Space Rock Sherlock

Overview

Participants become detectives as they use scientific instruments and "challenge cards" to find genuine space rocks amongst a collection of rocks. Challenge cards are split into three difficulties: "Junior Investigator" (easy), "Astro-Explorer" (medium), and "Super Sleuth" (hard).

Activity Time

20-40 minutes

Intended Audience

Pre-K, Early Elementary, Upper Elementary, Tweens, Teens

Type of Program

Facilitated hands-on experience

What's the Point?

- NASA scientists use tools to observe everything from Earth to exoplanets.
  - Different tools are used to observe objects of different sizes and types
  - Different tools used on the same object can provide us with new information
- Magnetism is all around us
  - Magnets are tools we use in everyday life, but their behavior can also be used to describe phenomena in the world around us
- Space Rocks are clues to our origins
  - Space Rocks provide us with information about the history and formation of our solar system
  - Space Rocks can tell us about places humans haven't been yet (like Mars or the outer solar system)

Materials

- Something to record observations
- Observation sheets (template included), chart paper, or white board
- Utensils to write or draw
- Colored pencils, crayons, or dry-erase markers
- Kit of Mystery Rocks Magnet
- Paper Clip
- Microscope or hand lens
- Ceramic Streak Plate Glass
- Scratch Plate
- Paper Towels (for cleanup)
- *Optional items:*
  - Digital Scale
  - Measuring Cylinder
  - Pitcher of Water
  - Plastic Tablecloth

Space Rocks

NWA (Northwest Africa) 869 (labeled as #4)

- Example stony meteorite, formally called Chondrite L3-6
- First found in 2000 in Africa's Sahara Desert region by nomads; one of the largest recoveries to date
- Lightly attracted to a magnet
- Streak: none/barely noticeable. Slight red color (due to rust), if there is any streak at all.
- Does not scratch glass
- May have visible crystal structures that are highlighted by UV light
- Approximate density: 2.5–3.5 g/mL

Campo del Cielo (labeled as #6)

- The Spanish, during their South American conquest, first discovered Campo del Cielo meteorites in 1576. The actual meteorite fall probably occurred 3,000 to 5,000 years ago. It is estimated that 50 metric tons has been recovered over the years.
- Campo del Cielo means "field of heaven."
- Strongly attracted to a magnet
- Streak: none/barely noticeable
- Does not scratch glass
- Approximate Density: 5.5–6.5 g/mL

Earth Rocks

Fluorite (labeled as #1)

- Fluorite can be found world-wide, often in hydrothermal reins associated with lead, silver, and zinc ores
- Light color with a crystalline structure and colorful inclusions
- Will not scratch glass
- Will leave a white streak on streak plate, regardless of the color of the specimen
- Will react to UV light, especially any inclusions
- Approximate density 3.01-3.56 g/ML

Lodestone (labeled as #2)

- Naturally-magnetized rock; also known as the mineral magnetite
- Often mistaken for meteorites
- Attracted to a magnet and has its own weak magnetic field (will attract metal)
- Streak: noticeable and dark
- Will not scratch glass
- Approximate density: 4.5-5.5 g/mL

Anorthosite (labeled as #3)

- Uncommon igneous rock that solidified from underground magma. This rock consists mostly of the mineral feldspar.
- One of the oldest rocks found on the Moon
- Not attracted to a magnet
- Streak: white
- Will scratch glass with enough force
- Approximate density: 3-4 g/ML

Pyrite (labeled as #5)

- Naturally-occurring iron sulfide Earth mineral.
- Commonly referred to as Fool's Gold
- Not attracted to a magnet
- Streak: noticeable and dark
- Will scratch glass
- Approximate density: 4.5-5.5 g/mL

River Rock (labeled as #7)

- Formed as water washes over rock, river rocks are usually found along large river & lake shores
- "River Rock" describes the process through which these rocks got their smooth shape.
- They may be any type of rock that can withstand water erosion.
- Most are not attracted to a magnet
- Most do not streak; some will
- Some will scratch glass, some will not
- Density will vary depending on type

Pumice (labeled as #8)

- Porous igneous rock that forms during volcanic pyroclastic eruptions
- Not attracted to a magnet
- Streak is color of rock. A light- colored piece of pumice will leave a light-colored streak on a darker plate, while a red piece of pumice will leave a red streak
- Does not scratch glass
- Approximate density: .25–.50 g/mL. This rock is so light that it will often float on water

Ammonite Fossil (labeled as #9)

- Ammenite were predatory, shelled cephalopods that went extinct at the end of the Cretaceous Period ~66 million years ago
- Will have “swirls” or circular patterns present from the chambered shell
- Will typically leave a white streak (carbon) on the streak plate, will not scratch glass
- Approximate density 2.6-2.8 g/ML

Indochinite (Tektite) (labeled as #10)

- Not a meteorite, but fused glass which was formed from a space rock impact
- The likely impact point was somewhere in Indochina some 780,000 years ago. This kind of fused glass forms from an impact’s ejected material. The powerful energy from the collision heats material and sends it flying. As it returns to Earth, it cools, forming these glassy, blob-shaped tektites.
- Chinese tektites are known as Lei-gong-mo, which means “Thunder God Ink-black Stone”
- These specimens have a varied appearance, with some looking like large water droplets from how the molten rock splashed back to the ground, others having “thumbprint” indentations, and many having vesicles (popped air pockets) from super heating and/or shiny areas that look like glass. Some may even have a see-through quality where you can actually see the glass that formed from the heat of the impact
- Not attracted to a magnet
- Streak: none
- Does not scratch glass
- Approximate density: 1.5-2.5 g/mL

Facilitator Information

Facilitation Options

The challenge cards each present a physical characteristic and can be used individually. If you are discussing a specific feature of space rocks, Earth rocks, and fossils, such as density or magnetism, then you may just want to use that individual challenge card with your group.

Tip: This option is useful if you are short on time or if you want to just discuss one of the rock/meteorite properties.

If you have a large group, then you can give individuals or pairs one mystery rock and their own set of cards to explore. You may want to set up "stations" for each challenge card and the materials. Patrons will take their mystery rock from station to station, exploring each challenge card with the corresponding instruments.

Tip: This option allows patrons to explore many different properties and instruments. It limits patrons to just one mystery rock.

With a large group, you can also assign patrons to a station with challenge card and materials. Rotate the mystery rocks through each station, giving patrons equal time to explore each mystery rock.

Tip: This option allows patrons to explore all the mystery rock. It limits patrons to just one physical property and one instrument.

With a smaller group or one-on-one session, you can have patrons use all mystery rocks to explore all challenge cards within their difficulty level.

Tip: This option requires more time than the others.

Tip: With a smaller group, assign patrons roles such as "recorder,""experimenter," and "helper." Have them alternate between roles for each card.

Modify the activity so that young patrons—or older patrons who need extra help—can use their senses of touch and sight to make observations. Have your younger patrons sit in a circle, handle the rocks, and make observations about each rock. Invite younger patrons to sort rocks into groups, such as a group of heavy rocks, a group of dark rocks, etc.

Next, invite patrons to make guesses about which rocks they think came from space. Walk them through some of the Junior Investigator and Astro-Explorer tests, like the magnetism, sturdiness, scratch, streak, and crust color tests, before telling them about each rock.

Warning: The magnet inside of the kit, as well as some of the "mystery rocks," are small and are a choking hazard. Never let children under three handle small items that may be a choking hazard.

Facilitation Tips

- If a participant makes it through all challenge cards, then they can use their observations to identify their mystery rock by using the "What's In Your Kit" section of the activity guide, or the dichotomous key.
- This activity is mainly an exercise in the process of science and not an identification guide for meteorites. Meteorites have different compositions, sizes, and appearances. Meteorite identification is best left to the experts (such as your local rock hound club or natural history museum).
- This activity will encourage patrons to observe and "think like a scientist. "The end result – whether the mystery rock was formed on Earth or in outer space – isn't as important as the process to get there. If the patron can use scientific instruments to make an accurate observation about a mystery rock, then the activity is a success!
- The first step to this activity should involve patrons making observations with their naked eye. When you hand them a mystery rock, ask "What's the first thing you notice? "There are no right or wrong answers to this question. It is meant to get patrons in the "observational" mindset.
- For younger audiences, try setting a scene to draw patrons in. Use dialogue such as, "I've gotten all my rocks and meteorites jumbled together. Can you help me figure out which is which?" or "Someone gave me this box and told me that there were rocks and meteorites in here; but, they didn't tell me which ones were which. Can you all help?"
- Be a "guide on the side," rather than a "sage on the stage."You do not need to provide correct answers, just give patrons an opportunity to observe, test, and explore in a safe environment and have a caring adult (you!) available to explore alongside them!
- Don't be afraid to say, "I don't know!" It's one of the most commonly used phrases in science! Be honest if you don't know their answer. Brainstorm with patrons on ways that you could figure out the answer.
- Don't rub the magnet on the mystery rocks. This could change the mystery rock's magnetic properties!
- Observation sheets should stay at the stations, so that patrons have a chance to contribute to each one. Include crayons, colored pencils, or other writing utensils that allow patrons the chance to be creative. If available, chart paper or a whiteboard and markers also provide a great communal recording experience.

Observation Sheet

Mystery Rock #1

Mystery Rock #2

Mystery Rock #3

Mystery Rock #4

Mystery Rock #5

Mystery Rock #6

Mystery Rock #7

Mystery Rock #8

Mystery Rock #9

Mystery Rock #10

Partner

Magnet Test (Junior Investigator)

Most space rocks are attracted to a magnet. Is yours?

What You'll Need:

- Magnet
- Paper clips
- Mystery rocks
- Observation Sheet

What to Do:

Move a magnet slowly towards the mystery rock until it is almost touching. Does the rock move? Does it stick to the magnet? Does a paperclip stick to the mystery rock?

What's Happening:

Most space rocks will move toward or stick to a magnet. This is because they have lots of metal like iron in them.

Tricky mystery rock: Some Earth rocks, like magnetite or lodestone, also stick to magnets. These Earth rocks can do something that space rocks can't do: a paperclip will move toward or stick to them. These Earth rocks are magnetic.

Observations

Use the observation sheet to write down what you observed!

Credit: Space Science Institute

Sturdiness Test (Junior Investigator)

Meteorites travel fast on their journey to Earth. They need to be sturdy to survive the trip! Could your mystery rock survive the trip?

Meteoroids enter Earth's atmosphere at Very high speeds.
Credit: NASA

What You'll Need:

- Mystery rocks
- Senses (sight and touch)
- (optional) Hand-lens or Digital Microscope
- Observation Sheet

What to Do:

Rub your fingers along the surface of a mystery rock. Does it feel like it would break apart easily, or does it feel strong and solid?

Use a hand lens or microscope to look at the mystery rock up close. Is it full of holes or does it look strong and solid?

What's Happening:

Any space rocks that travel through the atmosphere and land on Earth travel VERY fast – more than 20 miles per second! Space rocks that are lightweight, brittle, weak, or crumbly explode or vaporize during this journey. They do not make it to the Earth's surface. Only strong, solid space rocks make it all the way to the ground.

Observations

Use the observation sheet to write down what you observed!

Crust Color (Junior Investigator)

Meteoroids travel so fast through Earth's sky that their outer layer melts! This gives meteorites a dark crust. Is your mystery rock a dark color or a light color?

What You'll Need:

- Mystery Rocks
- (optional) Hand-lens or Digital Microscope
- Observation Sheet

What to Do:

Look at the color of the mystery rock. Does it have a light color or a dark color?

Look at the dark-colored mystery rock. Is the rock dark all the way through, or is it dark only on the outside?

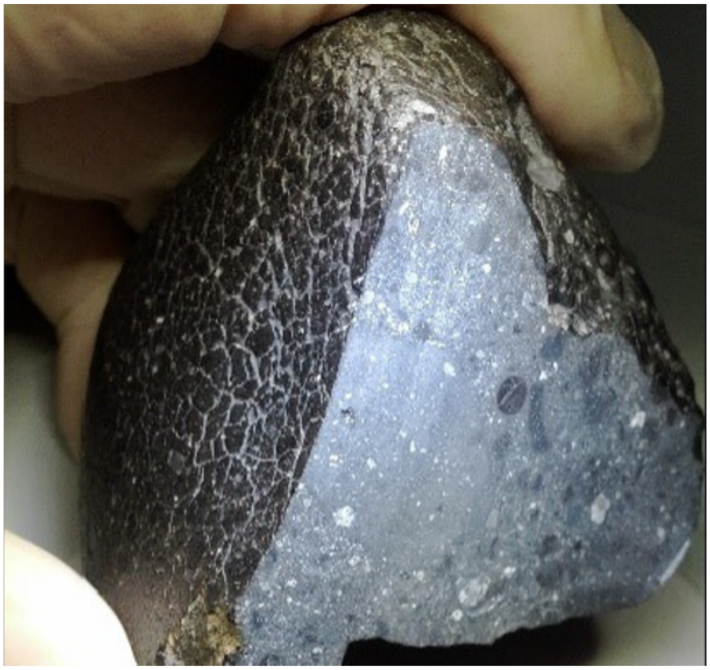
What's Happening:

Space rocks that are weak, snap apart easily, or are full of many small holes usually explode or vaporize as they fall to Earth. Stronger space rocks survive falling through Earth's atmosphere, but the trip through the sky melts their outer layer. Some meteorites get a dark crust (called a "fusion crust") while others can look like metal. Light-colored rocks are almost never meteorites.

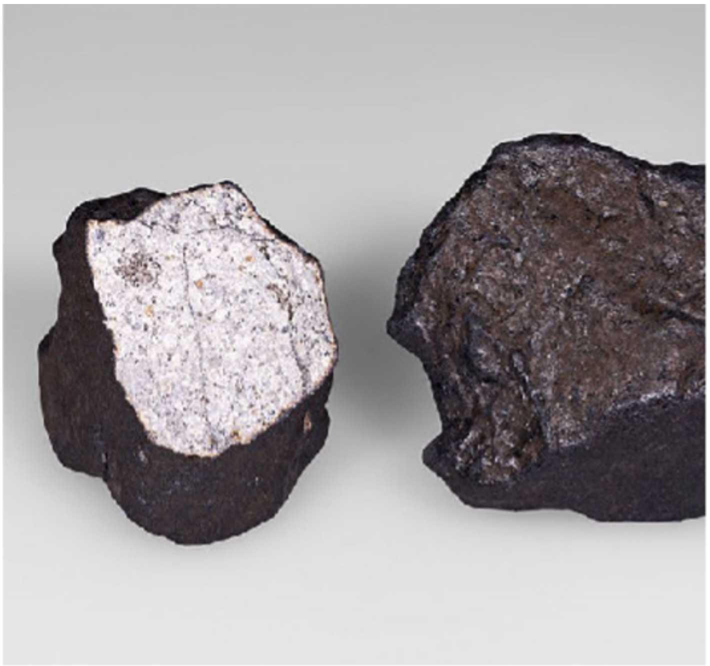
Tricky mystery rock: Some Earth rocks are a dark color, and some Earth rocks even have a crust...

Observations

Use the observation sheet to write down what you observed!



This Martian meteorite, nicknamed "Black Beauty', is over 2.1 billion years old! Note the dark crust.
Credit: NASA



Two pieces of the Chelyabinsk meteorite, part of a space rock that exploded over Russia in 2013
Credit: Didier Descouens, CC BY-SA 4.0

Streak Test (Junior Investigator)

Rocks may leave powder, or a "streak", when scratched against a special tool called a "streak plate." This powder can be a different color than the rock! Meteorites normally leave a very thin, small streak or no streak at all. Does your mystery rock leave a streak? What does it look like?

The streak of lodestone (left), a stony meteorite (middle), and pyrite (right)
Credit: Space Science Institute

What You'll Need:

- Mystery Rocks
- Streak Plate (or unfinished piece of ceramic tile)
- Observation Sheet

What to Do:

Rub the mystery rock on a streak plate. Does it leave a streak? If so, what color? Is it thick or thin?

What's Happening:

A "streak" is the powder that a rock leaves behind when scratched on a surface – like a crayon! The color of a rock's streak may be completely different than the rock's actual color. Not all rocks leave streaks.

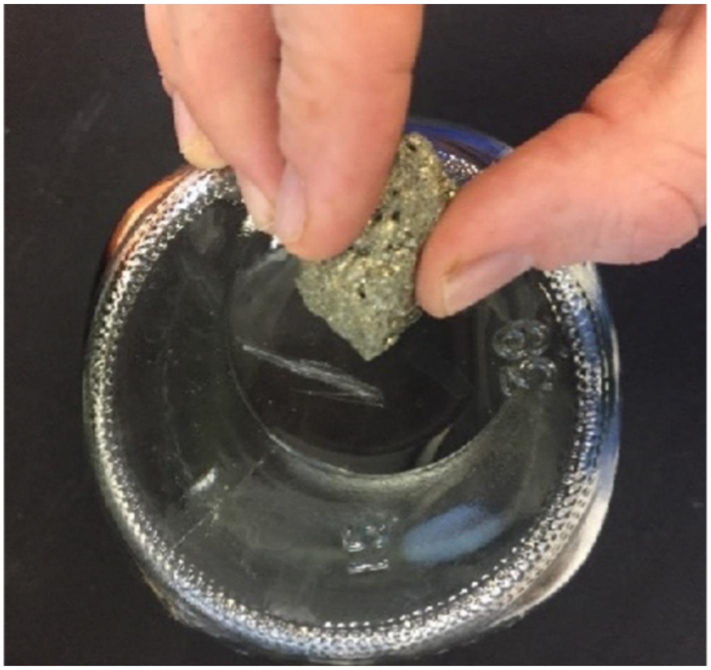
Some Earth rocks, such as hematite or magnetite, leave dark streaks when scratched against a ceramic tile. Hematite leaves a red-brown streak and magnetite leaves a black streak. Space rocks do not leave thick streaks.

Observations

Use the observation sheet to write down what you observed!

Scratch Test (Astro-Explorer)

Scientists measure how hard rocks are by scratching them against special tools. Meteorites do not have the minerals that are hard enough to scratch glass. Can your mystery rock scratch glass?



Pyrite is hard enough to scratch glass.
Credit: Space Science Institute

What You'll Need:

- Mystery Rocks
- Glass Scratch Plate
- Observation Sheet

What to Do:

Try to scratch the glass plate with your mystery rock. Did your mystery rock leave a scratch on the glass plate or not?

What's Happening:

Certain rocks are harder than the other, since they contain different minerals. Scientists measure how hard rocks and minerals are by scratching them against common objects like glass. Not all rocks can scratch a glass plate. Meteorites will not normally scratch a glass plate.

Observations

Use the observation sheet to write down what you observed!

Look for Patterns and Shapes (Astro-Explorer)

Look at your mystery rock with a microscope. Do you see any shapes or patterns?

Credit: Basilicofresco, CC BY 2.0

What You'll Need:

- ❍ Mystery Rocks
- ❍ Microscope
- ❍ Observation Sheet

What to Do:

Look at your mystery rock through a microscope. Do you see any shapes? Do you see any patterns?

What's Happening:

Scientists use microscopes to see the shapes and patterns of the minerals inside the rock.

Rocks are made up of different minerals. Minerals are made from elements (such as silicon, oxygen, aluminum, or iron) and occur naturally as crystals. This means that the atoms that make up these minerals are arranged in a unique pattern. That pattern repeats itself again and again and gives the mineral its shape!

Meteorites sometimes have the same types of shapes and patterns as Earth rocks – but the stuff they are made of is different.

Some meteorites have tiny, round grains that are not found in Earth rocks. These special round grains are called "chondrules." Chondrules formed and cooled in space before becoming part of an asteroid, and later, falling to Earth as a meteorite. They are some of the oldest "stuff" in the solar system!

Observations

Use the observation sheet to write down or draw what you observed!

Detecting Magnetic Fields with a Magnetometer App (Super Sleuth)

We use compasses to detect the invisible magnetic field of the Earth. NASA spacecraft use an even more sensitive tool, called a magnetometer, to study the magnetic fields of asteroids and planets. Download a magnetometer app on your phone to study space rocks – just like NASA studies asteroids in space!

Credit: Space Science Institute

What You'll Need:

- ❍ Mystery Rocks
- ❍ Tablet with Magnetometer app
- ❍ Observation Sheet

What to Do:

Run the magnetometer app and hold the tablet next to the mystery rock. Watch as the measurements are plotted as a graph. Does the measurement go above 200 units? If so, you have a magnetic rock. (If the measurement is between 1 and 120, it can be ignored. Magnetism is all around us, and the magnetometer is always detecting a low level of magnetic fields.)

What's Happening:

Magnetometers are like electronic compasses. They can also detect how strong a magnetic attraction is. Magnetic rocks act just like the magnet you might use on your refrigerator to hold a sheet of paper against the steel door. Lodestone and magnetite are types of Earth rocks that are magnetic. The magnetometer measures 200 units or higher for these rocks.

Tricky mystery rock: Meteorites are not magnetic rocks and the magneto-meter will not give you a high measurement (200 units or higher) for these rocks. Most meteorites DO have metals like iron and nickel, so they are attracted to magnets. But, they will not attract other metal, like lodestone or magnetite will.

Observations

Use the observation sheet to write down what you observed!

Weighing, Floating, and Sinking (Super Sleuth)

Meteorites are very heavy for their size. This means that they are "dense." Measure your rock's weight compared to its size. Is it dense?

What You'll Need:

- ❍ Mystery Rocks
- ❍ Digital Scale
- ❍ Measuring Cylinder
- ❍ Pitcher of Water
- ❍ Plastic Tablecloth
- ❍ Paper Towels (for cleanup)
- ❍ Observation Sheet

What to Do:

Measuring density is a multi-step process.

1. Weigh your mystery rock in grams using the scale:
   ________________ g
2. Fill a cylinder or beaker with enough water to cover your mystery rock. Measure how much water is in the cylinder:
   ________________ mL
3. Next, put your mystery rock in the cylinder or beaker and measure how high the water rose:
   ________________ mL
4. Do some simple math to see how high the water level rose. For example: if the water level rose from 50 ml to 75 mL, then the difference is 25 mL.
   ________________ mL
5. Density is the weight of the rock for its size. Calculate the mystery rock's density by dividing your rock weight (step 1) by how much the water level rose (step 3):
   ________________ g/mL
6. See how your rock compares to the densities of Earth rocks and space rocks. Find the closest match.

Credit: Outlook xp; CC BY-SA 4.0

Approximate Densities of Rocks in the Kit

- Magnetite/Lodestone: 4.5-5.5 g/mL
- Pumice: .25-.50 g/mL
- Pyrite: 4.5-5.5 g/mL
- NWA meteorite: 2.5-3.5 g/mL
- Campo meteorite: 5.5-6.5 g/mL
- Tektite: 1.5-2.5 g/mL

What's Happening:

Meteorites are normally denser than Earth rocks. They must be strong and sturdy to survive the fall through Earth's atmosphere!

Observations

Use the observation sheet to write down what you observed!

Partner