

Experiments with Dry Ice

A Chemistry Activity

Dry ice is frozen carbon dioxide, or $\text{CO}_2(\text{s})$. Carbon dioxide is normally a gas at room temperature and is found in small amounts in our atmosphere. Animals breathe out carbon dioxide and plants use carbon dioxide to grow.

Water freezes into ice cubes at 32°F (0°C). Carbon dioxide freezes at about -110°F (-79°C), so it is very cold. At normal air pressure, frozen carbon dioxide does not melt; it changes directly from a solid to a gas, leaving no puddle of carbon dioxide. When something changes directly from a solid to a gas, we say that it sublimates.

Because dry ice is so cold and because it skips being a liquid under normal air pressure, lots of really fun experiments can be done with dry ice.



Materials Needed:

See instructions below for materials needed for each activity. The materials are given in parenthesis after each activity description.

Safety Considerations:

- Kids should never use dry ice without adult supervision.**
- Always wear lab goggles when doing dry ice experiments.
- The biggest safety issue with dry ice is the fact that it is very cold. Do not touch dry ice with your bare skin! Use tongs or insulated gloves. Dry ice can cause severe frostbite. Never eat or swallow dry ice.
- Garden gloves, work gloves, or winter gloves work well for handling dry ice.
- Adults can buy dry ice at the customer service area of many large grocery stores.
- Never store dry ice in an airtight container. As the dry ice sublimates, pressure will build up until the container bursts, sometimes explosively. A styrofoam chest is one of the best ways to store dry ice.
- Never store dry ice in an unventilated room or car. If carbon dioxide builds up, you will not be able to breathe. Leave a crack in a window or door.
- A hammer works well for breaking up dry ice into smaller pieces.

Instructions:

1. Inflate a Balloon or Ziplock bag

Using crucible/barbeque tongs or a gloved hand, place a piece of dry ice about the size of a small gummy bear into a balloon. Once it is in the balloon, quickly crush it using gloved fingers. Tie off the balloon, and set it aside for later. The same thing can be done with a Ziplock bag, except use slightly less dry ice. (*gloves/tongs, dry ice, balloons, Ziplog bags*)

2. Popping Film Canisters

Place a small piece of dry ice into a plastic 35mm film canister, then wait. The cap will pop off and sometimes fly several meters. The clear Fuji brand containers shoot farther than the gray and black Kodak type. **DO NOT AIM THE CANISTERS AT ANYONE!** (*gloves/tongs, film canisters, dry ice*)

3. Hero's Engine

This experiment was done thousands of years ago by the Greek scientist Hero using the steam generated by boiling water. We will do it with the gas generated by subliming dry ice. Using a push-pin, poke two holes into opposite sides of a film canister, near the bottom. The holes should be off-center, like pinwheel rockets. Tie a loop of thread, fitting loosely over the cap like the diagram below. Loop it over the cap in a manner such that when you snap the cap onto the canister, you can hold the canister by the remaining length of thread. Place a small piece of dry ice into the can. Then, quickly add some warm water, and close the lid with the thread attached. Lift the can by the thread, and watch what happens! You have created a little pinwheel motor, power by the escaping carbon dioxide gas. (*gloves/tongs, film canisters, push pin(s)*) (*recommend that holes be pre-punched in film canisters, thread, warm water, dry ice*)

4. Sound Lens Using a Balloon

A balloon full of carbon dioxide gas can act as sound lens, because sound travels more slowly in carbon dioxide than it does in air, much like light travels more slowly in glass than in air or a vacuum. Using the balloon from Experiment 1, hold the balloon about a foot from your ear and listen for faint sounds, such as a radio turned low, a ticking clock, or a distant conversation, to appear louder. (*See Experiment 1*)

5. Singing quarter

Press a warm quarter firmly against a chunk of dry ice. The quarter will scream loudly as the heat of the quarter causes the dry ice to instantly turn to gas where the two make contact. The gas pressure pushes the quarter away from the dry ice and, without contact, the dry ice stops sublimating. The quarter falls back into contact again, and the cycle repeats. This happens so quickly that the quarter vibrates, causing the singing sound. (*gloves, quarters, dry ice*)

6. Dry Ice in Warm vs Cold Water

Place a small amount of dry ice into a small cup/beaker of cold water and a small cup/beaker of warm water side-by-side. Have the kids compare their observations and offer an explanation as to why one may look different from the other. The warm water causes the dry ice to sublime much faster. The "cloud" or "smoke" is caused by water condensing inside of the bubble to form tiny droplets of water. The "cloud" is released when the bubble makes it to the top of the water and bursts. The "cloud"/CO₂ mixture cascades down because the water droplets and CO₂ are denser than air. (*Gloves/tongs, clear cups or beakers, warm and cold water, dry ice*)

7. Can You Dye the Fog?

As Experiment 6 progresses, add one drop of food coloring to the water and see if that color is incorporated into the fog. (*See Experiment 6, plus food coloring*)

8. Lots of Bubbles!!!

In a glass/cup/beaker of warm water, add a squirt of dishwashing liquid. Place a small amount of dry ice into the warm water. Bubbles will begin to climb out of the container. Very cool. (*gloves/tongs, glass/cup/beaker, warm water, dishwashing liquid, dry ice*)

9. Floating Bubbles

Fill the bottom of a small aquarium-like tank about an inch deep in warm water. Add a few pieces of dry ice. Using a bubble wand and bubble fluid, blow a few bubbles into the aquarium. A few bubbles will appear to float in mid-air! The bubble is just floating on a cushion of invisible carbon dioxide gas. (*Gloves/tongs, aquarium tank, warm water, bubble wand with bubble fluid, dry ice*)

10. Acid-base Properties of Dry Ice in Water

Fill a beaker or clear plastic cup about 1/2 full of water. Stir in about 3-4 drops of an acid-base indicator: Yamada (universal) works best. Add a small piece of dry ice. Notice how the indicator changes color as the water becomes more acidic. Carbon dioxide forms carbonic acid when it reacts with water. (*Gloves/tongs, clear plastic cups or beakers, water, Yamada indicator, dry ice*)

Here are a few resources and websites that can give you additional information about dry ice experiments:

Dry Ice Investigations for Grades 6-8, LHS GEMS, Lawrence Hall of Science, University of California at Berkeley, 1999.

<http://www.wrh.noaa.gov/vef/kids/dryice.php>

A concise page from the National Oceanographic and Atmospheric Administration detailing safety issues with dry ice.

<http://www.west.net/~science/co2.htm> *The Saturday Scientists.*
Seven really good dry ice experiments!

<http://www.deepscience.com/experiments/dryiceday.html>
Fourteen short dry ice experiments.

<http://www.stevespanglerscience.com/experiment/00000055>
Colorado chemist Steve Spangler details six great dry ice experiments.