#### Explosive Stoichiometry

# **Purpose**: To investigate some principles of stoichiometry (limiting reagent), writing and balancing equations, and the ideal gas law to create a controlled explosion inside of a tennis ball canister.

**Discussion**: You will need to refer to your notes on the Ideal Gas Law in this lab.

Almost all organic molecules and some inorganic compounds will burn in air. Many will ignite quite readily and are considered flammable. When a compound or molecule burns in air, it is actually reacting with the oxygen in the air. As a result, chemists refer to **combustion** reactions as oxidation reactions. CH4 + 2 O2 🡪 CO2 + 2 H2O is an example. The general form of a combustion reaction is:

*hydrocarbon + oxygen 🡪 carbon dioxide + water*.

In this lab, you will have to calculate the exact amount of a particular gas needed to fill a tennis ball canister in order to produce the best explosion. If your calculation is low or high, no explosion will occur.

**Materials** Goggles, Aprons 60 ml Syringe Methane Gas

 Ignitor 850 ml Tennis Ball Canister Butane Gas

**CAUTION: this lab may be very hazardous to your health!**

**Procedures**

1. Go to the Calculations and Data Section and complete all the necessary calculations BEFORE going on to perform the actual lab.
2. Obtain a pair of goggles, an apron and sheet of cardboard for your lab station.
3. Go to the teacher to get the sample of gas (butane or methane).
4. Fill the 60 ml syringe to the appropriate volume based on your calculations.
5. Transfer the gas from the syringe to the sealed tennis ball canister through the small hole just above the bottom of the canister.
6. Give the system 10-15 seconds of wait time to allow the gas to diffuse.
7. Insert the ignitor.
8. Cover your ears and yell “FIRE IN THE HOLE.” Press the ignitor button.
9. If you are unsuccessful, open the top of the tennis ball canister and vent it while you recalculate and try the other gas.
10. Clean up.
11. If the atmospheric pressure is close to standard pressure (760 mm Hg) and temperature is near room temperature (25 C), the gas law calibration can be ignored.

**Calculations and Data** *Show all work and units for ALL calculations & measurements*.

1. Write down the formula of the gas that you will be using: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. Write a balanced chemical equation below for the combustion of that gas:
3. Record the current temperature in the room: \_\_\_\_\_\_\_\_\_\_ … \_\_\_\_\_\_\_\_\_\_\_.
4. Record the current atmospheric pressure in the room: \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. The canister is 850 ml and air is 21% oxygen. Calculate the number of milliliters of oxygen that are inside the canister when it is sealed.
6. Calculate the number of moles of oxygen that are in your canister.
7. Using your balanced chemical equation, calculate the number of moles of your gas that you will need to react completely with all of the oxygen that is in the canister.
8. Using your previous answer and the current temperature and atmospheric pressure, calculate the number of milliliters of your gas that you need to add to the canister. (*pay attention to units*).

**Conclusions and Questions**

1. Is the combustion reaction in this lab endothermic or exothermic? How do you know?

2. Based on your answer to question #1, what happens to the volume of the gas as the reaction progresses? Does this help or hinder the desired outcome of popping the lid off the canister?

**Calculations**

**Gas Law Calculation**

* P1V1/T1 = P2V2/T2 … rearrange to solve for V2 = P1V1 T2 / T1 P2

<http://somup.com/crn0q2D4sn> (1:28) Butane Exploding in Cannister.

**Butane**

* 2 C4H10 + 13 O2 🡪 8 CO2 + 10 H2O
* 850 ml x 21% = 178 ml = 0.178 L of O2 (g)  in the tennis ball canister
* 0.178 L x 22.4 L/ mol = 0.008 moles of O2 (g)
* Using mole ratios 🡪 0.0012 moles of butane (C4H10)
* 0.0012 moles x 22.4 L/mol = 0.0266 L = 27 ml
* 27 ml
* Containers of Butane can be purchased at a dollar store 🡪 find containers that have a small “neck” to dispense the gas into the syringe.

**Methane**

* CH4 + 2 O2 🡪 CO2 + 2 H2O
* 850 ml x 21% = 178 ml = 0.178 L of O2 (g)  in the tennis ball canister
* 0.178 L x 22.4 L/ mol = 0.008 moles of O2 (g)
* Using mole ratios 🡪 0.004 moles of methane (CH4)
* 0.004 moles x 22.4 L/mol = 0.089 L = 89 ml
* 89 ml of methane gas needed to fill the tennis ball canister
* Students will need to inject the syringe twice to get the 89 ml into the tennis ball canister

**Conclusions and Questions**

1. Is the combustion reaction in this lab endothermic or exothermic? How do you know?

 ***Exothermic … because heat is released … flame, lid of canister blows to ceiling***

2. Based on your answer to question #1, what happens to the volume of the gas as the reaction progresses? Does this help or hinder the desired outcome of popping the lid off the canister?

***The volume of the gas decreases RAPIDLY as the reaction proceeds. It happens almost instantaneously. Therefore, one would not be able to repeat the explosion without replenishing the gases.***

Weather.com will give the prevailing atmospheric pressure

* Students need to convert to K temperature when using the ideal gas law
* A Bar-B-Que gas grill ignitor is ideal for the ignitor system needed in this lab

Small opening to allow ignitor to fit inside

Tennis ball canister

Lid