

GCSE Chemistry (9 – 1)

Alternative methods of metal extraction

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/4
2	/6
3	/11
4	/9
Total	/30
%	
Grade	

Information

- The maximum mark for this paper is 30 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. As the Earth's supply of high-grade copper ores begins to run out, scientists and miners are using new methods to extract metals from low-grade ores and waste rock.

Circle the letter of the correct answer for each of the following questions.

- a) Aluminium is extracted from bauxite by electrolysis.

Which statement is correct?

- A** Aluminium ions are oxidised to form aluminium.
- B** The cathode has to be replaced regularly because it reacts with the oxygen which is formed.
- C** Carbon dioxide is produced at the anode
- D** Cryolite is added to remove impurities.

(1 mark)

- b) Which row correctly describes the process of phytomining?

	Organism used	How the metal is recovered from the organism
A	Bacteria	By collecting the liquid leachate.
B	Plants	By harvesting and burning the plants to produce ash.
C	Plants	By crushing the roots to squeeze out the metal.
D	Bacteria	By burning the bacteria to produce ash.

(1 mark)

- c) In bioleaching, bacteria feed on low-grade metal ores.

What is the name of the acidic solution produced by this process?

- | | | | |
|----------|-------------|----------|------------|
| A | B | C | D |
| Leachate | Precipitate | Filtrate | Distillate |

(1 mark)

- d) Why are methods such as phytomining and bioleaching becoming more important?

- A** They are much faster than traditional mining methods.
- B** They produce much larger quantities of metal than traditional mining.
- C** High-grade ores are becoming scarce, so we need to extract from low-grade ores.
- D** They do not require any energy to work.

(1 mark)

(Total for Question 1 is 4 marks)

2. Copper is a valuable metal. Traditionally, it is extracted from high-grade ores by mining and smelting. However, scientists are now using phytomining to extract copper from low-grade ores. The figure below shows a crop of wheat being used in phytomining.



- a) Describe the **process** of phytomining.

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(4 marks)

The process in part (a) produces a solution of copper sulfate.

- b) Scrap iron is often added to this solution to extract the pure copper.

- i. Explain why iron is used for this process.

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(1 mark)

- ii. Write a word equation for the reaction between scrap iron and copper sulfate.

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(1 mark)

(Total for Question 2 is 6 marks)

3. Copper is traditionally extracted from high-grade ores by mining and smelting. However, as high-grade ores are running out, bioleaching is increasingly used to extract copper from low-grade ores.

a) Explain how bacteria are used in the bioleaching process to extract copper.

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(3 marks)

To obtain pure copper metal from the solution produced in part (a), scrap iron is added.

b) Write a balanced symbol equation for the reaction between iron and copper(II) sulfate.
Include state symbols in your answer.

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(3 marks)

c) Calculate the percentage atom economy for producing copper in this reaction.
Give your answer to 2 significant figures.

Relative atomic masses (Ar: O = 16, S = 32, Fe = 56, Cu = 63.5)

Atom economy = ... %

(3 marks)

d) In industrial chemistry, it is desirable to have a high atom economy.
Give **two** reasons why.

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(2 marks)

(Total for Question 3 is 11 marks)

- b) A mining company uses phytomining to extract copper from a large area of waste land.
Based on the amount of copper compounds in the soil, the company calculates that the theoretical yield of copper should be 500 kg.

After burning the plants and processing the ash using electrolysis, the actual mass of copper obtained was 385 kg.

Calculate the percentage yield of copper for this process.

Percentage Yield = ... %

(2 marks)

- c) Suggest **one** reason why the percentage yield in part (b) was less than 100%

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(1 mark)

(Total for Question 4 is 9 marks)