## Teacher Information

**Experiment**: Build an Astronaut Lander - the updated egg drop

**Objective**: Design and build a lander to protect your “astronaut” as they land from “space”.

**Standards Covered:**
**5-PS2-1** Support an argument that the gravitational force exerted by Earth on objects is directed down.
**3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
**3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
**3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
**MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem
**MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**Materials Needed:**
- Per Student
    - 1 example “astronaut” - blue or black
- Different packing materials (e.g., bubble wrap, foam padding, cotton balls, paper towels, tissue paper)
- Testing + Measurement
    - A drop zone (pick a consistent height to drop from - recommended minimum is 5’, can do up to 20-25’)
    - A ruler/Measuring tape
    - A scale to record the mass of the lander
    - Measurement “astronaut” - orange
- Tools
    - Scissors (for cutting materials if needed)
    - Tape or glue
    - A pen and paper (for recording observations)

**Concepts Covered**
- Gravity: the force by which a planet or other body draws objects toward its center. The force of gravity keeps all of the planets in orbit around the sun.
    - https://spaceplace.nasa.gov/what-is-gravity/en/

**Ways to modify or change-up the experiment**

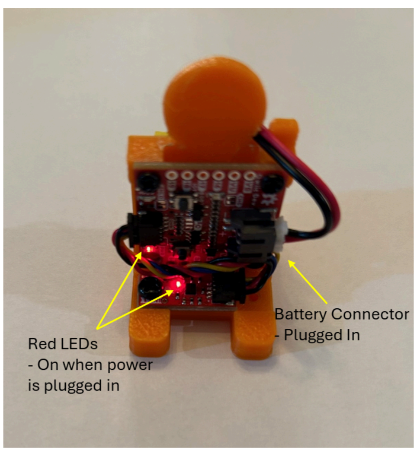
- Different drop heights
- Multiple landings
- Minimal amount of packaging to protect the astronaut
- Making your own packing material

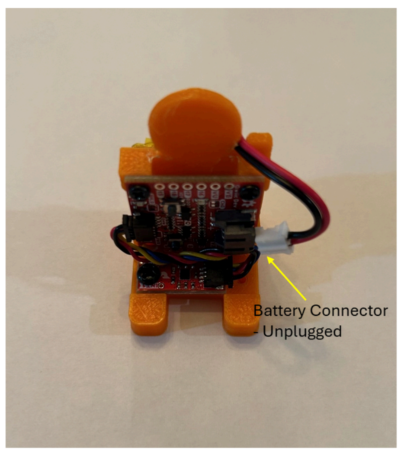
**Teacher Notes**:We recommend doing a few tests on your own to see if the drop height is high enough.  Use a consistent drop height across all students.  Each student can receive an “example” astronaut but there will only be 2 or 3 astronauts provided with the sensors included.

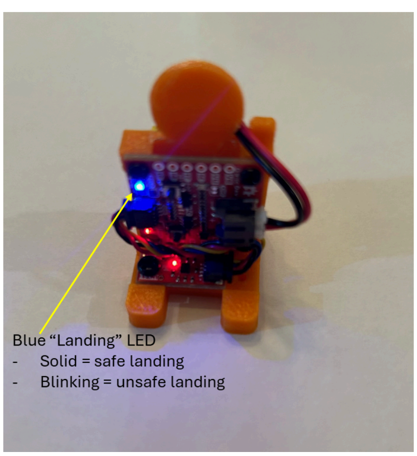
Sources:
- Science Buddies “Protect Your Eggstronaut”
https://www.sciencebuddies.org/stem-activities/egg-drop
- Science Buddies “Teaching Engineering Design with an Egg Drop”
https://www.sciencebuddies.org/teacher-resources/lesson-plans/egg-drop-engineering-design

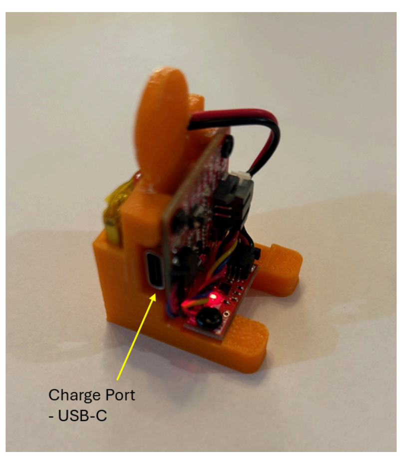
**“Astronauts”**

- Example astronauts are black or blue, do not have electronics
- Measurement astronauts are orange and have electronics mounted
    - Turning the astronaut on/off
        - Plug in the battery to turn the astronaut on
            - The red LEDs on the front will be lit when the astronaut is on
        - Unplug the battery to turn the astronaut off
        - When the astronaut first turns on
            - The following sequence will occur to enable you to know what it looks like when the blue LED is on and flashing
                - The blue LED will turn on and be solid for 3 seconds
                - The blue LED will flash for 3 seconds
                - The blue LED will shut off
    - Landing Types
        - When a “safe landing” occurs, the blue LED will turn on and be solid for 10 seconds.
        - When an “unsafe landing” occurs, the blue LED will flash for 10 seconds.
    - To recharge the battery of the astronaut, plug the battery in and a USB-C cable to a USB port (laptop, cell-phone charger, similar)



**Introduction**: Explain to the students that they will be designing a lander to allow the astronaut to land safely back on Earth.  Discuss what packing materials are and why they are important for protecting the astronaut.  We recommend setting design requirements first (some can be for the entire class, others can be for each student / team).

Example Requirements
- The lander must be used ___ number of times. (1 to 4)
- The astronaut must be easily placed into and removed from the lander. *recommended for all
- The light on the astronaut must be visible from outside of the lander. *recommended for all
- The lander must be made with recyclable materials
- The lander must be __% re-usable from trial to trial

**Procedure/Preparation:**

- Gather all the materials and set up a work area where students can prepare their landers
- Each student can have an "example" astronaut without sensors.
- Have students select their design requirements.
  - The entire class can have the same requirements, they can select their own or a mix.
- Have students write out a plan on what they will use, why they selected it, and how they will build the lander. They can draw their plan out and label the parts. (Student Sheet 1)
- The teacher should conduct a control test.
  - Ensure from the selected height that without a lander, the landing is "unsafe"
  - This data can be used as a reference for all students.

**Prepare the Landers:**

- Have the students select packaging material and a method for protecting the cookie package. It is recommended that each student test with two designs or methods.
- Build the landers
- Ensure that the astronaut can be installed prior to and removed after each test.  Use tape if necessary to keep the astronaut in place.

**Label the Landers:**

- Label each lander and have them make a fun design on it.

**Set Up the Drop Zone:**

- Set up a safe drop zone where the landers will be dropped. Make sure the area is clear of obstacles.

**Conduct the Drops:**

- Measure and record the height from which each lander will be dropped (e.g., 1 meter or 3 feet).
- Based on the requirements, determine how many times the landers will be dropped and from how high.

**Observe and Record:**

- After each drop session
  - Look at the astronaut - are they still healthy (solid blue LED) or are they injured (blinking blue LED)
  - Check for any damage to the lander and take pictures.
  - Record your findings
- Record the results in a table.

**Analyze Results:**

- Discuss with the students which materials and designs provided the best protection and why they think it worked the best.
- Compare the results and determine which packing material and designs were most effective at protecting the astronaut

**Conclusion:**

- Review the findings with the students. Summarize which packing material worked best and why.
- Create a class data collection after each group has analyzed and graphed their findings
- Discuss how this experiment applies to real-world problems like fragile items during shipping.

**Tools for taking it to the next level**

- "Slo-Mo" Camera Mode + Background Grid
    - Take a video of the impact with the black/white grid in the background to measure the impact speed and the bounce upon impact.
    - Each row of the grid is 0.2" tall (1 gray + 1 black = 0.4")