

Introduction

We outline here a practical activity that uses simple colorimetric analysis [1], to determine the percentage of copper in a simulated mineral-rich ore. This activity considers how market demands determine the economic viability of extracting the copper and how by simple electrolysis [2] the copper is refined in order for it to be used in everyday products.

These practical activities can be linked to the following science experiences and outcomes from the CfE – The Sciences:

SCN 3-17b - I can participate in practical activities to extract useful substances from natural resources.

SCN 3-19a - Through experimentation, I can identify indicators of chemical reactions having occurred. I can describe ways of controlling the rate of reaction and can relate my findings to the world around me.

SCN 3-19b - I have helped to design and carry out practical activities to develop my understanding of chemical reactions involving the Earth's materials. I can explain how we apply knowledge of these reactions in practical ways.

Preparation of ores

For the simulated ore samples **A**, **B** and **C**, weigh out the following for each, mix in a mortar and pestle (Figure 1) and place in an appropriately labelled jar marked **Ore A**, **B** and **C**:



Figure 1 - Prepared ore containing activated charcoal and copper carbonate.

Ore A - 1 g of copper carbonate (Harmful) and 9 g of activated charcoal (Highly Flammable).

Ore B - 3 g of copper carbonate and 7 g of activated charcoal

Ore C - 9 g of copper carbonate and 1 g of activated charcoal.

Solvent Extraction (SX)

This is divided into two practical activities. The first activity prepares the standardised copper sulphate solutions for the colorimetry and the second extracts the mineral from the ore producing a solution to be compared against the standardised solutions.

Standardised solutions

Place 30 cm³ of 1M copper sulphate solution (Harmful and Dangerous to the Environment) into a 100 cm³ beaker and 40 cm³ of distilled water into another 100 cm³ beaker. Use a 10 cm³ syringe to add 2 cm³ of copper sulphate solution and 8 cm³ of distilled water to a test tube and place in a test-tube rack. Now make

up the rest of the comparison solutions given in Table 1. Arrange the test tubes in the rack in the same order. This can be seen in Figure 2.

Extracting the mineral from the ore

Place all of ore A (copper carbonate is Harmful and powdered activated charcoal is Highly Flammable) into a 250 cm³ glass beaker. Pour approximately 100 cm³ of 1M sulphuric acid (Irritant) into another 250 cm³ beaker. Add 80 cm³ of acid to the ore, 10 cm³ at a time, using a 10 cm³ syringe. Carefully stir the mixture each time until there are no more bubbles being formed. Use a filter funnel and paper to filter off any excess solid into a 100 cm³ conical flask and make up to 100 cm³ with distilled water. This can be seen in Figure 3. This must be kept if the electro-winning is to be done at a later stage.

Finding the percentage of copper in the ore

Use a 10 cm³ syringe, place 10 cm³ of the filtered solution into a test tube. Now

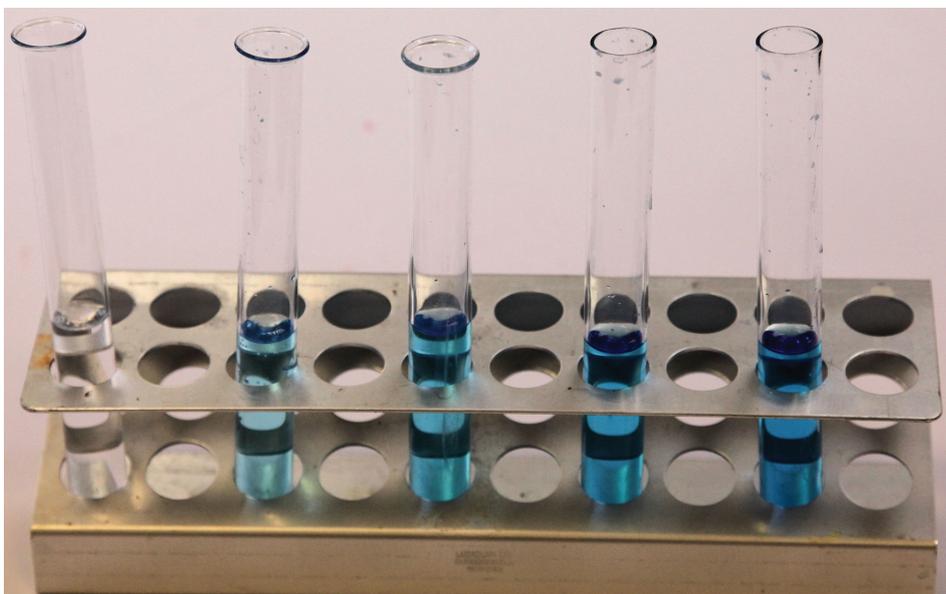


Figure 2 - Standardised solutions of copper sulphate solution.

Test Tube	1	2	3	4	5
Volume of Solution 1 (cm ³)	0	2	4	6	8
Volume of Water (cm ³)	10	8	6	4	2

Table 1 - Volume of copper sulphate solution to water for standardised solutions.

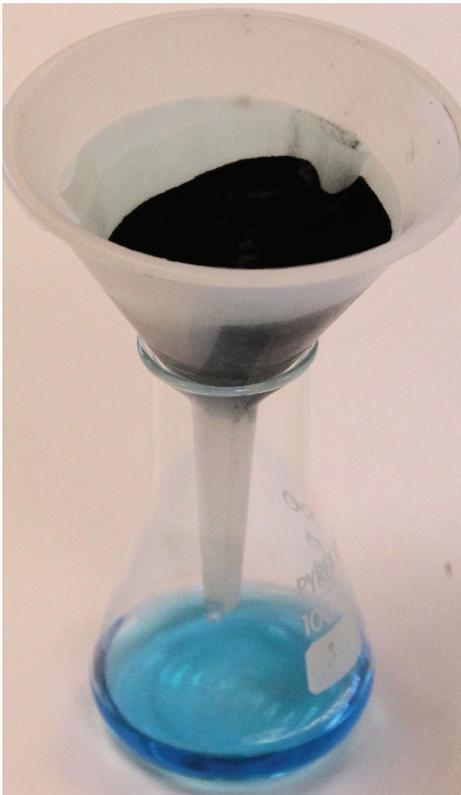


Figure 3 - Filtering and made up to 100cm³ in conical flask.

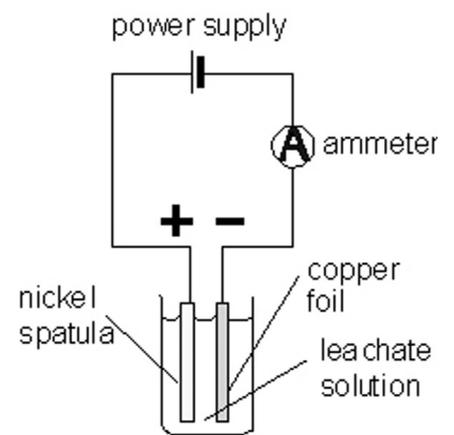
match the intensity or depth of colour of filtered solution against one of the standardised solutions. This is best done by looking through the test tube against a white background which is illustrated in Figure 4.

Note that the numeric values of copper in the ore have been given on a sliding scale to reflect that copper can be economically extracted from ores which contain 0.1 to 0.4% copper.

The instructions for the mineral extraction and determination of percentage of copper in the ore can be repeated for the other ore samples B and C.

Electro-Winning (EW) Extracting the copper from the leachate

Set up a circuit containing a power pack, a nickel spatula (electrode), a glass beaker and an ammeter as shown in Figures 5a & b. Use a piece of emery paper clean both sides of the copper strip and weigh it on a top pan balance.



Figures 5a & 5b - Electro-winning circuit.

This needs to be accurate to two decimal places. Now place the copper strip into the 100 cm³ beaker and make sure it is connected to the negative terminal (black connector). This can be seen in Figure 6.

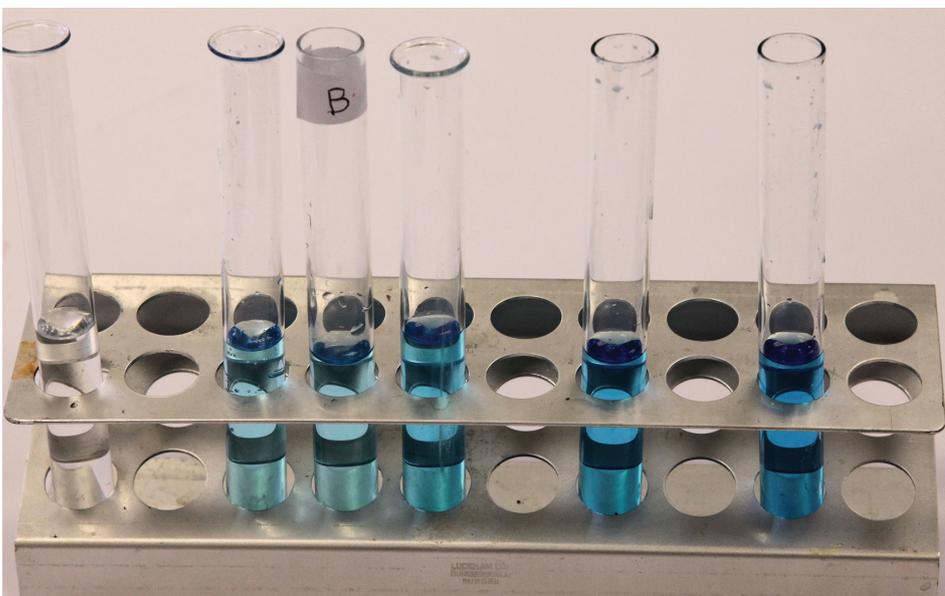


Figure 4 - Eye colorimetry.

Test Tube	1	2	3	4	5
Percentage of metal in ore (%)	0	0.13	0.26	0.39	0.51

Table 2 - The relationship between the standardised solutions and the percentage of copper present in the ore.

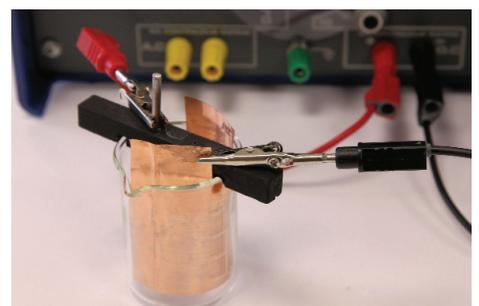


Figure 6 - Copper strip connect to black connector on power supply..



Figure 7 - Tongs and hairdryer.

Carefully pour the leachate (Harmful and Dangerous for the Environment) with the highest percentage of copper into the beaker. You can also add 5 cm³ of 1M sulphuric acid (Irritant) as this will help to reduce the evolution of oxygen bubbles. Turn on the power supply (use only a low tension (LT) supply and not to exceed 16 volts d.c.), start the timer and adjust the output

voltage until the ammeter reads 1 Amp. Note you need to keep checking the ammeter and adjusting the output voltage to keep the current at 1 Amp. After 10 minutes, turn off the power supply. Hold the copper strip with a pair of tongs and using a hair dryer, carefully dry it. This can be seen in Figure 7. Once all the liquid has evaporated weigh the strip on the top pan balance.

References

- [1] www.practicalchemistry.org/experiments/colorimetric-determination-of-a-copper-ore,302,EX.html
 [2] www.practicalphysics.org/go/Experiment_676.html

Antioxidants: Recipe Remedies

Introduction

Since the article in Bulletin 232 [1], there has been an increase in the number of enquires for Advanced Higher projects concerning antioxidants. Here are some possible solutions to some common problems.

Recipes

It is good practice for a competent member of staff to prepare these solutions (wearing appropriate protective equipment) and carry out the risk assessment. The recipes for solutions A, B and C are as follows:

Solution A (potassium iodate and sulphuric acid)

Dissolve 10.75 g of potassium iodate (Oxidizing and Harmful) into a beaker containing 100 cm³ of distilled water. Place on a magnetic stirrer/hotplate. Slowly add 1.08 cm³ concentrated sulphuric acid (Corrosive) whilst stirring. Warm if necessary to dissolve the potassium iodate (KIO₃, not the periodate, KIO₄). Transfer solution to 250 cm³ measuring cylinder. Rinse beaker and add rinses to measuring cylinder. Make up to 250 cm³ with distilled water.

Reference

- [1] SSERC Bulletin 232, *Antioxidants: Tastes good, good for you?*, Summer 2010, p4
<http://www.science3-18.org/sserc/images/Bulletins/232/Antioxidants.pdf>

1.08 cm³ of sulphuric acid is a very precise amount but using a 1 cm³ syringe will enable you to get close enough. Alternatively, you can measure it out by mass – 1.08 cm³ = 1.99 g of concentrated sulphuric acid.

As the solubility of the iodate is approximately 12 g in 250 cm³ at 0°C if the solution is stored at low temperatures it can start to crystallise out. Simply apply gentle heat and stir until fully dissolved.

Solution B (malonic acid and manganese sulphate)

Add 0.08 g of starch to a small quantity of the distilled water to make a slurry. Boil approximately 75 cm³ distilled water and add the starch slurry, stirring until completely dissolved. Measure out 4.0 g of malonic acid (Harmful) and 0.85 g of manganese sulphate (Harmful). Add the solids to 100 cm³ of distilled water, stirring until dissolved. Add the starch solution. Transfer the solution to 250 cm³ measuring cylinder. Rinse the beaker and add rinses to measuring cylinder. Make up to 250 cm³ with distilled water.

Solution C (hydrogen peroxide)

Measure out approximately 100 cm³ distilled water into 400 cm³ beaker. Measure 75 cm³ of 100 vol hydrogen peroxide (Corrosive & powerful Oxidizing agent) into a 100 cm³ measuring cylinder.

Stirring continuously, add the hydrogen peroxide to the beaker. Rinse measuring cylinder and add rinses to the beaker containing the hydrogen peroxide. Transfer to a 250 cm³ measuring cylinder. Rinse the beaker and add rinses to measuring cylinder. Make up to 250 cm³ with distilled water.

Reference sample timings

What is of importance is the timing for the completion of the colour cycle. In further tests in the lab these have been on average as low 10 seconds.

Delay in colour cycle

As some foods contain relatively higher concentrations of antioxidants it can appear, after the addition of the sample, that the colour cycle has stopped. This may not be the case. Increasing the dilution factor for the sample may allow the completion of the colour cycle.