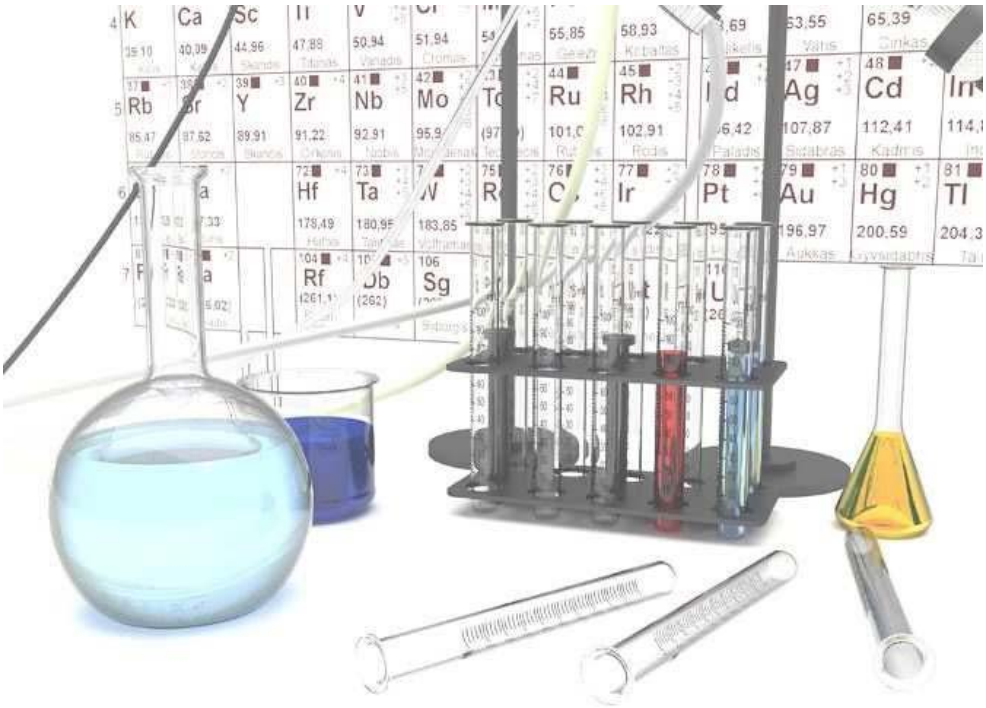
MAROOCHYDORE

STATE HIGH SCHOOL



Extracting Copper metal from rock

Experiment 3.1 - Leaching the copper ore

Experiment 3.2 - Visible light spectroscopy

Experiment 3.3 – Copper Electrowinning

Student booklet

NAME: _____

EXPERIMENT 3.1

LEACHING THE COPPER ORE

AIM:

To separate the copper from the rock by crushing the rock into smaller pieces and dissolving the copper in sulphuric acid (very dilute and safe) to make a copper sulphate solution.

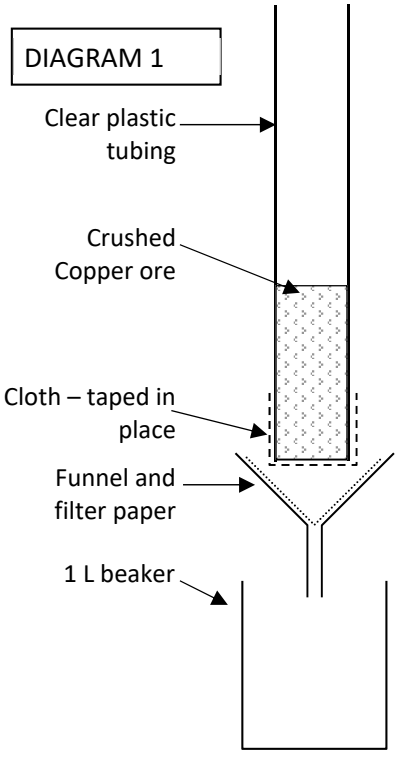
MATERIALS:

- Rocks of Copper ore
- 1 metre clear plastic 35mm tubing
- Mortar and Pestle
- 1 L and 500 mL beakers
- Filter paper and funnel
- Electronic balance (up to 200 gm)
- 3 small (~ 20 mL) sample bottles
- 12 cm piece of cloth (dishwashing cloth is ideal)
- Strong adhesive tape
- 500 mL measuring cylinder
- Labels

METHOD:

1. Weigh your rock. Mass of rock = _____ grams
2. Crush your rock with the mortar and pestle. You will probably need to do this in 3 parts due to the size of the mortar and pestle. A refinery would have a ball mill grinding the ore to a small granular size.
3. Arrange the tubing, 1 litre beaker, cotton wool, plastic webbing, filter paper and funnel, 1 litre beaker, and crushed ore as shown in diagram 1.
4. Slowly pour 500 mL of 0.01 M sulphuric acid into the top of the tubing. Observe the dilute acid moving through the ore, leaching the copper from the ore as soluble copper sulphate. The entire leaching process will take 10 minutes before your first leach solution has collected in the beaker below the ore.
5. Pour a few mls of this leach solution into one of your sample bottles. Label this sample as Leach 1.

DIAGRAM 1



6. Pour the leach solution back into the top of the tubing and repeat the process. Again after several hours or overnight, collect a sample of your second leach solution. Again pour a few mls of this solution into a sample bottle and label as Leach 2.
7. Repeat step 6 one more time – obtaining your third and final "leach solution". Pour off a third sample (labelled Leach 3), and pour the rest into a bottle labelled with your group name and "Leach 3 solution".
8. Take you apparatus apart, retaining the used ore in a sealed plastic bag clearly labelled with your groups name

EXPERIMENT 3.2

VISIBLE LIGHT SPECTROSCOPY - COLOURIMETRY

AIM:

To measure how much copper is in the leach solution (copper sulphate solution)

INTRODUCTION:

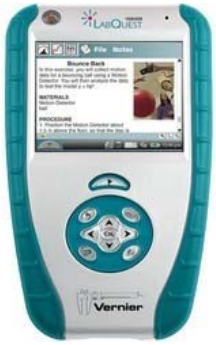
Spectroscopy is a means of finding unknown concentrations of chemicals in aqueous solution. Visible light spectrophotometers are often referred to as colourimeters as they use "normal" coloured light to measure concentration.

Any solution which is coloured will absorb one of the wavelengths of visible light but reflect the others – thus giving it a colour. For example, copper sulphate which is a blue solution actually absorbs light in the red to orange range (~ 700 nm). Because the red colours are absorbed, and only the other colours reflected, the copper sulphate solution looks blue.

The spectrophotometer/colourimeter simply shines a red light through the copper sulphate solution and measures how much is received the other side of the sample. The missing light is said to be absorbed by the solution, and is called the "absorbance". The more concentrated the solution the greater amount of light is absorbed (this is known as Beer's Law).

The absorbance can range between zero (the solution does not absorb any light – eg water) and one (the solution absorbs all the light). Using a colourimeter allows you to measure the absorbance of an unknown sample. By comparing the absorbance of an unknown sample to absorbances of known concentration (called standards), the concentration of the unknown solution can be worked out.

Using accurate standards (solutions of known concentrations) is an important part of colourimetry. Plotting a graph of absorbance versus concentration for the standards results in a straight line on a graph. You can use this relationship to interpolate any absorbance value within the range of your standards. Extrapolation is not consider accurate methodology with colourimetric data. If your unknown has an absorbance above the range of your standards then accurately dilute the unknown to provide a lower absorbance value that is within the range of your standards -your teacher will show you how to do this.



Metal Extraction Chemistry

MATERIALS:

For colourimetry:

- 3 sample bottles of leach solution
- Dataquest and colourimeter
- Cuvette and tissue
- Plastic pipette x 8
- Distilled water

Standards:

- 3.0 g per litre Copper
- 6.0 g per litre Copper
- 9.0 g per litre Copper
- 12.0 g per litre Copper
- 15.0 g per litre Copper

METHOD:

Using Colourimeter:

1. Turn on the Dataquest and plug the colourimeter into channel one (at the top). The Dataquest will automatically recognise the sensors as a colourimeter. The absorbance reading will appear in an band (orange) on the main screen of the Dataquest.
2. Use a permanent marker to place a dot on the top of one of the cuvette (not the cuvette lid, the actual cuvette) supplied with the colourimeter. Fill this cuvette about ¾ full with distilled water and wipe the clear plastic sides with a dry tissue so they are as clean as possible.
3. Place this cuvette in the colourimeter so that the clear plastic sides are facing to the front and the rear of the colourimeter. Remember the direct the dot is facing – the cuvette must always be placed in the machine in this way! Close the lid on the colourimeter.
4. The distilled water has a copper concentration of zero, so we will use it to "zero" (means calibrate) the colourimeter. Press the zero button on the colourimeter.
5. Record the concentration of the solution (it is distilled water so it is 0.0 g per litre of Copper), and the absorbance reading (on the Dataquest) in your results table on the following page, even if the absorbance is zero.
6. Take out the cuvette. Pour the contents into the sink. Using the plastic pipette, fill the cuvette to approximately ¾ full with some of the 3.2 g/L copper standard solution. Pour this out into the sink (it is a rinse solution). Again fill the cuvette to ¾ full with some of the 3.2 g/L copper standard. Wipe the sides clean and dry with a tissue, pace back in the cuvette and close the lid.
7. Again record the concentration of the solution (3.2), and the absorbance reading (on the Dataquest) in your results table.
8. Repeat steps 6 to 7 until you have recorded the absorbance of all the standards.

Table 1

Concentration of copper (g per litre)	Absorbance
3.0	
6.0	
9.0	
12.0	
15.0	

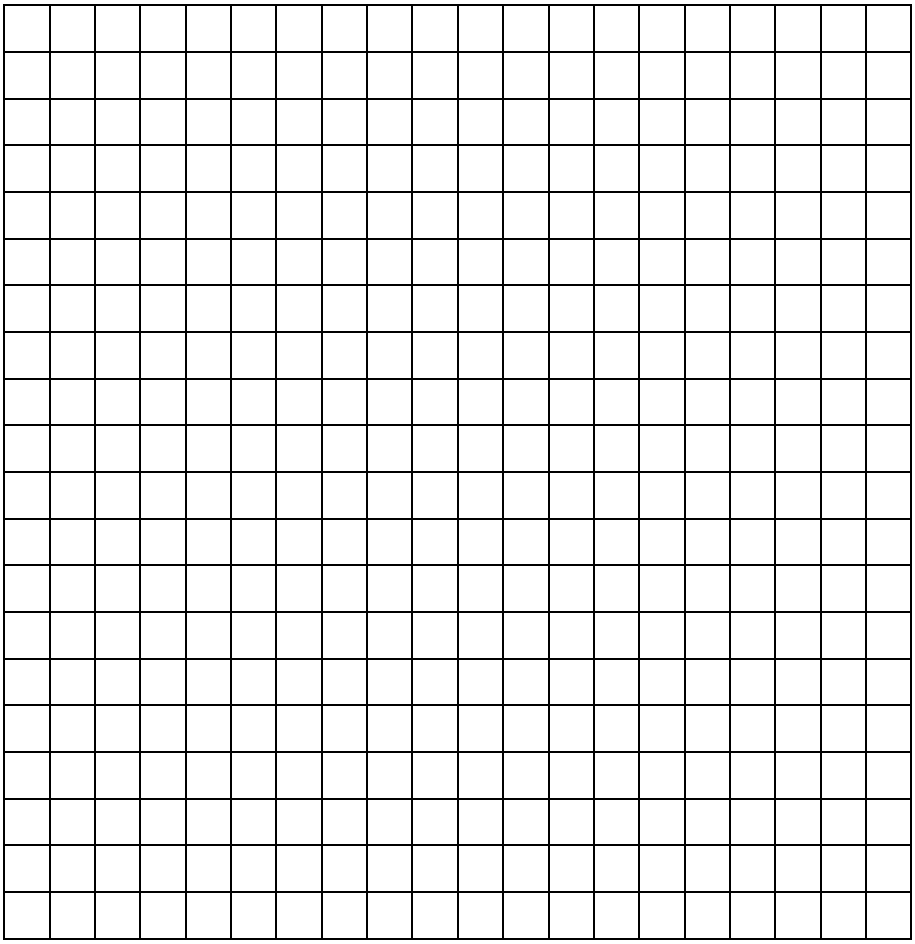
Table 2

Leach sample	Absorbance	Concentration of copper (g per litre)
1		
2		
3		

Table 3

Volume of final leach sample	=	mL

9. Your teacher will show you how to graph your results as a scatterplot in excel. This type of graph is used all the time by scientists. As well, graph your results on the graph paper below. Mark each absorbance and concentration value with a cross on the graph and draw a straight line of best fit. Your teacher will show you how to do this. The line shows the relationship between concentration of copper in the solution and the absorbance



10. Use the graph to interpolate (fancy word for reading between the lines) the concentration of each of your leach solutions. You teacher will explain this technique. Record the concentration of copper of each leach solution in table two on the previous page.

QUESTIONS and ANALYSIS

1. Which leach solution (1, 2, 3?) had the highest concentration of copper in it. _____

2. (a) Describe the pattern you can see in the copper concentration of the three leach samples?

_____

_____

_____

(b) Is this pattern what you would have expected? Explain why or why not?

_____

_____

_____

_____

_____

3. You now know the concentration of leach sample three. In table three you recorded the volume of leach solution three. Use this data to calculate the total amount of copper metal that should be in Leach solution 3.

_____

_____

_____

_____

_____

EXPERIMENT 3.3

COPPER ELECTROWINNING

AIM:
To separate the copper metal from the leach (copper sulphate solution) by using electroplating.

MATERIALS:

- Graphite Anode
- Stainless steel cathode
- 250 ml beaker
- Variable DC power source (power pack)
- Voltmeter
- Variable resistor
- Copper leach solution
- Measuring cylinder
- Safety glasses
- 2 x 20 ml sample bottles
- Electronic balance
- 6 electrical leads

Circuit diagram to go here

PROCEDURE:

1. Place leach solution into beaker.
2. Weigh the stainless steel cathode. Record the weight in the table below.
3. Place the stainless steel cathode and the graphite anode in the beaker and ensurethat they are NOT touching.
4. Connect the DC power source to the variable resistor and connect your anode and cathode to the variable resistor (your teacher will show you the connections to use) and turn the DC power source to approximately 2volts. Adjust the variable resistor so that the measured voltage is 1.0 volts.
5. Leave running for 2 – 4 hours.
6. Turn off power source. Remove a sample of solution for later analysis.
7. Remove stainless steel cathode and examine it carefully – it should have solid copper metal coated to it. Wash with water and allow to dry.
8. Weigh the stainless steel cathode. Record the result.
9. Strip the copper metal from the stainless steel cathode if you can.It should peel off in one piece (depending).

Mass of Stainless steel cathode at start (g)	Mass of Stainless steel cathode after electrowinning (g)	Mass of Copper plated on the cathode (g)

Metal Extraction Chemistry