National Aeronautics and Space Administration

NASA eClips™
Educator Guide

NASA's Our World:
More than Just Dirty Snowballs

Educational Product	
Educators & Students	Grades 3 -5

NP-2008-09-107-LaRC

www.nasa.gov

More than Just Dirty Snowballs

EDUCATOR GUIDE

National Standards:

National Science Education Standards (NSES)

Science as Inquiry

Earth and Space Science

Objects in the sky

Science and Technology

Abilities of technological design

National Council of Teachers of Mathematics (NCTM)

Measurement

Understand measurable attributes of objects and the units, systems, and processes of measurement.

Apply appropriate techniques, tools, and formulas to determine measurements.

International Society for Technology in Education: National Educational Technology Standards (ISTE/NETS)

Research and Information Fluency

Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

Grade Level:
3-5

Subjects:
Elementary science

Teacher Preparation Time:
40 minutes

Lesson Duration:
Three 50-minute classes.

Time Management:
Class time can be reduced to two 55-minute classes if students complete parts of the EXPLAIN, EXTEND and EVALUATE at home.

Note: This activity involves students handling food. Teachers may want to assess students' food allergies.

Lesson Overview:

Working in teams, students create ice cream comet models to be analyzed by another team of students. Students evaluate basic facts about comets to determine how scientists discovered this information. Students explore the Stardust Mission and Deep Impact Mission and discuss the scientific contributions of each mission. Several ways to evaluate the students understanding of comets and models are suggested, including an online interactive game. This lesson is developed using a 5E model of learning. Learning can be measured via KHWL (what I KNOW-HOW I know- what I WANT to know-what I LEARNED) comet chart comparisons before and after the activity.

Icons flag five areas of interest or opportunities for teachers.

- **Technology Icon** highlights opportunities to use technology to enhance the lesson.

- **Modification Icon** denotes opportunities to differentiate the lesson.

- **Resources Icon** relates this lesson to other NASA educator resources that may supplement or extend the lesson.

- **Connections Icon** identifies opportunities to relate the lesson to historical references and other topics or disciplines.

- **Check for Understanding Icon** suggests quick, formative assessment opportunities.

Essential Questions

- How do scientists study comets?
- How do models help us study comets?
- What can we learn from studying models?

Instructional Objectives

Students will

- create a model of a comet;
- analyze a comet model to learn more about comets;
- review comet facts and determine how scientists have discovered this information;
- use the Internet to discover how scientists study comets; and
- work as a NASA mission specialist to discuss the scientific contributions learned from two comet missions.

Materials List

Per group of four students

- 1 Student Guide
- 1 sandwich-size re-closable plastic bags
- 1 gallon-size re-closable plastic bags
- 5 small cups for ice cream (1 cup per person and 1 extra cup for the touch test)
- 4 plastic spoons
- 1 pair of kitchen mitts, gloves, or 1 towel
- ice (enough to fill the gallon-size bag half-full per team)
- 60 mL (4 T) rock salt
- 320 mL (1 1/3 C) whole milk
- 160 mL (2/3 C) evaporated milk
- 60 mL (4 T) sugar
- 2.5 mL (about 1/2 t) vanilla

Per class

- several food items to represent dust, rocks, gasses, early organic life (e.g., black or brown chunky cookies, crushed candies, gummy bears, coconut flakes, peanuts)
- something to use to crush cookies and other materials (rolling pin, clean bottle, etc.)
- 1 roll paper towels
- Internet access

EDUCATOR GUIDE

NASA Background for the Teacher

Figure 1. Comet P/Halley from the Giotto Mission. Image credit: NASA/NSSDC.

People have wondered about comets for centuries. Their unpredictable travels led early people to believe that they might be omens foretelling disasters. Through time, their sightings were noted and often blamed for catastrophic events on Earth. The first known sighting of a comet was recorded as early as 1059 B.C. by a Chinese astrologer.

Through more careful observation, scientists learned that a comet's path could be charted and predicted. Sightings that were once believed to be different comets, turned out to be sightings of returning comets. Edmund Halley was, at first, surprised to see significant similarities in comets seen in 1531, 1607, and 1682. Careful study helped him realize those were sightings of the same comet, traveling on an unusual, yet predictable path. Halley predicted the return of this comet using Newton's theory of gravity but, sadly, died twelve years before Comet Halley returned to view in 1758. It has since reappeared in 1986 and is expected back in 2061.

Small and unevenly shaped, comets are often described as "dirty snowballs" left over from the beginning of the solar system around 4.6 billion years ago. They are among the least-changed objects and, as such, may yield important clues about the formation of our solar system.

Based upon analysis of comet particles captured and returned to Earth by NASA's Stardust mission, scientists now believe that comets may be much more than simple chunks of water ice, frozen carbon dioxide and dust. Stardust samples contained some high- and low-temperature minerals, suggesting that comets may form in different locations and under a range of conditions.

Scientists were particularly excited to see particles rich in organic matter in these samples. This discovery led scientists to consider that comets may have carried water and organic matter to early Earth. These materials are important to the origin of life.

Each comet has only a tiny solid part, called a nucleus. The nucleus contains icy chunks, frozen gases, rock and dust and is often no bigger than a few kilometers across. At its center, the nucleus may have a small rocky core.

A comet's elliptical or egg-shaped orbit carries it close to the Sun and then back into deep space. When a comet travels near the Sun, heat changes some of its nucleus into a cloud of gas and dust. This cloud is called the coma. This coma may be hundreds of thousands of kilometers in diameter. The pressure of sunlight and high-speed solar particles blow the coma materials away from the Sun, forming the comet's long, and sometimes bright, tails. These tails point away from the Sun's direction.

Resources

Comet Lithograph
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Comets_Lithograph.html

Solar System Exploration: Comets
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Comets

The Study of Comets
http://stardust.jpl.nasa.gov/overview/comets.html

5E Inquiry Lesson Development

ENGAGE (20 minutes)

1. Have the class complete a KHWL chart to organize what your students KNOW, HOW they know this information, and what they WANT TO KNOW about comets.

Use these questions can help guide the discussion:

- What do you KNOW about comets? *(Answers will vary. Students may suggest ideas that are incorrect. Do not correct these ideas at this time. You will come back to this KHWL chart throughout the lesson to correct any misconceptions and add more facts. One general student misconception is not knowing that comets are part of the solar system. Students may also think that comets all look the same and are not much different than other small, interplanetary objects such as asteroids and meteoroids.)*
- Ask students to explain HOW they have learned the information stated about comets. *(Answers will vary. This is the time to help students consider the validity of their sources for information.)*
- What do you WANT TO KNOW about comets? *(Answers will vary. Encourage students to seek answers to their questions beyond this lesson.)*

(MODIFICATION) You may choose to have students complete the KHWL chart individually in a science notebook before sharing their thoughts with the class.

2. **(RESOURCES)** Continue the discussion about comets by showing your students the images displayed in the Comet Lithograph found at : http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Comets_Lithograph.html

(MODIFICATION) To save paper resources, project the images from the lithograph on an interactive whiteboard or group students into smaller groups and print one copy for each group. The Comet Lithograph includes some excellent content about comets and NASA missions. This content is NOT written at an elementary reading level, but is helpful teacher background information.

Guide the discussion by asking these questions:

- Based on the pictures of different comets, do you think comets are made of solid, liquid, or gas materials? *(The pictures show a solid nucleus and dust particles. The tail of one of the comets is made of dust and gas clouds.)*
- What might scientists do to discover more about the materials found in comets? *(Students may suggest taking more pictures of comets or perhaps capturing comet material and bringing it back to Earth for more careful study.)*
- Where do you think comets are found? *(Comets are found in our solar system.)*

3. **(TECHNOLOGY)** Show the NASA eClips video segment "Our World: Stardust" (6:35) to the students. This video or a captioned version may be streamed or downloaded from the NASA eClips page of the NASA web site:
   http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms=stardust&category=1000

(MODIFICATION) This video may be streamed from the NASA eClips You Tube™ channel:
http://www.youtube.com/watch?v=zmvdClx6m30&feature=PlayList&p=31002AD70975DC1B&index=3

EXPLORE (30 minutes)

Astronomers find it difficult to study the composition of comets because they are unable to capture much more than comet debris and dust. During this EXPLORE activity, students make, observe and analyze models of comets to gain a better understanding of comet composition. Scientists often use models to understand scientific observations and accepted scientific theory. As scientists gather new data, models may change.

(MODIFICATION) A Screen Reader/Braille Transcription Version of this activity for visually-impaired students may be found at:
http://www.ace-education.org/educ_resource/index.asp

Procedure

1. Pre-teaching preparations:
   a. Students will be eating their ice cream comet models to gather data. Survey your class to identify students that may have food allergies to foods included in this activity.

(MODIFICATION) You may substitute inedible materials for the food items. For instance:
- Replace ice cream with ice.
- Replace food items with sand, aquarium charcoal, pebbles, and dirt.

b. Have students gather the materials on page 2 for each group of four students.

c. Ask students to wash their hands before making the models. You may choose to have students wear food gloves for cleanliness.

d. Here are some tips to consider before beginning this activity:

- Caution students to shake and roll the bags carefully. They may break if handled roughly.
- Consider running this activity outside. Place newspapers under the bags while students make the ice cream.
- Limit the amount of extra materials added to the ice cream to conserve materials.

2. Return to the KHWL chart and add any information that students have learned about materials found in comets. Guide students to include these items in their list, e.g., dust, rocks, gases, and other materials.

3. Show students the materials gathered for this activity. Ask them to discuss, secretly, what items they want to add to their model. This information should NOT be shared with other teams. Ask students to record the items and what they represent on page 3 in the Student Guide.

(MODIFICATION) Encourage students to bring in their own materials to represent comet materials.

4. Ask students to follow the directions in Table 1 on page 4 in the Student Guide to help them create their models. While students make the models, they will also record observations in Table 2 on page 5 in the Student Guide.

(CONNECTIONS) Allow students to measure the ingredients to apply liquid and weight measurement skills.

5. Once the comet models are created, ask teams to switch models with another team. Ask students to follow directions and record their observations in Table 3 on page 6 in the Student Guide.

EDUCATOR GUIDE

EXPLAIN (25 minutes)

1. **(CHECK FOR UNDERSTANDING)** Use these questions to help lead a discussion about the EXPLORE activity:

   - How was the work that you were doing similar to how astronomers study comets? *(Astronomers make inferences about comets by studying comet dust and particles. The crumbs and candies in the ice cream comet models give the students clues about how they were created, just like the dust and dirt in actual comets gives clues about comet formation.)*
   - What are some limitations to the models you created? *(The mystery comets were made with materials easily found. These are not the materials found in real comets. These models are simple examples of how materials can be preserved in an icy mixture.)*
   - Based upon your observations, explain why comets are called "dirty snowballs." How else might you describe a comet? *(Answers may vary, but calling a comet a dirty snowball does describe the dirt and particles frozen inside the comet. Recent studies about comet, however, indicate that comets also carry different minerals and organic materials important to the origin of life.)*

2. Ten facts are listed on page 7 in the Student Guide. Ask students to think about each fact and identify how scientists have learned this information about comets.

(MODIFICATION) You can differentiate for reading ability if you separate the facts into fact cards and pass single fact cards out to students. Here are some additional facts that you may want to include for proficient readers.

- Different kinds of tails are formed when the comet is heated by the Sun.
  One type of comet tail is made of gas and dust.
  Another comet tail is made of electrically charged particles of gas.
  A third type of comet tail cannot be seen without special equipment. *(Learned with the help of tools like spectrometers and telescopes.)*
- Comets are made of different kinds of ice. One kind of ice is ice made of water. Comets are also made of ice made from carbon dioxide. We call this dry ice. *(Learned by both studying comet material and with special tool.)*
- The comets we see in our solar system come from an area outside the orbit of Neptune. This area is called the Kuiper Belt. *(Learned with the help of tools like spectrometers and telescopes.)*

3. **(TECHNOLOGY)** View a comet's orbit using the Interactive Comet Animation at:
   http://www.windows.ucar.edu/tour/link=/comets/comet_model_interactive.html&edu=elem

EXTEND (50 minutes)

It is difficult to study comets as they travel through space. Several spacecraft have helped scientists study comets in more detail.

In January 2004, NASA's Stardust mission flew by Comet Wild 2 (pronounced "Vilt 2"). Stardust took some impressive pictures of this comet's nucleus. One of these images was seen in the Comet Lithograph shared with students during the ENGAGE activity.

Stardust also captured comet dust using a material called aerogel. Aerogel is a strong, lightweight, manmade material sometimes called frozen smoke. It is the least dense material on Earth, made of 99% air and 1% silica dioxide. Silica dioxide is the material used to make glass. (More information about aerogel may be found at the Stardust Website: http://www.nasa.gov/mission_pages/stardust/spacecraft/aerogel-index.html

The dust samples captured by Stardust were returned to Earth on January 15, 2006. Since then, the samples have been studied by scientists and, via the Internet, by citizen scientists. This data helped scientists learn more about the origins and history of our solar system.

Another NASA mission, Deep Impact, consisted of a flyby spacecraft and a small impactor. In 2005, the impactor was released into the path of the nucleus of comet Tempel 1 in a planned collision. This collision vaporized the impactor and ejected massive amounts of fine, powdery material from beneath the comet's surface. A camera on the impactor and two cameras and a spectrometer on the flyby spacecraft showed dramatic brightening that revealed the interior composition and structure of the nucleus.

In this EXTEND activity, your students will become Stardust Mission or Deep Impact Mission specialists. In this role, they will learn more about their mission and what was learned about comets as a result of this mission. They will debate with each other, arguing which mission provided more valuable information about comets.

1. Divide your class into teams of two to four students. Half of the teams will be Deep Impact Mission specialists and half will be Stardust Mission specialists.

   (CONNECTIONS) Many people from different kinds of careers make up a mission team. More information about the Deep Impact Mission team is found at this website: http://solarsystem.nasa.gov/deepimpact/mission/bios.cfm

   Guide students to the "Up Close and Personal" interviews. These include interviews with Deep Impact team members answering student-generated questions.

2. **(TECHNOLOGY)** Guide the student mission specialists to one of two different pages found at NASA's Space Place.

a. Stardust specialists will explore Tails of Wonder found at:
http://spaceplace.nasa.gov/en/kids/stardust/index.shtml#

b. Deep Impact specialists will learn more about the comet's nucleus at:
http://spaceplace.nasa.gov/en/kids/deepimpact/index.shtml

(MODIFICATION) If you do not have Internet access, the information at these pages may be printed and shared offline. You may want to break the reading into smaller sections to accommodate students with varying reading abilities.

3. **(CHECK FOR UNDERSTANDING)** Ask students to add what they have learned to the KHWL chart. Run a class discussion asking students to determine what scientists learned about comets from each mission.
(Stardust took some impressive pictures of a comet's nucleus. This mission also captured comet dust. The comet dust samples were returned to Earth. From this work, scientists have been able to learn more about the origins and history of our solar system. During the Deep Impact mission, a spacecraft flew past a comet at the same time an object crashed into that comet. Cameras and a spectrometer captured pictures and data of the comet material ejected into space from the impact. This gave scientists a chance to see comet material beneath the comet's surface and to learn more about the structure of the nucleus.)

4. **(TECHNOLOGY)** Several other sections of the Stardust Website offer differentiated activities related to the Stardust mission. NASA's Captain Comet offers less difficult activities at http://stardust.jpl.nasa.gov/classroom/captaincomet.html.

   Your students will be challenged to become spacecraft engineers and to redesign the Stardust spacecraft at http://stardust.jpl.nasa.gov/classroom/jason/index2.html

5. **(CONNECTIONS)** Challenge your students to measure and build a 1/26 scale model of the Stardust spacecraft at this website:
   http://stardust.jpl.nasa.gov/classroom/model/index.html

EVALUATE (25 minutes)

1. Through discussion and the results of the **EXPLORE** and **EXPLAIN** experiences, determine if your students have an accurate understanding of comets.

2. Return to the KHWL chart to add more information that students have LEARNED throughout this lesson. Review the information under the KNOW column. With the help of the students, correct any misinformation placed there during the **ENGAGE** experience.

3. Ask students to answer these journal prompts to assess their understanding of the composition of comets and the use of models.

   a. Comets are sometimes described as "dirty snowballs." Is this an accurate description of comets? Why or why not?
   (For the most part, this is an accurate description for comets. A comet is mostly ice mixed with rocks and dust. Recent information also shows that comets contain more than dirt and snow. Scientists have discovered materials in comets that may be found in living things.)

   b. What can we learn from studying models?
   (A model represents the item being studied. It may be a drawing or a 3-D object, like the ice cream comet model created during this lesson. Models are smaller than the original object or made out of less expensive materials than the actual object. Models help us understand objects that we may not be able to actually see and touch.)

4. **(TECHNOLOGY)** Students may test their knowledge of comets by playing the Tails of Wonder game found at http://spaceplace.nasa.gov/en/kids/stardust/game.shtml

More than Just Dirty Snowballs

Essential Questions

- How do scientists study comets?
- How do models help us study comets?
- What can we learn from studying models?

Background

Comets have three parts: the **nucleus**, the **coma**, and the **tail**.

The nucleus is the solid center of the comet. It is made of gas, ice, and dust. Scientists believe that the dust may be left over from the time that the **solar system** first formed.

Comets **orbit** the sun just like the planets of the solar system. Comets move in long, narrow orbits. When a comet comes near the sun it heats up quickly.

Sunlight warms the surface of the comet. When this happens gas and dust come off the solid part of the comet. This creates the coma.

The coma is the gas and dust cloud around the nucleus.

Most comets have two tails that can be seen. One is made mainly of dust and is like a trail of crumbs left behind the comet. Sunlight **reflects** off the dust making the tail look yellow.

Another tail is made of gas that glows and looks blue.

Comet tails always point away from the sun.

NASA scientists study comets and are trying to find out more about the matter in comets. They believe that comets may be as old as the solar system. Scientists also believe that they will understand how the solar system was formed by studying comet matter. Learning more about comets may even help explain how dinosaurs became **extinct**.

Comets are sometimes described as dirty snowballs. Do you understand why?

STUDENT GUIDE

Vocabulary

absorb – Some materials **absorb**, or take in, light.

comet – A **comet** is a small object found in the solar system. It is made mostly of ice and dust.

coma – A **coma** is the cloud that forms around a comet's nucleus. This cloud is made when a comet travels near the sun.

extinct – An **extinct** animal or plant is one that has died out.

model – A **model** represents something else. A model might be a drawing or a 3-D object. Models are smaller than the original object or made out of less expensive materials than the actual object.

nucleus – The **nucleus** of the comet is the solid, rocky part of the comet.

orbit – Comets **orbit**, or travel around the sun following a certain path.

reflects – When light **reflects** off an object, the light hits that object and bounces back.

solar system – The **solar system** includes the sun, the planets, and other bodies that revolve around the sun including comets.

spectrometer – A **spectrometer** is a tool that helps scientists study comets. Spectrometers can be found on satellites, rockets, airplanes, and telescopes. A spectrometer works like our eyes, but it breaks light into colors like a rainbow.

tail – The comet's **tail** forms when the comet travels near the sun. The tail always points away from the sun.

telescopes – **Telescopes** are tools that help you see objects that are far away.

STUDENT GUIDE

EXPLORE

1. As a team, discuss the materials you will add to the ice cream comet model. List those items here. Beside each item, explain what this item represents in a real comet.

Materials in the Model	Materials in a Comet

2. Wash your hands before starting to build your ice cream comet model. Then follow the steps in Table 1 to build the model.

STUDENT GUIDE

Table 1: Directions to Build a Comet Model

Steps	Directions
1	One student should hold the team's sandwich size bag while the rest of the team measures and adds the following ingredients to the bag: • 320 mL (1 1/3 C) whole milk • 160 mL (2/3 C) evaporated milk • 60 mL (4 T) sugar • 2.5 mL (about 1/2 t) vanilla
2	Carefully add extra items to the bag to represent comet materials. When all items are in the bag, gently squeeze extra air out of the sandwich bag and seal it. Be sure the bag is sealed and will not leak.
3	Observe and describe the comet model mixture BEFORE you place the sandwich bag into the gallon bag. Record your observations in Table 2.
4	Place the sandwich bag into the bottom of the gallon bag. Add about 60 mL (about 4 T) of rock salt.
5	Fill the gallon bag half-full of ice.
6	Gently squeeze air out of the gallon bag and seal it. Check for leaks.
7	As a team, gently shake and roll the bag, keeping it in constant motion for six to ten minutes or until half the ice has turned to water. • Observe the changes to the comet model mixture. Record these observations in Table 2. • Begin the activity with bare hands to observe the temperature changes as the mixture changes. Wear gloves or wrap the bag with a towel when it becomes too cold to touch. • Continue to shake and roll the bag until the comet mixture hardens into soft ice cream. • Carefully open the gallon bag, remove the sandwich bag. • Rinse the bag with very cold, clean water. Then dry the outside of the sandwich bag with a towel.
8	Record observations about changes you observe to the comet model in Table 2.
9	Trade your comet model with another team. You will analyze their comet and they will analyze your comet.
10	Divide the ice cream comet model you will be analyzing into small cups so that each team member has their own sample. Make one extra cup and put it aside. Do not eat this extra sample.

Table 2: Observations While Making the Model of the Comet

Describe the model before you add ice to the bag	
Describe changes you observe while you are making the model	
Describe the model once the ice cream has frozen	

3. Special equipment can be used to help scientists study comets. One piece of equipment is called a spectrometer. **Spectrometers** work like our eyes, but a spectrometer can break light into colors like a rainbow. Droplets of water help to break light into the colors of a rainbow. A spectrometer breaks light into different wave-lengths, or colors. Gases in the comet **absorb** or reflect the different wavelengths. This helps scientists learn more about the gases in comets.

Each member of your team will use a different sense to gather data about the comet model. Record your observations in Table 3.

STUDENT GUIDE

Table 3: Observations of Another Team's Comet Model

Team Member	Task	Observations
1	Look carefully at the comet and record what you observe with the help of your spectrometer (eyes).	
2	Using the extra cup of comet material, use your sense of touch to gather more data about the comet.	
3	Analyze the comet using your sense of smell.	
4	Analyze the comet using your sense of sound.	
All team members	Analyze the comet using your sense of taste.	

4. As a team, identify the materials found in the model. Then decide what materials found in comets are represented by these materials. Compare your results with the team who created the comet model.

Materials in the Model	Materials in a Comet

STUDENT GUIDE

5. What is a model?

6. What can we learn from using a model like this to study comets?

EXPLAIN

Scientists do not have many chances to see or touch real comets. Much of the information we have about comets has come from observing comets in space using tools like spectrometers and **telescopes**. Read the table of comet facts.

Check the box that best describes how scientists have learned each fact below.

COMET FACTS **Scientist learned the information below by:**	**studying comet material**	**using tools like spectrometers and telescopes**	**studying comet material and using tools**
1. A comet is mostly ice mixed with rocks and dust. Comets are also made of gasses.			
2. A comet moves in a long, narrow orbit.			
3. When a comet comes near to the sun, it heats up quickly.			
4. Comet tails point away from the sun.			
5. Comets have three parts: the nucleus, the coma, and the tails.			
6. The solid part of a comet is called a nucleus. A comet's nucleus is like a dirty snowball.			
7. Comets orbit the sun, just like the planets of the solar system.			
8. Comets are as old as the solar system.			
9. When sunlight warms the surface of the comet, gas and dust come off the solid part. This creates the coma of gas and dust that surrounds the nucleus.			
10. Scientists believe comet dust may come from the time that the solar system formed.			

STUDENT GUIDE

EXPLORE

1. As a team, discuss the materials you will add to the ice cream comet **model**. List those items here. Beside each item, explain what this item represents in a real comet.

Materials in the Model	Materials in a Comet
crushed cookies or wafers	*dirt, dust*
candies that fizz	*gases*
gummy bears or candies that look like animals	*organic materials*
ice cream	*ice*

Table 2: Observations While Making the Model of the Comet

Describe the model before you add ice to the bag	*The liquid mixture will be entirely liquid. There will be a variety of materials mixed into the liquid.*
Describe changes you observe while you are making the model	*The mixture will become very cold. The liquid will begin to solidify and crystallize.*
Describe the model once the ice cream has frozen	*The mixture will have the consistency of soft ice cream.*

ANSWER KEY

Table 3: Observations of Another Team's Comet Model

Team Member	Task	Observations
1	**Look carefully at the comet and record what you observe with the help of your spectrometer (eyes).**	*These are qualitative observations. They describe what the students observe using their senses.* *Be sure students use descriptive terms and NOT opinions. For example, they should describe the colors and textures that they see.* *Students should NOT use terms such as good. This is an opinion, and scientific observations should NOT include opinions.*
2	**Using the extra cup of comet material, use your sense of touch to gather more data about the comet.**	*Answers may include cold, sticky, rough, gritty, smooth.*
3	**Analyze the comet using your sense of smell.**	*Answers may include sweet, like chocolate, like milk*
4	**Analyze the comet using your sense of sound.**	*There will probably not be a sound. But students should record this. No sound is an observation.*
All team members	**Analyze the comet using your sense of taste.**	*Again, caution that opinions may not be listed here. Students may say sweet, like chocolate, cold, smooth. Do not accept observations like good, bad, "I like it."*

ANSWER KEY

4. As a team, identify the materials found in the model. Then decide what materials found in comets are represented by these materials. Compare your results with the team who created the comet model.

Materials in the Model	Materials in a Comet
crushed cookies or wafers	*dirt, dust*
candies that fizz	*gases*
gummy bears or candies that look like animals	*organic materials*
ice cream	*ice*

Students compare their lists. Encourage them to discuss any differences.

5. What is a model?
   (A model represents something else. This model is made out of easy to find, inexpensive materials.)

6. What can we learn from using a model like this to study comets?
   (Besides learning about the parts of comets, this edible model shows how materials can change from a liquid to a solid.)

ANSWER KEY

EXPLAIN

Check the box that best describes how scientists have learned each fact below.

COMET FACTS **Scientist learned the information below by:**	**studying comet material**	**using tools like spectrometers and telescopes**	**studying comet material and using tools**
1. A comet is mostly ice mixed with rocks and dust. Comets are also made of gasses.			✓
2. A comet moves in a long, narrow orbit.		✓	
3. When a comet comes near to the sun, it heats up quickly.		✓	
4. Comet tails point away from the sun.		✓	
5. Comets have three parts: the nucleus, the coma, and the tails.			✓
6. The solid part of a comet is called a nucleus. A comet's nucleus is like a dirty snowball.			✓
7. Comets orbit the sun, just like the planets of the solar system.		✓	
8. Comets are as old as the solar system.			✓
9. When sunlight warms the surface of the comet, gas and dust come off the solid part. This creates the coma of gas and dust that surrounds the nucleus.		✓	
10. Scientists believe comet dust may come from the time that the solar system formed.			✓

ANSWER KEY