

3 A student carried out an experiment to see how reactive different metals are when they are placed in dilute hydrochloric acid.

A sample of each metal was placed in a separate test tube of acid.

(a) When zinc reacts with dilute hydrochloric acid, a gas is given off and zinc chloride is formed.

(i) Which gas is given off?

- A carbon dioxide
- B chlorine
- C hydrogen
- D oxygen

(1)

(ii) What is the formula of zinc chloride?

- A ZnCl
- B Zn₂Cl
- C ZnCl₂
- D Zn₂Cl₂

(1)

(b) In the experiment, the student used the same amount of each metal in a finely powdered form.

State **two** factors, concerning the hydrochloric acid, which should also be controlled to produce valid results.

(2)

1

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2

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(c) Part of the reactivity series is shown in Figure 8.

most reactive	magnesium
	aluminium
	iron
least reactive	silver

Figure 8

Iron is extracted from its ore by heating with carbon.
Aluminium is extracted from its ore using a different method.

(i) Give the name of the method used to extract aluminium. (1)

(ii) Explain why aluminium is extracted by a different method rather than heating the ore with carbon. (2)

(d) The extraction of iron involves the reduction of iron oxide, Fe_2O_3 , by carbon monoxide, CO. During this reaction, the iron oxide is reduced to iron, Fe, and the carbon monoxide is oxidised to carbon dioxide.

Write the balanced equation for the reaction. (2)

(Total for Question 3 = 9 marks)

5 Objects made from transition metals are sometimes coated with a thin layer of another transition metal to improve their appearance and to protect against corrosion.

(a) Figure 10 shows equipment that can be used to electroplate an iron spoon with silver.

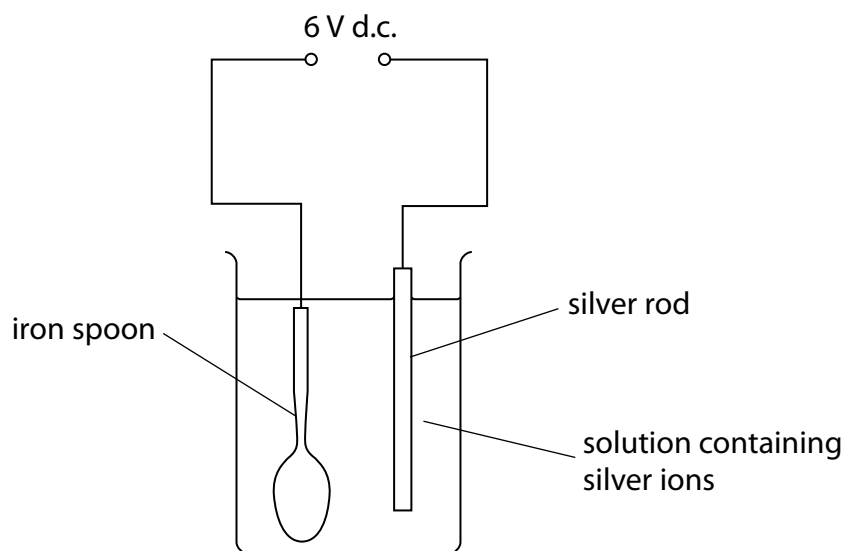


Figure 10

(i) Which row of the table correctly shows the charge on the silver rod electrode and the type of reaction occurring at this electrode?

(1)

	charge	type of reaction
<input type="checkbox"/> A	negative	oxidation
<input type="checkbox"/> B	negative	reduction
<input type="checkbox"/> C	positive	oxidation
<input type="checkbox"/> D	positive	reduction

(ii) Silver metal is deposited on the spoon.

Which half-equation represents this reaction?

(1)

- A** $\text{Ag} + \text{e} \rightarrow \text{Ag}^+$
- B** $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
- C** $\text{Ag}^+ + \text{e} \rightarrow \text{Ag}$
- D** $\text{Ag}^+ \rightarrow \text{Ag} + \text{e}^-$

(b) The voltage of a cell is 1.5V.

Give a reason why this voltage of the cell decreases when the cell is left connected in a circuit.

(1)

(c) Duralumin is an alloy of aluminium and copper.

The radii of the aluminium and copper atoms are shown in Figure 11.

	radius of atom / m
aluminium	1.43×10^{-12}
copper	1.27×10^{-12}

Figure 11

Explain why copper added to aluminium to form the alloy makes the alloy stronger than pure aluminium.

(2)

(d) Gold is often alloyed with other metals when it is used to make jewellery.

The proportion of gold in a piece of gold jewellery is measured in carats.

Pure gold is 24 carats.

A 9 carat gold ring has a mass of 12 g.

Calculate the mass of gold in this ring.

(2)

mass of gold ring = g

(Total for Question 5 = 7 marks)

6 Electrodes are placed in three different solutions, **J**, **K** and **L**.

A 6V direct current source is connected to the electrodes.

Any products formed at the electrodes are identified.

The results are given in Figure 12.

solution	solution conducts electricity	product at cathode	product at anode
J	yes	copper	chlorine
K	yes	hydrogen	oxygen
L	no	none	none

Figure 12

(a) Explain which solutions are electrolytes.

(2)

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(b) Which material is most suitable to make the electrodes for the electrolysis of a dilute acid?

(1)

- A** zinc
- B** sulfur
- C** iron
- D** graphite

- (c) When a solution of sodium sulfate, Na_2SO_4 , is electrolysed, the products formed at the electrodes are hydrogen and oxygen.

Explain the formation of the products at the electrodes.

(4)

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- (d) Copper is purified by the electrolysis of copper sulfate solution using an impure copper anode and a pure copper cathode.

Write the half-equation for the formation of a copper atom from a copper ion.

(2)

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(Total for Question 6 = 9 marks)

Acids and electrolysis

2 Acids can undergo neutralisation to form salts.

(a) Complete the sentence by putting a cross (☒) in the box next to your answer.

(1)

An acid reacts with a metal oxide to form

- A a salt + carbon dioxide
- B a salt + hydrogen
- C a salt + oxygen
- D a salt + water

(b) Acids also react with metal carbonates.

The equation for the reaction of calcium carbonate with dilute hydrochloric acid is



Describe what you would **see** when solid calcium carbonate reacts with dilute hydrochloric acid.

(2)

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(c) Hydrogen and oxygen are produced by the electrolysis of water, acidified with a small amount of dilute sulfuric acid.

(i) Explain what is meant by **electrolysis**. (2)

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(ii) Describe the test to show that a gas is oxygen. (2)

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(iii) Describe the test to show that a gas is hydrogen. (2)

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(Total for Question 2 = 9 marks)

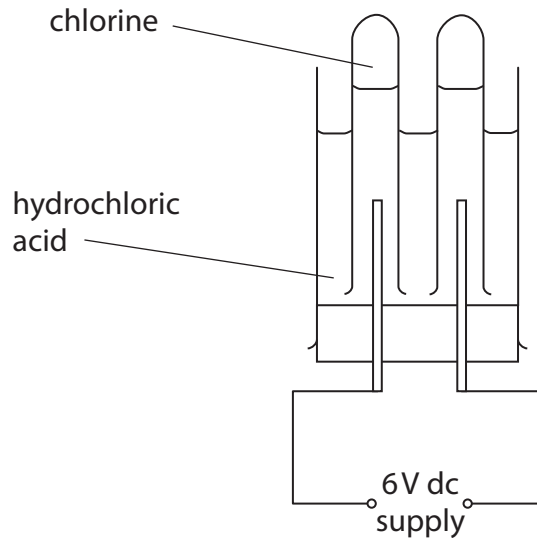


Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Hydrochloric acid and chlorine

1 (a) Hydrochloric acid can be electrolysed using this apparatus.



(i) State the form of energy used to carry out the electrolysis.

(1)

(ii) Chlorine gas is formed at one electrode.

Name the gas formed at the other electrode.

(1)

(iii) Describe the test to show that a gas is chlorine.

(2)



(b) Which of these can be used to obtain chlorine from sea water?

Put a cross (☒) in the box next to your answer.

(1)

- A corrosion
- B electrolysis
- C fractional distillation
- D neutralisation

(c) Acids react with metal carbonates.

Complete the word equation for this type of reaction.

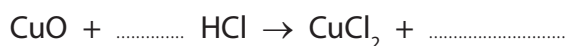
(1)

acid + metal carbonate → salt + water +

(d) Acids also react with metal oxides.

Complete and balance the equation for the reaction between copper oxide, CuO, and dilute hydrochloric acid, HCl.

(2)

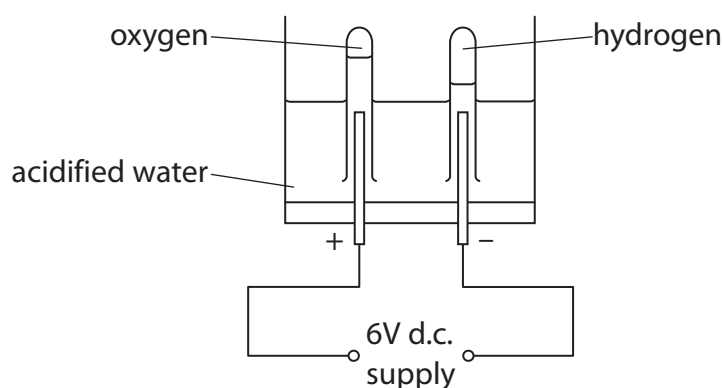


(Total for Question 1 = 8 marks)



Electrolysis and acids

- 4 (a) Water, acidified with a small amount of dilute sulfuric acid, can be decomposed by electrolysis using the apparatus shown.



- (i) State the form of energy used to carry out the electrolysis.

(1)

- (ii) During the electrolysis, hydrogen is formed at one of the electrodes.

Describe a test to show that this gas is hydrogen.

(2)

- (b) Electrolysis is also used to produce chlorine on a large scale.

Name a raw material that can be electrolysed to produce chlorine.

(1)



Acids and electrolysis

3 (a) Which of these substances is produced in the stomach to help digestion?

Put a cross (☒) in the box next to your answer.

(1)

- A calcium oxide
- B hydrochloric acid
- C magnesium oxide
- D sulfuric acid

(b) Nitric acid reacts with magnesium carbonate to form a salt, water and a gas.

(i) State the name of the salt formed in this reaction.

(1)

(ii) Which of these is the gas produced in this reaction?

Put a cross (☒) in the box next to your answer.

(1)

- A carbon dioxide
- B hydrogen
- C oxygen
- D nitrogen

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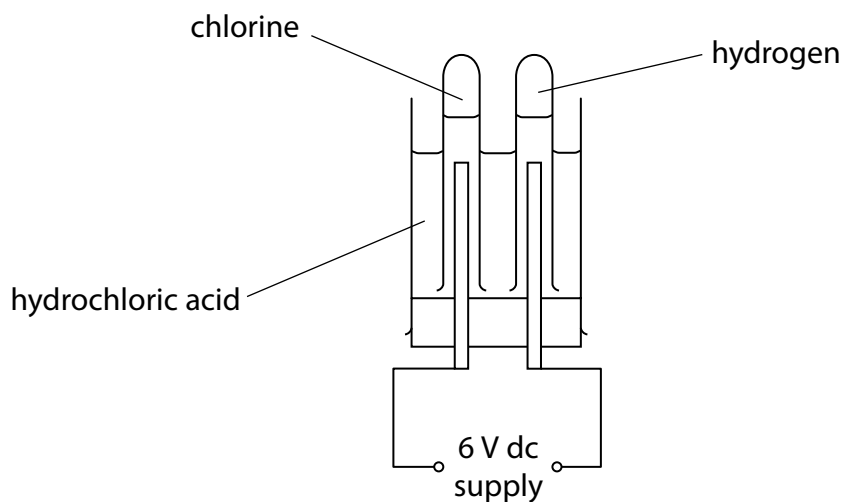


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(c) Hydrochloric acid is electrolysed using this apparatus.
Hydrogen and chlorine are produced.



(i) Describe the test to show that a gas is chlorine.

(2)

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(ii) Chlorine is a toxic gas.

State a safety precaution that should be taken when chlorine gas is formed in a reaction.

(1)

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(iii) Write the balanced equation for the decomposition of hydrochloric acid to form hydrogen and chlorine.

(3)

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(Total for Question 3 = 9 marks)

