

PEANUTS and SPACE FOUNDATION

Birdbath Buoyancy

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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 – 5

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.

- ◆ Why do you land on the ground when you jump up instead of floating off into space? Why do things fall down when you throw them or drop them? The answer is gravity: an invisible force that pulls objects toward each other. Earth's gravity is what keeps you on the ground and what makes things fall. Gravity is what holds the planets in orbit around the sun and what keeps the moon in orbit around Earth.
- ◆ Some people think that there is no gravity in space. But small amounts of gravity are everywhere. The pull of gravity gets weaker the farther apart two objects are. A spacecraft could go so far from Earth that a person would feel very little gravity. But this is not why things float on the International Space Station. The space station orbits Earth at about 200 to 250 miles high. At that height, Earth's gravity is still very strong. In fact, a person who weighs 100 pounds on the ground would weigh 90 pounds there.
- ◆ So why do astronauts float in space? The answer is that they are in free fall. Gravity pulls all objects the same way, even if they are different sizes. If you drop a hammer and a feather on Earth, the hammer will fall faster. But that is not because gravity pulls them differently. Air makes the feather fall more slowly. If there were no air, they would fall together at the same speed. That is what happens in a spacecraft. The spacecraft, its crew and everything aboard are all falling around Earth. Since they are all falling together, the crew and objects appear to float.
- ◆ What does it mean to "fall around Earth"? Earth's gravity pulls objects toward the surface. Gravity pulls on the space station, too. As a result, it is falling toward Earth's surface. The station also is moving very fast. It moves so fast it matches the way Earth's surface curves. If you throw a baseball, gravity will cause it to curve down. It will hit the ground soon. A spacecraft in orbit moves at the right speed so that the curve of its fall matches the curve of Earth. For the space station, that speed is 17,500 miles per hour. The spacecraft keeps falling toward the ground but never hits it. Instead, it falls around the planet. The moon stays in orbit around Earth for this same reason. The moon also is falling around Earth.
- ◆ NASA studies microgravity. The studies help show what happens to people and other things in space. Microgravity does things to the human body. For example, muscles and bones can get weaker.



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Astronauts on the space station spend months in microgravity. Astronauts who travel to Mars would have to live even longer in microgravity. That is because it will take a long time to get there and back. NASA must learn what microgravity does to astronauts. NASA will use this information to find ways to keep them safe and healthy.

- ◆ 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. Working in the Neutral Buoyancy Laboratory helps astronauts train for spacewalks.
- ◆ Neutral buoyancy is the state of keeping a person or thing under water from sinking or floating, using weights or floats. If an item is made neutrally buoyant through a combination of weights and flotation device, 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 microgravity of space. Neutral buoyancy is currently the best method available by which astronauts train for space.

VOCABULARY

Buoyant, Float, Sink, Neutral Buoyancy, Density

MATERIALS

- ◆ 2-4 large plastic containers (30-quart size) – students will share
- ◆ Markers
- ◆ Water
- ◆ 2-4 stopwatches – students will share
- ◆ Styrofoam cups – 1 per group
- ◆ Pennies – 2 to 4 per group
- ◆ Paper clips – 4 per group
- ◆ Painter’s tape – 1 foot per group
- ◆ Glue – 1 per group
- ◆ Toy figure – 1 per group (to represent astronaut)

SETUP

1. On the outside of the plastic containers, mark a dot halfway up the side.
2. Draw a horizontal line 2 inches above and 2 inches below the dot.



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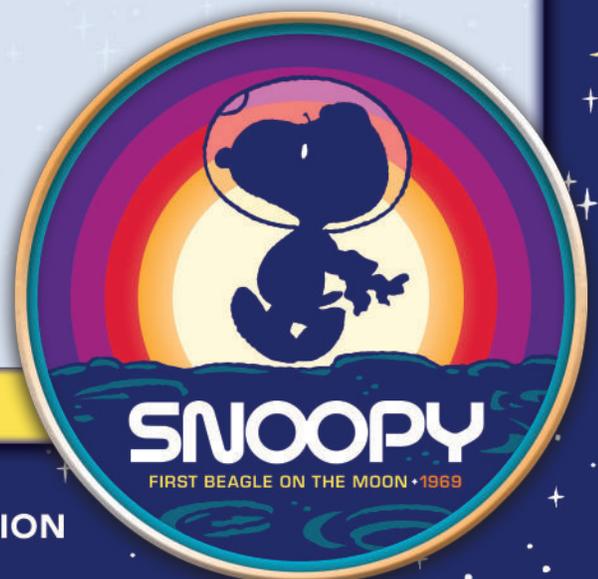
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3. This section in between the top and bottom lines will serve as the Green Zone for the astronauts.
 - a. The Green Zone is where the astronauts must remain to complete their work in space.
 - b. The Green Zone size may be increased or decreased to 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 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 set up earlier.
7. Explain the forces behind objects suspended in a liquid and how each force affects that object.
 - a. More weight added will cause the object to sink.
 - b. More Styrofoam added will cause the object to float.
 - c. To achieve neutral buoyancy, the astronaut must not sink to the bottom or float to the top. The astronaut must remain vertically suspended in the Green Zone.
8. Show all the materials students can use to design their suits (Styrofoam cups, pennies, paper clips, painter's tape, glue, toy figures).



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9. Divide students into groups of 2 or 3 and provide each group with the following materials:
 - 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 stopwatch
 - 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; 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 keeps the astronaut vertically suspended in the Green Zone for the longest amount of time.
13. Instruct students to explain their suit design along with their results achieved in the pool.

EXTENSIONS

- ◆ Add and stir 1-2 cups of salt into the water. This will increase the water's density and buoyancy. Have students reconfigure their suits to keep the astronaut vertically suspended in the Green Zone.

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RESOURCES

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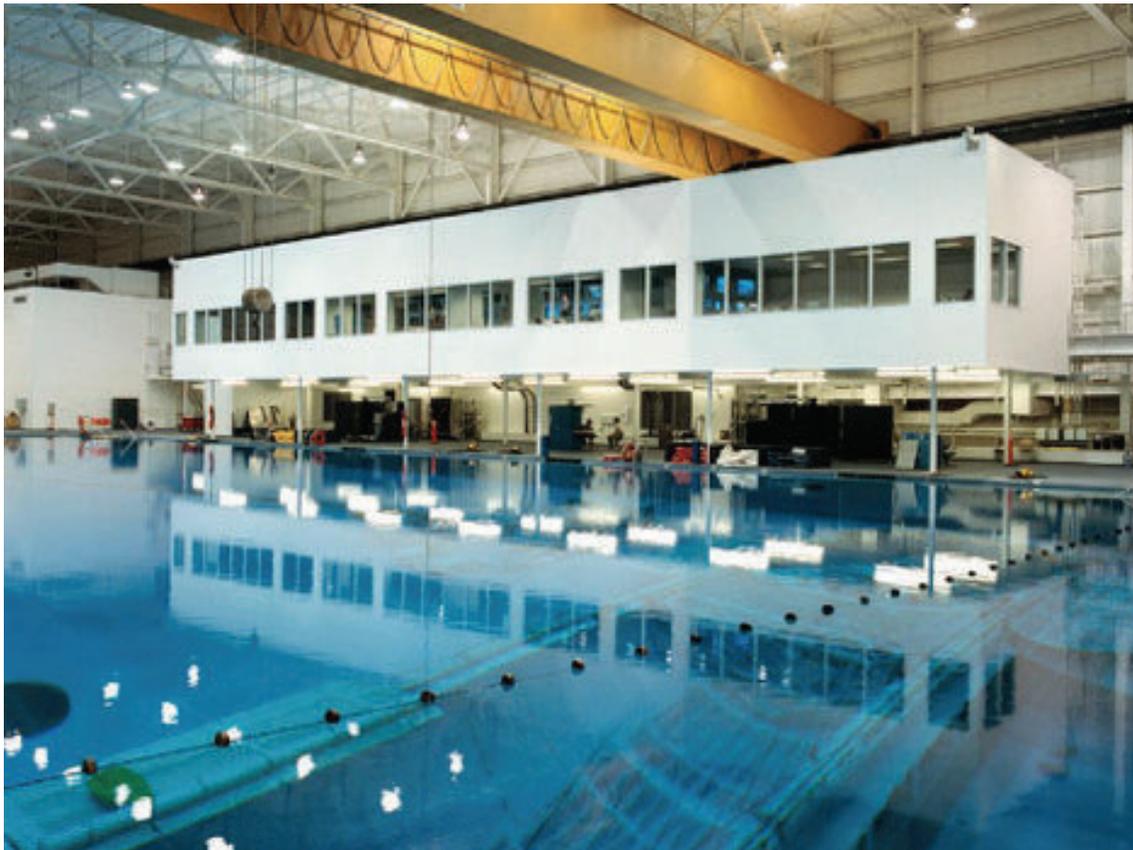
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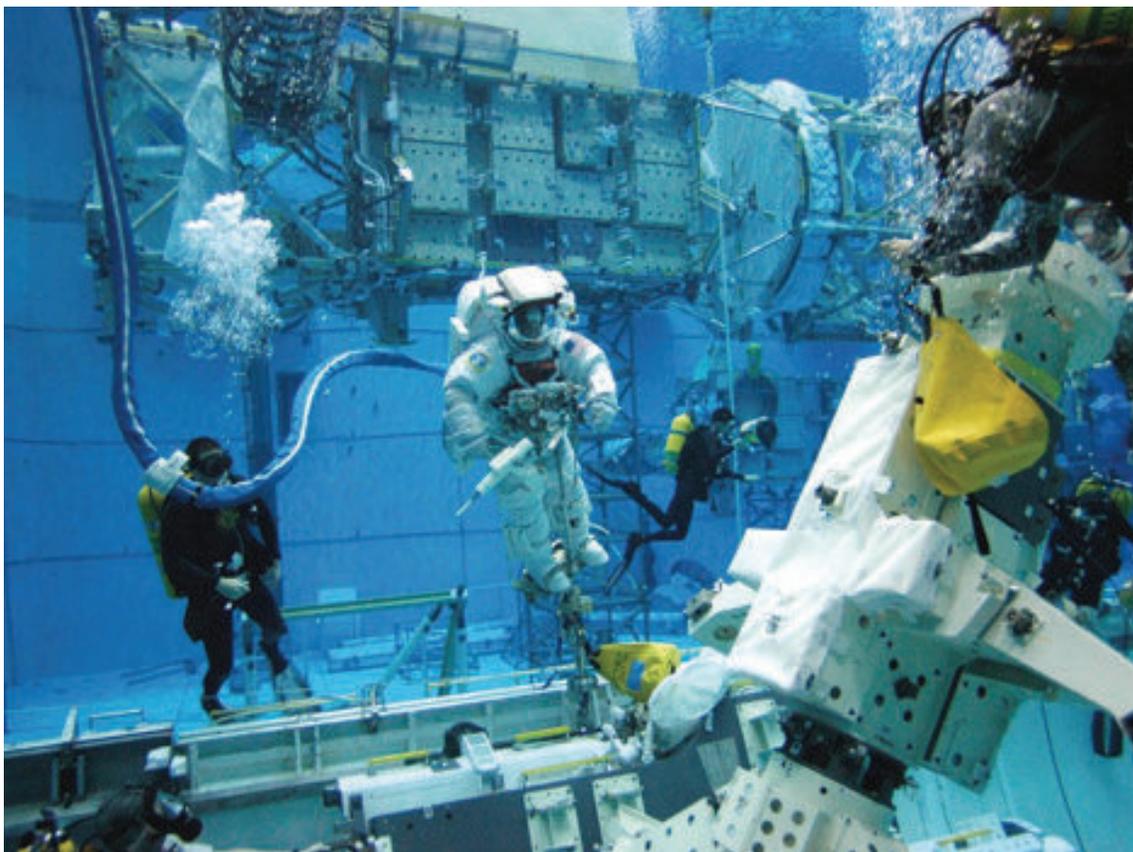
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Neutral Buoyancy Laboratory Opens

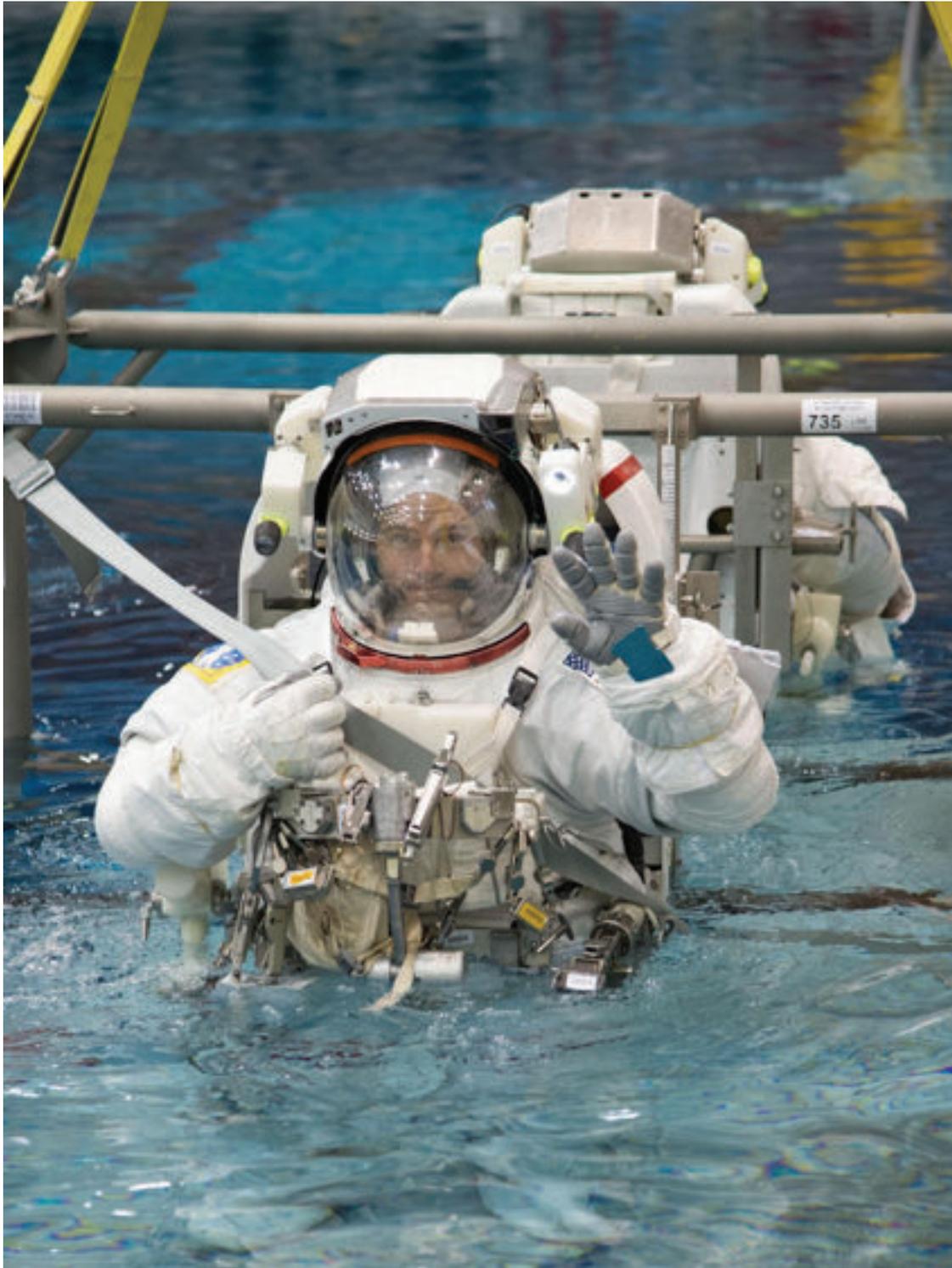
Photo credit: NASA

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