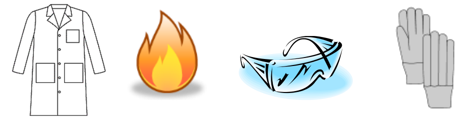
Dry Ice Investigation Lab; SB4bd, SB3a



Dry ice is the solid form of carbon dioxide gas. It is an interesting substance in that it sublimates, or changes directly from the solid to the gas phase. Since the liquid state is bypassed, dry ice does not melt. The solid magically seems to disappear as it changes to CO_2.

Carbon dioxide is a very common substance and the main element in the carbon cycle. It is a byproduct of cellular respiration, a reactant of photosynthesis. You exhale the very same type of molecules that are in dry ice. Ecosystems are dependent on abiotic factors like CO_2. As you have learned these materials (nutrients, etc.) cycle through ecosystems; however, this can be difficult to conceptualize since we cannot always see matter cycling.

Please exercise caution when using dry ice. The temperature of the solid is very low (-110 f). Dry ice absorbs heat from its surroundings. You will need to pick up the dry ice with a towel, tongs, or forceps. Tissue damage or frostbite can result from the improper handling of dry ice. The purpose of this lab is to relate changes in carbon dioxide to the cycling of matter and nutrients in ecosystem and to also understand the effects of carbon dioxide as a greenhouse gas in the biosphere.

Pre-Lab: Read through the entire lab. In addition to the usual lab write-up, you will need to 1) write a brief synopsis for the background information for both parts of the lab; 2) create a double bubble map that differentiates between greenhouse effect and global warming; 3) explain how bromophenol blue is used as a pH indicator.

Part 1: Exploration-

1. Obtain a small piece of dry ice. Place it on the counter of your lab station and observe. *What two states of matter are present?*

2. Place the dry ice in a 50 ml beaker or cup. Tightly cover the beaker with the palm of your hand. *What do you experience? Explain, in terms of molecular motion and_kinetic energy, why gas molecules can exert the pressure that you feel beneath your hand.*

3. Place the dry ice on the countertop. Using forceps push a coin vertically down into the ice. *Why does the coin vibrate? Why does icy frost form on the surface of the coin*?

4. Slide the block of dry ice across the table and attempt to have the block of ice come to rest as close to the edge as possible. *Why does dry ice slide so easily*?

5. Using an eyedropper, make a small (the size of a quarter) puddle of water on the counter. Using forceps, place a tiny piece of dry ice in the puddle. *What do you observe*?

6. Place several small pieces of dry ice into a clear plastic cup. Cover the cup with your hand to prevent the gas that forms from escaping. Have your partner light a candle. "Pour" the gaseous carbon dioxide over the candle flame. *What happens to the flame? Based on your observations, is CO2 lighter or denser than air?*

7. Add enough water to the dry ice in the plastic cup to cover the dry ice. Observe. Watch carefully. Once the bubbling begins to subside or slow down, you can notice that the dry ice is encapsulated by a layer of regular ice. The water in the cup will actually freeze around the outside of the dry ice. Add some tap water to the cup. The ice layer will melt and the dry ice will be free to bubble once again*. What is inside the bubbles that form?*

8. Add a few drops of Dawn detergent to the water in the cup. Stir to mix. Dip your fingers into the soapy water and spread a film of soap over the top of the cup. Watch as the carbon dioxide gas expands under the soap film to make a ghostly bubble*! What is the change of state from a solid to a gas called?*

9. Place a small piece of dry ice into a plastic 35mm film canister (if available), then wait. The cap will pop off and sometimes fly several meters. DO NOT AIM THE CANISTERS AT ANYONE. *What caused this to occur*?

Dry Ice Investigation Lab; SB4bd, SB3a (Part 2- Application)

The movement of carbon, in its many forms, between the biosphere, atmosphere, oceans, and geosphere is described by the carbon cycle. The carbon cycle is one of the biogeochemical cycles. In the cycle there are various sinks, or stores, of carbon and processes by which the various sinks exchange carbon. We are all familiar with how the atmosphere and vegetation exchange carbon. Plants absorb CO_2 from the atmosphere during photosynthesis and release CO_2 back in to the atmosphere during respiration. Another major exchange of CO_2 occurs between the oceans and the atmosphere. The dissolved CO_2 in the oceans is used by marine biota in photosynthesis. Two other important processes are fossil fuel burning and changing land use. In fossil fuel burning, coal, oil, natural gas, and gasoline are consumed by industry, power plants, and automobiles. Changing land use is a broad term which encompasses a host of essentially human activities. They include agriculture, deforestation, and reforestation.

Incoming energy from the sun is absorbed by the Earth and then redistributed by atmospheric and oceanic circulation before being radiated back to space. Naturally occurring 'greenhouse gases' in the Earth's atmosphere—water vapor (H2O), carbon dioxide (CO2),ozone (O3), methane (CH4) and nitrous oxide (N2O)—absorb some of this outgoing thermal radiation, which is ultimately reflected back to warm the Earth's surface. This phenomenon is typically known as the 'greenhouse effect'. An enhanced greenhouse effect is now considered to be occurring, due to substantially higher concentrations of greenhouse gases in the atmosphere. This is causing global warming and climate change. The oceans are not exempt. Sea level is rising, the oceans are becoming more acidic, species are changing habitats and migrating, corals are bleaching, and storms are becoming stronger and more frequent.

The current increase in global temperature of 0.7°C since pre-industrial times is already disrupting life in the oceans, from the tropics to the poles. The species affected include everything from plankton to corals, fish, polar bears, seals, penguins, and seabirds. Nearly half the CO2 produced by human activities in the last 200 years has been absorbed by the ocean. The ocean is now becoming more acidic as a result. When CO2 dissolves into water, it forms carbonic acid. As pH decreases (becomes more acidic), it decreases the ability of shellfish to make their shells and corals to build their skeletons. All coral need calcium carbonate ($CaCO_3$), which is a basic substance (high pH) used to build their skeletons.

Part 2: Application-

Obtain a beaker from the front of the classroom. Add 200 ml of water and 6 grams of table salt to the beaker. This will be your ocean. Next, add 3 ml of bromophenol blue solution to your ocean. Bromophenol blue is a pH indicator that will turn from blue to yellow as pH decreases and the solution becomes acidic. Your healthy ocean should be blue to start.

10. Place a small piece of dry ice into your ocean. *Describe what happens to the ocean and why this is harmful to marine ecosystems.*

11. Pour your ocean down the drain and make a new ocean using the same steps outlined above. Using a straw blow into the ocean until the same color change occurs. *If marine organisms also release CO_2 through cellular respiration, develop an explanation for why the ocean is not already acidic due to organisms' natural metabolic processes like cellular respiration*.

12. Place an antacid tablet into your ocean. *Describe what occurs*. Blow into the solution through the straw again. *Explain what happens using the term "buffer" in your explanation*.

13. *Write a paragraph explaining which specific human activities are directly influencing the amount of CO_2 in the atmosphere. Describe how this can potentially lead to global warming*.

14. In our anemone and elodea tanks, the pH levels steadily increase during the school day when the lights are on, while at night the pH levels decrease. *Formulate a hypothesis to explain this phenomenon*.