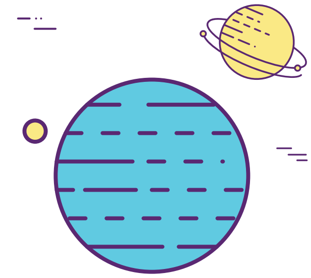
SCIENCE MUSEUM OKLAHOMA

SPACE DAY

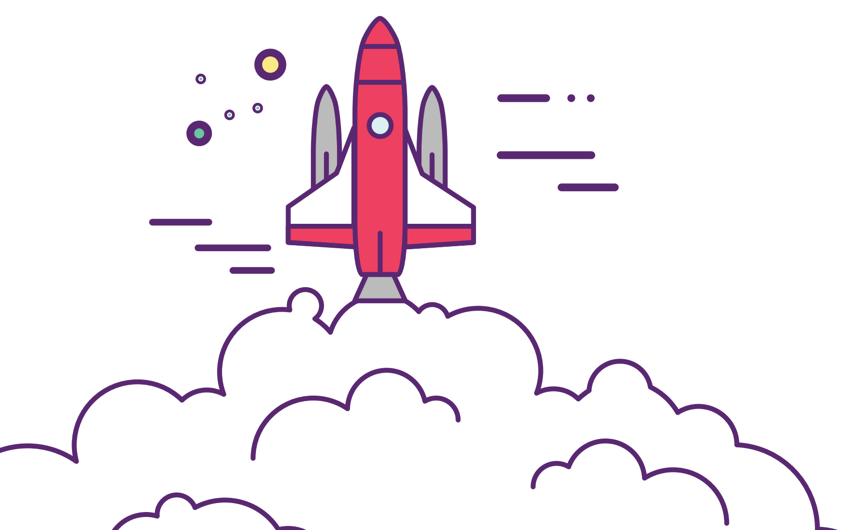


Space Day Teacher's Resource Guide

Thank you for participating in Science Museum Oklahoma's Space Day 2019! We compiled this resource guide to help enrich your students' experience beyond the museum. It includes thought-provoking talking points to encourage group discussions and extension activities that promote critical thinking skills.

Talking Points

- At one of the day's activities you constructed and launched water rockets using compressed air and water. Discuss the variables that could be altered in order to make the rocket travel higher. What factors affected the flight of the rocket? How are these similar to factors that affect the launch of full-scale rockets, satellites, and other orbital objects?
- Discuss the various types of preparations and training potential astronauts had to undergo, both physical and psychological, before being selected for missions.
- In 1969, hundreds of millions of people eagerly watched the Moon landing on television. Why do you think so many were interested? Have people's feelings about space travel changed over 50 years? If so, how?
- The Apollo 11 mission was dangerous, with no guarantee that the astronauts would return safely. If you were a family member or friend of the astronauts in 1960s, would you have encouraged them to be a part of Apollo 11?
- Put yourself into the shoes of one of those astronauts. Would you put your life at risk for something that could benefit others? Is it worth the risk in order to gain understanding of the unknown?
- With the advancements we've had in technology and science, how do you think a mission to the Moon might be different today?
- Astronauts often comment that their experiences impacted the way they view our place in the universe. How might a visit to the Moon change the way you see Earth?



Animals in Space

Classroom Discussion Topics and Follow up Questions

- Using animals in scientific research has always been controversial and space exploration is no exception. During the days of the space race human and animal astronauts faced a high probability of injury or death. Do you think the use of animals during the space race was ethical? Why or why not?
- How do you think the use of animals affected our advancements in space flight?
- In modern research, the use of animals has changed. Space travel has become safer and a majority of our research is done on the International Space Station (ISS). That being said, we still bring animals to into space for various type of research. Do you think the modern use of animals is space research is ethical? Why or why not?
- Why do you think scientists still find animals important in space research?
- What are some of the major problems you would encounter when sending animals into space? How would you solve these problems?
- A lot of different types of animals have been sent to space. What are some of the things these animals have in common, and why do you think these animals were chosen for space travel?
- If you could choose an animal for a space mission what would you choose and what would you research?

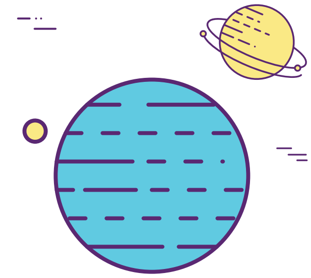
Fun Facts

- In 2007 A Madagascar hissing cockroach female became the first Earth creature to produce young conceived in space.
- November 3, 1957: Laika, a dog, was the first animal to orbit Earth.
- February 20, 1947: Fruit flies were the first animals in space. The flies were also successfully recovered alive.
- August 19, 1960, Belka ("Squirrel") and Strelka ("Little Arrow"), both dogs, were launched on Sputnik 5 or Korabl Sputnik 2, along with a gray rabbit, 40 mice, 2 rats, and 15 flasks of fruit flies and plants. Strelka later gave birth to a litter of six puppies, one of which was given to President John F. Kennedy as a gift for his children. These animals were the first animals to survive a trip into Earth's orbit.
- The first animals in deep space, the first to circle the Moon, and the first two tortoises in space were launched on Zond 5 on September 14, 1968. by the Soviet Union. The tortoises were sent on a circumlunar voyage to the Moon along with wine flies, meal worms, and other biological specimens.

The First Chimpanzee in Space

On January 31, 1961, Ham, whose name was an acronym for Holloman Aero Med, became the first chimpanzee in space, aboard the Mercury Redstone rocket on a sub-orbital flight very similar to Alan Shepard's.
Ham was brought from French Camaroon in West Africa, where he was born July 1957, to Holloman Air Force Base in New Mexico in 1959. The original flight plan called for an altitude of 115 miles and speeds ranging up to 4400 mph. However, due to technical problems, the spacecraft carrying Ham reached an altitude of 157 miles and a speed of 5857 mph and landed 422 miles downrange rather than the anticipated 290 miles.
Ham performed well during his flight and splashed down in the Atlantic Ocean 60 miles from the recovery ship. He experienced a total of 6.6 minutes of weightlessness during a 16.5-minute flight. A post-flight medical examination found Ham to be slightly fatigued and dehydrated, but in good shape otherwise.
Ham's mission paved the way for the successful launch of America's first human astronaut, Alan B. Shepard, Jr., on May 5, 1961.

Upon the completion of a thorough medical examination, Ham was placed on display at the Washington Zoo in 1963 where he lived alone until September 25, 1980. He then was moved to the North Carolina Zoological Park in Asheboro. Upon his death on January 17, 1983, Ham's skeleton would be retained for ongoing examination by the Armed Forces Institute of Pathology. His other remains were respectfully laid to rest in front of the International Space Hall of Fame in Alamogordo, New Mexico.



Space Docking Challenge

Build your teamwork skills like an astronaut!

For engineers and astronauts at NASA, being able to work well as a team is essential not only to the success of every launch, but also to the safety of the crew. This activity simulates the docking maneuvers performed to allow SpaceX astronauts to safely move from their rocket to the International Space Station.

What You'll Need:

- 3-inch PVC adapter
- A drill and drill bit (or a hardware store that will drill holes for you)
- 40+ feet of paracord or thin rope
- Playground ball
- 4-inch PVC adapter

Getting Ready:

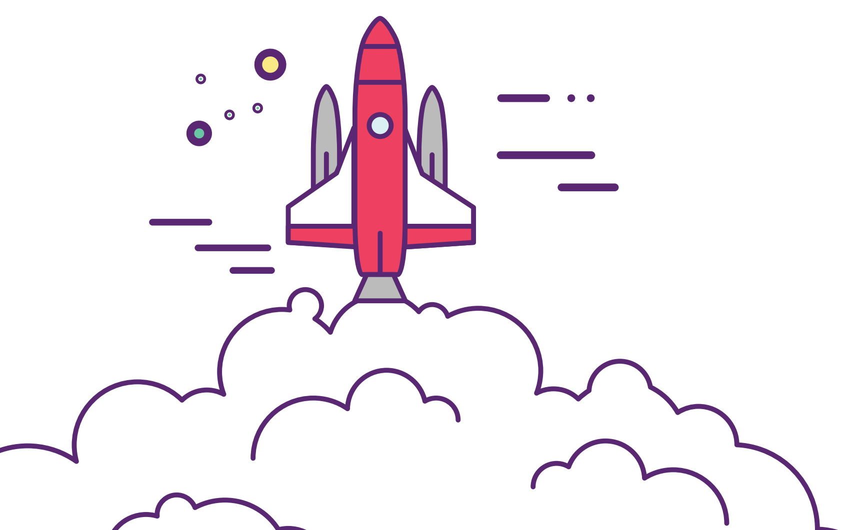
1. Drill eight holes spaced evenly around the center of the 3-inch PVC adapter.
2. Thread a five foot length of cord through each hole and tie off one end to attach it to the PVC. (Tie off or singe the other end as well to prevent fraying.)

What to Do:

3. Place the 4-inch PVC adapter in the middle of the floor.
4. Have eight students each hold an end of one of the cords and balance the playground ball on the 3-inch PVC adapter in the center.
5. Docking Challenge: Students must work together, maneuvering the 3-inch adapter over and down into the 4-inch adapter without losing the ball.

Take it Further:

Change up the variables! Try a ball that is larger, smaller, heavier or lighter. Lengthen or shorten the cords or try the activity with fewer participants. Which factors make the docking challenge easier to accomplish or which ones make it easier to work as a team?



TRAIN LIKE AN ASTRONAUT

Based on NASA's Project X: Train Like an Astronaut

Being an astronaut is an extremely challenging job, both physically and mentally. They must train in a variety of ways to help them prepare for their time in space as well as acclimate once they return to Earth. Students can complete these four challenges for a small experience of the training astronauts go through!

Challenge #1: Space Roll-n-Roll

What you'll need:

- A long, thick mat
- A large, open space, such as a gym

What to do:

- For this challenge, students will perform three somersaults in a row to simulate the spinning and flipping feeling that astronauts feel when they're on the International Space Station (ISS).
- Have each student complete three somersaults in a row on the mat. These somersaults can be performed from a sitting position ending in a sitting position, from a sitting position ending in a standing position, or from a standing position and ending in a standing position, depending on the physical skill of the student. These somersaults should be done safely and not too quickly.
- Have students write down how they feel physically before and after performing the somersaults. If they attempted all three variations, have them write down the differences they felt between the three levels.

Take it further:

Place a hula hoop on the mat and try to do a somersault without touching the hula hoop. Have someone hold a hula hoop vertically and slightly off the ground and try to do a somersault through it. Next time you're in a swimming pool, try doing a somersault in the water and compare to how it feels doing one on land.

Challenge #2: The Speed of Light

What you'll need:

- A ruler

What to do:

- Astronauts spend many hours before their mission training to improve their hand-eye reaction time. Operating the robotic arm on the ISS or landing the space shuttle requires astronauts to have quick reaction times. This challenge will test students' reaction times.
- Have students pair up. Give each student a ruler.
- One student will stand with their dominant arm extended out, hand in a fist. Then, they will extend just their index finger and thumb forward about 2 cm apart.
- Their teammate will hold the ruler vertically between the extended thumb and finger with the zero lining up with the top of the thumb level.
- Without warning, the teammate will drop the ruler and the other student must catch it was quickly as possible.
- Have the students record the measurement of where the ruler was caught, and then repeat this challenge 10 more times to gain an average of how quickly the student's reflexes are.
- After that is completed, have the students in each pair switch roles and perform the challenge 10 times again.

Take it further:

Squeeze a stress relief ball 15 times and then try the Speed of Light activity. Were the reaction times changed significantly? Do 20 jumping jacks and then perform the Speed of Light challenge. How did this affect the reaction time?

Challenge #3: Crew Assembly

What you'll need:

- 25-50 piece puzzle
- Fitted children's gloves (1 pair per child)
- Adult work gloves (1 pair per child)
- A stopwatch, timer, or clock

What to do:

- Astronauts must have outstanding hand-eye coordination. The space suits that they wear are bulky and oversized, so they must train to work with limited mobility before going into space. Teamwork and good communication is also imperative to the success of any space crew. This challenge will test students' coordination and teamwork.
- Before this exercise, separate the edge pieces from the center pieces for the puzzle.
- Have the students break into groups of four. Each student in the group should put on a pair of fitted children's gloves, and then a pair of adult work gloves over that. These are their space suit training gloves.
- As a team, they must now assemble the puzzle while wearing their space gloves. Two students can work together to assemble the border and two students can fill in the middle. Have them use a stopwatch to time how long it takes them to accomplish this.

Take it further:

Try this challenge with a puzzle with more pieces—75, or even 100! If there are multiple groups of students assembling puzzles at the same time, have two groups switch puzzles halfway through and complete the other team's work. Try having the two students currently assembling pieces wear blindfolds in addition to gloves and put the puzzle together based on their teammates' instructions.

Challenge #4: Agility Astro-Course

What you'll need:

- 8 marking cones/traffic cones, or other steady objects to mark a course
- Stopwatch
- A gym, dry field, or track course

What to do:

- While astronauts are in space, their bodies are affected by not experiencing the effects of gravity. Their muscles change and can grow weaker without this resistance, so they must train in fitness and agility both before their space mission as well as when they return to Earth so they can recover quickly from their space mission. This agility course will help students know how astronauts must physically train.
- Before this challenge, arrange the cones in a large area at least 30' x 20'. (Half of a basketball court would be a great size to work with if available.) Place four cones on each corner of your area to represent the start, finish, and two turning points. Place at least four more cones down the center at equal intervals. You can also adapt the cone set-up to fit whatever space you have!
- Show students how to run through the course on a determined path. They can circle around the cones on the corners as they run the length between them, and they can weave between the cones in the center. They just have to go as fast as they can, while also being precise and not knocking over any of the cones.
- Time students as they go through the course. Have them run through it several times if time allows. As they get more tired with each trial, ask them how they think their agility might be affected after being in space for an extended period of time. How might space travel affect their endurance or strength?

Take it further:

Try placing pool noodles or yard sticks on top of the cones to create a more challenging course. Try adding more cones to the center course and see if that impacts their time. Have students do jumping jacks for 30 seconds immediately before attempting the course. Do they feel any difference from doing the course without jumping jacks?

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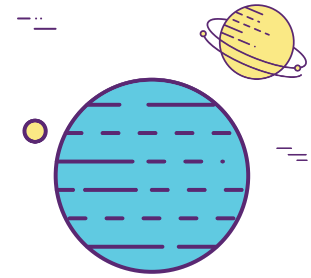


RE-ENTRY CAPSULE DESIGN CHALLENGE

Even though re-entry into Earth's atmosphere and a successful landing are at the end of any space mission, they are as important and high stakes as all other components. Parachutes and safety systems are an important part of a successful re-entry, as are braking systems or using a body of water to cushion the landing. Students will get the chance to engineer and design their very own landing device in this challenge.

What you'll need:

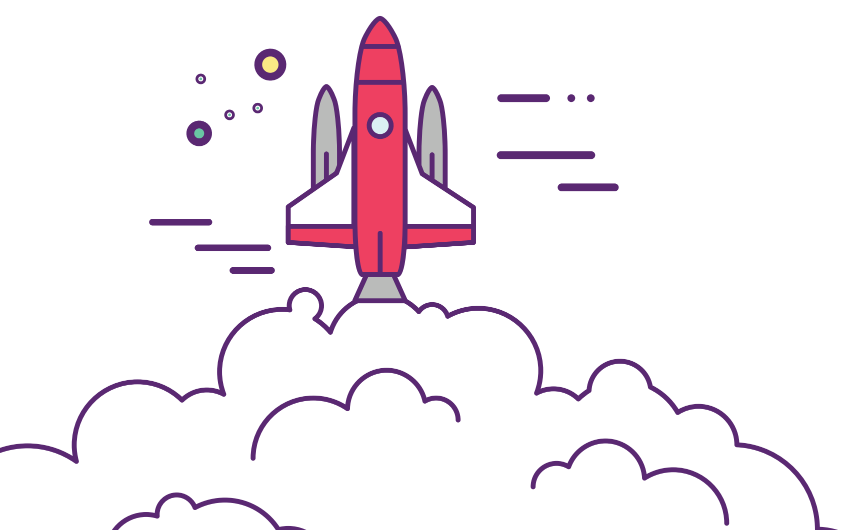
- Eggs (If you don't want to use real eggs, plastic Easter eggs can be substituted. Put a tissue or paper towel inside of the plastic egg and let students know their landing is only successful if the tissue is not wet after retrieval.)
- Assorted materials for building landing system (coffee filters, plastic bags, cups, bowls, cotton balls, foil, string, pipe cleaners—any materials you have on hand)
- Tubs
- Water
- Stepladder
- Disinfecting wipes and hand wipes/sink and soap
- Pencil and paper

What to do:

- Begin by having students pair off in groups of two. Have them sketch a design of what their landing device will look like, and make a list of the materials needed to build it.
- After gathering their materials, give each team one egg and let them know it must be launched and retrieved without getting broken to be considered a success. (This even includes if the egg gets broken during the building process!)
- Next comes the building part! Students can build and revise their design as many times as they need to, but they'll only have one chance to launch.
- For the launch, students will need to stand on a stepladder or chair or whatever is available to get them as high as is safely possible. They will release their "space capsule egg" and landing gear into a tub of water to simulate a splash down.
- After all students have tested and launched their eggs, each team can explain to the class what their design was, how they came up with the idea, whether it was successful or not, and what they would change if they could.

Take it further:

How could they amend their design to make it land safely from an even higher launch, like off a second story staircase? How would they change their design if their build materials were more limited?



WATER ROCKETS

Build a rocket out of a plastic bottle, using water and air pressure to generate the thrust.

What You'll Need:

- 2-liter soft drink bottle (2 per team, one for the nose cone and one for the pressure vessel)
- Plastic egg or ping pong ball
- Fin construction: cardboard, poster board, or craft foam
- Permanent marker
- Scissors
- Masking tape
- Cardboard mailing tube or small plastic cup
- Low-temperature glue guns and glue
- Eye protection
- Water rocket launcher
- Bicycle pump or small compressor

Optional Parachute Supplies

- Plastic grocery sacks or thin fabric scraps
- String

Getting Ready:

Give yourself plenty of time to collect 2-liter soft drink bottles before the activity. Look for bottles with straight sides.

Depending on your student's abilities and available class time, you may want to pre-cut the bottles for the nose cones.

You will need to build or purchase the water rocket launcher. There are a number of free, easy to make launcher plans available online:

Make Magazine's Simple Water Rocket Launcher: makezine.com/projects/water-rocket-launcher/

NASA's Water Rocket Launcher: www.nasa.gov/pdf/153405main_Rockets_Water_Rocket_Launcher.pdf

There are also several off-the-shelf launchers that you can purchase online:

Relationshipware StratoLauncher IV:
www.amazon.com/Relationshipware-StratoLauncher-Tilting-Launcher-StratoFins/dp/B071233ZB8

Aquapod Bottle Launcher:
www.amazon.com/Aquapod-Bottle-Launcher-Launch-Bottles/dp/B003Y5DOJC

What to Do:

Nose Cone Construction

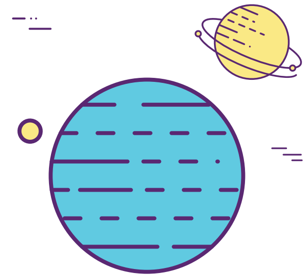
- Use the top section of one bottle to make a nose cone. The height of the nose cone is up to you. Use a marker to draw a cut line around the bottle. An easy way to get a straight line is to wrap a piece of paper around the bottle that lines up with your mark and then use the edge of the paper to draw a cut line. Remove the paper guide and then cut the bottle along the line with scissors.
- Place a cardboard tube over the neck of the bottle and use a maker to draw a circular cut line around the base of the neck. Remove the tube and cut the neck off the bottle so that you can mount a tip on the nose cone.
- Push half of a plastic egg or ping pong ball into the circular hole and secure it with glue.

Rocket Body/Pressure Vessel Construction

- Slide the nose cone over the bottom of a second 2-liter bottle and secure with tape.
- Use cardboard, craft foam, poster board or other similar material to construct stabilizing fins and mount them to the sides of the pressure vessel with tape or glue. The size, shape, number and mounting location of fins up to you.
- Test fit the appropriate stopper or launch fitting for your launcher.

Launching the Rocket:

- Put on your safety glasses
- Remove the stopper or launch fitting and partially fill your rocket with water. Record the amount of water you use. Attach stopper or launch fitting.

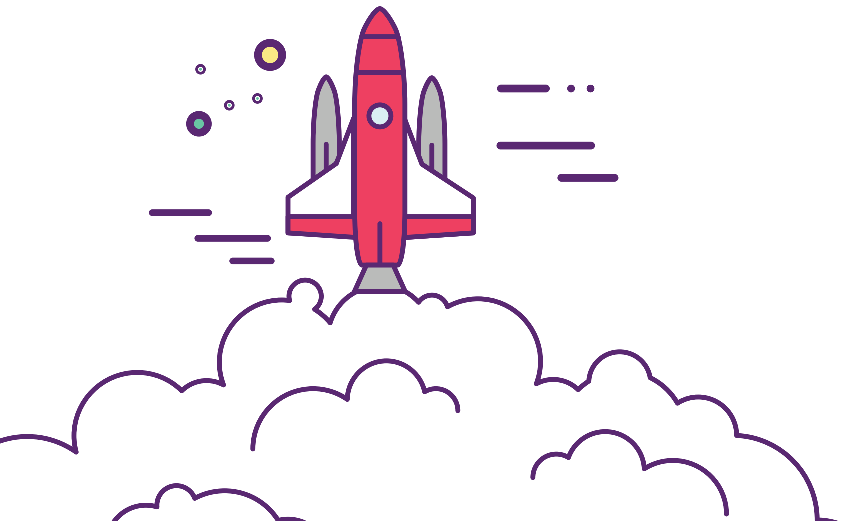


- Position your rocket onto the launch rod with the nozzle facing downward and the nose pointing towards the sky. Make sure it is stable.
- Add the compressed air to your pressure chamber by attaching a bicycle pump or compressor to the valve and start pumping.
- Make sure you are back a safe distance and then pull the launcher's release mechanism.

SAFETY NOTE:
New plastic (PET) soft drink bottles are capable of withstanding about 100 or more pounds per square inch (psi) of pressure. A 2 to 1 safety factor is recommended. Do not let students pump the bottle above 50 psi.

Take it Further:

- What design changes can you make to your rocket to increase its stability and decrease drag?
- What changes can you make to fly higher? Try launching your rockets multiple times, changing a variable each time (water level, PSI at release time) to find which combination gives your rocket the longest air time.
- Think up a way to add a parachute to your rocket to soften the landing. The nose cone will need to remain in place until the rocket reaches the top of its flight path before it opens to release a parachute.



Mission Patch Design

For any of NASA's manned space missions, an important (and potentially often overlooked part) of the development is the creation of the mission patch! Mission patches are created by the astronauts of each crew (along with the help of a graphic designer), and represent important and specific aspects of their individual group. All of the astronaut's names are always included in the patch, as are symbols to depict important aspects of the mission. These can be patriotic symbols, the Space Shuttle, the Orbiter, the International Space Station, or even symbols in remembrance of fallen colleagues.

In this activity, your students will have the opportunity to work in groups and design a mission patch that represents all of the most important parts of their team.

What You'll Need:

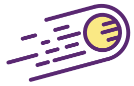
- Pencils
- Markers/colored pencils/crayons
- Paper
- 1 round patch sticker per student
- Example mission patches, see samples online at: https://history.nasa.gov/mission_patches.html

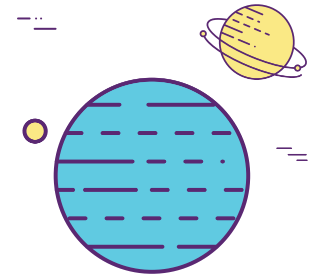
What To Do:

- Discuss with your students what a mission patch is and how it's designed. Then, have them break into groups of 4 to work as a team.
- They must design a mission patch that represents their story, combining their names, their interests, their goals, or important aspects of their lives.
- After the students collect the materials they will need, have them discuss and write down their ideas and possible designs before drawing their finalized design on their sticker.
- After they've finalized and decided on the design, now the students get to draw and fill in their sticker badge!
- After all the groups have finished drawing and coloring in their mission patch, have each team present to the class their finished product. They can talk about how they came to the decisions that they did, what their mission patch means, and any other interesting facts about it.

Take It Further:

Encourage students to research actual NASA mission patches and learn the history and design elements behind them. Try having all the students work together to have design a patch that represents the entire class—possibly future goals of the class, or dominant themes or traits that the class tries to uphold.





Mini-Meteor Craters

The moon's landscape is riddled with craters that are the result of meteoroids or space rocks crashing into its surface. This happens because the moon doesn't have the atmosphere needed to break them up before they impact the surface. While the Earth's atmosphere does usually protect it from meteoroids, some have managed to make it through, leaving significant marks. Those that survive to hit the surface are called meteorites. One of the most famous is the 4,000 ft. wide Arizona Meteor Crater. While it left a huge impact, the meteorite that hit was believed to only be about 164 feet in diameter.

Try these activities to explore how a small projectile can still leave an exponentially larger crater!

What you'll need:
- Trays or shallow pans with edges
- Flour
- Cocoa powder, pudding mix, or any powder that is contrasting
- Small round objects—marbles, balls, rocks, nuts, etc.
- Sifter (optional)

What to do:
- Fill each tray with an inch or so of flour.
- Either with the sifter or by hand, dust a layer of the contrasting powder all over the flour layer. These two layers of powder will represent the rocky base of the moon's surface and the finer dust that's on top.
- Have students choose what object they'd like to use as their "meteor."
- Before dropping their meteor, encourage students to share with the class what they think will happen when their meteor hits the powder surface. What size of a crater do they think it will leave? Will the meteor move after impact?
- Now comes the experimenting! Have students drop their meteors into the trays of powder from a few feet above it.
- How do their meteors change the powder surface? How did their predictions compare with what actually happens? Were any of the meteors fragile enough that they broke apart upon impact?

Take it further:
What difference would it make if students stood on a stool or chair and dropped their meteor from a much higher distance? What if they actually threw their meteor instead of just letting it fall based on gravity?

Bubble Painting the Moon

Have bubbly colorful fun while adding topography to the Moon!

What You'll Need:

- Bubble Paint Solution - See recipe below
- Cup
- Moon Template - See next page
- Cardstock sheets
- Bubble wands (Two homemade options for bubble wands are twisting chenille stems/pipe cleaners into a circle at one end or cutting the tip off the bulb end of a pipette to leave a circular opening.)

Getting Ready:

- Prepare the Bubble Paint Solution and pour enough into each student's cup to dip their wands.
- Copy the Moon Template onto a piece of cardstock for each student.

What to Do:

- Make sure each student has a cup of solution, a bubble wand and a piece of cardstock.
- Have the students blow bubbles onto the cardstock so that they burst, leaving circles of color behind.
- Students can get creative adding bubble circle "craters" to the Moon template! They can try to replicate how the actual Moon looks or branch out and make crater patterns of their own.
- After the pictures are finished, simply allow the bubble paint to dry.

Take it Further:

Try using straws to blow bubbles or bend chenille stems into different shapes and sizes. Try bundling straws together to blow several bubbles at a time. Experiment with making varying types or sizes of bubbles to create different effects on the cardstock!

Bubble Paint Recipe

- 2 parts tempera paint or liquid watercolor
- 2 parts dish soap (Dawn works best)
- 1 part warm water

Optional: add a little glycerin for extra durability

Mix the ingredients gently so as not to made a sudsy froth. You can experiment with the ratios, too, if the solution isn't behaving just the way you want.

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