SPUDS IN SPACE: A Tech Museum Floor Activity

Description:
Students design spacesuits for their potato astronauts that can withstand the hazards of high velocity impacts from space debris and meteoroids.

Grade Levels: 3-8

Educational Outcomes:
1. Students will explore the effect that velocity has upon an object when it collides with another object.
2. Students will explore the strength of different materials when used in varying combinations and placement.
3. Students will get a first-hand experience of the design process that scientists and engineers undergo.

Estimated Time: 20-25 minutes

California Science Standards Connections:

Grade 5: **Earth Science**
5b. Students know the solar system includes the planet Earth, the Moon, the Sun, eight other planets and their satellites, and smaller objects, such as asteroids and comets.
Grade 8: Physical Science:
Motion: 1. The velocity of an object is the rate of change of its position.
Forces: 2a: Students know a force has both direction and magnitude.
Earth Science: 4e: Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.
All Grades: Investigation and Experimentation: Scientific progress is made by asking meaningful questions and Conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

The Tech Museum Connections:
Explorations Gallery- jet pack chair, space exploration
LifeTech- Beyond our Limits
IMAX- Space Station

Materials* And Set-Up (Per Team Of 2-3)
Activity materials-

Rubber bands	Netting
String	Cellophane
Elastic	Paper towels
Plastic grocery bags	Newspaper/phone book pgs
Tissue paper	Wax paper
Aluminum foil	Scissors

Testing materials-
screwdriver (small and lightweight)
Tinker Toy Testing pads**
Ruler/Measuring Tape

Please note: This activity was initially developed to be a floor activity for guests of The Tech Museum. It has been modified for classroom use and is a good example of an introductory level design challenge.

Facilitator Notes:

*Other materials can be used in addition or as substitutes for those listed. Materials used should be lightweight, thin, and flexible.

**Testing Pads can be made from blue Tinker Toy bases with three pink Tinker Toy poles to keep potato in place. An alternative idea is to affix masking tape to the potato and place it inside a shoebox for testing.

Background Information
When astronauts take spacewalks, they are likely to encounter fast moving particles called meteoroids. These meteoroids are usually fragments of asteroids, made up of rock and/or metal, but they can also be bits of debris left over from previous space missions. Although these particles are usually quite small, they can still provide significant hazards due to the velocity at which they travel. Spacesuits are specially designed to provide impact protection through various fabric-layer combinations and strategically placed rigid materials. Although effective for particles of small mass, this protective suit does little if the particle is large. This is why it is especially important for astronauts to be incredibly careful when repairing satellites or working on the International Space Station.

DESIGN CHALLENGE

Challenge[1]

The Tech's potato astronauts have been sent on a mission to repair part of the International Space Station. You must protect them from the effects of being hit by small meteoroids at high speeds. Design and outfit your potato astronaut in gear that will protect her

Constraints

Your protective wear must fit snugly on your astronaut so that she can move freely. No adhesives can be used since their durability in space cannot be tested. Your protective wear can only use a maximum of four layers. It needs to be as lightweight and flexible as possible. Due to materials shortages, your layers must consist of at least three different materials.

Testing

Once finished, the participant should place the potato astronaut in the testing pad on the floor. A screwdriver should be held 2 feet above the potato and dropped five times so that the point collides with the astronaut five times. A potato with no nicks or scratches indicates success.

Teaching Points to guide Reflection Questions:

- ❑ The velocity of an object is the rate of change of its position.
  - meteoroids, which are fragments of asteroids, can move at high velocity (8000 meters per second)

- ❑ Force has both direction and magnitude
  - the larger (greater mass) the meteoroids and space debris particles are, the greater the hazard is to spacewalking astronauts

Reflection Questions:

Which layer(s) was penetrated? Why do you think this happened?
How can you change your design or use of materials?
Would you add other layers or materials if you were to redesign your spacesuit?
What do you think would have happened if the screwdriver was more massive? How about if it was dropped from a greater height?
Do you think that astronauts can be protected for all types and sizes of space debris and meteoroids?
Do you think it's important for an astronaut's space suit to fit snuggly? Why or why not?

Discussion:

If you were to do this again, how many of you think you could design an even better spacesuit? Discuss how scientists & engineers go through this Design Challenge process daily….learning from their mistakes, reflecting and improving upon what they have already designed.

RESOURCES

NASA Education Program: http://education.nasa.gov/
NASA Space Link Curriculum Support:
http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/.index.html
Suited for Spacewalking: A Teacher's Guide with Activities for Technology Education, Mathematics, and Science, NASA, 1998.

[1] Adapted from NASA's Potato Astronaut Investigation, found within the "Suited for Spacewalking" Teacher's Guide.

Teacher Notes:

The tip of the screwdriver simulates the impact of the small meteoroids that astronauts encounter in space. Traveling at high speeds, even the smallest meteoroid, can hurt an astronaut who is not well protected.

It is advisable to have students step away from the pad to avoid accidents.

Physics Information
The kinetic energy output of an impact, given in Joules, is calculated with the following equation:
KE = 1/2mv2
Where m = mass of impacting object; and
v = velocity of impacting object.