Cook Up a Comet

Learn About Comets By Making One

About the Activity

The Cook Up a Comet activity gives insight into the "dirty snowball" model of comets- composed of material from the early solar system in the form of frozen water and gases, simple organic compounds, and dust. Using dry ice and simple household materials, this comet concoction is a big hit with kids and adults alike.

Topics Covered

- What a comet is made of
- How the Solar System formed

Participants

This activity can be done as a demonstration with families, the general public, and school groups ages 9 and up. To have school groups make their own comet, it is recommended that each group have adult supervision. See more tips on leading this as a group activity, see the Helpful Hints.

Materials Needed

- Measuring cup
- Large spoon
- Mixing bowl
- 4 black garbage bags
- Hammer (use one for many comets)
- Work gloves and protective goggles
- Dry Ice – 2 cups per comet
- To find dry ice in your area: http://www.dryiceinfo.com/
- Ammonia (window cleaner) – 2 Tbs.
- Dark corn syrup (or cola) – 1 Tbs.
- Water – 2 cups
- Dirt - 1/4-cup
- *(Optional)* Overhead projector and glass bowl or a heat lamp to show comet tail

Location and Timing

You can make a comet in a classroom, at a star party, with youth groups, and the general public. It can get a bit messy so it is good to have newspaper to put down if you are inside. The demonstration takes about 10-15 minutes.

Included in This Activity
Preparation Instructions
Detailed Activity Description
Helpful Hints
Background Information

Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov

Preparation Instructions

Collect all ingredients/materials in advance. It is strongly advised that you try the activity yourself first.

Detailed Activity Description

Activity Notes:
You can run this activity as a demonstration or as an activity where groups of participants get to make their own comet. Follow all safety guidelines below and make sure that your audience can follow directions or have adult supervision. See Helpful Hints at the end of the activity.

Instructions	**Narrative**
Step 1: Begin this activity by arranging all the ingredients and utensils in front of you on a sturdy worktable. You will need a helper who is wearing goggles and gloves. (If you will have each group make their own comet, see the Helpful Hints at the end of the activity.)	Everyone needs to be conscious about safety! We'll be using dry ice today. It can cause cold "burns" and flying chips can be damaging to eyes, so whoever handles the dry ice must always wear protective gloves and goggles.
Step 2: Open up one garbage bag and use it to line your mixing bowl. This will help you shape your comet, and make cleaning up easier at the end.	In our solar system, comets were part of what nature didn't clean up after the solar system was formed from a swirling disk of gas and dust called the solar nebula. As this nebula of gas and dust swirling around the sun cooled, it formed small rocks or planetesimals, which then gathered together to make bigger rocks, which ended up forming the planets and moons. Comets were the leftovers. You can think of them as the bits of dough left in the bowl when you make cookies.
Step 3: Add the 2 cups of water to the mixing bowl.	Comets have water in them. Water is made from just 2 elements – hydrogen and oxygen. The gases hydrogen and oxygen, as well as water vapor were probably all present in the solar nebula.

Step 4: Add 1/4-cup sand or dirt, stirring well.	You can't buy interplanetary dust at the store, so we have to use sand and dirt in its place. Sand and dirt have the minerals, and simple compounds that are found in comets. But dirt also contains bacteria, and mold, which are not found in comets. These living things have been created over the eons since the earth was formed.
Step 5: Next, add a dash of organic material (e.g. corn syrup or cola), stirring until well mixed.	Organic material means anything made up of carbon, hydrogen, nitrogen, and oxygen. Sugar, alcohol, and methane are all organic compounds. All living things are also made mostly of these four substances. Scientists have discovered that our Milky Way galaxy actually contains a very simple kind sugar that probably existed before the planets were formed! Corn syrup represents the simple organic compounds that were probably present in the solar nebula, and these helped form life later on.
Step 6: Add about 1/8 cup (2 Tablespoons) of ammonia and stir some more. You should have a muddy, slightly icky-smelling, sludge.	Ammonia, the same compound we use to clean windows, is another organic compound that existed in the solar nebula. The atmospheres of the giant planets Jupiter and Saturn contain large amounts of ammonia.
Step 7: Make sure your helper is wearing goggles and heavy gloves to handle the dry ice.	Dry ice is frozen carbon dioxide, the same gas that makes bubbles in soda pop. Most of the atmosphere of Mars is carbon dioxide. When a comet is far from the sun, its carbon dioxide is frozen into dry ice.
Step 8: (If your dry ice has already been crushed, read the narrative and go immediately on to Step 9.) Put the dry ice inside several plastic bags and crush it by pounding it with a hammer. You will need 2 cups of the crushed dry ice.	We crush the dry ice to make it mix with the water, dirt and organic material. All the "ingredients" in the original solar nebula were pretty evenly mixed, so our comet's ingredients should be well mixed with no really big lumps.

Step 9: .Have your helper scoop up 2 cups of the dry ice and add the dry ice to the other ingredients in the mixing bowl while stirring vigorously. Be sure to mix the ingredients quickly, for about 30 seconds. Move fast, as the dry ice will start to freeze the water right away.	Stirring is like the rotation of the solar nebula that "mixed" the original batch of comets as it whirled through space. Mixing also brings all the ingredients to the same temperature.
Step 10: Now take the spoon out and just let the comet sit for a minute or two.	Although most of our ingredients are at the same temperature as the surrounding air, the dry ice is about -79 degrees Celsius (or -110 degrees Fahrenheit). The dry ice cools the other ingredients until they are frozen solid. In space, real comets are usually so far away from the sun, they are even colder than this.
Step 11: Lift the comet out of the bowl by the plastic liner. Have one person hold the bag loosely. The person with the gloves should use their hands to compress and mold the contents for at least a minute. If you have more gloves, get others to help.	If the person holding the bag shuts it too tightly, the bag starts to blow up, or inflate. This is because some of the carbon dioxide is sublimating, or turning from dry ice into carbon dioxide gas. It's called "dry" ice because it never becomes a liquid. If a comet's orbit takes it near the sun and the sun heats it up, the surface of the comet starts to disintegrate and break down. Some comets go so near the sun that they completely fall apart and burn up.
Step 12: Unwrap your comet from the plastic bag, and you're done!	Don't worry if our comet doesn't look round and smooth. Real comets aren't either. Comets orbit the sun and have a variety of different orbital periods, ranging from a few years, to hundreds of thousands of years.
Step 13 *(optional)*: Place the comet in a glass bowl on an overhead projector that has been heating up for awhile. You can also use a heat lamp or very hot light bulb. See the Helpful Hints.	If a comet's orbit takes it near the Sun and the Sun heats it up, the surface of the comet begins to change directly from a solid into a gas and starts to form a long gossamer tail. As it heats up, and the ice that is holding it together disappears, it will shed some of its material leaving a trail of dust and small rocks in its wake. Some of these can contain ice.

Helpful Hints

If you would like to do this demonstration as an activity with many groups making their own comets, it is important that these groups are over the age of 9 and able to follow directions closely to reduce risk of injury. With school and youth groups, it is recommended that an adult supervise each group. You will need to supply the materials list for each comet. (One overhead projector or heat lamp is sufficient for the whole group.)

If you set up a heat lamp to demonstrate the how a comet's coma forms, point the lamp at the ceiling and hold a comet over it (with gloves on!) and you may see plumes of steam coming off. This steam is really water vapor that is condensed by the super-cold CO2 sublimating (changing directly from a sold to a gas) from the surface.

The disappearance of the comet might raise questions about what happens to real comets. You then have a chance to discuss how comets get close to the sun, how they are heated and "shed" material as they get close to the Sun in the form of gas, dust, and meteoroids, and thus gradually disintegrate.

Clean Up: The comets themselves can be placed in a large container like a detergent bucket. Students should not touch the comets with bare hands except very briefly. After they have melted again, dispose of the sludge in a well-lined garbage can or a toilet.

Background Information

Comets have a variety of different orbital periods, ranging from a few years, to hundreds of thousands of years, while some are believed to pass through the inner Solar System only once before being thrown out into interstellar space. Short-period comets are thought to originate in the Kuiper Belt, or associated scattered disc, which lie beyond the orbit of Neptune. Long-period comets are believed to originate at a very much greater distance from the Sun, in a cloud (the Oort cloud) consisting of debris left over from the condensation of the solar nebula. Comets are thrown from these outer reaches of the Solar System inwards towards the Sun by gravitational perturbations from the outer planets (in the case of Kuiper Belt objects) or nearby stars (in the case of Oort Cloud objects), or as a result of collisions.

An astronomer named Fred Whipple suggested in 1950 that comets were a lot like "dirty snowballs." He was right--they are mostly frozen water, with some other gases and dirty stuff. Comets spend most of their time as frozen globs traveling far away from the sun on huge orbits, that may or may not go near the sun. However we also know that a few times each century, we see one in sky, often with long fiery tails. You might want to discuss what your audience thinks causes these drastic changes.

This activity is adapted from a classroom activity, for use in schools and with further explorations. Learn more here:
http://cse.ssl.berkeley.edu/SegwayEd/lessons/cometstale/com.html

The bits of comets that fall off when they get close to the Sun are what often cause meteor showers here on Earth. When that happens, we are passing through the trail where a comet once passed. You can find out which comets produce some of the annual meteor showers here:
http://ssd.jpl.nasa.gov/?meteor_streams

For some great activities to use with younger audiences, see NASA's Solar System Exploration site. It also talks about how the tail of a comet always points away from the Sun:
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Comets&Display=Kids

To learn about how NASA's LCROSS mission is investigating water that may have been left on the Moon from comet impacts, see their website:
http://lcross.arc.nasa.gov/