**Teacher note:**

**In this lab, students will calculate the amount of baking soda to add to the container. This will be the limiting reagent. You will provide the acid.**

**To determine the amount of acid to give to each student, measure the volume of your Ziploc bag and consider that to be the liters of CO2. Use that information to calculate moles of acid and then liters of acid (depending on molarity).**

**I would increase the amount (perhaps even double it) to ensure that the amount of acid does not limit production.**

**I used 20 mL of 1 M HCl (but I think it was old and not quite 1M anymore).**

**The steps to complete the lab are intended to guide students through the process and should be modified to fit the needs of your classroom. If your students are comfortable with the material and accustomed to inquiry, these steps could be completely eliminated.**

**Assignment**

You and your team have just received your assignment from Toyota. They are attempting to cut the budget while still maintaining the integrity of their cars. They want you to find out if you can use less expensive chemicals, like baking soda, to fill up air bags. The chemicals they currently use are slightly more expensive.

The boss wants you to show her that it can be done by filling up a Ziploc bag using the reaction between baking soda and hydrochloric acid.

Other teams are on the task as well, so the team that best completes the task at the next meeting will receive a pay raise (10 bonus points on this assignment).

The boss doesn’t like to be bothered, so you may only ask her three questions during this assignment (more and you may lose your job ☹). She will, however, be walking around to monitor your progress and safety.

Have fun!

**Info to know**

**Safety**—Goggles should be worn at ALL times while working with or around chemicals. HCl is a very strong acid. Avoid contact with your skin, eyes, etc.

**Supplies**—You have at your disposal everything that is on your desk.

**Reaction**—The reaction that takes place in the airbag is

NaHCO3 + HCl → NaCl + H2O + CO2

Carbon dioxide is a gas, the other compounds are solids or liquids.

**You will be graded on the following:**

* The effectiveness of your airbag (is it full? Did it pop?)
* The thoroughness of your procedure (could it be repeated?)
* The accuracy and clarity of your calculations
* Your responses to the pre-lab and post-lab questions

**Pre-lab discussion**

1. Describe the characteristics of a “good” airbag versus a “bad” airbag.

Good Airbag Bad Airbag

2. How could you control the amount of air that was produced in the air bag?

**Steps to complete the task**

1. Write a balanced equation for the reaction used to fill up your “airbag” with gas.

2. Find the volume of your airbag in mL.

3. Convert mL to liters.

4. The liters that you found in step 3 is the number of liters of gas (CO2) that are required to fill up the airbag. From this number, determine how many grams of baking soda (NaHCO3) are needed for this reaction.

5. Measure out the baking soda.

**When you get to this step, have your calculations approved by your teacher. \_\_\_\_\_\_\_\_**

**Also, look at the next step. Write a plan (on scratch paper) for completing this step and have it approved by your teacher. \_\_\_\_\_\_\_\_**

6. Add the acid and baking soda to the Ziploc bag, ensuring that the reaction does NOT start until after the reaction is sealed. Your group will need to be creative to ensure that the two do not mix until after you have sealed the bag.

**Calculations—These should clearly show how you arrived at your answer.**

**Post-lab questions**

1. How did you find the volume of the airbag? What equipment did you use?

2. If you had weighed the airbag before and after the experiment, how would the mass have changed and why?

3. Where did the gas that filled the bag come from?

4. Why did the gas fill up the bag but the other components did not?

5. Compare your airbag to others from the class and complete the table below:

|  |  |
| --- | --- |
| Airbag plumpness | Amount of baking soda added |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

6. Based on your table, do you think the amount of baking soda added affected the amount of air produced?

Why?