BALLOONS

Lesson Plan: Helium Balloon Race

Grade Level: 7-8

Subject Area: Science, Math

Time required: ***Preparation:*** 2 hours
Activity: 2 hours

National Standards Correlation:

Science (grades 5-8)

- Unifying Concepts and Processes Standard: Evidence, models, and explanation.
- Physical Science Standard: Motions and forces.
- History and Nature of Science Standard: Nature of science.

Math (grades 6-8)

- Problem Solving Standard: Apply and adapt a variety of appropriate strategies to solve problems.
- Measurement Standard: Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Measurement Standard: Apply appropriate techniques, tools, and determine measurements.

Summary:

Students determine the upward force of a helium balloon and then use a downward force that allows the balloon to rise a specific distance. The amount of downward force is calculated and measured by using the concept of "area density". In a class contest, the slowest rising balloon is the winner.

Objectives:

Students will:

- Attach weights to a helium filled balloon and launch it to the ceiling.
- Determine the net upward force caused by a helium filled balloon.
- Determine the area density of a uniformly thick piece of paper.
- Calculate the amount of paper needed to construct a weight for a downward force.

Background:

The Buoyancy of Air

Archimedes' Principle applies to bodies immersed in air, just as it does to bodies immersed in liquids. A body which is weighed by means of a spring scale, first in air and then in a vacuum will be found to weigh somewhat less in the air because it is buoyed up by the air about it. The apparent loss of mass of the body when in air is exactly equal to the mass of the air displaced by it. Since air is very light, this difference is usually extremely small. However, large, hollow bodies, such as dirigibles, actually displace somewhat more than their own mass, which explains why they float in air. Since the air is less dense at higher altitudes, a balloon ultimately stops rising at a level where the mass of the air it displaces is exactly equal to its own mass. The density of air at sea level is 0.001275 g/cm3. The lifting capacity of 10003 feet of helium is equal to about 29.5 kg. The density of helium is 0.0001786 g/cm3. Therefore, helium filled balloons will rise at ground level. Helium is an inert gas and is used in nearly all U.S. meteorological and scientific balloons. Helium is extracted from natural gas.

Originally published as part of *Project SOAR™: Science in Ohio through Aerospace Resources, Volume I-III.* Dayton, Ohio: The National Museum of the United States Air Force and The Air Force Museum Foundation, Inc. 1997-1999.

Materials:

You will need:

- 1 good quality balloon for each lab group
- Helium tank (contact a local supplier)
- String
- Index cards (to use the first day)
- Colored construction paper or stock paper (to use the second day)
- Calculators
- Large paper clip for each lab group
- Triple beam balance
- Metal weight
- Plastic trash bags
- Masking tape
- Scissors
- Metric ruler
- Stopwatch

Special Instructions:

Remind the student that helium is escaping through the skin of the balloons so the upward force is always changing. To reduce the loss of helium, try not to handle the balloon or let it touch the surface of any object. Once the upward force has been calculated, work as quickly as possible. The amount of paper used as a weight must equal calculated amount needed for a weight. Designate a special area in the room for "balloon rises" and cover any air vents in the ceiling of the room with the plastic trash bags and tape. The first day of work is for practice, the second day is the actual contest. On the day of the contest each lab group is allowed one practice rise and must announce it as such.

Procedure:

A. Warm-up

1. Review the concept of buoyancy and gravity and how they will not be at equilibrium in the contest.

2. Go through the process of finding the area density of a piece of notebook paper.

3. Demonstrate how to determine the upward force of a balloon.

4. Explain the rules for the race and announce the prize for the winning group.

B. Activity

Determine the net upward force exerted by the helium filled balloon to which a string and paper clip are attached. A paper clip is at the end of the string exactly 50 cm from the balloon. Put a known mass on a balance. Then attach the balloon to the mass on the balance with the paper clip. The difference between the mass alone and the mass attached to the balloon is the upward force. Determine the area density. Determine the area density of the index card that you will be using for a weight. Area density is equal to the mass of the card divided by its area. Record the area in g/cm2. Calculate the amount of paper needed to construct a weight, which when attached to the balloon, can be lifted by the balloon. It is suggested that you take 90-99% of the upward force, to ensure a slow rise. Try different percents of the upward force for the downward force. Construct the weight from the assigned material and verify its mass by using the balance. Paper weights may be bent into any shape. A flat edge must be provided so that it can be attached to the paper clip. If the weight falls from the clip during the rise of the balloon, the student will be permitted to restart the rise. Attach the weight to the paper clip and touch the paper to the floor. On a signal from the timer release the paper and balloon. No rise time points will be given if:

Originally published as part of *Project SOAR™: Science in Ohio through Aerospace Resources, Volume I-III.* Dayton, Ohio: The National Museum of the United States Air Force and The Air Force Museum Foundation, Inc. 1997-1999.

- ✓ The assembly fails to rise.
- ✓ The balloon does not touch the ceiling within four minutes.
- ✓ The paper touches the floor after the release.

C. Wrap-up

1. After each lab group has had a turn in the race, complete the data table. Make sure that calculations are correct.

2. Record each group's rise time on the board. Announce the winners (the team with the slowest rise time) and hand out the prizes.

Assessment/ Evaluation:

Students will turn in one data sheet per lab group. They will be evaluated by the rise time and the accuracy of calculations.

Extensions:

1. Draw a vector diagram of the forces involved in their balloon rise.

2. Calculate the speed of their balloon. Calculate a class average.

3. What could you do to make the rise time better (i.e. slower)?

4. What problems did you have with the calculations?

Resources/ References:

Helium, Chem Matters. American Chemical Society, Washington D.C., 1994.

Matter: Building Block of the Universe. 2d ed. New Jersey: Prentice Hall, 1994.

Science Olympiad. Competition Event for 1990. Little Pine Lane, Rochester, MI 48064

Originally published as part of *Project SOAR™: Science in Ohio through Aerospace Resources, Volume I-III.* Dayton, Ohio: The National Museum of the United States Air Force and The Air Force Museum Foundation, Inc. 1997-1999.

Helium Balloon Race

Names: _____

Lab Group # _____

Balloon Race	
Area of paper material -one piece (length x width)	cm^2
Mass of paper material-one piece	g
Area density of paper material- one piece (mass/area)	g/cm^2
Upward force of the balloon (mass of the metal weight minus the mass of the weight attached to the balloon)	g
Mass of the paper used for a downward force attached to the balloon.	g
Area of paper used for downward force (mass of paper divided by the area density)	cm^2
Rise time	seconds

Originally published as part of *Project SOAR™: Science in Ohio through Aerospace Resources, Volume I-III.* Dayton, Ohio: The National Museum of the United States Air Force and The Air Force Museum Foundation, Inc. 1997-1999.