4A Counting Atoms in a Chemical Reaction

The mole is a very important concept since it allows chemists to determine the number of atoms or molecules of substances involved in chemical reactions. As you know, in chemistry, the mole represents a very large number (6.02×10^{23}) of atoms or molecules. In this experiment, you will react a sample of zinc metal with a solution of hydrochloric acid and determine the number of atoms of zinc that react. As you have learned in class, this "counting of atoms" is achieved by measuring the mass of an element then converting that mass first into moles then into atoms.

In this experiment, your goal is to react a sample of zinc metal with a solution of hydrochloric acid. The balanced chemical equation for this reaction is:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g) + \text{heat}$$

Hence, the progress of the reaction will be evidenced by bubbles of hydrogen gas produced. When the bubbles stop, the reaction is finished.

This experiment is intentionally designed so that some zinc will remain when the reaction ends. Therefore, by simply weighing the zinc sample before and after the reaction, the mass of zinc that has reacted can be easily determined. Knowing this value, you will be able to convert it to the actual number of atoms of zinc reacted.

Metals commonly react with acids and in some instances such reactions are intentionally performed. For instance, artists often use acid to etch designs in metal art and mechanics sometimes use acid to etch their names into metal tools.

OBJECTIVES

1. to determine the number of moles of atoms of zinc reacted
2. to determine the number of atoms of zinc reacted

SUPPLIES

Equipment

beaker (250 mL)
graduated cylinder (100 mL)
beaker tongs
hot plate
crucible tongs
centigram balance
stirring rod
lab apron
safety goggles

Chemical Reagents

mossy zinc
3*M* hydrochloric acid, HCl

PROCEDURE

1. Put on your lab apron and safety goggles.
2. Use a centigram balance to weigh a clean, dry 250 mL beaker. Record its mass in your copy of Experimental Results. This mass will be needed before and after the reaction.
3. Add one piece of dry mossy zinc to the beaker. Weigh and record the mass of the beaker and zinc. A piece of zinc between 1.0 g and 2.0 g is optimum.
4. Add approximately 50 mL of 3*M* HCl to the beaker and make and record qualitative observations about the reaction.
5. Allow the reaction to continue for 15 to 20 min.
6. To stop the reaction slowly add 100 mL of water to the beaker to dilute the acid solution. Carefully decant (pour just the solution) into a sink without dumping out the zinc. Add another 100 mL of water to the beaker and decant again.
7. Use the tongs to remove the zinc from the beaker and place it on a piece of paper towel.
8. Pour any remaining solution down the sink and rinse the sink with water. Also rinse out the beaker and return it to your lab station.
9. Put the wet zinc back into the beaker and place the beaker on a hot plate set at low heat. Periodically inspect the zinc by using tongs to remove it, then return it to the beaker. When the beaker and zinc appear to have slowly dried, remove the combination from the hotplate and allow it to cool.
10. Once again weigh the beaker and zinc and record this mass.
11. Clean up all of your materials.

3*M* HCl is corrosive to skin and clothing. Wash spills with plenty of water then notify your instructor.

REAGENT DISPOSAL

Rinse all solutions down the sink with copious amounts of water. Any solid waste should go into the designated waste container.

POST LAB CONSIDERATIONS

The chemical reaction in this experiment has been:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g) + \text{heat}$$

The fact that bubbles were produced is evidence that a gas was given off. Further tests would reveal that this gas was hydrogen. The mass of zinc should have decreased during the reaction making it possible to determine the number of atoms of zinc that reacted.

EXPERIMENTAL RESULTS

Before the reaction:

Mass of dry beaker

Mass of dry beaker + zinc

After the reaction:

Mass of dry beaker + zinc

Qualitative Observations

ANALYSIS OF RESULTS

1. Use your data to determine the mass of zinc that reacted.
2. Calculate the number of moles of atoms of zinc reacted.
3. Calculate the number of atoms of zinc reacted.
4. Compare your answer to Analysis #3 to that of another lab group. Suggest an obvious reason for any difference.

FOLLOW-UP QUESTIONS

1. Suggest a reason why the reaction started very slowly then increased after a few minutes.
2. How would the results compare if twice the mass of zinc were used in this experiment?
3. **a.** How would the results compare if twice the amount of acid were added?
   b. How would this affect the amount of hydrogen gas produced?

CONCLUSION

State the results of Objectives 1 and 2.