EETT Project

Title: **Suspending A Helium Balloon In Midair!**

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Subject: Math

Grades: 7th

Learning objectives: Students will measure spheres and balloons to calculate circumference, diameter, radius and volume (using Pi = 3.14). They will investigate the principles of buoyancy, including displacement, and density. They will calculate the lifting force of a Helium balloon system (gondola).

Sunshine State Standards:

MA.A.1.3.4, MA.A.3.3.2, MA.A.3.3.3, MA.B.1.3.4, MA.B.2.3.2, MA.B.3.3.1

NETS:

STANDARD 1 : NUMBER AND OPERATION

Mathematics instructional programs should foster the development of number and operation sense so that all students —

- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
- understand the meaning of operations and how they relate to each other;
- use computational tools and strategies fluently and estimate appropriately.

STANDARD 4 : MEASUREMENT

Mathematics instructional programs should include attention to measurement so that all students —

- understand attributes, units, and systems of measurement;
- apply a variety of techniques, tools, and formulas for determining measurements.

STANDARD 6 : PROBLEM SOLVING

Mathematics instructional programs should focus on solving problems as part of understanding mathematics so that all students —

- build new mathematical knowledge through their work with problems;
- develop a disposition to formulate, represent, abstract, and generalize in situations within and outside mathematics;
- apply a wide variety of strategies to solve problems and adapt the strategies to new situations;
- monitor and reflect on their mathematical thinking in solving problems.

Day 1 Activity:

Materials needed:
Four different size spheres (basketball, soccer ball, softball, etc.)
Cloth or flexible measuring tape (1 for each two students)
Calculators
"**Spheres**" worksheet (included with this lesson)
Digital camera or video camera (take pictures of students as they work)

Time for activity: approximately one hour

Activity:
Begin the lesson with a short review of circumference, diameter and radius. Give the "Spheres" worksheet to each student and have them complete the first page. Distribute measuring tapes and review the centimeter / millimeter increments. Have students work in pairs and measure the circumference of the four spheres to the nearest millimeter. Check answers for accuracy. Now that the students have a radius for all four spheres (round all answers to two decimal places), have them complete the last page for volume of each sphere.

Discussion questions:
1) How does circumference affect radius?
2) How does circumference affect volume?
3) Have you ever taken a basketball or something similar, into a swimming pool and held it under water? What happens when you release it? Why?

Day 2 Activity:

Materials needed:
"**Balloon Math**" worksheet (included with this lesson)
Calculators
Four latex balloons, blown up to different sizes
Digital camera or video camera (take pictures of students as they work)

Time for activity: approximately one hour

Activity:
Distribute the "Balloon Math" worksheet and have them complete the worksheet through the balloon volume portion. It is almost identical to the "Sphere" activity. The purpose is to speed up the calculations to find volume and give the students experience with measuring a round object that is not a true sphere. This will be essential practice before actually measuring a balloon filled with helium on day 3. The most important part of today's lesson is to discuss that air has weight and introduce the concept of density. After completing the volume questions and checking answers, go to the discussion questions.

Discussion questions:
1) What is air made up of? What molecules?
2) What is water made up of? Does water have weight?
3) Since air has some of the same molecules as water, does air have weight?
4) What is heavier, water, ice or steam? What affects the differences in weight?
5) Does the air in Florida weigh the same as the air in Colorado? Why?

The main learning objective is to relate the weight of an object to its density. Therefore, air has weight due to its density. Now introduce the Air Weight Constant, which is the density of air at sea level (0.00125 g/cm^3), and have the students complete the final part of the worksheet.

Day 3 & 4 Activity:

Materials needed:
"**Helium Balloon**" worksheet (included with this lesson)
Full tank of Helium (rent from a party supply store)
Latex balloons (11 inch round, assorted colors, one for each student pair)
Box of small Dixie cups (3 oz or "bathroom" size)
Plastic straws (use thicker ones, like for an "Icee" or "Slushee")
Ribbon (cut into 24 inch pieces, 2 pieces per gondola)
Paper clips (3 boxes of large, 1 box of small)
Electronic scale
Calculators
Digital camera or video camera (take pictures of students as they work)

This activity requires a considerable amount of prep time. A "gondola" (the balloon system that you will balance in midair) needs to be assembled for each student pair team.

Each gondola is made up of : 1 Dixie cup, 1 straw, 2 pieces of ribbon, 1 latex balloon.

Assembly:
Poke two holes near the top of the Dixie cup so the straw can slide through across the cups diameter. (a hand held hole punch works great). Tie two pieces of ribbon to both sides of the straw, on the outside of the cup. Creating slip knots on each end of the ribbon works best and saves time. The other end of both pieces of ribbon will tie on to the bottom of the balloon, once it is filled with helium. Put one balloon (NOT filled) in the cup and weigh the gondola system on the electronic scale. If you weigh each system that you build, make sure you mark each one and keep a list of the individual weights. This is very important information for the worksheet. Or, weigh several that you build and take an average weight. Your gondola system, cup, straw, ribbon and balloon will probably weigh between 6.5 and 7.5 grams.

Activity:
Fill balloons with Helium. Tie knots at the balloon end and tie the two ribbon pieces on to the balloon knot. Have students help you to expedite the process. Place enough large paper clips into the Dixie cup to weigh the balloon system down so it doesn't fly away. (about 25 grams should do it) Give each pair of students a balloon system and have them start measuring the balloon circumference and complete the calculations on the "Helium Balloon" worksheet. The balloons volume times the Air Weight Constant equals the amount of lifting force the system has. Now, subtract the materials weight (cup, straw, ribbon, balloon) that you calculated earlier. The result is the Net Lift Force. This is the target amount of weight that should make the balloon hover and suspend in mid air.

How To Suspend the Balloon in Midair:
Hold the Dixie cup gently and remove all of the large paper clips. Add the large paper clips back into the cup, one at a time, until one clip is the difference between the balloon rising or falling. Take the clip out so the system rises. Next, repeat that process, adding small paper clips, one at a time, until one clip is the difference between the balloon rising or falling. Take the clip out so the system rises. Now you will need to add small paper shards or paper wads to fine tune the balancing. Don't add weight to the cup while the system is moving. You must hold it steady, add or remove weight, then gently release the cup from your hands. It will drift and you can see in a matter of seconds whether it rises or falls. Add or remove paper shards as necessary to suspend the system in midair.

When a system hovers and stays suspended in midair for several seconds, then it is time to check the weight that is in the Dixie cup. This is the "target" the students are shooting at. Based on their calculations, this is the Net Lift Force listed on the worksheet and is the weight that should suspend the system in midair. Use the electronic scale and be sure you weigh ALL of the contents in the cup - paper shards and paper clips. Write this number on the worksheet at the lines that states, "Actual weight added to balance system". How close are you to the Net Lift Force? You may be surprised at how close the students actually are… within several hundredths of a gram is quite possible!

NOTE: You will need to have your air conditioning off during the balancing portion of the activity. Air currents make it difficult to suspend the balloons in midair. Also, the balloon will leach out helium after about an hour. If you want to use this activity for back-to-back classes, the second class will not have near the accuracy of the first. It is a good idea to use Day 3 as a practice session and Day 4 as the graded results. Please take pictures or videos of the balloons suspended in your classroom! It looks really cool!!

Technology Integration:
We have our students take their worksheets into the computer lab and create an Excel spreadsheet that will do the circumference to volume, times Air Weight Constant calculations. They experiment with different size circumferences and see the immediate effect on Lift Force.

Day 5: Wrap-Up

The purpose of this lesson is help the students come to a deeper understanding of why the Helium balloon rises. We want them to make connections with the scientific concepts of density and buoyancy. A common misconception that many students have is that the helium balloon rises because helium is lighter than air. Helium is lighter than air… but that is not the point that we want the students to understand. So, the analogy that we use is the one of floating a ship in water. The weight of the water displaced by the ship is greater than the weight of the ship, therefore the ship floats. Likewise, the weight of the air displaced by the balloon is greater than the weight of the balloon, therefore the balloon rises. When you add enough weight to the system to equal the displaced air weight, the balloon hovers or suspends in mid air. Use the following discussion questions to guide your lesson:

Discussion questions:
1) How is the floating of a ship similar to the floating of a helium balloon?
2) How does temperature and elevation affect air density?
3) Why does a balloon lift more weight under water than on land?

After a sufficient class discussion, distribute the "**Helium Balloon Essay Questions**" assignment.

Have students assemble all worksheets and essay responses and submit for grading.