Name: _____

Determination of Relative Mass

Background: The term *relative mass* is used in chemistry to compare masses at the atomic level. Relative mass can be defined for any quantity. For example, the weight of an individual class member can be expressed in terms of a selected standard. Assume that a 105-pound student is selected as the standard weight unit for your class. The relative weight of a l20-pound student would be 120 lb/ 105 lb, or 1.14. The value 1.14 is determined by the "standard student" selected; therefore, it is a relative mass. The standard is selected as a basis for comparison.

Since atomic masses are small, a relative scale is useful. The standard for the atomic mass unit is carbon-12. One atomic mass unit is defined as exactly one twelfth of the mass of one carbon-12 atom. In this experiment the relative masses of iron and copper atoms will be determined. Copper sulfate will react with steel wool (iron) to replace the iron with copper. The displaced copper will be collected on a piece of filter paper. The ratio of relative masses can be determined by dividing the mass of the steel wool by the mass of the copper residue.

Objective: To determine the relative masses of iron and copper atoms.

Safety: Cupric sulfate is moderately toxic. Wear goggles, gloves, and closed-toe shoes.

Disposal: Follow your instructor's directions regarding disposal.

Materials:

- approximately 1 g of steel wool
- approximately 9 g of cupric sulfate pentahydrate
- centigram or electronic balance
- 250 ml Erlenmeyer flask
- stirring rod
- funnel
- 250-ml beaker
- drying oven
- weighing boat
- filter paper
- wash bottle containing distilled water
- 100-ml graduated cylinder

Procedure (Day 1)

1. Use a weighing boat to weigh out a sample of cupric sulfate pentahydrate having a mass of approximately 9 g.
2. Add 150 ml of warm (50^0C) water to a 250 ml Erlenmeyer flask.
3. Add the cupric sulfate to the flask. Swirl the solution until all cupric sulfate is dissolved.
4. Tare a weighing boat (zero on balance) and weigh out a piece of steel wool having a mass of approximately 1 g and record the mass in the Data Table.
5. Place the steel wool in the solution. Use a stirring rod to push the steel wool below the surface of the solution. Wait until no more steel is visible. Meanwhile…
6. Determine the mass of a piece of filter paper and a clean labeled (your group) weigh boat and record the mass in the Data Table.
7. Place a 250 ml flask below the funnel to collect the filtrate.
8. Fold the filter paper, place it in the funnel, and wet it with distilled water.
9. When all the steel has been replaced by copper, slowly pour the contents of the Erlenmeyer flask into the funnel. Do not overfill the filter paper. You may use a couple quick squirts of dH_2O to transfer any remaining copper from the flask to the paper. When the liquid has drained, rinse the residue and the filter paper with a few more squirts of distilled water.
10. Follow your instructor's directions regarding the disposal of the filtrate.
12. Carefully transfer the filter paper to the labeled weighing boat and place the boat in a drying oven.

Procedure (Day 2)

1. Determine the mass of the weighing boat plus contents. Record it in the Data Table.

2. Discard the weighing boat in the non-hazardous waste container.

Analysis

Show all work below. Be sure to record all calculated values in the Calculations Table.

1. Determine the mass of the copper residue by subtracting the mass of the labeled weighing boat and the mass of the filter paper from the mass of the weighing boat plus contents. Record the result in the Calculations Table.

2. Assume that the iron and copper atoms "replace" each other on a one-to-one basis. Determine the relative mass of iron and copper atoms using the following formula:

If # atoms of iron= #atoms of copper (assumption of replacement reaction)

$$\frac{mass\ of\ iron\ atom}{mass\ of\ copper\ atom} = \text{relative mass} = \frac{mass\ of\ iron\ reacted}{mass\ of\ copper\ reacted}$$

Record the result in the Calculations Table.

4. Calculate the accepted relative mass ratio using the masses obtained from the periodic table. Record the result in the Calculations Table.

5. Determine the absolute error (Ea) and % relative error (Er) and record them in the Calculations Table.

6. Record your value for the ratio on the chart on the shared Google spreadsheet.

7. Using the data collected in the spreadsheet, determine the class average for the mass ratio and record it in the Calculations Table.

8. Determine the Er for the class average and record it in the Calculations Table.

Data Table

Day 1	
mass of steel wool	
mass of dry filter paper + labeled weighing boat	
Day 2	
mass of weighing boat + contents	

Calculations Table

mass of copper residue	
calculated relative mass Fe/Cu	
accepted relative mass Fe/Cu	
absolute error	
% relative error	
class average (relative mass)	
class %relative error	

Report

1. Provide overview of procedures. – i.e. "In this lab we measured the mass of potassium iodide in saturated solutions at different temperatures." Reflect back on the objective (s) of the lab as you do this.

2. State the results and discuss results including any patterns or trends. - i.e. " We found that at 95^0C, KCl was more soluble than at any other temperature. At this temperature, the mass% was ____. Reflect back on the objective(s) as you do this.

3. Include a report of any calculated error. i.e. "This was very close (2% relative error) to the accepted value of ____." Discuss whether your values too high or too low and how your results compare with those of your peers.

4. Regardless of your error, reflect back on every step and every piece of equipment to identify specific measurements or techniques that would most likely lead to error and suggest an improvement for lab to decrease likelihood of error.