What Is in Our Solar System?

The sun, the planets, and their moons are not the only objects in our solar system. There are also many smaller bodies, including comets, asteroids, and meteoroids. Scientists study these objects to learn about the formation and composition of the solar system.

What Are Comets?

A comet is a small, loosely packed body of ice, rock, and dust. The core, or nucleus, of a comet is made of rock, metals, and ice. A comet’s nucleus can range from 1 km to 100 km in diameter. A spherical cloud of gas and dust, called a coma, surrounds the nucleus. The coma may extend as far as 1 million km from the nucleus.

COMET TAILS

A comet’s tail is its most spectacular feature. Sunlight changes some of the comet’s ice to gas, which streams away from the nucleus. Part of the tail is made of ions, or charged particles. The ion tail, pushed by the solar wind, always moves away from the sun, no matter which way the comet is moving. A second tail, made of dust, follows the comet in its orbit. Some comet tails are more than 80 million km long, glowing brightly with reflected sunlight.

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

• What are comets and what are they made of?
• What are asteroids and where are they found?
• What is a meteoroid?

STUDY TIP

Organize In your notebook, create a Comparison Table that compares comets, asteroids, and meteoroids.

READING CHECK

1. Describe What is a comet made of?

2. Identify Draw an arrow from the “Nucleus” label to show the direction the comet is moving.
ORIGINS OF COMETS

Scientists think that many comets come from the Oort cloud. The *Oort cloud* is a spherical cloud of dust and ice. It surrounds the solar system far beyond the orbit of Pluto. Comets may be attracted by the gravity of nearby stars. This may cause them to fall into an elliptical orbit around the sun, as shown in the figure below. Other comets are found in the *Kuiper belt*, a flat ring of objects just beyond Neptune's orbit.

Scientists think that comets are made of matter that was left over when the solar system formed. They would like to learn more about comets to better understand the solar system's history. Several spacecraft have been launched to gather comet dust. In 2004, the spacecraft Stardust collected material from a comet named Wild 2.

LONG- AND SHORT-PERIOD COMETS

Comets in orbit come close to the sun over and over again. Many of their orbital periods have been calculated and some have been observed several times. If a comet takes more than 200 years to complete one orbit, it is called a long-period comet. Other comets, mostly from the Kuiper belt, take less than 200 years. The famous Halley's comet is a short-period comet, returning every 76 years.

![Comet Image](image-url)

Comets have very long orbits that take them close to the sun and well beyond Pluto.

**READING CHECK**

3. **Identify** Where is the Oort cloud located?

4. **Explain** Why does the ion tail extend in different directions during most of the comet's orbit?

**Critical Thinking**

5. **Describe Events** Why can Halley's comet be seen from Earth only for about 1 year of its 76-year orbit?
What Are Asteroids?

Small, rocky bodies that revolve around the sun are called **asteroids**. They range in size from a few meters to almost 1,000 km in diameter. More than 50,000 asteroids have been discovered. None of them can be seen from Earth without a telescope. In fact, they were not known to exist until 1801.

Most asteroids orbit the sun in the asteroid belt. This is a 300-million-km-wide region located between the orbits of Mars and Jupiter. Astronomers think that asteroids are made of material from the early solar system. The pull of Jupiter’s gravity prevented this material from coming together to form a planet.

**COMPOSITION OF ASTEROIDS**

It is hard to determine what asteroids are made of. This is because they are small and usually far away from Earth. Mostly, they are composed of either rock or metal. Some asteroids may contain carbon and carbon compounds.

In general, asteroids do not have a spherical shape because of their small size. Gravity must be very large to pull matter together into a spherical shape. The table below gives several facts about selected asteroids.

<table>
<thead>
<tr>
<th>Asteroid</th>
<th>Date discovered</th>
<th>Size or diameter (km)</th>
<th>Interesting fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceres</td>
<td>1801</td>
<td>960 x 940</td>
<td>largest known</td>
</tr>
<tr>
<td>Pallas</td>
<td>1802</td>
<td>570 x 525 x 482</td>
<td>second largest</td>
</tr>
<tr>
<td>Vesta</td>
<td>1807</td>
<td>530</td>
<td>brightest</td>
</tr>
<tr>
<td>Ida</td>
<td>1884</td>
<td>58 x 23</td>
<td>has a satellite asteroid</td>
</tr>
<tr>
<td>Eros</td>
<td>1898</td>
<td>33 x 13 x 13</td>
<td>first near-Earth asteroid discovered</td>
</tr>
<tr>
<td>Ganymede</td>
<td>1924</td>
<td>32</td>
<td>largest near-Earth asteroid</td>
</tr>
</tbody>
</table>

NASA’s NEAR spacecraft landed on the asteroid Eros in 2001. This view of the cratered surface of Eros was taken from an altitude of 200 km.
NEAR-EARTH ASTEROIDS

More than 1,000 asteroids have wide, elliptical orbits that bring them close to Earth. They are called near-earth asteroids. Scientists are interested in these asteroids because they can cause great damage if they strike Earth. The Barringer meteorite crater is shown in the figure below. It was made when an asteroid struck Earth about 40,000 years ago. The asteroid was less than 50 m in diameter, but it caused a crater 1,200 m across!

Asteroid detection programs now identify and track asteroids whose orbit may bring them close to the planet. Scientists hope to be able to prevent future collisions by identifying asteroids that could be a problem in the future.

Barringer Crater in northern Arizona has a diameter of 1,200 m.

What Are Meteoroids?

Pieces of dust and debris from asteroids and comets, called meteoroids, are scattered throughout the solar system. Most meteoroids are about the size of a grain of sand. When a meteoroid enters Earth's atmosphere, it can reach a speed between 35,000 and 250,000 km/h.

Friction with the atmosphere heats meteoroids and the air around them to thousands of degrees, causing a bright glow. The glowing trails that form when meteoroids burn up in the atmosphere are called meteors. A meteor trail can be a few hundred meters in diameter and tens of kilometers long before it fades.

Every few days, a larger meteoroid enters the atmosphere. Some of these bodies pass through the atmosphere without burning up completely. The meteoroids that reach Earth's surface are called meteorites.
COMPOSITION OF METEORITES

Meteors are classified as one of three types: stony, metallic, and stony-iron. Stony meteorites are similar to rocks on Earth. Some of them include carbon compounds similar to those found in living organisms. Metallic meteorites have a distinctive metallic appearance and do not look like terrestrial rocks. Stony-iron meteorites are made of rocky material, iron, and nickel.

METEOR SHOWERS

Meteors can be seen on most clear nights. When many small meteoroids enter the atmosphere in a short period, it is called a meteor shower. During some meteor showers, several meteors are visible every minute. Meteor showers occur at the same time each year. These showers happen because Earth passes through orbits of comets that have left a dust trail.

Three Major Types of Meteorites

| Stony Meteorite: rocky material | Metallic Meteorite: iron and nickel | Stony-iron Meteorite: rocky material, iron, and nickel |

IMPACTS ON EARTH

Most objects that enter Earth’s atmosphere are small and burn up completely before reaching the surface. However, scientists think that impacts powerful enough to cause a natural disaster happen every few thousand years. An impact large enough to cause a global catastrophe may occur once every 50 million to 100 million years.

About 65 million years ago, a meteor 10 km wide struck Earth. Massive amounts of debris from this impact entered the atmosphere. The debris may have left the planet in darkness for months and dropped temperatures to near freezing for years. The impact may have caused 15% to 20% of the species on Earth, including the dinosaurs, to become extinct.
Section 5 Review

SECTIOh VocaBULARY

| **asteroid** | a small, rocky object that orbits the sun; most asteroids are located in a band between the orbits of Mars and Jupiter |
| **comet** | a small body of ice, rock, and cosmic dust that follows an elliptical orbit around the sun and that gives off gas and dust in the form of a tail as it passes close to the sun |
| **meteor** | a bright streak of light that results when a meteoroid burns up in Earth’s atmosphere |
| **meteorite** | a meteoroid that reaches Earth’s surface without burning up completely |
| **meteoroid** | a relatively small, rocky body that travels through space |

1. **Describe** How can a comet become the source of meteoroids and meteors?

2. **Classify** Fill in the blanks to complete the table.

<table>
<thead>
<tr>
<th>Object</th>
<th>Composition</th>
<th>Main location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>large chunks of rock or metal, much smaller than planets</td>
<td>Oort cloud and Kuiper belt</td>
</tr>
<tr>
<td></td>
<td>small chunks of rock or metal</td>
<td>throughout the solar system</td>
</tr>
</tbody>
</table>

3. **Evaluate Theories** Why is information about comets, asteroids, and meteoroids important for understanding the development of the solar system?

4. **Compare and Contrast** How do the orbits of comets differ from the orbits of most asteroids?

5. **Apply Concepts** Why would scientists want to know if an asteroid is on a course to collide with Earth in 20 years?