

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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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.

### Advice

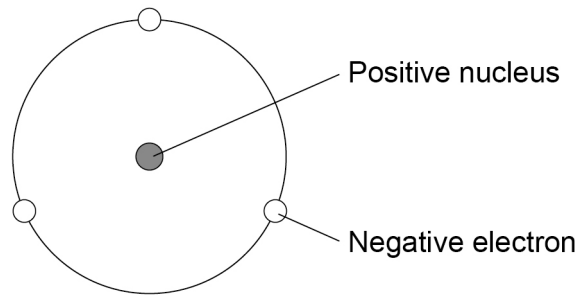
You are advised to spend about 65 minutes on **Section A** and 25 minutes on **Section B**.

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



**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 \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

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**

<b>m/z</b>	<b>Percentage abundance</b>
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 ►



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



**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** $\text{Cr}_2\text{O}_7^{2-}$  can oxidise  $\text{SO}_3^{2-}$  in acidic conditions to form  $\text{Cr}^{3+}$  and  $\text{SO}_4^{2-}$ Deduce a half-equation for the oxidation of  $\text{SO}_3^{2-}$  to  $\text{SO}_4^{2-}$ Deduce a half-equation for the reduction of  $\text{Cr}_2\text{O}_7^{2-}$  to  $\text{Cr}^{3+}$ Deduce the overall equation for the oxidation of  $\text{SO}_3^{2-}$  by  $\text{Cr}_2\text{O}_7^{2-}$ **[3 marks]**Half-equation for the oxidation of  $\text{SO}_3^{2-}$  to  $\text{SO}_4^{2-}$ 

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Half-equation for the reduction of  $\text{Cr}_2\text{O}_7^{2-}$  to  $\text{Cr}^{3+}$ 

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Overall equation

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

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 <sub>2</sub> SO <sub>4</sub> (aq)	Warm with NaOH(aq)	Add acidified AgNO <sub>3</sub> (aq)
<b>A</b>	white precipitate	no visible change	no visible change
<b>B</b>	effervescence	a gas is formed that turns damp red litmus blue	effervescence
<b>C</b>	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**

\_\_\_\_\_



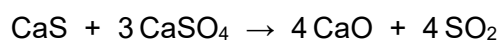






0	6
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Calcium sulfide reacts with calcium sulfate as shown.



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.

$$M_r(\text{CaS}) = 72.2$$

$$M_r(\text{CaSO}_4) = 136.2$$

**[5 marks]**

Mass of sulfur dioxide \_\_\_\_\_ g

5
---

**Turn over for the next question**

**Turn over ►**



**0 7**

This question is about combustion.

**0 7 . 1**

State the meaning of the term standard enthalpy of combustion.

**[2 marks]**

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**0 7 . 2**A student does an experiment to determine the enthalpy of combustion of propan-1-ol ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ ,  $M_r = 60.0$ ).

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  $\text{kJ mol}^{-1}$ , for the enthalpy of combustion of propan-1-ol in this experiment.The specific heat capacity of water is  $4.18 \text{ J K}^{-1} \text{ g}^{-1}$ **[3 marks]**Enthalpy of combustion \_\_\_\_\_  $\text{kJ mol}^{-1}$ 

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]

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6

Turn over for the next question

Turn over ►



**0 8**

A student is provided with a 5.60 g sample of ethanoic acid ( $\text{CH}_3\text{COOH}$ ) contaminated with sodium ethanoate ( $\text{CH}_3\text{COONa}$ ).

The student dissolves the sample in deionised water and makes the volume up to  $200 \text{ cm}^3$

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

**Table 3** shows the results of these titrations.

**Table 3**

	<b>Rough</b>	<b>1</b>	<b>2</b>	<b>3</b>
Final volume / $\text{cm}^3$	20.85	41.10	20.50	40.80
Initial volume / $\text{cm}^3$	0.00	20.85	0.00	20.50
Titre / $\text{cm}^3$	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 \_\_\_\_\_  $\text{cm}^3$



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]**

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8

**Turn over for the next question**

**Turn over ►**

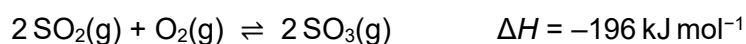






**1 0**

Sulfur dioxide reacts with oxygen to form sulfur trioxide.

**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  $1800 \text{ cm}^3$  at temperature  $T$ .At equilibrium, the mixture contains  $0.176 \text{ mol}$  of sulfur dioxide and  $0.461 \text{ mol}$  of sulfur trioxide.At temperature  $T$  the equilibrium constant,  $K_c = 15.0 \text{ mol}^{-1} \text{ dm}^3$ 

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

**[3 marks]**

Amount of oxygen \_\_\_\_\_ mol





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<sup>3</sup> reaction vessel is 255 kPa

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

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

**[5 marks]**

Temperature \_\_\_\_\_ °C

9

**Turn over for Section B****Turn over ►**

## 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.

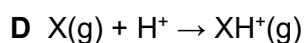
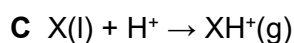
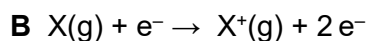
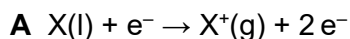
You may do your working in the blank space around each question but this will not be marked.  
Do **not** use additional sheets for this working.

1 | 1

In a time of flight mass spectrometer, molecule X is ionised using electrospray ionisation.

What is the equation for this ionisation?

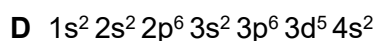
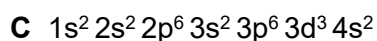
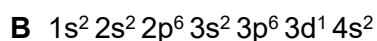
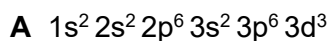
[1 mark]



1 | 2

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

[1 mark]



**1 3**Which molecule is **not** able to form a co-ordinate bond with another species?**[1 mark]****A** BH<sub>3</sub>**B** CH<sub>4</sub>**C** NH<sub>3</sub>**D** H<sub>2</sub>O**1 4**

Which species has a square planar shape?

**[1 mark]****A** NH<sub>4</sub><sup>+</sup>**B** SF<sub>4</sub>**C** XeF<sub>4</sub>**D** PCl<sub>4</sub><sup>+</sup>**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****Turn over ►**

**1 6**

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

**[1 mark]****A**  $\text{KClO}_4$ **B**  $\text{CCl}_4$ **C**  $\text{ClO}_2$ **D**  $\text{ClO}_2\text{F}$ **1 7**

Which element is classified as a d block element?

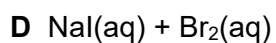
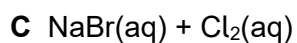
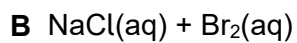
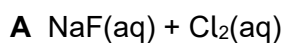
**[1 mark]****A** Antimony**B** Molybdenum**C** Strontium**D** Uranium**1 8**

Which element in Period 3 has the highest melting point?

**[1 mark]****A** Aluminium**B** Silicon**C** Sodium**D** Sulfur

**1 9**

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

**[1 mark]****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]**

**Turn over for the next question**

**Turn over ►**

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

**[1 mark]**

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
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Which ion has the largest radius?

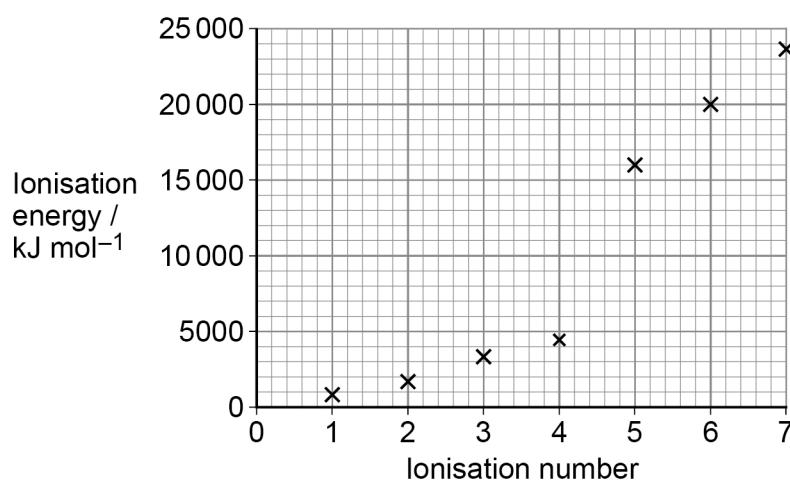
**[1 mark]**

**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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2 8



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