

Making a Comet in the Classroom

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Halley's Comet, March 1986, photographed using the Burrell Schmidt telescope at Kitt Peak National Observatory. (Farnham & Meech, *Ap.J. Supplement*, 1994, 91, 419.) To create the nucleus of Comet P/Halley from the following recipe, all ingredients must be increased by a factor of 300 trillion, +/- 20%.

A dramatic and effective way to begin a unit on comets is to make your own comet right in front of the class. The ingredients for a comet are not difficult to find and watching a comet being "constructed" is something the students will remember for a long time.

The "ingredients" for a six-inch comet are:

- 2 cups of water
- 2 cups dry ice (frozen carbon dioxide)
- 2 spoonfuls of sand or dirt
- 2 teaspoons of corn starch
- a splash of white vinegar
- a dash of rubbing alcohol (it is an antifreeze)
- a dash of organic material (dark corn syrup works well)

Other materials you should have on hand include:

- an ice chest
- a large mixing bowl (plastic if possible)
- 4 medium-sized plastic garbage bags
- work gloves
- a hammer, meat pounder, or rubber mallet
- a large mixing spoon
- paper towels
- safety goggles

Dry ice is available from ice companies in most cities (look under "ice" in the Yellow Pages for a local source). Day-old dry ice works best, so you might want to buy it the afternoon before the day you do the activity. Keep the dry ice in an ice chest when transporting it and in your

refrigerator's freezer compartment overnight. Most ice companies have a minimum on the amount of ice they will sell (usually 5 pounds). But having extra dry ice on hand will be useful because some will evaporate and also because it is advisable to practice this activity at least once before doing it with the class.

Here are the steps for making a 6-inch comet (students make good baker's assistants for this exercise!):

1. Cut open one garbage bag and use it to line your mixing bowl.
2. Have all ingredients and utensils arranged in front of you.
3. Place water in mixing bowl.
4. Add sand or dirt, stirring well.
5. Add dash of ammonia
6. Add dash of organic material (e.g. corn syrup), stirring until well mixed.
7. Place dry ice in 3 garbage bags that have been placed inside each other. Be sure to wear gloves while handling dry ice to keep from being burned.
8. Crush dry ice by pounding it with hammer.
9. Add the dry ice to the rest of the ingredients in the mixing bowl while stirring vigorously.
10. Continue stirring until mixture is almost totally frozen.
11. Lift the comet out of the bowl using the plastic liner and shape it as you would a snowball.
12. Unwrap the comet as soon as it is frozen sufficiently to hold its shape.

Now you can place the comet on display for the students to watch during the day as it begins to melt and sublime (turn directly from a solid to a gas - which is what carbon dioxide does at room temperature and comets do under the conditions of interplanetary space when they are heated by the Sun).

The comet is reasonably safe to touch without getting burned by the dry ice, but it is still best to have a spoon or a stick for the students to use while examining it. As the comet begins to melt, the class may notice small jets of gas coming from it. These are locations where the gaseous carbon dioxide is escaping through small holes in the still frozen water. This type of activity is also detected on real comets, where the jets can sometimes expel sufficient quantities of gas to make small changes in the orbit of the comet.

After several hours, the comet will become a crater-filled ice ball as the more volatile carbon dioxide sublimates before the water ice melts. Real comets are also depleted by sublimation each time they come near the Sun. Ultimately, old comets may break into several pieces or even completely disintegrate. In some cases, the comet may have a solid, rocky core that is then left to travel around the comet's orbit as a dark barren asteroid.