

Please write clearly in block capitals.

Centre number

Candidate number

Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

I declare this is my own work.

# INTERNATIONAL AS CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

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.
- All working must be shown.
- 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).
- 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	
<b>TOTAL</b>	



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

0 1

This question is about calcium.

0 1 . 1

State why calcium is an s block element.

[1 mark]

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0 1 . 2

State why  $^{40}\text{Ca}$  and  $^{44}\text{Ca}$  have the same atomic radius.

[1 mark]

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0 1 . 3

How many neutrons are there in an atom of  $^{44}\text{Ca}$ ?

[1 mark]

Tick (✓) **one** box.

20

24

44

0 1 . 4

A sample of calcium is ionised by electron impact in a time of flight (TOF) mass spectrometer.

Write an equation, including state symbols, for the ionisation of calcium by electron impact.

[1 mark]

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**0 1 . 5** Table 1 shows information about the three isotopes in a sample of calcium.

**Table 1**

<b>Mass number</b>	40	42	44
<b>Relative abundance</b>	48.0	1.5	2.0

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

**[2 marks]**

Relative atomic mass \_\_\_\_\_

**Question 1 continues on the next page**

**Turn over ►**



0 1 . 6 A  $^{44}\text{Ca}^+$  ion travels, at speed  $v \text{ m s}^{-1}$ , along a 1.25 m flight tube in a TOF mass spectrometer.

The time of flight of the  $^{44}\text{Ca}^+$  ion is  $8.98 \times 10^{-7} \text{ s}$

The speed of the  $^{44}\text{Ca}^+$  ion is shown by the equation

$$v = \sqrt{\frac{2KE}{m}}$$

$KE$  = kinetic energy (J)

$m$  = mass (kg)

Calculate the kinetic energy, in J, of the  $^{44}\text{Ca}^+$  ion.  
Give your answer to 3 significant figures.

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

**[4 marks]**

Kinetic energy \_\_\_\_\_ J

10



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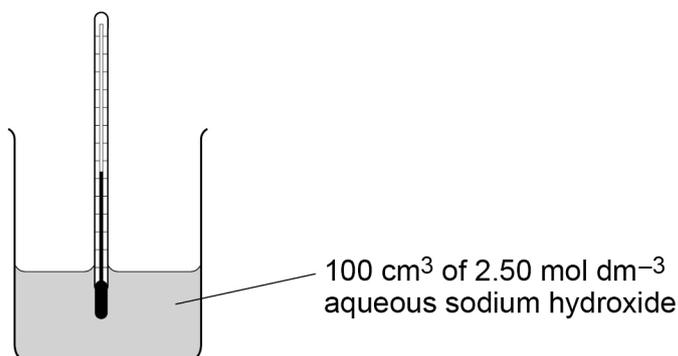
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0 2

An experiment is done to find the enthalpy change when aqueous sodium hydroxide is neutralised by hydrochloric acid.

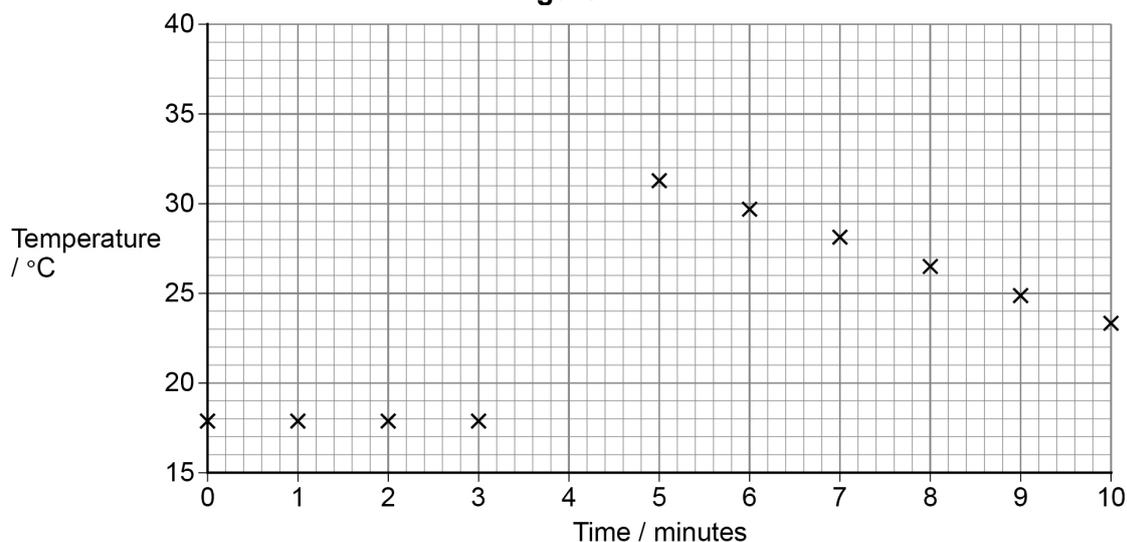


#### Method

- The temperature of the aqueous sodium hydroxide is measured every minute for 3 minutes.
- At the fourth minute 100 cm<sup>3</sup> of 2.50 mol dm<sup>-3</sup> hydrochloric acid are added, the solution is stirred, but no temperature measurement is made.
- The temperature is measured at the fifth minute and every minute for 5 more minutes.

Figure 1 shows the results.

Figure 1



0 2 . 1

Use **Figure 1** to calculate the temperature rise during the reaction.

Show your working.

[2 marks]

Temperature rise \_\_\_\_\_ °C



**0 2 . 2** Use your answer to Question **02.1** to calculate the heat energy, in kJ, released in this reaction.

The specific heat capacity of the final solution is  $4.18 \text{ J K}^{-1} \text{ g}^{-1}$

(If you were unable to answer Question **02.1** you should use the value  $19.3 \text{ }^\circ\text{C}$   
This is **not** the correct answer.)

**[2 marks]**

Heat energy \_\_\_\_\_ kJ

**0 2 . 3** Use your answer to Question **02.2** to calculate the enthalpy change, in  $\text{kJ mol}^{-1}$ , for the reaction between sodium hydroxide and hydrochloric acid.

(If you were unable to answer Question **02.2** you should use the value  $10.4 \text{ kJ}$   
This is **not** the correct answer.)

**[2 marks]**

Enthalpy change \_\_\_\_\_  $\text{kJ mol}^{-1}$

**0 2 . 4** The method used in Question **02.1** to calculate the temperature change allows for heat loss to the surroundings.

Suggest **one** reason for the difference between the experimental value and a data book value.

**[1 mark]**

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7

Turn over ►



**0 3**

This question is about redox reactions.

**0 3 . 1**

Identify the element that is oxidised in the reaction



Explain your answer using oxidation states.

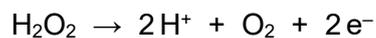
**[2 marks]**

Element \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_**0 3 . 2**

The half-equation for the oxidation of hydrogen peroxide is



The half-equation for the reduction of manganate(VII) ions in acidic conditions is



Write the overall equation for the oxidation of hydrogen peroxide by manganate(VII) ions in acidic conditions.

**[2 marks]**

\_\_\_\_\_



0	3	.	3
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In acidic conditions,  $\text{Cr}^{3+}$  ions can be oxidised to  $\text{Cr}_2\text{O}_7^{2-}$  ions by  $\text{MnO}_2$ .  
The  $\text{MnO}_2$  is reduced to  $\text{Mn}^{2+}$  ions.

Write a half-equation for the oxidation process.

Write a half-equation for the reduction process.

**[2 marks]**

Oxidation half-equation

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Reduction half-equation

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6
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**Turn over for the next question**

**Turn over ►**



**0 4**

This question is about the elements in Group 7 and their compounds.

**0 4 . 1**

Explain why chlorine has a lower boiling point than bromine.

**[2 marks]**

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**0 4 . 2**

Explain why bromine is a more powerful oxidising agent than iodine.

**[2 marks]**

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**0 4 . 3**

When chlorine reacts with aqueous sodium iodide a redox reaction occurs.

State what is observed.

Write an ionic equation for the reaction.

State the role of chlorine in the reaction.

**[3 marks]**

Observation \_\_\_\_\_

Ionic equation \_\_\_\_\_

\_\_\_\_\_

Role \_\_\_\_\_

\_\_\_\_\_



**0 4 . 4** A student tests an aqueous solution, **X**, to see if it contains chloride ions.

Method

**Step 1** Add dilute nitric acid to **X**

**Step 2** Add aqueous silver nitrate to the result of Step 1

**Step 3** Add dilute aqueous ammonia to the result of Step 2

State why dilute nitric acid is added in Step 1

State the observation in Step 2 and the observation in Step 3 that would show that **X** contains chloride ions.

**[3 marks]**

Why nitric acid is added \_\_\_\_\_

\_\_\_\_\_

Observation in step 2 \_\_\_\_\_

\_\_\_\_\_

Observation in step 3 \_\_\_\_\_

\_\_\_\_\_

**0 4 . 5** Hydrogen fluoride is a polar molecule.

Draw a diagram to show how two molecules of hydrogen fluoride are attracted to each other.

Include all partial charges and all lone pairs of electrons.

State the strongest type of intermolecular force between molecules of hydrogen fluoride.

**[4 marks]**

Diagram

Strongest intermolecular force \_\_\_\_\_

14

Turn over ►



**0 5**

This question is about compounds of boron.

**0 5 . 1**Draw the shape of the  $\text{BF}_3$  molecule.

State its bond angle.

Shape

**[2 marks]**

Bond angle \_\_\_\_\_

Boron trifluoride reacts with sodium fluoride as shown.

 $\text{NaBF}_4$  contains the  $\text{BF}_4^-$  ion.**0 5 . 2**Draw the shape of the  $\text{BF}_4^-$  ion.Name the shape of the  $\text{BF}_4^-$  ion.

Shape

**[2 marks]**

Name of shape \_\_\_\_\_

**0 5 . 3**Explain why  $\text{NaBF}_4$  has a high melting point.**[2 marks]**

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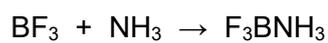
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Boron trifluoride reacts with ammonia.



**0 5 . 4** State how the B–N bond is formed.

Name this type of bond formation.

**[2 marks]**

How bond is formed \_\_\_\_\_

\_\_\_\_\_

Type of bond formation \_\_\_\_\_

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8

**Turn over for the next question**

**Turn over ►**



0 6

This question is about Group 2 elements and their compounds.

0 6 . 1

State the element that has the lowest melting point in Group 2 from calcium to barium.

**[1 mark]**

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0 6 . 2

Explain why the first ionisation energies in Group 2 decrease from magnesium to barium.

**[2 marks]**

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0 6 . 3

State **two** observations that would be made when magnesium reacts with steam.

Write an equation, including state symbols, for the reaction.

**[3 marks]**

Observation 1 \_\_\_\_\_

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Observation 2 \_\_\_\_\_

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Equation

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0 6 . 4

Titanium can be extracted from titanium(IV) chloride by reaction with magnesium.

Write an equation for this reaction.

**[1 mark]**

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**0 6 . 5** Give **one** use of magnesium hydroxide in medicine.

**[1 mark]**

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**0 6 . 6** Barium ions are toxic but barium sulfate can be swallowed safely in medicines as a 'barium meal'.

State why barium sulfate can be swallowed safely.

**[1 mark]**

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**9**

**Turn over for the next question**

**Turn over ►**



**0 7**

This question is about sodium carbonate.

Sodium carbonate reacts with hydrochloric acid as shown.

**0 7 . 1**

A hydrate of sodium carbonate has the formula  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ , where  $x$  is a whole number.

A 2.88 g sample of  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$  is dissolved in deionised water to make 250 cm<sup>3</sup> of solution.

In a titration, 16.55 cm<sup>3</sup> of 0.15 mol dm<sup>-3</sup> hydrochloric acid reacts completely with 25.0 cm<sup>3</sup> of this solution.

Calculate the value of  $x$  in  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$

**[6 marks]**

$x$  \_\_\_\_\_



07.2

The reaction is repeated using a different sample of sodium carbonate.

The carbon dioxide collected occupies a volume of  $598 \text{ cm}^3$  at  $300 \text{ K}$  and  $100\,000 \text{ Pa}$

Calculate the mass of carbon dioxide collected.

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

**[4 marks]**

Mass \_\_\_\_\_ g

07.3

State what a student would observe in a beaker after a reaction between sodium carbonate and an excess of hydrochloric acid.

**[1 mark]**

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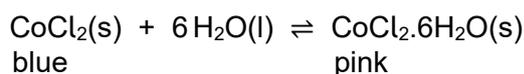
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0 8

When water is added to anhydrous cobalt chloride, the blue solid turns pink as shown.



**Table 2** shows some enthalpy data for this reaction.

**Table 2**

Substance	CoCl <sub>2</sub> (s)	H <sub>2</sub> O(l)	CoCl <sub>2</sub> ·6H <sub>2</sub> O(s)
Standard enthalpy of formation $\Delta_f H^\ominus / \text{kJ mol}^{-1}$	-326	-286	-2130

0 8 . 1

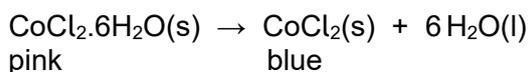
Use the equation and the data in **Table 2** to calculate the enthalpy change, in  $\text{kJ mol}^{-1}$ , for the reaction.

**[2 marks]**

Enthalpy change \_\_\_\_\_  $\text{kJ mol}^{-1}$

0 8 . 2

Use your answer to Question **08.1** to deduce the enthalpy change for the following reaction.



(If you were unable to answer Question **08.1**, you should use the value  $-200 \text{ kJ mol}^{-1}$ . This is **not** the correct answer.)

**[1 mark]**

Enthalpy change \_\_\_\_\_  $\text{kJ mol}^{-1}$



0	8	.	3
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A student heats a sample of solid  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  to obtain some completely dry  $\text{CoCl}_2$

Suggest how the student could find out if the sample is completely dry.

**[2 marks]**

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**END OF QUESTIONS**



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2 4



2 2 6 X C H 0 1

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