

## Chemistry and Environmental Sciences

### Oxygen Give and Take

#### Summary

This is a series of three activities followed by a worksheet. The concepts taught include gas production ( $O_2$  and  $CO_2$ ), chemical reactions, catalysts, and pollution caused by combustion.

#### Correlation to National Science Education Standards

Content Standard 9-12

##### Physical Science B Chemical Reactions

Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light.

Content Standard 9-12

##### Earth and Space Science D Geochemical Cycles

The earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on earth moves among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.

Content Standard 9-12

##### Science in Personal and Social Perspectives F Environmental Quality

Materials from human societies affect both physical and chemical cycles of the earth.

#### Prerequisite Knowledge and Skills

Students need to be able to use a balance to measure mass to the nearest .01 g., and have basic knowledge of chemical reactions

#### Materials Needed

candle, matches, tin can(as platform for candle), glass jar, test tube, balance, weighing paper, manganese dioxide, hydrogen peroxide, wood splints, baking soda, vinegar

#### Suggestions for introducing and teaching the activities

A demonstration showing combustion is a good way to introduce this. One possibility is the ping pong popper which can be purchased as a kit from Flinn Scientific. Discuss characteristics of combustion reactions. The  $MnO_2$  catalyst should be collected from students in a beaker so it can be dried out and reused in the future. The worksheet can be given as an out of class assignment after the activity is done.

Oxygen Give and Take in the Air  
What Gives? What Takes?

Part I Oxygen:

Name \_\_\_\_\_

Oxygen gas is used in two very important processes that release energy: respiration and combustion. When hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) breaks down into water, oxygen is given off as a gas. This happens slowly normally, but is sped up when light is present. It is greatly sped up when  $\text{MnO}_2$ , manganese dioxide is present as a catalyst (something that speeds up a chemical reaction). To observe and test for oxygen do the following.

1. Measure out 10.0 ml of  $\text{H}_2\text{O}_2$  into a test tube
2. Measure out 3.0 g of  $\text{MnO}_2$  onto weighing paper
3. Prepare a wood splint by lighting the end on fire
4. Quickly add the  $\text{MnO}_2$  to the test tube and gently cover the end with your finger
5. When a small amount of pressure builds up from oxygen being produced, blow out the wood splint and put the glowing end down into the gas produced

Part I questions

1. Give two properties of oxygen that you observed
2. Name three specific ways that people use combustion
3. List three organisms that use respiration
4. Why is  $\text{H}_2\text{O}_2$  sold in dark bottles?
5. What is a catalyst?

Part I Summary: Oxygen is used in releasing energy from compounds. Plants produce oxygen from photosynthesis. The reactions that use oxygen and release energy also produce carbon dioxide ( $\text{CO}_2$ )

## Oxygen Give and Take in the Air

### Part II. Carbon Dioxide

Name \_\_\_\_\_

Respiration and combustion use oxygen and produce carbon dioxide. When vinegar reacts with baking soda, bubbles of carbon dioxide gas are produced. Baking soda also produces carbon dioxide under other circumstances. For this reason, baking soda can be useful for putting out grease fires in kitchens. Water added to a grease fire can cause violent spattering. In this activity we will test for carbon dioxide by putting a burning splint into carbon dioxide to see if it puts it out.

1. Put 2.0 g of baking soda in a test tube
2. Measure 5.0 ml of vinegar in a graduated cylinder
3. Prepare a wood splint by lighting the end on fire
4. Add the vinegar to the test tube and put the flaming splint down into the gas produced, not into the liquid.

### Part II Questions

1. How is a gas tested to see if it is carbon dioxide?
2. What is a good way to put out a kitchen grease fire?
3. What process uses carbon dioxide out of the air?

Part II Summary : Respiration and combustion produce  $\text{CO}_2$ , therefore they can be called carbon dioxide sources. Photosynthesis uses  $\text{CO}_2$ , therefore it is called a carbon dioxide sink.

## Oxygen Give and Take in the Air

### Part III. The results of Combustion

Name \_\_\_\_\_

When you consider what is in air, the first thing that comes to mind may be oxygen. In 1774, the English scientist Priestly “discovered” oxygen by heating what we now call mercury oxide. He called it “good air” since he discovered that a mouse lived longer in it than in ordinary air. Priestly later tried some himself, and stated that so far only “two mice and myself” had ever breathed the new substance. He met the French scientist Lavoisier a short time later and described the oxygen experiment to him. Lavoisier quickly concluded that oxygen must be present in ordinary air. He tested this by heating mercury in air, and found that  $1/5^{\text{th}}$  of the air was taken out as the mercury oxide was formed. We will now determine what is produced as oxygen is used by combustion.

1. Light a candle and allow wax to drip on the provided can.
2. Place the candle in the wax so it will be held upright.
3. Hold a jar the flame for two minutes so that anything produced will go up into the jar.
4. Wipe your finger around the inside of the jar to observe the material collected there.
5. Hold the bottom of the jar partly into the flame for 30 seconds so that soot collects.
6. Set the jar over the burning candle and observe what happens.
7. Find the mass of a piece of weighing paper to the nearest .01 gram, and carefully wipe the soot onto it from the bottom of the jar.
8. Measure and record the new mass of the weighing paper.

### Part III Questions

1. Why did the candle go out in step 6?
2. What was removed from the air by the burning candle?
3. Was anything added to the air by the candle?
4. If the candle produced soot at the same rate as it did during the thirty seconds, how many grams would be produced in one year?
5. What was the material that cooled and collected inside the jar during step 3?

Part III Summary : Combustion and Respiration both use oxygen and produce water and carbon dioxide.

## Oxygen Give and Take in the Air Student Worksheet

Name \_\_\_\_\_

Joseph Priestly was an English scientist who helped others understand the air that covers the earth. He is considered the first to describe the relationship between gases given off or taken in by animals to gases given off or taken in by plants. He didn't call these gases carbon dioxide and oxygen, but had a good understanding of the concept. In his own words, "The injury which is continually done to the atmosphere by the respiration of such a large number of animals is, in part, at least, repaired by the vegetable creation" This animal plant relationship is very important to stability of our environment. In 1815 a volcano called Tambora had a massive eruption. The following summer, temperatures around the world were cool enough that it snowed in June and July in New England states. If there was enough material to block out sunlight, or reverse the greenhouse effect, this would likely affect the amount of photosynthesis done. Photosynthesis uses energy, water and carbon dioxide to produce sugar and oxygen. Respiration uses sugar and oxygen to produce energy, carbon dioxide, and water.

Answer the following questions.

1. If one half of all animals were removed from earth, how would this affect the amount of oxygen in the air?
2. If one half of all plants were removed from earth, how would this affect the amount of oxygen in the air?
3. In the candle experiment, would a mouse do well if placed in the jar after the candle went out?
4. In the candle experiment, would a plant do well in the jar after the candle went out?
5. Go to the website <http://www.epa.gov/ttn/chief/ap42/index.html> and read the section on emission factors. Scroll down to Chapter I, External combustion sources. Go to residential fireplaces, final section. Using table 1.9-1, what is the emission factor for particulate matter (PM)?
6. How long would the candle need to burn to produce the same amount of particulate matter (soot) as the ton of wood in question 5?
7. What affect does particulate matter have on the sunlight reaching the surface of the earth?