

## Questions

Q1.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 14.



Figure 14

\* Aluminium is extracted from its ore by electrolysis.

Iron is extracted from its ore by heating with carbon.

Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(Total for question = 6 marks)

Q2.

A student carried out an investigation to determine the order of reactivity of four metals, W, X, Y and Z.

A piece of metal W was added to a test tube containing excess dilute hydrochloric acid.

This was repeated with the other three metals, X, Y and Z.

In each case, the size of each piece of metal was the same.

The student recorded observations on each reaction for three minutes.

The observations obtained are shown in Figure 8.

metal	observations with dilute hydrochloric acid
W	Bubbles formed quickly with some metal remaining after three minutes.
X	A few bubbles were seen to form. The metal looked unchanged after three minutes.
Y	Bubbles formed quickly. After three minutes all the metal had reacted.
Z	Bubbles formed very quickly with no metal remaining after three minutes.

Figure 8

(i) Use the information in Figure 8 to place the metals in order of reactivity from the least reactive to the most reactive.

(2)

least reactive  $\longrightarrow$  most reactive

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(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid  $\rightarrow$  metal sulfate + hydrogen

When metal Y reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.

Most of the solid metal remains.

Explain why the reaction between metal Y and excess dilute sulfuric acid stopped even though there was solid metal Y left.

(2)

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(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid.

This is because ethanoic acid is a weak acid.

Explain the meaning of the term weak acid.

(2)

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(Total for question = 6 marks)

Q3.

The reactivity of copper, magnesium and zinc was investigated. Each metal was placed separately in dilute hydrochloric acid. The amount of effervescence was observed.

(i) The same mass of metal was used in each experiment.

Which piece of apparatus should be used to find the mass of metal used?

(1)

- A a balance
- B a pipette
- C a stopwatch
- D a thermometer

(ii) State two variables, apart from the mass of the metals, that should be controlled in this investigation.

(2)

1 .....

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2 .....

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(iii) Magnesium produces the most vigorous effervescence. Copper does not produce any effervescence.

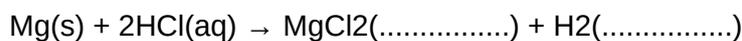
Give the reason why copper does not produce any effervescence.

(1)

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(iv) The magnesium reacts with dilute hydrochloric acid to form magnesium chloride solution and hydrogen gas.

The equation for the reaction is



Fill in the missing state symbols in the spaces provided.

(2)

(Total for question = 6 marks)

Q4.

Some metals are found in the Earth's crust as uncombined elements.  
Reactive metals are found in ores.

In ores, metals are combined with other elements.

An ore of iron is mostly iron oxide, Fe<sub>2</sub>O<sub>3</sub>.

Iron can be extracted from this iron oxide by heating it with carbon.

Balance this equation for the reaction that takes place.

(1)



(Total for question = 1 mark)

Q5.

One way to extract metals from land contaminated with metal compounds is phytoextraction. When plants grow they absorb metal ions through their roots. The plants are harvested, dried and burned forming an ash. The ash contains metal compounds.

Plants were grown in a piece of ground contaminated with nickel compounds.

(i) 1 kg of the ash from these plants contained 142.0 g of nickel compounds.

Calculate the percentage by mass of nickel compounds in the ash.

(3)

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percentage by mass = .....

(ii) Nickel is extracted from nickel compounds.

State an advantage of extracting nickel by phytoextraction rather than from its ore.

(1)

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(Total for question = 4 marks)

Q6.

Some metals are found in the Earth's crust as uncombined elements.  
Reactive metals are found in ores.

In ores, metals are combined with other elements.

Most copper ores are described as low grade.  
This means that the percentage of copper in the ore is very small.  
5000 kg of one copper ore was found to contain 42.5 kg of copper.

Calculate the percentage of copper in this ore.

(2)

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.....

percentage of copper in ore = .....

(Total for question = 2 marks)

Q7.

The order of reactivity of copper, magnesium and zinc can be determined by the displacement reactions between these metals and solutions of their salts.

You are provided with

- samples of the three metals
- solutions of copper sulfate, magnesium sulfate and zinc sulfate.

Describe the experiments that can be done to determine the order of reactivity of these metals by displacement reactions.

(3)

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(Total for question = 3 marks)

Q8.

The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.

(2)

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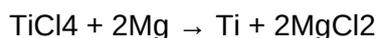
(Total for question = 2 marks)

Q9.

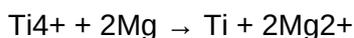
Some questions must be answered with a cross in a box (  ). If you change your mind about an answer, put a line through the box (  ) and then mark your new answer with a cross (  ).

The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

(i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride,  $\text{TiCl}_4$ , and magnesium.



This equation can be simplified as



Explain why this displacement reaction can be described as a redox reaction.

(3)

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(ii) The formula of the sulfate ion is  $\text{SO}_4^{2-}$ .

Which of the following is the formula of titanium sulfate containing the  $\text{Ti}^{4+}$  ion?

(1)

- A  $\text{TiSO}_4$
- B  $\text{Ti}_2\text{SO}_4$
- C  $\text{Ti}(\text{SO}_4)_2$
- D  $\text{Ti}_2\text{S}_2\text{O}_8$

(Total for question = 4 marks)

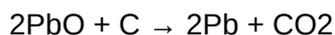
Q10.

Some metals are found in the Earth's crust as uncombined elements.  
Reactive metals are found in ores.

In ores, metals are combined with other elements.

In one stage of the extraction of lead from its ore, lead oxide is heated strongly with carbon.

The equation for the reaction is



Explain, using this equation, which substance has been oxidised in this reaction.

(2)

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(Total for question = 2 marks)

Q11.

Metals can be extracted from ores found in the Earth's crust.

Explain why aluminium cannot be extracted from its ore by heating with carbon but can be extracted by electrolysis.

(2)

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(Total for question = 2 marks)

Q12.

The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

Aluminium is extracted from its ore by electrolysis.

Explain why this method is used to extract aluminium from its ore.

(2)

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(Total for question = 2 marks)

Q13.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

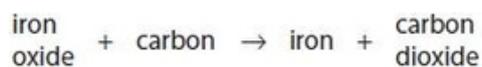
Part of the reactivity series is shown in Figure 14.



Figure 14

Iron ore contains iron oxide.

Iron is extracted from iron oxide by heating the oxide with carbon.



(i) In this reaction

- A carbon is reduced
- B iron oxide is neutralised
- C iron oxide is reduced
- D iron is oxidised

(1)

(ii) The formula of the iron oxide is Fe<sub>2</sub>O<sub>3</sub>.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe<sub>2</sub>O<sub>3</sub>.

(relative atomic masses: O = 16, Fe = 56)

(3)

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.....

.....

mass of iron = ..... tonnes

(Total for question = 4 marks)

Q14.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 14.



Figure 14

Aluminium cannot be extracted by heating its oxide with carbon.

Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

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.....

(Total for question = 2 marks)

Q15.

The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

Phytoextraction is an alternative biological method that can be used to extract metals from very low-grade ores.

Give one disadvantage of phytoextraction as a method of extraction of metals.

(1)

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.....

(Total for question = 1 mark)

Q16.

Metals are extracted from substances naturally occurring in the Earth's crust.

Aluminium is extracted from aluminium oxide by electrolysis.

Aluminium oxide is made up of ions.

(i) The formula of aluminium oxide is  $Al_2O_3$ .

Give the number of ions in the formula  $Al_2O_3$ .

(1)

.....

(ii) Complete the balanced equation for the overall reaction by putting numbers in the spaces.

(2)



(Total for question = 3 marks)

Q17.

Some metals are found in the Earth's crust as uncombined elements.  
Reactive metals are found in ores.

In ores, metals are combined with other elements.

Give two advantages of recycling metals rather than extracting metals from their ores.

(2)

1 .....

.....

2 .....

.....

(Total for question = 2 marks)

Q18.

Metals are extracted from substances naturally occurring in the Earth's crust.

Which of these metals is usually found uncombined in the Earth's crust?

(1)

- A calcium
- B gold
- C iron
- D magnesium

(Total for question = 1 mark)

Q19.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross .

Some metals are found in the Earth's crust as uncombined elements.

Reactive metals are found in ores.

In ores, metals are combined with other elements.

Which of these metals is found as the uncombined element in the Earth's crust?

(1)

- A aluminium
- B gold
- C potassium
- D zinc

(Total for question = 1 mark)

Q20.

Metals are extracted from substances naturally occurring in the Earth's crust.

(i) The environmental impact of a product is assessed in a life-cycle assessment.

The stages in this assessment are given below.

They are not in the correct order.

A disposal of the product

B manufacturing the product

C obtaining and processing the raw materials

D using the product

List the stages of the life-cycle assessment, using letters A, B, C, D, in the correct order from start to finish.

(2)

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(ii) Aluminium can be obtained by recycling aluminium waste.

Give two advantages of obtaining aluminium by recycling aluminium waste rather than mining the raw material and extracting aluminium from that raw material.

(2)

1 .....

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2 .....

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(Total for question = 4 marks)

Q21.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 14.



Figure 14

Predict the method that will have to be used to extract calcium from its ore.

(1)

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(Total for question = 1 mark)

Q22.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross .

Three different metals are added to separate test tubes of acid.

The observations are shown in Figure 4.

metal	observation
silver	no change is seen
iron	very slow bubbling
magnesium	steady bubbling

Figure 4

(i) Place the metals in order of reactivity from most to least reactive.

(1)

most reactive .....

.....

least reactive .....

(ii) Hydrogen is given off when magnesium reacts with acid.

The hydrogen is tested by collecting the gas in a test tube and igniting it.

What is the safest way to ignite the gas?

(1)

- A add fuel to the test tube
- B heat the test tube with a Bunsen burner
- C put a lighted splint at the open end of the test tube
- D put the test tube in an oven

(iii) State the observation made in this test that shows that the gas is hydrogen.

(1)

.....

.....

(Total for question = 3 marks)

Q23.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

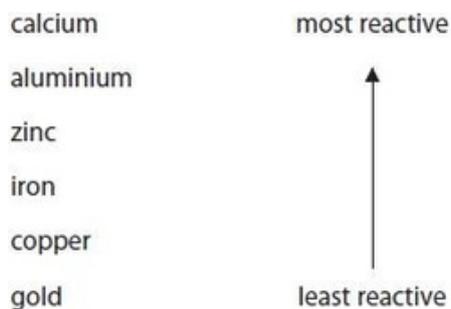


Figure 2

In recent years, researchers have been investigating alternative methods of extracting metals from soils.

Researchers have found that growing certain plants in appropriate areas can result in the phytoextraction of copper.

Describe how growing plants can result in the phytoextraction of copper.

(2)

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(Total for question = 2 marks)

Q24.

A student placed a piece of metal P in a test tube containing excess dilute sulfuric acid. The student repeated this with three other metals, Q, R and S. All the pieces of all four metals were the same size.

(i) The student recorded the observations until each metal had reacted with the acid for two minutes.

The observations are shown in Figure 9.

metal	observations
P	bubbles produced very slowly some metal remained
Q	bubbles produced quickly no metal remained
R	bubbles produced slowly no metal remained
S	bubbles produced very quickly no metal remained

Figure 9

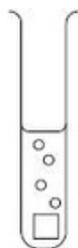
Use this information to put the four metals in order of reactivity from the least reactive to the most reactive.

(2)

least reactive     most reactive

(ii) Complete the diagram below to show how the student could add to the apparatus to measure the volume of gas produced in the two minutes.

(2)



(Total for question = 4 marks)

Q25.

Calcium and potassium react with water in similar ways.

(i) One similarity in the reactions is that hydrogen gas is produced.

State one other similarity in the products of the reactions of calcium and potassium with water.

(1)

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(ii) Potassium is higher in the reactivity series than calcium and reacts more vigorously with water than calcium reacts with water.

State why potassium is higher in the reactivity series and reacts more vigorously with water than calcium.

(1)

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.....

(Total for question = 2 marks)

Q26.

Iron is extracted by heating iron oxide with carbon.  
Electrolysis of molten iron oxide is not used to extract iron.

(i) State why iron can be extracted by heating iron oxide with carbon.

(1)

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(ii) State why electrolysis is not used to extract iron.

(1)

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(Total for question = 2 marks)

Q27.

Some nickel ores contain nickel sulfide.

(i) In the first stage of extracting nickel from nickel sulfide, the nickel sulfide, NiS, is heated in air to form nickel oxide, NiO, and sulfur dioxide.

Write the balanced equation for this reaction.

(2)

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.....

(ii) In the final stage of the extraction process, a nickel compound is electrolysed to produce pure nickel.

An advantage of producing a metal by electrolysis is that

(1)

- A electrolysis uses a large amount of electricity
- B the metal produced by electrolysis is very pure
- C electrolysis is a very cheap method of extraction
- D electrolysis is the only method of extracting unreactive metals

(Total for question = 3 marks)

Q28.

Metals are extracted from substances naturally occurring in the Earth's crust.

Zinc can be extracted by heating zinc oxide with carbon.

The products are zinc and carbon dioxide.

(i) Write the word equation for this reaction.

(2)

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.....

(ii) In this reaction zinc oxide loses oxygen.

State the type of reaction taking place when an oxide loses oxygen.

(1)

.....

(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Indicative content	Mark
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> <li>• recycling conserves raw materials/natural resources</li> <li>• less power/energy used</li> <li>• therefore conserves fossil fuels</li> <li>• reduces waste in landfill sites</li> <li>• mining for ores avoided</li> <li>• less damage to habitats/landscape</li> <li>• less energy required to melt and reform metals than to extract them</li> <li>• produces less carbon dioxide than extracting/ reduces carbon footprint</li> <li>• carbon dioxide is a greenhouse gas</li> <li>• greenhouse gases cause global warming</li> <li>• avoids use of large amounts of electricity to extract aluminium from its ore</li> <li>• electricity is expensive</li> <li>• avoids release of carbon dioxide when carbon burns</li> <li>• avoids use of large amounts of heat energy needed to extract iron from its ore</li> </ul> <p>IGNORE:</p> <ul style="list-style-type: none"> <li>• environmentally friendly</li> <li>• cheaper</li> <li>• faster</li> <li>• employment</li> </ul>	<p><b>(6)</b></p> <p>AO 1 1</p> <p>AO 2 1</p>

Edexcel Chemistry GCSE - Obtaining and using metals

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> <li>No awardable content</li> </ul>
Level 1	1-2	<ul style="list-style-type: none"> <li>Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li> <li>The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li> <li>The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li> <li>The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)</li> </ul>

Q2.

Question number	Answer	Additional guidance	Mark
(i)	least            most X - W - Y - Z (2)	X - Y - W - Z (1)	(2) AO3-1

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking <ul style="list-style-type: none"> <li>metal sulfate {insoluble / coats the metal / forms a barrier} (1)</li> <li>prevents further reaction of metal with acid (1)</li> </ul>	ignore tarnish	(2) AO2-2

Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking <ul style="list-style-type: none"> <li>partially {dissociated / ionised} (1)</li> <li>{concentration of H<sup>+</sup> ions lower / fewer H<sup>+</sup> ions} than expected (1)</li> </ul>	concentration of H <sup>+</sup> ions lower than concentration of acid (1) ignore references to pH	(2) AO1-1

Q3.

Question number	Answer	Mark
(i)	A a balance The only correct answer is A.  B is incorrect because a pipette is used to measure out a volume of liquid and is not used to find the mass of a metal. C is incorrect because a stopwatch is used to measure time and is not used to find the mass of a metal. D is incorrect because a thermometer is used to measure temperature and is not used to find the mass of a metal.	(1)

Question number	Answer	Additional guidance	Mark
(ii)	Any two from the following <ul style="list-style-type: none"> <li>• (same) volume of acid (1)</li> <li>• (same) concentration of acid (1)</li> <li>• (same) size of metal (pieces) (1)</li> <li>• (same) temperature (1)</li> </ul>	allow amount / mass of acid allow strength / pH allow surface area  ignore references to time	(2)
(iii)	copper is {not reacting / no reaction / unreactive / low in reactivity series / not reactive enough}	allow less reactive (than hydrogen)  ignore inert (alone)	(1)
(iv)	MgCl <sub>2</sub> (aq) (1) H <sub>2</sub> (g) (1)  Mg(s) + 2HCl(aq) → MgCl <sub>2</sub> (aq) + H <sub>2</sub> (g)	allow AQ allow G	(2)

Q4.

Question number	Answer	Mark
	2Fe <sub>2</sub> O <sub>3</sub> + 3 C → 4 Fe + 3 CO <sub>2</sub>	(1)

Q5.

Question number	Answer	Additional guidance	Mark
(i)	14(.2) with or without working scores 3  1kg = 1000g (1)  $\frac{142}{1000}$ (1)  x 100% = 14(.2) (1)	If the percentage of non nickel compounds is calculated to give 85.8%/86% score 2  $\frac{142}{1000}$ or 0.142 will score MP1 and MP2  $\frac{142 \times 100}{1} = 14200$ scores (1)	(3)
(ii)	decontaminates ground / conserves {nickel / nickel ores / ores} / allows use of low-grade ore /  specified environmental reason: e.g. less noise due to mining / carbon neutral / less carbon dioxide	Ignore any reference to cost/ better for environment etc. / time / energy	(1)

Q6.

Question number	Answer	Additional guidance	Mark
	$\frac{42.5}{5000} \times 100$ (1) (= 0.85) (1)	0.85 alone scores 2	(2)

Q7.

Question number	Answer	Additional guidance	Mark
	A description to include <ul style="list-style-type: none"> <li>place separate pieces of each metal into solutions of each of salt (in spotting tray/container) (1)</li> <li>observe changes in appearance/colour of {metal/solution} (1)</li> <li>the more reactive metal shows the greater number of reactions (1)</li> </ul>	two reactions of different metals in different metal sulfate solutions plus conclusion about reactivity (2)  Allow 1 mark for one correctly described reaction between a metal and a different metal sulfate solution	(3) AO2

Q8.

Question number	Answer	Additional guidance	Mark
	<p>A method to include</p> <ul style="list-style-type: none"> <li>• mix copper oxide with {carbon / powdered charcoal} (in a suitable container) (1)</li> <li>• heat (with carbon) (strongly until no further change) (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• react copper oxide with dilute {sulfuric / hydrochloric} acid (1)</li> <li>• electrolyse the solution formed (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• pass hydrogen (or methane) (1)</li> <li>• over heated copper oxide (1)</li> </ul>	<p>In each the 2<sup>nd</sup> MP depends on the 1st</p> <p>reject burn / combust</p> <p>allow {react/displace} with carbon (alone) (1)</p> <p>allow heat with more reactive metal (1)</p> <p>suitable method to isolate copper from other oxide (1)</p>	(2) AO3-3a

Q9.

Question number	Answer	Additional guidance	Mark
(i)	<p>An explanation linking</p> <ul style="list-style-type: none"> <li>• (redox involves both) reduction <b>and</b> oxidation (1)</li> <li>• magnesium (atoms) loses electrons (and are oxidised) (1)</li> <li>• titanium <b>ions</b> accept electrons (and are reduced) (1)</li> </ul>	<p>ignore references to loss and gain of oxygen allow <math>\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^{-}</math></p> <p>allow <math>\text{Ti}^{4+} + 4\text{e}^{-} \rightarrow \text{Ti}</math></p> <p>If no other mark awarded, then allow description of what happens to both reactant particles without mention of electrons (1) OR</p> <p>allow titanium gains electrons and magnesium loses electrons (1)</p>	(3) AO1-1

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Question number	Answer	Mark
(ii)	C $\text{Ti}(\text{SO}_4)_2$ is the only correct answer  A, B and D are incorrect formulae	(1) AO1-1

Q10.

Question number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> <li>• carbon / C (1)</li> <li>• gained oxygen (to form carbon dioxide) (1)</li> </ul>	reject other elements for MP1 allow oxidation is gain of oxygen / oxidation is loss of electrons (1)	(2)

Q11.

Question number	Answer	Additional guidance	Mark
	An explanation linking any two from <ul style="list-style-type: none"> <li>• aluminium is more reactive than carbon (so electrolysis required) (1)</li> <li>• carbon cannot remove the oxygen / there is no reaction between carbon and aluminium oxide / carbon cannot displace aluminium (1)</li> <li>• electrolysis can be used to reduce aluminium ions (1)</li> </ul>	allow electrolysis is a more powerful method of reduction (1)	(2) AO1

Q12.

Question number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> <li>aluminium is (very) high in the reactivity series / very reactive (1)</li> <li>needs a lot of energy (to remove oxygen from the oxide) (1)</li> </ul>	allow aluminium more reactive than carbon  allow cannot be {extracted by heating with / extracted by / reduced by} carbon allow cannot be displaced by carbon	(2) AO1-1

Q13.

Question Number	Answer	Mark
(i)	C iron oxide is reduced  <b>1. The only correct answer is C</b>  <i>A is not correct because carbon gains oxygen</i>  <i>B is not correct because it is not an acid-base reaction</i>  <i>D is not correct because iron oxide loses oxygen</i>	(1) AO 1 1

Question Number	Answer		Mark
(ii)	<p>final answer of 168 (tonnes) with or without working (3)</p> <p>OR</p> <p>relative formula mass <math>\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)</math> (1)</p> <p>160 tonnes <math>\text{Fe}_2\text{O}_3</math> produces <math>\{2 \times 56 / 112\}</math> tonnes Fe (1)</p> <p>240 tonnes <math>\text{Fe}_2\text{O}_3</math> produces <math>\frac{2 \times 56}{160} \times 240</math> (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass <math>\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)</math> (1)</p> <p><math>\frac{240}{160}</math> (1) = 1.5</p> <p>1.5 x 112 (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass <math>\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)</math> (1)</p> <p><math>\frac{112}{160}</math> (1) = 0.7</p> <p>0.7 x 240 (1) = 168 (tonnes)</p>	<p>allow ECF throughout</p> <p><math>M_r [\text{Fe}_2\text{O}_3] = 160</math> seen without working (1)</p> <p>allow 320 tonnes : 224 tonnes (1)</p> <p>final answer 84 (tonnes) with or without working (2)</p> <p>Note : final answer 1.5 scores 2 overall</p>	(3) AO 2 1

Edexcel Chemistry GCSE - Obtaining and using metals

Q14.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation linking the following points</p> <ul style="list-style-type: none"> <li>aluminium is high in reactivity / aluminium oxide is (very) stable (1)</li> <li>aluminium (oxide) cannot be reduced by carbon (1)</li> </ul>	<p>allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone)</p> <p>allow carbon cannot displace aluminium / aluminium <b>oxide</b> does not react with carbon</p> <p>ignore aluminium extracted by electrolysis</p>	<p><b>(2)</b> AO 1 1</p>

Q15.

Question number	Answer	Additional guidance	Mark
	<p>slow process / large area of land required / only extracts metal from the ground surface / metals need further extraction</p>	<p>ignore expensive / cost implications ignore { carbon dioxide / greenhouse gases } evolved ignore references to bioleaching allow {harmful / toxic} gas released on burning plants allow specific environmental effect</p>	<p><b>(1)</b> AO1-1</p>

Edexcel Chemistry GCSE - Obtaining and using metals

Q16.

Question number	Answer	Additional guidance	Mark
(i)	five / 5 (ions)	allow 2 + 3	(1)

Question number	Answer	Mark
(ii)	$2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$	(2)

Q17.

Question number	Answer	Additional guidance	Mark
	Any two from preserves ore reserves / reduces waste / reduces energy needed for metal extraction / preserves {habitats/ landscape / resources}	allow reduces carbon emissions  ignore cheaper	(2)

Q18.

Question number	Answer	Mark
	B gold      The only correct answer is B.  A, C and D are incorrect because calcium, iron and magnesium respectively, are all found chemically combined to other elements in the Earth's crust.	(1)

Q19.

Question number	Answer	Mark
	B gold  A, C, D – these metals too reactive to exist as uncombined elements	(1)

Edexcel Chemistry GCSE - Obtaining and using metals

Q20.

Question Number	Answer	Additional guidance	Mark
(i)	C B D A (2) any two in the correct order and adjacent to each other max (1)	CB / BD / DA next to each other in this order in any position (1) allow lower case for letters c b d a	(2)
(ii)	Any two from the following <ul style="list-style-type: none"> <li>conserves {natural reserves of raw materials/ ore / aluminium (ore)} (1)</li> <li>less damage to {landscape / habitats} / less {noise / dust} (pollution) (1)</li> <li>less {energy / electricity} required (to process aluminium waste compared to extracting aluminium from its ore) (1)</li> <li>less waste metal goes into landfill (1)</li> </ul>	{pollution / environment / resources} needs to be qualified  less waste needs to be qualified  ignore 'less mining (of ore)' which is in stem  ignore references to cost / time / fuel	(2)

Q21.

Question Number	Answer	Mark
	electrolysis	(1) AO 3 2a

Q22.

Question number	Answer	Mark
(i)	magnesium iron silver	(1) AO3

Question number	Answer	Mark
(ii)	C put a lighted splint at the open end of the test tube is the only correct answer  A, B and D are incorrect because they would not work	(1) AO2

## Edexcel Chemistry GCSE - Obtaining and using metals

Question number	Answer	Additional guidance	Mark
(iii)	(squeaky) pop / flame	ignore references to ignites reject references to relights	(1) AO1

Q23.

Question Number	Answer	Additional guidance	Mark
	<p>A description to include</p> <ul style="list-style-type: none"> <li>plants absorb {copper/metal} (ions) from the {soil/ores} / plants concentrate copper ions (1)</li> <li>plants (harvested and) burned (to leave copper/metal compound) (1)</li> </ul>	<p>ignore plants absorb copper from solid metal ignore copper {atoms/metal/compounds}</p> <p>ignore plants heated mark independently</p>	(2) AO 1 1

Q24.

Question Number	Answer	Additional guidance	Mark
(i)	P R Q S (2)	two in correct order (1)	(2) AO 3 2a AO 3 2b

Question Number	Answer	Additional guidance	Mark
(ii)	<p>A workable diagram showing a method to measure the volume of the gas</p> <ul style="list-style-type: none"> <li>delivery tube between test-tube and (1)</li> <li>gas syringe / (graduated tube / inverted burette / measuring cylinder) over water bath (1)</li> </ul>	<p>if diagram is not workable (eg no bung at top of test tube), max 1 mark</p> <p>allow connection shown as </p> <p>if collection vessel not labelled, graduations must be shown for the second mark</p>	(2) AO 3 3a AO 3 3b

Q25.

Question number	Answer	Additional guidance	Mark
(i)	both form a <b>hydroxide</b>	allow formulae  ignore observations	(1)

Question number	Answer	Additional guidance	Mark
(ii)	potassium {forms cations / loses (outer) electron} more easily ORA	ignore speed of electron loss / sizes of atoms / number of shells / distance of electrons from nucleus / number of electrons in outer shell	(1)

Q26.

Question number	Answer	Mark
(i)	iron is less reactive (than carbon) ORA	(1) AO2

Question number	Answer	Mark
(ii)	electrolysis is expensive/ more expensive method than heating with carbon/ heating with carbon is cheaper/ electrolysis needs a large amount of electricity	(1) AO2

## Edexcel Chemistry GCSE - Obtaining and using metals

Q27.

Question number	Answer	Additional guidance	Mark
(i)	$2\text{NiS} + 3\text{O}_2 \rightarrow 2\text{NiO} + 2\text{SO}_2$ (2) all four formulae (1) balancing correct formulae only (1)	allow = for $\rightarrow$ allow multiples if wrong subscript or misuse of capital/small letter e.g. O2, O <sup>2</sup> , niO, NIS, allow MP1 but cannot score MP2 if more than 4 formulae, can score MP1 but not MP2 ignore state symbols	(2)

Question number	Answer	Mark
(ii)	<b>B</b> the metal produced by electrolysis is very pure is the only correct answer <b>A</b> is incorrect because this is a disadvantage <b>C</b> is incorrect because electrolysis is expensive <b>D</b> is incorrect because heating with carbon can be used	(1)

Q28.

Question number	Answer	Additional guidance	Mark
(i)	zinc oxide + carbon $\rightarrow$ zinc + carbon dioxide zinc oxide + carbon $\rightarrow$ (1) $\rightarrow$ zinc + carbon dioxide (1)	allow reactants on LHS or products on RHS in either order allow $2\text{ZnO} + \text{C} \rightarrow 2\text{Zn} + \text{CO}_2$ (2) unbalanced equation (1) ignore state symbols allow = for $\rightarrow$	(2)
(ii)	reduction	allow phonetic spellings	(1)