A Guide to Collecting Micrometeorites

Introduction: After our Sun formed it was surrounded by a large disk of debris called an accretion disk. This debris slowly formed the planets, asteroids, and comets. NASA's Near Earth Object Program uses instruments such as the WISE spacecraft and programs such as NEOWISE, CSS, Pan-STARRS, LINEAR, and Spacewatch to identify and track larger, near earth objects such as comets and asteroids whose paths may cross earth's orbit as they make their way through space. The remaining smaller pieces of rock are called meteoroids. Some meteoroids are non-metallic, while others are metallic, usually containing iron and nickel. These meteoroids are as small as dust, and as large as hundreds of feet across. As we travel around the Sun, the Earth constantly "bumps" into this debris, and when it does, it is called a meteor if it enters our atmosphere and burns up because of friction. We sometimes refer to this event as a "shooting star". If the meteor survives and makes it to the ground, it is called a meteorite. People search for meteorites, and many are on display at museums. However, there are millions of meteorites landing on Earth every day that are microscopic. Even in your own backyard! These micrometeorites are what we will search for today.

Equipment/Materials:
Compound light microscope
Microscope slides (plastic) concavity or flat slides
Dustpan and brush
Small Zip-lock© bag
White copy paper
Magnet
Cellophane (clear) tape
Scissors
Small plastic box with magnification
Clip on book reading light

Activity:
Go outside, with a dustpan and brush, and quickly whisk the dirt and sand from the gutters or sidewalk where there is rain runoff into your dustpan, then bring the dirt/sand, and dustpan inside.


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Take a piece of white copy paper and fold and crease it in half and then open the paper back up.

Place the magnet inside the plastic bag and seal the bag.

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Drag the plastic bag and magnet through the dirt/sand in the dustpan.

Shake off any loose dirt/sand back into the dustpan. Place the magnet and plastic bag in the center of the white creased paper.

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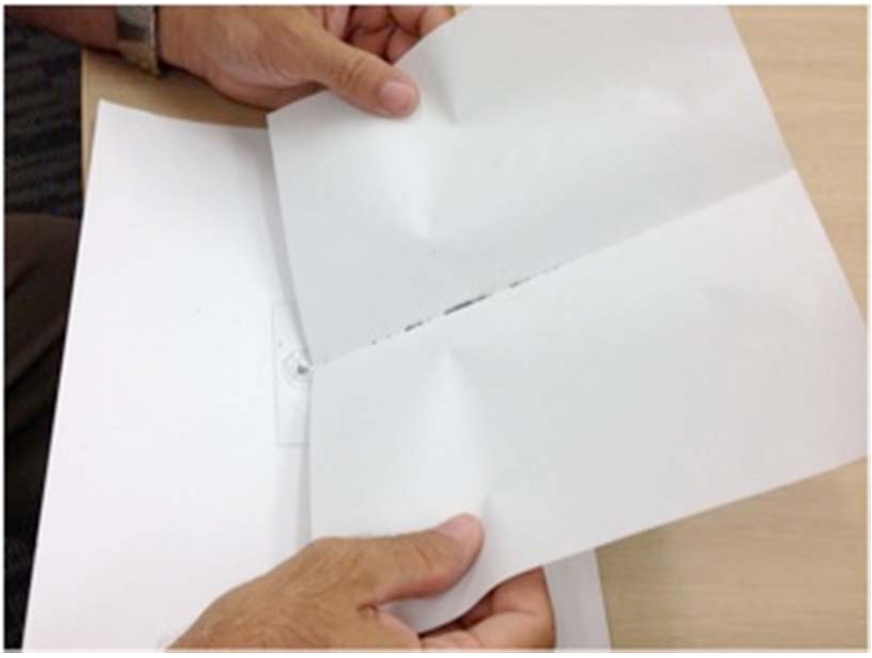
Carefully open the plastic bag, reach in and remove the magnet, keeping the plastic bag in contact with the paper. Next remove the bag from the paper leaving behind mainly metallic debris in the center crease of the paper.

Gently shake some of the magnetic debris on to a microscope slide.



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Do not pile the debris on the slide. You only want a single layer of magnetic material on the slide.

Note: There should be enough material left on your paper for about five to ten slides.

Carefully place the slide under the microscope at the lowest objective setting. Find the material on the slide and clip the book light to the stage and turn it on. Carefully manipulate the book light until the materials on the slide are illuminated from the top as well as bottom. Once the book light is adjusted lower the amount of light entering from the bottom of the stage by adjusting the iris/diaphragm of your scope if possible.

Using the microscope at 40X and 100X, and search patiently for the micrometeorites. If you cannot find one in about 5 minutes, make a new slide. The micrometeorites will be perfectly round, very tiny, and usually black or brownish black, and sometimes silver and shiny if they are metallic.

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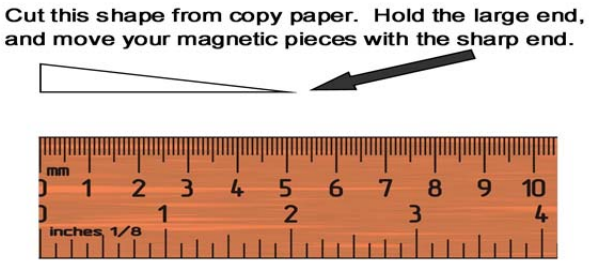
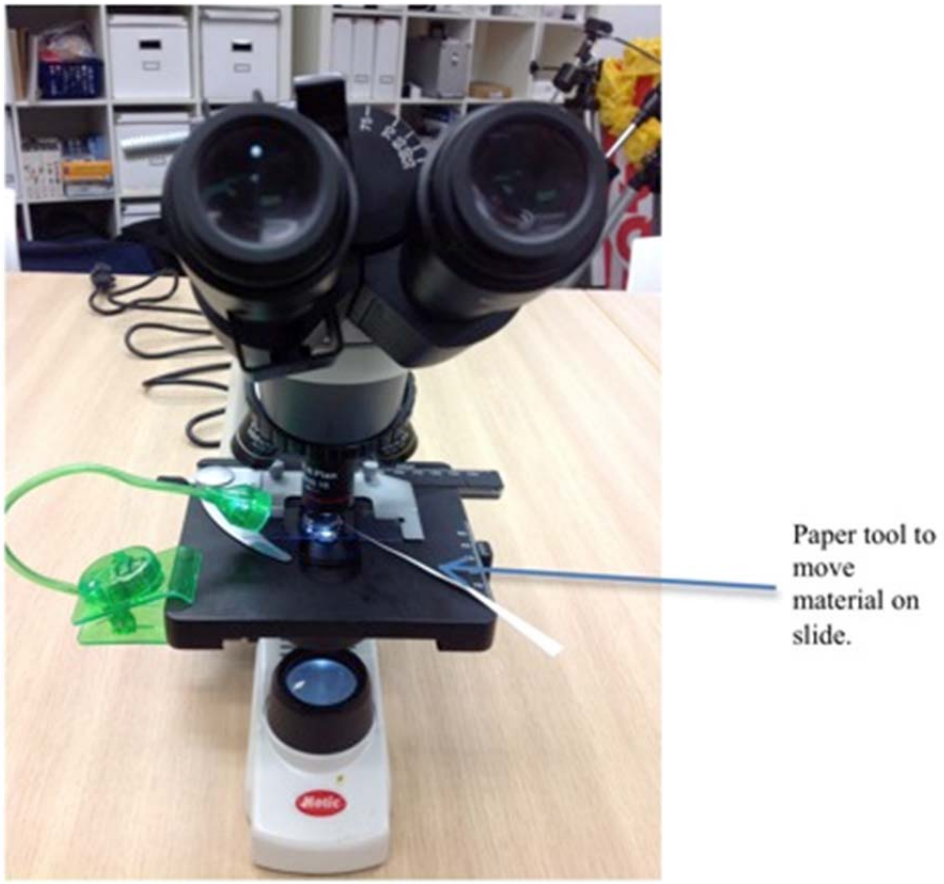
As you are searching, you may want to move the pieces around on the slide. Remember, the way you collected them made them magnetic, so they will stick to metal objects. The best tool to move around the pieces is a piece of paper. With scissors, cut a thin paper triangle from the copy paper about 5 centimeters long or longer; see image below. Use the point of this paper triangle to move your particles around on the microscope slide.



When you think you found a micrometeorite, ask for someone to check it out. They are usually round and shine/reflect light when illuminated. Here are some images of metallic micrometeorites at 40X and 100X magnification:



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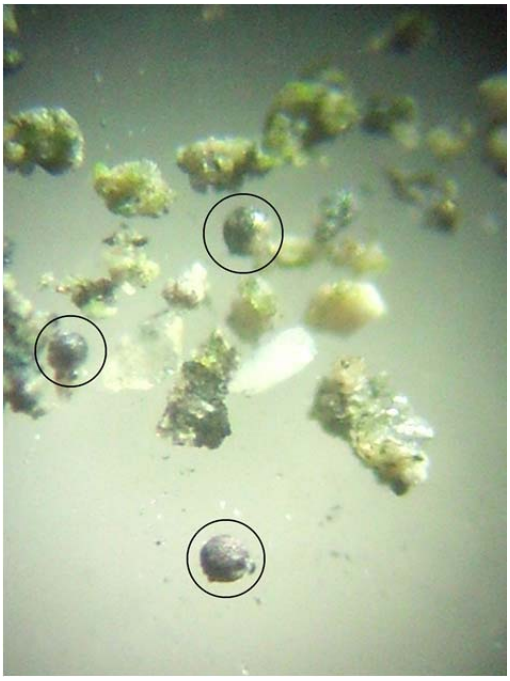

Micrometeorites at 40 X Magnification (black circles)

Micrometeorites at 100X Magnification (black circles)

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Once you know it is a micrometeorite, you can seal it with clear scotch tape and take it home, or instead of taping them; you may want to pour them into the small plastic box for storage.

If preserving in a magnifying box carefully remove the slide from under the microscope and place on the magnet to hold the micrometeorites in place.

Next place the BOTTOM of the box over the top of the slide.

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Flip the box, slide, and magnet over with the magnet on top.

Carefully remove the magnet and tap the bottom of the slide to empty the contents into the box of the container. Place the magnifying cover over the box to view your micrometeorites!

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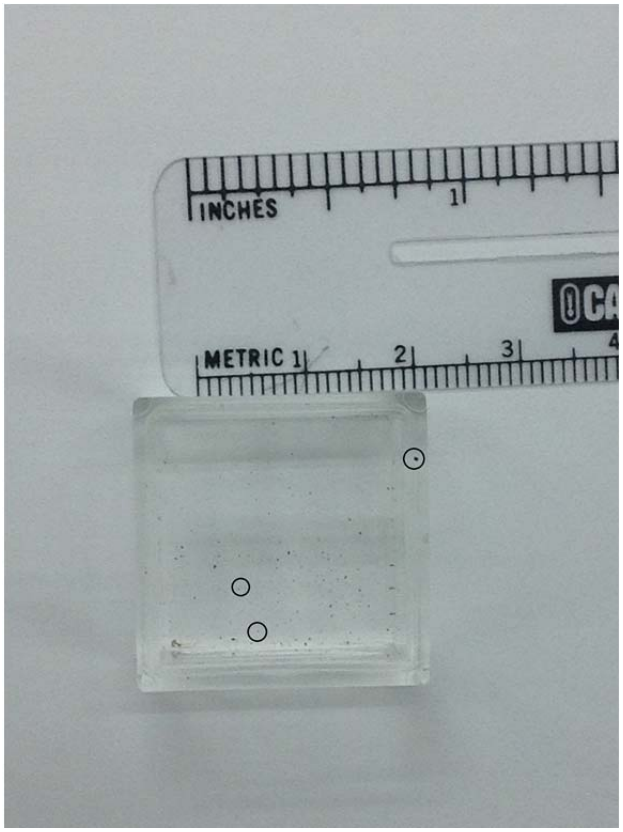
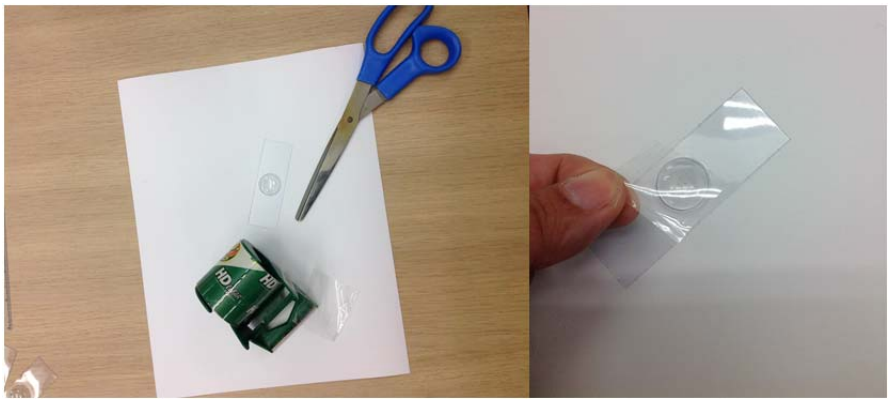


Micrometeorites in Container (black circles)

Note: Even with a magnifying glass built into the box the micrometeorites are still incredibly small and difficult to see. Remember they are only several hundred microns (millionth of a meter) in size!

If preserving sample on the slide, cut a piece of clear cellophane tape (packaging tape), place over the specimens on the slide and press firmly to slide.



These tiny pieces of the solar system are estimated to be 3 to 4 billion years old!

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References:

NASA Near Earth Object Program http://neo.jpl.nasa.gov/neo/

NASA Exploring Meteorite Mysteries, A Teacher's Guide With Activities for Earth and Space Science; EG-1997-08-104-HQ
http://er.jsc.nasa.gov/seh/Exploring_Meteorite_Mysteries.pdf

Whipple, Fred (1950), "The Theory of Micro-Meteorites", *National Academy of Sciences* **36**(12): 687–695.

Resources:
http://www.pbs.org/wgbh/nova/education/activities/3111_origins.html

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Instructor's Notes:

There are various ways this activity can be conducted however after trying various methods this was the most efficient, producing the highest success rate for participants.

Stereoscopes or dissection scopes can be used instead of compound light microscopes without the additional clip on book light, however the limitation is the magnification capability of the instrument. They will require a minimum of 40X total magnification. The advantage is most of the scopes provide two sources of lighting for specimens from below the stage and above the stage. The above stage light source helps identify materials that are metallic because of their reflective sheen. This is VERY difficult to see if using only the light source below the stage for illumination.

Some sights suggest using a dissecting probing needle to move the materials under the microscope while observing. Although the micrometeorites are exposed to the magnet for only a short period of time during the separation of magnetic and non-magnetic materials, they often become magnetized and stick to the probing needle, making it difficult to remove them without losing them due to their spherical shape and size. Therefore it is suggested to use the paper tool to move the materials around and separate the micrometeorites.

It is suggested to use PLASTIC microscope slides for the activity with or without concavity wells. This allows the students to apply clear cellophane tape to mount the micrometeorites to the slide and take them safely home without the hazard of broken glass slides.

When looking for areas to collect materials, which contain the micrometeorites, it is suggested to identify a location where run off either from downspouts of rain gutters or building roofs collects during rainstorms. It is better to select buildings, which do not have shingled roofs if possible because of the excessive amount of magnetic material that often collects in the runoff from the shingles themselves.

Photographs of specimens are also an option using cell phones and smart devices if an attachment device such as a SteadyPix^{TM} Pro Universal Camera and Smartphone Mount by ORION.

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