Lesson 1: Asteroids, Comets, Meteoroids

Overview:
This lesson examines three types of small bodies found in the solar system: asteroids, comets, and meteoroids. Students learn important terminology and examine factors such as the size, origin, and composition of each. They also study the part these objects play in the formation of craters on larger bodies in the solar system. Students apply their knowledge in a hands-on activity that illustrates differences in size and structure among the three types of small bodies. Follow-up questions and lesson extensions are included.

Objectives:
• Upon completion of the lesson, students will state that asteroids, comets, and meteoroids are all examples of small bodies found within the solar system.
• Following class discussion, students will describe the size of asteroids, comets, and meteoroids as smaller than planets and moons, and less than 1,000 km in diameter.
• After being introduced to the similarities and differences among asteroids, comets, and meteoroids, students will create a simple scale model showing that the average asteroid is far larger than either meteoroids or even the largest comets.

Time Required:
Approximately two 45-minute class periods.

Day 1: Topic Introduction
• Give students copies of Background reproducible.
• Discuss important terminology and give brief overview of upcoming lab.

Day 2: Lab Activity
• Students construct a scale model comparing selected physical properties of asteroids, comets, and meteoroids.
• Assign Follow-Up reproducible as homework.
• Use portion of following class period to discuss results and summarize lesson.

Materials Needed (for each student):
• metric ruler
• glue stick or white school glue
• scissors
• 2 paper clips
• unlined paper

Optional Materials:
• colored pencils
• sand
• cotton balls
• variety of seeds and spices for creating models (see next section for details)

Steps for Conducting Lab:
Day 1: Setup and Topic Introduction
• Carefully review student Lab Activity sheet to gauge amount of material each student will use; determine amount needed for all classes.
• Obtain a variety of inexpensive products that students can use to illustrate the three objects (things that represent rocks, ice, iron, dust, ammonia gas, carbon, comet tails, comets, etc.). Select items that will easily stick to paper when affixed with glue stick or white school glue. Most can be found as generics or in bulk at supermarkets.
Lesson 1: Asteroids, Comets, Meteoroids (continued)

Below are a few examples of items and how the students might choose to use them:

- powdered drink mix (comet tail, dust)
- salt crystals, sugar (ice of comet)
- whole oats (ice of comet)
- cotton balls (gas around comet)
- rice vermicelli noodles (comet tail)
- brown or red colored spices such as paprika and cinnamon (red iron)
- poppy seeds, tea leaves (carbon)
- sand, cinnamon (dust, rock)
- seasoned salts in different types and colors (variety of uses)

- Determine setup of supplies (for example, in baskets at various lab stations, to be shared by three to four students).
- Decide where to locate optional lab items.
  Before lab, give students copies of Background reproducible, discuss important terminology, and give brief overview of upcoming lab.
- Copy all required sheets.

Day 2: Lab Activity

- Before class, place required sheets in central location; set up lab supplies.
- As students enter, have them pick up required reproducibles.
- Tell class Background reproducible may be used as a reference.
- Review purpose of activity: to use information about asteroids, comets, and meteoroids to create models of each.
- Review important safety guidelines (for example, no tasting allowed in the laboratory).
- Point out supplies and discuss the maximum number of items and amount of each that can be used in creating each model.
- Instruct students to form teams that will share supplies, and begin.

Teacher Resources

Images of asteroids and more:
www.nasm.si.edu/ceps/etp/asteroids/

Related resources on comets:
http://stardust.jpl.nasa.gov/classroom/comets.html

Ancient beliefs about comets:
www.nasa.gov/mission_pages/deepimpact/media/f_ancient.html

More information about meteoroids:
www.solarsystem.nasa.gov/planets/profile.cfm?Object=Meteors&Display=Overview
Connections to National Science Education Standards

Unifying Concepts and Processes
• Evidence, models, and explanation
• Change, constancy, and measurement

Physical Science
• Properties and changes of properties in matter
• Motions and forces
• Transfer of energy

Earth and Space Science
• Earth’s history
• Earth in the solar system

Science in Personal and Social Perspectives
• Natural hazards

Source: National Research Council

Reproducible Answers:
Follow-Up: 1. comets and meteoroids; 2. all three can have rock and iron as part of their makeup; 3. answers will vary; most will probably suggest that larger craters are caused by asteroids, smaller ones by meteoroids.
In today’s lesson, you will be studying some very important parts of our solar system: asteroids, comets, and meteoroids. Even though today’s scientists consider the three to be small bodies, you will soon see how very big and important they actually are. So, let’s find out more about all three!

What is considered a small body?
- Any object in the sky that is smaller than a planet or a moon, such as an asteroid, a comet, or a meteoroid

What are some things scientists want to know about small bodies?
- Their size and shape
- Their composition (what substances they contain)
- Their origin (where and how they were formed)
- Their location (where to find them)

Asteroid:
- Size and Shape: Irregular, rocklike fragment; from a few meters up to 1,000 kilometers in diameter
- Composition: Rock containing carbon; a few have iron and other metals
- Origin: Leftover material from formation of solar system
- Location: Most found between orbit of Mars and Jupiter (asteroid belt)
- Famous Example: An asteroid’s crashing to Earth formed Chicxulub crater in Mexico’s Yucatan Peninsula; it is thought to be responsible for extinction of dinosaurs

Comet:
- Size and Shape: Nucleus (center) up to 20 kilometers in diameter; surrounded by gas (two tails, one gas and one dust, which are millions of kilometers long)
- Composition: Ice, rock, ammonia and other gases
- Origin: Leftover material from formation of solar system
- Location: They enter the solar system from deep space, orbit near sun, then move far out into space again
- Famous Examples: Comet Halley, Comet Hale-Bopp

Meteoroid:
- Size and Shape: Irregular, rocklike fragment; a few centimeters up to a few meters in diameter
- Composition: Rock, iron, or a combination of both
- Origin: Most are broken pieces of asteroids; a few are comet dust (called meteors if they enter Earth’s atmosphere)
- Location: If they enter Earth’s atmosphere and hit the ground, they are meteorites
- Famous Example: Iron meteorite found by Mars Exploration Rover Opportunity (first ever found on another planet)
Introduction:
Astronomers consider asteroids, comets, and meteoroids to be examples of small bodies in our solar system. In many ways they are similar: They move at great speeds, they have helped scientists learn more about how our universe and solar system formed, and they have created fear and wonder in human beings through history. Today, however, you will be examining several differences in these groups. The Background sheet will be a useful reference for this activity.

Your Assignment:
Today, you will create a simple scale model that will demonstrate the average relative size, shape, and makeup of the three types of small bodies.

1. To compare sizes, you will measure and cut strips of paper so each length represents the diameter of one of the small bodies.
2. To compare shapes, you will create a sketch of one of the objects on each of the paper strips.
3. To compare makeup, you will select items to glue onto your drawings representing the substances in each.

Procedure (Creating Scale Model Strips):
1. Get a plain sheet of white paper and turn it sideways.
2. Measure four equal strips of paper, each 5 cm wide.
3. Cut strips (see diagram).
4. Select one of the paper strips; starting at end of strip, use metric ruler to measure 0.5 cm along length of strip.
5. Draw line on strip at 0.5 cm and cut off the 0.5 cm section; this represents the scaled size of a meteoroid; glue the strip to the Data Sheet in the space provided.
6. Starting at the end of strip where the cut was made, repeat the process, but this time measure 2 cm; again, draw a line at 2 cm and cut off the 2 cm section; this section represents the scaled size of a comet; glue it to the Data Sheet too.
7. Repeat the process, except this time measure a line that is 100 cm in length (you will need to measure more than one strip and add distances together!)
8. When done, cut at 100 cm; attach strips together by barely overlapping end of one strip to end of next and gluing overlapped ends together; these strips represent the scaled size of an asteroid.
9. Glue the bottom strip to the Data Sheet in the space provided; neatly fold remaining strips back and forth over the bottom strip; use a paper clip to hold remaining strips in place.

Creating Shapes and Makeup:
1. On each white strip, sketch the small body it represents (use the Background sheet as a reference); you may extend the comet’s two tails beyond the strip if you want, but be sure that you only draw on the top strip for the asteroid).
2. Now, illustrate the composition of each (see Background sheet); decide which lab items would be good examples of the material (for example, a comet has an icy center; items that are white or look like ice would be good to use in the middle of your comet drawing).
**Name:**

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**Meteoroid**

Glue here

**Comet**

Glue here

**Asteroid**

Glue bottom strip along here

Fold remaining strips back and forth on top of glued strip and use paper clip to hold.
Making Comparisons (write your answers on the back of this page):

1. Based on your scale model, which two small bodies are most similar in size?

2. Name two ways the compositions of asteroids, comets, and meteoroids are alike.

3. Throughout history, Earth’s surface has been hit by asteroids, comets, and meteorites. When that happens, craters are often formed. Some, like Sudbury Crater in Ontario, Canada (image at right), are very large; others are not. Suggest how a scientist might be able to tell if the crater was caused by an asteroid, a comet, or a meteorite.

EXTEND YOUR KNOWLEDGE

- Learn more about NASA’s Deep Impact Discovery Mission to look below the surface of Comet Tempor 1:
  

- Great information about small bodies and other interesting aspects of our solar system for student astronomers:
  