Experiment: Moles, Mass & Particles

Purpose: The Law of Definite Composition states that a compound always contains the same ratio of atoms of the elements that make it up. This atom ratio can also be expressed as a mole ratio between the elements, a mass ratio, and for gaseous elements, even a volume ratio. Use these relationships as conversion factors to calculate an unknown quantity, given the initial amount of the compound. Show all data and work used, including units and labels. Conduct the experiments to produce the specified amount of the desired substances, and calculate your percent error values.

1. Calculate the mass of 0.0200 mole copper (II) sulfate pentahydrate. Measure out this amount in a clean, dry, massed beaker. Heat this beaker, with occasional stirring, to drive off the water trapped in the hydrated crystals. Continue heating until no more water vapor is visible, and the crystals have changed from a royal blue color to a powdery, pale blue color. Re-mass the beaker and dehydrated solid, then determine the mass of water lost by heating. Calculate the theoretical mass of water present in 0.0200 mole of the original compound and use this value to determine your percent error.

Data

mass beaker_________ g mass beaker & hydrate_________ g mass beaker & residue________ g

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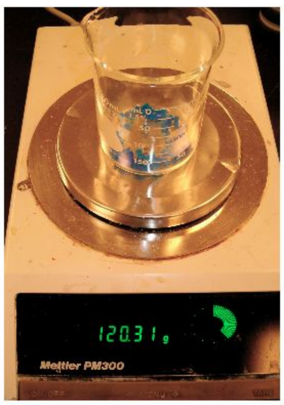
Mass of empty beaker



How many moles of copper (II) sulfate pentahydrate have been added to the beaker?

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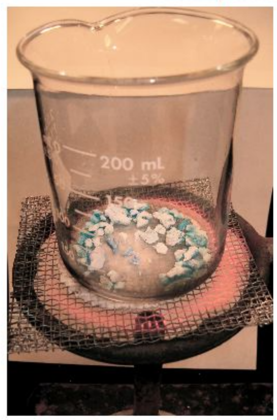

A Bunsen burner is used to heat the solid. How can you tell when all the water is gone?

Based upon the mass of the dried copper (II) sulfate, what mass of water was lost? Calculate the % error for this experiment.

2. Copper metal will react with a colorless solution of silver nitrate to form silver metal and a blue solution of copper (II) nitrate. Measure out 10.0 mL of 0.250 M silver nitrate solution and place it in a clean test tube. ***Caution:*** *Silver nitrate is poisonous and will stain the skin black. Avoid skin contact and ingestion.* Mass between 0.3 - 0.4 g of copper metal turnings and add it to the solution. The silver metal will begin to deposit on the copper turnings as the reaction progresses. Stir occasionally to expose fresh copper metal for further reaction. After 10 minutes, filter the mixture through a massed piece of filter paper. Wash the solid several times with 5 mL volumes of distilled water. There should be some unreacted copper metal remaining in the filter paper, since an excess amount was used. Remove this copper with your forceps and wash off any silver clinging to it. Dry the solid silver under the heat lamp, then determine the mass produced. The original 10.0 mL of 0.250 M silver nitrate solution contains 2.50×10^{-3} mole of silver nitrate. Calculate the theoretical mass of silver metal that should form and use this value to determine your percent error.

Data

mass filter paper ___________ g mass filter paper & silver metal ___________ g

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Copper metal turnings were added to a tared weighing boat, and 10.0 mL of 0.250 M silver nitrate was measured out in a graduated cylinder.

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The copper was added to the silver nitrate solution.

After 3 minutes

After 10 minutes

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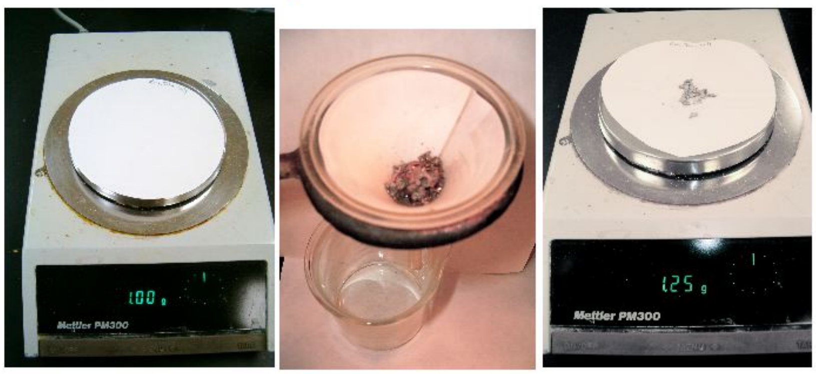

A piece of filter paper is Labeled and massed.

The silver is filtered out and excess copper metal is removed with forceps.

After drying the silver and filter paper with a heat lamp, it is re-massed. Calculate the % yield of Ag.

3. Baking soda (sodium hydrogen carbonate) can be reacted with excess hydrochloric acid to produce carbon dioxide gas. Set up an apparatus, as described by your teacher, to collect the gas generated by the reaction using water displacement. Place 1.5 - 1.7 g of sodium hydrogen carbonate in the large test tube. (Record the actual mass you use.) Add 5 mL of 6 M hydrochloric acid to the small test tube, and place it in the larger tube. ***Caution:*** *Hydrochloric acid is corrosive to the skin. Avoid contact and neutralize spills with baking soda.* Stopper the large test tube with a one-hole stopper fitted with a piece of glass tubing and a rubber hose connected to a pneumatic trough filled with water. Fill a 500 mL cylinder with water, invert it in the trough, and position it over the gas inlet hole. Slowly tilt the large test tube to allow some of the acid to mix with the baking soda. *Be careful to prevent the acid from entering the rubber tubing.* Continue mixing and when all bubbling has stopped, record the volume of gas collected in the cylinder. Under normal lab conditions, 1.00 mole of sodium hydrogen carbonate will produce approximately 24.0 liters of carbon dioxide gas, when reacted with excess acid. Calculate the theoretical volume of gas that should be produced from the mass of sodium hydrogen carbonate you used in this experiment. Determine your percent error.

Data

mass sodium hydrogen carbonate used _______ g volume carbon dioxide gas collected _______ mL

Lab Quiz: Moles, Mass & Particles

Directions: Solve each of the following problems based on the experimental work you completed. Show all data and work used, including units and labels, in the spaces below.

1. What is the theoretical mass of water that would be lost if 3.00 moles of copper (II) sulfate pentahydrate is heated to drive off the water trapped in the hydrated crystals.

calculated # g water lost __________

2. Calculate the theoretical mass of silver metal that should form if 5.00 x 10^2 moles of silver nitrate solution reacts completely with copper metal.

calculated # g Ag formed __________

3. If 25.0 g of baking soda (sodium hydrogen carbonate) can be reacted with excess hydrochloric acid to produce carbon dioxide gas, how many mL of the gas should form. Remember, under normal lab conditions, 1.00 mole of sodium hydrogen carbonate will produce approximately 24.0 liters of carbon dioxide gas, when reacted with excess acid.

calculated # mL carbon dioxide gas formed __________