1. When magnesium reacts with hydrochloric acid, a gas is also made.

What is the name of the gas?

Put a (ring) around the correct answer.

hydrogen **nitrogen** **oxygen** **chlorine**

[1]

2(a). Alpine cress takes up zinc ions from contaminated soil very well.

Oilseed rape cannot take up zinc. The table shows data on Alpine Penny-cress and oilseed rape.

Plant	Height (cm)	Dry mass per plant (g)	Plants per m^2	Time to fully grown (days)
Alpine Penny-cress	25	1	20	100
Oilseed rape	125	2	50	85

Scientists have put genes from Alpine Penny-cress into the oilseed rape plant.

Explain what effect this modified plant could have on the uptake of zinc ions in contaminated soil.

---

[2]

(b). The Alpine Penny-cress contains toxic zinc ions.

Abi decides to do some experimental research to find out whether the Alpine Penny-cress can be used as grazing for sheep.

What research would she need to do to find out if the Alpine Penny-cress is safe for sheep to eat?

---

[2]

3(a). A mining company wants to find a new area to mine for metals.

The company tests rock from two possible sites for a new mine.

The table shows their results.

Elements in the rock	Percentage of each element in rock from site A	Percentage of each element in rock from site B
oxygen	47	38
silicon	28	21
aluminium	8	18
iron	5	10
copper	0	0.5
other elements		12.5

What percentage of **other elements** are in the rock taken from site A?

_____ % **[2]**

(b). What are the main **similarities** between the rocks taken from the two sites?

---**[2]**

(c). The company wants to mine for metals.

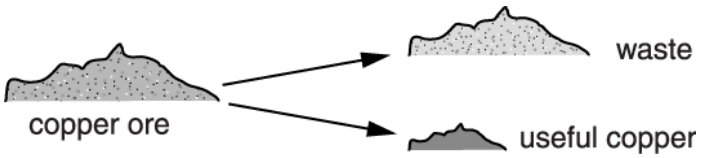
Which site is better?

Explain your reasoning.

---**[2]**

4(a). Zoe works for a company that mines copper ores.

She tests different copper ores to find out how much useful copper can be extracted from each one.



The table shows some of her results.

	Mass of ore in g	Mass of copper extracted from the ore in g	Mass of copper extracted per gram of ore	Mass of copper extracted per kilogram of ore
Ore 1	200	10	10 ÷ 200 = 0.05 g	50 g
Ore 2	200	15	15 ÷ 200 = 0.075 g	75 g
Ore 3	200	12		

(i) Calculate the mass of copper extracted per gram for **ore 3**.

answer _____ g **[2]**

(ii) Use your answer to calculate the mass of copper extracted per kilogram for **ore 3**.

answer _____ g **[1]**

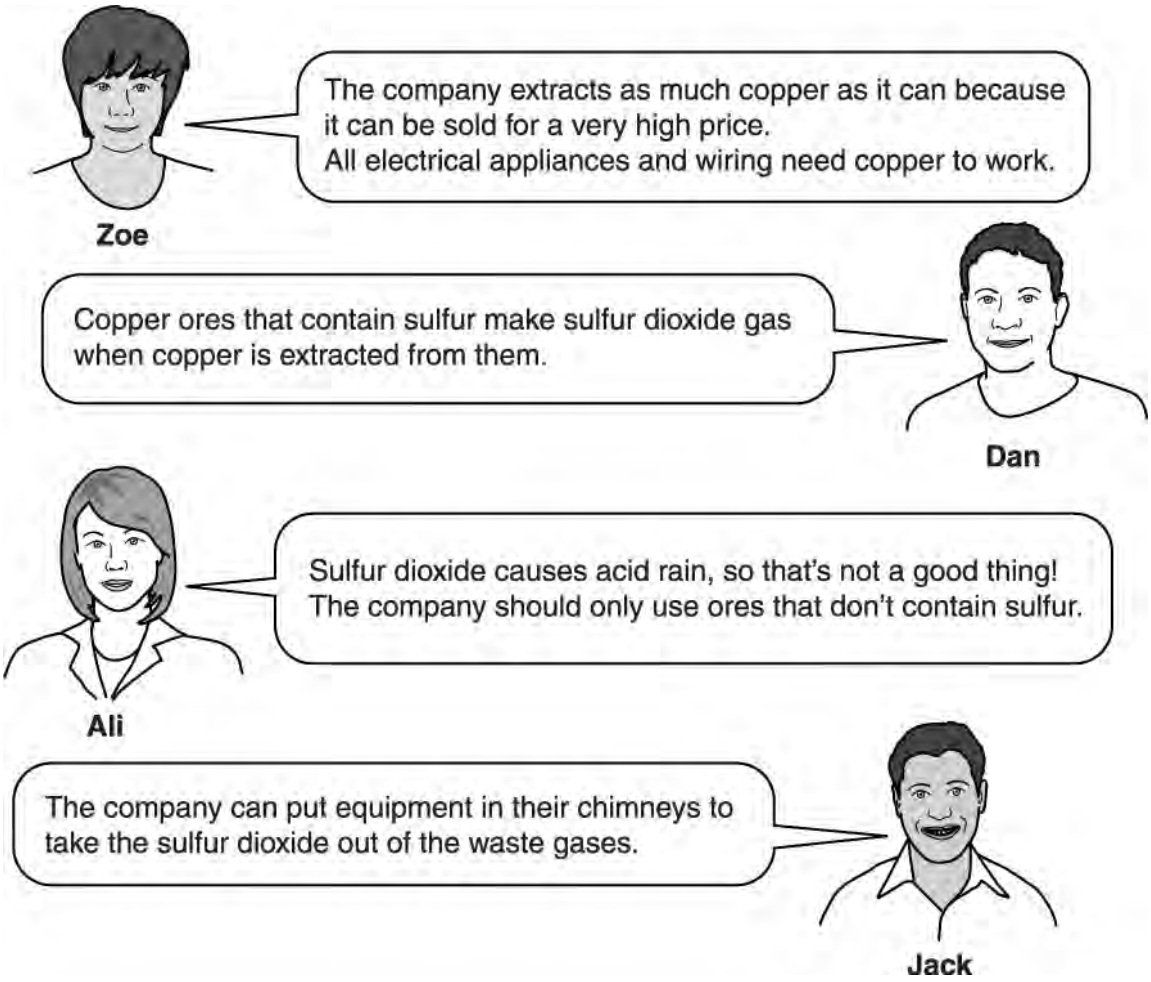
(iii) The company wants to make as little waste as possible when it extracts copper.

Which of the ores should the company use?

Explain why.

[2]

(b). Zoe and her friends discuss some issues about extracting copper.



(i) Use the information to describe the advantages and disadvantages of mining copper.

[3]

(ii) Use the information to explain **one** way in which the mining company can make the extraction of copper more sustainable.

---

[1]

(iii) Dan says that compounds that contain sulfur make sulfur dioxide when copper is extracted from them.

Which compounds make sulfur dioxide when copper is extracted from them?

Put rings around the **two** correct answers.

Cu_2O CuS Cu_2S $CuCO_3$ CuO

[1]

5(a). Large-scale metal extraction processes involve both costs and benefits.

(i) Companies choose metal extraction processes that use as little energy as possible.

Why does using less energy reduce the **cost to the company** and the **cost to the environment**?

Put a tick (✓) in the boxes next to the **three** correct answers.

Using less energy uses less fuel.	☐
Some fuels are less flammable than others.	☐
All fuels burn to give off energy.	☐
Using more fuel gives off more pollutant gases.	☐
Different types of fuel can be used for the process.	☐

[2]

(ii) Give **two** examples of the ways that people **benefit** from large-scale metal extraction processes.

---

[2]

(b). The table shows some data about the most cost-effective methods for extracting metals from metal oxides.

Metal oxide	Minimum temperature to make metal by heating with carbon in °C	Most cost-effective method of extraction
calcium oxide	2100	electrolysis
magnesium oxide	1600	electrolysis
aluminium oxide	2100	electrolysis
zinc oxide	900	heating with carbon
iron oxide	700	heating with carbon
lead oxide	400	heating with carbon
copper oxide	100	heating with carbon

Use the data to explain how the method chosen to extract a metal is related to its reactivity and the energy involved.

The quality of written communication will be assessed in your answer.

[6]

6. Mining copper produces large amounts of waste rock.

Why does mining copper produce large amounts of waste rock?

Put a tick (✓) in the box next to the correct answer.

Copper ore contains only small amounts of copper. ☐

The machinery is designed to handle large amounts of rock. ☐

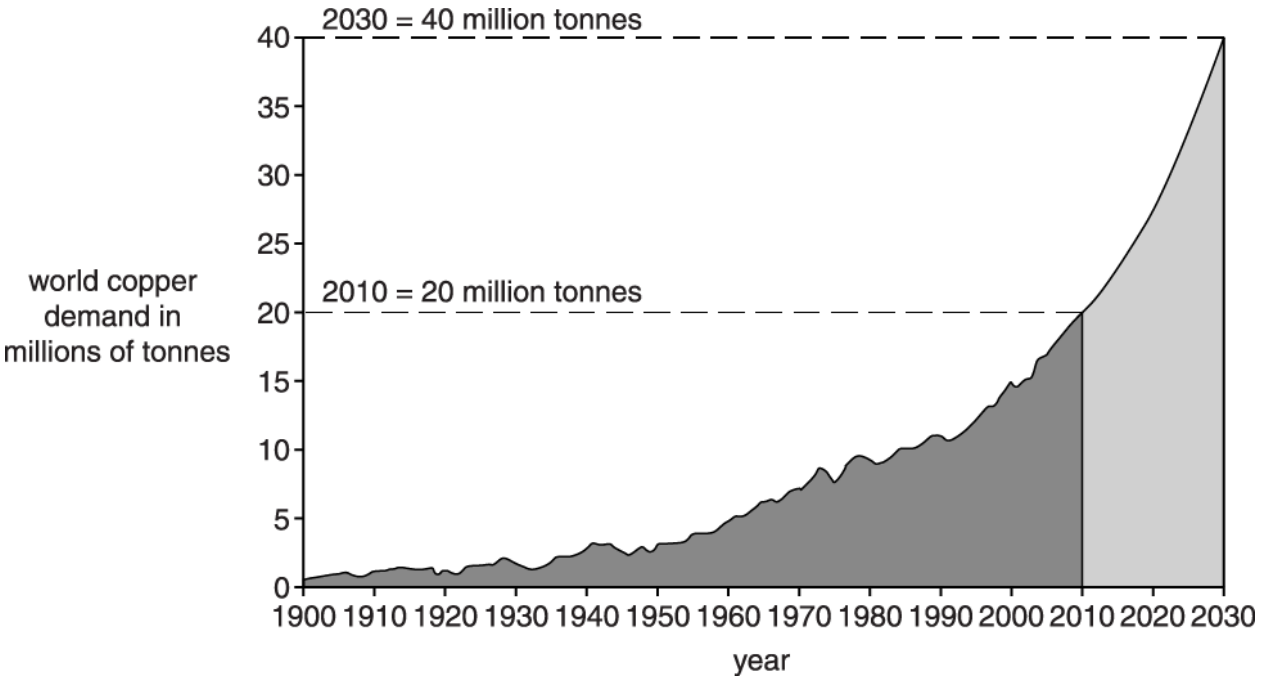
The rock is broken up into pieces and so has no use. ☐

There is a high percentage of other metals in the rock. ☐

[1]

7. Scientists are concerned about how the demand for copper is changing and how this will affect the supply of copper for the future.

The graph shows how the total world **demand** for copper has changed since 1900. The graph also shows the predicted demand for copper between 2010 and 2030.



The **supplies** of copper in the world come from four main countries. The copper deposits left in these countries are shown in the table.

Country	Estimated copper deposits in millions of tonnes
Chile	140
United States	90
Canada	23
Poland	36

Even if all scrap copper is recycled, this meets less than 50% of the world demand for copper.

Scientists are very concerned about the balance between the supply and demand for copper from 2010 onwards.

Use the information to discuss why they are so concerned.

The quality of written communication will be assessed in your answer.

[6]

8. Manganese is a metallic element. It is mixed with iron to make an alloy.

Manganese is made by heating manganese oxide with carbon.

(i) Write a **word** equation for this reaction.

[1]

(ii) Aluminium **cannot** be made by heating aluminium oxide with carbon.

Which of the statements below are **true** and which are **false**?

Put a tick (✓) in one box in **each** row.

	True	False
Carbon is more reactive than aluminium.		
Carbon reduces manganese oxide.		
Aluminium is more reactive than manganese.		

[4]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			hydrogen ✓	1	
			Total	1	
2	a		any **TWO** from: larger plants therefore take up more zinc ✓ more plants grow per m^2 therefore absorb more zinc per m^2 ✓ plants grow more quickly therefore more zinc can be removed in a shorter time ✓	2	
	b		find out amount / concentration of zinc ions in Alpine Penny-cress ✓ find out tolerance of sheep for zinc ions / whether zinc ions get into wool / meat ✓	2	
			Total	4	
3	a		12% (2) shows working that adds up 47 + 28 + 8 + 5 (1)	2	Look at table for 12% if not on the line **Examiner's Comments** There were no problems with this question overall, although occasional marks were lost where candidates had correctly added up percentages but subtracted 88% from 100% to give 22% instead of 12%.
	b		(both) contain oxygen / silicon / aluminium / iron / other elements (1) Refers to correct percentages / amounts (1)	2	Any mention of copper = 0 marks for first marking point **allow** they have similar percentages of "other elements" for two marks **allow** highest percentage in both is oxygen for two marks **Examiner's Comments** This question wasn't well-answered and very few candidates achieved 2 marks. Many candidates concluded that both tables have similar percentages (which they haven't overall) with no reference to the elements. Many stated low copper, but one site had no copper at all; this is not therefore a similarity.

Question			Answer/Indicative content	Marks	Guidance
	c		site B because it contains more (different) metals idea (1) site B contains more aluminium / iron / copper than site 1 (1)	2	ORA Candidate should give specific name(s) of metal(s) Chooses site A = 0 Examiner's Comments 1 mark was most commonly achieved. Site B was suggested but then no reason was given in the weakest responses. The best responses were those where candidates clearly suggested “a greater percentage of (stated) metal *and* has copper.”
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
4	a	i	12 ÷ 200 (1) = 0.06 g (1)	2	correct answer scores (2) Examiner's Comments Candidates usually achieved 2 marks. If they didn't achieve 0.06 it was often due to a calculation error and they still got 1 mark for 12/200.
		ii	60 g	1	**allow** ecf (answer to (i) × 1000) Examiner's Comments The vast majority of candidates achieved a mark.
		iii	Ore 2; (1) It contains the most copper per gram / kg of ore; (1)	2	**allow ecf** from (a) (ii) If ecf and over 75g then answer must be ore 3 Examiner's Comments Many candidates were able to select 'Ore 2' as the correct ore. The second mark was rarely awarded; 'more useful copper extracted/most copper/less waste' were common incorrect responses rather than responses being specific to per gram or kilogram.
	b	i	*Any three from:* copper can be sold for a high price; (1) needed for electrical goods; (1) produces sulfur dioxide; (1) causes acid rain (1)	3	**ignore** references to equipment in chimneys here Examiner's Comments Candidates who studied the 'talking heads' scored 3 marks easily. Some re-phrased it 'makes lots of money/lots of profit/used to make electricity/good conductor of electricity; polluting gases/harmful gases/bad for the environment/workers unemployed' which were insufficient for marks. The best responses were those organised clearly into advantages and disadvantages and were specific about those they stated.

Question			Answer/Indicative content	Marks	Guidance
		ii	use ores that don't contain sulfur; put equipment in chimneys / trap sulphur dioxide	1	Examiner's Comments The majority of candidates were able to suggest either using ores without sulphur, or placing a “trap” in chimneys for sulphur dioxide.
		iii	CuS and Cu_2S	1	Examiner's Comments Very few candidates were able to select the correct ores from the list. Too many incorrectly thought that to make sulfur dioxide you had to choose something containing sulfur and something containing oxygen. Usually candidates selected one ore with sulphur and another, containing oxygen.
			Total	10	

Question			Answer/Indicative content	Marks	Guidance
5	a	i	box 1; box 3; box 4;	2	All 3 correct = (2) 2 correct and only 3 ticks shown = (1) Examiner's Comments Most candidates understood that using less energy reduced the cost by using less fuel and that the production of more pollutant gases by burning more fuel was damaging to the environment. The relevance of the link between energy and burning fuels was less well understood with many choosing that different fuels can be used instead.
		ii	any 2 from: jobs / income; use of metals for products / example of metal use (e.g. cars / fridges etc); idea of local economy; idea of national economy; advantage of large scale: transport links to one area / control of waste is in one area / economy of scale idea / more efficient or more economic to extract on a large scale / lower energy costs on a large scale / large scale can use continuous not batch processes;	2	**Ignore** 'to meet demand' or 'need metals' or 'use a lot of metals' alone (not enough) **Allow** mark for 'economy' alone MP5 must be linked to idea of large scale extraction Examiner's Comments The most common benefit of large scale metal extraction given in this question was the creation of jobs or the need for metals for specific uses. Responses focussing on the large scale aspect did not always make this clear and there were many vague references to less pollution or to make more money.
	b		[Level 3] Links **reactivity** with the **method used** and to **energy**. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)	6	**This question is targeted at grades up to C** **Indicative scientific points may include:** **Level 3: (Links reactivity and method and energy)** • More reactive metals use electrolysis which uses high energy / the more reactive a metal the more energy is needed and electrolysis is used

Question	Answer/Indicative content	Marks	Guidance
	[Level 2] Makes a link between trends. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Makes a correct statement about the data. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)		• Less reactive metals use extraction with carbon which uses less energy / the less reactive a metal the less energy is needed and heating with carbon is used Level 2: (Link between trends) • Links reactivity to method of extraction • Links reactivity to temperature needed • Links reactivity to energy needed • Links temperature needed to method of extraction • Links temperature to energy • Links method used to energy Level 1: (data) • Ca / Mg / Al are most reactive metals • Zn / Fe / Pb / Cu are less reactive metals • Ca / Mg / Al need a high temperature (for extraction) • Zn / Fe / Pb / Cu need a lower temperature (for extraction) • Ca / Mg / Al use electrolysis • Zn / Fe / Pb / Cu use heating with carbon • Mg / Al does not fit the trend Ignore references to melting point Statements about one metal alone indicate level 1 Examiner's Comments Most candidates were able to make some use of the data in this level of response question. Good answers linked the method of extraction chosen with both reactivity of the metal and the energy required. Responses at lower levels did not address all the parts of the question, especially by concentrating on the temperatures given without linking that to the energy needed. There was some confusion about what the reactivity was referring to with many describing increasing reactivity of the metal oxides rather than the metals.

Question			Answer/Indicative content	Marks	Guidance
			Total	10	
6			Box 1	1	Examiner's Comments Most candidates successfully chose the small amount of copper in copper ore as the reason for the production of large amounts of waste rock. Many others chose the comment about why the rock is considered to be waste.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
7			[Level 3] Processes data about supply or demand and links data about both to a problem. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Identifies a problem and uses data about both supply and demand OR identifies a problem linked to processed data about supply or demand. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Identifies a problem and uses data about supply or demand. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to C Indicative scientific points may include: Problems • idea that copper supplies will run out in the future / are finite / limited • Supply cannot meet demand Data about supply and demand Demand • demand for copper is rising • Quotes value(s) from demand graph Supply • Recycling / scrap can only supply 50% of demand • Quotes value(s) from supply table • only four countries have (large) copper supplies. Processed data • between 2010 and 2030 copper demand is expected to double. • Demand for copper is rising faster (over time) • Attempts to estimate number of years' supply. • uses values from the supply table to compare to the annual demand. • Total supply from 4 countries is 289 million tonnes • discusses a shortfall between demand and supply using data from both the table and the graph Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments Good responses to this level of response question used information from both the graph about demand and the table about supply, to explain that there is a concern that supply will no longer meet demand for

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>copper in the future. The best candidates being able to process the data by showing that demand is expected to double or is now increasing more rapidly than before. A few responses were also able to process the information about supply by discussing the problems with there only being a few countries currently supplying copper. Many responses gave good descriptions of the data, especially the graph about demand, but did not explain why they show a reason to be concerned. Some candidates tried to explain concerns about the availability of copper in the future without referring to the information given.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
<tr><td>8</td><td></td><td>i</td><td>Manganese oxide + carbon → carbon oxide/monoxide/dioxide + manganese ✓</td><td>1 (AO 1.2)</td><td>IGNORE symbol equations

<u>Examiner's Comments</u>

Most candidates wrote "manganese oxide + carbon → manganese". Some of the higher ability candidates realised the equation had to show what happened to the carbon.

Some candidates wrote word equations involving magnesium instead of manganese.</td></tr>
<tr><td></td><td></td><td>ii</td><td><table><tr><th></th><th>True</th><th>False</th></tr><tr><td>Carbon is more reactive than aluminium.</td><td></td><td>✓</td></tr><tr><td>Carbon reduces manganese oxide.</td><td>✓</td><td></td></tr><tr><td>Aluminium is more reactive than manganese.</td><td>✓</td><td></td></tr><tr><td>Carbon reduces aluminium oxide.</td><td></td><td>✓</td></tr></table></td><td>4

(AO 1.1)

(AO 2.1)

(AO 2.1)

(AO 2.1)</td><td><u>Examiner's Comments</u>

Most candidates gained some credit on this question. Examiners wondered how familiar a concept this was to candidates, as the higher ability candidates did not perform significantly better than the others.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
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