

## Stoichiometry Air Bag Lab

**Introduction:** The airbag is now a common piece of safety equipment found in all new automobiles. Its development required the combined efforts of engineers and chemists. The concept is very simple; during a crash an impact is detected which sets off a controlled explosion and fills a bag in front of the car's occupants with gas. The reaction that occurs completely fills a plastic bag in front of the driver or passenger preventing possible head injuries. When designing a suitable reaction for an airbag several factors are taken into consideration. The reaction needs to be initiated quickly and easily, the reaction needs to come to completion quickly to ensure that the bag is filled before the driver's head strikes the steering wheel, and the gas produced should be inert and non-toxic to prevent possible explosion or poisoning. It is also necessary to use the right amount of chemicals (reactants) to completely fill the bag but not burst it. This last condition is an application of stoichiometry that we will investigate today.

Real airbags utilize the decomposition of sodium azide ( $\text{NaN}_3$ ). Sodium azide decomposes explosively when an electrical current is passed through it to produce nitrogen, a chemically inert gas. Airbags have enough sodium azide to produce approximately 60L of gas in about 30 milliseconds.



In this experiment we will avoid the use of explosive reactions and concentrate on a slower gas producing reaction. The purpose of the experiment is to calculate the amount of reactants needed to fill but not burst a plastic bag. You will test your calculated values in the laboratory and refine as necessary. In order to complete this experiment it is necessary to remember that one mole of any gas occupies approximately 22.4 L at STP.

**Objective:** Create a small-scale air bag out of a zipper baggie using the reaction between baking soda and vinegar to create the  $\text{CO}_2$  gas needed to inflate the airbag. The finished air bag must have a mass that does not exceed 12.00 grams. You will be given limited raw materials with which to complete the task and ultimately you must maximize the volume of the bag.

### Pre-lab discussion:

1. How is our lab experiment similar to a real airbag's reaction and how is it different?
2. Summarize the objective of the lab.

**Background:** You will use stoichiometric quantities of baking soda and vinegar to maximize the amount of  $\text{CO}_2$  gas created and minimize added mass due to unreacted vinegar or baking soda. Vinegar is only a 5% Acetic Acid solution and has a density of 1.01g/mL. Every mL you use will add 1.01 gram of mass. Since vinegar is only a 5% solution you need to multiply your mass by 5% (0.05) to calculate the actual amount of Acetic Acid being used. The balanced chemical equation for the reaction between baking soda and vinegar is:



**Materials:** Each group will be given:

3 Baggies  
2 pipettes  
5 grams of baking soda  
30 mL of vinegar

1 gram balance  
10 mL graduated cylinder  
1 weighing boat

# Airbag Stoichiometry Lab Work And Answers

**Thomas Bond,Chris Hughes**



**Airbag Stoichiometry Lab Work And Answers:**

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