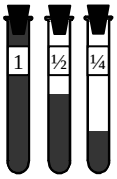
The Reaction of Calcium with Water

Purpose: To predict the intensity of chemical reactions based on balanced equations

Part I: Collecting the Gas

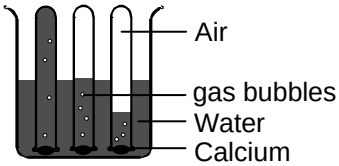
i. Obtain: 3 test tubes, 3 stoppers, a 600 ml beaker, and a 400 mL beaker. Half fill the 600 mL beaker with tap water. Place a piece of tape around each test tube (the tape should go all the way around the tube so that one end sticks to the other end – this will keep the tape in place even when the test tubes get wet). With a ballpoint pen, label the test tubes "1", "½", and "¼".



ii. Fill the "1" tube to the top with tap water. Fill the "½" tube half way with water and the "¼" tube one quarter full of water. Stopper the tubes. (See illustration to the right).

iii. Place the stopper end of each tube under the water in the 600 mL beaker. Remove the stoppers without allowing any water to escape from the tubes (this is most easily done using crucible tongs).

iv. Ask your teacher to place some calcium into your beaker. Collect the resulting gas by displacing the water in the tubes. If you have trouble seeing the calcium, lift the beaker up and view it from the bottom. Fill each tube with gas but do not let the tubes bubble over (this could affect your results).



v. Stopper each tube by placing a stopper in the bottom of the beaker (using tongs) and pushing the open end of the tube over the narrow end of the stopper. Try to get as little liquid in the test tubes as possible.

vi. Stand the tubes up in the 400 mL beaker. Dump the water from the 600 mL beaker into the sink.

Part II: Testing the Gas

Put on safety goggles. Get a lit candle and a splint. With a flaming splint ready, remove the stopper from the "1" tube and quickly place the burning splint in the mouth of the tube (keep a firm grip on the tube). Repeat for the "½" tube and then for the "¼" tube. When finished, remove the tape from your test tubes and throw it in the garbage. Wash out the glassware, wipe down your lab bench, and return all equipment.

Questions (answer on a separate sheet of paper)

1. List the seven elements that naturally occur as diatomic molecules (see page 170 of your textbook).
2. Write the balanced chemical equation for the reaction of Ca + H_2O (see "activity series" note for help).
3. What gas was given off by Ca and collected in the test tubes?
4. Write the balanced chemical equation showing hydrogen and oxygen combining to form water (keep in mind that hydrogen and oxygen are diatomic molecules).
5. Imagine that you manufacture cars. Let's say you have 100 chassis (body of the car) and 400 wheels; you can make 100 cars. If you have 1000 chassis and 400 wheels you can still only make 100 cars (because you are limited by the number of wheels). In this second case, 900 chassis will go unused. In chemical terms, a reaction is "incomplete" when there are reactants left over. The example of 100 chassis plus 400 wheels would represent a "complete" reaction. Based your balanced equation in question 4, what is the ideal mole ratio of H_2:O_2 (where all hydrogen and oxygen are used up)?
6. It is known that equal volumes of gases contain equal numbers of moles. In other words, if you want to combine gases in a 5:3 ratio by moles, you can simply combine them in a 5:3 ratio by volume. With this in mind, what is the ideal volume ratio of H_2:O_2?
7. Look at the table to the right. Notice that the ½ tube has a 50:50 ratio of H_2:air. However, because air is only 20% oxygen the H_2:O_2 ratio is actually 50:10 (or 5:1). Based on the information in the table, which test tube should have the most complete reaction (with almost no reactants left over)?

Test tube	H_2:Air ratio	H_2:O_2 (ratio)
1	100:0	100:0
½	50:50 (1:1)	50:10 (5:1)
¼	25:75 (1:3)	25:15 (1.7:1)

8. Do your observations from the lab support your answer to question 7? Explain.