**Name** _____ **TA** _____ **Time** _____

# The Chemistry of Oxygen

In this lab you will make several compounds, all oxides. You will do this by burning several elements in oxygen gas or watching your TA burn some elements. The goal of this experiment is to not set off the fire alarm. Be careful! Work in the hoods!

## I. Production of oxygen gas

We will need oxygen gas in this lab to make several oxides. Oxygen gas can be produced by the decomposition of hydrogen peroxide. The first part of this lab is to test different ways to decompose hydrogen peroxide into oxygen.

In a rack, place four test tubes and add 3.0 mL hydrogen peroxide to each.

In the first, add about 10 drops of 1M $FeCl_3$.

In the second, add about the tip of a spatula (pea size) of solid $MnO_2$.

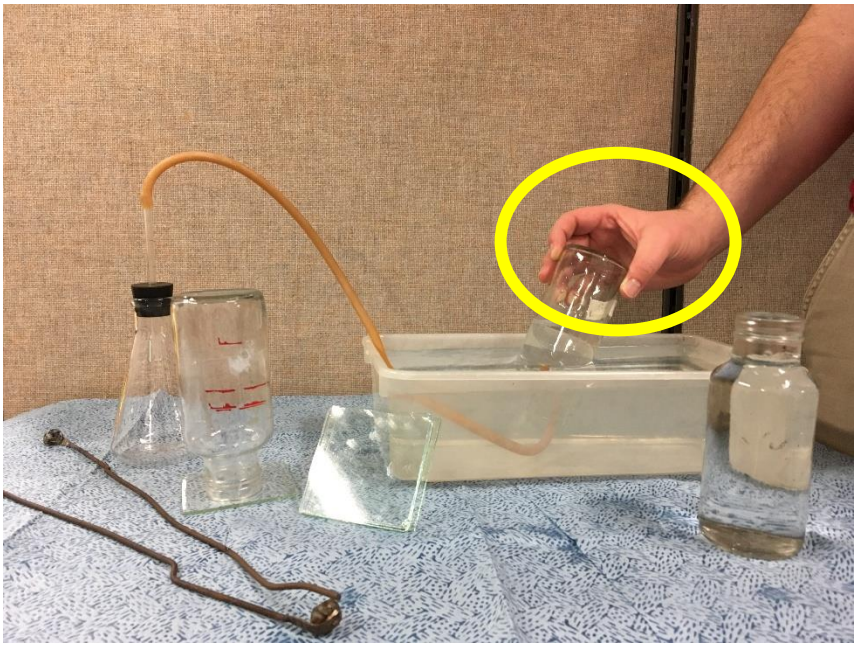
In the third, add 10 grains of active dry yeast.

In the fourth, add nothing, this is your control.

Observe the reactions. Which of the four is the most effective oxygen gas producer?

What are $FeCl_3$, $MnO_2$ and yeast called in the reactions above?

Assemble the apparatus shown below for producing oxygen gas using the best method you determined earlier.



| Universal indicator color | pH |
|---|---|
| Red | 4 or less |
| Orange | 5 |
| Yellow | 6 |
| Green | 7 |
| Blue | 8 |
| Indigo | 9 |
| violet | 10 or greater |

Fill the tank or bucket with water and fill 4 jars with water. To a 250 mL Erlenmeyer flask, add hydrogen peroxide and the best reagent determined to produce oxygen gas. Attach the stopper with the rubber tubing and after the initial air is blown out of the tube start collecting oxygen by bubbling $O_2$ into the inverted water filled jar. When the water reaches the bottle neck of the jar, stop collecting oxygen. Cover the jar, invert it and continue to collect oxygen until the 4 are filled with oxygen.

## II. Preparation of four oxides (demos)

Your TA will demonstrate the igniting and burning in $O_2$ of Lithium, Phosphorus, Titanium powder and Barium using the oxygen you produced.

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**III. Preparation of four other oxides**

**Magnesium**

Take a ~ 2 cm ribbon of Mg in a pair of tongs and set it on fire by placing it in the flame of a Bunsen burner. Once it ignites, place it in a bottle of $O_2$. (Shield your eyes; it will be bright!)

**Calcium**

Pick up a calcium shaving with tongs, heat it, at first slowly then strongly. It is hard to ignite but burns brightly. After cooling wash the residue in the crucible into a beaker with distilled water.

**Carbon (coal)**

Ignite a piece of coal held with tongs or in a deflagrating spoon using the Bunsen burner and quickly put in a bottle of oxygen. [Note: drop a small piece of dry ice into the bottle.]

**Sulfur**

Take a half a pea size sample of sulfur in a deflagrating spoon (make sure this one is in a hood) Hold it over the Bunsen burner until it ignites, then quickly place the sample in a bottle of $O_2$. Sulfur will melt then burn with smoke.

**Experimental results**

Table 1 Reactions of selected elements with oxygen.

| Element name | Symbol | Observations |
|---|---|---|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

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**Reactions of the oxides with water**

Next the reactions of the oxides with water left in the jars will be examine. The pH of the solution will be determined. By convention, the formulation involves addition of one or more water molecules to the oxide; the way this is done is illustrated by the reaction of C with $O_2$ to give $CO_2$ and then the reaction of $CO_2$ with $H_2O$ to yield either a basic or acidic compound as illustrated in Table 2 below. The correct hydrated formula is determined by the pH of the corresponding solution.

**IV. Testing the pH of the eight oxides**

To each oxide you made in a bottle or beaker add a little distilled water and then drip 2-3 drops of the solution onto universal indicator paper. Record the color of each in the table. Translate the color of the universal indicator to a pH value using the color code on the chart.

**V. Obtain and test the pH of some other oxides**

Several other oxides have already been prepared. Take a little on the tip of a spatula and transfer to a clean test tube add about 1 mL of hot distilled water and then drip 2-3 drops of the solution onto universal indicator paper. Again translate the color of the universal indicator to a pH value using the color code on the chart.

Table 2 Metal oxides formed and reactions in water.

| Elements symbol | Metal, Nonmetal, or metalloid | Oxide formula | Hydrated formula written as: | | Universal indicator color | pH | Acidic, Basic, or Neutral | Correct hydrated formula |
|---|---|---|---|---|---|---|---|---|
| | | | Base | acid | | | | |
| C | | $C0_2$ | $CO(OH)_2$ | $H_2CO_3$ | | | | |
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Consider your results above and predict the formulas of two acidic oxides and two basic oxides that you did not test.

Acidic _____ _____ Basic _____ _____

What does the term anhydride mean?

The reverse of our experiment would be to make anhydrides. Try removing water from the molecules below and see what remains. (What should you do with an odd number of hydrogens?)

Determine the formulas of the anhydrides of the following oxides.

| | | | |
|---|---|---|---|
| HClO _____ | $HNO_3$ _____ | $H_2SO_4$ _____ | $Sn(OH)_4$ _____ |
| $HClO_3$ _____ | $HNO_2$ _____ | $H_2SO_3$ _____ | $Sr(OH)_2$ _____ |
| $H_2CO_3$ _____ | $La(OH)_3$ _____ | $H_4SiO_4$ _____ | CsOH _____ |