

Project-Based Learning: Soda Can ReDesign, a Lesson on Volume

A Hands-On Mathematics Project for Sixth Graders by Karyn Hodgens

This lesson plan is designed to be used with the video lesson found on the Kidnexions YouTube Channel

CCSS: 5.MD.3; 5.MD.4; 5.MD.5
6.G.1; 6.G.2; 6.G.4
7.G.6

TEKS: 6th grade 4B, 6C, 8A, 8B

Time: 3 - 90 minute lessons or 6 - 45 minute lessons

Materials Needed:

- inch graph paper on 8.5 x 11 tagboard/cardstock
- large sheets of inch graph paper
- large sheets of tagboard/cardstock
- centimeter graph paper on 8.5 x 11
- tagboard
- wooden inch cubes
- inch rulers
- pie tins with flat bottom or paper plates
- clear tape
- scissors
- glue
- uncooked rice, about $\frac{1}{2}$ cup per pair
- soda can/1 per student
- calculators, optional

Day 1:

- Describe the project. If you like, you can provide students with several options of soda for them to choose from that you will buy and bring back to class on Day 2.
- Review surface area and volume formulas for rectangular prisms:
 - o Have students work in pairs to create a net for a rectangular prism/cube that is 2" x 2" x 2". Students tape the edges together leaving the "lid" open.
 - o Using cubic inches as the unit of measure, have students determine the volume of their prism. Students can use wooden cubes to fill up their prism, if needed.
 - o Have students create a new net for a 2" x 2" x 2" prism, but leave off the "top" and "bottom".
 - o Share with students a 4" x 4" x 4" net (without top and bottom). Fold it so that all faces are together and flat. Ask students how many faces they would end up with if you folded it in half. Since there are 4 faces before the fold, students should be able to guess that there will be 8 faces after the fold.
 - o Then ask how many faces there would be if you folded it in half again. 16 faces. Hold up the net so they can see through it and ask, if you continued folding in half and then opening, what shape is the net getting closer to? A circle.

- o Have students take their 2" x 2" x 2" net and make the first fold so that they end up with 8 faces. Then have them use a pencil and roll the net on the pencil so their net will take on the shape of a cylinder.
- o Ask students if they cut and threw away any pieces when turning their net into a "circle". Next ask if they think the volume of their original 2" x 2" x 2" prism is the same, less than, or greater than the cylinder they just created.
- o Working in their pairs, one student fills the 2" x 2" x 2" prism with rice. Then they use that rice to fill the cylinder. Use a paper plate or pie tin to hold the cylinder. Students should see that the volume of the cylinder is greater than the volume of the prism. The closer a polygon gets to a circle, the greater the area...therefore, the greater the volume of the corresponding solid.
 - § You may want to show this with a piece of yarn. Tie the ends together and hold the yarn around your two index fingers. Note the area. Using thumbs and index fingers, slowly turn the long, skinny rectangle into a square. Notice how the area grows the closer the shape gets to a square.

Day 2 and 3

- Pass out soda cans.
- Working in pairs, have students determine the volume of the can/cylinder. Discuss that the measurements won't be exact because there are indents in the can. The unit of measurement will be cubic inches.
 - o Ask students how they determine the volume of a rectangular prism: $l \times w \times h$. We want students to get comfortable with the idea that they multiplied the base ($l \times w$) times the height. To do this, show a different solid like a hexagonal prism, and ask how they would determine the volume. They should see that if they find the area of the base (the hexagon) and multiply it by the height, they will arrive at the volume.
 - o Ask how they would use this information to find the volume in cubic inches of the soda can/cylinder. They should see that they need to multiply the base (circle) by the height.
 - o Students will need to use the area formula for a circle to determine the area of the base of the can. Ask if anyone has heard of 3.14, pi. Describe it as the relationship between the diameter and circumference of a circle. Tell them that they will need to use pi to help them figure out the area of the circle.
 - o Share the area formula for a circle: $A = \pi r^2$
 - o Have students measure the diameter of the can to determine the radius. It's easiest to place the can on the ruler to get an accurate measurement of 2.5". This means the radius is 1.25" and they can now plug that into the formula:
 - § $\pi(1.25)^2 = 3.14(1.6) =$ approximately 5 square inches
 - o Now that they know the area of the base of the cylinder, they multiply it by the height (4.75 inches) to arrive at 23.75 cubic inches. Round that to 24 cubic inches and that is the volume they need to use when designing their can.

- o Allow students to pop open their cans and begin sipping soda!
- Share a simple net of a soda can redesign. A hexagonal prism with a base of 4 square inches works well because students can figure out that if they multiply the base by 6, they will arrive at the 24 cubic inches they need.
 - o Emphasize the importance of creating the base first before adding the faces/height. Share how your net was designed on the graph paper. If students create a net that will make a non-rectangular prism, they will need to be very careful when drawing the faces that will represent the height. Be sure they use a ruler to measure the exact height and stop drawing when that height has been reached. The video does a nice job of explaining this.
 - o Pass out centimeter graph paper for students to begin sketching out their design. Students need to clear their design by you before they get their inch graph paper and tagboard.

After their net has been created, they can “name” and add designs to the newly redesigned can.