# PEANUTS and SPACE FOUNDATION

# Birdbath Buoyancy



## OBJECTIVES

Students will:

- Read *Snoopy, First Beagle on the Moon!* and *Shoot for the Moon, Snoopy!* to give students some background knowledge.
- Learn how astronauts train for space using the Neutral Buoyancy Laboratory (NBL).
- Test different material for buoyancy.
- Design a spacesuit that allows the astronaut to be neutrally buoyant.

## SUGGESTED GRADE LEVELS

K – 5th

## SUBJECT AREAS

Science, Math, Literature

## TIMELINE

40 – 60 minutes

## NEXT GENERATION SCIENCE STANDARDS

- K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.
- 3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

## 21st CENTURY ESSENTIAL SKILLS

Critical thinking/problem solving, collaboration and teamwork, carrying out investigations, peer communication, and constructing explanations.

## BACKGROUND

- According to NASA.gov, NASA has proudly shared an association with Charles M. Schulz and his American icon Snoopy since Apollo missions began in the 1960s. Schulz created comic strips depicting Snoopy on the Moon, capturing public excitement about America's achievements in space. In May 1969, Apollo 10 astronauts traveled to the Moon for a final trial run before the lunar landings took place

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on later missions. Because that mission required the lunar module to skim within 50,000 feet of the Moon's surface and "snoop around" to determine the landing site for Apollo 11, the crew named the lunar module Snoopy. The command module was named Charlie Brown, Snoopy's loyal owner.

- Microgravity is the condition in which people or objects appear to be weightless. The effects of microgravity can be seen when astronauts and objects float in space. Microgravity can be experienced in other ways, as well. "Micro-" means "very small," so microgravity refers to the condition where gravity seems to be very small. In microgravity, astronauts can float in their spacecraft - or outside on a spacewalk. Heavy objects move around easily. For example, astronauts can move equipment weighing hundreds of pounds with their fingertips. Microgravity is sometimes called "zero gravity," but this is misleading.
- Gravity causes every object to pull every other object toward it. Some people think that there is no gravity in space. In fact, a small amount of gravity can be found everywhere in space. Gravity is what holds the moon in orbit around Earth. Gravity causes Earth to orbit the sun. It keeps the sun in place in the Milky Way galaxy. Gravity, however, does become weaker with distance. It is possible for a spacecraft to go far enough from Earth that a person inside would feel very little gravity. But this is not why things float on a spacecraft in orbit. The International Space Station orbits Earth at an altitude between 200 and 250 miles. At that altitude, Earth's gravity is about 90 percent of what it is on the planet's surface. In other words, if a person who weighs 100 pounds on Earth's surface could climb a ladder all the way to the space station, that person would weigh 90 pounds atop the ladder.
- If 90 percent of Earth's gravity reaches the space station, then why do astronauts float there? The answer is because they are in free fall. In a vacuum, gravity causes all objects to fall at the same rate. The mass of the object does not matter. If a person drops a hammer and a feather, air will make the feather fall more slowly. But if there were no air, they would fall at the same acceleration. Some amusement parks have free-fall rides, in which a cabin is dropped along a tall tower. If a person lets go of an object at the beginning of the fall, the person and the object would fall at the same acceleration. Because of that, the object would appear to float in front of the person. That is what happens in a spacecraft. The spacecraft, its crew and any objects aboard are all falling towards Earth. Since they are all falling together, the crew and objects appear to float when compared with the spacecraft.

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- The Neutral Buoyancy Laboratory, also known as the NBL, is a large pool located at the Sonny Carter Training Facility in Houston, Texas. The pool is 40.5 feet deep, 202 feet long and 102 feet wide and holds 6.2 million gallons of water.
- The mission of the NBL is to prepare for space missions involving spacewalks. NASA team members use the NBL to develop flight procedures, verify hardware compatibility, train astronauts and refine spacewalk procedures during flight that are vital to mission success.
- The ability to perform on-orbit assembly and maintenance operations successfully and predictably is critical to future space endeavors. The International Space Station will require hundreds of hours of spacewalks for assembly. The phenomenal scientific discoveries of the Hubble Space Telescope are a result of successful maintenance spacewalks. Clearly, spacewalks are the cornerstone for current and future space initiatives and the NBL is the foundation for successful spacewalk preparation.
- What is neutral buoyancy, and how does it resemble zero gravity (weightlessness)? Neutral buoyancy is the equal tendency of an object to sink or float. If an item is made neutrally buoyant through a combination of weights and flotation devices, it will seem to "hover" under water. In such a state, even a heavy object can be easily manipulated, much as it is in the zero gravity of space. However, there are two important differences between neutral buoyancy as achieved in the NBL and weightlessness. The first is that suited astronauts training in the NBL are not truly weightless. While they are neutrally buoyant, they nonetheless feel their weight while in their suits. The second is that water drag hinders motion, making some tasks easier, and others more difficult to perform in the NBL than in zero gravity. These differences must be recognized by spacewalk trainers. However, despite these differences, neutral buoyancy is currently the best method available by which astronauts train for spacewalks.

### VOCABULARY

Buoyant, Float, Sink, Neutral Buoyancy, Density

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### MATERIALS

- Styrofoam cups
- Small items that sink in water
- Pennies, paper clips, small weights
- 2-4, large plastic containers (30 Quart size)
- Water
- 2-4, Stopwatches
- Scissors
- Painter's tape
- Glue
- 10-15, Toy figures to serve as "astronauts"
  - Action figures, toy characters

### SETUP

1. Outside the plastic containers, mark a dot half-way up the side.
2. Draw a horizontal line two inches above and two inches below the half-way dot drawn in step 1.
3. This section in between the top and bottom lines will serve as the Green Zone for the astronauts.
   a. The Green Zone is where the astronauts must remain to complete their work in space.
   b. The Green Zone size may be increased or decreased to change difficulty. (The larger the Green Zone, the lower the difficulty)
4. Fill plastic containers three-fourths full of water.
5. Setup a stopwatch near each container.

### LESSON PROCEDURES

1. Read *Snoopy, First Beagle on the Moon!* and *Shoot for the Moon, Snoopy!* to the entire class to give students some background knowledge.
2. Reference pages 13-16 and discuss the differences in gravity between the Earth, outer space, and the Moon.
3. Discuss with students the following terms and ask them to provide a definition for each: float, sink, buoyant, neutral and neutral buoyancy.
4. Show images of the Neutral Buoyancy Laboratory and explain how astronauts train using the NBL to simulate microgravity. *see images provided
5. Explain to students that NASA has contracted them to provide a new suit that will be used by astronauts as they train in the NBL for the next



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mission to space. This suit must allow the astronaut to be neutrally buoyant and remain in the Green Zone of the pool to complete their tasks. The longer their astronauts stay in the Green Zone, the better the suit.

6. Reference the Green Zone on each container that was setup earlier.
7. Explain the forces behind objects suspended in a liquid and how each force effects that object.
   a. The more weight added with cause the object to sink
   b. The more Styrofoam with cause the object to float
   c. The achieve neutral buoyancy, the object must not sink to the bottom or float to the top, it remains vertically suspended in the same spot of pool.
8. Show all the material available for students to use to design suits
   a. Styrofoam cups, pennies, paper clips, Painters tape, glue, and toy figures
9. Divide students into groups of 2 or 3 and provide each group with the following material:
   a. Styrofoam cup
   b. 2-4 pennies
   c. 4 paper clips
   d. One toy figure (this will serve as their astronaut)
10. Instruct students to test their designs.
    Rules to testing:
    a. One group member will serve as a timekeeper and grab the stop watch
    b. Another group member will submerge the astronaut in the pool.
    c. Students should gently shake their astronaut while submerged to remove any unwanted bubbles that may be trapped in the suit.
    d. Position astronaut in the Green Zone.
    e. Release astronaut so that it is freely suspended in the pool and start timer
    f. Observe when the astronaut is completely out of the Green Zone and stop the timer.
    g. Record how long the astronaut remained in the Green Zone.
11. Give students time to design and test their suits. Suits must be attached to the toy figure provided.
12. Perform a final test to determine which group's suit works the best- provides the longest time in the Green Zone.
13. Instruct students to explain their suit design along with their results achieved in the pool.

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### EXTENSIONS

- Instruct students to create their own constellation. Students will draw an outline of the constellation using dots, then connecting the dots to create the full constellation outline. The dots would serve as the placement for their stars.
- Print out other constellations and research the distances of other stars.

### RESOURCES

Dunbar, B. (2015, June 16). What Is Microgravity? Retrieved from https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is microgravity-58.html

Oceaneering. (2019). Neutral Buoyancy Laboratory (NBL) Facilities. Retrieved from https://www.oceaneering.com/space-systems/nbl-facilities/

Sonny Carter Training Facility: The Neutral Buoyancy Laboratory, NASA. (2006, November). PDF. Houston. Retrieved from: https://www.nasa.gov/centers/johnson/pdf/167748main_FS_NBL508c.pdf

*Images provided by:*

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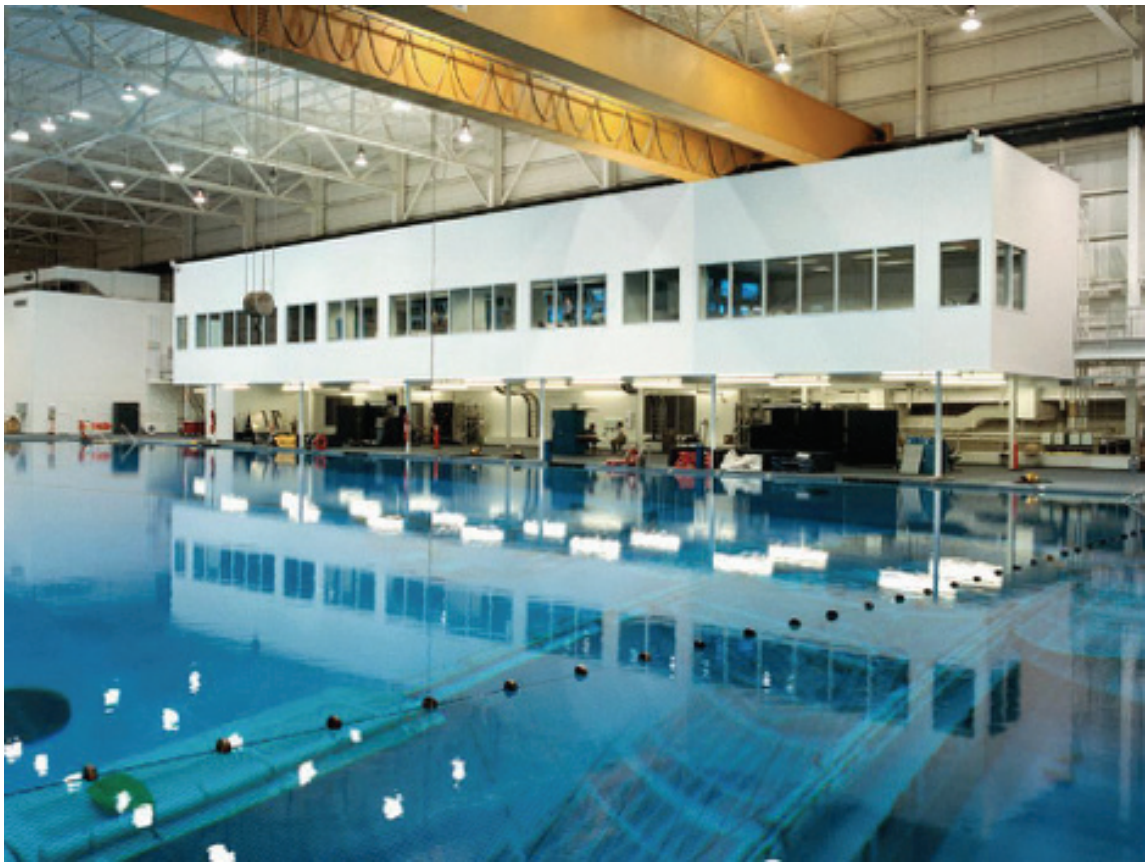
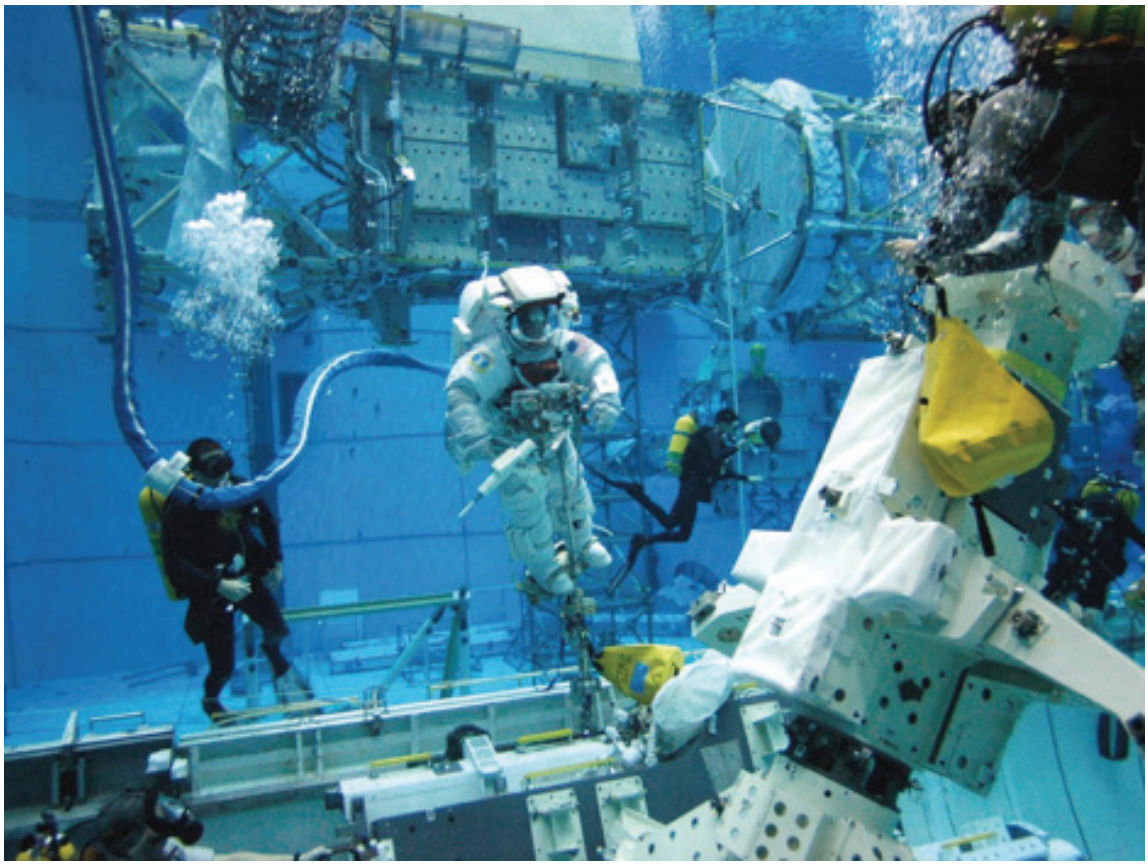
Ramsey, S. (2015, August 26). NASA Invites Student Teams to Participate in Underwater Research. Retrieved from https://www.nasa.gov/press-release/nasa invites-student-teams-to-participate-in-underwater-research

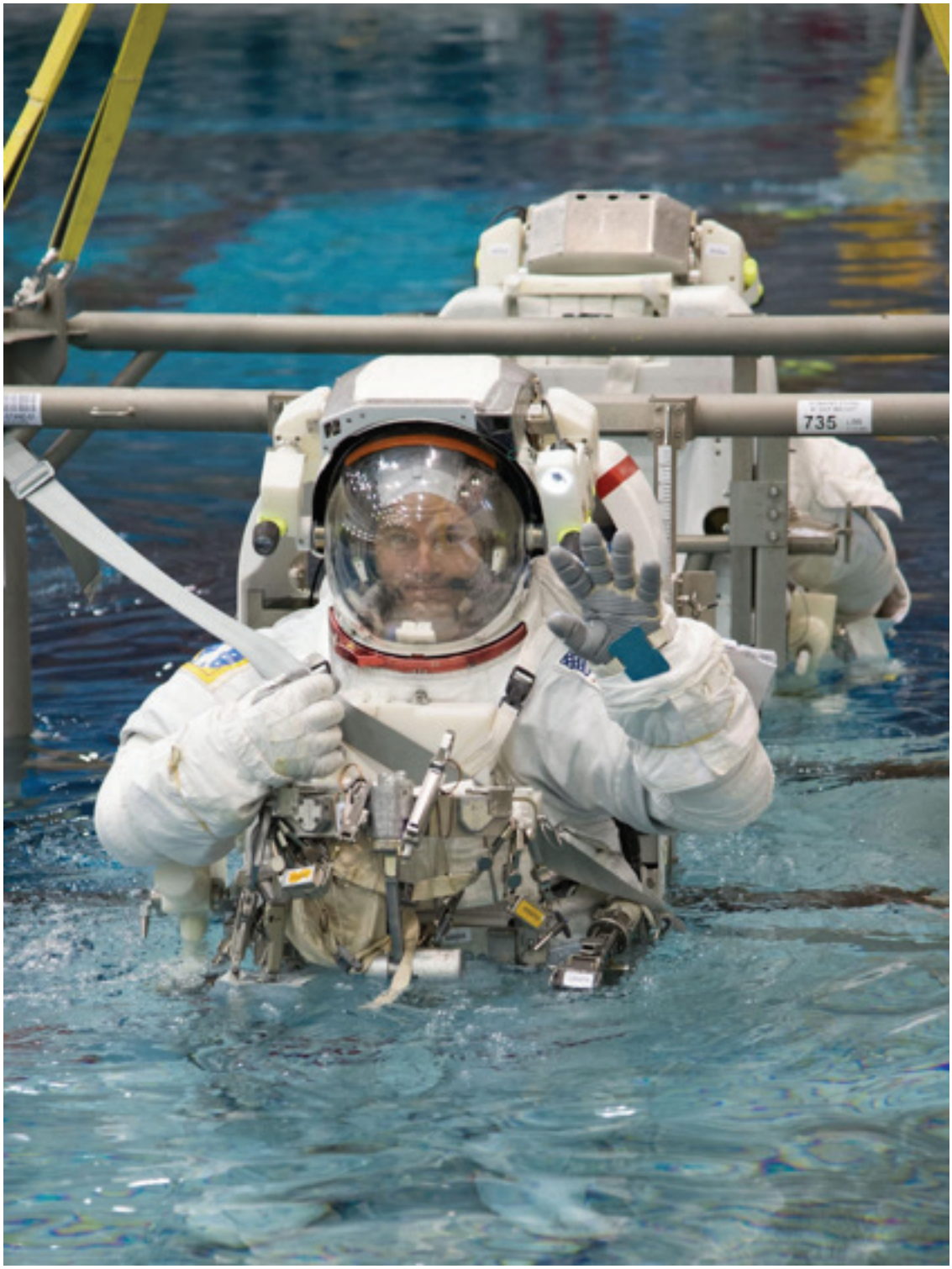


***Neutral Buoyancy Laboratory Opens*** ***Photo credit: NASA***

S97-02544 (March 1997) — Located at the Sonny Carter Training Center, a new pool for testing and training called the Neutral Buoyancy Laboratory (NBL) awaits visitors to the grand opening in March 1997.



***Training in the Neutral Buoyancy Laboratory*** ***Photo credit: NASA***.




In this image taken on Nov. 7, 2012, NASA astronaut Reid Wiseman and European Space Agency astronaut Alexander Gerst (partially obscured), both Expedition 40/41 flight engineers, attired in training versions of their Extravehicular Mobility Unit (EMU) spacesuits, are submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near NASA's Johnson Space Center. Divers (out of frame) are in the water to assist Wiseman and Gerst in their rehearsal, which is intended to help prepare them for work on the exterior of the International Space Station.

***Photo credit: NASA***