



STEAM Subject: Astronomy

Lab: Planets in a Bottle

Grades: 5-8

Learning objective:

Students learn about environments that make a planet habitable and explore the concept of terraforming Mars.

ENGAGE:

Ask students the following questions:

- How many planets are in our solar system?
- What does life need to flourish? (Water, sunlight, oxygen)
- How many planets have these nutrients available for life? Do you think that some moons or dwarf planets might have the ingredients to support life?
- Did you know that NASA is currently planning missions to send humans to Mars?
- Do you think humans can thrive on Mars given its current conditions? (Average temperature of -81°F , atmosphere made of carbon dioxide)

EXPLORE:

Planets in a Bottle Experiment

Students will conduct an experiment that looks at how certain conditions make life possible on planets. To begin, create the Earth environment in a bottle, which is perfect for supporting life as we know it. Compare and contrast Earth to different planet environments for Mercury, Venus, and Pluto.

Materials needed:

- 4 empty plastic water bottles (16 oz)
- 1 small funnel (optional)
- 1 cup lukewarm water + 1 tablespoon of Sugar (Earth)
- 1 cup boiling water* + 1 tablespoon of Sugar (Mercury)
- 1 cup orange juice (or similar juice) (Venus)
- 1 cup cold water + 1 tablespoons of Sugar (Pluto)
- 4 quarter-oz package of yeast
- 4 party balloons (different colors or use permanent marker to write the planet name with)
- 1 measuring tape or yarn and a ruler

Directions: Prepare the ingredients beforehand and begin with planet Earth.

Procedure:

1. Mix water and sugar in water bottle until the sugar is dissolved.
2. Using the funnel add yeast* then gently swirl the mixture. *For Pluto freeze the yeast before adding to the nutrient mix**
3. Cap the bottle with a balloon.
4. Use the yarn and ruler to measure the diameter of the balloon
5. Record measurements every 10 minutes on a hand-drawn table similar to the one below:

	0 minutes	10 minutes	20 minutes	30 minutes	40 minutes
Earth	<i>5 inches</i>	<i>7.5 inches</i>	<i>9 inches</i>	<i>11 inches</i>	<i>13 inches</i>
Mercury					
Venus					
Pluto					



Earth is found in the 'goldilocks zone'. It has liquid water, oxygen in the air, and is not too hot or cold.



Mercury has a very hot surface when it is exposed to the Sun! Boil the water before adding sugar and yeast.

Safety note Use extreme caution when pouring boiling water into the bottle, students should wear protective gear like hot pads/pot holders at all times when handling hot water.



Venus is very hot and has an acidic atmosphere. Instead of water and sugar, use orange juice as a nutrient mix. The citric acid in the juice represents sulfuric acid in Venus's hot atmosphere.



Pluto is very far from the sun and is very cold. Use ice-cold water and sugar, plus freeze the yeast before adding to the nutrient mix.

Discussion: In this experiment, we created different “planets” by creating conditions for microorganisms to grow. Yeast is a living organism that metabolizes sugar and produces carbon dioxide. The carbon dioxide is the gas that fills up the balloon. The rate of carbon dioxide production at any given instant is related to the number of healthy microbes in the bottle. Because the yeast is constantly reproducing through cell division, the number of microbes increases along with carbon dioxide production. The balloon inflates slowly at first, then rapidly accelerates. Compare Earth to the other planets, how has the yeast performed in each environment?

EXPLAIN:

- Ask students to describe the type of planet environment best suited for life.
- *Explore Earth/Mars Facts:* <https://mars.nasa.gov/all-about-mars/facts/>
- Ask what challenges humans might face when trying to live on Mars?



Concept image of life on Mars. Protective domes with plants and oxygen, space suits, hearty equipment to endure dust storms. You can only survive on Mars for 2 minutes without a spacesuit. Where will all of this equipment come from?

Vocabulary

- **Astrobiology:** nature, existence, and search for extraterrestrial life (life beyond Earth). Astrobiology encompasses areas of biology, astronomy, and geology. Video: <https://www.youtube.com/watch?v=SOzZnVxlqsc>
- **Goldilocks Zone:** A habitable zone around a star where it is not too hot or cold, this zone creates environments for liquid water to exist on a planet.
- **Habitable Planet:** a planet in outer space where conditions are best suited for life to form as on Earth. Among many factors making it habitable, these planets must have atmospheres and are orbiting a stable star in its 'goldilocks zone'.
- **Microorganism:** A diverse group of simple life forms including bacteria, algae, fungi, protozoa, and viruses. Microorganisms are usually viewed through a microscope because of their small size.
- **Terraforming:** transforming a planet so that it can support human life.

EVALUATE:

Have your student write a story about the day in the life of a student scientist living on Mars.

- What are the student's scientists' jobs?
- *Robotics engineer, farmer, doctor assistant, etc.*
- What is the student scientist assigned duties?
- What do they have to wear when they go outside?
- What is the weather like?
- How does it feel to jump and run?
- Is life the same as it is on Earth?



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