

# Meteorites

Guided Notes – Student Edition

## Meteoroids, Meteors, and Meteorites

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ - are they all the same? And if they're not, what makes one different from the other?

\_\_\_\_\_ are chunks of space rocks that differ in size, ranging from \_\_\_\_\_. They are rocky, metallic, or a combination of those that orbit the sun like other objects in the solar system. Meteoroids are common in the solar system and can even be found \_\_\_\_\_.



Meteoroids are pulled by the \_\_\_\_\_ and fall as it comes close to the Earth. The \_\_\_\_\_ in the atmosphere causes the meteoroids to \_\_\_\_\_, and we may see it as flashes of light in the sky. Possibly, you may have seen and wished upon it thinking that is a shooting star or a falling star.



Well, if you did, you were wishing upon a \_\_\_\_\_. A \_\_\_\_\_ is a space rock that crashes through the Earth's atmosphere. It's a streak of light in the sky that looks even more beautiful if seen at night. There can be several meteors in any given hour, and there are cases when these events dramatically increase – and this is called a \_\_\_\_\_.

As the Earth passes through a dusty debris trail left by a \_\_\_\_\_, meteor showers can happen once a year, or can even be in regular intervals. \_\_\_\_\_ are named after the \_\_\_\_\_ where they closely appeared. Every August, the most famous meteor shower which swings by the sun every \_\_\_\_\_ is named \_\_\_\_\_.

\_\_\_\_\_ on the other hand are space rocks that can survive and fall onto the Earth's surface. Before these space rocks became meteorites, they were \_\_\_\_\_ first. And before they became meteors, they were \_\_\_\_\_ first.



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### Classification and Composition of Meteorites

A variety of processes is involved in the formation of meteorites. \_\_\_\_\_ of these meteorites are found on Earth and are classified by scientists into three main types: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. Each of these types have sub-groups too.

#### Stony Meteorites

These types of meteorites are made up of minerals that have \_\_\_\_\_. \_\_\_\_\_ is a material composed of \_\_\_\_\_ and \_\_\_\_\_, as well as some \_\_\_\_\_ – \_\_\_\_\_ and \_\_\_\_\_. \_\_\_\_\_ have two types: \_\_\_\_\_ and \_\_\_\_\_.



Stony Meteorites

#### Chondrites



Ordinary Chondrites

\_\_\_\_\_ too have their own sub-groups: \_\_\_\_\_ and \_\_\_\_\_.

Named after the hardened droplets of lava called \_\_\_\_\_, these \_\_\_\_\_ are formed from \_\_\_\_\_ and \_\_\_\_\_ coming together to form \_\_\_\_\_ in the early solar system. \_\_\_\_\_ are essential to the study of the solar system's origin, age and composition because both were almost made at the same time, more than \_\_\_\_\_.

The most common type of stony meteorites are the \_\_\_\_\_ making up \_\_\_\_\_ of all meteorites that fell onto the Earth's surface. \_\_\_\_\_ are classified into three main groups, indicating the quantity of iron: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.

H Chondrite	L Chondrite	LL Chondrite
This group of chondrites has a high amount of iron.	This group of chondrites has a low amount of iron.	This group has a low amount of iron and a low amount of metal in general.



Carbonaceous Chondrites

On the other hand, \_\_\_\_\_ are rare than ordinary chondrites. According to astronomers, these are formed far away from the sun, as early as the solar system was developed. As the name suggests, carbonaceous chondrites contain \_\_\_\_\_ in form of \_\_\_\_\_ like \_\_\_\_\_. Similar to ordinary chondrites, carbonaceous chondrites can be classified based on their \_\_\_\_\_.

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Groups of carbonaceous chondrites are marked with a two- or three-letter code, starting with C.

CI Group	CV Group
Named after the Ivuna meteorite that crashed into Tanzania in 1938. This group has a high amount of clay and carbon.	<p>This group is named after the place where the specimen was first found. In 1910, a meteorite crashed near the city of Vigarano, Italy.</p> <p>Allende meteorite is the most famous CV meteorite that crashed near Pueblo de Allende, Chihuahua, Mexico, in 1969.</p>

### Achondrites

On the other hand, \_\_\_\_\_ don't contain lava droplets called chondrules that are present in Chondrites. These meteorites are very rare that they only make up about \_\_\_\_\_ of all known meteorites. These meteorites are formed from the brittle outer layers of asteroids.

\_\_\_\_\_ are classified into several groups as well. \_\_\_\_\_ has a very similar mineral composition to chondrites.



Achondrites

\_\_\_\_\_ are achondrites from the Moon that crashed to Earth. \_\_\_\_\_ on the other hand crashed to Earth from Mars. Only about \_\_\_\_\_ of these meteorites come from \_\_\_\_\_ and the \_\_\_\_\_. These achondrites are the result of their own \_\_\_\_\_ where large meteorites hit their surfaces cracking off bits of rocks, but rarely make their way to the Earth's atmosphere as \_\_\_\_\_, making it even more impossible to fall to the Earth's surface.



Primitive Achondrites



Lunar Meteorites



Martian Achondrite

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### Iron Meteorites

As the name suggests, \_\_\_\_\_ are mostly made up of a heavy mineral composition of \_\_\_\_\_ and \_\_\_\_\_. These meteorites make up \_\_\_\_\_ of all known meteorites on Earth. Their \_\_\_\_\_ allows them to survive the plunge to the Earth’s atmosphere without blasting off into smaller pieces. Namibia’s \_\_\_\_\_ is the largest meteorite ever found, and yes, it is an \_\_\_\_\_.



Iron Meteorites

### Stony-Iron Meteorites

These meteorites have almost equal amounts of \_\_\_\_\_. Silicate minerals contain the elements \_\_\_\_\_ and \_\_\_\_\_, including metals \_\_\_\_\_ and \_\_\_\_\_. \_\_\_\_\_ are one group of \_\_\_\_\_ that contains \_\_\_\_\_ encased in \_\_\_\_\_. Their chemical composition is the same as the other \_\_\_\_\_.



Stony-Iron Meteorites

### History’s Famous Meteorites

The following are the most famous meteorites to have fallen on the Earth’s surface.

\_\_\_\_\_ - Chelyabinsk Meteorite fell on the Earth’s surface on February 15, 2013. This giant fireball smashed around 7,200 buildings, and wounded over 1,500 people. The largest fragment of this meteorite was found in Chelyabinsk, Russia at the bottom of Chebarkul Lake.



Chelyabinsk Meteorite



Hoba

\_\_\_\_\_ - Weighing about 60 tons, it was impossible for this meteorite to be moved to another place considering its weight. This largest meteorite known to mankind can be seen on a farm Hoba West in Namibia. It is said that Hoba reached the Earth’s surface about 80,000 years ago. It has become a tourist attraction that is visited by people from all over the world. Because of this, it was declared a national monument in 1955.

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\_\_\_\_\_ - Meteorite hunters working on ASMNET project are responsible for the discovery of this meteorite that was found in the Allan Hills, Antarctica in December 1984. The rock is believed to be one of the oldest forms weighing 1.93 kilograms. This meteorite was believed to have come from Mars suggesting traces of life on Mars, and this made ALH 84001 famous.



ALH 84001



Orgueil

\_\_\_\_\_ - Fell in France in 1864, this meteorite is considered an older meteor and the most researched of all meteorites that fell on Earth. It is just one of the eight meteorites that belongs to the group of CL chondrite. This meteorite has a composition like the sun. This meteorite is split into pieces for a deeper study and is found in museums in Europe and United States.

\_\_\_\_\_ - The meteorite shower that covered the largest known area in Earth is the fall of a meteorite named Gibeon. It covered an area of about 275 by 100 kilometers. At present, there are about hundreds of specimen weighing more than 25 tons have been documented.



Gibeon



Ensisheim

\_\_\_\_\_ - This meteorite fall was widely written in stories. It is considered a miracle since it happened on the night before St. Martin's Day, 7<sup>th</sup> of November 1492 in Ban of Ensisheim. The stone that fell from the sky weighed 260 pounds.

\_\_\_\_\_ - A meteorite that belongs to carbonaceous chondrites group - a rare class of meteorites. The meteorite fall happened on the 8<sup>th</sup> of February 1969 in Chihuahua district Mexico and was estimated to cover over 250 square kilometers of field. The largest fragment of meteorites collected had a mass about 110 kg but broke up on impact.



Allende Meteorite

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\_\_\_\_\_ - This meteorite contains fragments of asteroid that created Meteor Crater - also known as Barringer Crater in Arizona USA. The meteorite is named after the nearby Canyon Diablo which lies three to four miles west of Meteor Crater. The asteroid is believed to fall about 50,000 years ago. This meteorite has been known, collected, and used by prehistoric Native Americans since the mid - 19<sup>th</sup> Century.



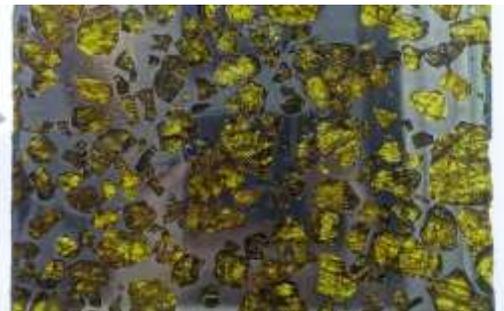
Canyon Diablo



Sikhote-Alin

\_\_\_\_\_ - On February 2, 1947, in the Sikhote - Alin Mountains, Primorye, Soviet Union, a large iron meteorite fall had been witnessed. According to witnesses the meteor came out of the north and dropped at an angle of 41 degrees. The fall was observed for 300 kilometers around the point of impact near Luchegorsk and approximately 440 km northeast of Vladivostok. A smoke trail estimated to be 32 kilometers in length was witnessed in the sky for several hours.

\_\_\_\_\_ - The Fukang meteorite is a stony-iron meteorite known as pallasite. As mentioned above pallasites are one group of stony-iron meteorites that contains yellow-green olivine crystals encased in shiny metal. It was found in mountains near Fukang China in 2000.



Fukang Meteorite



Muonionalusta

\_\_\_\_\_ - The Muonionalusta is believed to have impacted the Earth a million years ago. It is considered as the oldest discovered meteorites. In 1906, the first fragment of the meteorite was found in Pajala district, Norrbotten, Sweden in a 25-by-15 kilometers area. It was named after the municipality of Muonio by Professor A. G. Högbohm. It was classified as fine octahedrite, and is believed to be part of the iron core of the mantle of a planetoid before its fall on planet Earth.

\_\_\_\_\_ - Fragments of this meteorite were found in the vicinity of Bre nham Kansas. This iron meteorite was used to make ornaments and implements before it became famous in 1920. It was lately discovered that it came from a meteor when a professor from McPherson College, Harvey



Brenham Meteorite

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Harlow found the Haviland crater. Most pieces of the fragments of Brenham Meteorite are size of a grapefruit or even smaller.



Willamette Meteorite

\_\_\_\_\_ - This iron-nickel meteorite known to be the largest in the United States (weighing about 15.5 tons), and sixth in the world, was discovered near Oregon.

\_\_\_\_\_ - Weighing 272.3 kilograms, this meteorite was found in the dry riverbed of Hekandue in the Magadan District, Russia. It was found by a geologist, F. A. Mednikov in June 1967, while he was doing a survey. In October 1967, a second specimen with a mass of 51 kilograms was found 20 kilometers away from the location where the first was found. It was discovered by I.H. Markov in the same year. Many of the specimens found contained olivine crystals indicating that the meteorite is silicate in nature.



Seymchan Meteorite

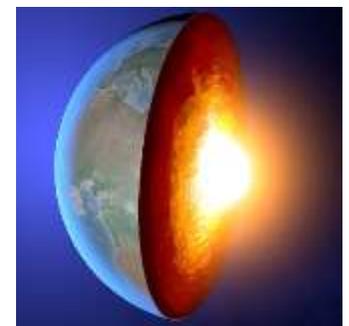
### The Importance of Meteorites in the Study of the Earth and Other Planets

Scientists' never-ending study of the importance of meteorites provides a glimpse of what could have happened some 4.8 billion years ago. These meteorites hold records of how the sun, the planets, and the solar system came to be, and how it could possibly impact the future.



Researchers said that \_\_\_\_\_ contain the first solid materials to form in our solar system. These materials are said to be \_\_\_\_\_, and this also determines how old our solar system is. A lot of these primitive meteorites are kept unchanged since the time they were formed. Not only that, but primitive meteorites also provide clues to the elements present in the solar system.

Meteorites also help scientists understand the planets in our solar system including the processes that take place deep inside, like Earth for example. From meteorites, we know that the Earth has a \_\_\_\_\_, composed of \_\_\_\_\_ and \_\_\_\_\_. When planets are formed, metal sinks to the center of the body while the lighter ones form the \_\_\_\_\_ and the \_\_\_\_\_.



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\_\_\_\_\_ and other bodies can hit with immense force that it can create \_\_\_\_\_, sometimes even huge craters. The moon for one has millions of craters indicating how frequently these bodies enter the solar system. The Earth has craters too but has disappeared because of geological factors. Without a doubt, our planet will be hit by meteorites again, in the future.



## The Hazards of a Meteorite Impact

Most meteorites are small and can give only very little effect on the Earth's surface. This causes very little damage like breaking windows and roofs. Very large meteorite impacts rarely happen, but when it does, the impact can be very devastating. It is believed that the meteorite impact 66 million years ago in the Yucatan Peninsula, Mexico has caused the \_\_\_\_\_, including dinosaurs.

This meteorite impact has affected the Earth in many ways:

- The surface of the Earth was temporarily heated to some hundred degrees Celsius from the \_\_\_\_\_ ejected by the impact.
- After the intense heating, a drop in the temperature for several months. This is because of the \_\_\_\_\_.
- Due to the limited sunlight, \_\_\_\_\_ was disturbed. This reduces \_\_\_\_\_ and \_\_\_\_\_.
- Changes in the landscape in the location of the impact including its surrounding areas. Impacts can trigger \_\_\_\_\_ causing \_\_\_\_\_ and \_\_\_\_\_.
- \_\_\_\_\_ caused by the melting of rocks in the impact site, releasing carbon dioxide.
- Water with sulfur dioxide and carbon dioxide reacts and forms \_\_\_\_\_.
- \_\_\_\_\_ in the location of the impact.
- \_\_\_\_\_ of many organisms changing the history of life on Earth.



Fire Generated by Impact