

Learning Cycle Planner

CO2 Aquariums Greenhouse Gas Lesson

Common Curriculum Goal:

Topics: Systems thinking, global climate change, ecological preservation

Learning Objective: Observe and measure the heat trapping capacity of CO₂, the principle green house gas. Learn the role of CO₂ in climate change.

Exploration Phase:

Hands-on Activity: “CO₂ Aquariums” Measure heat trapping capacity of CO₂ (materials and procedure below).

Exploration through Media:

NPR videos “It’s All about Carbon” <http://www.npr.org/news/specials/climate/video/>

Bath Tub Simulation: http://www.sustainer.org/tools_resources/climatebathtubsim.html

Concept Development Phase:

Concepts to be taught: Carbon cycle, Heat transfer, energy flow in ecosystems, human impact on ecosystems and climate, non-renewable energy, resource consumption, pollution.

Procedures to be taught: Inquiry, experimental design, data collection over time, graphing, interpreting results, using computer models and simulations.

Activities: NPR videos “It’s All about Carbon” (Krulwich, 2009)

<http://www.npr.org/news/specials/climate/video/> Use for class discussions and worksheet (questions below).

Connections to other Lessons:

Ecosystem in a Bottle, Ocean currents, Chemistry- CO₂ molecules, non-polar covalent double bonds

Teaching across the Curriculum:

Social studies- culture of consumption responsible for ongoing CO₂ level rise, behavior change

CO2 Aquariums Experiment

(Adopted from Horning, 2009 and altered by Orzali, 2009)

Allow at least one 45 minute class period to set up and then 5 – 10 minutes each class period for the duration of the experiment.

Materials:

2 aquariums, 3 thermometers, cardboard, duct tape, vinegar, baking soda, balloons, heat lamp (if it is not possible to place both aquariums near windows with similar solar gain), and large paper for data record.

Procedure:

1. Set up two aquariums, each with a thermometer and one heat lamp or direct sun exposure, set both aquariums next to windows with the equal sun exposure. For example, both windows should face the south and have similar amounts of solar gain.
2. In one of the aquariums add CO₂ gas and cover the top and in the other just cover the top. Then take measurements over a 1-2 week period. Use the table below to record the data and have students make their own data tables in their notebooks.
3. The CO₂ gas must be produced and then added to Aquarium B. To do this place 1 teaspoon baking soda (4g sodium bicarbonate) in a balloon.
4. Add 4 tablespoons of vinegar (60 ml of 5% acetic acid) into a 1 liter water bottle.
5. Stretch the mouth of the balloon over the mouth of the bottle then turn the balloon completely upright so that the baking soda inside the balloon pours into the vinegar.
6. The balloon will fill with CO₂ rapidly. Remove the balloon from the 1 liter bottle and seal by holding it tightly.
7. Attached the balloon to a nozzle on Aquarium B and squeeze it to force the CO₂ into the aquarium.
8. Repeat steps 3-7 each class for the duration of the 2 week data collection period.
9. Keep records of each aquarium's temperature, the classroom temperature, and date/time side by side. Have students graph the results after all the data is collected.

Helpful information:

Allow 15 minutes for introduction to the experiment. Identify students on a daily basis who will produce and inject CO₂ into Aquarium B at the beginning of class each day. Rotate the schedule so that all students have the opportunity to participate. End class each day with an update of the temperature readings and data recording for the class and in each student's notebook.

Thermometers should be attached to the inside of the aquariums in advance so they can clearly be read. A Thermometer to monitor the classroom temperature should be set in a location near the aquariums and also be receiving a similar amount of solar gain. Baking soda and vinegar react to form CO₂. This reaction is endothermic and requires heat, or will take heat from the area in which the reaction takes place. For this reason, it

is important to produce the CO₂ outside the aquarium and then “inject” it into the aquarium.

The tops of the aquariums will be thick cardboard fastened down with duct tape. This is not the most airtight apparatus, but it is accessible and adequate. In the cardboard top of Aquarium B make a hole that can be completely covered by a screw top nozzle from a 1 liter bottle (the nozzle should come from a bottle similar in size to the one in which the vinegar was placed and the balloon attached). Use duct tape to attach the nozzle and keep the cap on, except to attach the balloon and squeeze CO₂ in to the aquarium. Adding CO₂ continually over time assures that CO₂ will remain at a high level in Aquarium B and should result in higher temperatures as more heat is trapped by CO₂ than in Aquarium A.

Activity worksheet

It's All About *Carbon*

Name _____

Directions: Answer question from the videos

<http://www.npr.org/news/specials/climate/video/>

1. “Getting to the heart of climate change science” requires understanding a lot about what atom?
2. Name 5 things that are made of carbon (primarily).
3. Why are all these things made of Carbon?
4. Draw the structural formula of ethanol.
5. Draw the structural formula of fructose.
6. What proves that Carbon bonds are very strong?
7. Explain how oil was formed in the Middle East.
8. Oil is ancient life that is _____.
9. Coal is ancient life that is in a _____.

10. Natural gas is _____ that is a vapor.
11. How do you get the energy out of paper (or any other fuel)?
12. Why is a fire warm?
13. How do you get energy from food?
14. (Maybe) Human civilization began when we figured out how to break what?
15. Carbon is the atom of _____, meaning more carbon bonds you break the more \$\$\$ you have.
16. New CO₂ gets absorbed by the _____ and by _____. Dumping more
17. CO₂ into the atmosphere increases the _____ effect.
18. The rest of the CO₂ goes into the _____, where sunlight reflected from the earth hits it and causes it to _____ which leads to global _____.
19. Name 4 of the main characteristics of Carbon.
20. What are 3 strategies for putting less CO₂ into the atmosphere?
21. Global warming is less about science and more about _____.

References:

Fiddaman, T., Sterman, J., Sweeney, L. B., Senge, P. & Caperton, I. (2004). Climate Bath Tub Simulator. Retrieved June 25, 2009, from, http://www.sustainer.org/tools_resources/climatebathtubsim.html

Horning, K. (2009). *Middle school climate change unit*. Unpublished project, Portland, OR.

Krulwich, R. (Director/Writer). (2009). It's all about carbon [Video]. Climate Connections NPR and National Geographic. Retrieved July 27, 2009, from, <http://www.npr.org/news/specials/climate/video/krulwich.html>

© Joe Orzali 2009