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# GCSE CHEMISTRY

# H

Higher Tier Paper 1

Thursday 17 May 2018

Morning

Time allowed: 1 hour 45 minutes

## Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

## Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

## Information

- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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



0 1

Soluble salts are formed by reacting metal oxides with acids.

0 1 . 1

Give **one** other type of substance that can react with an acid to form a soluble salt.

**[1 mark]**

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0 1 . 2

Calcium nitrate contains the ions  $\text{Ca}^{2+}$  and  $\text{NO}_3^-$

Give the formula of calcium nitrate.

**[1 mark]**

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0 1 . 3

Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

**[6 marks]**

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**Turn over for the next question**

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0 2

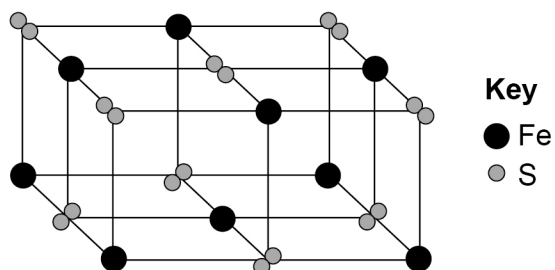
This question is about metals and metal compounds.

0 2 . 1

Iron pyrites is an ionic compound.

**Figure 1** shows a structure for iron pyrites.

**Figure 1**



Determine the formula of iron pyrites.

Use **Figure 1**.

[1 mark]

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0 2 . 2

An atom of iron is represented as  ${}^{56}_{26}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons \_\_\_\_\_

Number of neutrons \_\_\_\_\_

Number of electrons \_\_\_\_\_

0 2 . 3

Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_



Nickel is extracted from nickel oxide by reduction with carbon.

**0 2 4** Explain why carbon can be used to extract nickel from nickel oxide.

**[2 marks]**

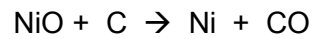
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**0 2 5** An equation for the reaction is:



Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses ( $A_r$ ): C = 12 Ni = 59

Relative formula mass ( $M_r$ ): NiO = 75

Give your answer to 3 significant figures.

**[3 marks]**

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Percentage atom economy = \_\_\_\_\_ %



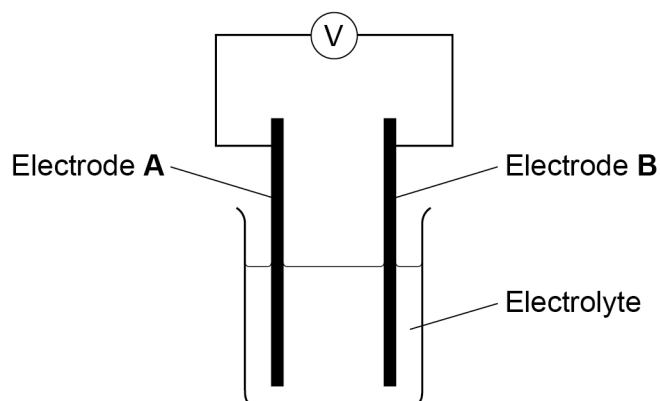
0 3

Chemical reactions can produce electricity.

0 3 . 1

Figure 2 shows a simple cell.

Figure 2



Which of these combinations would **not** give a zero reading on the voltmeter in Figure 2?

[1 mark]

Tick **one** box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	<input type="checkbox"/>
Zinc	Zinc	Water	<input type="checkbox"/>
Copper	Zinc	Sodium chloride solution	<input type="checkbox"/>
Copper	Zinc	Water	<input type="checkbox"/>



Alkaline batteries are non-rechargeable.

0 3 . 2 Why do alkaline batteries eventually stop working?

[1 mark]

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0 3 . 3 Why can alkaline batteries **not** be recharged?

[1 mark]

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**Question 3 continues on the next page**

**Turn over ►**



Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

**0 3 . 4** Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

**[2 marks]**



**0 3 . 5** **Table 1** shows data about different ways to power electric cars.

**Table 1**

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use **Table 1** and your own knowledge.

**[6 marks]**

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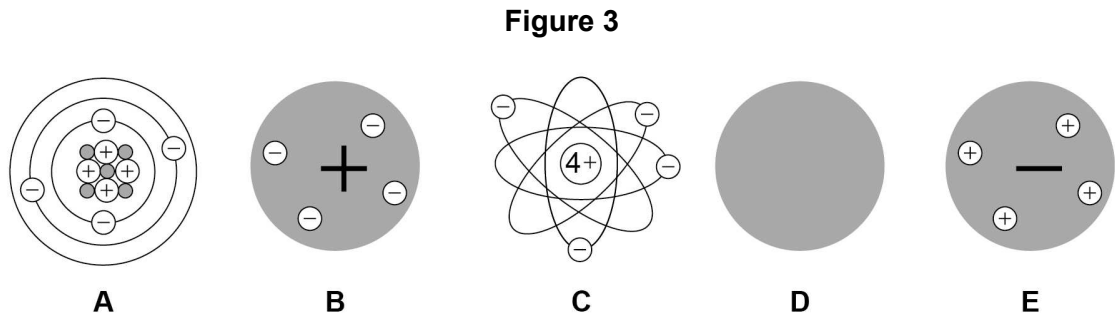






0 4

Figure 3 represents different models of the atom.



0 4 . 1

Which diagram shows the plum pudding model of the atom?

[1 mark]

Tick **one** box.

<b>A</b>		<b>B</b>		<b>C</b>		<b>D</b>		<b>E</b>	
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0 4 . 2

Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

[1 mark]

Tick **one** box.

<b>A</b>		<b>B</b>		<b>C</b>		<b>D</b>		<b>E</b>	
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0 4 . 3

Which diagram shows the model of the atom resulting from Bohr's work?

[1 mark]

Tick **one** box.

<b>A</b>		<b>B</b>		<b>C</b>		<b>D</b>		<b>E</b>	
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**0 4 . 4** Define the mass number of an atom.

[1 mark]

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**0 4 . 5** Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of  $^{69}\text{X}$
- 40% of  $^{71}\text{X}$

Estimate the relative atomic mass of element **X**.

[1 mark]

Tick **one** box.

< 69.5

Between 69.5 and 70.0

Between 70.0 and 70.5

> 70.5

**0 4 . 6** Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

[3 marks]

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Turn over ►



**0 5**

A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

**Table 2** shows the student's results.

**Table 2**

<b>Metal</b>	<b>Temperature increase in °C</b>
Copper	0
Iron	13
Magnesium	43
Zinc	17

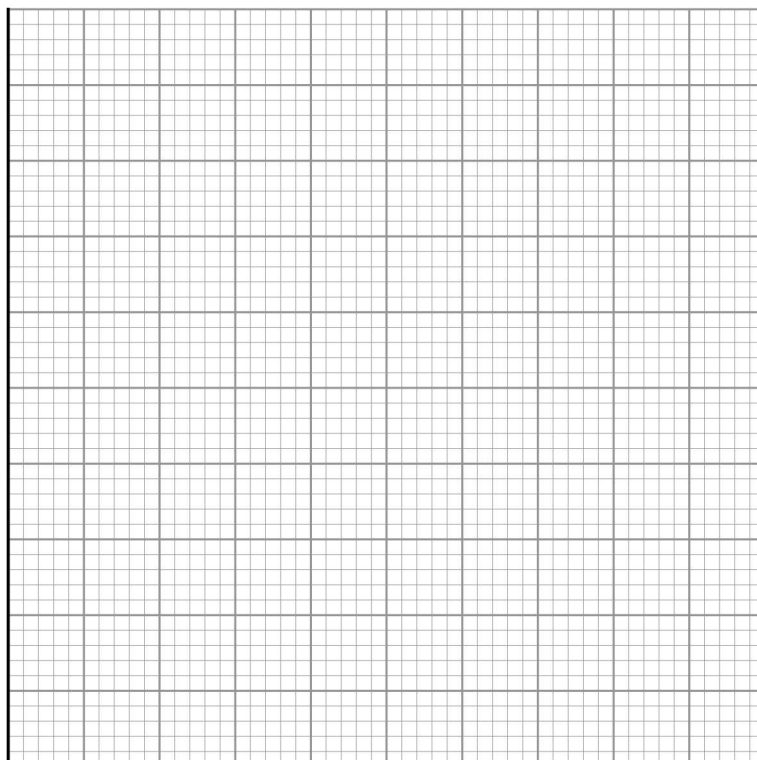
**0 5****1**

Plot the data from **Table 2** on **Figure 4** as a bar chart.

**[2 marks]**

**Figure 4**

Temperature  
increase  
in °C



Metal



0 5 . 2

The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

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0 5 . 3

The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.

Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

[4 marks]

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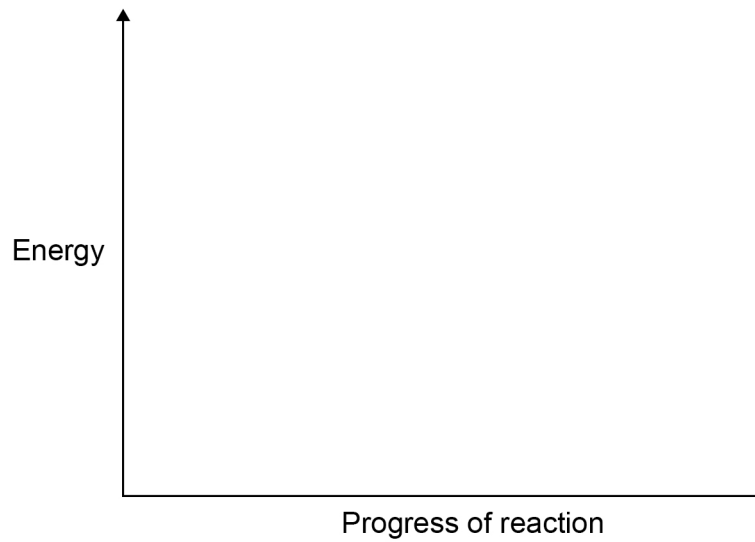
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0 5 . 4

Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 5**.

**[3 marks]****Figure 5**

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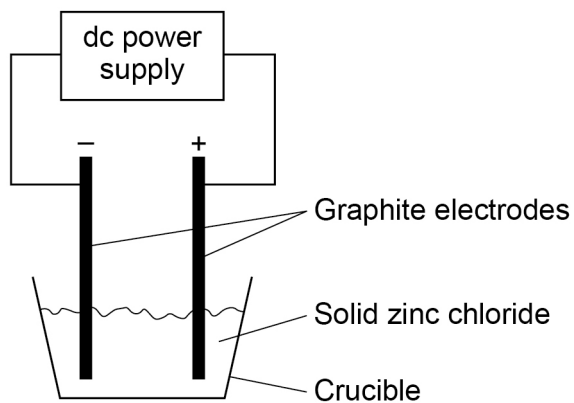


0 6

A student investigated the electrolysis of different substances.

**Figure 6** shows the apparatus.

**Figure 6**



0 6 . 1

Explain why electrolysis would **not** take place in the apparatus shown in **Figure 6**.

**[2 marks]**

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0 6 . 2

Explain why graphite conducts electricity.

Answer in terms of the structure and bonding in graphite.

**[3 marks]**

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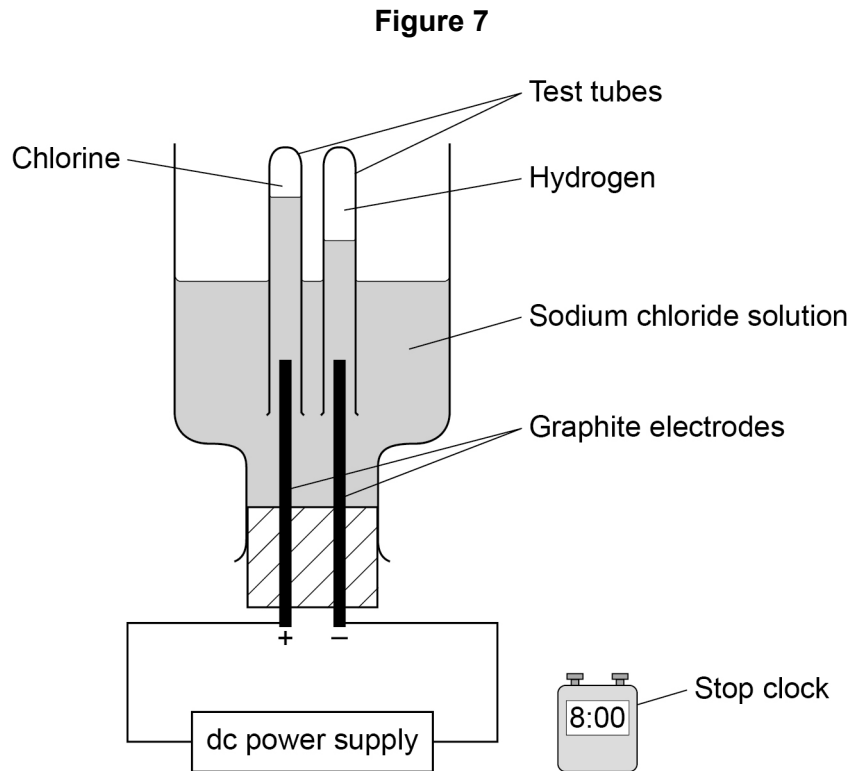
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The student investigated how the volume of gases produced changes with time in the electrolysis of sodium chloride solution.

**Figure 7** shows the apparatus.



**0 6 . 3** The student made an error in selecting the apparatus for this investigation.

How should the apparatus be changed?

Give **one** reason for your answer.

**[2 marks]**

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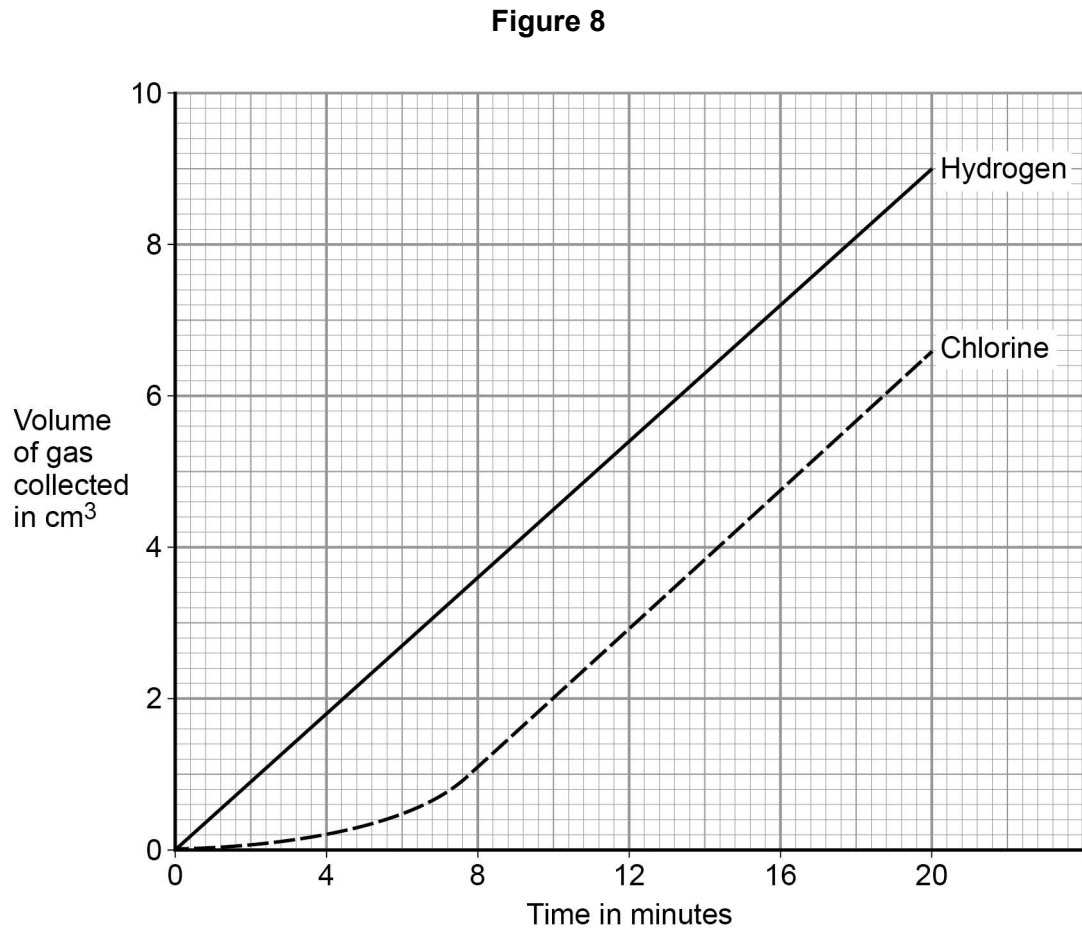
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Another student used the correct apparatus.

This student measured the volumes of gases collected every minute for 20 minutes.

**Figure 8** shows the student's results.



**0 6 . 4** Describe the trends shown in the results.

Use values from **Figure 8**.

**[3 marks]**

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0 6 . 5

The number of moles of each gas produced at the electrodes is the same.

No gas escapes from the apparatus.

Suggest **one** reason for the difference in volume of each gas collected.

[1 mark]

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0 6 . 6

Calculate the amount in moles of chlorine collected after 20 minutes.

Use **Figure 8**.

The volume of one mole of any gas at room temperature and pressure is  $24.0 \text{ dm}^3$

Give your answer in standard form.

[3 marks]

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Moles of chlorine = \_\_\_\_\_ mol

Turn over for the next question

14

Turn over ►



**0 7**

This question is about Group 7 elements.

Chlorine is more reactive than iodine.

**0 7 . 1**

Name the products formed when chlorine solution reacts with potassium iodide solution.

**[1 mark]**

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**0 7 . 2**

Explain why chlorine is more reactive than iodine.

**[3 marks]**

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**0 7 . 3**

Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

**[3 marks]**

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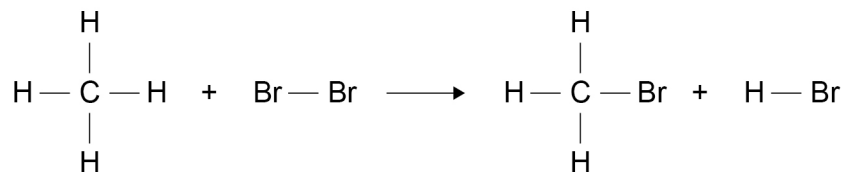
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0 7 . 4

Bromine reacts with methane in sunlight.

Do not write  
outside the  
box**Figure 9** shows the displayed formulae for the reaction of bromine with methane.**Figure 9****Table 3** shows the bond energies and the overall energy change in the reaction.**Table 3**

	C—H	Br—Br	C—Br	H—Br	Overall energy change
Energy in kJ/mol	412	193	X	366	– 51

Calculate the bond energy **X** for the C—Br bond.Use **Figure 9** and **Table 3**.**[4 marks]**


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Bond energy **X** = \_\_\_\_\_ kJ/mol

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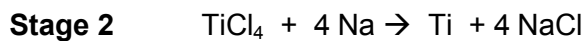
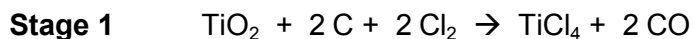
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0 8

Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two stage industrial process.



0 8 . 1

Suggest **one** hazard associated with **Stage 1**.

[1 mark]

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0 8 . 2

Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

[1 mark]

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0 8 . 3

Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

[2 marks]

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0 8 . 4 Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

[3 marks]

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In **Stage 2**, sodium displaces titanium from titanium chloride.

0 8 . 5 Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

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0 8 . 6 Complete the half equation for the oxidation reaction.

[1 mark]

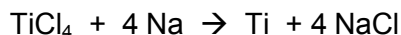


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**0 8 . 7** In **Stage 2**, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:



Relative atomic masses ( $A_r$ ): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

**[4 marks]**

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**0 8 . 8** For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

**[2 marks]**

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Mass of titanium = \_\_\_\_\_ kg

15





**0 9**

This question is about acids and alkalis.

**0 9 . 1**

Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

**[2 marks]**

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**0 9 . 2**A  $1.0 \times 10^{-3}$  mol/dm<sup>3</sup> solution of hydrochloric acid has a pH of 3.0What is the pH of a  $1.0 \times 10^{-5}$  mol/dm<sup>3</sup> solution of hydrochloric acid?**[1 mark]**

pH = \_\_\_\_\_

**Question 9 continues on the next page****Turn over ►**



0 9 . 4

Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

**[2 marks]**

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0 9 . 5

Calculate the mass of sodium hydroxide in 30.0 cm<sup>3</sup> of a 0.105 mol/dm<sup>3</sup> solution.

Relative formula mass ( $M_r$ ): NaOH = 40

**[2 marks]**

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Mass of sodium hydroxide = \_\_\_\_\_ g

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**END OF QUESTIONS**

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