# Preparing a soluble salt: supporting resources

## This resource supports the practical video Preparing a soluble salt, available here: <rsc.li/3pmV9sw>

## Using the follow-up worksheet

This follow-up student worksheet covers the relevant practical skills, chemical knowledge and appropriate calculations. The worksheet is in three parts: the first part offers structured questions around the practical, the following two sections include calculation questions. Learners will need to use and apply their knowledge of quantitative chemistry to complete the calculations. Select the level of challenge appropriate to your learners.

As described in the teacher notes, learners can use their own data to calculate the percentage yield, all you need to do is to remember to weigh the dry copper sulfate crystals at the end of the experiment. And, the second part of the worksheet would work with an additional practical to find the formula of hydrated copper sulfate, see <rsc.li/37tP5IA>. If you are not carrying out the actual experiment, you can show the short video clip ‘Just add water 02’ to set the scene, available at <rsc.li/3pmV9sw>.

Use these worksheets after the practical activity for example as a homework activity or a revision activity.

## Follow-up worksheet

1. Making a soluble salt involves several different steps.

Match the step in the procedure with the reason for doing it. Draw a line from the left hand column to the right hand column. The first one has been completed.

**STEP REASON**

**To remove the water**

**Crystallisation**

**So the reaction can take place**

**Carefully measure out the reactants**

**To separate the product from the unreacted reactant**

**Evaporation**

**A**

**B**

**C**

**D**

**Filtration**

**To ensure we have the correct amount of reactants**

**E**

**Mix the reactants together and warm**

**To allow the crystals to form**

1. A student wanted to make some copper sulfate crystals using the steps given in question 1.
	1. Put the steps into the correct order using the letters A–E.

 → → → →

* 1. Name the reactants the student should use.

 acid and oxide.

* 1. Write the word equation for the reaction.

 + → +

1. The soluble salt produced is determined by the acid used and the metal present in the base. Complete the table.

|  |  |  |
| --- | --- | --- |
| **Acid** | **Base** | **Salt** |
| Sulfuric acid | Zinc oxide |  |
| Hydrochloric acid |  | Calcium chloride |
|  | Magnesium hydroxide | Magnesium sulfate |
|  | Sodium carbonate | Sodium chloride |
| Nitric acid | Copper oxide |  |

1. Complete the word equations:
	1. sulfuric acid + zinc oxide → + water
	2. hydrochloric acid + → copper chloride +
	3. + → calcium sulfate +
	4. acid + base → +

### Finding the formula of hydrated copper(ii) sulfate

1. A student wanted to determine the value of *x* in the formula CuSO4.*x*H2O.

He heated 2.70 g of blue hydrated copper(ii) sulfate in a crucible to remove the water of crystallisation. After 5 minutes, the blue crystals had turned white.

The white solid had a mass of 1.72 g.

* 1. Use the information in the question to complete the table

|  |  |
| --- | --- |
|  | ***Mass in grams*** |
| *Mass of hydrated copper(ii) sulfate* |  |
| *Mass of anhydrous copper(ii) sulfate* |  |
| *Mass of water of crystallisation* |  |

* 1. Calculate the molar masses of H2O and CuSO4 (relative atomic masses: H=1, O=16, S=32, Cu=64).
	H2O

M*r* CuSO4

* 1. Calculate the number of moles of anhydrous copper(ii) sulfate formed.
	2. Calculate the number of moles of water driven off.
	3. Work out the mole ratio H2O : CuSO4
	4. Write down the formula for hydrated copper(ii) sulfate.

### Calculating percentage yield

1. A student reacted 15 cm3 of 1.4 mol dm-3 sulfuric acid with excess copper oxide and produced 4.10 g of copper(ii) sulfate.

Use the following steps to calculate the percentage yield of the reaction.

* 1. Write the word equation for the reaction.

 + → +

* 1. Write a balanced symbol equation for the reaction.

 ( ) + ( ) → ( ) + ( )

* 1. Calculate the number of moles of sulfuric acid.
	2. How many moles of copper(ii) sulfate could theoretically be produced from 0.021 moles of hydrochloric acid?
	3. Calculate the theoretical mass of copper(ii) sulfate.

*Note: You will need to use the formula of hydrated copper(ii) sulfate CuSO4.5H20 when calculating the theoretical mass and the following relative atomic masses: H=1, O=16, S=32, Cu=64.*

RFM CuSO4.5H20 =

Theoretical mass =

* 1. Calculate the percentage yield of copper(ii) sulfate.
	2. Suggest two reasons why the percentage yield is less than 100%.

## Follow-up worksheets: answers

1. Making a soluble salt involves several different steps.

Match the step in the procedure with the reason for doing it. Draw a line from the left hand column to the right hand column. The first one has been completed.

##### Carefully measure out the reactants → To ensure we have the correct amount of reactants. Crystallisation → To allow the crystals to form.

##### Filtration → To separate the product form the unreacted reactant.

##### Mix the reactants together and warm → So the reaction can take place.

1. A student wanted to make some copper sulfate crystals using the steps given in question 1.
	1. Put the steps into the correct order using the letters A–E.

##### B, E, D, A, C

* 1. Name the reactants the student should use.

**sulfuric** acid and **copper** oxide.

* 1. Write the word equation for the reaction.

##### sulfuric acid + copper oxide → copper sulfate + water

1. The soluble salt produced is determined by the acid used and the metal present in the base. Complete the table.

|  |  |  |
| --- | --- | --- |
| **Acid** | **Base** | **Salt** |
| Sulfuric acid | Zinc oxide | **Zinc sulfate** |
| Hydrochloric acid | **Calcium hydroxide/ carbonate/oxide** | Calcium chloride |
| **Sulfuric acid** | Magnesium hydroxide | Magnesium sulfate |
| **Hydrochloric acid** | Sodium carbonate | Sodium chloride |
| Nitric acid | Copper oxide | **Copper nitrate** |

1. Complete the word equations:
	1. sulfuric acid + zinc oxide → **zinc sulfate** + water
	2. hydrochloric acid + **copper oxide** → copper chloride + **water**
	3. **sulfuric acid** + **calcium oxide/hydroxide** → calcium sulfate + **water**
	4. acid + base → **a salt** + **water**

### Finding the formula of hydrated copper(ii) sulfate

1. A student wanted to determine the value of *x* in the formula CuSO4.*x*H2O.

He heated 2.70 g of blue hydrated copper(ii) sulfate in a crucible to remove the water of crystallisation. After 5 minutes, the blue crystals had turned white.

The white solid had a mass of 1.72 g.

* 1. Use the information in the question to complete the table

|  |  |
| --- | --- |
|  | ***Mass in grams*** |
| *Mass of hydrated copper(ii) sulfate* | **2.70** |
| *Mass of anhydrous copper(ii) sulfate* | **1.72** |
| *Mass of water of crystallisation* | **2.70 – 1.72 = 0.98** |

* 1. Calculate the molar masses of H2O and CuSO4 (relative atomic masses: H=1, O=16, S=32, Cu=64). M*r* H2O **2 + 16 = 18**

M*r* CuSO4 **64 + 32 + (4 x 16) = 160**

* 1. Calculate the number of moles of anhydrous copper(ii) sulfate formed.

##### mass/M*r* = 1.72/160 = 0.01075 mol

* 1. Calculate the number of moles of water driven off.

##### mass/M*r* = 0.98/18 = 0.54 mol

* 1. Work out the mole ratio H2O : CuSO4

##### 0.54/0.01075 = 5.06

##### ratio = 5.06:1

* 1. Write down the formula for hydrated copper(ii) sulfate.

##### CuSO4.5H2O

### Calculating percentage yield

1. A student reacted 15 cm3 of 1.4 mol dm-3 sulfuric acid with excess copper oxide and produced 4.10 g of copper(ii) sulfate.

Use the following steps to calculate the percentage yield of the reaction.

* 1. Write the word equation for the reaction.

##### sulfuric acid + copper(ii) oxide → copper(ii) sulfate + water

* 1. Write a balanced symbol equation for the reaction.

##### H2SO4(aq) + CuO(s) → CuSO4(aq) + H2O(l)

* 1. Calculate the number of moles of sulfuric acid. **Volume = 15 cm3 = 15/1000 dm3 Concentration = 1.4 mol dm-3**

##### Moles = volume x concentration = (15/1000) x 1.4 = 0.021 mol

* 1. How many moles of copper(ii) sulfate could theoretically be produced from 0.021 moles of hydrochloric acid?

##### 1: 1 ratio; so max number of moles of copper sulfate = 0.021 mol

* 1. Calculate the theoretical mass of copper(ii) sulfate.

*Note: You will need to use the formula of hydrated copper(ii) sulfate CuSO4.5H20 when calculating the theoretical mass and the following relative atomic masses: H=1, O=16, S=32, Cu=64.*

RFM CuSO4.5H20 = **250**

Theoretical mass = **mol x RFM = 0.021 x 250 = 5.25 g**

* 1. Calculate the percentage yield of copper(ii) sulfate.

##### (actual mass/theoretical mass) x 100 = 4.10/5.25 x 100 = 78.1%

* 1. Suggest two reasons why the percentage yield is less than 100%.

Some of the copper sulfate was left in the conical flask/on the filter paper. The reaction was
 not left long enough, so not all the acid reacted.