Name:_____ Date:_____

**Why are some mixtures of hydrogen and oxygen more explosive than others?**

The combustion reaction of hydrogen and oxygen has been used to propel rockets into space. The reaction is also being engineered to serve as a source of energy for fuel cells in electric vehicles. Do all mixtures of hydrogen and oxygen gases react equally well?

There will be two parts to this lab:
Part 1: Test various mixtures of hydrogen and oxygen gases in a "pop test" to find the loudest and most powerful mixture.
Part 2 (optional): Use the most powerful mixture of hydrogen and oxygen gases from the "pop test" to see how far you can launch a rocket.

**Pre-Lab Questions:**

1. Hydrogen gas will be generated by reacting hydrochloric acid with zinc. Write the balanced chemical equation for this reaction.

2. Oxygen gas will be generated through the decomposition of hydrogen peroxide. In this reaction, hydrogen peroxide decomposes into oxygen and water. Write the balanced chemical equation for this reaction.

3. When mixtures of hydrogen gas and oxygen gas are ignited, explosions occur as the hydrogen and oxygen react to produce water. Write the balanced chemical equation for this reaction.

**Procedure:**

Part 1:

1. Completely fill a pipet bulb with water and then collect various mixtures of hydrogen gas and oxygen gas by water displacement.

2. Determine how combustible the various mixtures of gases are by igniting them and assessing the relative loudness of the explosions. Rank them from softest (least combustible) to loudest (most combustible). Test the following hydrogen-to-oxygen ratios:

| | | | |
|---|---|---|---|
| 6 $H_2$ : 0 $O_2$ | 5 $H_2$ : 1 $O_2$ | 4 $H_2$ : 2 $O_2$ | 0 $H_2$ : 6 $O_2$ |
| 3 $H_2$ : 3 $O_2$ | 2 $H_2$ : 4 $O_2$ | 1 $H_2$ : 5 $O_2$ | |

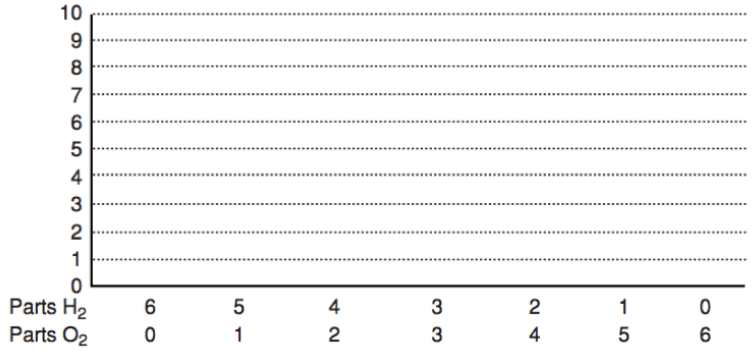
   You should test each mixture at least two times. Be sure to record your results.

Part 2 (Optional):

3. Collect the optimum (loudest) gas mixture one more time, and take it to the launch zone. Place the pipet bulb on the piezo sparker and ignite it. DO NOT POINT YOUR PIPET AT OTHER PEOPLE. How far does your rocket travel?
4. Collect the optimum mixture again, but this time leave about 1 mL of water in the bulb and launch it again. Does your rocket travel further? Can you hit the target? Why do you think leaving some water in the bulb might make a difference?

**Conclusion (Complete all the items below on your own piece of binder paper)**

1. Evidence/Data:
   - Draw a bar graph that illustrates the relative loudness of the various hydrogen-to-oxygen ratios you tested, 10 is the loudest and 0 is the softest. Your graph should be setup like this:




   - Based on the balanced equation, complete the table below:

| **Parts $H_2$** | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| **Parts $O_2$** | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| **Which reactant is present in excess?** | | **$H_2$** | | | | | |
| **How much of that reactant is left over?** | | **3** | | | | | |

2. Explanation and Argument Paragraph:

   Explanation

   - Based on your results and the table above, answer the question: "Why are some mixtures of hydrogen and oxygen more explosive than others?"

   Argument: Describes why your explanation makes sense and why others should believe it.

   - Write the balanced chemical equation for the combustion reaction of hydrogen and oxygen to give water.
   - How does the ratio of hydrogen-to-oxygen in your most combustible mixture relate to the mole ratio* in the balanced equation?
   - Why would having reactants left over cause the reaction to be less powerful?
   - Why did pure oxygen and the pure hydrogen have the least powerful combustions?

*Find information about mole ratios at: https://goo.gl/LEV4Ym