WJEC Chemistry GCSE

2.3: Metals and their Extraction

Practice Questions

Wales Specification

1.

The table below shows some information about elements **A-F**. The letters are not the chemical symbols of the elements.

Element	Colour	Melting point (°C)	Boiling point (°C)	Conducts electricity	Density (g/cm^3)
A	dull grey	1414	2900	yes	2.03
B	pale yellow	–219	–188	no	0.0017
C	orange brown	–7	59	no	3.10
D	shiny brown	1084	2927	yes	8.92
E	shiny grey	1538	2861	yes	7.87
F	colourless	–157	–153	no	0.0033

(a) State which of the elements **A-F** are gases at room temperature. [1]

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(b) Give the letter of the element **A-F** that has the biggest difference between melting point and boiling point. [1]

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(c) The following diagram shows an outline of the Periodic Table.

(i) Element **A** is found in area **Y** of the Periodic Table. Explain how the information in the table supports this. [2]

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(ii) From elements **B-F**, identify **all** that would be found in area **X**. [1]

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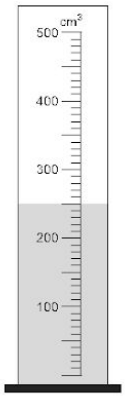
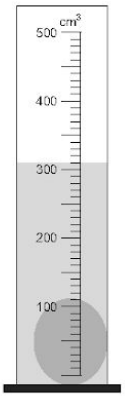
(d) A student has a sample of element **D** of mass 540 g. She measures its volume using a measuring cylinder as shown below.



Measuring cylinder before adding sample of element **D**



Measuring cylinder after adding sample of element **D**

(i) Using the information given above and the equation below, calculate the density of the sample of element **D**. [2]

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Density of sample of element **D** = ... g/cm^3

(ii) Another pupil obtained a value of 9.10 g/cm^3. Suggest why this value is different to that given in the table. [2]

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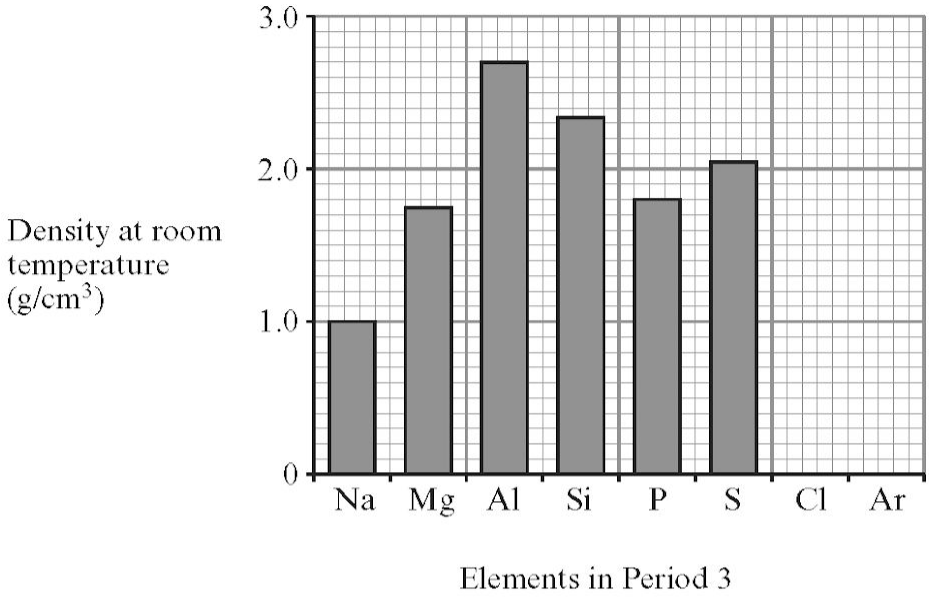
2.

(a) A bar chart of the densities *at room temperature* of all the elements in Period 3 of the Periodic Table is shown below.



(i) Name **all** the **metals** in this period. [1]

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(ii) Name the element in this period that has both metallic and non-metallic properties. [1]

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(iii) Give the reason that the bars for chlorine and argon are too small to be seen. [1]

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(iv) Give the trend in the densities of the **metals** going across this period. [1]

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(b) The table below gives the melting points of all the elements in Period 3.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting point (°C)	98	650	660	1410	44	113	–101	–189

How well does the evidence in the table support the following statement?

'The melting points of non-metals ***decrease*** *from left to right across the Periodic Table.'*

[2]

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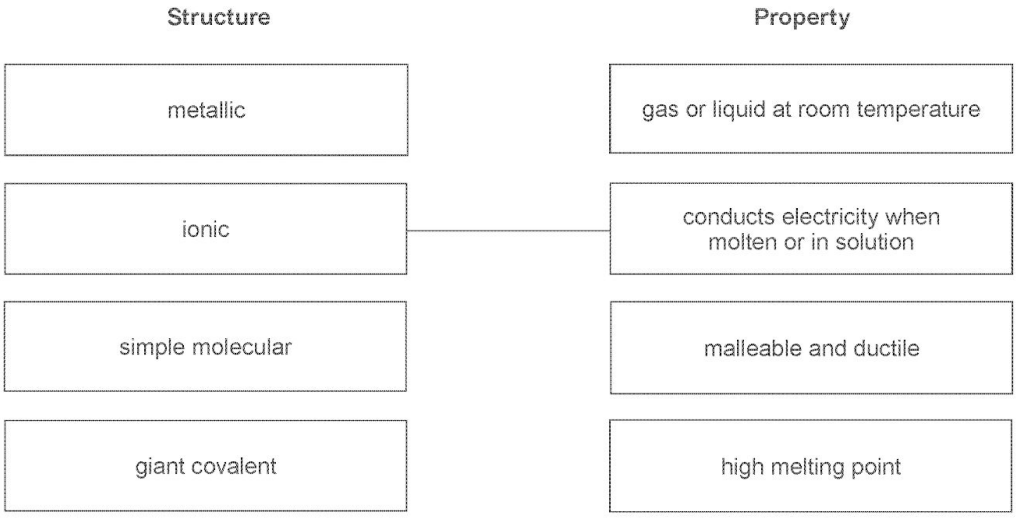
3. *(a)* Draw a line from each type of structure to its property. One has been done for you. [2]



(b) Smart materials have properties which change reversibly with a change in their surroundings. The box below shows the names of some smart materials.

hydrogel	**shape memory alloy**	**photochromic pigment**
thermochromic pigment	**shape memory polymer**	

From the box above, choose the smart material used in making each of the following items. [3]

Mug .....

Gumshield .....

Disposable nappy .....

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4.

(a) The table below shows some properties of three elements in the Periodic Table.

Element	Melting point (°C)	Boiling point (°C)	Appearance	Malleable or brittle?	Electrical conductivity
aluminium	660	2519	shiny solid	malleable	good
silicon	1414	3265	shiny solid	brittle	semiconductor
phosphorus	44	280	white solid	brittle	poor

Describe how the information in the table shows that silicon is difficult to classify as a metal or a non-metal. [2]

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(b) Give the **symbol** of the element which is found in Group 2 and Period 3 of the Periodic Table. [1]

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(c) (i) The chemical formula of copper(II) nitrate is $Cu(NO_3)_2$. Give the number of nitrogen atoms in the formula $Cu(NO_3)_2$. [1]

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(ii) Give the chemical formula of silver oxide. [1]

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(d) Nano-scale silver particles are added to socks to reduce the effects of smelly feet. Recent research has found that these particles can easily leak into waste water during washing.

(i) State the property of nano-scale silver particles that makes them useful in socks.

..... [1]

(ii) Suggest a reason why some scientists are concerned about nano-scale silver particles entering waste water. [1]

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5.

(a) Give the electronic structure of sodium, Na. [1]

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(b) Draw a diagram to show the metallic bonding in sodium. [2]

(c) (i) Sodium reacts vigorously with water.

Give **two** observations you would make when a small piece of sodium is added to a trough of water. [1]

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(ii) Name the products of this reaction. [1]

..... and .....

(d) As you go down Group 1 of the Periodic Table the elements become more reactive.

State the main difference you would see if potassium instead of sodium was added to water. [1]

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(e) Explain why Group 1 metal reactivity increases down the group. [2]

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6.

Lithium, sodium and potassium are Group 1 metals.

(a) A teacher wanted to demonstrate the similarities and differences in how each metal reacted with water. She added a small piece of each metal separately to a trough of water.

Describe what you would see when each metal is added to water and state how the observations can be used to establish the trend in reactivity within the group. [6 QWC]

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(b) The teacher then demonstrated the reaction of sodium with oxygen.

Complete and balance the symbol equation for this reaction. [2]

$\square$ Na + O_2 ⟶ $\square$ .....

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7.

Copper and titanium are important metals. The following table shows some of their uses.

Metal	Uses
copper	electrical wiring, water pipes, saucepan bases, jewellery
titanium	hip replacements, rotors on helicopters, pipes in chemical industry

Describe how the properties of copper and titanium make them suitable for these uses.
[6 QWC]

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8.

Describe the properties of metals and relate these properties to the uses of two metals of your choice. [6 QWC]

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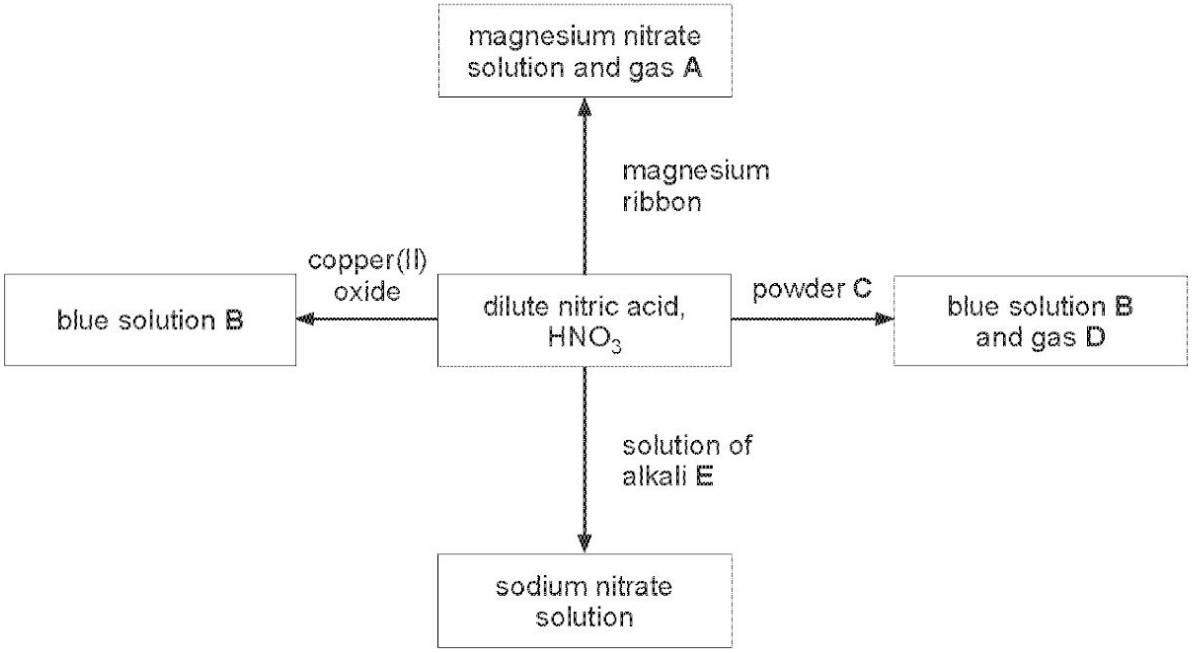
9.

(a) The following diagram shows some reactions of dilute nitric acid.



(i) Name the following substances. [3]

Powder C .....

Solution B .....

Alkali E .....

(ii) Name gases A and D and describe how they can be identified. [4]

Gas A

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Gas D

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(b) When sodium hydroxide reacts with sulfuric acid a solution of sodium sulfate is produced.

(i) Give the formula of sodium sulfate. ..... [1]

(ii) Describe how crystals of sodium sulfate can be obtained from a solution of sodium sulfate. [2]

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(c) Phosphoric acid can be used to remove rust, Fe_2O_3. Balance the equation for the reaction taking place. [1]

Fe_2O_3 + ☐ H_3PO_4 ⟶ ☐ $FePO_4$ + ☐ H_2O

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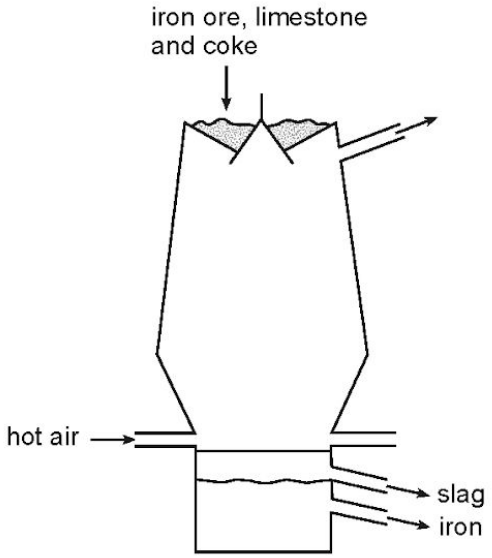
10.

The diagram below shows the blast furnace which is used to extract iron.



Give a detailed description of the extraction of iron. [6 QWC]

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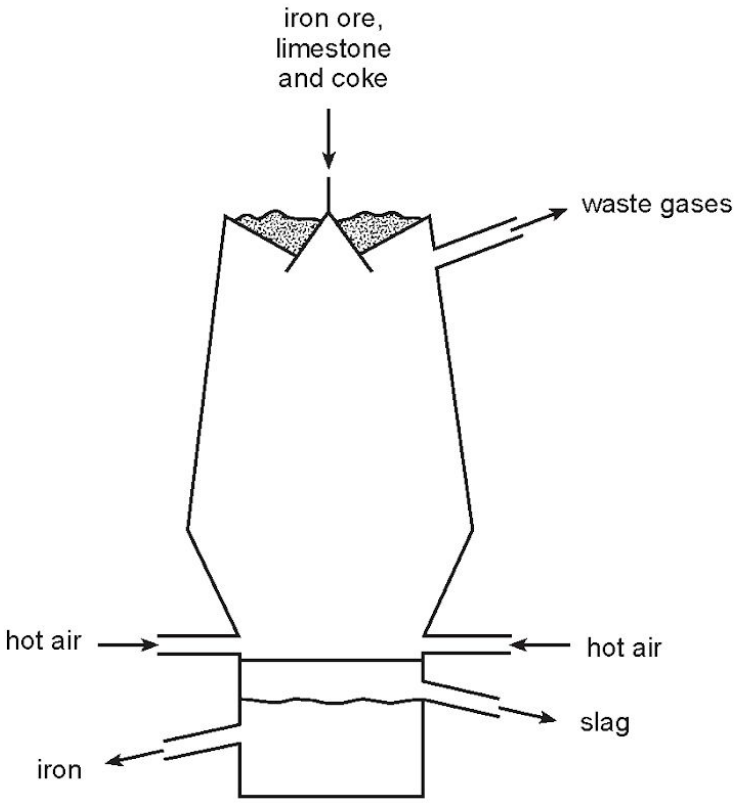
11.

(a) Iron is extracted in the blast furnace. Iron ore, limestone, coke and hot air are the raw materials.



(i) Give the reason for adding each of the following to the furnace:

I coke; [1]

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II limestone. [1]

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(ii) I Balance the symbol equation that represents the main reaction occurring in the furnace. [1]

Fe_2O_3 + ☐ CO ⟶ ☐ Fe + ☐ CO_2

II Give the chemical name of the substance which is reduced in the furnace. [1]

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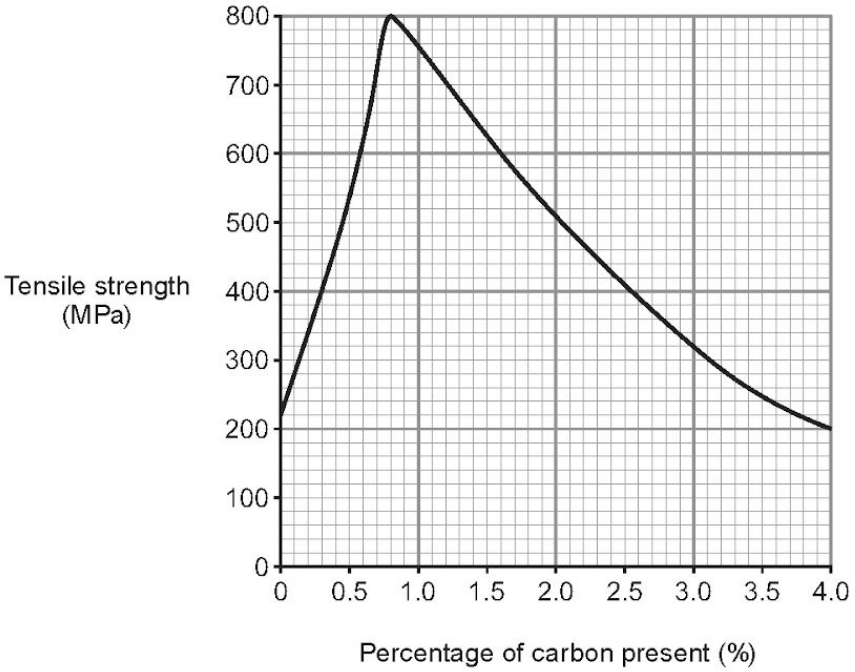
(b) The graph below shows how the tensile strength of iron alloys changes with the percentage of carbon present.



(i) Describe how the tensile strength changes as the percentage of carbon present increases. [2]

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(ii) The table below shows the percentage of carbon present in some iron alloys.

Alloy of iron	Percentage of carbon present in the alloy (%)
wrought iron	0.1
mild steel	0.3
high-carbon steel	0.9
cast iron	3.6

Use the information in the table and the graph to name the alloy which has the **lowest** tensile strength. [1]

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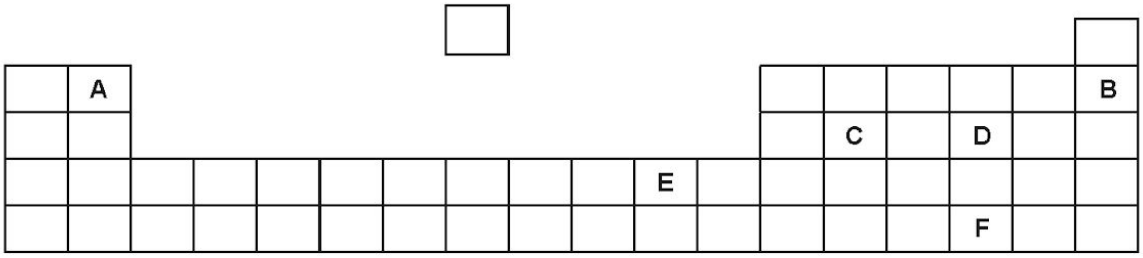
12.

The following diagram shows an outline of the Periodic Table.
The letters shown are NOT the chemical symbols of the elements.



(a) Give the **letter** of the element which is found in Group 0 and Period 2. [1]

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(b) Give the **letters** of the **two** elements which you would expect to have similar chemical properties. Give a reason for your choice.

Letters ..... and .....

Reason ..... [2]

(c) The table below shows the properties of three elements **1**, **2** and **3**.

Element	Properties			
	Melting Point (°C)	Boiling Point (°C)	Appearance	Malleable or brittle
1	1084	2927	shiny brown solid	malleable
2	1414	2900	shiny grey solid	brittle
3	115	445	yellow solid	brittle

State, giving reasons, which of elements **1**, **2** or **3** could be element **C** in the Periodic Table above. [2]

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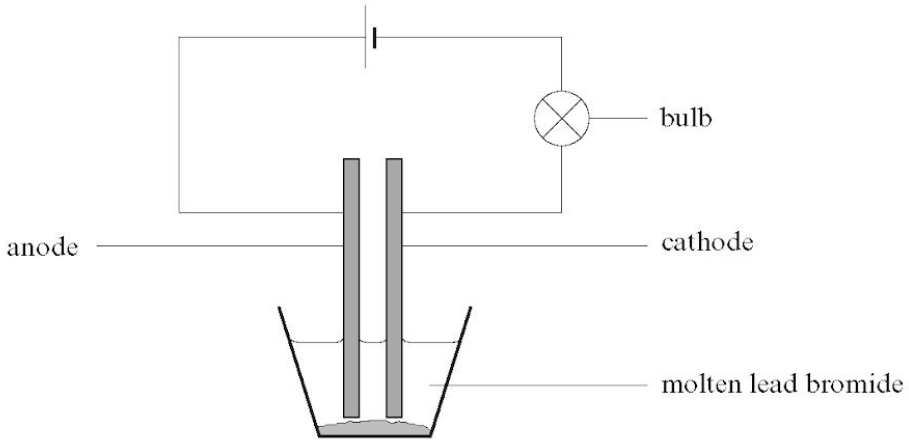
13.

The diagram below shows the apparatus used during the electrolysis of molten lead bromide.



(a) For electricity to flow the lead bromide must be molten. Give the reason for this. [1]

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(b) Balance the electrode equation which takes place at the anode. [1]

$\square\ Br^- \_ \square\ e^- \longrightarrow Br_2$

(c) (i) State, **in terms of electrons**, what happens to the lead ions at the cathode. [1]

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(ii) Describe what you would expect to observe at the cathode. [1]

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(iii) Electrolysis is allowed to continue for some time before the apparatus is cooled to room temperature. The bulb remains lit. Explain this observation. [2]

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14.

(a) Aluminium can be extracted by the electrolysis of molten aluminium oxide.

(i) State what is added to aluminium oxide to reduce its melting point. [1]

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(ii) Aluminium metal is released at the cathode according to the following electrode equation.

$$Al^{3+} + 3e^- \longrightarrow Al$$

Balance the electrode equation for the reaction that takes place at the anode. [1]

$$\square\ O^{2-} - \square\ e^- \longrightarrow O_2$$

(b) Lead can be produced by the electrolysis of molten lead(II) bromide, $PbBr_2$.

(i) Complete the balanced electrode equation for the reaction that takes place at the cathode. [2]

..... + ... $\longrightarrow$ Pb

(ii) Explain the formation of bromine during the electrolysis of molten lead(II) bromide. [3]

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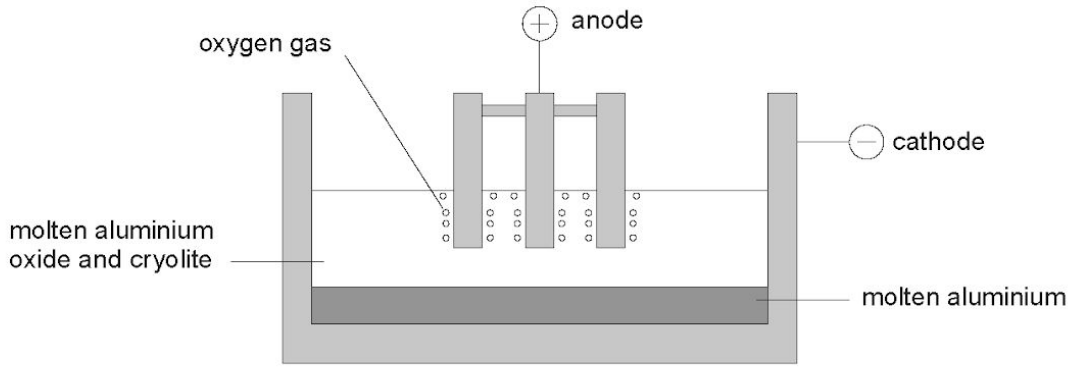
15.

The diagram below shows an electrolysis cell used in the extraction of aluminium.



Outline the industrial extraction of aluminium. [6 QWC]

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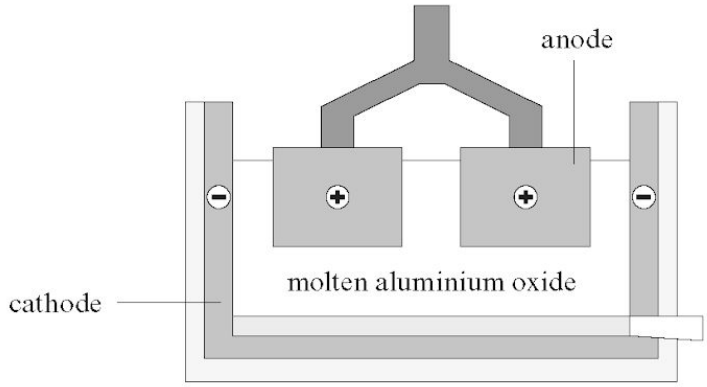
16.

Aluminium is extracted using electrolysis. The diagram below shows the apparatus used.



Describe and explain how electrolysis can be used to extract aluminium from its ore.

[6 QWC]

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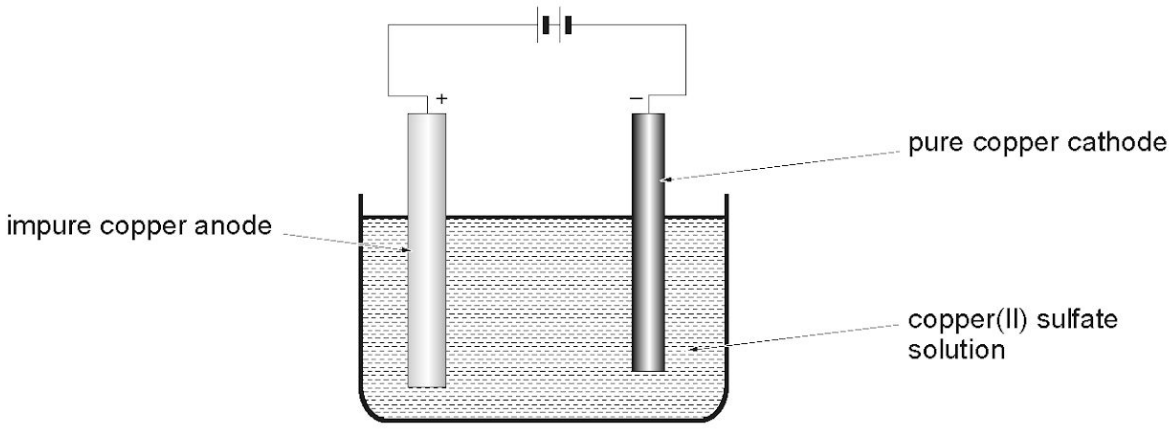
17.

Copper can be purified by electrolysis using the apparatus shown below.



(a) During the process copper(II) ions move to the cathode where they become copper atoms.

(i) Explain why copper(II) ions move towards the cathode. [2]

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(ii) Complete and balance the following electrode equation that shows how copper forms at the cathode. [1]

..... + ☐ e^- ⟶ Cu

(b) A student carried out an investigation to find out how the amount of copper deposited on the cathode varied with the voltage used. He weighed the cathode at the beginning and then after 1 minute. He repeated the experiment 3 times at 5 different voltages. The results obtained are shown below.

Voltage (V)	Mass of copper deposited after 1 minute (g)			
	1	2	3	Mean
1.0	0.12	0.13	0.11	0.12
2.0	0.13	0.13	0.14	0.13
3.0	0.16	0.10	0.16	0.16
4.0	0.18	0.18	0.17	0.18
5.0	0.19	0.21	0.29	.....

(i) Using only the reliable results, calculate the mean mass of copper deposited on the cathode at 5.0 V. [1]

Mean mass of copper deposited = ... g

(ii) Calculate the percentage error of the unreliable result at 5.0 V. [1]

$$\text{Percentage error} = \frac{\text{difference between result and mean}}{\text{mean result}} \times 100\,\%$$

Percentage error = ... %

(iii) Use the results to predict the mass of copper deposited after 1 minute when a voltage of 8.0 V is applied. Give a reason for your answer. [2]

Mass deposited ..... g

Reason .....

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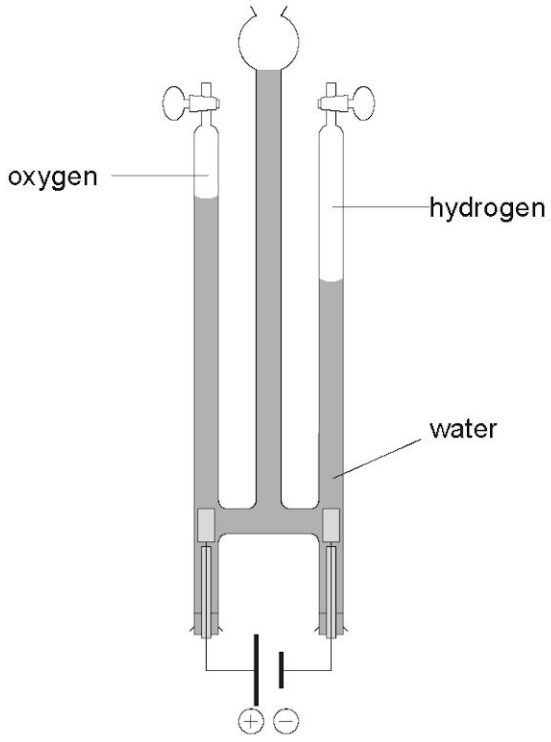
18.

(a) The apparatus below is used to break down water into hydrogen and oxygen using an electric current.



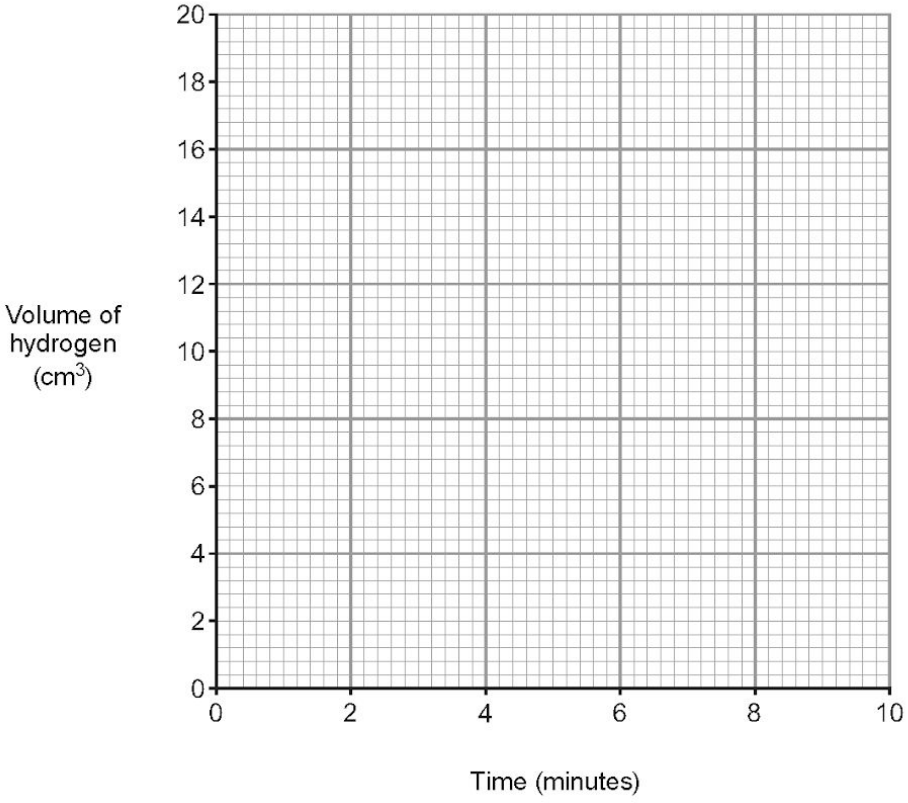
(i) Name this process. ..... [1]

(ii) The table below shows the total volume of hydrogen formed over 10 minutes.

Time (minutes)	0	2	4	6	8	10
Volume of hydrogen (cm^3)	0	4	8	12	16	20

I Plot the results from the table on the grid opposite and draw a suitable line. **Label this line 'hydrogen'.** [2]

II Draw a second line on the grid to show the volume of oxygen that would be collected during the same 10 minutes. [2]
Label this line 'oxygen'.

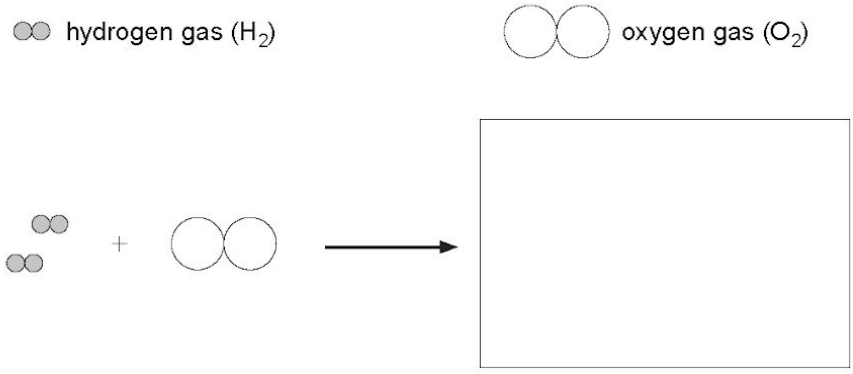


(b) Hydrogen burns in air forming water. This reaction is represented by the following symbol equation.

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Use this and the key below to complete the equation in the form of a diagram.

[2]



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19. A student was investigating the reactivity of copper, magnesium and zinc. He placed each metal into the solutions shown in the table and recorded his observations.

Metal	Solution	Observations
magnesium	copper sulfate	a brown solid forms and the solution turns from blue to colourless
zinc	copper sulfate	a brown solid forms and the solution turns from blue to colourless
magnesium	zinc sulfate	the magnesium ribbon turns dark grey
copper	zinc sulfate	no reaction

(a) Use the information in the table to place the metals in order of reactivity. [1]

Most reactive .....

.....

Least reactive .....

(b) Name the products formed in the reaction between magnesium and copper sulfate solution. [2]

..... and .....

(c) Give the chemical formula for zinc sulfate. ..... [1]

(d) Lead can be extracted from its oxide using carbon in a furnace.

(i) Balance the following symbol equation for the reaction taking place. [1]

$$\square\ PbO + C \longrightarrow \square\ Pb + CO_2$$

(ii) Oxidation and reduction both take place in the above reaction. Name the substance being oxidised and give a reason for your choice. [2]

Substance being oxidised .....

Reason .....

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(iii) State why heating with carbon cannot be used to extract aluminium from its ore. [1]

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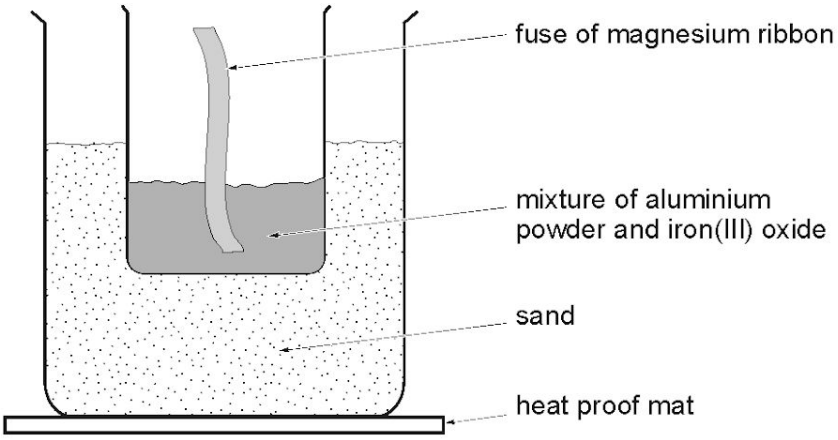
20.

(a) When a mixture of iron(III) oxide and aluminium powder (thermite) is heated in the apparatus shown below, there is a violent reaction. There is a bright flame, sparks are produced and molten iron is formed.



(i) Write a **word** equation for the reaction taking place. [2]

..... + ... ⟶ ..... + ...

(ii) Explain this reaction in terms of reactivity. [2]

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(iii) State how the observations would be different if the mixture were replaced with a mixture of copper powder and aluminium oxide. [1]

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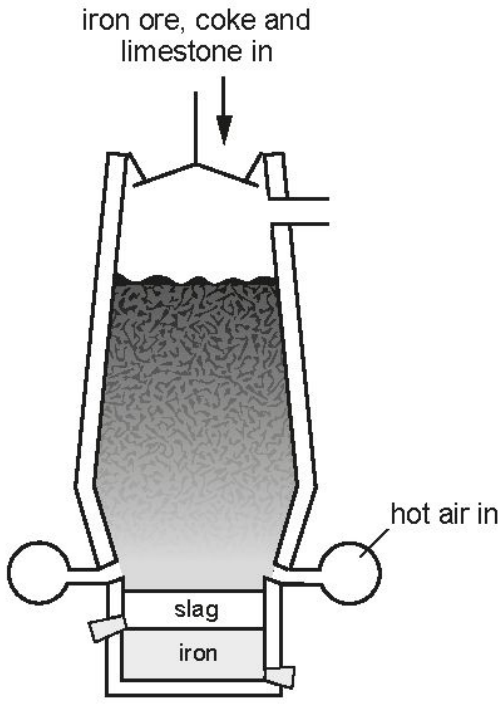
(b) Iron is extracted from its ore in a blast furnace.



(i) State the purpose of the following raw materials. [3]

Iron ore

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Coke

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Limestone

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(ii) The following equation shows the reaction taking place.

$$Fe_2O_3 + \square\ CO \longrightarrow \square\ Fe + \square\ CO_2$$

I. Balance the equation. [1]

II. Iron(III) oxide is reduced during the reaction. Give the meaning of *reduction*. [1]

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