

Design for Maximizing Volume Module

Description:

This module is a great way to introduce the concepts and math behind the maximization of volume given a specific surface area of a 3-dimensional object. By the end of this activity, students will gain an understanding of how design choices are critical when engineers attempt to build ships, vessels and underwater robots. Using a hands-on activity, students will test different types of shapes, calculate their volumes and figure out optimal dimensions.

Pre-requisite Knowledge:

The math knowledge required for this course can be adjusted based on the class. For grades 9-10, students should know formulas for surface area and volume of 3D objects. Students should also be familiar with substituting variable in equations to solve for a single variable. If students need a reminder, there are examples and formulas built into this lesson .

Advanced math students can try the “Advanced Extensions” which utilizes calculus and differentiation to determine optimal object dimensions to maximize volume.

Math Skills:

- Measurement
- Formulas for surface area and volume of 3D objects
- Substitution
- Algebra, systems of equations
- Differentiating Equations (advanced extension)

Materials:

Popcorn (or other light objects) = “weights” for this lesson
12 x 18 sheet of construction paper for each student
Scotch Tape
Scissors
Rulers

Introduction:

Students will first view a clip from The Simpsons to motivate the lesson. Once the clip is over, clearly explain the task/competition to all students. Their job is to use a single sheet of construction paper to try to design an object that will have the greatest volume. Students will use popcorn as “weights” and whoever can fit the most popcorn in their shape will get the treasure first. It is important to emphasize that volume is not the only factor in determining if an object will sink. See if students know what other factors come into play (mass, density, buoyancy, etc.). In this lesson, everyone has the same weights (popcorn) and surface area to deal with.

Procedures:

1. Show the Simpsons video clip and present the problem/goal of the module
2. Emphasize the goal of maximizing volume and make sure students understand this is only one of the critical elements that determine if an object will sink
3. Have students form groups of 3-4 students and get supplies
4. Each student will design a DIFFERENT 3D object made out of a SINGLE SHEET of construction paper
5. In each group students will figure out how to compare object volume without counting individual pieces of popcorn
6. Groups will report which object held the most popcorn. Then winners from each group will compare their objects to get a classroom winner.
7. Introduce / Review formulas for volume of 3D objects and have students measure their objects in order to calculate volume
8. Next, have students complete the chart on slide 11 using substitution. If necessary, choose one of the radius values and solve in front of the class, explaining each step.
9. Students will answer the questions on slide 12.
10. Review the lesson and go over how this information is used in the real world, make connections to robotics challenge, ballasting ships, etc.
11. Slides (15-20) are available to students who have experience with calculus and differentiation. Using calculus, we can figure out optimal dimensions to maximize volume only knowing the surface area.
12. Do example problem with class (box), then let them try the example with PVC pipe (cylinder) and lead shots.