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| **Foundation Year** | **The Preparation of Copper(II) Sulfate** | **Semester 1** |

**The Preparation of Copper(II) Sulfate**

**Aim**

To prepare copper(II) sulfate in its crystalline hydrated form and calculate a percentage yield.

**Introduction**

An insoluble metal oxide (a base) reacts with a dilute acid to form a soluble salt with water as another product. Copper(II) oxide, a black solid, and colourless dilute sulfuric acid react to produce copper (II) sulfate, giving a characteristic blue solution. Blue hydrated copper(II) sulfate crystals are obtained from this solution. Hydrated crystals contain a certain proportion of water which is bound in some way to the ions in the salt.

**Skills associated with this practical**

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| **Practical Skills**   * Correct use of a top pan balance * Correct use of a measuring cylinder * Correct use of a Bunsen burner * Folding a fluted filter paper * Carrying out a gravity filtration | **Scientific Skills**   * Writing an experimental method * Calculation of a percentage yield |

**Signposts**

Carry out research into acid-base reactions (particularly metal oxides reacting with acids).

**Understanding Hazard and Minimising Risk**

You must stand up throughout the practical, and safety glasses must be worn at ALL times in the lab. You must wear a labcoat whilst you are carrying out ALL practical work. Long hair must be tied back, and trousers (jeans are OK) must be worn. Open-toed shoes and clothing revealing bare skin are not permitted.

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| Substance | Amount | Hazards | Minimising Hazards | Disposal / Spillage |
| 0.5 M Sulfuric acid, H2SO4(aq) | 40 cm3 | Irritant. | Wear safety glasses. | Wash down sink with water. |
| Copper(II) oxide, CuO(s) | ~2.5 g | Harmful, dangerous to the environment. | Avoid inhalation of dust. | Return unused copper oxide to ‘Unused copper’ beaker. |
| Copper(II) Sulfate (hydrated) | 2-4 g | Harmful if swallowed, irritant to eyes and skin, toxic to aquatic organisms. | Wear gloves (optional), wear safety glasses. | Return waste solutions to ‘Unused copper’ beaker. |

**Procedure**

Apparatus

PER PAIR: 100 cm3 beaker Bunsen burner and gauze

100 cm3 conical flask Tripod and heat mat

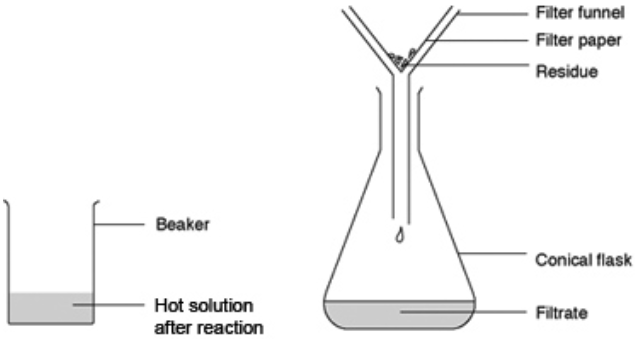
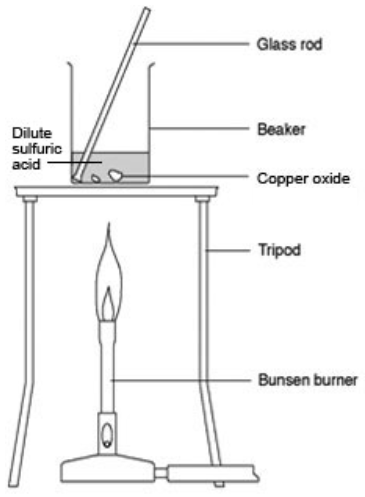
Spatula Glass rod

Funnel and filter paper Evaporating basin

50 cm3 Measuring cylinder Clay-pipe triangle

Sample vial or bottle

Method

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**Fig. 2**

**Fig. 1**

1. Accurately weigh ~2.5 g of copper(II) oxide into a weighing boat, and record the mass. Take a photo to illustrate the correct use of a top pan balance for your *Skills Portfolio*.
2. Measure 40 cm3 of 0.5 M sulfuric acid in a 50 cm3 measuring cylinder. Take a photo to illustrate the correct use of a measuring cylinder for your *Skills Portfolio*.
3. Add the measured sulfuric acid to the 250 cm3 beaker and heat carefully on a tripod with a gentle blue Bunsen flame until nearly boiling (see **Fig. 1**).
4. As an additional safety measure, place a clamp loosely around the beaker once it is on the tripod. The beaker should be resting firmly on the gauze with the clamp providing support to prevent the beaker from being knocked over.
5. Use a spatula to add small portions of copper(II) oxide to the beaker, stirring gently with a glass rod for up to half a minute after each addition. When adding the solid to the beaker, move carefully and slowly to avoid knocking the beaker over. You should not be sitting down. Continue adding the copper(II) oxide with stirring until no more will dissolve.
6. Allow to cool and allow any solids to settle.
7. Weigh the unused copper(II) oxide to work out the mass added to the acid, and then place this in the ‘unused copper(II) oxide’ beaker.
8. Place the filter funnel in the neck of the conical flask.
9. Fold a fluted filter paper to fit the filter funnel. Each student should fold a fluted filter paper, which should be shown to a demonstrator to check that it formed correctly. Take a photo of your fluted filter paper for *Skills Portfolio*. (If you are really keen you might make a video showing how to fold a fluted filter paper).
10. Before proceeding, make sure the beaker is cool enough to hold at the top, but that the contents are still hot. Swirl the flask gently to mix, and carefully pour the contents into the filter paper in the funnel. Allow to filter through to the conical flask (see **Fig. 2**).
11. A clear solution should collect in the flask. If the solution is not clear, and any solid remains in it, you will need to repeat the filtration. Take a photo to illustrate the correct procedure for gravity filtration for your *Skills Portfolio*.
12. Pour the clear solution into an evaporating basin and place on a clay-pipe triangle or gauze on the tripod.
13. Heat the solution gently over a medium Bunsen flame so that the liquid boils steadily.
14. When about half the liquid has boiled away, take a drop of the hot solution on the end of a glass rod and let it cool. If the drop crystallises on cooling the solution is ready for the next stage; if it does not crystallise keep boiling and repeat the testing until the drop does crystallise on cooling. **Do not boil the basin dry.**
15. Set the solution aside to cool in a warm place safe from interference until it has produced a crop of crystals. Ensure that you label the basin with the name of the salt being prepared and the names of the group members.
16. Collect the crystals from the basin by transferring to a filter paper laid out on a paper towel and allow the crystals to air-dry. The process may be repeated with a second fresh filter paper if required.
17. Weigh the dried crystalline product and place it in a sample vial labelled with its identity, its mass and your name.

**Analysis and Questions – to be completed in your lab book**

1. Write a balanced symbol equation for the reaction between copper(II) oxide and sulfuric acid (don’t include water of crystallisation in the formula of copper sulfate).
2. Based on the mass of copper(II) oxide that you added to the acid, work out the theoretical yield of copper(II) sulfate from your reaction. Use this to work out the percentage yield of copper(II) sulfate based on the mass of crystals you obtained.
3. Sulfate salts can be prepared by the reaction of dilute sulfuric acid with the metal itself. Write a balanced symbol equation to show the formation of magnesium sulfate in this way.

**Deadlines, Assessment and Feedback on Performance**

You are required to complete the *Skills Portfolio* document associated with this practical. This should be completed electronically with all photos inserted in the appropriate places and accompanying text typed in. The submission deadline for *Skills Portfolios* will normally be midnight on the Sunday following the practical, although you will be given specific guidance during the practical session. Submission is via the e-submission system Turnitin which you will be able to access in the appropriate folder in the Laboratories and Coursework Blackboard course.