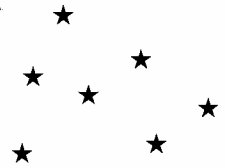


# Cookin' Up a Comet



## Background

As long as the night sky is clear, we can see that it is filled with twinkling stars. Other objects can be seen too, such as the Moon or planets depending on the timing. One of the more exciting and rare things to see in the night sky is a comet, which appears as a fuzzy light with a tail streaming behind.

Why do comets look so undefined when other objects are clearer and unchanging? The answer lies in what comets are made of and what happens to them when they get close to the heat of the Sun. We often hear of comets described as “dirty snowballs,” a model that Harvard astronomer Fred Whipple came up with in 1950 that describes comets as being made of rock and ice. Today, by studying the light that comes from the comets, scientists can determine the presence of specific substances: frozen water, frozen carbon dioxide and other frozen gases, dust and rock, and organic (carbon-based) substances.

The comet takes on its familiar shape as it nears the Sun. When a comet moves through the Solar System, the Sun’s heat begins subliming the ice and releasing gas and dust from the core of the comet, called the nucleus. As the ices turn to gas, they shoot away from the nucleus in jets. This process is called outgassing. A fuzzy cloud of dust and gas forms around the nucleus and is called the coma. The solar wind and pressure from sunlight push the coma of the comet away from the Sun, forming two tails, a yellowish dust tail and a blue tail of gas particles.

## Topics

Composition of comets  
Physical features of comets

## Objectives

Students will:

- Compare and identify the parts of the comet model to the parts of a real comet.
- Describe how comets change over time.

## Overview

Students will learn the basic components of a comet and demonstrate how the comet’s head and tail form by building a comet model.

## Key Question

What are the parts of a comet?

## Key Concepts

- We can use models to investigate distant or large objects at a scale that is easily used by humans.
- Comets are made of dust, rock, and ice, which changes to a gas when it comes close enough to the Sun.

## Materials & Preparation

- 5 lbs (~ 2 kg) dry ice pellets or block
- 3 cups of water
- A few drops of ammonia
- A handful of sand
- A can of soda (cola)
- A large wide mixing bowl
- A large wooden or plastic spoon for stirring
- A hammer
- A large metal tub
- Heavy dishwashing gloves
- Protective eye goggles (1 pair per student)
- Cloth or paper towels
- Optional: Overhead projector, hair dryer, and plastic wrap

**CAUTION!** Dry ice is  $-79^{\circ}\text{C}$  ( $-110^{\circ}\text{F}$ ). Any more than brief exposure will cause “burns.” Everyone handling dry ice should wear heavy rubber dishwashing gloves! Be sure to discuss safety precautions with students when working with dry ice.

1. **Put on rubber gloves.** Using a hammer, crush the dry ice pellets or block in the large metal tub to the consistency of snow. Everyone should wear protective eye goggles. **DO NOT HANDLE THE DRY ICE WITH-OUT PROTECTIVE GLOVES!!**

2. Pour 18 oz (2.5 cups) of water into the mixing bowl. Add a handful of sand, a little ammonia, and the cola, mixing as you pour.
3. Add 2.5 cups of dry ice to the mixture, stirring carefully. Vapor will form as you stir, and the mixture will get slushy. Keep stirring for a few seconds while it thickens.
4. Use the mixing spoon to clean the slush away from the sides of the bowl into the bottom. Reach in and pack the slush into a ball. Keep packing and forming until you have a ball that forms a big lump. Too dry and the mixture is not sticking, add water. Too wet and slushy, add more dry ice.
5. **DO NOT HANDLE DRY ICE MIXTURE WITH BARE HANDS!**
6. Observe the behavior of your miniature comet nucleus.
7. Cool Comet Viewing Tip: So the whole class can watch the gas jetting out of the comet, use an overhead projector. Be sure to protect the overhead projector by covering the glass with plastic wrap. **CAUTION! Do not leave the comet on the projector long; the dry ice could damage it.**
8. Blowing hard on the comet gives a sense of simulating a comet tail. Some teachers use a hair dryer set on a low setting. Experiment for yourself. Discuss the parts of a comet using the Comet Fact Sheet on page viii.
9. The ingredients used to “build” a comet nucleus represent our current understanding of some of the components found in actual comets: frozen water, frozen carbon dioxide, ammonia, dust and rock, and organic (carbon-based) molecules.
10. Scientists have studied the spectrum of light coming from real comets’ comas and tails to determine the presence of these substances. The research carried out in the Comet Halley fly-by missions and the ICE mission to Comet Giacobini-Zinner provided further evidence of comet composition.
11. As the comet in this experiment melts, you can see little jets of gas coming off the model comet nucleus just like the observed “outgassing” of real comets, which can actually affect the movement of the comet. After further melting of the experimental comet, the

nucleus will begin to break apart just like real cometary nuclei after many passes by the Sun.

12. Discuss the Reflection & Discussion questions as a class.

### Management

#### THIS SHOULD ONLY BE DONE AS A TEACHER DEMONSTRATION.

Purchase dry ice from ice companies or ice cream parlors the day of or evening prior to the demonstration. If possible, get the pellet form of dry ice. Be sure to purchase five pounds of dry ice, although more will be needed if purchased the evening before. You will want to get enough extra for a test run at home the night before.

Store the dry ice in an ice chest. Place an inch or so of newspaper between the dry ice and the container to prevent the container from cracking.

Conduct this activity before using it in the classroom to get a feel for the correct amount of water to use.

### Reflection & Discussion

1. When you place the comet on the tray to observe, what part of the comet does it represent?
2. Describe changes, if any, in the comet after five minutes have elapsed.
3. Use the hair dryer to represent the Sun. Set the dryer on the low setting and blow air on the comet. What part of the comet begins to form? What happens when you move the hair dryer closer to the comet?
4. What does the air from the hair dryer represent?
5. What components of real comets are represented by each of the ingredients in your comet?

### Transfer/Extension

1. Research the differences between this model and a real comet. Experiment to see if you can come up with a better model.
2. Investigate where comets are believed to have spent the majority of their lives—either in the Kuiper Belt or the Oort Cloud.
3. Choose some other object, system, or phenomena, and ask your students to model it. How do models help us understand the world we live in?