mol of sulfur trioxide.

At temperature T the equilibrium constant, $K_c = 15.0\,mol^{-1}\,dm^3$

Calculate the amount, in moles, of oxygen at equilibrium.

[3 marks]

Amount of oxygen _____ mol

Do not write outside the box

1 0 . 3 At a different temperature, a mixture contains

0.025 mol of sulfur dioxide
0.049 mol of oxygen
0.034 mol of sulfur trioxide.

The total pressure of the mixture in a 3500 cm^3 reaction vessel is 255 kPa

Use the data to calculate the temperature, in °C, of the mixture.

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

[5 marks]

Temperature _____ °C

9

Turn over for Section B

Do not write outside the box

Section B

Answer **all** questions in this section.

Only **one** answer per question is allowed.
For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD ⬬ WRONG METHODS ⊗ ⊙ ≈ √

If you want to change your answer you must cross out your original answer as shown. ⊠

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. ⊗

You may do your working in the blank space around each question but this will not be marked. Do **not** use additional sheets for this working.

1 1 In a time of flight mass spectrometer, molecule X is ionised using electrospray ionisation.
What is the equation for this ionisation?

[1 mark]

A $X(l) + e^- \rightarrow X^+(g) + 2\,e^-$ ⬭

B $X(g) + e^- \rightarrow X^+(g) + 2\,e^-$ ⬭

C $X(l) + H^+ \rightarrow XH^+(g)$ ⬭

D $X(g) + H^+ \rightarrow XH^+(g)$ ⬭

1 2 What is the electron configuration of V^{2+} in the ground state?

[1 mark]

A $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3$ ⬭

B $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^1\,4s^2$ ⬭

C $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3\,4s^2$ ⬭

D $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^2$ ⬭

Do not write outside the box

1 3 Which molecule is **not** able to form a co-ordinate bond with another species?

[1 mark]

A BH_3 ⬭

B CH_4 ⬭

C NH_3 ⬭

D H_2O ⬭

1 4 Which species has a square planar shape?

[1 mark]

A NH_4^+ ⬭

B SF_4 ⬭

C XeF_4 ⬭

D PCl_4^+ ⬭

1 5 Which bond has the most unsymmetrical electron distribution?

[1 mark]

A H–O ⬭

B H–S ⬭

C H–N ⬭

D H–P ⬭

Turn over for the next question

Do not write outside the box

1 6 Which compound contains a chlorine atom with an oxidation state of +4?

[1 mark]

A $KClO_4$ ⬭

B CCl_4 ⬭

C ClO_2 ⬭

D ClO_2F ⬭

1 7 Which element is classified as a d block element?

[1 mark]

A Antimony ⬭

B Molybdenum ⬭

C Strontium ⬭

D Uranium ⬭

1 8 Which element in Period 3 has the highest melting point?

[1 mark]

A Aluminium ⬭

B Silicon ⬭

C Sodium ⬭

D Sulfur ⬭

Do not write outside the box

1 9 Which pair of solutions, when mixed, reacts to form a dark brown solution?

[1 mark]

A $NaF(aq) + Cl_2(aq)$ ⬭

B $NaCl(aq) + Br_2(aq)$ ⬭

C $NaBr(aq) + Cl_2(aq)$ ⬭

D $NaI(aq) + Br_2(aq)$ ⬭

2 0 Some solid sodium halides are reacted with concentrated sulfuric acid.

Which solid sodium halide does **not** produce a sulfur-containing gas as one of the products?

[1 mark]

A NaCl ⬭

B NaBr ⬭

C NaI ⬭

D NaAt ⬭

Turn over for the next question

Do not write outside the box

2 1 Which atom has one more proton and two more neutrons than $^{31}_{15}P$?

[1 mark]

A $^{33}_{16}P$ ⬭

B $^{34}_{16}P$ ⬭

C $^{33}_{16}S$ ⬭

D $^{34}_{16}S$ ⬭

2 2 What is a use for barium sulfate?

[1 mark]

A In agriculture to act as a fertiliser ⬭

B In agriculture to neutralise acidic soil ⬭

C In medicine to produce an X-ray image ⬭

D In medicine as an antacid to treat indigestion ⬭

2 3 Which ion has the largest radius?

[1 mark]

A F^- ⬭

B Mg^{2+} ⬭

C Na^+ ⬭

D O^{2-} ⬭

Do not write outside the box

2 4 Which element has a first ionisation energy lower than that of sulfur?

[1 mark]

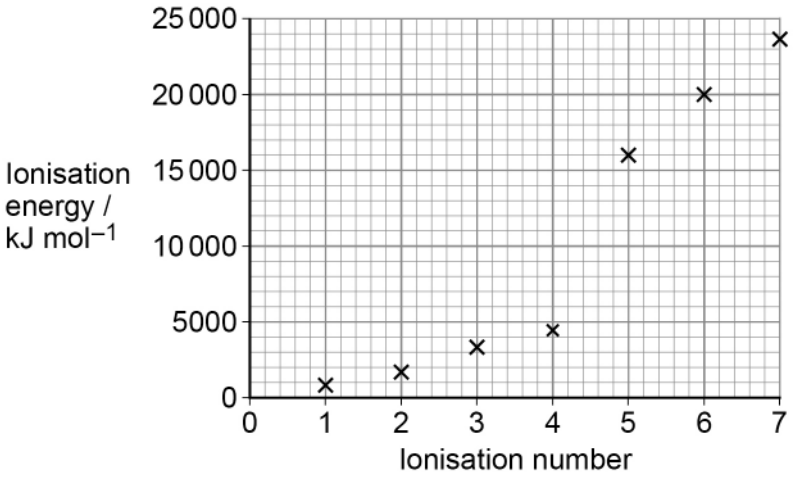
A Chlorine ⬭

B Oxygen ⬭

C Phosphorus ⬭

D Selenium ⬭

2 5 The first seven successive ionisation energies for element Z are shown.



What is element Z?

[1 mark]

A Carbon ⬭

B Nitrogen ⬭

C Silicon ⬭

D Phosphorus ⬭

15

END OF QUESTIONS

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