AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.4.1 REACTIVITY OF METALS (PACK 1)

SCORE	PERCENTAGE
/334	%

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Q1.

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

This is the method used.

1. Measure 50 cm^3 of the copper sulfate solution into a polystyrene cup.
2. Record the starting temperature of the copper sulfate solution.
3. Add the metal and stir the solution.
4. Record the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1-5 with different metals.

(a) Draw **one** line from each type of variable to the name of the variable in the investigation.

Type of variable	Name of variable in the investigation
	Concentration of solution
Dependent variable	Particle size of solid
	Temperature change
Independent variable	Type of metal
	Volume of solution

(2)

(b) The student used a polystyrene cup and not a glass beaker.

Why did this make the investigation more accurate?

Tick **one** box.

Glass is breakable ☐

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Glass is transparent ☐

Polystyrene is a better insulator ☐

Polystyrene is less dense ☐

(1)

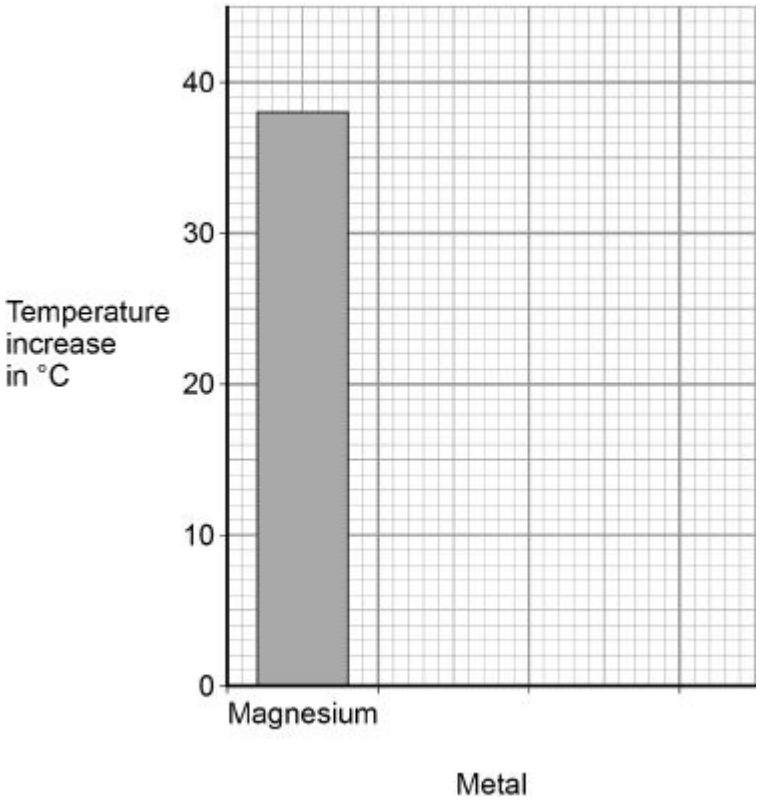
The table below shows the student's results.

Metal	**Temperature increase in °C**
Magnesium	38
Nickel	8
Zinc	16

(c) Complete **Figure 1**.

Use data from the table above.

Figure 1



(2)

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

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

_____

_____

(1)

(e) The temperature increase depends on the reactivity of the metal.

Write the metals magnesium, nickel and zinc in order of reactivity.

Use the table above.

Most reactive _____

_____

Less reactive _____

(1)

(f) **Y** is an unknown metal.

Describe a method to find the position of **Y** in the reactivity series in Question **(e)**

_____

_____

_____

_____

_____

_____

_____

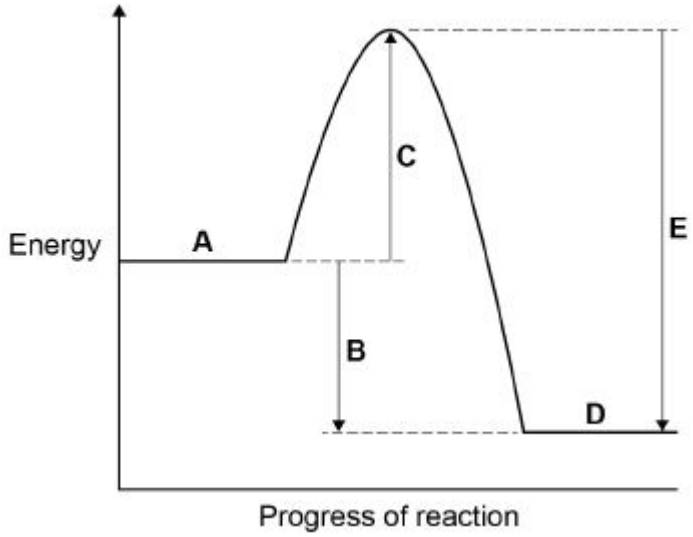
_____

(3)

Figure 2 shows the reaction profile for the reaction between zinc and copper sulfate solution.

Figure 2

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(g) Which letter represents the products of the reaction?

Tick **one** box.

A		B		C		D		E	

(1)

(h) Which letter represents the activation energy?

Tick **one** box.

A		B		C		D		E	

(1)

(Total 12 marks)

Q2.

This question is about elements in Group 1.

A teacher burns sodium in oxygen.

(a) Complete the word equation for the reaction.

sodium + oxygen ⟶ _____

(1)

(b) What is the name of this type of reaction?

Tick **one** box.

Decomposition	
Electrolysis	

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Oxidation ☐

Precipitation ☐

(1)

(c) The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

Tick **one** box.

1 ☐	4 ☐	7 ☐	13 ☐

(1)

(d) The solution contains a substance with the formula NaOH

Give the name of the substance.

_____

(1)

(e) All alkalis contain the same ion.

What is the formula of this ion?

Tick **one** box.

H^+ ☐

Na^+ ☐

OH^- ☐

O^{2-} ☐

(1)

(f) A solution of NaOH had a concentration of 40 g/dm^3

What mass of NaOH would there be in 250 cm^3 of the solution?

_____

_____

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_____

_____

Mass = _____ g

(2)

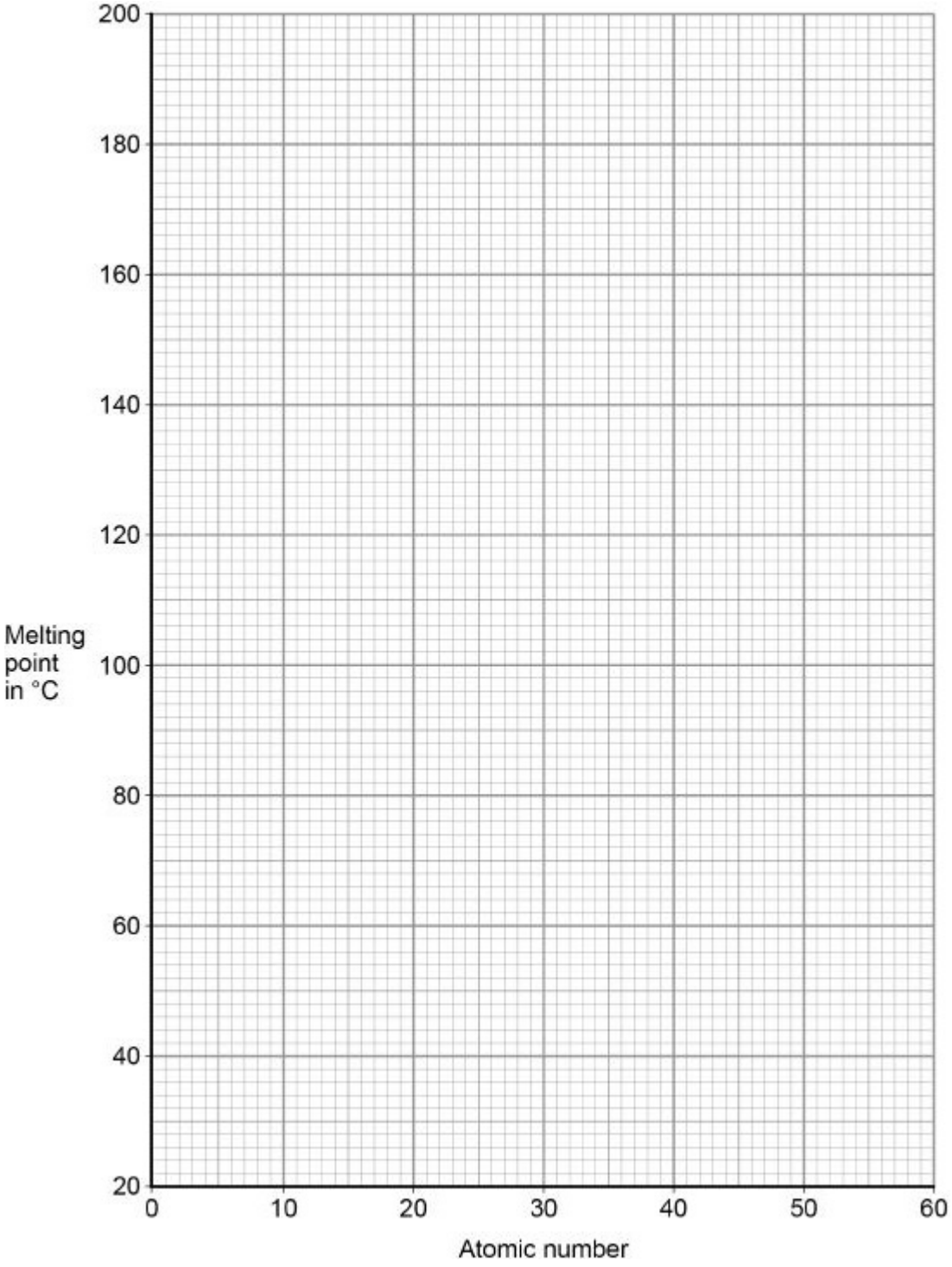
(g) The melting points of the elements in Group 1 show a trend.

The table below shows the atomic numbers and melting points of the Group 1 elements.

Element	**Atomic number**	**Melting point in °C**
Lithium	3	181
Sodium	11	98
Potassium	19	63
Rubidium	37	**X**
Caesium	55	29

Plot the data from the table on the graph below.

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(2)

(h) Predict the melting point, **X**, of rubidium, atomic number 37

Use the graph above.

Melting point = _____ °C

(1)

(Total 10 marks)

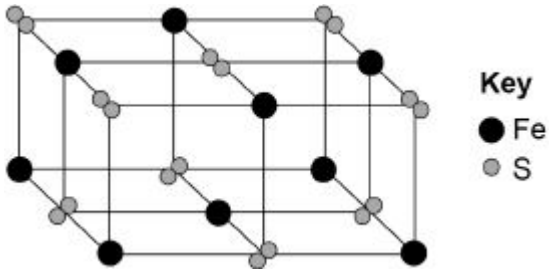
Q3.

This question is about metals and metal compounds.

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(a) Iron pyrites is an ionic compound.

The diagram below shows a structure for iron pyrites.



Determine the formula of iron pyrites.

Use the diagram above.

_____

(1)

(b) An atom of iron is represented as $^{56}_{26}Fe$

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

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(c) Iron is a transition metal.

Sodium is a Group 1 metal.

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

1. _____

_____

2. _____

_____

(2)

Nickel is extracted from nickel oxide by reduction with carbon.

(d) Explain why carbon can be used to extract nickel from nickel oxide.

_____

_____

_____

_____

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(2)

(e) An equation for the reaction is:

$$NiO + C \longrightarrow Ni + CO$$

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.

_____

_____

_____

_____

_____

_____

Percentage atom economy = _____ %

(3)

(Total 11 marks)

Q4.

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

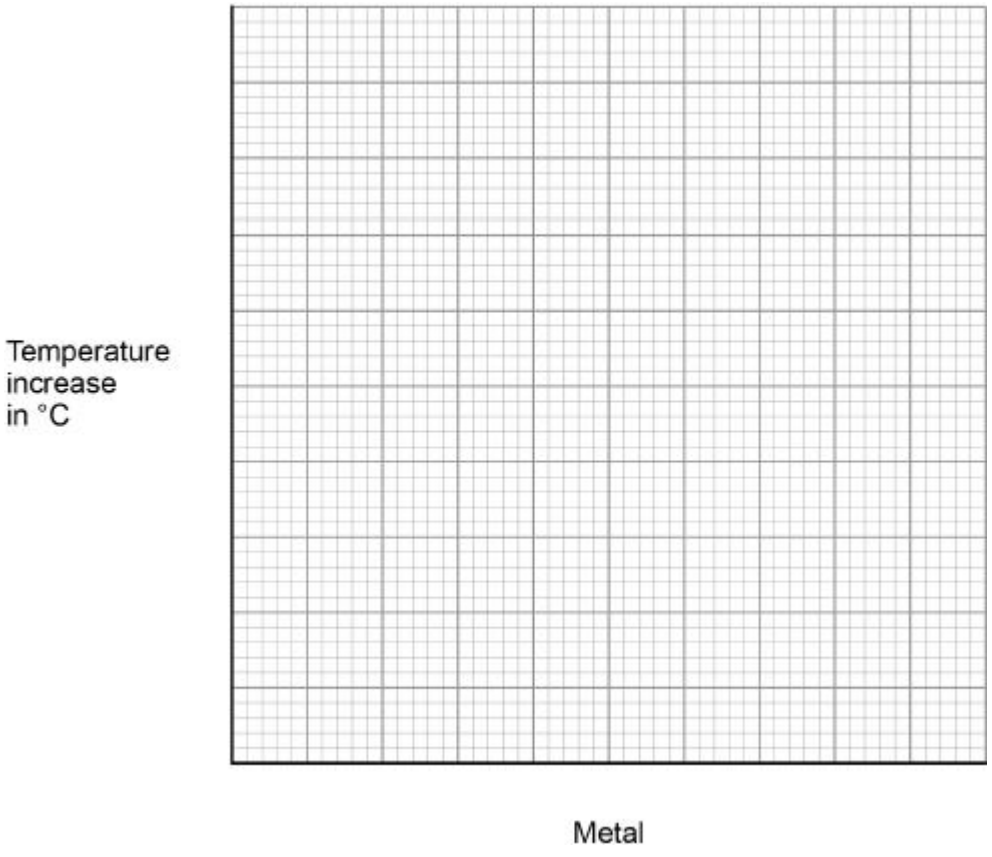
The table below shows the student's results.

Metal	**Temperature increase in °C**
Copper	0
Iron	13
Magnesium	43
Zinc	17

(a) Plot the data from the table above on **Figure 1** as a bar chart.

Figure 1

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(2)

(b) 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)

(c) 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.

_____

_____

_____

_____

_____

_____

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_____

_____

(4)

(d) Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 2**.

Figure 2



(3)

(Total 10 marks)

Q5.

Titanium is a transition metal.

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

Stage 1 $TiO_2 + 2\ C + 2\ Cl_2 \longrightarrow TiCl_4 + 2\ CO$

Stage 2 $TiCl_4 + 4\ Na \longrightarrow Ti + 4\ NaCl$

(a) Suggest **one** hazard associated with **Stage 1**.

_____

_____

(1)

(b) 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)

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

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_____

_____

_____

_____

(2)

(d) Titanium chloride is a liquid at room temperature.

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

_____

_____

_____

_____

_____

_____

_____

(3)

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

(e) Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

_____

_____

(1)

(f) Complete the half equation for the oxidation reaction.

$$Na \longrightarrow _____ + _____$$

(1)

(g) In Stage 2, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

$$TiCl_4 + 4\ Na \longrightarrow Ti + 4\ NaCl$$

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.

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_____

_____

_____

_____

_____

_____

_____

_____

(4)

(h) 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.

_____

_____

_____

Mass of titanium = _____ kg

(2)

(Total 15 marks)

Q6.

This question is about metal oxides.

When sodium is heated in oxygen, sodium oxide is produced.

(a) Balance the equation for the reaction.

_____ Na + O_2 ⟶ 2 Na_2O

(1)

(b) Why is this an oxidation reaction?

_____

_____

(1)

(c) Sodium oxide is added to water and shaken.
Universal indicator is added.
The pH of the solution is 14

What is the colour of the universal indicator?

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Tick (✔) **one** box.

Green ☐

Purple ☐

Red ☐

Yellow ☐

(1)

(d) Aluminium oxide reacts with hydrochloric acid to produce a salt.

What is the name of the salt produced?

Tick (✔) **one** box.

Aluminium chloride ☐

Aluminium nitrate ☐

Aluminium sulfate ☐

Aluminium sulfide ☐

(1)

A student investigates the solubility of four metal oxides and four non-metal oxides in water.

The student tests the pH of the solutions formed.

The table shows the student's results.

Type of oxide	Oxide	Solubility in water	pH of solution
Metal oxides	Sodium oxide	Soluble	14
	Calcium oxide	Soluble	10
	Magnesium oxide	Slightly soluble	9
	Zinc oxide	Insoluble	No solution formed
Non-metal oxides	Carbon dioxide	Soluble	5
	Sulfur dioxide	Soluble	2

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	Phosphorus oxide	Soluble	1
	Silicon dioxide	Insoluble	No solution formed

The student makes two conclusions.

Conclusion 1: 'All metal oxides produce alkaline solutions.'

Conclusion 2: 'All non-metal oxides produce acidic solutions.'

(e) Explain why the student's conclusions are only partly correct.

Use information from the table above.

(4)

(f) Give an improved conclusion for metal oxides.

Use the table above.

(2)

(Total 9 marks)

Q7.

A student investigated the reactivity of three different metals.

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This is the method used.

1. Place 1 g of metal powder in a test tube.
2. Add 10 cm^3 of metal sulfate.
3. Wait 1 minute and observe.
4. Repeat using the other metals and metal sulfates.

The student placed a tick in the table below if there was a reaction and a cross if there was no reaction.

	Zinc	**Copper**	**Magnesium**
Copper sulfate	✓	✗	✓
Magnesium sulfate	✗	✗	✗
Zinc sulfate	✗	✗	✓

(a) What is the dependent variable in the investigation?

Tick **one** box.

Time taken ☐

Type of metal ☐

Volume of metal sulfate ☐

Whether there was a reaction or not ☐

(1)

(b) Give **one** observation the student could make that shows there is a reaction between zinc and copper sulfate.

_____

_____

(1)

(c) The student used measuring instruments to measure some of the variables.

Draw **one** line from each variable to the measuring instrument used to measure the variable.

Variable	**Measuring instrument**
	Balance
	Measuring cylinder
Mass of metal	

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powder	
	Ruler
	Burette
Volume of metal sulfate	
	Theromometer
	Test tube

(2)

(d) Use the results shown in table above to place zinc, copper and magnesium in order of reactivity.

Most reactive _____



_____

Least reactive _____

(1)

(e) Suggest **one** reason why the student should **not** use sodium in this investigation.

_____

_____

(1)

(f) Which metal is found in the Earth as the metal itself?

Tick **one** box.

Calcium ☐

Gold ☐

Lithium ☐

Potassium ☐

(1)

(g) Iron is found in the Earth as iron oxide (Fe_2O_3).

Iron oxide is reduced to produce iron.

Balance the equation for the reaction.

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___Fe_2O_3 + ___C → ___Fe + ___CO_2

(1)

(h) Name the element used to reduce iron oxide.

_____

(1)

(i) What is meant by reduction?

Tick **one** box.

Gain of iron ☐

Gain of oxide ☐

Loss of iron ☐

Loss of oxygen ☐

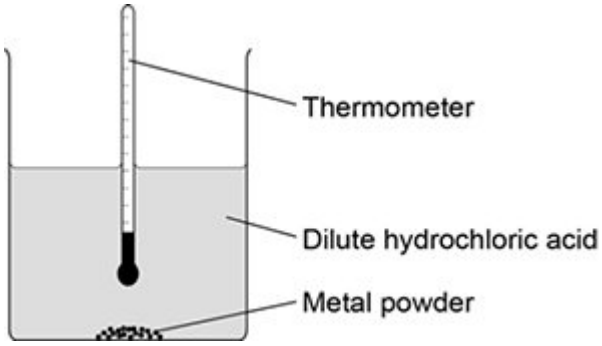
(1)

(Total 10 marks)

Q8.

A student investigated the reactivity of different metals.

The student used the apparatus shown in the figure below.



The student used four different metals.

The student measured the temperature rise for each metal three times.

The student's results are shown in the table below.

Metal	**Temperature rise in °C**			**Mean temperature rise in °C**
	Test 1	Test 2	Test 3	
Calcium	17.8	16.9	17.5	
Iron	6.2	6.0	6.1	6.1
Magnesium	12.5	4.2	12.3	12.4

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Zinc	7.8	8.0	7.6	7.8

(a) Give **two** variables the student should control so that the investigation is a fair test.

1. _____

_____

2. _____

_____

(2)

(b) One of the results for magnesium is anomalous.

Which result is anomalous?

Suggest **one** reason why this anomalous result was obtained.

Result _____

_____

Reason _____

_____

(2)

(c) Calculate the mean temperature rise for calcium.

_____

Mean temperature rise = _____ °C

(1)

(d) The temperature rose when the metals were added to sulfuric acid.

Give **one** other observation that might be made when the metal was added to sulfuric acid.
How would this observation be different for the different metals?

_____

_____

_____

_____

(2)

(e) Aluminium is more reactive than iron and zinc but less reactive than calcium and magnesium.

Predict the temperature rise when aluminium is reacted with dilute hydrochloric acid.

_____

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Temperature rise = _____ °C

(1)

(Total 8 marks)

Q9.

The figure below shows magnesium burning in air.



© Charles D Winters/Science Photo Library

(a) Look at the figure above.

How can you tell that a chemical reaction is taking place?

_____

_____

(1)

(b) Name the product from the reaction of magnesium in the figure.

_____

(1)

(c) The magnesium needed heating before it would react.

What conclusion can you draw from this?

Tick **one** box.

The reaction is reversible ☐

The reaction has a high activation energy ☐

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The reaction is exothermic ☐

Magnesium has a high melting point ☐

(1)

(d) A sample of the product from the reaction in the figure above was added to water and shaken.

Universal indicator was added.

The universal indicator turned blue.

What is the pH value of the solution?

Tick **one** box.

1 ☐

4 ☐

7 ☐

9 ☐

(1)

(e) Why are nanoparticles effective in very small quantities?

Tick **one** box.

They are elements ☐

They are highly reactive ☐

They have a low melting point ☐

They have a high surface area to volume ratio ☐

(1)

(f) Give **one** advantage of using nanoparticles in sun creams.

_____

_____

(1)

(g) Give **one** disadvantage of using nanoparticles in sun creams.

_____

_____

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(1)

(h) A coarse particle has a diameter of 1×10^{-6} m.
A nanoparticle has a diameter of 1.6×10^{-9} m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

_____

_____

_____

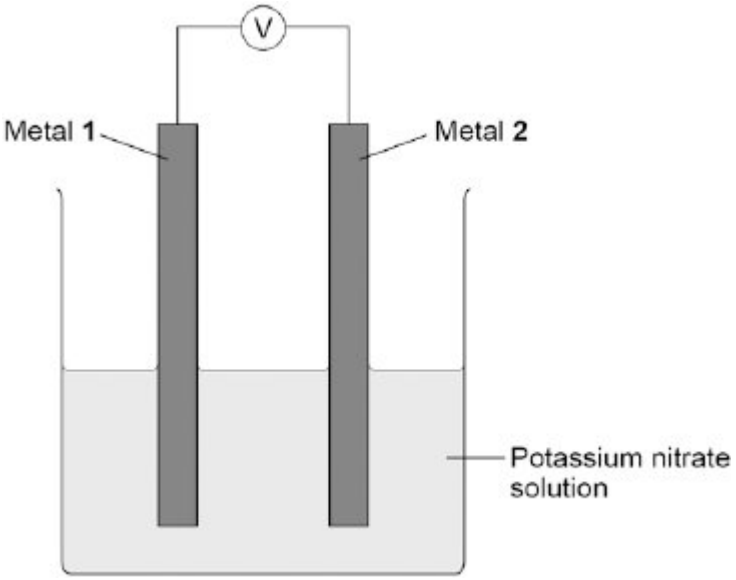
_____

(2)

(Total 9 marks)

Q10.

A student investigated simple cells using the apparatus shown in the figure below.



- If metal **2** is more reactive than metal **1** then the voltage measured is positive.
- If metal **1** is more reactive than metal **2** then the voltage measured is negative.
- The bigger the difference in reactivity of the two metals, the larger the voltage produced.

The student's results are shown in the table below.

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Metal 2 / Metal 1	Chromium	Copper	Iron	Tin	Zinc
Chromium	0.0 V				
Copper	1.2 V	0.0 V			
Iron	0.5 V	not measured	0.0 V		
Tin	0.8 V	-0.4 V	0.3 V	0.0 V	
Zinc	0.2 V	-1.0 V	-0.3 V	-0.6 V	0.0 V

(a) The ionic equation for the reaction occuring at the zinc electrode in the simple cell made using copper and zinc electrodes is:

$$Zn \rightarrow Zn^{2+} + 2e^{-}$$

Zinc is oxidised in this reaction.

Give a reason why this is oxidation.

_____

_____

(1)

(b) Look at the table above.

Which **one** of the metals used was the least reactive?

Give a reason for your answer.

Metal _____

Reason _____

_____

_____

(2)

(c) Predict the voltage that would be obtained for a simple cell that has iron as metal **1** and copper as metal **2**.

Explain your answer.

_____

_____

_____

_____

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_____

_____

_____

_____

(3)

(d) Hydrogen fuel cells have been developed for cars.

Write a word equation for the overall reaction that takes place in a hydrogen fuel cell.

_____

(1)

(e) Write the **two** half equations for the reactions that occur at the electrodes in a hydrogen fuel cell.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q11.

Metals are extracted from ores in the Earth's crust.

Some ores contain metal carbonates and some ores contain metal oxides.

(a) (i) Name the type of reaction that happens when a metal carbonate is heated.

_____

(1)

(ii) Which solid product is formed when copper carbonate is heated?

Tick (✔) **one** box.

copper ☐

copper nitrate ☐

copper oxide ☐

copper sulfide ☐

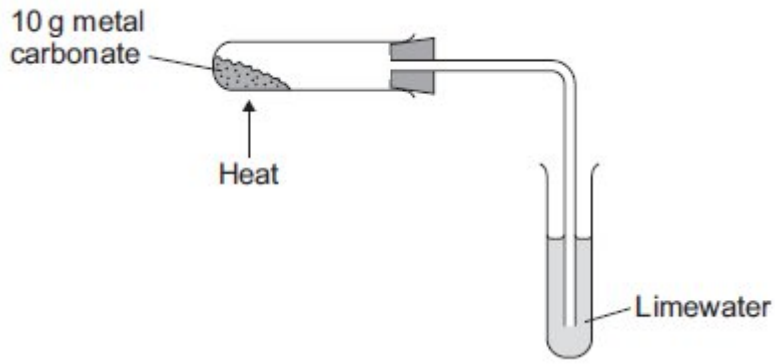
(1)

(b) A student investigated heating four metal carbonates.

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Figure 1 shows the apparatus used.

Figure 1



The student heated each metal carbonate for five minutes.

The table below shows the results.

Metal carbonate	Mass of metal carbonate at start in g	Mass of solid after heating for 5 minutes in g	Observations
Copper carbonate	10.0	6.9	Limewater turns cloudy
Magnesium carbonate	10.0	9.1	Limewater turns cloudy
Potassium carbonate	10.0	10.0	Limewater does not turn cloudy
Zinc carbonate	10.0	8.3	Limewater turns cloudy

(i) Explain the results for potassium carbonate.

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Suggest how the reactivity series can be used to predict which metal carbonate reacts most easily when heated.

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_____

_____

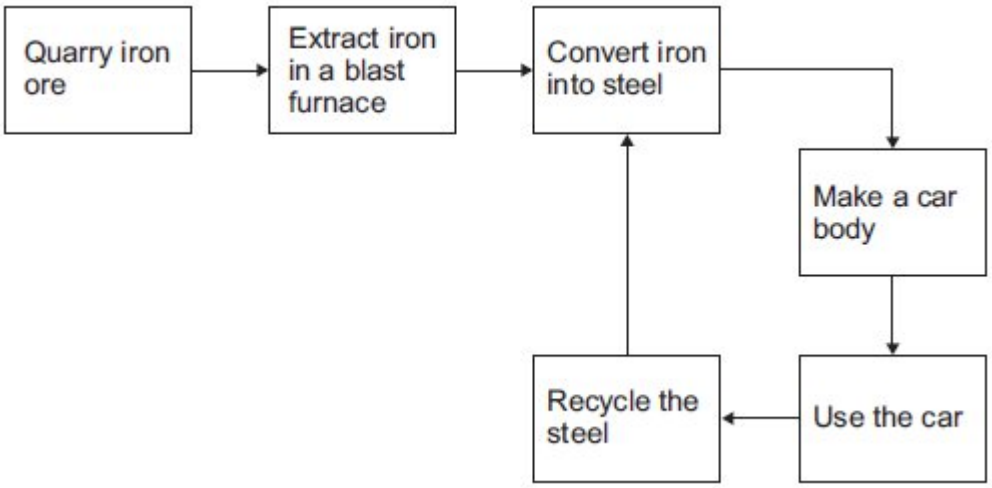
_____

_____

(2)

(c) **Figure 2** shows a simple life cycle of a car body.

Figure 2



(i) Complete the sentence.

Iron ores must contain enough iron to _____

_____

(1)

(ii) Some iron ores contain iron oxide (Fe_2O_3).

Complete and balance the equation for a reaction to produce iron from iron oxide.

_____ Fe_2O_3 + _____ C $\longrightarrow$ _____ + _____ CO_2

(2)

(iii) Give **two** reasons why iron produced in a blast furnace is converted into steel.

_____

_____

_____

_____

(2)

(iv) When a car reaches the end of its useful life, the car body can be:

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- recycled
- reused
- sent to landfill.

Give **three** reasons why a steel car body should be recycled and **not** reused or sent to landfill.

_____

_____

_____

_____

_____

_____

(3)

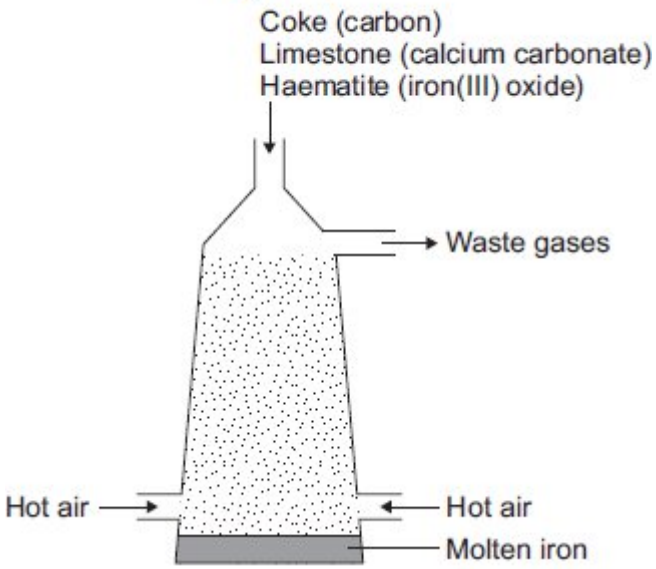
(Total 15 marks)

Q12.

This question is about iron and aluminium.

(a) Iron is extracted in a blast furnace. **Figure 1** is a diagram of a blast furnace.

Figure 1



(i) Calcium carbonate decomposes at high temperatures.

Complete the word equation for the decomposition of calcium carbonate.

calcium carbonate ⟶ _____ +

_____

(2)

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(ii) Carbon burns to produce carbon dioxide.

The carbon dioxide produced reacts with more carbon to produce carbon monoxide.

Balance the equation.

$$C(s) + CO_2(g) \longrightarrow _____ CO(g)$$

(1)

(iii) Carbon monoxide reduces iron(III) oxide:

$$Fe_2O_3(s) + 3\ CO(g) \longrightarrow 2\ Fe(s) + 3\ CO_2(g)$$

Calculate the maximum mass of iron that can be produced from 300 tonnes of iron(III) oxide.

Relative atomic masses (A_r): O = 16; Fe = 56

_____

_____

_____

_____

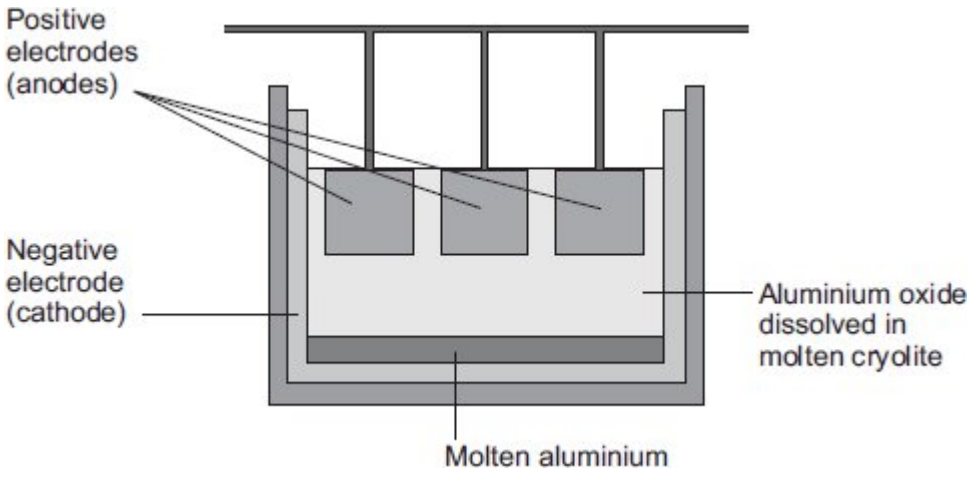
_____

Maximum mass = _____ tonnes

(3)

(b) Aluminium is extracted by electrolysis, as shown in **Figure 2**.

Figure 2



(i) Why can aluminium **not** be extracted by heating aluminium oxide with carbon?

_____

_____

(1)

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(ii) Explain why aluminium forms at the negative electrode during electrolysis.

_____

_____

_____

_____

_____

_____

_____

(3)

(iii) Explain how carbon dioxide forms at the positive electrodes during electrolysis.

_____

_____

_____

_____

_____

_____

(3)

(Total 13 marks)

Q13.

This question is about metals.

(a) Which unreactive metal is found in the Earth as the metal itself?

Tick (✓) **one** box.

aluminium ☐

gold ☐

magnesium ☐

(1)

(b) Complete the sentence.

Aluminium is an element because aluminium is made of

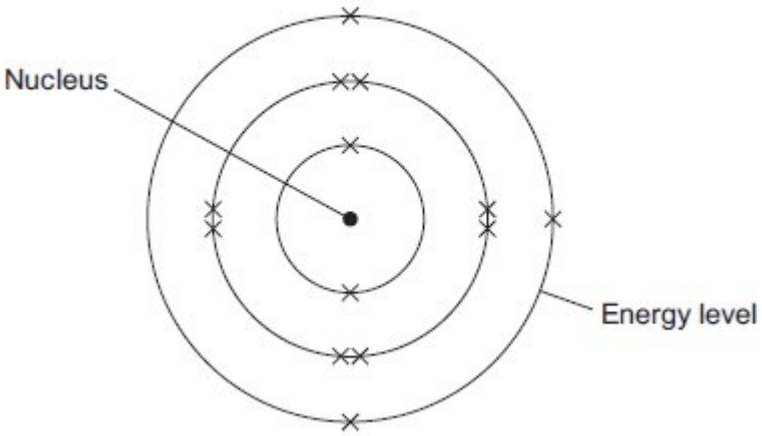
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only one type of _____ .

(1)

(c) **Figure 1** shows the electronic structure of an aluminium atom.

Figure 1



(i) Use the correct words from the box to complete the sentence.

electrons	**ions**	**protons**	**neutrons**	**shells**

The nucleus of an aluminium atom contains _____ and

_____ .

(2)

(ii) Complete the sentence.

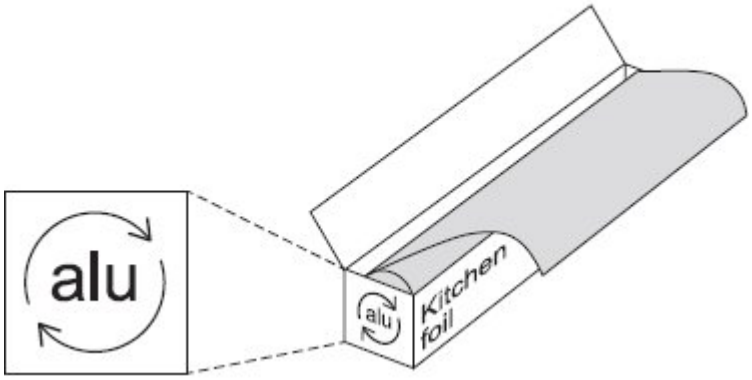
In the periodic table, aluminium is in Group _____ .

(1)

(d) Aluminium is used for kitchen foil.

Figure 2 shows a symbol on a box of kitchen foil.

Figure 2



The symbol means that aluminium can be recycled. It does not show the correct chemical symbol for aluminium.

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(i) What is the correct chemical symbol for aluminium?

_____ .

(1)

(ii) Give **two** reasons why aluminium should be recycled.

_____

_____

_____

_____

(2)

(e) Aluminium has a low density, conducts electricity and is resistant to corrosion.

Which **one** of these properties makes aluminium suitable to use as kitchen foil?
Give a reason for your answer.

_____

_____

_____

_____

(2)

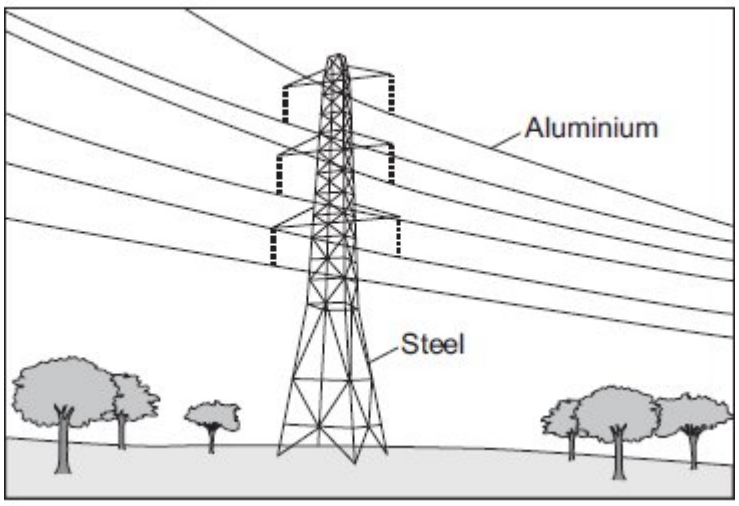
(Total 10 marks)

Q14.

This question is about metals.

Figure 1 shows the metals used to make pylons and the wires of overhead cables.

Figure 1

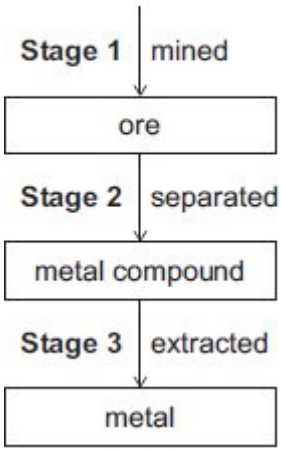


(a) An ore contains a metal compound.

A metal is extracted from its ore in three main stages, as shown in **Figure 2**.

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Figure 2



Explain why **Stage 2** needs to be done.

_____

_____

_____

_____

(2)

(b) Cast iron from a blast furnace contains 96% iron and 4% carbon.

(i) Cast iron is not suitable for the manufacture of pylons.

Give **one** reason why.

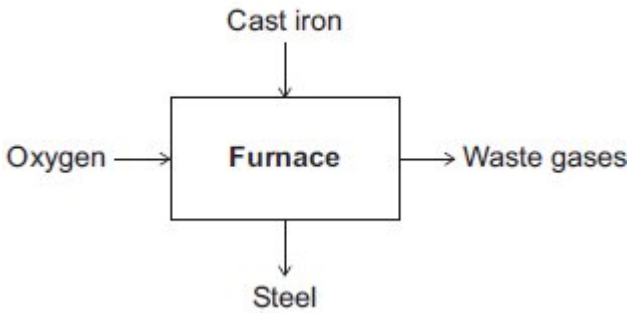
_____

_____

(1)

(ii) Most cast iron is converted into steel, as shown in **Figure 3**.

Figure 3



Describe how cast iron is converted into steel.

Use **Figure 3** to help you to answer this question.

_____

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_____

_____

_____

(2)

(c) Aluminium and copper are good conductors of electricity.

(i) State **one** property that makes aluminium more suitable than copper for overhead cables.

_____

_____

(1)

(ii) How can you tell that copper is a transition metal and aluminium is **not** a transition metal from the position of each metal in the periodic table?

_____

_____

_____

_____

(2)

(iii) Copper can be extracted from solutions of copper salts by adding iron.

Explain why.

_____

_____

_____

_____

(2)

(Total 10 marks)

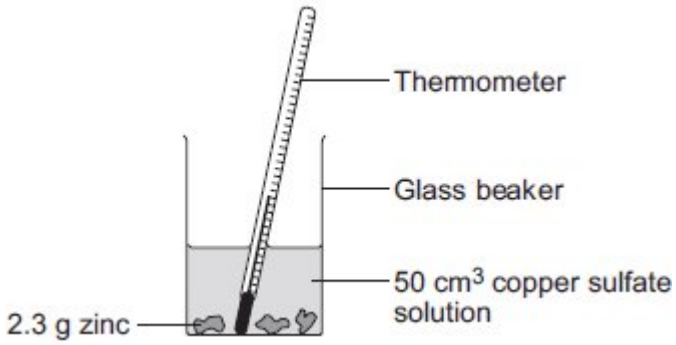
Q15.

A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

The student used the apparatus shown below.

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The student:

- measured 50 cm^3 copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:

$Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$

zinc + copper sulfate solution $\longrightarrow$ copper + zinc sulfate solution

(a) The thermometer reading changes during the reaction.

Give **one** other change the student could **see** during the reaction.

_____

_____

(1)

(b) Suggest **one** improvement the student could make to the apparatus.

Give a reason why this improves the investigation.

Improvement _____

_____

Reason _____

_____

(2)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

The student's results are shown in the table below.

Experiment number	**Concentration of copper sulfate in moles per dm^3**	**Increase in temperature in °C**
1	0.1	5

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2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

Describe **and** explain the trends shown in the student's results.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 9 marks)

Q16.

Iron is extracted from iron oxide in the blast furnace.

(a) The equation for one of the reactions in the blast furnace is:

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

(i) Complete the word equation for this reaction.

iron oxide + carbon monoxide ⟶ _____ + _____

(2)

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(ii) Oxygen is removed from iron oxide in the blast furnace.

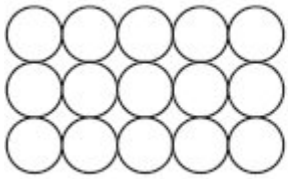
Draw a ring around the correct answer to complete the sentence.

The iron oxide is

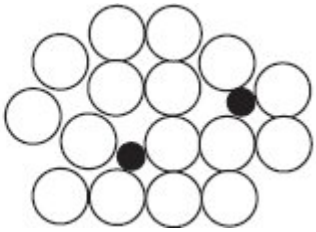
neutralised.
oxidised.
reduced.

(1)

(b) The diagrams represent pure iron and iron from the blast furnace.



Pure iron



Iron from the blast furnace

(i) Draw **one** line from each statement to the correct explanation.

Statement	Explanation
Pure iron is an element because	it is made of one sort of atom only.
	it contains two elements not chemically combined.
Iron from the blast furnace is a mixture because	every atom has the same number of neutrons.
	it contains two elements chemically combined.

(2)

(ii) Explain why iron from the blast furnace is harder than pure iron.

Use the diagrams on page 4 to help you.

_____

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_____

_____

_____

(2)

(Total 7 marks)

Q17.

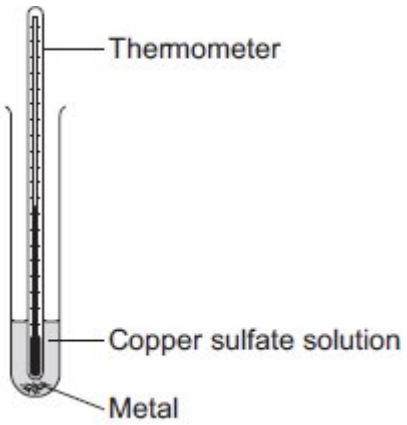
A student investigated displacement reactions of metals.

The student added different metals to copper sulfate solution and measured the temperature change.

The more reactive the metal is compared with copper, the bigger the temperature change.

The apparatus the student used is shown in **Figure 1**.

Figure 1



(a) State **three** variables that the student must control to make his investigation a fair test.

1. _____

2. _____

3. _____

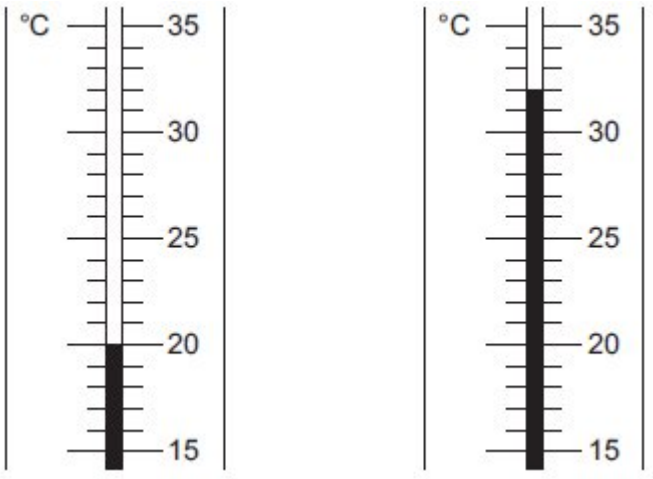
(3)

(b) **Figure 2** shows the thermometer in one experiment before and after the student added a metal to the copper sulfate solution.

Figure 2

Before adding metal **After adding metal**

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Use **Figure 2** to complete **Table 1**.

Table 1

Temperature before adding metal in °C	_____
Temperature after adding metal in °C	_____
Change in temperature in °C	_____

(3)

(c) The student repeated the experiment three times with each metal.

Table 2 shows the mean temperature change for each metal.

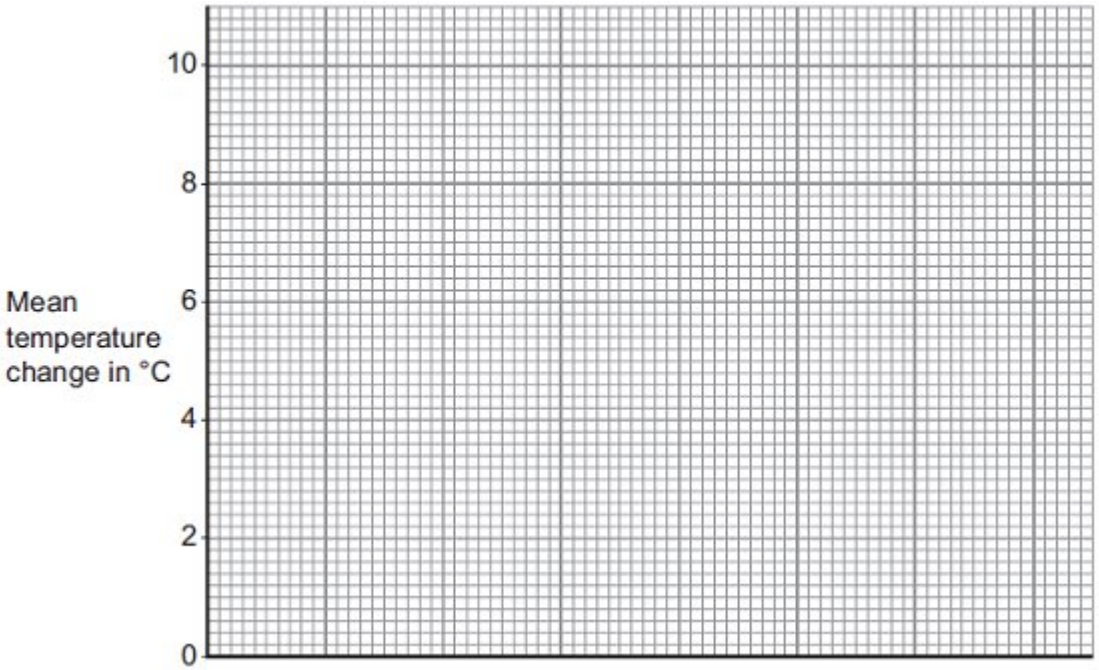
Table 2

Metal	**Mean temperature change in °C**
Cobalt	4.5
Gold	0.0
Magnesium	10.0
Nickel	3.0
Silver	0.0
Tin	1.5

(i) On **Figure 3**, draw a bar chart to show the results.

Figure 3

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(3)

(ii) Why is a line graph **not** a suitable way of showing the results?

_____

_____

(1)

(iii) Use the results to work out which metal is the most reactive.

Give a reason for your answer.

Most reactive metal _____

Reason _____

_____

(2)

(iv) Explain why there was no temperature change when silver metal was added to the copper sulfate solution.

_____

_____

_____

_____

(2)

(v) It is **not** possible to put all six metals in order of reactivity using these results.

Suggest how you could change the experiment to be able to put all six metals into order of reactivity.

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_____

_____

_____

_____

_____

(2)

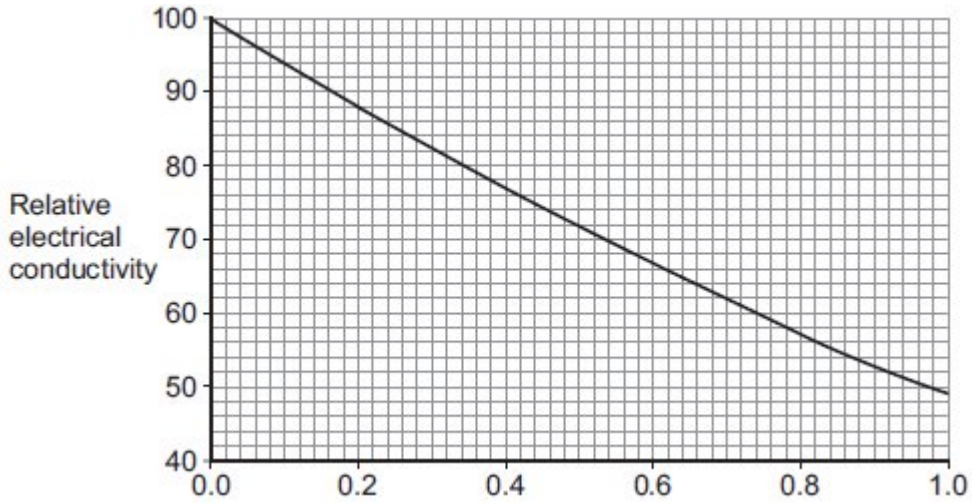
(Total 16 marks)

Q18.

This question is about copper.

(a) Most of the copper extracted is used in electric circuits.

The figure below shows how impurities change the electrical conductivity of copper.



Copper extracted by smelting is about 99% pure.

The 99% pure copper produced by smelting is purified to 99.9999% pure copper by electrolysis.

Use values from the graph to explain why copper is purified to 99.9999%.

_____

_____

_____

_____

(2)

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Read the information in the box.

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Copper extraction

World demand for copper for the year 2011 was about 20 million tonnes.

World reserves of copper are estimated to be 700 million tonnes.

Most of the copper used is obtained from copper ores, which are mined.

The copper ore chalcopyrite is heated in a furnace to produce copper sulfide, CuS

The furnace is heated by burning fossil fuels.

Air is then blown through the hot copper sulfide, to produce copper and sulfur dioxide.

$$CuS + O_2 \rightarrow Cu + SO_2$$

A scientist made the statement: 'Copper should be recycled'.

Use the information in the box and your own knowledge and understanding to justify the scientist's statement.

Extra space

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_____

_____

_____

_____

_____

_____

_____

(6)

(c) Phytomining is used to obtain copper from land that contains very low percentages of copper compounds.

Describe how copper compounds are obtained by phytomining.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

Q19.

Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

One way to extract the copper is to grow plants on the land.

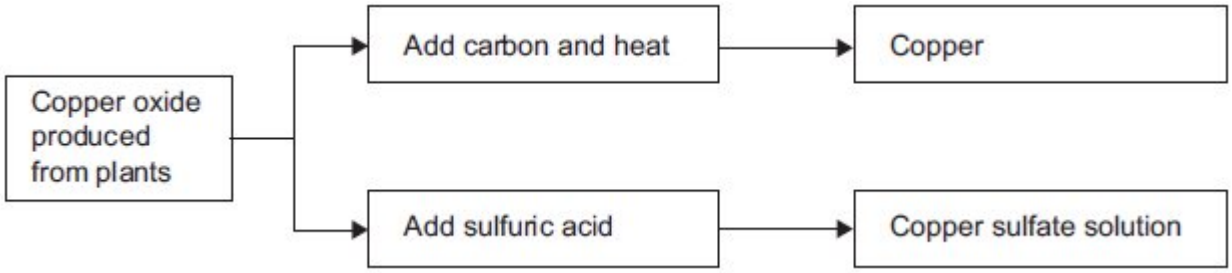
The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 1**.

Figure 1

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(a) Draw a ring around the correct answer to complete each sentence.

(i) Copper ores contain enough copper to make extraction of the metal

carbon neutral.
economical.
reversible.

(1)

(ii) Using plants to extract metals is called

photosynthesis.
phytomining.
polymerisation.

(1)

(iii) Copper oxide reacts with carbon to produce copper and

carbon dioxide.
oxygen.
sulfur dioxide.

(1)

(b) Copper is produced from copper sulfate solution by displacement using iron or by electrolysis.

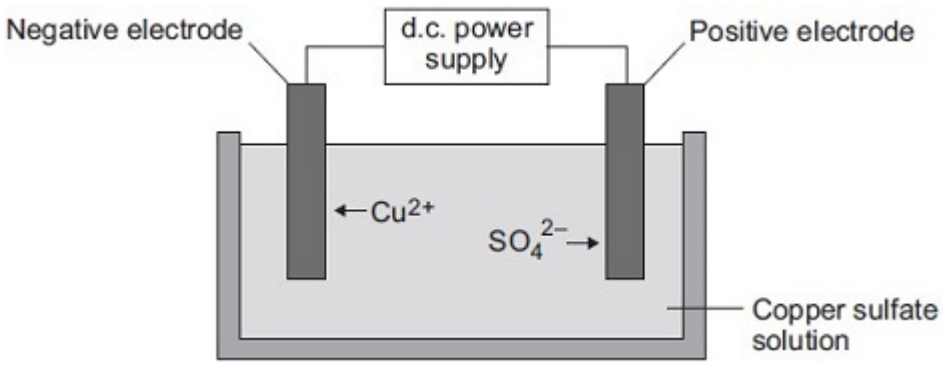
(i) Complete the word equation.

copper sulfate + iron ⟶ _____ + _____

(2)

(ii) **Figure 2** shows the electrolysis of copper sulfate solution.

Figure 2



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Why do copper ions go to the negative electrode?

_____

_____

(1)

(c) Suggest **two** reasons why copper should **not** be disposed of in landfill sites.

_____

_____

_____

_____

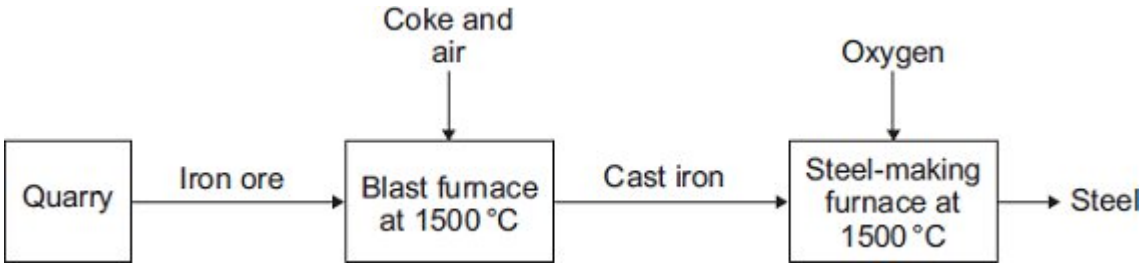
(2)

(Total 8 marks)

Q20.

The iron produced from iron ore in a blast furnace is called cast iron.

Cast iron is converted into steel in a furnace.



Iron ore contains iron oxide.
Coke contains carbon.

(a) Quarrying iron ore will have an impact on everything near to the quarry.

(i) Describe **one** positive impact and **one** negative impact of quarrying iron ore.

positive impact _____

_____

negative impact _____

_____

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

Ores contain enough metal to make extraction of the metal

carbon neutral.
economical.
reversible.

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(1)

(b) Many chemical reactions take place in a blast furnace.
Use the flow diagram to help you to answer this question.

Suggest how the blast furnace is heated.

_____

_____

(1)

(c) A chemical reaction for the extraction of iron is:

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(i) Complete the word equation for this chemical reaction.

_____ + carbon monoxide → iron + _____

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

Iron is extracted from its ore by

decomposition.
oxidation.
reduction.

(1)

(d) Cast iron contains about 4% carbon.
Cast iron is converted into low-carbon steels.

(i) Low-carbon steel is produced by blowing oxygen into molten cast iron.

Suggest how oxygen removes most of the carbon.

_____

_____

_____

_____

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

Metals, such as nickel, are added to low-carbon steels to make

the steel

corrode easily.
easy to shape.
much harder.

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(1)

(e) Recycling steel uses less energy than producing steel from iron ore.

Tick (✓) **one** advantage and Tick (✓) **one** disadvantage of recycling steel.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
Iron is the second most common metal in the Earth's crust.		
Less carbon dioxide is produced.		
More iron ore needs to be mined.		
There are different types of steel which must be sorted.		

(2)

(Total 12 marks)

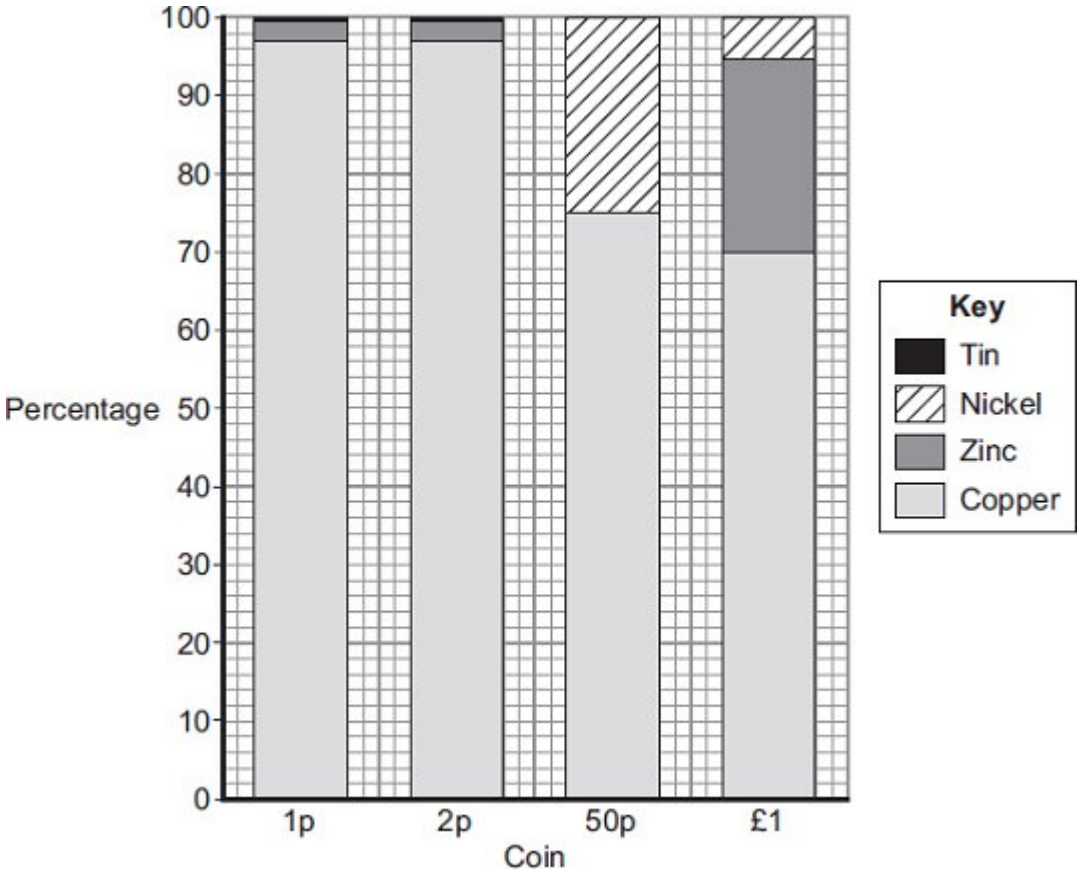
Q21.

This is the headline from a newspaper:



(a) The bar chart shows the percentage of metals in UK coins in 1991.

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Use the bar chart to answer these questions.

(i) Which metal is in all of these coins?

_____

(1)

(ii) Which coin does **not** contain zinc?

_____

(1)

(iii) What is the percentage of nickel in a 50 p coin?

Percentage = _____ %

(1)

(iv) Draw a ring around the correct metal to complete the sentence.

Pure copper is too soft to be used for 1 p and 2 p coins.

Copper is mixed with zinc and | iron / nickel / tin | for 1 p and 2 p coins.

(1)

(b) The value of the metal in 2 p coins, made in 1991, is now 3.3 p.

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Suggest why a 2 p coin made in 1991 is worth 3.3 p.

_____

_____

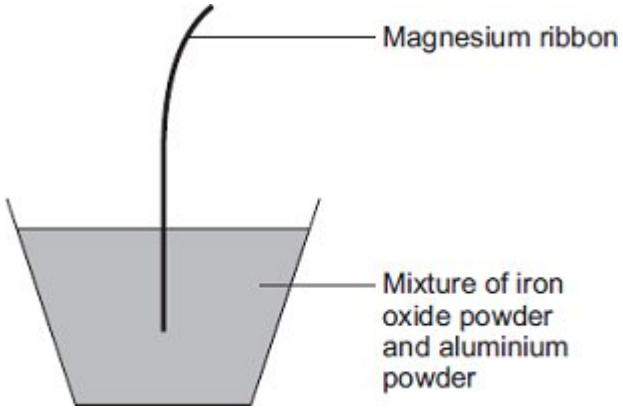
_____

(1)

(Total 5 marks)

Q22.

The diagram shows one way of producing iron.



Iron oxide reacts with aluminium to produce iron.

The symbol equation for the reaction is:

$Fe_2O_3 + 2\ Al \longrightarrow 2\ Fe + Al_2O_3$

(a) (i) Complete the word equation for this reaction.

iron oxide + aluminium ⟶ iron + _____

(1)

(ii) The magnesium ribbon is lit to start the reaction.

Why does the burning magnesium ribbon start the reaction?

_____

_____

(1)

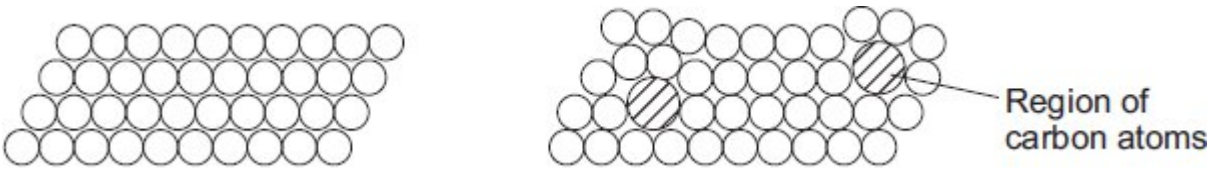
(b) In industry, iron is produced in the blast furnace when iron oxide is heated with carbon.

The iron from the blast furnace is called cast iron.

Cast iron contains carbon.

The diagrams show the structure of pure iron and cast iron.

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Pure iron Cast iron

Use the diagrams to help you answer the questions.

(i) Draw a ring around the correct answer to complete the sentence.

Pure iron is an element because pure iron

contains only one sort of atom.
is magnetic.
is a metal.

(1)

(ii) Suggest why cast iron is harder than pure iron.

_____

_____

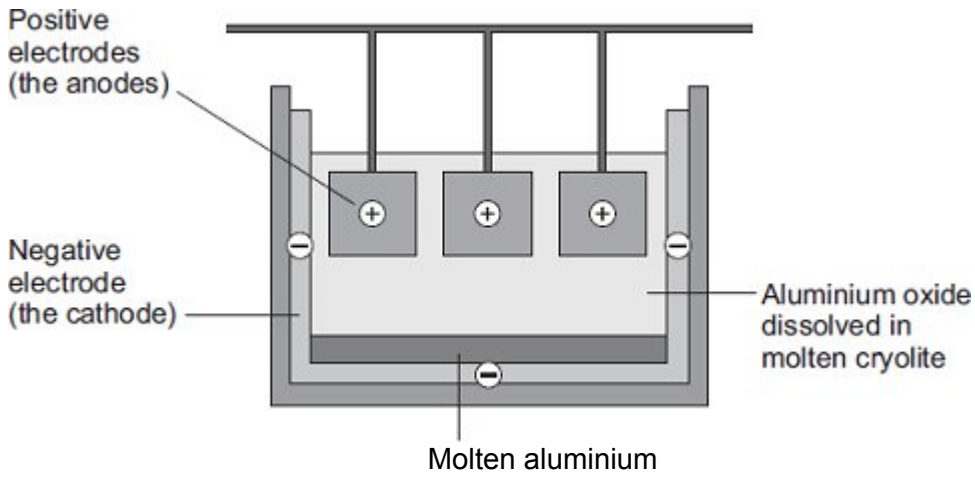
_____

_____

_____

(2)

(c) Aluminium is extracted by electrolysis using the ionic compound aluminium oxide.



(i) Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Suggest why.

_____

_____

(1)

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(ii) Why is aluminium oxide dissolved in molten cryolite?

_____

_____

(1)

(iii) Aluminium metal is produced at the negative electrode (cathode).

Complete the half equation for the process.

Al^{3+} + _____ e^- ⟶ Al

(1)

(iv) Use the half equation to state why Al^{3+} ions are reduced.

_____

_____

(1)

(v) Explain why the positive electrodes (anodes) burn away.

Use your knowledge of the products of electrolysis to help you.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

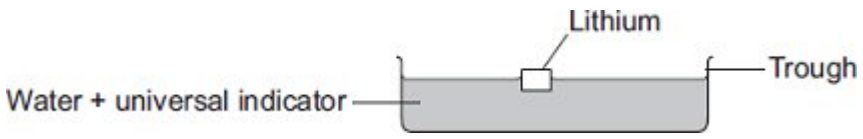
(4)

(Total 13 marks)

Q23.

A student was investigating the reaction of lithium and water.

She added a few drops of universal indicator to water in a trough and added a piece of lithium.



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The word equation for the reaction is:

lithium + water ⟶ lithium hydroxide + hydrogen

(a) (i) The lithium floated on the water.

State **two** other observations that the student would **see** during the reaction.

1. _____

2. _____

(2)

(ii) Balance the symbol equation for the reaction of lithium and water.

2 Li(s) + _____ $H_2O(l)$ ⟶ _____ LiOH(aq) + $H_2(g)$

(2)

(iii) Describe a simple test and the result that would show the gas was hydrogen.

_____

_____

(1)

(iv) All Group 1 metals have similar reactions with water.

State why, in terms of electronic structure.

_____

_____

(1)

(b) Lithium and other Group 1 metals have different properties from the transition metals.

Tick (✔) **two** properties that are properties of Group 1 metals.

They react with oxygen. ☐

They form coloured compounds. ☐

They are strong and hard. ☐

They have low melting points. ☐

(2)

(c) The electronic structure of a potassium atom is 2, 8, 8, 1

(i) Draw a diagram to show the electronic structure of a potassium ion.

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Show the charge on the potassium ion.

(2)

(ii) Potassium is more reactive than sodium.

Explain why, in terms of electronic structure.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 13 marks)

Q24.

Magnesium burns in oxygen.



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By Kingsway School [CC BY 2.0],
via Flickr

(a) Use the Chemistry Data Sheet to help you to answer this question.

The word equation for magnesium burning is:

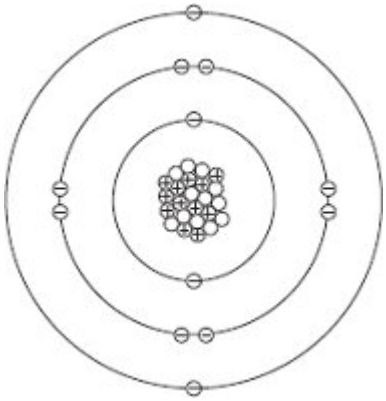
magnesium + oxygen ⟶ magnesium oxide

Draw **one** line from each substance to its correct description.

Substance	Description
magnesium	compound
magnesium oxide	metal
oxygen	mixture
	non-metal

(3)

(b) The diagram represents a magnesium atom.



Complete the table to show the name of each particle and the charge of each particle in the magnesium atom.

Name of particle	Charge
proton	+1
neutron	_____
_____	−1

(2)

(c) Use the Chemistry Data Sheet to help you to answer these questions.

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Draw a ring around the correct answer to complete each sentence.

(i) In a magnesium atom, the protons and neutrons are in the

core.
nucleus.
shell.

(1)

(ii) The number of protons in a magnesium atom is the

atomic number
mass number.
group number.

(1)

(iii) The sum of the protons and neutrons in a magnesium atom is the

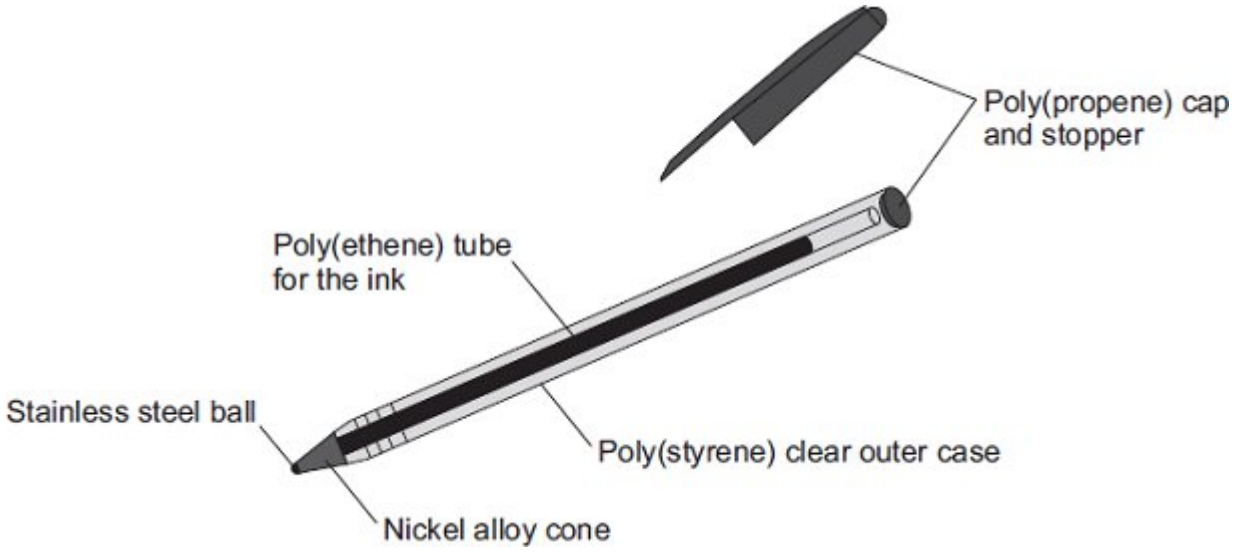
atomic number.
mass number.
group number.

(1)

(Total 8 marks)

Q25.

The diagram shows a ballpoint pen.



(a) Polymers are used to make the ballpoint pen.

(i) Name the monomer used to make poly(ethene).

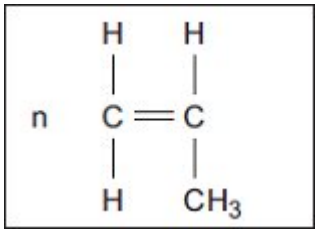
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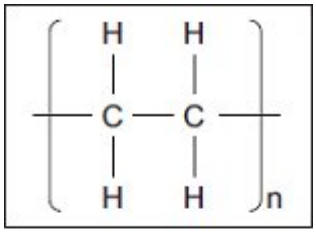
(1)

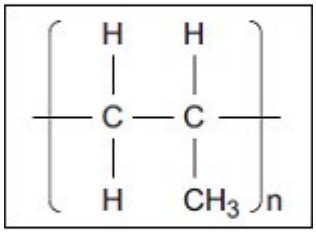
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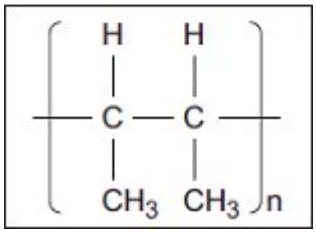
(ii) Draw **one** line from the monomer propene to its polymer poly(propene).

Monomer **Polymer**



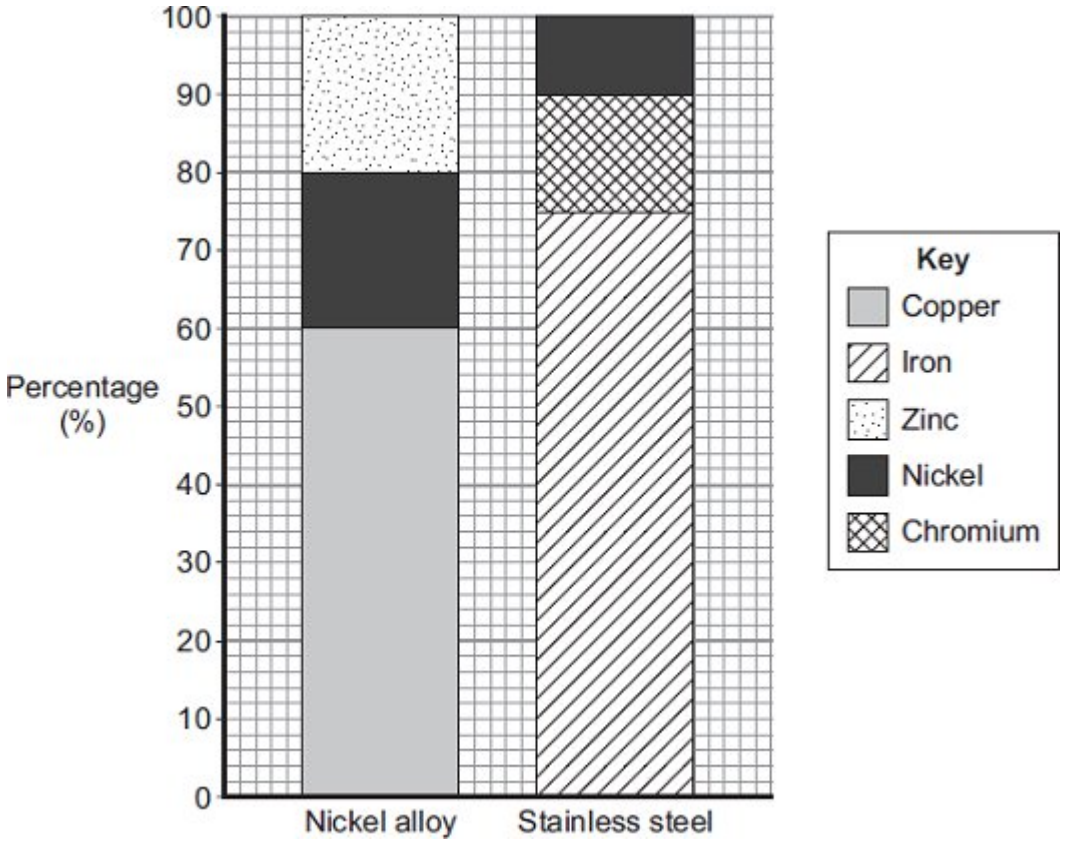






(1)

(b) Two alloys are used to make the ballpoint pen.



Use the bar chart to answer these questions.

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(i) Which metal is in both of these alloys?

_____

(1)

(ii) What is the percentage of iron in the stainless steel?

_____ %

(1)

(iii) The alloy stainless steel is used instead of pure iron for the ball of the pen.

Give **two** reasons why.

_____

_____

_____

_____

(2)

(c) Tick (✓) **one** advantage and tick (✓) **one** disadvantage of **recycling** this type of ballpoint pen.

	Advantage Tick (✓)	**Disadvantage Tick (✓)**
Can be refilled and reused		
Conserves resources of crude oil and ores		
High cost of separating materials		
Polymers and alloys are not expensive		

(2)

(Total 8 marks)

Q26.

Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

(a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

_____

_____

_____

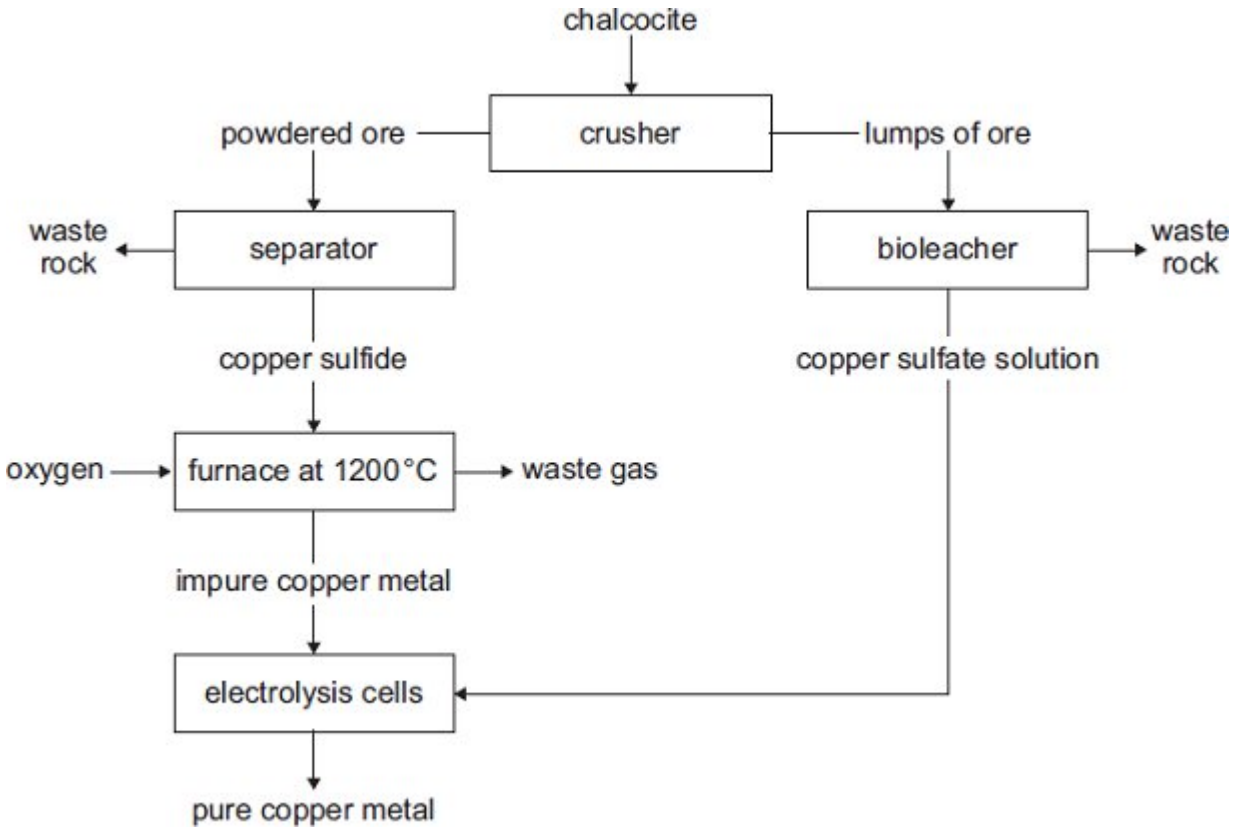
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_____

(2)

(b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



(i) Suggest **one** reason why it is difficult to dispose of the waste rock.

_____

_____

(1)

(ii) The reaction in the furnace could cause environmental pollution.
Explain how.

_____

_____

_____

_____

(2)

(iii) The extraction of pure copper is expensive.
Give **one** reason why.

_____

_____

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(1)

(iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

_____

_____

_____

_____

(2)

(v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

_____

_____

(1)

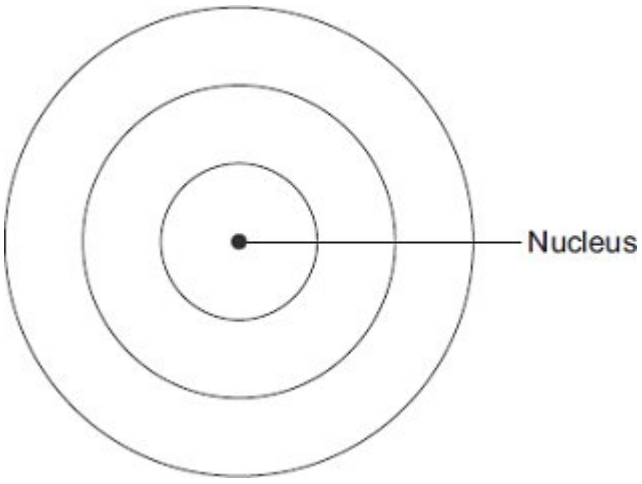
(Total 9 marks)

Q27.

Aluminium has many uses.

(a) An aluminium atom has 13 electrons.

(i) Draw the electronic structure of an aluminium atom.



(1)

(ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

_____ and _____

(1)

(iii) Why is there no overall electrical charge on an aluminium atom?

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_____

_____

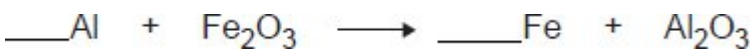
(1)

(b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

(i) Balance the chemical equation for the reaction.



(1)

(ii) Why does aluminium react with iron oxide?

_____

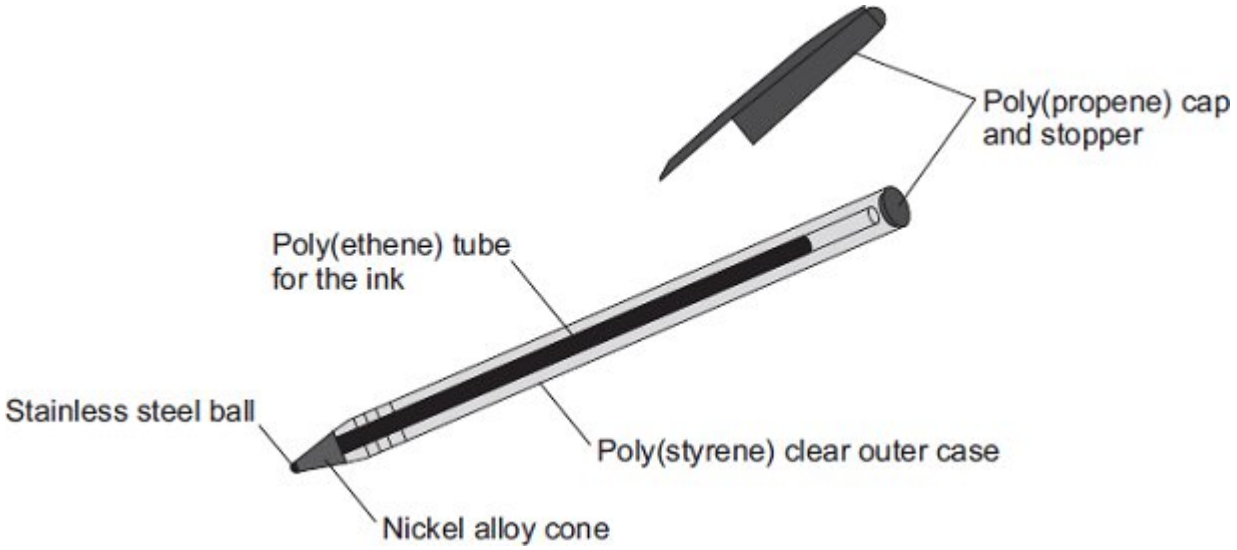
_____

(1)

(Total 5 marks)

Q28.

The diagram shows a ballpoint pen.



(a) Give **one** advantage and **one** disadvantage of recycling the materials from this type of ballpoint pen.

_____

_____

_____

_____

(2)

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(b) Alloys are used to make the ballpoint pen.

Give **two** reasons why alloys are used in the ballpoint pen.

_____

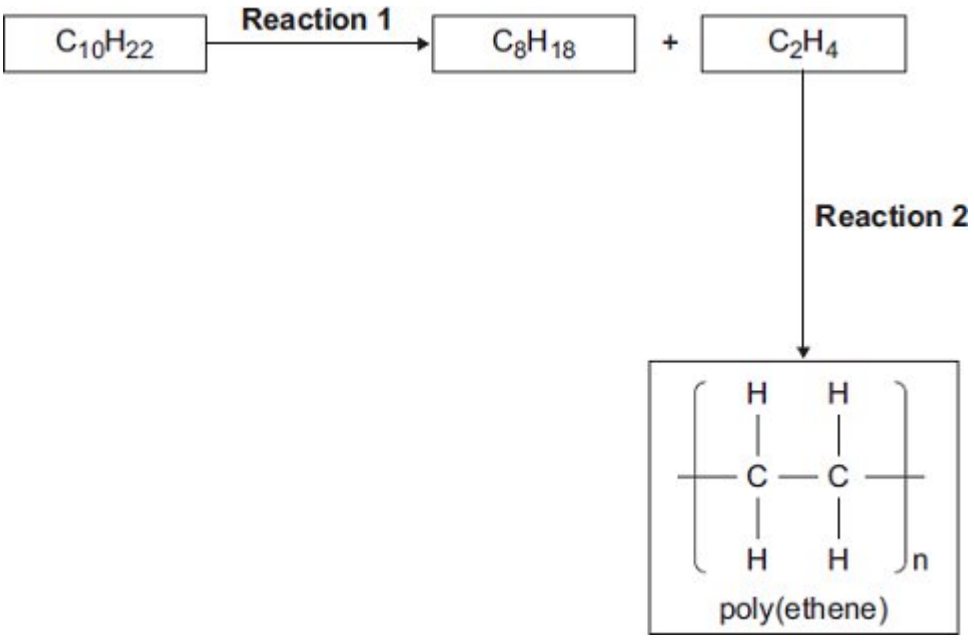
_____

_____

_____

(2)

(c) Decane ($C_{10}H_{22}$) can be used to produce poly(ethene).



(i) Describe the conditions needed for **Reaction 1**.

_____

_____

_____

_____

(2)

(ii) Describe, in terms of molecules, how poly(ethene) is produced in **Reaction 2**.

_____

_____

_____

_____

(2)

(d) Complete the displayed structure of the product in the equation.

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styrenepoly(styrene)

(2)

(Total 10 marks)

Q29.

This question is about potassium.

(a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

(i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

_____

_____

_____

_____

(2)

(ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

_____

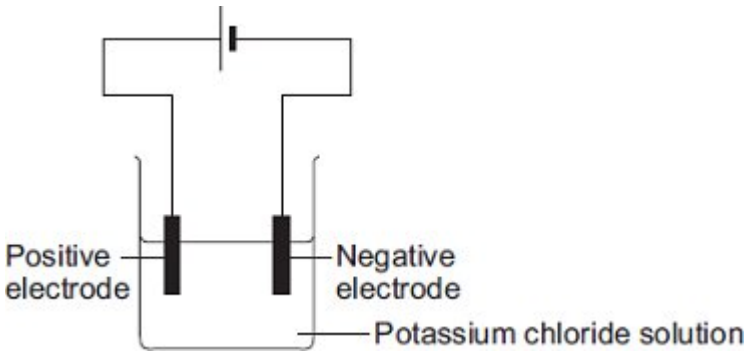
_____

(1)

(b) A student dissolved some potassium chloride in water. The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.

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The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

_____

_____

_____

_____

_____

_____

(3)

(c) The student tried to electrolyse molten potassium chloride to produce potassium.

(i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

_____

_____

_____

_____

(2)

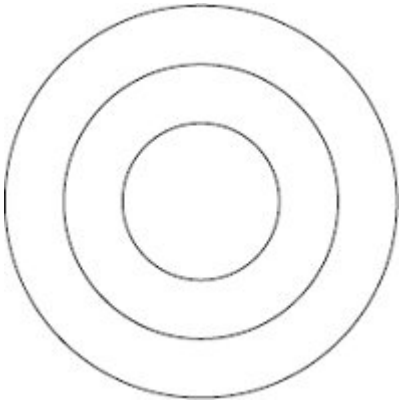
(ii) Complete and balance the equation for the reaction at the positive electrode.

_____Cl^- ⟶ Cl_2 + _____

(1)

(iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).

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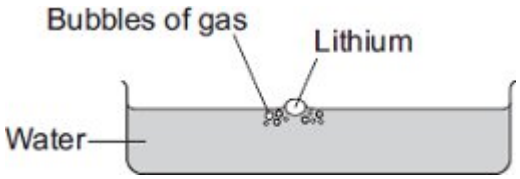
(1)

(Total 10 marks)

Q30.

Lithium is in Group 1 of the periodic table.

Lithium reacts with water to produce a gas and an alkaline solution.



(a) (i) Name the gas produced.

_____

(1)

(ii) Which ion causes the solution to be alkaline?

_____

(1)

(b) Potassium is also in Group 1 of the periodic table.
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q31.

Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.

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(a) Reacting iron oxide with carbon produces iron.

Draw a ring around the correct answer to complete the sentence.

The reaction to produce iron from iron oxide is

decomposition.
oxidation.
reduction.

(1)

(b) Aluminium cannot be produced by reacting aluminium oxide with carbon.

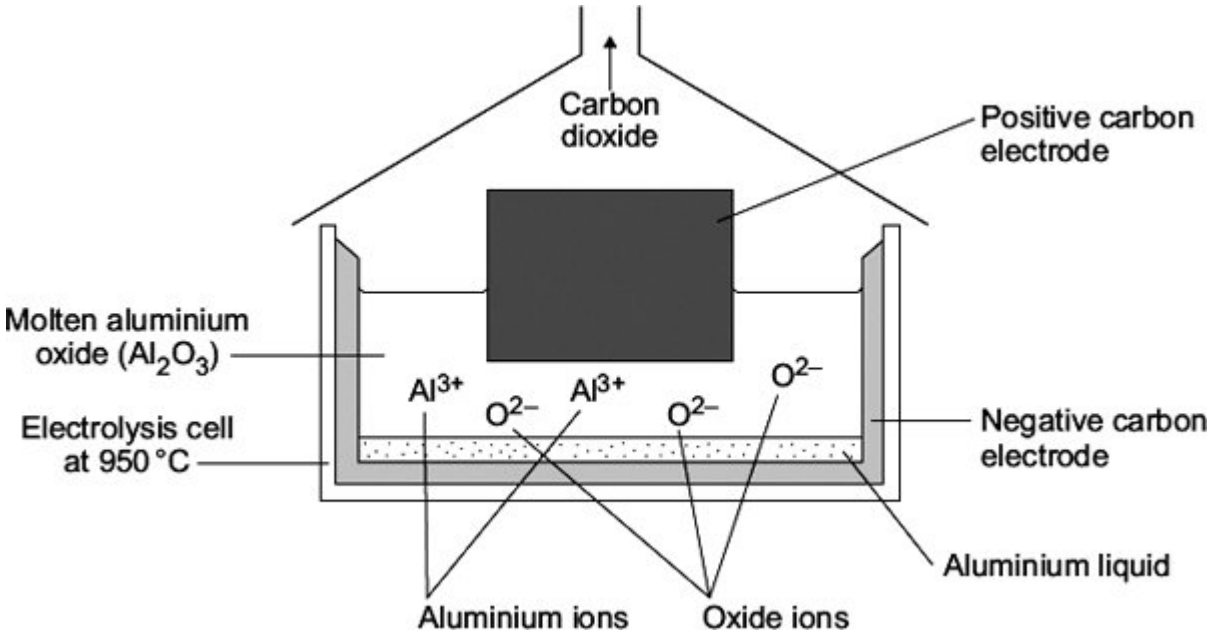
Why does aluminium oxide **not** react with carbon?

Tick (✓) the correct answer.

Answer	Tick (✓)
aluminium is less reactive than carbon	
carbon is less reactive than aluminium	
oxygen is more reactive than carbon	

(1)

(c) Aluminium can be produced by electrolysis.



Why do the aluminium ions collect at the negative electrode?

_____

_____

_____

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_____

(2)

(d) Some statements about aluminium are given below.

Tick (✓) **two** statements that are correct reasons why aluminium is used to make cans.

Statement	Tick (✓)
aluminium conducts electricity	
aluminium is not a transition metal	
aluminium has a low density	
aluminium is resistant to corrosion	

(2)

(e) Recycling aluminium cans uses less fossil fuels than producing aluminium from its ore.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of recycling aluminium to make aluminium cans.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
aluminium is the most common metal in the Earth's crust		
less carbon dioxide is produced		
more aluminium ore needs to be mined		
used aluminium cans have to be collected and transported		

(2)

(Total 8 marks)

Q32.

Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.

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via Wikimedia Commons

(a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

(i) Name this type of reaction.

_____

(1)

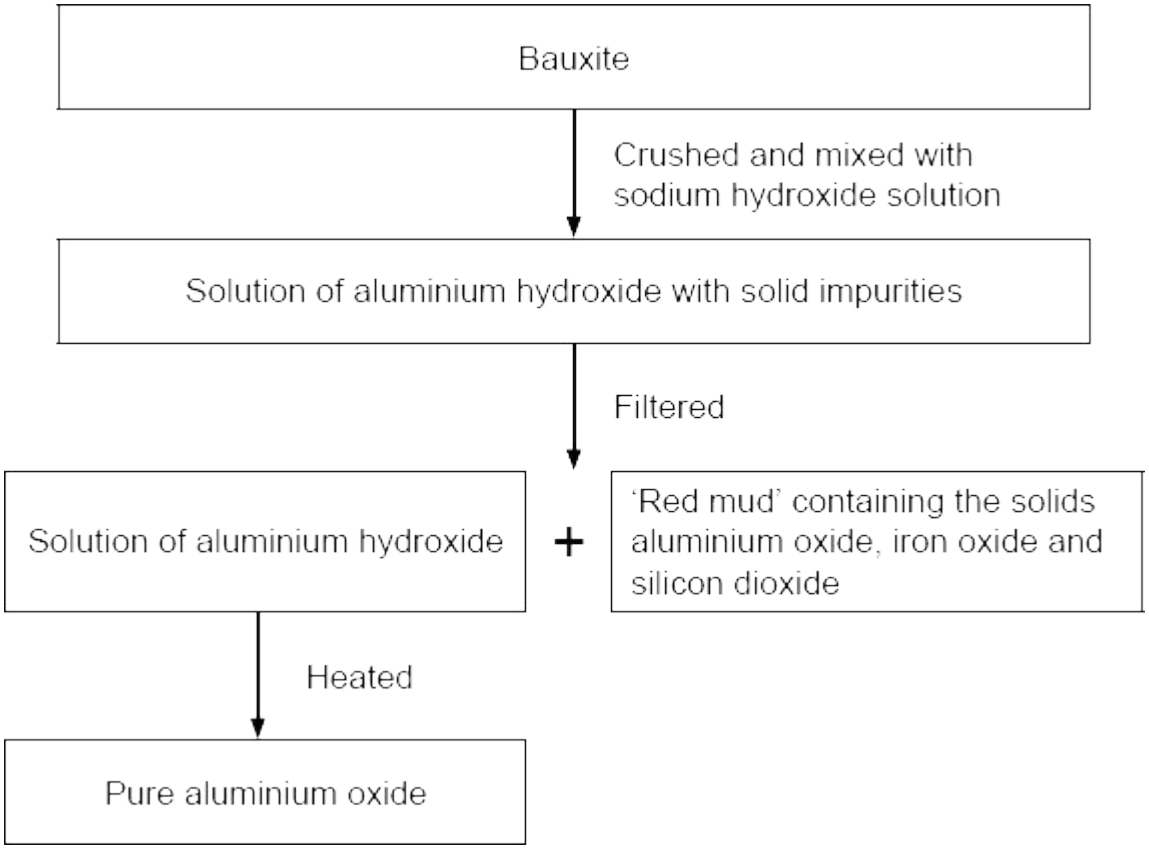
(ii) Balance the symbol equation for this reaction.

$2Fe_2O_3$ + _____ C → _____ Fe + _____ CO_2

(1)

(b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide. Aluminium is extracted by electrolysis of aluminium oxide.

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The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

(i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

_____

Answer = _____ %

(1)

(ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

_____

(1)

(iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

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_____

(1)

(c) Aluminium is used to make many things including cans.

During one year in the USA:

- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental _____

_____

Ethical or social _____

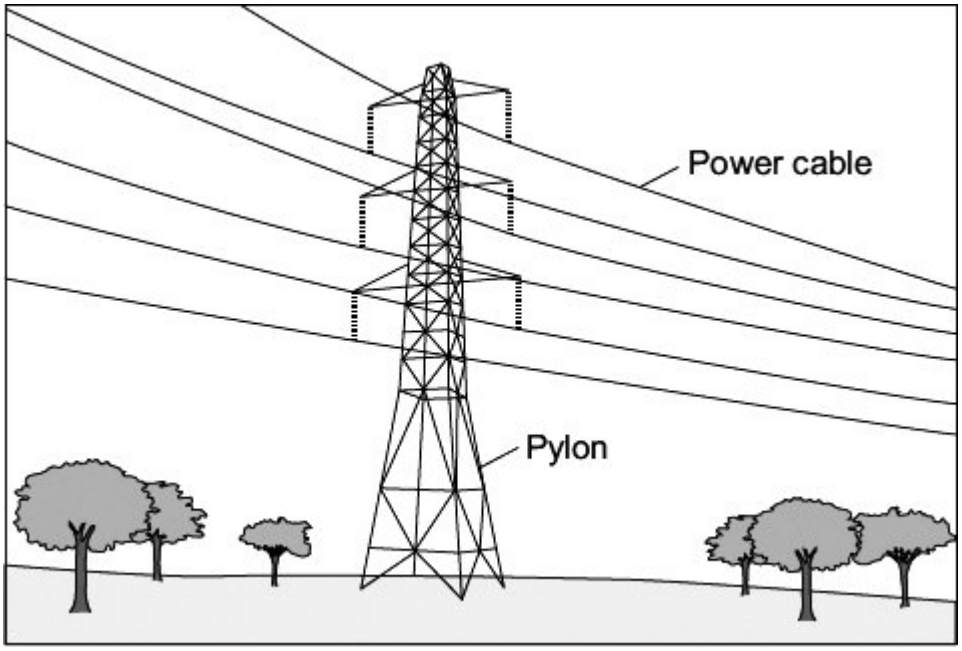
_____

(2)

(Total 7 marks)

Q33.

Metals are used in the manufacture of pylons and overhead power cables.



(a) Suggest **one** reason why iron (steel) is used to make pylons.

_____

_____

(1)

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(b) The table shows some of the properties of two metals.

Metal	Density in g per cm^3	Melting point in °C	Percentage(%) relative electrical conductivity	Percentage(%) abundance in Earth's crust
copper	8.92	1083	100	0.007
aluminium	2.70	660	60	8.1

Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

_____

_____

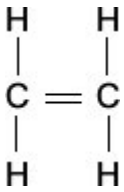
_____

_____

(2)

(c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



Draw a ring around the correct answer to complete each of the sentences.

(i) The chemical formula of this alkene is

CH

CH_4

C_2H_4

(1)

(ii) The two lines between the carbon atoms are called a

double bond.

nucleus.

single bond.

(1)

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(iii) The name of the polymer formed when many of these alkene molecules join together is

poly(ethene).
poly(ethenol).
poly(propene).

(1)

(Total 6 marks)

Q34.

Read the information.

> Alumina is a white solid. In 1800, scientists thought that alumina contained an undiscovered metal. We now call this metal aluminium. At that time, scientists could not extract the aluminium from alumina.
>
> In 1825, Christian Oersted, a Danish scientist, did experiments with alumina.
>
> **Step 1** He reacted a mixture of hot alumina and carbon with chlorine to form aluminium chloride. The reaction is very endothermic.
>
> **Step 2** The aluminium chloride was reacted with potassium. He was left with potassium chloride and tiny particles of aluminium metal.
>
> Other scientists were **not** able to obtain the same results using his experiment and his work was not accepted at that time.
>
> In 1827, Friedrich Wöhler, a German chemist, made some changes to Oersted's experiment. He obtained a lump of aluminium. He tested the aluminium and recorded its properties.

(a) Suggest why scientists in 1800 could not extract aluminium from alumina.

_____

_____

(1)

(b) Oersted's experiment in 1825 was **not** thought to be reliable.

Explain why

_____

_____

(1)

(c) Why must the reaction in **Step 1** be heated to make it work?

_____

_____

(1)

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(d) Complete the word equation for the reaction in **Step 2**.

aluminium chloride + potassium → _____ + _____

(1)

(e) Suggest how Wöhler was able to prove that he had made a new metal.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q35.

Iron is extracted from its ore.

(a) Iron ore is quarried.



Photograph supplied by Stockbyte/Thinkstock

Quarrying iron ore has impacts that cause environmental problems.

Tick (✓) **two** impacts of quarrying that cause environmental problems.

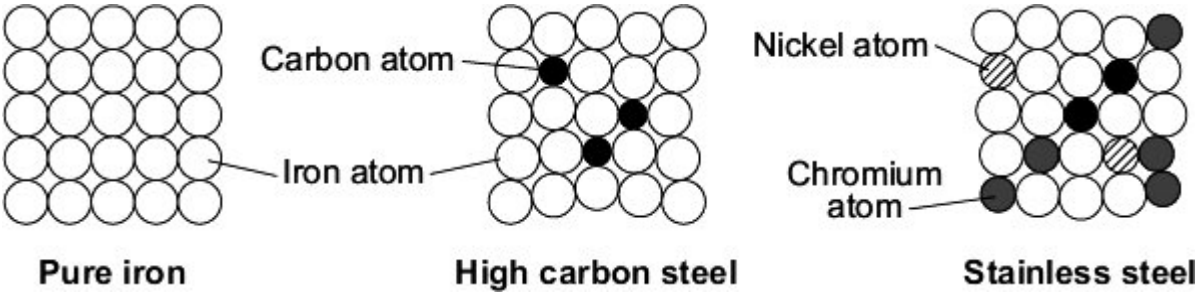
Impact of quarrying	Tick (✓)
puts off tourists	
causes dust pollution	
increases jobs	

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increases traffic	

(2)

(b) The diagrams represent the atoms in iron and the atoms in two alloys of iron.



Use the diagrams to help you to answer these questions.

(i) Complete the sentence.

Pure iron does **not** have many uses because _____

_____

(1)

(ii) Stainless steel is more expensive than pure iron.

Suggest why.

_____

_____

(1)

(c) Draw a ring around the correct answer to complete each sentence.

(i) Pure iron is

a compound.
an element.
a mixture.

(1)

(ii) High carbon steel is used for a drill bit because it is

brittle.
easily bent.
hard.

(1)

contains three different atoms.

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(iii) Stainless steel is used to make cutlery because it

melts at a very high temperature.
is resistant to corrosion.

(1)

(Total 7 marks)

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