**Lesson Title:** Neutral Buoyancy Challenge

**Subject / Topic Areas:** Physics, Aerospace, Real-World Science Applications, Citizen Science

**Designed by:** Dr. Richard Cairncross, Serenity Baruzzini

**Grade Levels:** High School

**Time Frame:** 1 hour

## Lesson Materials

Slides:
https://docs.google.com/presentation/d/1EmeBOCJFIdMTqHml7Eqp44cGsMCiDWxIEtuxJp_vO7o/edit

Engineer's Week Doc:
https://docs.google.com/document/d/1NSBt7EpDIeobKXkxbOZeXyEYN66DEqYGLWBQ3kikqxw/edit?usp=sharing

Entry/Exit Ticket:

Resources for Archimedes Principle:

- https://physics.weber.edu/carroll/archimedes/principle.htm
- https://www.grc.nasa.gov/www/k-12/WindTunnel/Activities/buoy_Archimedes.html

*Lesson Template: Understanding by Design, Grant Wiggins*

## Brief Summary of Lesson

In this introductory level lesson, students will learn about how and why weather balloons are used to collect atmospheric data, as well as the science behind how balloons work. The instructor will share footage and narrative from collecting data during the 2023 and 2024 eclipses via a weather balloon with a team of students, followed by a conversation about Archimedes Principle. Armed with context and knowledge, students will work in

teams to complete a challenge, creating a neutrally buoyant balloon. This lesson is a great introduction to both the scientific principles behind helium balloons, but also how to approach a goal oriented mission.

**Stage 1: Desired Results**

<table>
<tr><th colspan="2">Established Goals</th></tr>
<tr><td colspan="2">NGSS:<br><br>- HS-PS2-2 Motion and Stability: Forces and Interactions: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.<br>-</td></tr>
<tr><th>Essential Questions</th><th>Students will understand that…</th></tr>
<tr><td>- How are weather balloons used to collect atmospheric data? What are the associated challenges?<br>- Why does a helium balloon float?<br>- What makes a helium balloon become buoyant?</td><td>- Adding weight or venting a balloon reduces lift.<br>- It’s impossible to make a balloon perfectly stationary due to other environmental contributions, i.e. airflow.</td></tr>
<tr><th>Students will know…</th><th>Students will be able to…</th></tr>
<tr><td>- Archimedes Principle<br>- Weather balloons are an affordable way to collect atmospheric data, though they have limitations.</td><td>- Work as a team to plan for a mission with limited time, then execute their plan accordingly.<br>- Make a common helium balloon neutrally buoyant for at least 10 seconds, aiming for 30 or longer.</td></tr>
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**Stage 2:**

**Acceptable Evidence**

| **Performance Tasks** |
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| Neutral Buoyancy Challenge— In small groups (2-4 students), students make a balloon neutrally buoyant using tape (or other objects). Student support can look like discussing airflow in the room or studying the balloon's movements, though the challenge is mostly self-led. |
| **Other Evidence** |
| Challenge Results— Total floating time from each team without interactions. |
| **Student Self-Assessment and Reflection** |
| Entry and Exit Tickets? |

| **Assessment Task Blueprint** |
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| **What understandings or goals will be assessed through the task?** |
| Students will collaborate on how to approach the challenge carefully and will not intervene with other teams' balloons or their own during flight. |
| **Task Overview** |
| Mission of the "Neutral Buoyancy Challenge"<br>- Primary mission (minimum success): create a neutrally-buoyant balloon that will float for at least 10 seconds before touching the ground, ceiling, or any other stationary object.<br>- Challenge mission (comprehensive success): create a neutrally-buoyant balloon that will float for at least 30 seconds before touching the ground, ceiling, or any other stationary object. |

- Competition mission: which team's balloon remains floating for the longest time before touching the floor or stationary objects? In competition mission, any balloon that touches the ceiling is disqualified.

NOTE: “touching” includes any part of balloon and material (tape, ribbon) attached to balloon. People interacting with balloon (blowing, fanning, etc.) also will count as “touching”. If two balloons collide, this will NOT terminate their mission.

**What student products and performances will provide evidence of desired understandings?**

- Final results
- Post-mission debrief

**By what criteria will student products and performances be evaluated?**

- No interacting with the balloon
- Balloon’s time spent in the air

## Stage 3:
## Planned Learning Experiences

**Lesson Specifics with Timing**

1. (10 minutes) As students arrive, have them rate their understanding via Entry Tickets. Ask students what types of missions they think NASA conducts. Introduce NASA mission examples, as well as AREN.
2. (5 minutes) Share narrative and photos/videos from ballooning team.
3. (5 minutes) Present slides on neutral buoyancy and Archimedes Principle. Supporting instructors should also receive one-pager summary.
4. (5 minutes) Introduce mission, phases, and challenge rules. Take any questions, split students into pairs, and distribute materials.

5. (8 minutes) Building: Students create a neutrally buoyant balloon in their teams with provided materials.
6. (2 minutes) Preparation: Students get into position for launch.
7. (15 minutes) Launch and Testing: All teams simultaneously receive a 10-second countdown, then one team member records how long their balloon stays in the air without intervention by a person or inanimate object. This can also be done sequentially, depending on space and time constraints.
8. (10 minutes) Analysis: Discuss with students: What was challenging? Did anything unexpected happen? Why do you think your balloon behaved the way it did? What would you do differently next time?
9. (5 minutes) Conclusion: Clean-up and Exit Tickets / Feedback