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School of Maths & Science
Science Practical

Colorimetric Determination of Copper Ore

◆ Aim

To practice using a colorimeter and preparing a calibration curve in order to plot samples of unknown concentration.

◆ Introduction

Forensic geology can examine and compare rock types and samples and help geologists to decide whether an area is worth mining or not. To determine this, it is necessary to find out how much of the useful mineral it contains, and how much is waste. This experiment illustrates how this might be done.
A colorimeter is an instrument that measures the amount of light which either passes through, or is absorbed by a coloured solution. (For further details see coursework booklet).
Determination of the concentration of a substance requires the use of a calibration curve. This is prepared by plotting a graph of the absorbance of a range of standard solutions against their concentrations. The concentration of the test solution is then found by reading a value from the calibration curve. If the absorbance of the test solution is off the scale, or higher than the maximum value on your calibration curve, an appropriate dilution of the test solution must be made.

An example of a calibration curve is shown overleaf.

◆ Safety

Control Measures

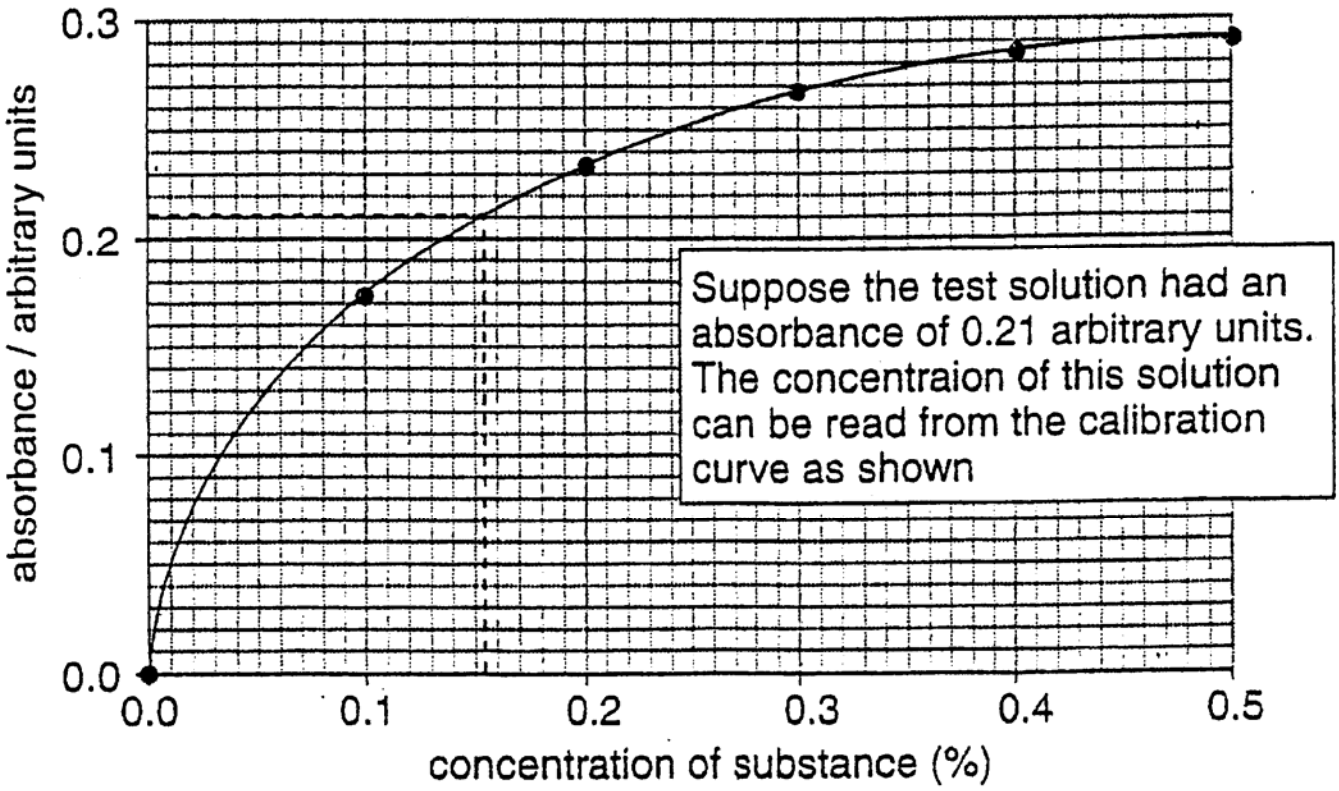
- The wearing of **safety glasses** and a **laboratory coat** at all times will be sufficient to take account of most hazards and significant risks.
- Always use a pipette filler when filling graduated pipettes. **NEVER** suck up liquids by mouth.
- All waste is to be placed in the labelled container immediately after use.

Hazards

Harmful — **Copper Sulfate**, **Copper Sulfate solution**, **Copper Carbonate**

Irritant — **Sulfuric acid**

Figure 1: An example of a calibration curve for a colorimeter



◆ Materials

$CuSO_4 \cdot 5H_2O$ 1 mol dm^{-3} solution
Distilled water
Copper Carbonate solid
Copper Sulfate and sand mixture (50:50 w/w)
Sulfuric Acid 1 mol dm^{-3}

◆ Apparatus

250 cm^3 volumetric flasks
10 cm^3 volumetric flasks
Colorimeter
Tissues
Filter Paper
Conical flasks
Graduated pipettes and pipette filler
Cuvettes
Funnels

◆ Procedure

1) A standard solution of Copper Sulfate of concentration 1 mol dm^{-3} is provided. Calculate how much of this 1M solution must be measured out in order to make up 250 cm^3 of a 0.5 mol dm^{-3} solution?

   Once you have completed your calculation, check the answer before pipetting out the correct volume into a new 250 cm^3 volumetric flask.

2) Using the new solution, makeup a dilution series by using the following table:

$CuSO_4$ (cm^3)	10	8	6	4	2
H_2O (cm^3)	0	2	4	6	8

   Find the concentration of each solution using the equation:
   $\frac{\text{Vol. x conc.}}{\text{Total Vol.}}$

Concentration (mol dm^{-3})					

3) Make up solutions from the two copper ores.

   Weigh 10 g of substance 1 into a beaker and add 30 – 40 cm^3 of deionised water then stir until no further dissolving occurs. Filter the mixture into a small conical flask and label as unknown 1.
   Weigh 1 g of substance 2 into a beaker and add 10 cm^3 of H_2SO_4. Add the acid carefully and do not let the mixture go over the top of the beaker.
   When the reaction finishes, filter the mixture into a small conical flask and label as unknown 2.

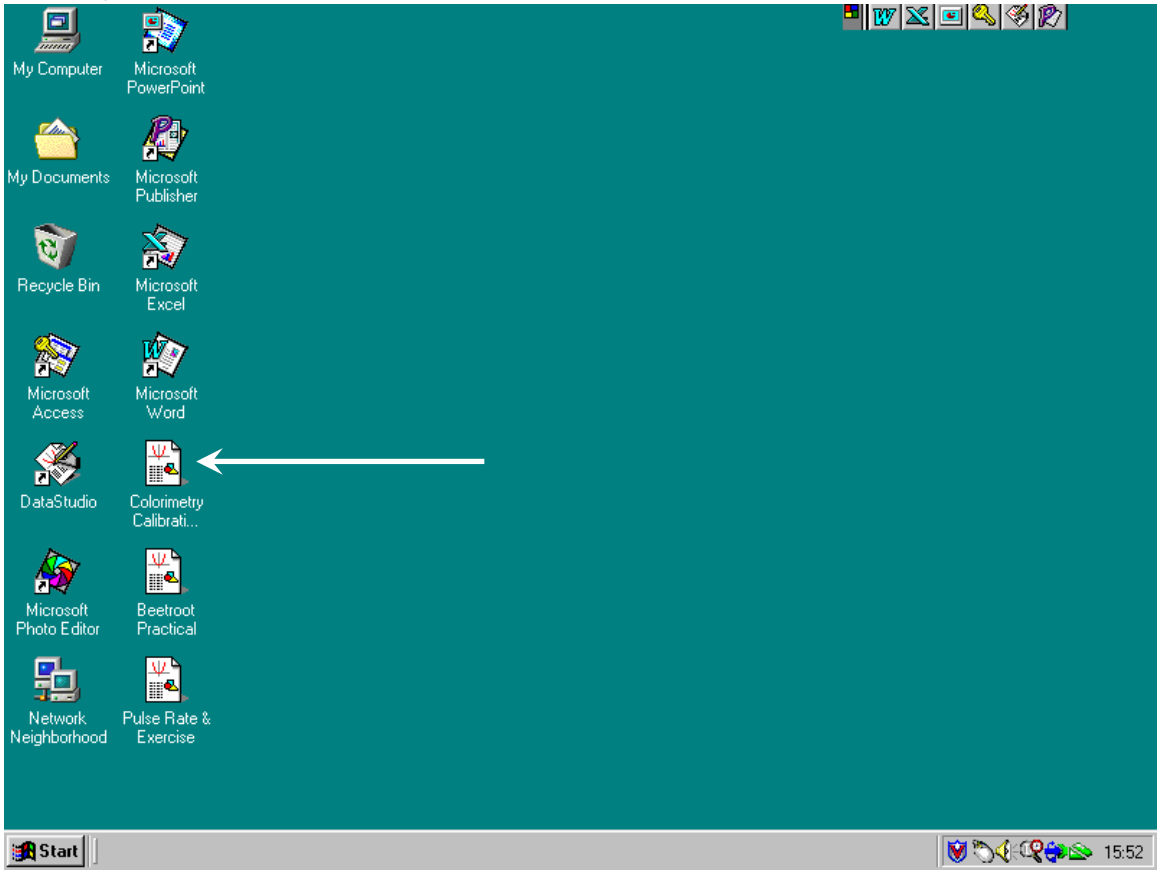
4) Measure the absorbance of each solution using a colorimeter. Draw a graph of absorbance against concentration to give a standard curve.

   Plot the unknown solutions onto the graph by absorbance and find their concentrations.

5) Estimate which of the two unknown substances would provide a better yield by establishing the concentration if 10g of each substance was compared.

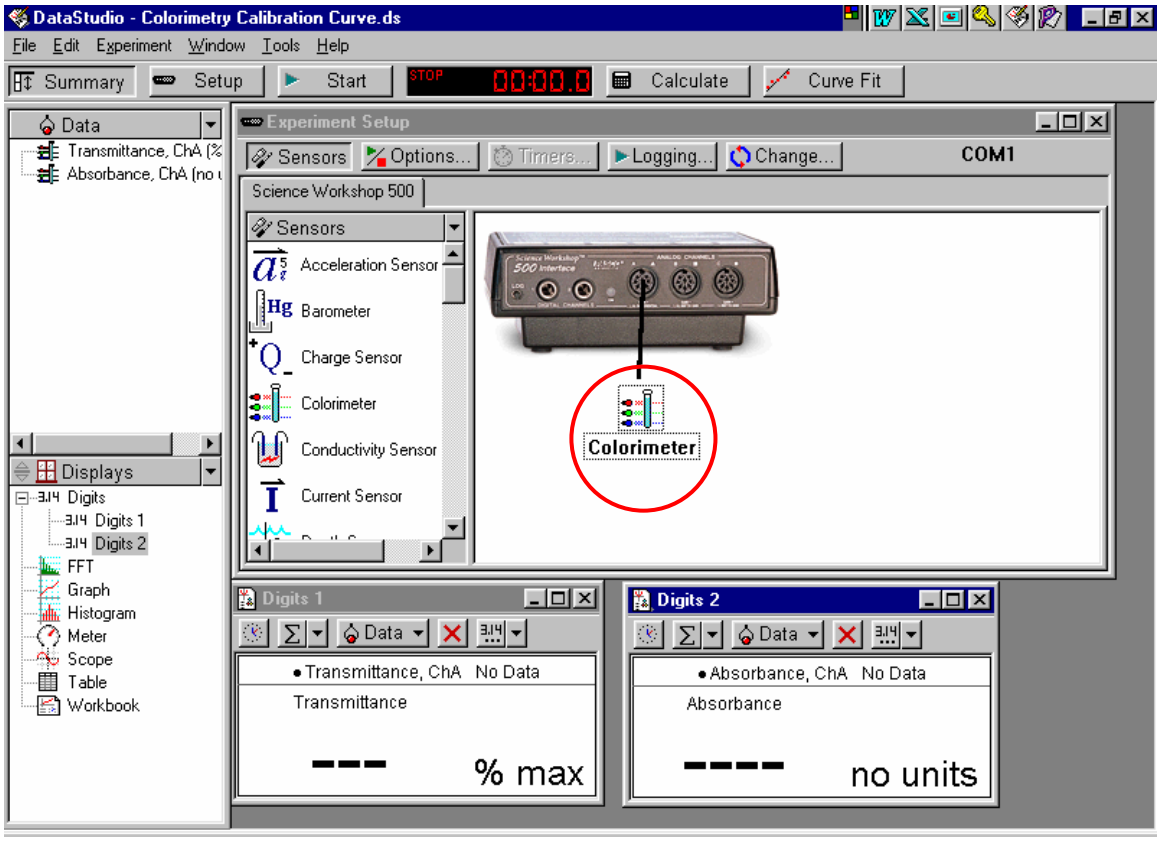
To measure the absorbance of the samples you will use a Data Logging computer package.

When you see the screen



Double click on the ***"Colorimetry Calibration"*** icon.

You will see this screen



Read the following instructions carefully:

◆ Calibrate the colorimeter

1. Fill a clean cuvette with distilled water and cap the cuvette.

   *Ensure that the cuvette is clean and avoid touching the optical surfaces. Use the **same** cuvette for all readings, rinsing between each solution. Wipe the outside of the cuvette with a tissue to make sure it is dry before placing in the colorimeter.*

2. On the **colorimeter** press the **Select** button and the **Start/Stop** button at the **same** time.

3. The colorimeter LCD display will show "**Insert reference then push SELECT**".

4. Place the capped cuvette inside the colorimeter. Make sure that the clear sides of the cuvette (without ridges) are lined up with the light path in the colorimeter. Close the lid on the colorimeter.

5. On the **colorimeter**, press the **Select** button.

6. The colorimeter LCD reads
   "Please wait" then "CAL done, push SELECT or START".

◆ Calibrate the Software

1. Leave the cuvette with distilled water inside the colorimeter.

2. On the **computer screen** in the **Experiment Setup window** double-click the **colorimeter icon** attached to the interface (circled on image on previous page).

3. The **sensor properties window** will open. Click **"calibration" tab**. The **sensor setup window** will open.

4. On the **colorimeter** press the **SELECT** button until **"Orange 630nm"** appears on the LCD.

5. On the **colorimeter** press the **Start/Stop** button. The LCD shows
   "Orange 630nm 100.0% T RUN".

6. On the **computer screen** check the **voltage "Current Reading".** When the voltage stabilises click the **"Take Reading"** button under **"High Point".**

7. On the **colorimeter** press the **Start/Stop** button, the LCD changes from **RUN** to **STOP**.

8. On the **computer screen** click "**OK**" in the **sensor properties window** to return to the **Experiment Setup window**. The software will now be calibrated for the colorimeter.

Recording Absorbance Readings at Varying Concentrations

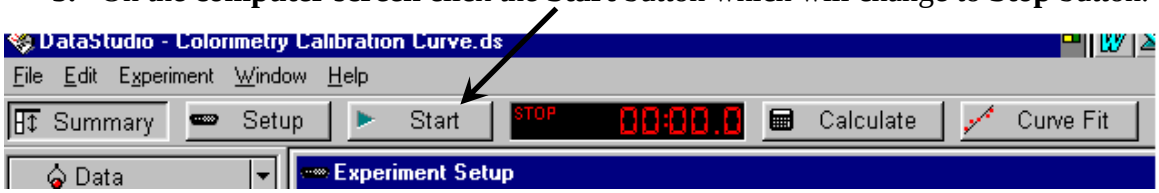
1. You need to construct an appropriate table to record your results

2. Fill cuvette with de-ionised water and cap cuvette.

3. Place cuvette inside **colorimeter** and close lid.

4. Press **Start/Stop** button to start **colorimeter**, the LCD shows **"Orange 630nm % transmittance RUN".**

5. On the **computer screen** click the **Start** button which will change to **Stop** button.



6. Click the **Stop** button to record the **absorbance** value, enter this value in your table.

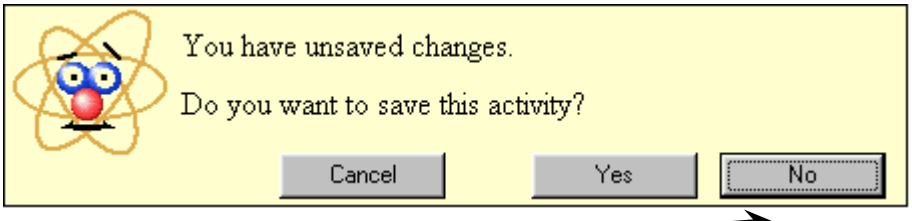
7. Press **Stop** on the **colorimeter** to STOP reading.

8. Remove cuvette from colorimeter and **repeat stages 3 -7** for the various concentrations to be measured.

9. Rinse the cuvette and fill with an **unknown solution**, cap the cuvette. **Repeat stages 3 – 7.**

10. To exit the program, click the **close** button in the far right corner.

11. You will see this window on screen:



12. Click **NO.**

- Plot a calibration curve for your standard solutions, as shown in Figure 1.
- Read off the concentration of the unknown solution from the calibration curve.