



Please write clearly in block capitals.

Centre number

Candidate number

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 1H

Time allowed: 1 hour 15 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.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- 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.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 70.
- 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	
TOTAL	

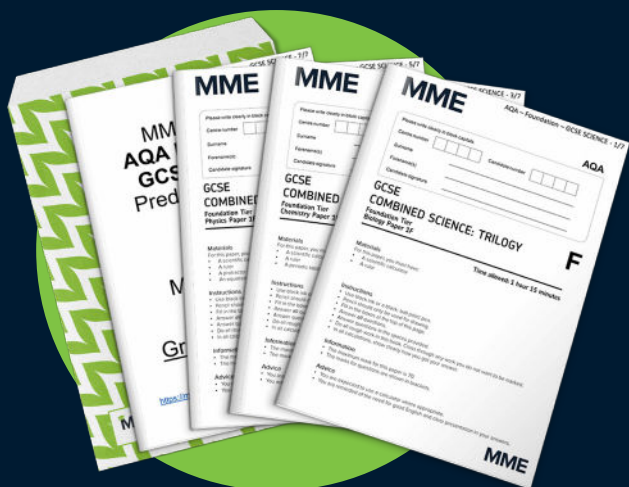


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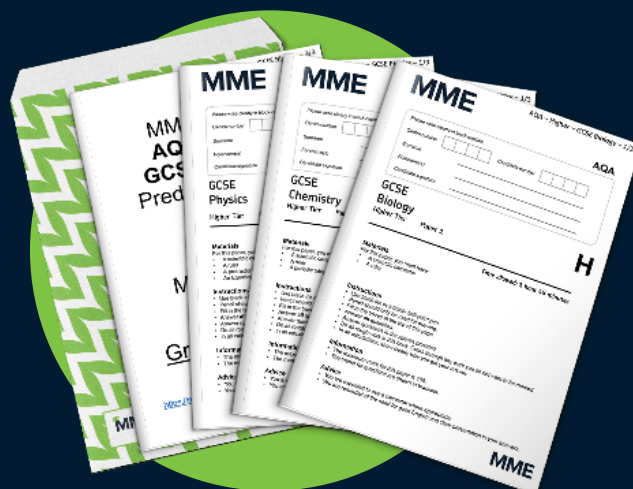
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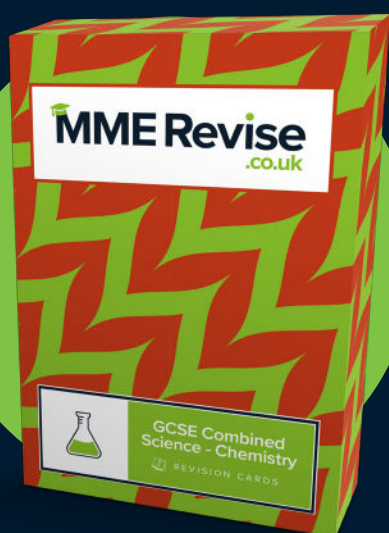
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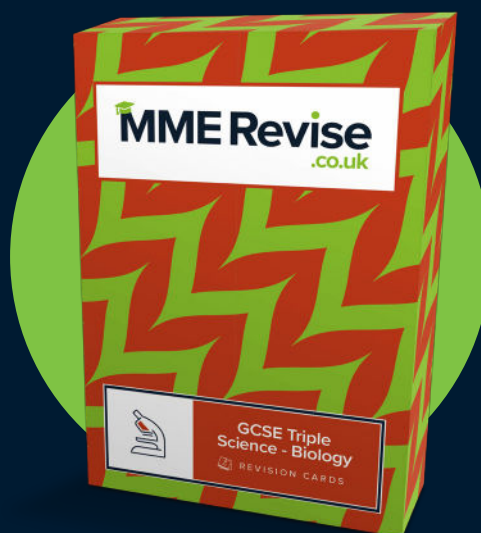
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0 1

This question is about salts.

Green copper carbonate and sulfuric acid can be used to produce blue copper sulfate crystals.

0 1 . 1

Excess copper carbonate is added to sulfuric acid.

Give **three** observations you would make.

[3 marks]

1 effervescence

2 blue solution formed

3 copper carbonate (solid) disappears.

0 1 . 2

How can the excess copper carbonate be removed?

[1 mark]

Filtration

0 1 . 3

The pH of the solution changes during the reaction.

What is the pH of the solution at the end of the reaction?

[1 mark]

pH = 7

0 1 . 4

Copper carbonate and sulfuric acid react to produce copper sulfate.

What type of reaction is this?

[1 mark]

neutralisation

Turn over ►

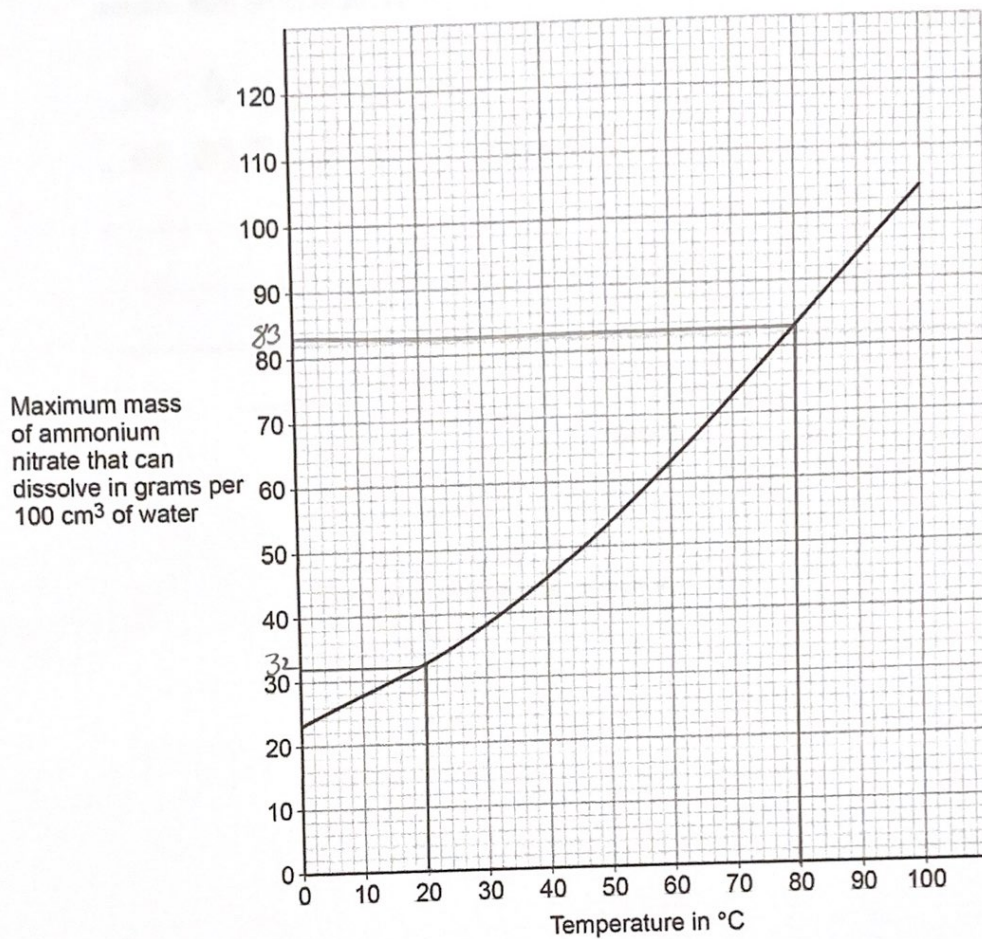


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0 1 . 5 Ammonium nitrate is a salt.

Figure 1 shows the maximum mass of ammonium nitrate that can dissolve in 100 cm³ of water at different temperatures.

Figure 1



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A student adds ammonium nitrate to water at $80\text{ }^{\circ}\text{C}$ until no more dissolves.

The student cools 100 cm^3 of this solution of ammonium nitrate from $80\text{ }^{\circ}\text{C}$ to $20\text{ }^{\circ}\text{C}$ to produce crystals of ammonium nitrate.

Determine the mass of ammonium nitrate that crystallises on cooling 100 cm^3 of this solution from $80\text{ }^{\circ}\text{C}$ to $20\text{ }^{\circ}\text{C}$

[3 marks]

See lines on graph

at $80\text{ }^{\circ}\text{C}$: 83 g at $20\text{ }^{\circ}\text{C}$: 32 g

$$83\text{ g} - 32\text{ g} = \underline{\underline{51\text{ g}}}$$

Mass = 51 g

9

Turn over for the next question

Turn over ►

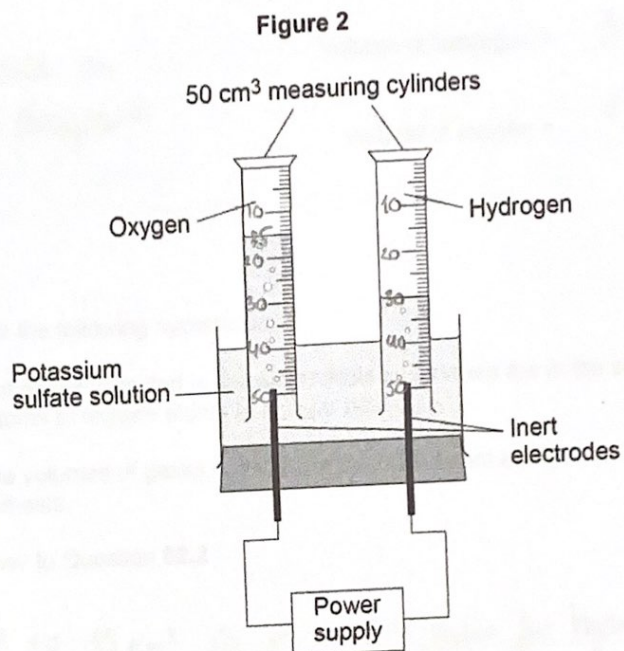


0 5

0 2

This question is about electrolysis.

Figure 2 shows the apparatus used to investigate the electrolysis of potassium sulfate solution.



0 2 . 1

Potassium sulfate contains K^+ and SO_4^{2-} ions.

What is the formula of potassium sulfate?

[1 mark]

Tick (✓) **one** box.KSO₄K₂SO₄K(SO₄)₂K₂(SO₄)₂

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0 2 . 2

What are the volumes of gases collected in the electrolysis experiment?

Use Figure 2.

[1 mark]

See on
diagramVolume of hydrogen = 30 cm³Volume of oxygen = 15 cm³

0 2 . 3

A student made the following hypothesis:

'The volumes of gases collected in this electrolysis experiment are in the same ratio as hydrogen atoms to oxygen atoms in a water molecule.'

Explain how the volumes of gases collected in the experiment in **Figure 2** support the student's hypothesis.

Use your answer to Question 02.2

[2 marks]

30 cm³ to 15 cm³ is in a 2:1 ratio for hydrogen:oxygen
in water (H₂O) the hydrogen:oxygen ratio is also 2:1

Question 2 continues on the next page

Turn over ►



0 7

0 2 . 4

The experiment is repeated 4 times.

The volumes of oxygen collected in the 4 experiments are:

6 cm³ 9 cm³ 10 cm³ 11 cm³The mean volume of oxygen collected in the 4 experiments is 9 cm³

The measure of uncertainty is the range of a set of measurements about the mean.

What is the measure of uncertainty in the 4 experiments?

[1 mark]

Tick (✓) one box.

9 ± 1 cm³9 ± 2 cm³9 ± 3 cm³

0 2 . 5

The potassium sulfate solution has 0.86 g of potassium sulfate dissolved in 25 cm³ of water.Calculate the mass of potassium sulfate needed to make 1.0 dm³ of solution.

[3 marks]

$$25 \text{ cm}^3 = 25 / 1000 = 0.025 \text{ dm}^3$$

$$\text{Concentration} = \frac{0.86 \text{ g}}{0.025 \text{ dm}^3} = \underline{\underline{34.4 \text{ g/dm}^3}}$$

Mass = 34.4 g

8



0 3

Plan an investigation to find the order of reactivity of three metals.

You should use the temperature change when each metal reacts with hydrochloric acid.

[6 marks]

Take 3 polystyrene cups. In each measure out 100 ml of HCl (of the same concentration). With a thermometer measure the starting temperature of each acid. Add a fixed, say 3g, of metal filings to each cup a different one. (Making sure filing size is the same for all metals). Stir each acid with the metal then place a thermometer in each and monitor the change in temperature. For each metal also record the highest temperature reached during each reaction. Using the starting temperature and highest temperature for each metal calculate the temperature change. Repeat the same steps and repeat for each metal with the same volume and concentration of HCl. Use these repeats to calculate a mean change in temperature for each metal. You can use these changes in temperature to arrange the metals in the order of reactivity. The metal with the highest change in temperature would be the most reactive and the one with the least change would be the least reactive.

6

Turn over for the next question

Turn over ►



0 4

This question is about Group 7 elements.

0 4 . 1

What are the Group 7 elements known as?

[1 mark]

Halogens

0 4 . 2

Why do Group 7 elements react in similar ways?

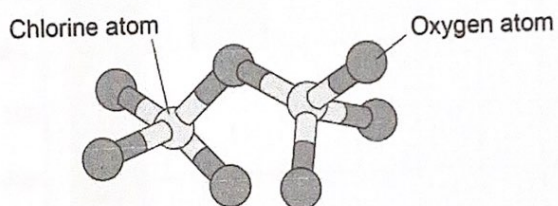
[1 mark]

All have 7 electrons in their outer electron
shell

0 4 . 3

Figure 3 shows the structure of a molecule of chlorine oxide.

Figure 3



What is the molecular formula of the chlorine oxide molecule in Figure 3?

[1 mark]

Cl₂O₂

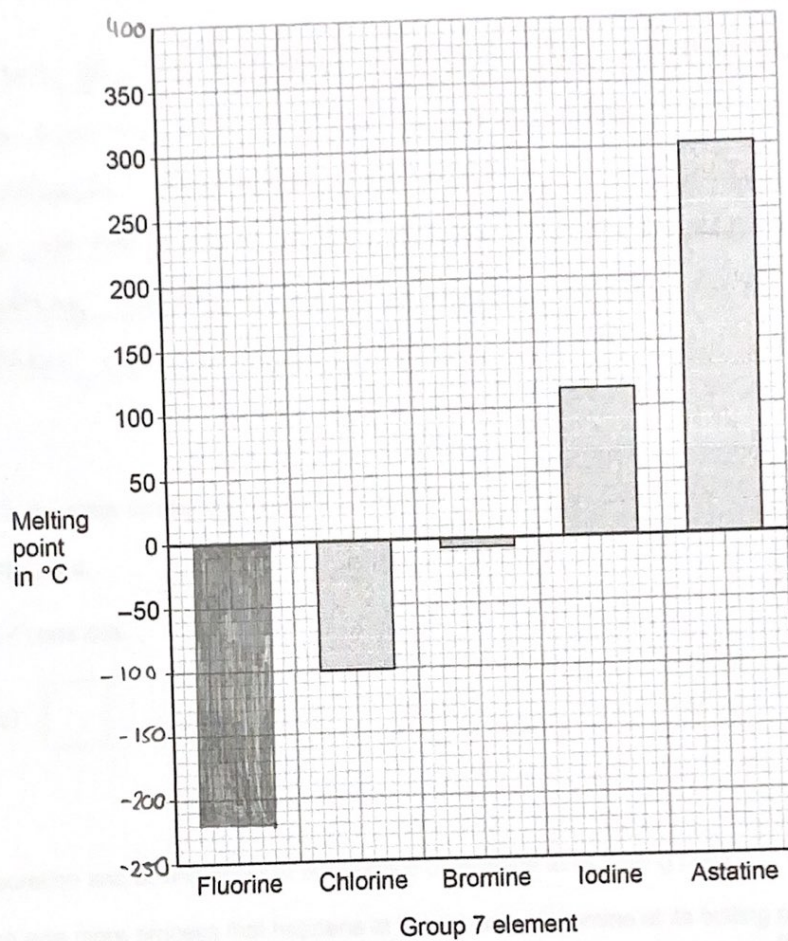
Question 4 continues on the next page

Turn over ►



Figure 4 shows the melting points of some Group 7 elements.

Figure 4



0 4 . 4

The melting point of fluorine is $-220\text{ }^{\circ}\text{C}$

Complete **Figure 4**.

You should:

- complete the scale on the y-axis
- draw the bar for the melting point of fluorine.

[2 marks]



1 2

0 4 . 5 Explain the trend in the melting points of the Group 7 elements.

Use Figure 4.

[3 marks]

As we go up the group molecules size is ~~size~~ size.
This causes intermolecular forces (forces between
molecules) ~~decreases~~ increases.
As intermolecular forces increase, so does their
melting point, as more energy is needed to break
these intermolecular forces.

0 4 . 6 What is the state symbol for bromine at $-50\text{ }^{\circ}\text{C}$?

Use Figure 4.

[1 mark]

Tick (✓) one box.

(aq)

(g)

(l)

(s)

0 4 . 7 Evaporation and boiling occur at the surface of bromine at its boiling point.

Name **one** more process that happens at the surface of bromine at its boiling point.

[1 mark]

Condensation

10

Turn over for the next question

Turn over ►



1 3

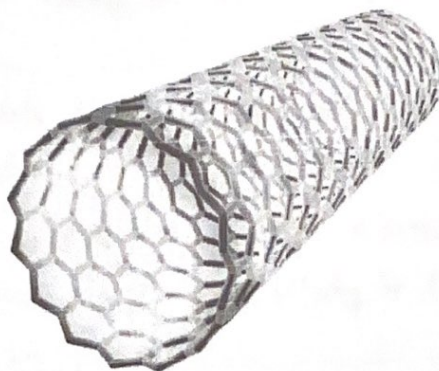
0 5

This question is about structure and bonding.

0 5 . 1

Figure 5 represents part of a carbon molecule.

Figure 5



Name the type of carbon molecule in Figure 5.

[1 mark]

Fullerene

0 5 . 2

Suggest **one** property that makes the carbon molecule in Figure 5 useful in nanotechnology.

[1 mark]

Its able to conduct electricity.



0 5 . 3

An alloy of aluminium contains small amounts of other metals.

Explain why other metals are added to aluminium.

[4 marks]

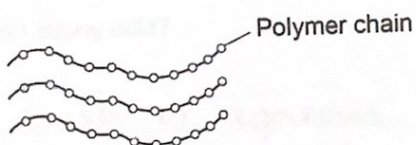
It allows the alloy to be harder than pure aluminium.

As other metals have atoms of different size to aluminium them being indisperced in the structure disrupts the structure of the aluminium atoms. This way they are less likely to slide past each other in layers.

0 5 . 4

Figure 6 represents part of the structure of a polymer.

Figure 6



Compare the bonding within the chains with the forces between the chains in this polymer.

[3 marks]

Within a chain between atoms there is strong covalent bonds.

Between polymer chains there are weaker intermolecular forces.

Intramolecular covalent bonds are stronger than the weaker intermolecular forces between molecules.

9

Turn over ►



0 6

This question is about hydrogen chloride and hydrochloric acid.

0 6 . 1

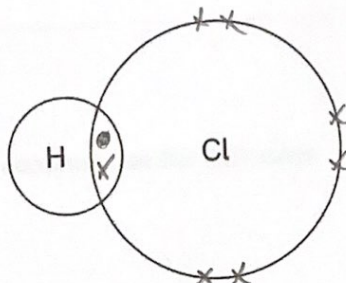
Complete the dot and cross diagram to represent the bonding in hydrogen chloride on Figure 7.

Use dots (o) and crosses (x) to represent electrons.

You should show only the electrons in the outer shells.

[2 marks]

Figure 7



0 6 . 2

Hydrogen chloride dissolves in water to produce hydrochloric acid.

Hydrochloric acid is a strong acid.

What is meant by the term strong acid?

[1 mark]

Completely ionises in aqueous solution
(fully dissociates): $\text{HCl} \rightarrow \text{H}^+(\text{aq}) + \text{Cl}^-(\text{aq})$

0 6 . 3

Describe how magnesium can be used to distinguish between a strong acid and a weak acid of the same concentration.

[2 marks]

For the stronger acid the reaction rate would be much faster, so we would see the magnesium disappear at a much faster rate.



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0 6 . 4

The concentration of hydrochloric acid is increased by a factor of 100

What is the change in pH?

[2 marks]

$$100 = 10^2 \Rightarrow 2$$

The pH would decrease by a factor of 2.

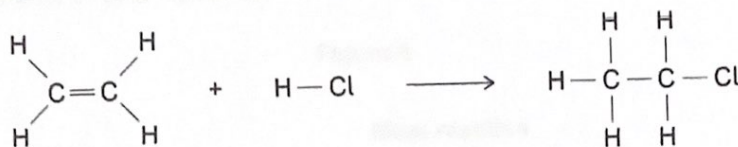
Question 6 continues on the next page

Turn over ►



06.5 Ethene and hydrogen chloride react to produce chloroethane.

The displayed formulae equation for the reaction is:



The reaction is exothermic.

In the reaction the energy released forming new bonds is 56 kJ/mol greater than the energy needed to break existing bonds.

Table 1 shows some bond energies.

Table 1

Bond	H-C	C=C	H-Cl	C-C	C-Cl
Bond energy in kJ/mol	413	X	431	346	339

Calculate the bond energy X.

[4 marks]

$$\text{Energy released} = \text{bonds made} - \text{bonds broken}$$

$$\begin{aligned} \text{Bonds made} &= (1 \times \text{C-Cl}) + (5 \times \text{C-H}) + (1 \times \text{C-C}) \\ &= (1 \times 346) + (5 \times 413) + (1 \times 339) = 2750 \end{aligned}$$

$$\begin{aligned} \text{Bonds broken} &= (1 \times \text{C=C}) + (4 \times \text{C-H}) + (1 \times \text{H-Cl}) \\ &= (1 \times x) + (4 \times 413) + (1 \times 431) = 2083 + x \end{aligned}$$

$$56 = 2750 - (2083 + x)$$

$$2694 = 2083 + x \Rightarrow x = 611 \text{ kJ/mol}$$

$$x = 611 \text{ kJ/mol}$$

11



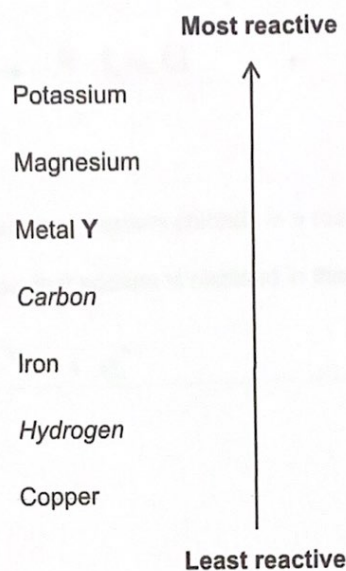
07

This question is about elements and compounds.

07.1

Figure 8 shows a reactivity series.

Figure 8



Give the method and conditions used to extract metal Y from a compound of metal Y. [2 marks]

Electrolysis can be used if compound of metal Y is molten.

Question 7 continues on the next page

Turn over ►



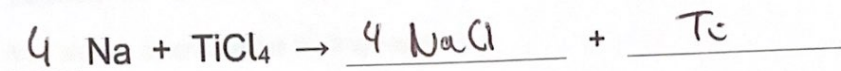
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Sodium reacts with titanium chloride (TiCl_4) to produce titanium.

07.2 Complete the equation.

You should balance the equation.

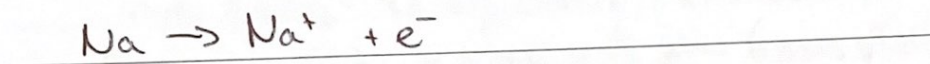
[2 marks]



07.3 The reaction between sodium and titanium chloride is a redox reaction.

Write a half-equation to show that sodium is oxidised in this reaction.

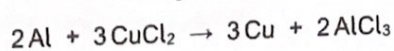
[2 marks]



07.4

108 g of aluminum reacts with 1.21 kg of copper chloride to produce copper.

The equation for the reaction is: \downarrow 1210g



Calculate the maximum mass of copper produced in grams (g).

You should determine the limiting reactant.

Relative atomic masses (A_r): Al = 27 Cu = 63.5

Relative formula masses (M_r): $\text{CuCl}_2 = 134.5$ $\text{AlCl}_3 = 133.5$

[6 marks]

$$\text{moles of Al} = 108\text{g} / 27 = 4 \quad (\text{mass} / M_r)$$

$$\text{moles of CuCl}_2 = 1210\text{g} / 134.5 = 8.9963 \dots \approx 9$$

Al : CuCl_2 is 2 : 3 so 4 moles of Al gives 6 moles of CuCl_2

therefore Al is the limiting reactant.

$$\text{mass of Cu} = 2 \times 3 \times 63.5 = \underline{381\text{g}}$$

Limiting reactant is aluminium (Al)

Mass of copper = 381 g

Question 7 continues on the next page

Turn over ►



Sodium metal and sodium chloride are both able to conduct electricity.

0 7 . 5

Describe how sodium metal conducts electricity.

[2 marks]

Sodium is a metal so has delocalised electrons. These electrons are able to move through the metal structure ~~and~~ and transfer charge through the metal.

0 7 . 6

Explain how sodium chloride can conduct electricity.

[3 marks]

In a liquid state, when molten.

In such instance ions are able to move around freely and transfer charge.

17

END OF QUESTIONS

