M.A.R.S. (Mouse Astronaut Recovery System)

Parachutes Lesson Plan

Engage:

One of the videos below could be used to engage students:

Curiosity Main Site:

http://marsprogram.jpl.nasa.gov/msl/index.cfm

Curiosity Mars Rover Landing Video - with Engineers:

http://solarsystem.nasa.gov/multimedia/video-view.cfm?Vid_ID=1642

Mars in a Minute – How Hard is it to Land on Mars?

https://www.youtube.com/watch?v=syA7ml64zY4

NASA video 7 Minutes of Terror

https://www.youtube.com/watch?v=oQEHwfV6WGs

Be A Martian Video Series (Testing the Parachute Part 1 - Note: there are 4 parts regarding the parachute)
http://www.youtube.com/watch?v=O7vf2HUMMdo

Pack Launch and Land Curiosity

https://www.youtube.com/watch?v=VzjgmzwxuYg

Curiosity Has Landed – Shows JPL Mission Control Room

https://www.youtube.com/watch?v=Ti_yre6dsa4

Explore:

I. Drag Racers - Exploring the Force of Drag

Materials:

- 3 foot length of rope
- Large piece of cardboard, poster board, plastic garbage bag, table cover, etc.
- Stopwatch/Timer
- Variations: Longer rope and playground nylon parachute for group race or umbrella for individual runners.
- Stuffed Toy (or other balloon filled slightly with weights - beans or washers) – 1 per group
- Plastic garbage bag or plastic table cover
- String (use hole punch and tie or use stickers/tape to attach string to chutes)
- Stopwatch/Timer
- Various material for designing other chutes (cloth, tissue paper, etc.)
- Rulers
- Compasses or circular objects/templates of varying sizes to trace
- Scissors

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Procedure:

1. Engage the participants by having them run "drag" races. Pair up runners and have each hold one end of the rope. Have them spread apart the length of the rope and run together for a determined distance. Use a timer/stopwatch to time their race.
2. Replace the rope with a piece of cardboard, poster board, table cover or large garbage bag that they hold between them as they run. Time the race over the same distance as used before and compare results.
3. Try different items during timed runs to demonstrate the force of drag (e.g. individuals run with an umbrella behind them closed and then open. Use the longer piece of rope followed by the big playground parachute for a run with several students at the same time. What about the edge of a piece of cardboard versus the full width between two runners?)

II. M.A.R.S. (Mouse Astronaut Recovery System)

Procedure:

1. Discuss with participants the uses of parachutes (slow down human descent for safe landing, drop supplies, slow down vehicles (drag chute versus parachute, etc.) Next, invite participants to apply the Goldilocks Theory in designing a parachute to save their mousetronaut during his Emergency Egress Exercise (E3). Just as the planet Earth is not too close to the sun (too hot) or not too far (too cool) and it is "just right" for life to exist, the animal's chute needs to be "just right" for a safe landing. If the mouse drops too fast, he might be injured. In order to slow the mouse down, the team of engineers/scientists must make and test several designs of chutes so the mouse will land within a specified range of time in order to meet NASA's safety standard (time set by the instructor). NOTE: For an easier challenge, the mouse must take more than X seconds to descend. For a harder challenge for older students, the mouse must descend within a range of times – more than X seconds but less than Y seconds. Repeat and average trials as age appropriate and graph results.

2. Each group should cut a designated shape and size of a parachute, attach four shroud lines equally spaced around parachute and connect to the mouse for drop testing.
3. Find an area where participants may safely drop their mouse and chute. Be sure the landing zone is clear before dropping the test subject. Time the rate of descent.

Change the size of the parachute (using same shape) as necessary until the mouse meets the rate of descent criteria that was set

Explain:
Background Information: Have you ever wondered how a parachute works—or which design features are most important in slowing someone's descent? Parachutes come in many different shapes and sizes, but they work based on the same general principles.

Parachutes are generally used to slow the descent of a person or object to Earth or another celestial body within an atmosphere.

The word parachute is a combination of two words, 'para' which is a Latin word for 'against' and 'chute', which is a French word for 'fall'. The idea of a parachute is to cushion a fall. It is achieved by a combination of various physics concepts, which gradually developed over the years. Records of its use or attempts at parachuting have been traced as far back as the 9th century Chinese civilization. Significant developments and sketching of its design was vigorously pursued in Italy, during the pre-renaissance and the renaissance period. The most notable among the contributions in this field was that of Leonardo Da Vinci. Many of the future designs for parachutes were influenced by his work. The first ever flying trial was conducted in 1595 by Faust Vrancic, a Croatian inventor. Since that time, to the present day, its design and implementation has gone through innumerable changes due to developments in parachute science.

In the sport of skydiving, a person jumps out of an airplane from a very high altitude, falls through the air, and releases a parachute to help the skydiver slow his or her way down and land safely on the ground. How does the parachute break the free-fall so well? As the skydiver is falling, the force of gravity is pulling the person and his or her parachute toward the earth. The force of gravity can make an object fall very fast! The parachute slows the skydiver down because it causes air resistance, or drag force. The air pushes the parachute back up and creates a force opposite to the force of gravity. As the skydiver falls, these "push and pull" forces affect their rate of descent. If the forces were equal in strength, the parachute would not move; it would be stuck in the air, but since gravity is stronger, the parachute is attracted downwards and so it floats down slowly.

Elaborate:
Next, have the participants change other variables such as the following for testing:
Variation 1 - change the shape but keep similar size (circle, square, triangle, etc.)
Variation 2 - keep the same size and shape, but change material
Variation 3 - change the length of the shroud lines
Variation 4 - is there a point where increasing the size of the chute doesn't yield additional benefit?

Evaluate:
(TBD per classroom need) Example: Informally assess through student discussions regarding the implications of having added weight that is unnecessary during space exploration.