 Extracting copper from malachite

Specification reference

* C10.1.4 Alternative methods of extracting metals 

Aims

In this activity students will find out how to extract copper from a sample of copper ore.

Learning outcomes

After completing this activity, students should be able to:

* describe the processes of phytomining and bioleaching
* write balanced symbol equations to explain metal extraction techniques
* explain the need for new ways of extracting metals (in particular copper)
* explain in detail how phytomining and bioleaching extract metals
* write word, symbol and ionic equations to explain metal extraction techniques and identify the species being oxidised or reduced
* realise low quality ores can be extracted economically by certain methods.

Teacher notes

Students weak at practical work should use Method 2.

It is safer to convert malachite (copper carbonate) into copper sulfate solution by adding sulfuric acid. If the thermal decomposition method is used, gas tends to become trapped and blows copper carbonate powder out of the mouth of the test tube. There are lots of safety hazards! Adding a plug of mineral wool will help stop this and reduce the fumes.

Answers

1 a copper carbonate → copper oxide  carbon dioxide (*2 marks*)

 b CuCO3(s) → CuO(s)  CO2(g) (*2 marks*)

2 a copper sulfate  iron → iron sulfate  copper (*2 marks*)

 b CuSO4(aq)  Fe(s) → FeSO4(aq)  Cu(s) (*2 marks*)

 c Cu2+(aq)  Fe(s) → Fe2+(aq)  Cu(s) (*2 marks*)

3 a copper carbonate  sulfuric acid → copper sulfate  carbon dioxide  water (*3 marks*)

 b CuCO3(s)  H2SO4(aq) → CuSO4(aq)  CO2(g)  H2O(l) (*3 marks*)

4 Cu2+(aq)  2e– → Cu(s) (*2 marks*)

Student follow-up answers

1 In **phytomining** plants are used to absorb copper **ions** from soil containing low-grade copper ore. The plants are then **burnt** and the copper is extracted from the copper compounds in the **ash**. In **bioleaching** bacteria feed on low-grade copper ores. By various processes, a solution of **copper** ions, called the leachate is formed, which then undergoes **electrolysis** to obtain the copper. (*6 marks*)

2 malachite is copper carbonate (CuCO3) (1)

 relative formula mass of CuCO3  63.5  12  (3 × 16)  123.5 (1)

 24.70 g of malachite is   0.2 moles (1)

 0.2 moles of copper carbonate (CuCO3) if pure should contain 0.2 moles of copper (1)

 0.2 moles of copper is 63.5 × 0.2  12.70 g of copper (1)

 the student obtained 7.62 g of copper

 percentage of copper in the ore    60% (1) (*5 marks*)

Safety

* Students must NOT LOOK into the test tube when heating.
* Copper oxide, copper carbonate, and copper sulfate solution are harmful and corrosive chemicals (CLEAPSS Hazcards 26/27C).
* Sulfuric acid is a corrosive chemical (CLEAPSS Hazcard 98A).
* Chemical splash proof eye protection should be worn throughout.
* Wash hands after completing the practical.
* CLEAPSS Student Safety Sheet 22 for ‘sulfuric (VI) acid’ and ‘heating solids in test tubes’.

Equipment

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| --- | --- |
| * Bunsen burner
* flameproof mat
* spatula
* dropping pipette
* boiling tube
* boiling tube holder
* boiling tube rack
* filter funnel
* filter paper
* 100 cm3 conical flask
* mineral wool
 | * 100 cm3 beaker
* three wires
* two crocodile clips
* low voltage power supply
* two carbon electrodes
* copper carbonate powder
* 2 mol/dm3 (dilute) sulfuric acid
* iron nail
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