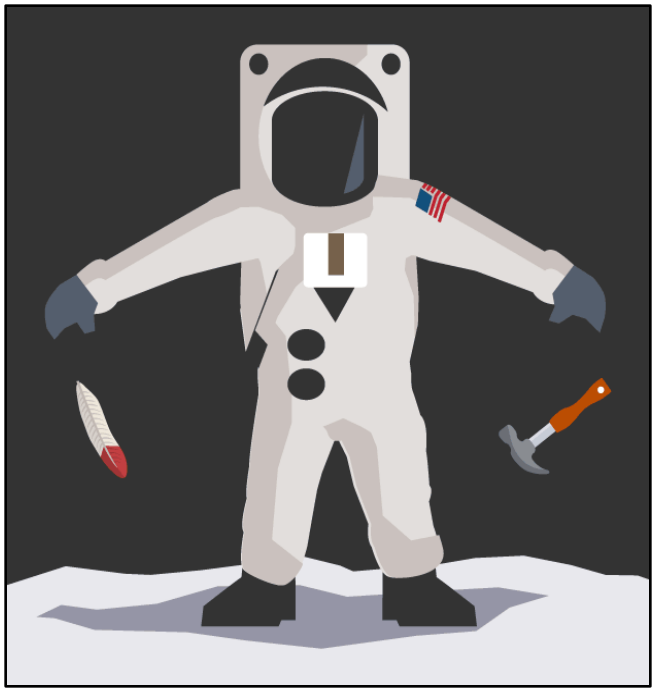
Apollo 15: Galileo & Lunar Gravity Experiment

Next Generation Science Standards: **MS-PS2-2, MS-PS2-4, HS-PS2-1, HS-PS2-4**



Background:

In a 1971 live broadcast on television, astronaut David Scott conducted Galileo's famous hammer and feather drop experiment on the moon surface during the last Apollo 15 moonwalk. In 1634, Galileo concluded that all objects, regardless of mass, fall at the same speed -- however, the resistance caused by the air (as in the case of the feather in Earth's atmosphere) can cause the feather to drop slower. On the moon there is little atmosphere (a vacuum), so the objects should drop at the same speed.

Mission Controller Joe Allen wrote in the *Apollo 15 Preliminary Science Report*:

During the final minutes of the third extravehicular activity, a short demonstration experiment was conducted. A heavy object (a 1.32-kg aluminum geological hammer) and a light object (a 0.03-kg falcon feather) were released simultaneously from approximately the same height (approximately 1.6 m) and were allowed to fall to the surface. Within the accuracy of the simultaneous release, the objects were observed to undergo the same acceleration and strike the lunar surface simultaneously, which was a result predicted by well-established theory, but a result nonetheless reassuring considering both the number of viewers that witnessed the experiment and the fact that the homeward journey was based critically on the validity of the particular theory being tested. ~ Joe Allen, NASA SP-289, Apollo 15 Preliminary Science Report, Summary of Scientific Results, p. 2-11

Supplies:

- Triple beam balance/scale (mass in grams)
- Meter Stick (distance in meters)
- Hammer
- Feather
- Two stop watches (time in seconds)
- Pencil and paper
- Calculator
- Media play access of the Apollo 15 Lunar Experiment (Link: https://youtu.be/-4_rceVPVSY)

Procedure:

[**This activity can be done as a classroom demonstration or group activity**]

- Using the triple beam balance/scale, find the mass of the hammer and record here:
  - **Mass of hammer _____ grams**
- Using the triple beam balance/scale, find the mass of the feather and record here:
  - **Mass of feather _____ grams**
- Instruct each student to firmly hold the hammer in one hand and the feather in the other.
- Instruct each student to hold the hammer and feather with hand outstretched in front of them so their hands are both outward and parallel to the floor.
- Use the meter stick to record the distance from the objects to the floor, and record it here:
  - **Distance of hammer to floor _____ meters**
  - **Distance of feather to floor _____ meters**
- Using the stop watches, have two students ready to record the start times as soon as the objects are released. One student will need to record the drop time of the hammer and the other record the drop time of the feather. Start the stopwatch as soon as the object is released from the hand, and stop the stopwatch as soon as the object hits the floor.
- Let go of each object at the same time, and observe their fall.
- Note the times from the time keepers.
  - **Time for hammer _____ seconds**
  - **Time for feather _____ seconds**
- Using the collected data, calculate the force in Newtons. Use the following formulas and given variables in calculating Force.

$$Force = Mass\ x\ Acceleration$$

$$Acceleration\ due\ to\ gravity\ (g) = 9.8\ meters/second^2$$

$$Force\ due\ to\ gravity\ (g) \quad = M\ x\ g$$

Force for hammer _____ Newtons

Force for feather _____ Newtons

[In this calculation, the calculated force due to gravity is equal to weight. Weight is the product of your mass and the pull of gravity. Since weight is a force, its unit of measurement is in Newtons.]

- From the drop observations, ask the following questions:
    - Which object (hammer or feather) hit the ground first? Answer: Hammer
    - What force caused the object to hit the floor first? Answer: Gravity (Weight)
    - What force slowed the feather? Answer Air resistance/Drag
    - Does drop height play a factor in this experiment? Test this question to find out by dropping the objects at various recorded heights and recording the times. Answer: No. The hammer will hit the floor first every time.
    - What if you did this experiment on a planet or moon that had no air resistance? Discuss this question as a class.
    - Follow up this class discussion with the video of Apollo 15 doing this same test, but on the surface of the moon. Discuss the lunar experiment result with the class.

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