SPACE DAY
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Science Museum Oklahoma and Boeing present

Space Day Teacher's Resource Guide

Thank you for your participation in Space Day. Science Museum Oklahoma and Boeing want to ensure your students' experience goes beyond the museum. Included in this resource guide are six thought provoking talking points that draw upon the experiences had at Space Day and three classroom-appropriate experiments.

Four Talking Points:

1. One of the activity tables allowed students to create and set off reaction rockets using Alka-Seltzer and water. Discuss with students how many variables could be altered in order to make the rocket travel the highest. What factors affected the flight of the rocket? Are these factors the same that might affect the launch of rockets, satellites, and other orbital objects?

2. NASA provides teachers and educational institutions with Shuttle tiles and space food kits for use in the classroom. Science Museum Oklahoma displayed one such Shuttle tile on Space Day. Discuss with your students what environmental factors needed to be considered in the design of the heat-protection shield of the network of silica fiber tiles that covered each shuttle. What factor would likely be of utmost importance to the engineers? How would those factors be changed while in space? Are there different challenges to be concerned with in space as opposed to on Earth?

3. Discuss with your students the various types of preparations and training potential astronauts had to undergo, both physical and psychological, before being selected for missions.

4. Astronauts used low-gravity environment simulations, such as underwater environments, to prepare for Extra Vehicular Activities (EVAs), or space walks. Discuss key similarities and differences in training under water as opposed to being in space.

Reaction Rockets

Materials:

- White film canisters and lids (The black ones with grey lids will not work.)
- Water
- Goggles
- Solid, level launch surface (Lunch trays work well)
- Alka-seltzer tablets
- Water pitchers
- Bin for wet waste
- Towels

What to do:

1. Provide and fit safety goggles.
• Ensure that students have safety goggles and that they fit property. No student should be near the launch zones until wearing safety goggles. Reaction rockets are projectiles. Water spray may contain parts of the tablet which should not come into contact with eyes

2. Prepare level area for launch.
• The area will be wet after launch, so ensure that carpeting can be protected and that there are no breakables overhead. (Rockets can launch more than twenty feet under the right conditions.)
• Designate a safe zone about ten feet from the launch site.
• Open packets of Alka-Seltzer.

3. Provide students a launch tutorial.
• Demonstrate how to secure cap on film canister. Flip the canister lid side down, and place on launch site quickly.
• Have students practice securing cap and flipping the canister lid side down.
• After securing the lid and flipping the canister lid side down, students should quickly move into the safe zone.

4. Add water.
• Instruct students to fill their film canister with their desired amount of water.
• Students may experiment with using varying amounts of water in each canister to see which travels the highest.
• Student may document the levels of water and chart results

5. Dispense fuel (Alka-Seltzer).
• Instruct each student not to add fuel (Alka-Seltzer) until it is time to launch.
• Give each student approximately half of an Alka-Seltzer tablet. If the students are documenting launch heights and introducing variables, allow them to select how much of the tablet to add. Be sure to establish a control amount before altering variables.

6. Assist students with launch.
• Review the cap and flip procedure once more. Remind students to step into the safe zone.
• Have students add the tablet to the water, quickly secure cap, and flip the canister lid side down.
• Launches are more effective if more than one can be launched at a time for comparison

What's Happening?
Water allows the sodium bicarbonate and citric acid in the Alka-Seltzer tablet to combine, creating a chemical reaction. A number of things can indicate that a chemical reaction is taking place. There may be a temperature change, a color change, or something entirely new might form. In this case a gas, carbon dioxide, forms when the substances combine. Like bubbles in soda, gas is released as the bubbles travel to the top of the water. If left uncapped, this gas would be released harmlessly into the air. However, when the cap is secured, the gas has no way to escape and pressure builds up inside the container. Eventually the pressure exceeds the force that holds the cap to the film canister. This pressure propels the film canister upward.

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Drop Site (Construction and Drop)

Materials:

- Coffee filters
- Plastic eggs
  (Real eggs work well, but can be messy)
- Tape
- Foil
- Paper
- Tissue to fill plastic eggs
- String
- Cotton balls

Assemble egg capsule

1. Place tissue in egg. The tissue represents the equipment and the astronauts.
2. Explain that after re-entering the atmosphere, the capsule must be protected from impact. Students should create a safety system around the outside of the egg to prevent the astronauts and equipment from being tossed out.

Allow students to assemble their safety rig

1. Student may not tape the eggs shut if using plastic eggs.
2. Parachutes are effective, but are not the only method of protecting the egg and cargo. Capsules and shuttles were designed with redundant braking systems and methods of resisting impact damage.

Once the student is satisfied with the construction of their safety rig, take them to the drop area. As long as the drop site is approximately ten feet off the ground, it should ensure that the egg will break should the student's rig fail.

What's Happening?

Parachutes and safety systems have been an integral part of space travel. All Mercury, Gemini and Apollo capsules were dependent on a parachute system to slow the capsule's speed, ensuring a safe splash down. The orange fuel tanks attached to the shuttle launch systems are also equipped with parachutes. Once their fuel was expended they would detach, fall in a ballistic arc and parachute down to be recovered and used for future launches. Parachutes rely on air resistance and aerodynamics to slow the descent of the object. The capsules from the Mercury, Gemini and Apollo also used water to cushion the landing. Students may find other methods of cushioning their egg from the impact.

Mr. Spud

Materials:

- Medium Sized Potatoes
- Large Nail, as big as you can find. (Nails in excess of 6" in length and 3/8" thick can be found at hardware stores or ordered online.)
- PVC pipe about 48" length and large enough for the nail to fit through
- Mylar (Can be found at many craft or fabric stores or ordered online. Aluminum foil can be used as an alternative.)
- Vinyl material (Vinyl gloves can be used)
- Kevlar (this can be purchased at many fabric stores, Army surplus suppliers or online)
- Marker
- Safety Goggles

About this Activity:
Astronauts need protection from many different elements while in space. Mr. Spud uses a potato as a test subject to demonstrate the effects of accelerated particles on the human body. Remember to always wear safety goggles!

Activity 1: No protection
1. Set a potato on the ground or low surface. Have a student hold the PVC pipe vertically, with one end a few inches above the potato. Make sure all feet and body parts are clear of the immediate area surrounding the potato.
2. Drop a nail, point side down, into the top of the pipe. It is important that the pipe remain still and positioned over the potato.
3. Inspect the potato. What was the effect on the potato from the impact of the nail? Draw a circle around the damaged areas. You may cover damaged areas with a bandage for effect.

Activity 2: Protecting Mr. Spud
1. Wrap the potato in Mylar. Mylar provides insulation preventing astronauts from getting too hot or too cold. A space suit will have at least five layers of this material.
2. Wrap the potato in vinyl material or glove. Space suits have a thicker material that is different in construction from the previous layer. In fact, a space suit is made up of many layers including a polyurethane-coated nylon pressure bladder (simulated here) and a polyester structural restraint layer with folded pleats to allow for mobility.
3. Next wrap the potato in Kevlar. This layer of material protects astronauts from space debris and micrometeoroid impacts. Kevlar is used in bulletproof vests. A space suit has a blended outer layer which includes Kevlar. The outer layer also allows other appliances, tools, and other important equipment to be strapped to the suit.
4. Finally, repeating previous steps of holding the PVC pipe above the potato, drop the nail into the tube. After the nail has struck the potato, lift the pipe and let the nail fall to the ground.
5. Unwrap and inspect the potato. Describe the impact the nail has on the potato this time.

Discussion:
A space suit is referred to as an Extravehicular Mobility Unity (EMU). Many different materials including Nylon tricot, Spandex, urethane-coated Nylon, Neoprene-coated Nylon, Dacron, Mylar, and Ortho-Fabric which includes Kevlar are used in the construction of an EMU. These layers combine to protect the astronaut from extreme temperatures and impacts from micrometeorites and space trash, debris from launch vehicles including paint chips and hardware. Space trash may travel as fast as 17,500 mph! Micrometeorites can travel even faster! How long do you think you would could survive in space without a space suit? Why would an astronaut need to be in space outside his or her spacecraft? Besides protection from speeding debris and the extreme temperatures of space, what other necessities can a space suit or EMU provide? Take this activity further, what would happen if the potato was only protected by one layer of material at a time?