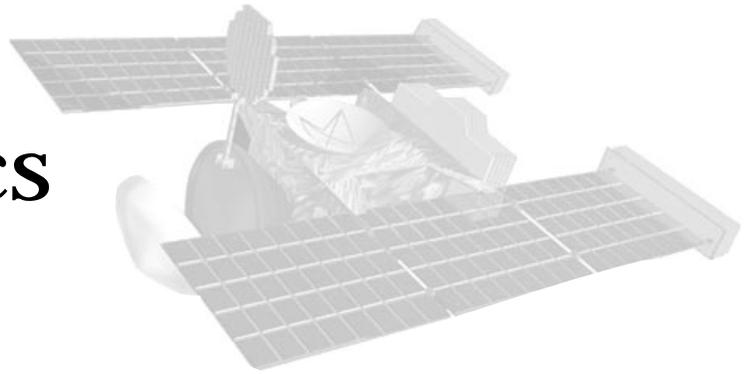


Comet Basics



Sir Edmund Halley began our present day understanding of comets in 1705. He deduced that comets are actually objects within the Solar System and that one comet in particular kept coming back every 76 years. He predicted this comet's return and in 1758 (12 years after his death), his prediction came true, thus the name Halley's comet. The comet was last sighted in 1986 and will reappear in 2061.

Astronomers both professional and amateur have studied the skies for centuries, studying the passage of comets in the heavens, and searching the skies for new comets to bear the discoverer's name. Much of our present day knowledge about comets results from this research. In addition four spacecraft studied Comet Halley the last time it passed by Earth in 1986. The upcoming missions in the next ten years will lead to new insights and discoveries about these cosmic travelers. For example, STARDUST launched in 1999. The mission's primary goal is to collect comet dust and volatile samples during a planned close encounter with Comet Wild 2 in January of 2004. Comet Wild 2 was discovered by Paul Wild on January 6, 1978, during its first passage relatively near Earth (1.21 AU). (An astronomical unit, AU, is the distance between Earth and the Sun.) Although this comet is not considered to be a spectacular comet to view from Earth, since it will not travel closer to the Sun than Mars, it is of interest because it should still yield valuable information.

The activities on the next pages include basic information on comets. Interestingly enough, not all scientists agree that this information is "the truth." Perhaps it is safer to say, these are common scientific theories about comets. Scientists often interpret the same data in different manners, developing theories based on these interpretations. The upcoming missions will provide new information, possibly changing the "facts" and theories presented in these activities.

- ◆ **Cookin' Up a Comet** - Dramatically simulates a comet using dry ice and other ingredients.
- ◆ **Incredible Edible Comet** - Reviews the parts of a comet and serves as a sweet ice cream treat.
- ◆ **Famous Comets** - Uses the Internet to explore several famous comets.

Remember: Comets generally do not display comas or tails past Jupiter's orbit. The Sun's energy is not strong enough at this distance to turn the ices in the nucleus into gas and dust tails. Usually, the closer a comet travels to the Sun, the more ices sublime and the larger the coma and tail grow.

A great comet is one that can be seen with the naked eye, like Comet Hale-Bopp in 1997. Such a comet has a distinct tail. A person is lucky to see one or two such comets in a lifetime.

Cookin' Up a Comet



Notes

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.

Objective

- ◆ Compare the parts of the model to the parts of a comet.

Preparation

1. Purchase dry ice from ice companies or ice cream parlors the afternoon or evening prior to the demonstration. If possible, get the pellet form of dry ice. Be sure to purchase at least five pounds of dry ice. You will want to get enough extra for a test run at home the night before.
2. 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.
3. Conduct this activity before using it in the classroom to get a feel for the correct amount of water to use.

CAUTION! Dry ice is -79°C (-110°F). Any more than brief exposure to the skin will cause “burns.” Everyone handling dry ice should wear heavy, rubber gloves! Be sure to discuss safety precautions with students when working with dry ice.

Timeline

1 class

Key Question

Of what are comets made?

Materials

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



Management

This comet recipe is fun to do. It is also messy and one of the more scientifically accurate demonstrations in astronomy.

Procedure

1. Put on heavy gloves before using a hammer to crush the dry ice pellets or block in the large plastic tub to the consistency of snow. Everyone should wear protective eye goggles.
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. Stir 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. Add water to help the ice stick together.
REMINDER: DO NOT HANDLE DRY ICE MIXTURE WITH BARE HANDS!
5. Sprinkle more sand over the comet. Pour some of the remaining water over the comet turning it as you do, so that a layer of water ice forms over the entire surface.
6. Observe the behavior of your miniature comet nucleus. Cool Comet Viewing Tip: So the whole class can watch the gas sublimating 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.
7. Blowing hard on the comet gives a sense of simulating a comet tail. One suggestion is to use a hair dryer set on a low setting.
8. Discuss the parts of a comet using the Comet Fact Sheet.

The ingredients used to “build” a comet represent our current understanding of the components found in actual comets: frozen water, frozen carbon dioxide and other frozen gases, dust and rock, and organic (carbon-based) substances.

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 flyby missions and the ICE mission to Comet Giacobini-Zinner provided further evidence of comet composition.

As the comet in this experiment melts, you can see little jets of gas coming off the comet just like the observed “outgassing” of real comets, which can actually affect the movement of the comet. After further melting of the experimental comet, craters will begin to form, another characteristic of real comets.

9. Discuss the Reflection Questions as a class.





Reflection Questions

1. When you place the comet on the tray to observe it, what part of the comet does it represent?
2. Describe changes, if any, in the comet after 5 minutes have elapsed.
3. Use the hair dryer to represent the Sun and the solar wind. 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 components of real comets are represented by each of the ingredients in your comet?

Answer Key

1. The nucleus or the head.
2. You could see melting, small gas jets escaping.
3. The tail; jets begin to point away from the blow dryer (Sun).
4. The ingredients are either actual components or handy analogous ones. Dry ice is frozen carbon dioxide. Water is water. Ammonia is ammonia. Cola provides the organic (carbon-based) molecules, and sand is rocky material.



The Incredible Edible Comet



Overview

Using ice cream and ice cream toppings, students explore the anatomy of a comet.

Objective

- ◆ To construct an edible model of a comet.
- ◆ To determine the anatomy of a comet.

Preparation

1. Collect the necessary ingredients as described in the materials list.
2. Prepare the model comets using the following procedure:
 - ◆ Mix the ice cream, crumbled candy bars, chopped nuts, and caramel syrup in a large bowl. Mix them together as thoroughly as possible.
 - ◆ Using the ice cream scoop, place single scoops of the ice cream mixture into a bowl, and freeze immediately.
 - ◆ Make one for each student, plus one for demonstration purposes.

Timeline

1 class

Key Question

What are the major parts of a comet?

Materials Needed

- Enough ice cream to provide one scoop for each student (representing the ice in a comet)
- Crumbled chocolate and butter-crunch candy bars (for the look of silicon)
- Finely chopped nuts (for the rock and dust within the comet nucleus)
- Caramel syrup (for the organic molecules, i.e., simple sugars)
- Whipped topping (for a tail)
- 1 liter ginger ale
- A mixing bowl
- A mixing spoon
- Ice cream scoop
- Individual bowls, one for each student, plus one for demonstration purposes
- Plastic spoons and napkins





Management

Due to the sugar content, you may prefer to save this activity for the last period of the day as a class-wide party.

Procedure

1. Distribute the Comet Fact Sheet. You may want to divide the class into groups at this time for easier distribution of the additional comet dishes later in the class period.
2. Unveil your comet nucleus for the class. Have students observe the nucleus and identify parts of the comet using the Comet Fact Sheet.
3. Using one bowl as a sample model, pour in a small amount of the ginger ale. The carbonation in the beverage represents carbon dioxide, one of many gases that have been observed escaping from comets. This outgassing causes the coma to appear.
4. Squirt whipped topping to represent the tail.
5. Ask the Reflection Questions to reinforce the parts of a comet. (See Materials Needed list.)
6. Distribute the additional comet model dishes and enjoy! You can let the students pour the ginger ale and whipped topping.

Reflection Questions

1. What does the ice cream represent? The crumbled candy bar? The ginger ale? The chopped nuts? The whipped cream?
2. Was there a dust tail in this comet? Why not? Did you observe a gas tail or coma?
3. How was the comet model like a real comet? How was it different?
4. How would this comet nucleus change as it entered the inner Solar System?



Famous Comets



Overview

Comets have played significant roles in both recent and ancient history. Usually considered bad omens by our ancestors, comets have more recently sparked interest due to their beauty, uniqueness, and sometimes their dramatic fates. This lesson has students research some of the more notable comets using the Internet and give a report on their findings.

Objective

- ◆ Research comets which are historically, scientifically, or otherwise significant.

Preparation

1. Copy enough Team Worksheets to provide one for each team.
2. Copy enough Comet Fact Sheets for each student.
3. Make arrangements for each team to have at least 1 hour of Internet access.

Management

Allow students plenty of time to research their comet. If necessary, encourage them to work on their project after-hours. Many libraries have Internet access.

Materials Needed

- Comet Research Team Worksheet for each team
- Comet Fact Sheet for each student
- Computers with access to the World Wide Web for each team
- Reference books/periodicals, etc.

Procedures

1. Review comets using the Comet Fact sheet. Discuss the anatomy, location, orbital paths, and composition of comets.
2. Assign students to cooperative groups and they will assign roles for students to study one of the following comets:
 - ◆ Comet Hale-Bopp
 - ◆ Comet Halley
 - ◆ Comet West
 - ◆ Comet Shoemaker-Levy 9
 - ◆ Comet Tempel-Tuttle
 - ◆ Comet Encke
 - ◆ Comet Wild 2

Timeline

- 1 class: Overview comet parts and assign teams.
- 2-3 class: Research famous comets and write a creative narrative.
- 1 class: Share stories and ask Reflection Questions.

Key Question

What roles have famous comets played in history?





3. Using the given Internet addresses and reference materials, have students answer the questions on the Team Worksheets.
4. Based on the information in the Comet Fact Sheet or from what they gathered, have the teams write a creative narrative about their comet using the writing prompts.
5. Have the team reporter share their story with the rest of the class (suggest a broadcast format).
6. Conclude the entire lesson with Reflection Questions.

Reflection Questions

1. What do comets have in common? How are comets different?
2. Do you think that a comet may hit a planet sometime in the future? Why or why not?
3. Does a comet's tail ever point towards the Sun? Why not?
4. Do you think that we see a lot of the Solar System's comets, or only a few? Why can't we see the other ones?

Answer Key

Worksheet answers will vary because each team has a different comet. Here are the basics:

Comet Hale-Bopp

period = 4,000 years

Hale-Bopp was an exceptionally bright comet that appeared in 1997.

Comet Halley

period = 76.03 years

Named for the man who first predicted the comet's return, Halley has appeared in numerous historical records as far back as 239 B.C.

Comet West

period = no longer applicable

A spectacular comet that appeared in 1976. When West approached perihelion, however, it broke into several pieces.

Comet Shoemaker-Levy 9

period = no longer applicable

Comet Shoemaker-Levy 9 gained notoriety when it slammed into Jupiter during July 1994.

Comet Tempel-Tuttle

period = 32.92 years

The leftover remnants of this comet's tail are responsible for the Leonid meteor shower that occurs annually.

Comet Encke

period = 3.3 years

This comet has the shortest known orbital period. It will also be investigated by the spacecraft *Contour*.

Comet Wild 2

period = 6.17 years

This short-period comet will be the subject of investigation by STARDUST.



Comet Research Team Worksheet



Name _____ Date _____

Team Roles

Decide which team member will perform each of the following roles:

Recorder: Records the results of the team's research.

Computer Operator: Uses the computer to navigate the Internet and print out any essential materials.

Literary Supervisor: Records team's input for the story.

Reporter: Presents the team's story to the rest of the class.

Steps

Name of your team's comet: _____

This activity has two parts. In the first part you will research the significance of a specific comet. In the second part you will write a story based on the facts surrounding your comet.

Using the Internet, answer the questions on the next page. Have the recorder write down what the team learns. It may help to use the following websites:

STARDUST Home Page

<http://stardust.jpl.nasa.gov>

Comets and Meteor Showers

<http://medicine.wustl.edu/~kronkg/index.html>

Comets and Asteroids at National Space Science Data Collection

<http://nssdc.gsfc.nasa.gov/planetary/planets/asteroidpage.html>

Comet Observation Home Page

<http://encke.jpl.nasa.gov/>

Challenger Center for Space Science Education Comet Links

<http://www.challenger.org/cometl.html>





1. What makes this comet unique?

2. How long is this comet's period?

3. What major events in history have happened when the comet has appeared?

4. How did this comet change the way astronomers think about comets or the Solar System?

5. Who discovered the comet? What country was the discoverer from? Was the discoverer a professional or amateur astronomer?

6. Print out a picture of the comet. Label its coma, gas tail, dust tail, and nucleus (if visible).

7. What was the most recent great comet?

8. What comets will appear in the night sky over the next three years?



Writing Prompts

Use the following writing prompts to help your team write a two-page story about your comet. Have the Literary Supervisor write the story as the rest of the team provides ideas and suggestions. Base your story on actual facts and science concepts.

- ◆ Imagine you are a reporter writing a headline story about sighting this comet.
- ◆ Imagine that you belong to another culture in another century when your comet appears. Describe what you see, what you think it is, and how you feel.
- ◆ Imagine you are an amateur astronomer watching the night sky when you think you discover a comet. How do you feel? Who do you tell?
- ◆ Imagine you are the comet. Talk about where you would travel during your entire orbit.
- ◆ Think of your own story!

Illustrate your story with the photo you printed of your comet. Make sure that its parts are labeled.

