

## *INQUIRY BASED ACTIVITY*

### **COWSEE West Weather, Sea Level Rise and Climate Change**

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#### **BACKGROUND:**

Carbon dioxide (CO<sub>2</sub>) is a natural product of several chemical reactions. Increased levels of CO<sub>2</sub> gas have been linked as the major contributor to the greenhouse effect, global warming, climate change and sea level rise. CO<sub>2</sub> can be produced from a variety of sources, the amount of which can be increased by human activities.

Students need to research the topics of CO<sub>2</sub> production, greenhouse effect and global warming, by doing a series of web quests. These websites are provided and the students are given 1-2 class periods to research the sites and answer questions so that their understanding of the topics are clear. Often students have misconceptions in these areas.

Following a classroom discussion about the three topics (1 class period) students will investigate the amounts of CO<sub>2</sub> from four sources in a controlled experiment.(1 class period). The technique of acid/base titration will quantitate the results.

The lesson is geared towards 10<sup>th</sup>- 11<sup>th</sup> grade high school students who are taking, or have taken, chemistry.

**STANDARDS** These standards are from the NECAP (New England Common Assessments Program) to which the states of Rhode Island, New Hampshire and Vermont belong. They were recently adopted, and testing in science was begun last spring. Our curriculum is currently being aligned to all of the standards.

- **ESS1(9-11) SAE + POC – 3 (Ext)** Students demonstrate an understanding of processes and change over time within earth systems by using computer modeling/simulations to predict the effects of an increase in greenhouse gases on earth systems
- **LS2(9-11) INQ + SAE – 3bb** Students demonstrate an understanding of equilibrium in ecosystems by researching and citing evidence of global warming to describe the potential impact on both the living and physical systems on earth.
- **LS2(9-11) NOS- 5b** Students will evaluate potential bias from a variety of media sources in how information is interpreted by applying additional scientific data to develop logical arguments concerning environmental issues
- **LS4(9-11) NOS + INQ-9b** Students demonstrate an understanding of how humans are affected by environmental factors by providing an explanation of how the human species impacts the environment and other species.
- **PS2(9-11) INQ + SAE – 6a** Students demonstrate an understanding of physical, chemical and nuclear changes by writing simple balanced chemical equations to represent chemical reactions and illustrate the conservation of matter.

#### **RELEVANT VOCABULARY**

global warming  
greenhouse effect  
titration

acid  
base

## OBJECTIVES:

1. To research the effects of increased CO<sub>2</sub> levels on greenhouse effect, global warming and climate change.
2. To identify sources of CO<sub>2</sub> and compare amounts from some sources of CO<sub>2</sub> in an investigation using a titration technique.
3. To identify the connection between CO<sub>2</sub> sources and human activities.

## WEB QUEST

Each group of 2-4 students will go to the computer lab for 1-2 class periods. Each group will research (1) gases and sources of gases linked to the green house effect

(<http://teachersdomain.org/resource/tdc02.sci.life.eco.greenhouse/>)

(2) how the greenhouse effect works

(<http://teachersdomain.org/resource/phy03.sci.ess.watercyc.co2/>)

(3) global warming : *Top Ten Things You Need To Know About Global Warming* by Susan Joy Hassol (<http://hdgc.epp.cmu.edu/teachersguide/teachersguide.htm>)

## LAB INVESTIGATION: *Determining Amounts of CO<sub>2</sub>*

Following the Web Quest and class discussion, students will be introduced to the lab *Determining Amounts of CO<sub>2</sub>*. This lab was adapted from *Bringing the Greenhouse Effect Down to Earth* ([http://teachersdomain.org/resources/ess05.sci.ess.watcyc.lp\\_global1](http://teachersdomain.org/resources/ess05.sci.ess.watcyc.lp_global1))

Each group of students (2-4) will work on a pre-lab assignment so that they are familiar with the topic, technique and lab materials. They will be required to establish a purpose, hypothesis and list of materials needed for the investigation as well as construct a data table.

### PreLab

1. From your WebQuest identify some sources of CO<sub>2</sub>. Which source(s) are controlled by humans and which are not? Of those that are controlled by humans, which one(s) have the greatest effect on global warming? Explain. Describe the car analogy as it relates to the greenhouse effect. What are 5 facts about CO<sub>2</sub> as it relates to the greenhouse effect?
2. Read over the lab and answer the following:
  - (a) What are the sources of CO<sub>2</sub> that you will be analyzing in the lab?
  - (b) Make a list of materials that you will need for this lab.
  - (c) Construct a data table that will allow you to record all of your information.
  - (d) Describe the technique of titration. (You may need to consult your textbook)
3. When you have answered the above questions, show your materials list and data table to your teacher so that you may begin the lab.
4. In your lab notebook, write down an appropriate purpose and hypothesis for this lab.

## ***Determining Amounts of CO<sub>2</sub>***

**Purpose** To compare the amount of CO<sub>2</sub> found in four different sources of the gas.

**Materials** For each group (2-4) students:

- 5 test tubes 25 x 150 mm
- Test tube rack
- 2 graduated cylinders, 1 – 25 ml and the other, 100ml
- 4 different colored balloons with twist ties
- BTB(bromthymol blue) indicator solution in dropping bottle
- Dilute household ammonia indicator solution in dropping bottle (1 part ammonia/50 parts water)
- 100 ml of vinegar
- 5 grams of baking soda
- Balance and weighing paper
- Spatula
- Funnel
- Drinking straw and marble size piece of modeling clay
- Narrow neck bottle or 125 Erlenmeyer flask – opening must allow a balloon neck to fit over it
- Safety goggles
- Marking pencil or grease pencil
- Piece of paper 8 1/2 x 11
- Tape
- Centimeter ruler

### **Lab Procedure**

1. Add 15 ml of water using the graduated cylinder to each test tube; then add 10 drops of BTB indicator. Label the test tubes A, B, C, D and Control.
2. Cut a strip of paper about 1.0 cm x 10.0 cm. Overlap the ends and tape in place to create a 7.5 cm circle. This is your balloon sizer – to make sure each inflated balloon is the same size.
3. Fill each balloon until it has a diameter of 7.5 cm according to the following:
  - Sample A (ambient air) – Use a bicycle tire pump to inflate the balloon to 7.5 cm. Twist the neck of the balloon and fasten it shut with the twist tie. The twist tie should be at least 1 cm from the opening of the balloon. Record the color of this balloon in your data table.
  - Sample B (human exhalation) – Have one group member blow up a balloon to 7.5 cm. Twist and tie the balloon. Record the color of this balloon in your data table.
  - Sample C ( automobile exhaust) – Your teacher will supply you with this balloon. Record the color of this balloon in your data table.
  - Sample D (nearly pure CO<sub>2</sub>) – Using the graduated cylinder, put 100ml of vinegar in the Erlenmeyer flask. Using the funnel, slowly add the 5 grams of baking soda. Let the mixture bubble for about 5 seconds to drive the air out of the flask. Slip the balloon over the neck of the flask and inflate the balloon to 7.5 cm diameter. Twist and tie the balloon and record its color in your data table.

4. Take the piece of clay and wrap it around one end of the straw to make a small airtight collar that will fit into the neck of the balloon, acting like a plug. You will use this apparatus to transfer each of the gas samples to the test tubes.
5. Pick up balloon A. Keeping the tie on, carefully slip the balloon's neck over the clay collar and hold the neck against the collar to make an airtight seal. Place the other end of the straw into the test tube with the water and BTB marked A. Have another group member remove the tie and slowly untwist the balloon. Keeping the neck of the balloon pinched to control the flow of gas, gently squeeze the balloon so the gas slowly bubbles into the solution. Observe the color of the solution and record in your data table.
6. Repeat the same procedure with the other balloons (B, C and D) making sure to record your observations in the data table.
7. **Titration** You will now determine the relative amount of CO<sub>2</sub> present by titrating each sample with drops of dilute ammonia. BTB will return to its original color when all of the acid has reacted with the ammonia. Carefully count the number of drops of ammonia added to each test tube and record in your data table.

### Concluding Questions:

1. Based on your data, which source of CO<sub>2</sub> contains the most CO<sub>2</sub>? The least amount of CO<sub>2</sub>? Explain.
2. Which source(s) are controllable by human activity?
3. Do you think any of these sources will have an effect on the greenhouse effect? On global warming? On climate change? Explain.
4. How was the CO<sub>2</sub> produced by the automobile? Write the chemical reaction.
5. How was the CO<sub>2</sub> produced by the vinegar and baking soda? Write the chemical reaction.

**Going Further:** As a research report or project, investigate one of the following for extra credit:

1. Complete a Family Driving Fact Sheet and a Family CO<sub>2</sub> Contribution Worksheet to calculate the amount of CO<sub>2</sub> emitted in a year.  
([http://teachersdomain.org/resource/ess05.sci.ess.watcyc.lp\\_global1](http://teachersdomain.org/resource/ess05.sci.ess.watcyc.lp_global1))
2. Investigate the effect of CO<sub>2</sub> (global warming) on the melting of the glaciers and sea level rise. (<http://teachersdomain.org/resource/ess05.sci.ess.watcyc.climatechange/>) and (<http://teachersdomain.org/resource/ess05.sci.ess.watcyc.sealevel/>)

### ASSESSMENT:

1. Each group of students is required to submit:
  - (a) completed Web Quest sheet – answer questions based on participation in the Web Quest assignment
  - (b) completed PreLab sheet
2. Each student is required to complete a formal lab report based on the investigation *Determining the Amounts of CO<sub>2</sub>* including purpose, hypothesis, materials list, data table, concluding questions and conclusion.
- 3.