CRATERS

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Smack! Smash! Strike! Stories with an Impact!

On a large scale and on a small scale, impact craters take on a circular shape. The disturbed ground around the crater is called a splash field.

A raindrop makes a splash and some ripples when it hits the water. But a few seconds later, all evidence of this impact is gone.

When two objects smash into each other, they usually leave evidence of impact. High speed contact between a baseball and a window tends to result in a lot of broken glass. Drop a bowling ball into a sandbox, and sand goes flying out. Do the same with a balloon and... Raindrops leave marks on puddles, even if temporarily.

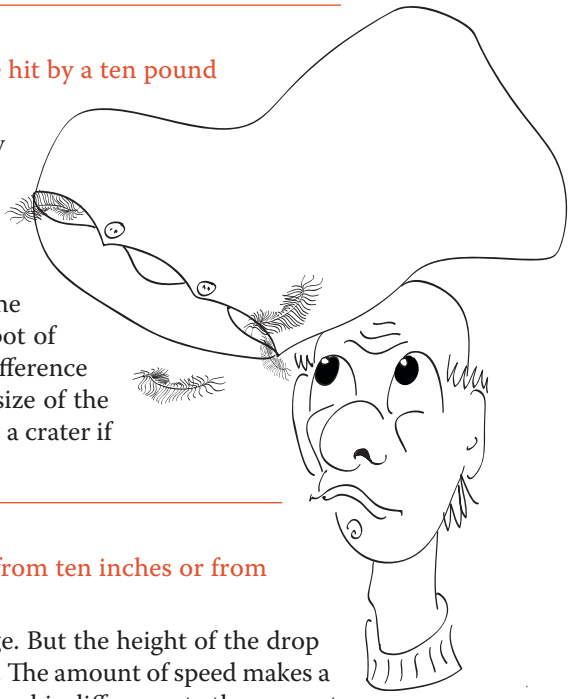
We can make some predictions on the size, duration, and amount of destruction a particular impact will cause by examining the physical properties of the projectile. And by looking at an impact crater, we can make some guesses as to what kind of object was responsible for this damage.

Mass—the bigger you are, the harder you fall

Big things tend to generate big impacts: the bigger you are, the harder you fall. A giant asteroid hitting the earth would be bad. A small meteorite crashing down will leave a small crater, if it doesn't burn up in the atmosphere first. The more mass the object has, the harder it will strike the ground.

Density—big pillows and small rocks

What does it mean to be big? Would you rather be hit by a ten pound bag of feathers or a ten pound bag of rocks?



Why? Ten pounds is ten pounds, right? But it clearly makes a difference how much space those ten pounds occupy: a ten pound rock is a small rock; a ten pound pillow is a humongous pillow. It would hurt if either one was dropped on your head. But a giant pillow would spread the blow, while a rock dropped from the same height would concentrate all its force on one spot of your head. So the density of the material makes a big difference and is an important variable in the prediction of the size of the impact. A ten pound pillow just wouldn't leave as deep a crater if dropped into a sand box as a ten pound rock.

Speed—high-speed collisions

Would it make a difference if a rock was dropped from ten inches or from ten feet? Would the impact crater be the same?

It's the same rock, its weight and density didn't change. But the height of the drop changes the speed with which the rock hits the ground. The amount of speed makes a big difference to the amount of damage an impact causes. A collision between two cars speeding on the freeway is far more catastrophic then a parking lot fender bender. If we know the size of the impact crater and we can locate the object responsible for the damage, we can calculate the speed with which that object hit.

Do you think there these cars were moving fast when they hit each other?

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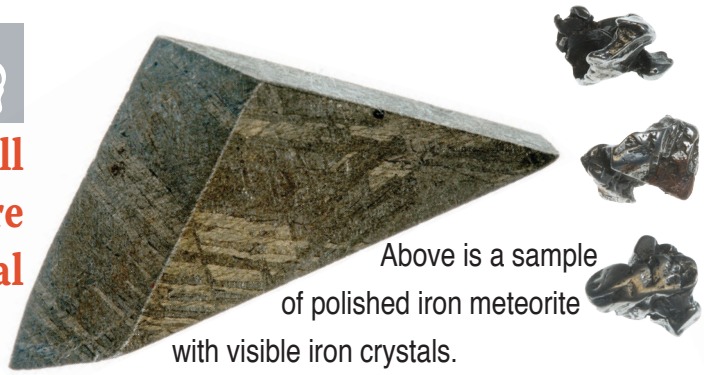
Not All Meteorites are Created Equal

A space rock doesn't become a meteorite until it hits the ground. Before then, it's just a meteor.



Above is a sample of polished iron meteorite with visible iron crystals.

Below and on the left are six samples of iron meteorites with molten exteriors.

Iron Meteorites

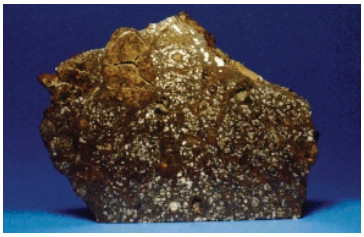
Iron meteorites, as their name suggests, are made out of iron. But if a specimen of iron meteorite is cut, the inside looks very different from a piece of iron ore which originated on planet Earth. When iron melts and then cools in space, the iron atoms reorganize themselves into a crystal formation. The iron crystals look like striped patterns visible only if the meteorite is polished. The outside surface of iron meteorites hides the crystals under the molten exterior.

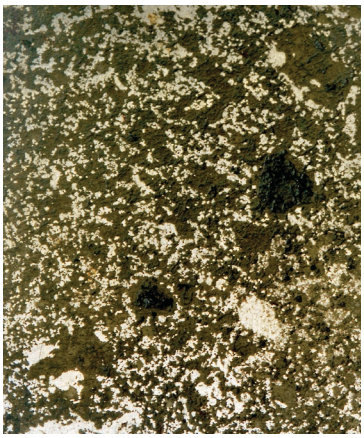
Above is a stone meteorite in Tampere Mineral Museum. Photo by Tiia Monto.

Stone Meteorites

Stone meteorites are made of stone. They are classified according to their content (the materials from which they are made), how much change they endured due to heat and pressure (this is analogous to the metamorphic rocks on Earth), and where they come from. Some stone meteorites are of Moon origin, some came from Mars, others traveled to Earth from various asteroids. There are only a few meteorites that we found that originated on Mars, and those specimens are extremely valuable.

Vaca Muerta mesosiderite was found in a South American desert in 1861.





This is a close-up view of Vaca Muerta mesosiderite, showing a complex pattern of iron and stone.

Stony-iron Meteorites: Mesosiderites

Vaca Muerta—meaning "a dead cow" in Spanish—is a rare stony-iron meteorite that impacted the driest desert in the world, the Atacama Desert in Chile, a long time ago. It was discovered in 1861. Vaca Muerta is classified as a mesosiderite—a stony-iron meteorite with multiple inclusions. Mesosiderites are among the most strange meteorite specimens. They are formed on the surface of a larger parent body as a result of multiple impacts with other objects in space. With each impact, the surface melts and fuses back together, incorporating the small inclusions into its composition. Inclusions in Vaca Muerta are believed to have come from the asteroid Vesta. How do you think it got such an evocative name?

Tektites

Tektites are globules of glass found around the world at meteorite impact sites. They are still not well understood. The theory is that extreme heat and pressure from a meteorite collision transforms the sand and rock at the impact crater into glass-like substance. Some tektites are semi-transparent, and their color ranges from light yellow-green to deep green. Tektites come in many shapes, some resembling tear-drops (look below). Their surfaces are puckered by marks and dings.

This tektite has a large spherical hole on its surface—probably the result of a burst bubble.

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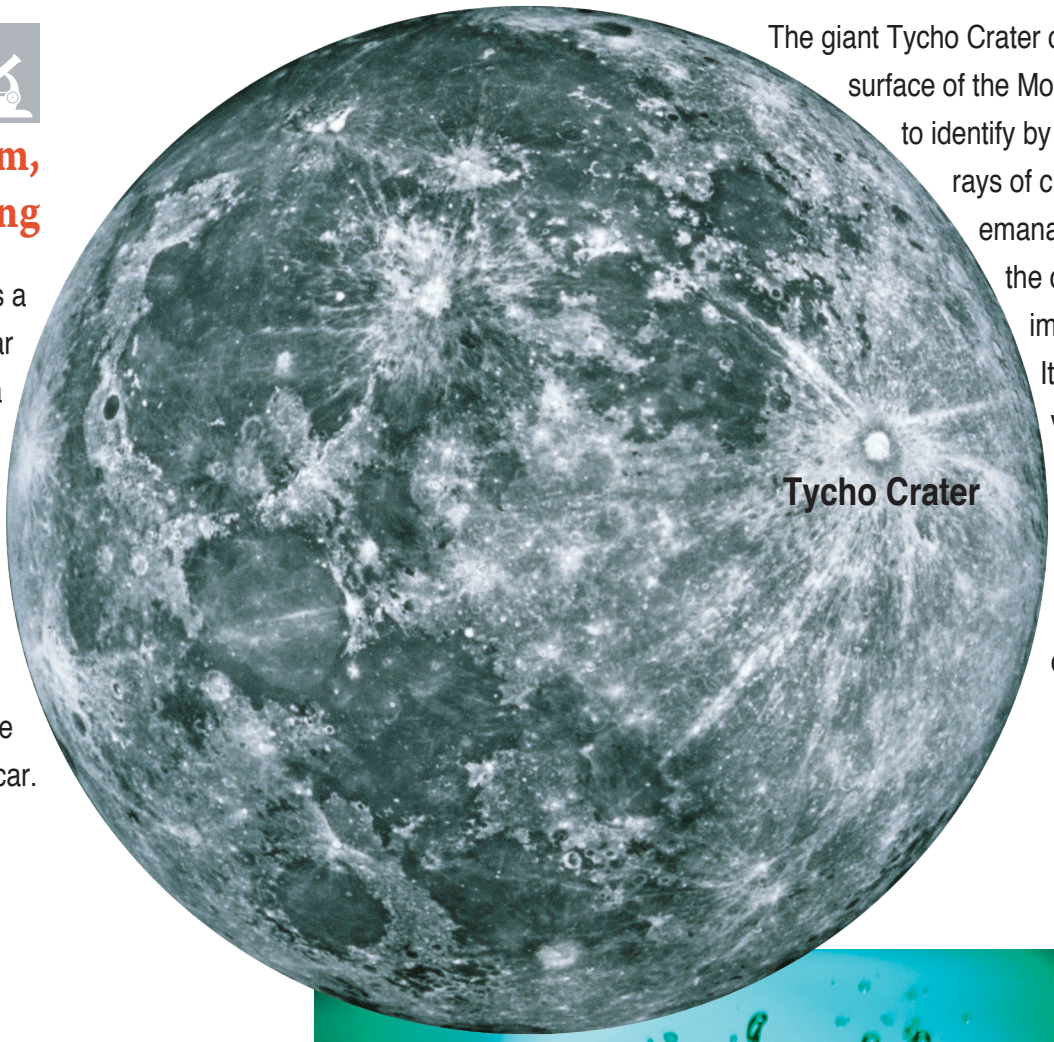
Big Boom, Little Bang

A crater is a surface scar that proves a cataclysmic event happened on that spot some time ago. The bigger the impact, the larger the scar.



The giant Tycho Crater on the surface of the Moon is easy to identify by the long rays of cracks emanating from the central impact site. It's clearly visible from the Earth even to the unaided eye.

A drop of water forms a little crater on the surface of a puddle. A big rock smashes the surface of the Earth forming a crater nearly a mile wide and 570 feet deep in Arizona. While the surfaces and projectiles are different, the phenomenon is the same.

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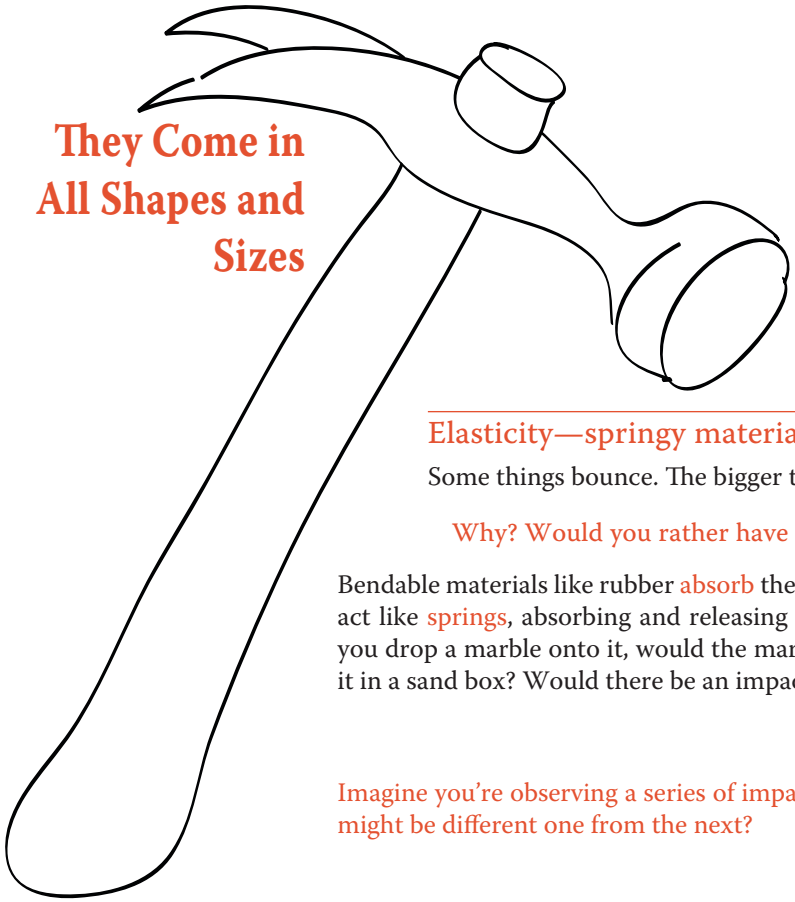
They Come in All Shapes and Sizes



Shape—pointy versus round

How hard would it be to push a metal marble into a wall? What if you use a nail that weighed the same amount as the metal marble? Would the nail be easier to push into the wall? Why?

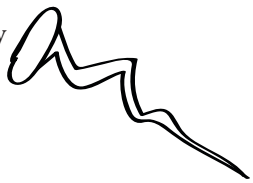
The shape of the object makes a big difference to the size and depth of the impact crater. A sharp-edged object can penetrate deeper without disturbing the areas next to the impact site—think of dropping a nail into a sand box. A blunt object spreads the blow, leaving a wider but shallower crater—think of dropping a marble into a sand box.

Elasticity—springy materials absorb the force of impact

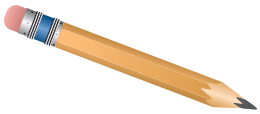
Some things bounce. The bigger the bounce, the smaller the impact crater.

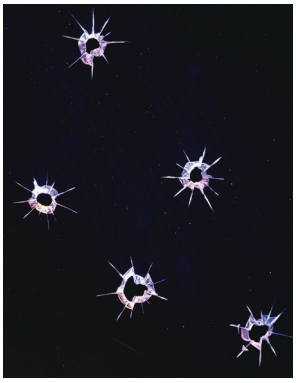
Why? Would you rather have knee pads made out of glass or rubber? Why?

Bendable materials like rubber absorb the energy of impact by changing shape. They act like springs, absorbing and releasing impact energy. Imagine a trampoline. If you drop a marble onto it, would the marble bounce higher than if you dropped it in a sand box? Would there be an impact crater on the trampoline?



Imagine you're observing a series of impact craters. What are some of the features of the craters that might be different one from the next?





Bullets fired into a glass window make tiny craters in the glass. If the gun was fired from the street, which side of the window has more damage: the inside or the outside? Why?

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Out of This World Bling

Some tektites, called Moldavites, are especially prized for their clarity and green color. Moldavites are found in a "splash field" around Moldavia (former Czechoslovakia)—and are believed to have come from a meteorite that hit Germany a long time ago and left a large impact crater that have eroded with time. Moldavites are sometimes cut as gemstones and used in jewelry. The gold and silver bolo tie designed by Andrew Werby (on the left) shows off a natural, uncut Moldavite with its own micro impact crater on the lower right corner of the specimen.

A collection of tektites.

This necklace is made from a small chip of Vaca Muerta mesosiderite: 0.4 centimeters by 5.5 cm. by 3.5 cm.

Moldavite necklace.

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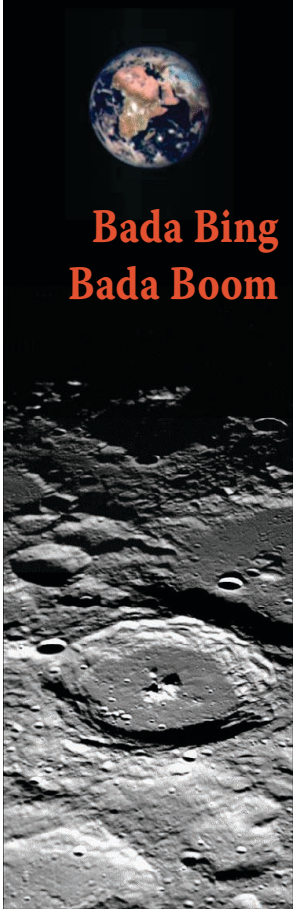
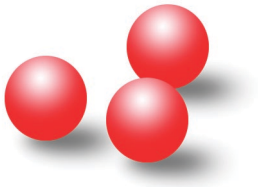


Bada Bing Bada Boom



In this activity, you will measure the size of the impact craters left by dropping marbles onto sand. You should have a box of sand, a ruler, hairspray, and some marbles. Start by smoothing over the surface of the sand in the box with the side of the ruler and then carefully spraying the surface with hairspray. Smooth and spray between each drops. Follow the directions carefully.

Experiment I: Height versus Diameter of the Impact Crater

Pick one marble and work with just that one—it's important to keep the number of differences between experiments as low as possible. In the first experiment, you will drop the marble from different heights and measure the diameter of the crater your marble created on impact with the sand. Make sure that you are letting go of the marble and not throwing it. A throw would increase the energy of the collision between the sand and a marble, altering the outcome of the experiment.

Next to each height measurement, write down the diameter of the impact crater that you've measured (look at the photograph above). Draw the picture of your crater and write down your observational notes about the impact. See example below.

Height of Drop	Diameter of Crater	Diagram	Notes
6 inches (0.5 feet)	*one inch*		*From six inch height, the marble kicked up sand on impact up to two inches high.*
12 inches (1 foot)			
18 inches (1.5 feet)			
24 inches (2 feet)			

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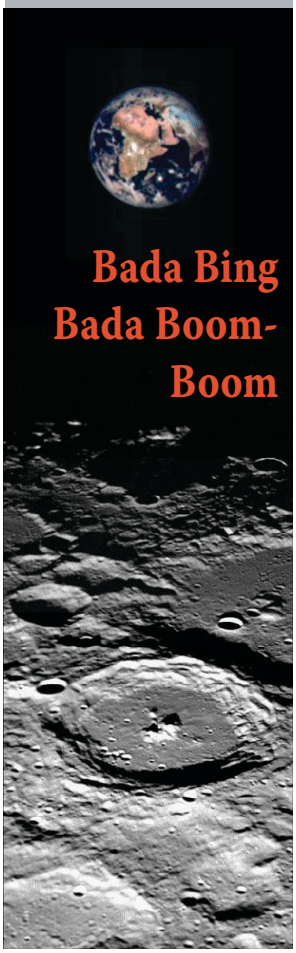
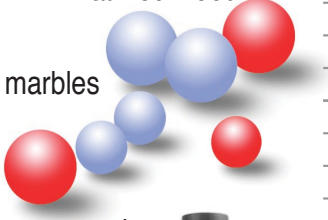
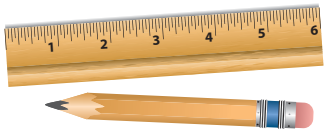


What You Need:





Experiment II: Mass versus Diameter of the Impact Crater

In this experiment, you will use two same sized marbles of different weights: heavy and light. Drop the two marbles from the same height and compare the size of the craters they make.

Height of Drop	Crater Diameter: Heavy Marble	Crater Diameter: Light Marble
6 inches		
12 inches		
18 inches		
24 inches		

Graph the Data

Use the measurements you've obtained in Experiment I & II to graph the diameter of the crater versus the height of the marble drop. What can you tell from the shape of the graph? Please label each axis: the y-axis for height and x-axis for diameter. Use different color pencils to plot the outcomes of different marbles.