

COOKING UP LIFE IN A COMET

Comets are small, icy bodies that orbit the Sun. They spend most of their time in the cold outer regions of our solar system as frozen relics of the material that formed the Sun and planets. Every once in a while, a comet comes near the Sun, heats up, and forms a tail of ice and dust that makes a spectacular show in the night sky. Comets give us clues about how Earth was formed and about the chemical activity at the time life originated. They play an ongoing role in the evolution of life on Earth.

Comets are sometimes called “dirty snowballs” and are made of interstellar ice, dust, and rock. The ices are frozen states of water (H_2O), ammonia (NH_3), and a number of organic compounds such as carbon monoxide (CO), carbon dioxide (CO_2), methane, (CH_4), ethane (C_2H_6), formaldehyde (CH_2O), alcohols (methanol and ethanol), long-chain hydrocarbons, and amino acids. They are held together by gravity.

The demonstration, “Let’s Make a Comet,” at Griffith Observatory teaches a number of fundamental physical and chemical concepts that are aligned with the California State Standards.

WARNING: Dry ice is $-79^{\circ}C$. ($-110^{\circ}F$.) and can cause frostbite or burns if brought in contact with the skin. Thick, thermally insulating gloves should be worn at all times when handling dry ice. This is an adult demonstration only. Children should not handle dry ice and must be supervised at all times in its presence.

Materials and Comet Ingredients

- sturdy ice chest
- 2 large mixing bowls
- large mixing spoon
- large resealable bags
- cold-resistant/chemical-resistant gloves
- safety goggles
- mallet (at least 3 pounds)
- towel
- paper towels for clean-up
- sand
- crushed charcoal (regular, not insta-light)
- glass cleaner (ammonia)
- water
- dry ice
- corn syrup



Preparation

Dry ice can be purchased from any ice store. Purchase enough (at least 5 pounds) to try the demonstration at least once before classroom use. Be aware that you will lose some ice over time due to sublimation in the cooler. It is wise to purchase more than you think you will need, especially if the demonstration is more than a day away.

Wearing the gloves, wrap the dry ice in the towel and crush it with the mallet. Allow the dry ice to sit in the ice chest for a few hours. Fresh dry ice tends to crush to a coarse texture rather than to the powdery consistency that you want. Put the dry ice in one of the mixing bowls and cover the towel.



LET'S MAKE A COMET!

Procedure

1. Place an empty resealable bag in the empty mixing bowl. Add, in order, the following ingredients
 - 1 cup of water
 - 3 spoonfuls of sand
 - 3-4 spoonfuls of crushed charcoal
 - 3-5 squirts of glass cleaner (ammonia)
 - a splash of corn syrup
2. Add 1½ cups of dry ice, and mix vigorously for about 30 seconds.
3. Wearing protective gloves, lift up the mixture, and squeeze it together to allow any run-off to spill into the mixing bowl. Hold the comet and allow it to freeze, for about 20-30 seconds.
4. Tear the bag open, you've made a comet!

Discussion

In order to mix the comet, a liquid water substrate is used. After the ingredients are mixed, the liquid is flash-frozen with dry ice to replicate the comet's true icy disposition.

- Water is the primary ingredient of comets and is a necessary ingredient for life as we know it.
- The sand and charcoal represent the rock and dust in the comet. Comets are surprisingly dark—as dark as charcoal! This is contrary to the familiar experience of ice as something shiny and bright.
- The glass cleaner and corn syrup represent the ammonia and organic molecules that are also found in comets. These compounds are essential ingredients for life on Earth and perhaps elsewhere.

Observing the comet over several hours can be quite enlightening. Over the course of about 3-4 hours, the comet will sublime and release wisps of carbon dioxide. Eventually it becomes a crater-filled mass before it melts completely to a sludgy residue. The formation of a comet tail can be simulated by using a hair dryer on a low setting to pass warm air over the comet.

