Science @ Home

SPACE ROCKS

Day 1: Size and Scale
60 minutes

- Sorting the Solar System (activity)
- Searching for Space rocks (activity) (en español)
- Scale of asteroids & comets (activity)

Day 2: Comets
45–60 minutes

- DIY Comet flipbook (activity)
- Comet Streamers (craft) (en español)
- 360° Video: Rosetta Encounter (video)

Day 3: Meteors
45–60 minutes

- How to View a Meteor Shower (video)
- Meteor Shower in a Bottle (experiment)
- Shooting star origami (craft)

Day 4: Impact!
45 minutes

- Make a crater (activity) (en español)
- Amy Mainzer on Detecting Near Earth-Objects (video)
- 360° Video: Chelyabinsk Meteor (video)

Kid & Caregiver Extension Activities

- Edible Ice Cream Comet Investigation (activity)
- Cosmic Conversations with astronaut Ed Lu (video)
- Seasonal Skywatch (resource)

3…2…1…Blast off! Embark on a week of out-of-this-world adventures, featuring over a dozen activities for future astronauts ages 8-11.

Ready to rock? Your mission is to explore the incredible objects that zip and zoom through space—asteroids, comets, meteors, and more—through hands-on activities, crafts, experiments, and videos.

Please note: While Science @ Home activities are designed to be conducted by kids, some little ones might need adult help with reading instructions and preparing crafts.

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Sorting the Solar System

Our Solar System contains objects ranging in size and composition from microscopic dust all the way up to the Sun. Investigate the characteristics of a variety of these objects and use your scientific skills to sort them into categories of your making.

Materials

Solar System cards (pages 3-12)
Scissors

Directions

1. **Print** the Solar System cards, single-sided and in color.
    a. **Cut** each page along the solid black lines into three strips, so that the image and object description are on the same strip.
    b. **Fold** each strip in half along the dotted black line, making two-sided cards. *Optional*: Paste or tape the blank sides together.
2. **Read** the Solar System object cards to learn more about the variety of planets, asteroids, comets, and more in our Solar System.
3. **Sort** the objects into categories based on their characteristics. Scientists sort things by their characteristics—size, composition, and position are examples of categorizing things. It's up to you to determine what categories to create.
4. When you have completed sorting the objects, **select** one card and describe how you categorized it.
    a. What characteristics does it share with the others in that category?
    b. Could the object fit into more than one category you have created?

5. *Bonus:* With your friends or family, play a guessing game with the objects on the cards. *Optional:* Just use the information printed on the card or spend a little bit of time researching the objects together as a group to learn more about each one first.

   a. Player 1: Pick an object card. Don't let the others see what it is!

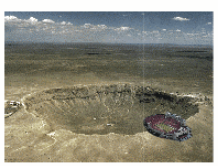
   b. Remaining players: Take turns asking player 1 yes or no questions about the object inthe card. When a player has a guess as to what the object is, ask player 1.

   c. The person who guesses correctly becomes player 1 and gets to pick the next object. Continue this until all object cards are used.

This activity and the sorting cards were originally created by Night Sky Network Resources, for educational use only.

Barringer Crater

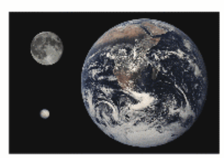
- This crater is located in Arizona, USA
- It was created 50,000 years ago by a chunk of **METAL** from space
- It measures about **1.2 km** in diameter



Size of crater compared to a stadium

Ceres

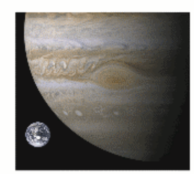
- Ceres is the largest object between the orbits of Mars and Jupiter
- It is made mostly of **ROCK** and **ICE**
- Ceres is about **950 km** in diameter



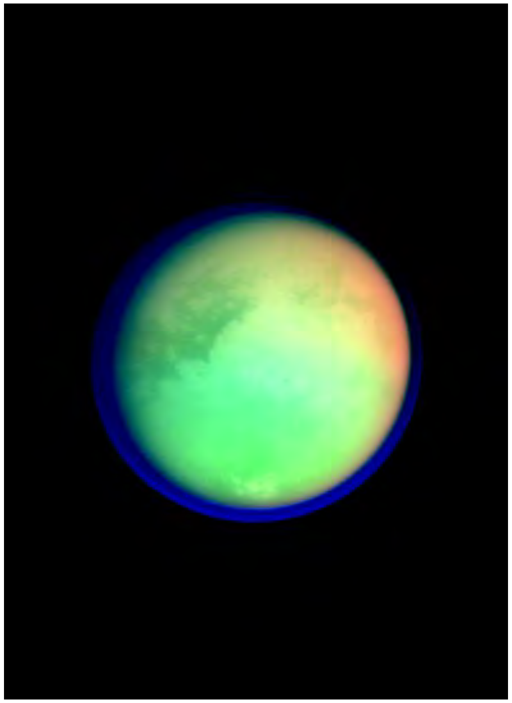
Ceres (bottom left) compared to the Earth and Moon

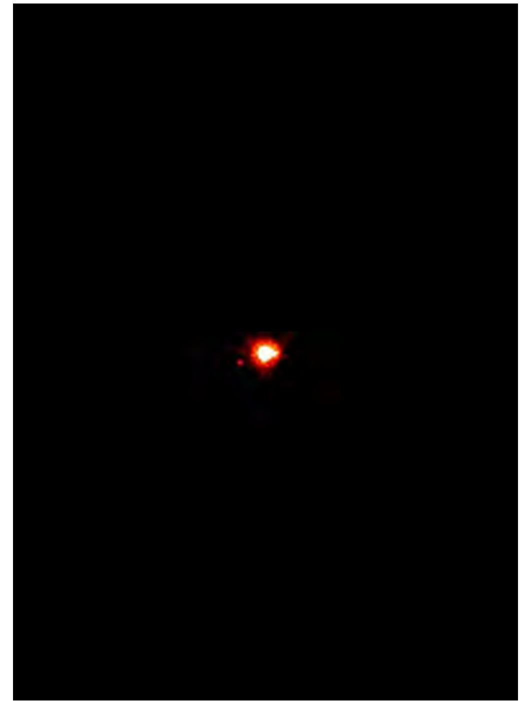
Earth

- It orbits the Sun between Venus and Mars
- Earth is made of **ROCK**, a **METAL** core and both solid and liquid **ICE** (water, that is) on its surface
- Its diameter is **12,650 km**



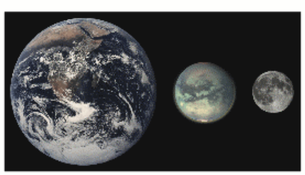
Size of Earth compared to Jupiter





Titan

- Titan orbits Saturn
- It is made of **ROCK** and ICE and has a thick atmosphere
- It is **5,150 km** in diameter, between the size of the Earth and Moon



Size of Titan (center) compared to the Earth and Moon

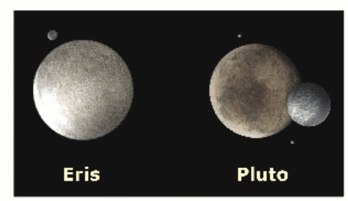
Wild 2

- Wild 2 orbits the Sun between Mars and Jupiter, though its orbit used to be much more distant
- It is made of ICE and **DUST**
- It is about **4 km** across

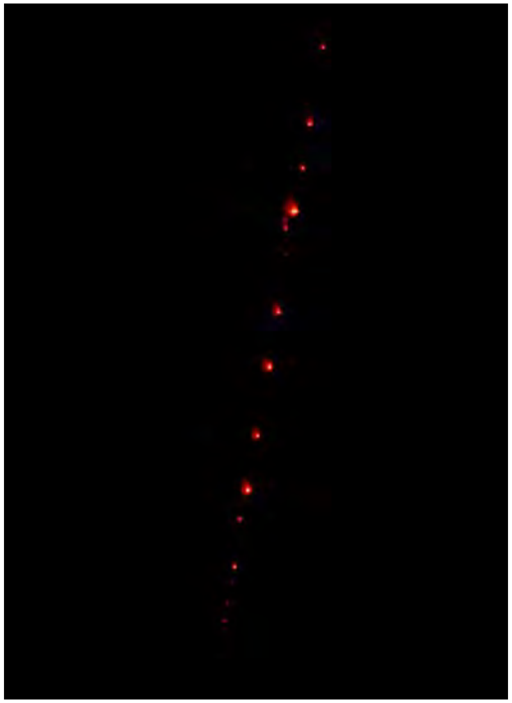
Size of Wild 2 compared to Manhattan

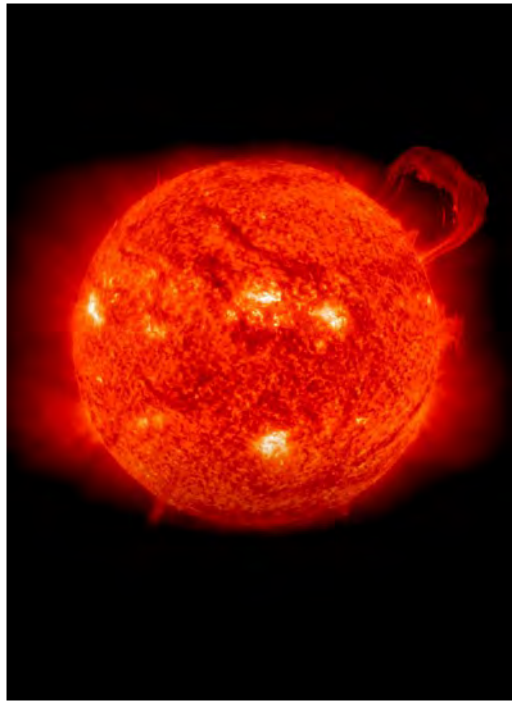
Eris

- The orbit of Eris is very distant, mostly beyond Pluto's orbit.
- It is made of ICE and **ROCK**
- The diameter of Eris is about **2,600 km**



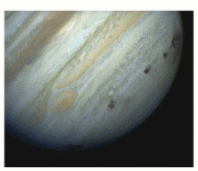
Size of Eris compared to Pluto





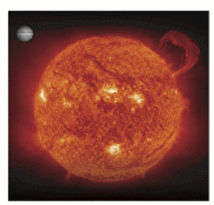
Shoemaker-Levy 9

- Its orbit originally took it beyond Pluto. After it was captured by Jupiter's gravity, it was torn apart and eventually smashed into Jupiter.
- Made of ICE and ROCK
- Largest pieces were **1km** and left huge marks on Jupiter



Sun

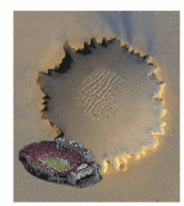
- The Sun is located in the center of our Solar System
- It is made mostly of hydrogen and helium GAS
- The Sun is **1.4 million km** in diameter



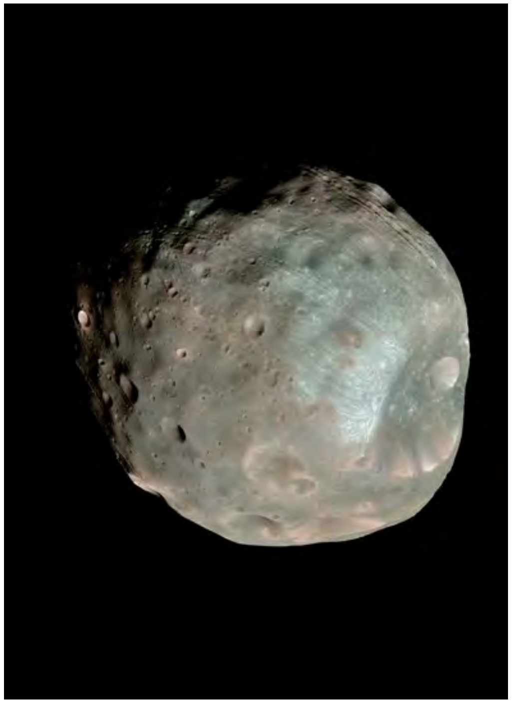
Size of Sun compared to Jupiter

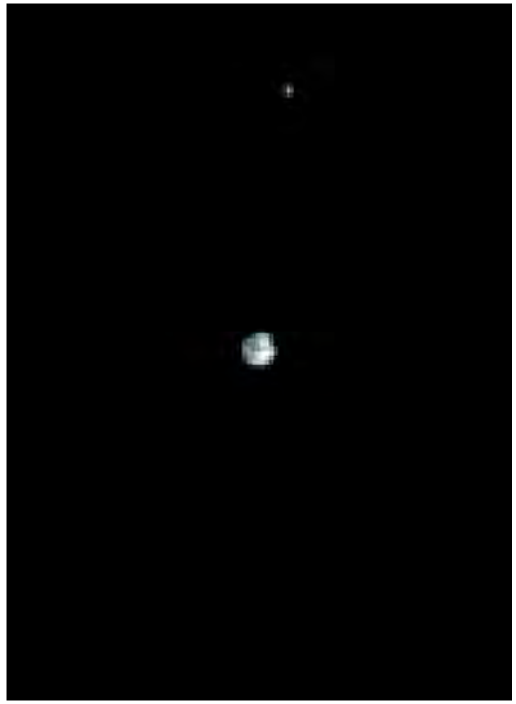
Victoria Crater

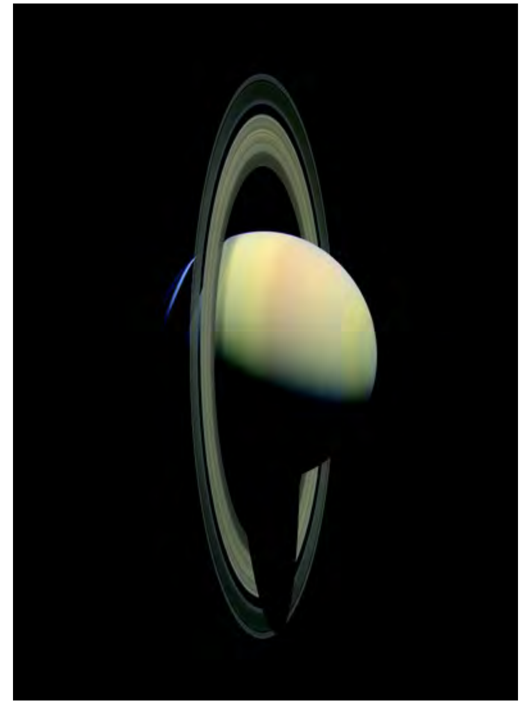
- This crater is one of the smaller craters on Mars
- The rim's jagged edges are due to erosion caused by ROCK and DUST
- It is **750 meters** across



Size of crater compared to a stadium

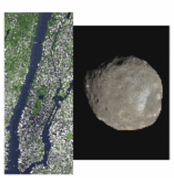






Phobos

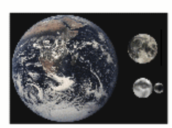
- Phobos closely orbits Mars and will eventually collide with it
- It is mostly made of **ROCK** but may have **ICE** inside
- Phobos is about **11 km** across



Size of Phobos compared to Manhattan

Pluto & Charon

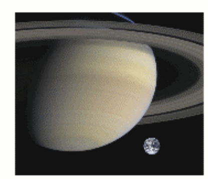
- Pluto and Charon orbit orbit each other, together are mostly outside Neptune's orbit
- These round objects are made of **ICE** and **ROCK**
- Pluto is about **2,300 km** across



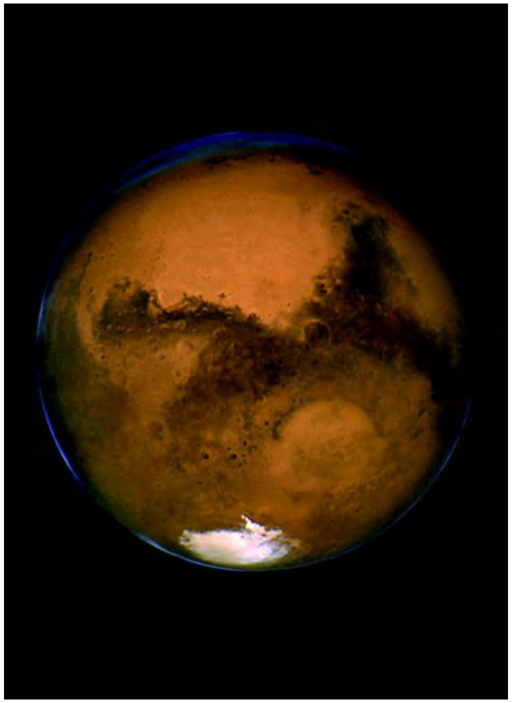
Size of Pluto & Charon compared to Earth and Moon

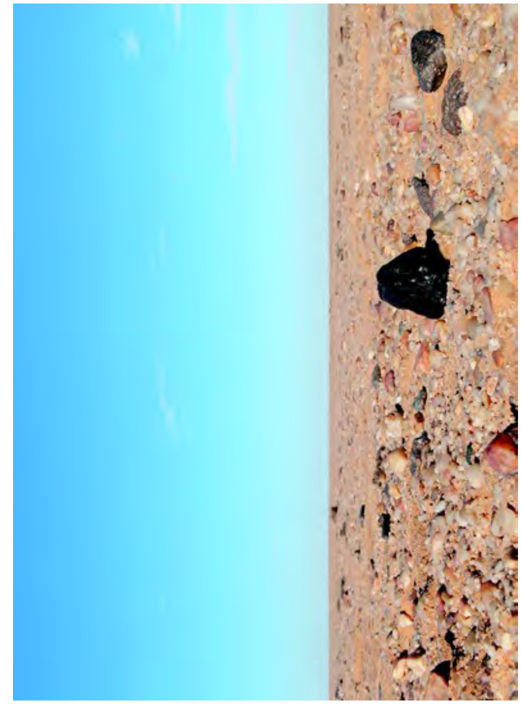
Saturn

- Saturn orbits the Sun between Jupiter and Uranus
- Saturn is mostly made of **GAS**
- The main body is **120,000 km** across



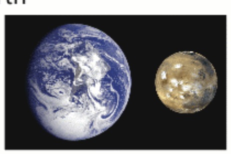
Size of Saturn compared to Earth





Mars

- The orbit of Mars is between Earth and the Asteroid Belt
- Mars is made of **ROCK** with a **METAL** core and some solid **ICE** on its surface
- It is **6,800 km** in diameter, about half as wide as the Earth



Size of Mars compared to Earth

Meteor

- Meteors occur in Earth's atmosphere, about 75km above the surface
- We see the glowing pieces of **ROCK**
- The pieces of rock are mostly less than **1cm**, or the size of a coin

Size of rock compared to a coin

Meteorite

- Meteorites are pieces of asteroids that land on other worlds
- They are made of **METAL** and **ROCK**
- Almost all meteorites on Earth are smaller than **1 meter**

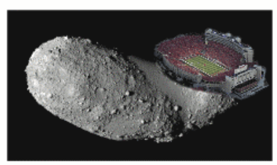
Ida and Dactyl

- Together they orbit the Sun between the orbits of Mars and Jupiter. Dactyl (the smaller object) orbits Ida.
- They are mixtures of **ROCK** and **METAL**
- Ida is about **15 km** across

Size of Ida compared to Manhattan

Itokawa

- Itokawa's orbit crosses the orbits of Earth and Mars but is not a threat to either
- It is made of a loose pile of boulders made of **ROCK** and **METAL**
- Its longest side is **535 meters**



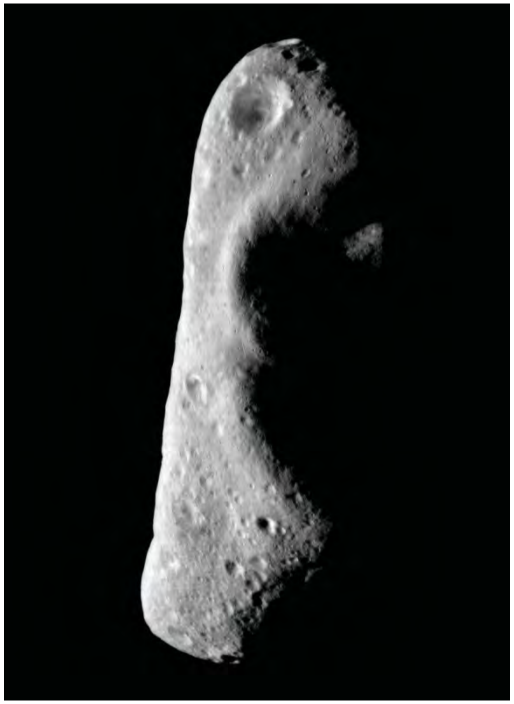
Size of Itokawa compared to a stadium

Jupiter

- Jupiter orbits the Sun between the Asteroid Belt and Saturn
- It is made of **GAS**
- Its diameter is about

143,000 km

Size of Jupiter's Red Spot compared to Earth



Eros

- The orbit of Eros ranges between Earth and Jupiter, crossing Mars's orbit
- It is a mixture of **ROCK** and **METAL**
- This object is **34 km** on its longest side

Size of Eros compared with Manhattan

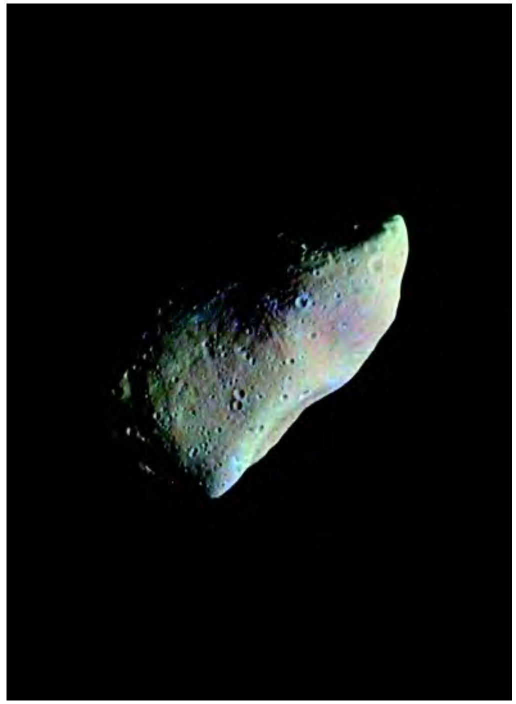
Hoba

- This object landed on Earth 80,000 years ago in what is now the country of Namibia
- Hoba is made of **METAL**
- It measures about **3 meters** across

Iapetus

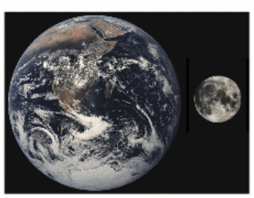
- Iapetus orbits Saturn
- This walnut-shaped object is made of **ICE** with some **ROCK**
- It is **1,500 km** across, or about half as wide as the Earth's Moon

Size of Iapetus compared to Moon



Earth's Moon

- The Moon orbits Earth
- It is made of **ROCK** with a small **METAL** core
- The Moon is **3,500 km** in diameter or about ¼ the width of Earth



Size of Moon compared to Earth

Gaspra

- This object orbits the Sun between Mars and Jupiter
- It is made of a mixture of **ROCK** and **METAL**
- It is **18 km** on the longest side

Size of Gaspra compared to Manhanttan

Hale-Bopp

- Hale-Bopp orbits between Earth's orbit and the distant Solar System — far beyond the orbit of Pluto
- Hale-Bopp is made of **ICE** and **DUST**
- The tail shown here extends more than **1 million km**

Key to Sorting the Solar System Cards

Object	Description	Size (km)	Picture Credits
Barringer Crater	Also known as Meteor Crater, it is located in Arizona, USA. Created by the impact of a meteorite about 50,000 years ago, this crater was formed before humans inhabited the Americas.	1.2	B.P. Snowder
Ceres	Ceres is the largest object in the Asteroid Belt. The International Astronomical Union classifies Ceres as a Dwarf Planet. It is the target of the Dawn spacecraft in 2015.	950	NASA, ESA, J. Parker (SwRI) et al.
Earth	Earth is the third planet from the Sun and is the fifth largest planet in the Solar System. About 71% of Earth's surface is water, the remainder consists of land.	12,650	Taken from Apollo 17 in 1972, credit NASA
Earth's moon	The moon is the fifth largest satellite in the Solar System. It is the only celestial body on which humans have landed. Although it appears bright in the sky, it is actually as dark as coal.	3,500	NASA/JPL/USGS
Eris	Eris is a Dwarf Planet with a moon called Dysnomia. It is more massive than Pluto and orbits the Sun three times farther. It was discovered in 2005 and caused a stir after initially being described as the 10th planet.	2,600	NASA/ESA/M. Brown
Eros	Eros was the first near-Earth asteroid discovered. It is also one of the largest. The probe NEAR Shoemaker landed on this asteroid in 2001. Eros orbits between Earth and Jupiter, crossing Mars's orbit.	34	NASA/JPL/JHUAPL
Gaspra	Gaspra is an asteroid that orbits the inner edge of the main Asteroid Belt. The Galileo spacecraft flew by Gaspra on its way to Jupiter.	18	NASA/JPL/USGS
Hale-Bopp	Hale-Bopp was one of the brightest and most widely viewed comets of the 20th century. It came into the inner Solar System in 1997 and has an orbital period of over 4,000 years.	1,000,000	E. Kolmhofer, H. Raab; Johannes-Kepler-Observatory
Hoba	The Hoba meteorite is the largest known meteorite on Earth. It landed here about 80,000 years ago in what is now Namibia. Hoba weighs over 60 tons and is the most massive piece of naturally-occurring iron on Earth's surface.	0.003	Patrick Giraud
Iapetus	Iapetus is the third largest moon of Saturn. It has an equatorial ridge that makes it look a bit like a walnut, as well as a light and a dark side. Astronomers think that the dark side is covered with a thin layer of residue from the icy surface sublimating.	1,500	NASA/JPL/Space Science Institute
Ida and Dactyl	Ida is a main belt asteroid and the first asteroid found to have a moon, Dactyl. It was imaged by the Galileo spacecraft on its way to Jupiter.	15	NASA/JPL
Itokawa	Asteroid Itokawa crosses the orbits of both Mars and Earth. It is a rubble pile of rocks. In 2005, the Hayabusa probe landed on Itokawa to collect samples.	0.5	ISAS, JAXA
Jupiter	Jupiter is the largest planet in the Solar System, more massive than all the other planets combined. This gas giant has been explored by many spacecraft, notably the Galileo orbiter. It has four large moons and dozens of smaller moons.	70,000	NASA/JPL/University of Arizona

Key to Sorting the Solar System Cards

Object	Description	Size (km)	Picture Credits
Mars	Mars is the fourth planet from the Sun. Iron oxide gives it a reddish appearance. It has polar ice caps and a very thin atmosphere. Two tiny moons might be captured asteroids.	6,800	NASA
Meteor	Small pieces of asteroids or comets collide with Earth's atmosphere to create meteors. The compressed air in front of the rock heats up, causing it to glow and leave a trail of ionized gas.	0.00001	Chuck Hunt
Meteorite	Most meteorites are pieces of the Asteroid Belt that land on Earth's surface. Over 90% of meteorites are considered stony meteorites. About 5% are iron meteorites. Both types contain a significant about of iron.	0.001	Dr. Svend Buhl www.meteorite-recon.com
Phobos	Phobos is the largest moon of Mars, but still quite small. It is likely a captured asteroid and will break up and crash into Mars in the next 40 million years.	11	NASA/JPL-Caltech/University of Arizona
Pluto and Charon	Pluto is the 2nd largest dwarf planet in the Solar System (after Eris). It has a large moon Charon and two smaller moons, Nix and Hydra. Pluto and Charon are sometimes treated as a binary system since their center of gravity is between the two.	2,300	ESA/ESO/NASA
Saturn	Saturn is the second largest planet in the Solar System. It is made of gas and has very thin icy rings. It also has dozens of moons. The Cassini-Huygens spacecraft has been orbiting Saturn since 2004.	120,000	NASA/JPL/Space Science Institute
Shoemaker-Levy 9	Comet Shoemaker-Levy 9 provided the first direct observation of the collision of extraterrestrial solar system objects. It broke into many fragments, called the "String of Pearls," and impacted Jupiter in 1994.	1	NASA/HST
Sun	The Sun is the star at the center of our Solar System, about 150 million km from Earth. It contains 99.9% of all the mass in our Solar System. It travels once around the Milky Way Galaxy in about 250 million years.	1,400,000	ESA/NASA/SOHO
Titan	Titan is the largest moon of Saturn, comprising 96% of the mass of all Saturn's moons combined. It is a cold world with a thick nitrogen atmosphere and liquid methane lakes on its surface. The Huygens probe landed on its surface in 2005 and took pictures of icy conditions.	5,150	NASA/JPL/Space Science Institute
Victoria Crater	This impact crater near the equator of Mars was visited by the Mars Exploration Rover *Opportunity*. The scalloped edges of the crater are caused by erosion. Although Mars has very little atmosphere, it does have dust storms.	0.75	NASA/JPL-Caltech/University of Arizona/Cornell/Ohio State University
Wild 2	Comet Wild 2 is officially named 81P/Wild. It once orbited beyond Jupiter but got too close to the giant planet in 1974 and was tugged into a smaller orbit between Jupiter and Mars. The Stardust sample return mission took pictures and captured some of the comet's coma in 2004.	4	NASA/JPL-Caltech

Night Sky Network Resources
You can print your own cards here:
http://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=459


Image source: NASA

Searching for Space Rocks

What is a meteorite? It's a rock from space! Just like Earth rocks, meteorites can come in a variety of shapes and sizes, and can be made of many different materials—but that doesn't mean they're the same as the "ordinary" rocks found on our planet. Because they form far away in space, meteorites have unique qualities that make them unlike anything else on Earth. So, how do you tell the difference between an Earth rock and a meteorite? Let's find out!

Materials

Streak plate (or unglazed porcelain tile)
Magnet
4 rock samples
Results sheet (page 4)
Pencil

Directions

1. **Collect** samples of rocks to study.
    a. **Ask yourself** what you think a meteorite could look like.
    b. **Collect** at least *two rocks* that you think look like meteorites, and at least *two rocks* that you think look like Earth rocks. Your samples should be small enough to pick up and handle easily, and shouldn't include any sharp edges or other hazards.
    c. **Assign** each of your samples a number to help you keep track of which one is which.

2. **Study** your samples by putting them through the following series of tests. Use the "Results" sheet on page 4 to record your observations.

    a. Appearance: Look at the rock closely. What color is it? What shape? Is it rough or smooth? Does it contain any crystals, layers, veins, holes, or smaller rocks?

    b. Weight: How heavy does your rock feel? Compare it to another rock the same size. Does it feel heavier or lighter?

    c. Streak: Drag your rock across your streak plate like you're trying to draw a line. Does the rock leave a streak behind? If so, what color is the streak?

    d. Magnet Test: Hold a magnet against the rock. Does the magnet stick?

3. **Evaluate** your results to see what they say about where each sample came from.

    a. Appearance: Most meteorites are dark brown or black, sometimes with rusty red patches. Some meteors have unique shapes called regmaglypts, which look like smooth thumbprint-sized indentations. Meteorites are not likely to have crystals, layers, veins, or holes. They are also not likely to be colors like white, tan, or gray.

    b. Weight: Meteorites are made of dense materials like metal, making them heavier than most Earth rocks.

    c. Streak: Meteorites will not usually leave a streak, but some Earth rocks will.

    d. Magnet Test: Meteorites almost always contain the metals iron and nickel, which will cause a magnet to stick to them. Some Earth rocks also contain these metals, while others do not.

Conclusion

Did any of your samples pass the test? If so, does that mean you've found a meteor?

It's possible! But keep in mind that some Earth rocks have a lot in common with meteors, enough to pass the same tests. Because meteorites are so rare, it's more common to find look-alikes from Earth (sometimes jokingly called meteor-wrongs) than it is to find real meteorites.

While this activity can't tell you for sure if you've found a meteorite, it can help you learn about the rocks you've collected.

By now you've probably identified several rocks among your samples that can't be meteorites, but plenty of Earth rocks have their own interesting features and stories. Do you think you can identify which kinds of Earth rocks you've collected? If you want to investigate further, you can learn a lot from books and online references, and you can learn even more by continuing to explore the world around you.

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Results

Appearance

Specimen #	Observations

Weight

Specimen #	Observations

Streak

Specimen #	Observations

Magnet Test

Specimen #	Observations

Buscando rocas espaciales

¿Qué es un meteorito? ¡Es una roca del espacio! Como las rocas de la Tierra, los meteoritos pueden tener una gran variedad de formas y tamaños, y pueden estar hechos de muchos materiales diferentes, pero eso no significa que sean iguales a las rocas "normales" que se encuentran en nuestro planeta. Cómo se forman bien lejos en espacio, los meteoritos tienen cualidades únicas que los hacen diferentes de cualquier otra cosa en la Tierra. Entonces, ¿cómo puedes distinguir entre una roca terrestre y un meteorito? ¡Averigüémoslo!

Materiales

Placa de raya (o teja de porcelana sin esmaltar)
Iman
4 muestras de rocas
Hoja de resultados (pagina 4)
Lapiz

Instrucciones

1. **Recoge** muestras de rocas para estudiarlas.
    a. **Pregúntate** cómo se parece un meteorito.
    b. **Recoge** al menos dos rocas que creas que se parecen como meteoritos, y al menos dos rocas que creas que se parecen a las rocas de la Tierra. Tus muestras deben ser lo suficientemente pequeñas para manipularlas con facilidad, y no deben incluir bordes afilados o otros peligros.
    c. **Asigna** a cada una de tus muestras un número que te ayude a saber cuál es cada una.

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2. **Estudia** tus muestras sometiéndosla a la siguiente serie de pruebas. Usa la hoja de "Resultados" de la página 4 para anotar tus observaciones.

    a. Aparencia: Observa la roca de cerca. ¿Qué color es? ¿Qué forma tiene? ¿Es áspera o lisa? ¿Contiene cristales, capas, vetas, huecos o rocas más pequeñas?

    b. Peso: ¿Cuánto pesa tu roca? Compárala con otra roca del mismo tamaño. ¿Parece más pesada o más liviana?

    c. Raya: Arrastra tu roca por tu placa de rayas como si estuvieras intentando dibujar una línea. ¿Deja la piedra una raya? Si es así, ¿qué color es la raya?

    d. Prueba del imán: Coloca un imán sobre la piedra. ¿Se pega el imán?

3. **Evalúa** los resultados para ver qué dicen sobre de dónde viene cada muestra.

    a. Aparencia: La mayoría de los meteoritos son de color marrón oscuro o negro, y a veces con manchas rojas oxidadas. Algunos meteoritos tienen formas únicas llamadas regmagliptos, que parecen como hendiduras suaves del tamaño de una huella digital. No es probable que los meteoritos tengan cristales, capas, venas o agujeros. Tampoco es probable que tengan colores como el blanco, el bronceado o el gris.

    b. Peso: Los meteoritos están hechos de materiales densos como metal, haciéndolos más pesados que la mayoría de las rocas terrestres.

    c. Raya: Los meteoritos no dejan rayas, pero algunas rocas terrestres sí.

    d. Prueba del imán: Los meteoritos casi siempre contienen los metales hierro y níquel, que hacen que un imán se pegue a ellos. Algunas rocas terrestres también contienen estos metales, mientras que otras no.

Conclusión

¿Alguna de tus muestras pasaron la prueba? Si es así, significa que has encontrado un meteorito?

Es posible! Pero ten en cuenta que algunas rocas terrestres tienen mucho en común con los meteoritos, lo suficiente como para pasar las mismas pruebas. Como los meteoritos son tan raros, es más común encontrar imitaciones de la Tierra que encontrar meteoritos reales.

Aunque esta actividad no puede decirte con seguridad si has encontrado un meteorito, puede ayudarte a aprender sobre las rocas que has recogido.

Probablemente ya hayas identificado varias rocas en tus muestras que no pueden ser meteoritos, pero muchas rocas terrestres tienen sus propias características e historias interesantes. ¿Crees que puedes identificar qué tipos de rocas terrestres has recogido? Si quieres investigar más, puedes aprender mucho de libros y las referencias en línea, y puedes aprender más si sigues explorando el mundo alrededor de ti.

Results

Appearance

Specimen #	Observations

Weight

Specimen #	Observations

Streak

Specimen #	Observations

Magnet Test

Specimen #	Observations

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Scale of Asteroids and Comets

We know that planets are big, but what about asteroids, comets, or even dwarf planets? Scientists often make comparisons to known objects to better understand what they are studying. Compare well-known asteroids and comets to the size of parks, cities, and even US states to get a better sense of scale.

Materials

Map of Golden Gate Park (A) (page 3)
Map of San Francisco (B) (page 4)
Map of Western United States (C&D) (page 5)
Images of space rocks - Objects A, B, C & D (page 6)

Directions

1. **Print** all three maps and four images of space rocks and **cut** around the black edges of the image squares.

2. **Think**: How do you usually measure the size of things? With a ruler or measuring tape? How would you measure big things in space? Scientists often make comparisons to known objects—we're going to use maps to help us compare the size of space rocks to areas of land.

3. **Observe** Map A (page 3); this is a map of Golden Gate Park in San Francisco, CA, which is about 3 miles long and half a mile wide. You might recognize some familiar-sized features, like a baseball field or city blocks.

4. **Place** Object A onto Map A.

    a. **Compare** Object A to the size of Golden Gate Park. How big is Object A? How many baseball fields would you need to cover the length of Object A? Can you think of anything else this size?

5. **Observe** Map B (page 4); this is a map of the city of San Francisco, CA, which is about seven miles wide and seven miles long. Can you find Golden Gate Park? What other features can you see that you might know the size of?
6. **Place** Object B onto Map B.
    a. **Compare** Object B to the size of San Francisco. How big is Object B? How many Golden Gate Parks would you need to cover the length of Object B?
7. **Observe** Map C&D (page 5); this is a map of the western United States. Can you find the state of Arizona, California, or Texas? What other States can you identify?
8. **Place** Object C onto Map C&D.
    a. **Compare** Object C to the size of the Western US. Does it fit in California, Arizona, or Texas? Can you think of anything else that big?
9. **Place** Object D onto Map C&D.
    a. **Compare** Object D to the size of the Western US. Does it fit in California, Arizona, or Texas? Can you think of anything else that big?
10. **Think**: Scientists use the size of an object to help identify what type thing it is. Thinking about the size of the objects A, B, C, C, and D compared to their respective maps. Given that information, what type of object do you think each one is based on the definitions below?
    a. **Meteoroid:** a solid natural object of a size roughly between 30 micrometers and 1 meter that is moving in, or coming from, interplanetary space.
    b. **Asteroid:** a small, rocky object that orbits the Sun. Although asteroids orbit the Sun like planets, they are much smaller than planets and dwarf planets, but larger than meteoroids.
    c. **Dwarf Planet:** a natural, celestial object that orbits the Sun, has enough mass to be round or nearly round, has not cleared the neighborhood around its orbit (meaning there are other objects that share its orbital path), and is not a moon.

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Image source: NASA

Comet Flipbook

Some comets that we see from Earth drift back out of view, but others return again and again, like the famous Halley's Comet which is visible every 76 years. Scientists can predict the return of a comet by examining its movement through the sky, and use that information to figure out where it will be next. Make an animated flipbook to predict how one comet will move through the sky as seen from Earth.

Materials

Printed flipbook pages (page 2)
Pen or pencil
Scissors

Directions

1. **Print** the template (page 2), which has 8 flipbook pages with grids where you'll draw the comet's path. Two of the grids have already been filled in. This is the information we currently have about the comet.
    a. On page 1 it was in the top left corner.
    b. On page 2 the comet moved **two squares to the right** and **one square down**.

2. We know this comet is traveling in a straight line, without speeding up or slowing down. That means that it will keep moving the same way it did before.
    a. **Think**: if the comet keeps moving **two squares to the right** and **one square down**, where will it be on page 2?
    b. **Draw** a picture of the comet on page 3 in the place where you think it will end up.
    c. **Repeat** this for the rest of the pages.

3. **Assemble** the flipbook.
    a. **Cut** each page out along the dotted line
    b. **Stack** all of the pages in order, so that page 1 is on the top.
    c. **Staple** the flipbook together along the left edge. Otherwise you can pinch the left edge to hold it together while you flip it.

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Page 1

Page 2

Page 3

Page 4

Page 5

Page 6

Page 7

Page 8

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Comet Streamer

Comets are frozen, rocky objects that usually dwell far away in the outer Solar System. But every now and then, one will come close enough to Earth to be observed. As a comet approaches the Sun, its icy surface begins to melt, leaving beautiful plumes of water vapor behind. You can recreate that beauty by making your very own comet streamer!

Image source: NASA

Materials

Stick (chopstick, pencil, popsicle stick, or similar)
Aluminum foil
Ribbons or streamers (2 colors)
Scissors

Directions

1. The plumes a comet creates when it approaches the Sun are called tails. Most comets have two tails, one made of gas, and one made of dust. Use your two colors of ribbons to represent the two tails.

    a. **Cut** 3 long pieces of your brightest color ribbon. These will be the comet's dust tail, which is larger and brighter than the gas tail.

    b. **Cut** 2 medium pieces of the other ribbon. These will make up the comet's gas tail, which is smaller and harder to see.

    c. **Tie** one end of each ribbon tightly to the end of your stick.

2. The icy, rocky center of the comet is called a nucleus. This is often surrounded by a bright glow called a coma. Use the aluminum foil to create the glowing nucleus.

    a. **Cut out** three square-shaped pieces of aluminum foil.

    b. **Hold** the comet tails off to the side, and **wrap** each piece of foil around the end of the stick, scrunching it up into a tight ball. Be careful to keep the tails outside of the ball!

3. Now you have a comet on a stick! Make sure everything is secure, and take it on a test flight!

Cometa de serpentina

Cometas son objetos rocosos congelados que suelen habitar muy lejos en el Sistema Solar exterior. Pero de vez en cuando, uno se acerca suficientemente a la Tierra para poder observar. Cuando un cometa se acerca al Sol, su superficie helada comienza a derretirse, dejando hermosos plumeros de vapor de agua. ¡Puedes recrear esa belleza haciendo tu propia cometa de serpentina!

Materiales

Palo (palillo, lápiz, palito de paleta o similar)
Papel de aluminio
Cintas o serpentinas (2 colores)
Tijeras

Image source: NASA

Directions

1. Los plumeros que crea un cometa cuando se acerca al Sol se llaman colas. La mayoría de los cometas tienen dos colas, una de gas y otra de polvo. Use tus dos colores de cintas para representar las dos colas.
    a. **Corta** 3 trozos largos de tu cinta de color más brillante. Estos van a ser la cola de polvo del cometa, que es más grande y brillante que la cola de gas.
    b. **Corta** 2 trozos medianos de la otra cinta. Éstos formarán la cola de gas del cometa, que es más pequeña y más difícil de ver.
    c. **Amarre** un extremo de cada cinta con fuerza al extremo de tu palo.

2. El centro helado y rocoso del cometa se llama un núcleo. Éste suele estar rodeado de un brillo intenso llamado una coma. Use el papel de aluminio para crear el núcleo brillante.

   a. **Corta** tres trozos de papel de aluminio de forma cuadrada.

   b. **Detenga** las colas del cometa a un lado y **enrolla** cada trozo de papel de aluminio alrededor del extremo del palo, apretando hasta que forme una bola apretada. Tenga cuidado de mantener las colas fuera de la bola!

3. ¡Ahora tienes un cometa en un palo! Asegúrate de que todo está bien seguro y llevalo a un vuelo de prueba!

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Meteor Shower in a Bottle

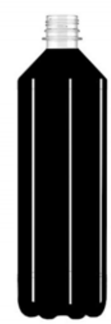
Meteor showers occur when our planet passes through a stream of dust particles (meteoroids) that were left behind by a passing comet. The particles are swept up by Earth and penetrate the atmosphere so fast that they burn up and appear as brief, fiery streaks of light in the sky. Meteor showers, like the Orionids, Perseids, or Leonids, are usually named after the constellations in which the radiant is located (which constellation they appear to be coming from). This activity will help you understand why meteor showers seem to radiate from one spot, called the radiant.

Materials

1 tall, clear plastic water bottle—around 12 inches long
1 inch thick black masking tape or black electrical tape

Directions

1. **Empty** the bottle of all contents, rinse if necessary, and let dry. **Remove** all labels—many bottles have adhesive labels that can be fairly easily removed (this step isn't absolutely required, but it will produce a cleaner effect) .



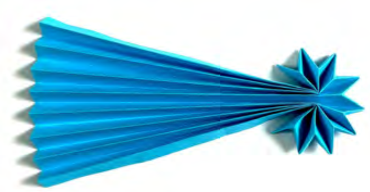
2. **Cover** the bottle with vertical strips of tape, leaving about 6 clear, narrow slits (about 1/16 inch wide) along the length of the bottle, as shown. The clear slits represent the paths of meteoroids as they fall through Earth's atmosphere. Cover the bottom of the bottle and the slanted part on top with tape as well.

3. **Look** through the mouth of the bottle (the open end). What do the lines look like? When we observe a meteor shower in the sky, we look into the distance where the meteors are coming from, like looking into the bottle from the open end. Although the lines along the sides

of the bottle are all parallel to each other, they seem to converge (come together) at the far end of the bottle. This effect is called *perspective* and is the same reason that the parallel rails of a straight train track seem to converge in the distance.

Meteor fun facts

a. In most cases, the streak of light we call a meteor is caused by a particle about the size of a grain of sand moving at very high speed (as fast as 40 miles *per second*). Most burn up completely about 50 miles above the ground—they're not as close as you might think!
b. According to NASA, Earth sweeps up about 50-100 tons of meteoritic dust every day. Meteoroids big enough to survive their fiery journey through the atmosphere and land on the ground are relatively rare and are called meteorites.
c. Single, isolated meteors—called sporadic meteors—can be seen about 4-6 times per hour on a clear, moonless night. These are not necessarily part of a meteor shower.
d. The most intense meteor showers known—called meteor storms—are very rare and can produce more than 1000 meteors per hour.
e. The oldest record of a meteor shower was made in 687 BC by Chinese astronomers—that's more than 2,700 years ago!
f. What to learn more about meteors? Check out this Academy-made video about how to observe meteor showers: https://www.calacademy.org/explore-science/how-to-observe-a-meteor-shower



Shooting Star Origami

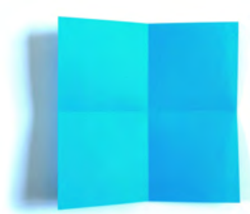
Sometimes called "shooting stars," meteors are created when rocks or other debris fall from space and burn up in Earth's atmosphere, resulting in a bright light and glowing trail. This origami project will recreate that iconic shape using a single piece of folded paper.

Materials

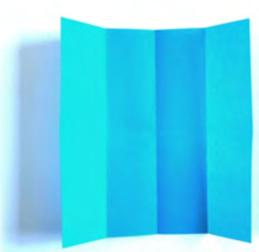
Origami paper (or other paper square)

Directions

1. **Fold** the paper in half from right to left, **unfold**, and then **fold** in half from top to bottom.



2. **Fold** the left side of the paper in so the edge meets the center crease, then **unfold**. **Fold** the right side of the paper in so the edge meets the center crease, then **unfold**. This should create 4 sections.

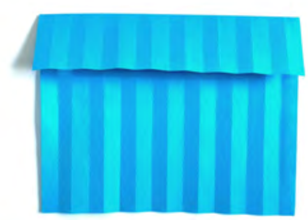


3. **Fold** each of the 4 sections in half again, between the creases, then **unfold**. This should create 8 sections.

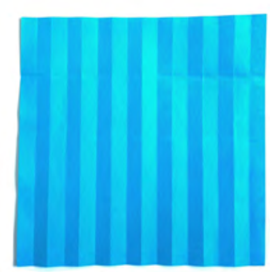
4. **Flip** the paper over.

5. **Fold** each section in half again to create a zig-zag shape. There should be 16 sections.

6. **Fold** the top down to the center of the paper.



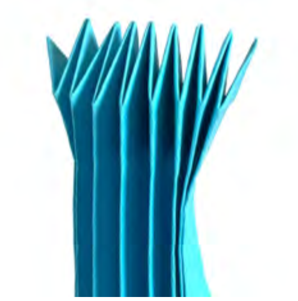
7. **Unfold**, leaving a crease.



8. **Fold** so that the top edge touches the crease made in the previous step.

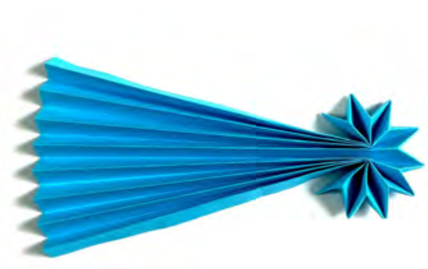
9. **Fold** the paper up along the zig-zag creases.

10. **Push** the top corners on one side in, creating triangle shape at the top of the paper.



11. **Pinch** the paper together where the top fold ends, and **pull** the left and right edges down to unfurl the star.

12. **Fan** out the bottom of the paper, and watch the shooting star take shape!



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Need a square piece of paper? Use this template and cut along the dotted line.

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Creating Craters

The surface of the Moon isn't smooth—it's covered in craters! Craters form when meteorites (rocks from space) crash into the surface of a moon or a planet. The impacts of these space rocks leave holes in the ground and tell scientists about the history of the moon or planet. In this activity, observe patterns like a scientist and learn how craters are formed.

Materials

1 wide tupperware bin
2-4 cups white flour*
½ cup cocoa powder* in a shake jar
At least 5 "impact objects" of different sizes and density
(Roundish objects, like marbles, ping pong balls, bouncy balls, or pebbles work best)

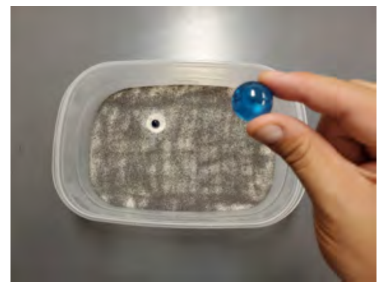
**If you want to avoid food products, you can use white sand covered in a layer of darker colored sand. Two contrasting sand colors work best.*

Directions

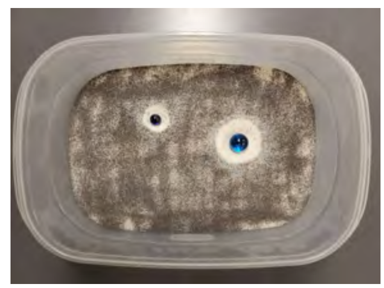
1. **Fill** your bin with flour about 3 inches deep.
   Shake the bin gently back and forth until the flour is about level.
2. **Sprinkle** a thin layer of cocoa powder over the flour like in the picture. This represents the surface of the Moon.
3. **Collect** the 5 or more "impact objects" to be the meteorites, rocks from space that will strike the Moon surface.
   Think: What do you think will happen when the object hits the powder?

4. **Hold** the impact object about 2 feet above the bin and **drop** it into the flour bin. What happened?

5. **Select** a different, heavier impact object and again **hold** it 2 feet above the bin before **dropping** it into the flour bin. Now you have two impact sites.



6. **Compare** crater size from both marbles. What similarities or differences do you notice between the two craters? Which marble made a bigger crater? Why do you think it did?



7. **Continue dropping** more objects like pebbles or bouncy balls into the flour bin. Try creating different craters by dropping your object at different heights, speeds, or even directions. What shapes can you make? Craters can be layered on top of each other. Scientists can tell if a crater is older or newer by comparing the two. The craters on the bottom are older and the newer craters would be on top.

8. **Carefully remove** your impact objects from the flour bin, trying not to disturb the craters. The flour bin should look like the surface of the Moon.

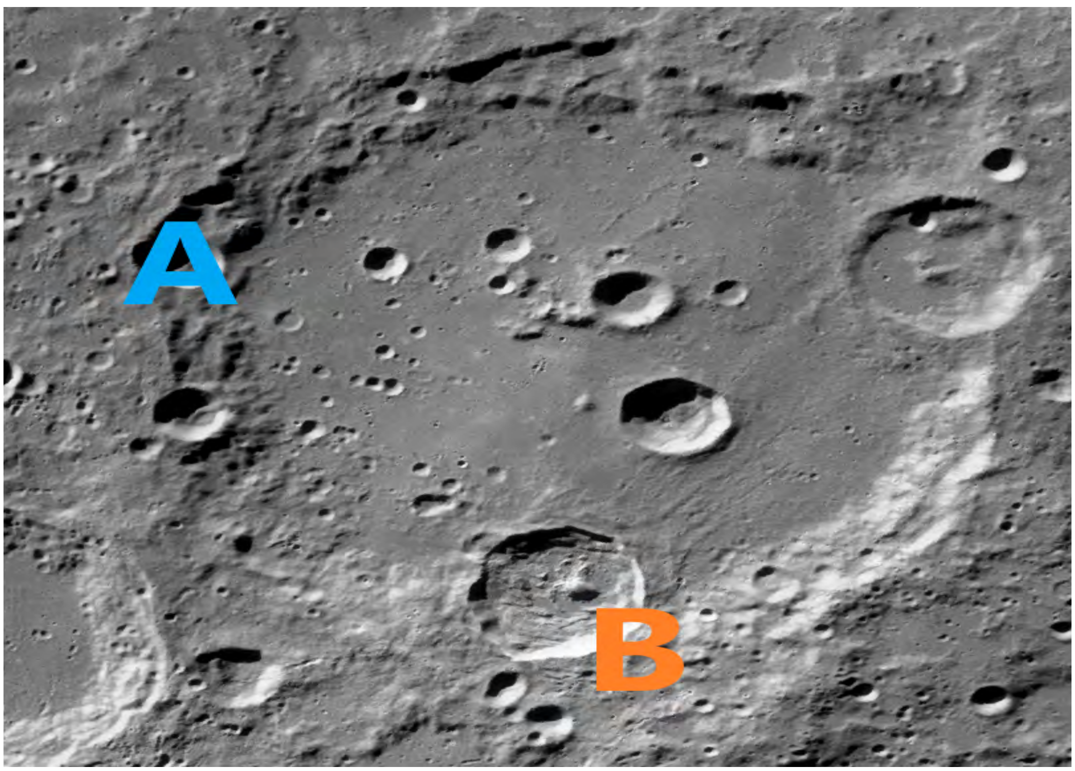
9. **Challenge:** Use the photo below to answer the questions, using crater A or crater B.

    a. What do you think formed these craters?

    b. Which crater was made by a big meteorite? A smaller one?

    c. Which craters might be older? Newer?

    d. Do your flour bin craters look like the ones in the photo?
    How are they similar? Different?



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Creando crateres

La superficie de la Luna no es lisa — está cubierta de cráteres! Los cráteres se forman cuando los meteoritos (rocas del espacio) chocan contra la superficie de una luna o un planeta. Los impactos de estas rocas espaciales dejan huecos en el suelo e informan a los científices sobre la historia de la luna o el planeta. En esta actividad, observa los patrones como un científico y aprende cómo se forman los cráteres.

Materiales

1 tupperware ancho
2-4 tazas de harina blanca*
½ taza de cacao en polvo* en un jarro para agitar
Al menos 5 "objetos de impacto" de diferentes tamaños y densidad

(*Objetos redondos, como canicas, las pelotas de ping pong, las pelotas hinchables o piedritas trabajan mejor*)
**Si quieres evitar los productos de alimento, puedes usar arena blanca cubierta por una capa de arena de color más oscuro. Arena de colores que contrasten trabajan mejor.*

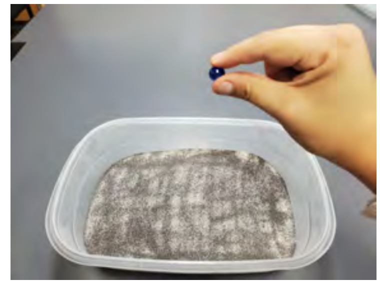
Instrucciones

1. **Llena** el tupperware con harina a unos 3 pulgadas de profundidad. **Agite** el tupperware suavemente hacia adelante y atrás hasta que la harina esté más o menos nivelada.

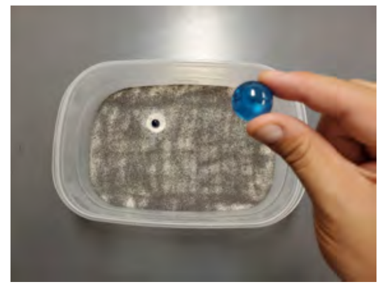
2. **Espolvorea** una fina capa de cacao en polvo sobre la harina como en la imagen. Esto representa la superficie de la Luna.

3. **Recoge** los 5 o más "objetos de impacto" que serán los meteoritos, rocas del espacio que chocarán contra la superficie de la Luna. **Piensa**: ¿Qué crees que ocurrirá cuando el objeto choque con el polvo?

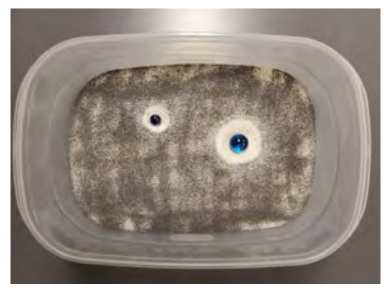
4. **Detenga** el objeto de impacto a unos 2 pies por encima del tupperware y déjalo **caer** en el tupperware de harina. ¿Qué pasó



5. **Selecciona** un objeto de impacto diferente, más pesado, y **detenlo** de nuevo a 2 pies por encima del tupperware antes de dejarlo **caer** en el tupperware de harina. Ahora tienes dos sitios de impacto.



6. **Compara** el tamaño del cráter de ambas canicas. ¿Qué similitudes o diferencias observas entre los dos cráteres? ¿Cual canica hizo un cráter más grande? ¿Por qué crees que lo hizo?

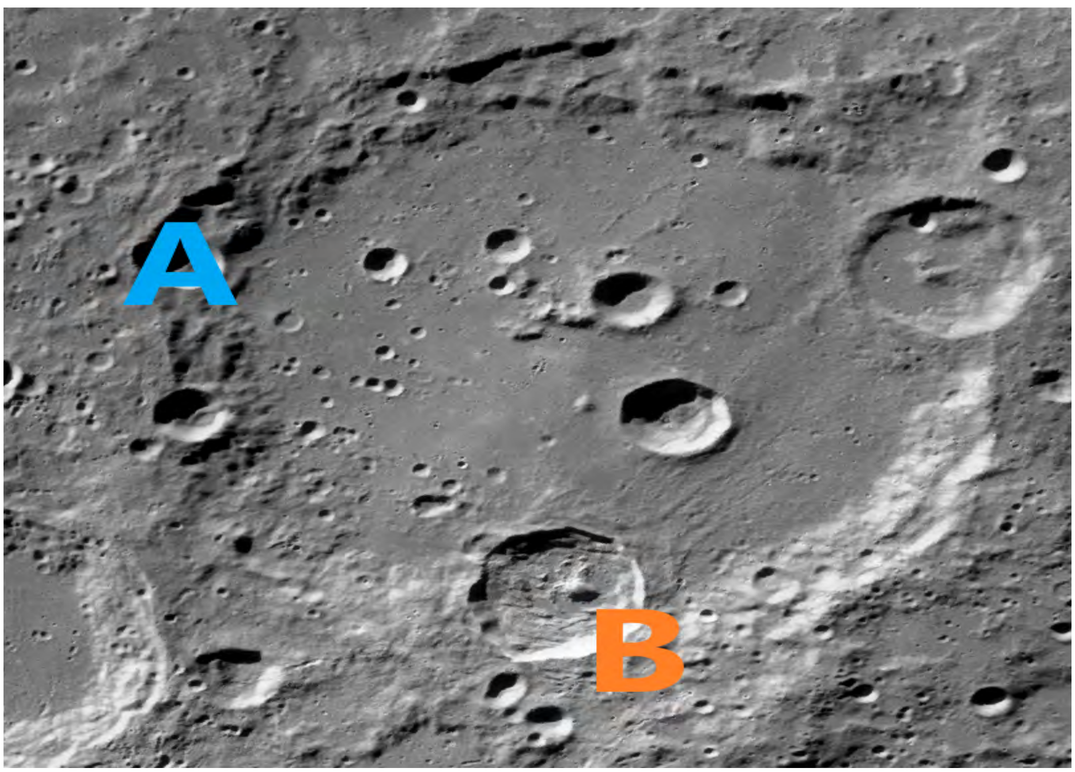


7. **Sigue dejando** caer más objetos, como piedritas o pelotas saltarinas, en el tupperware de harina. Trata de crear diferentes cráteres dejando caer tu objeto a diferentes alturas, velocidades o incluso direcciones. ¿Qué formas puedes crear? Los cráteres pueden superponerse unos a otros. Los científices pueden saber si un cráter es más viejo o más recién cuando comparan los dos. Los cráteres de la parte inferior son más viejos y los más nuevos estarían en la parte superior.

8. **Quite cuidadosamente** los objetos de impacto del tupperware de harina, tratando de no alterar los cráteres. El tupperware de harina debe de parecerse a la superficie de la Luna.

9. **Reto**: Use la foto siguiente para contestar las preguntas, usando el cráter A o el cráter B.

a. ¿Qué crees que formó estos cráteres?
b. ¿Qué cráter fue formado por un meteorito grande? ¿Uno más pequeño?
c. ¿Qué cráteres pueden ser más viejos? ¿Los más nuevos?
d. ¿Son parecidos los cráteres de tus tupperware de harina a los de la foto? ¿Cómo son similares? ¿Diferentes?



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Ice Cream Comet Investigation

Grab an adult and a friend to create edible comets as you explore what real comets are made of. Instead of a tool to identify different materials that make up a comet, you'll use your senses to identify what your model comet is made of! You can see what materials are represented by different foods below.

Materials

For experiment:
Pencil or pen
Piece of paper
1 small cup per participant
1 spoon per participant
Black or brown cookies to be crushed ("*space dust*")
Coconut flakes or marshmallows ("*carbon dioxide*")
Peanuts, or nuts ("*rocks")*
Crushed candies such as toffee, peppermint, or sprinkles (to *represent "new discoveries" in your comet*)
Ice cream (a plain flavor like vanilla) OR

For ice cream:
⅔ cup whole milk (2% or other reduced fat will not work)
⅓ cup evaporated milk
5 tbsp sugar
¼ tsp vanilla extract
Salt
1 sandwich-size resealable plastic or reusable bag
1 gallon-size resealable plastic or reusable bag
Pair of rubber kitchen gloves or oven mitts
Ice (enough to fill a gallon size bag ½ full) or fresh snow

Directions

1. **Make** the ice cream that will serve as your comet.
   If you are using pre-made ice cream, skip to step #8.

2. **Mix** the following ingredients into the *sandwich* size bag.
   Helpful hint: One person can hold the bag while another adds ingredients.
   Squeeze the bag to mix ingredients and then to remove as much air out of the bag as much as possible:
   a. 1/3 cup evaporated milk (or cream)
   b. 2/3 cup whole milk
   c. 5 tablespoons of sugar
   d. Less than 1/4 teaspoon of vanilla

3. **Put** approximately 10 heaping spoonfuls of salt into the *gallon* size bag. **Place** the sandwich size bag into the gallon size bag (checking again that the sandwich bag is sealed tight).

4. **Fill** the gallon bag at least ⅓ full of ice. Close the bag tightly and remove as much air as possible. Be sure to check for leaks.

5. **Gently shake and roll** the bag, keeping it in constant motion for approximately 6-10 minutes or until half the bag has turned to water. You can start with bare hands to feel the temperature change, but switch to gloves when the bag becomes very cold.

6. **Gently feel** the sandwich bag through the icy mixture. When the milk/sugar mixture in the sandwich bag has hardened into soft ice cream, open the gallon bag and remove the sandwich bag.

7. **Rinse** the outside of the sandwich bag briefly to remove the salt/ice mixture (*the ice cream will carry the taste without rinsing*)

8. **Scoop** the ice cream into one cup per member of your tasting/identifying team. You can decide on some cups for tasting only and some for touching only.

9. Add in your choice of amounts of "rock," "dust," "carbon dioxide," and "new discovery" pieces in your individual cups of ice cream to make a unique comet for others to investigate.

10. Sample your "comet"

a. With a real comet, scientists use a tool called a spectrometer to identify what the comet is made of. With your model comet, your spectrometer is YOU and your many senses!

b. Pretend that your eyes, hands, and taste buds are filters on a spectrometer taking data from your "comet."

11. Record the following data on your piece of paper:

a. Look at the "comet" and see what you can observe **visually**. Record what you notice on your data sheet.

b. Take the cup you've decided is just for touching and **feel** the "comet" with your fingers. Record anything you notice that was different from just looking.

c. **Smell** the "comet" and record any additional data.

d. **Taste** the "comet" and record anything else you notice!

12. Compare notes. Share what data you recorded with your fellow scientists! Did you notice anything that surprised you in your comet?