



Determination of Moles of Copper and Iron in Reaction

Teacher's Edition

Rehab
the
LAB

Topical Unit of Instruction: Moles or Stoichiometry

Introduction

This is the classic iron nails in CuCl_2 activity with a slightly different twist. Instead of using excess CuCl_2 which produces large quantities of toxic Cu^{+2} ions, CuCl_2 is the limiting reactant. If the iron nails are allowed to sit in the small amount (2.0 g) of CuCl_2 overnight, the reaction will go to completion, yielding Fe^{+2} in excess, which can be flushed down the sink with excess water. Fe^{+2} is the ion that is incorporated into the hemoglobin molecule and is frequently prescribed (as ferrous sulfate or ferrous gluconate, for example) for patients who are anemic.

Time

Day 1: 30 minutes

Day 2: 30 minutes

Day 3: 40 minutes, including calculations

Objectives

1. To determine moles of iron used and copper produced in a single replacement reaction.
2. To determine the ratio of moles of iron to moles of copper in order to generate a balanced equation for the reaction.

Preparation

To make 500 mL 1 M HCl: Fill a 500 mL volumetric flask about $\frac{3}{4}$ full of distilled H_2O . Working in a fume hood and wearing goggles, carefully measure 42 mL concentrated HCl in graduated cylinder and slowly add to volumetric flask. Swirl to mix and allow to come to room temperature. Dilute to volume. It will take a few hours for the diluted acid to cool, so make this at least the day before students will use it.

Typical Results

1. Data (A)-(D) = .61g of iron used
2. Data (E)-(B) = .69 g of copper produced
3. $(.61 \text{ g} / 55.8 \text{ g/mole}) = 0.011 \text{ mole Fe}$
4. $(.69 \text{ g} / 63.6 \text{ g/mole}) = 0.011 \text{ mole Cu}$
5. $(.011 / .011) = 1:1$
6. $\text{CuCl}_2(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{FeCl}_2(\text{aq})$

Materials

(For a class of 32 students working in pairs)

- 32 iron nails (length slightly less than inside diameter of 250 mL beaker)
- 8 sheets of fine sand paper cut into quarters
- balances (sensitive to 0.01g)
- 16 250 mL beakers
- several wax pencils
- 32 g $\text{CuCl}_2 \cdot 2 \text{H}_2\text{O}$
- several liters distilled H_2O
- 16 pairs of crucible tongs
- 8 squirt bottles with distilled H_2O
- 16 stirring rods
- 16 large beakers for decanting
- ~500 mL of 1 M HCl
- drying oven



Determination of Moles of Copper and Iron in Reaction

Disposal

1. Have students dump decanted HCl into a large container. Neutralize with base to a pH between 6 and 9 before flushing down sink with water.
2. Collect used nails. They can be used for several years until they are about $\frac{1}{2}$ mm in thickness.
3. Solid copper produced can be saved for later use or put in garbage.

Hints

1. Make sure you purchase iron nails that will lie flat on the bottom of 250 mL beakers.
2. If your drying oven is small and you have several classes, you may have to dry beakers in class shifts for a couple of hours per shift.
3. If you have a little iron residue in your beakers, you may have to scrub them with a steel wool soap pad such as SOS[®] or Brillo[®].

