

# Wrap it up!

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**Grade levels:** 6-8<sup>th</sup> grade

**Time allotment:** Two class periods - 55 minutes

**Overview**– This lesson develops the concepts of surface area through a variety of hands-on activities culminating in the use of the standard formula. The lesson will further explore the relationship between changes in one dimension and the effect on surface area.

**Subject Matter:** Middle School Mathematics, High School Geometry

## **Learning Objectives:**

- The students will be able to apply the correct formula for various situations for either surface area or volume.
- The students will be able to predict the relationship between an increase in one dimension and the effect on area and surface area.

## **Standards:**

The objectives will in part meet the following State Standards.  
Virginia Math Standards of Learning

- 7.8 The student will investigate and solve problems involving the volume and surface area of rectangular prisms and cylinders, using concrete materials and practical situations to develop formulas.
- 8.7 The student will investigate and solve practical problems involving volume and surface area of rectangular solids (prisms), cylinders, cones, and pyramids.

Standards can be found at

<http://www.pen.k12.va.us/VDOE/Superintendent/Sols/home.shtml>

## **MEDIA COMPONENTS**

Video:

*Geometry Journeys*, “Polyhedrons and Solids of Revolution, Episode 11”  
(available from Blue Ridge PBS.)

## **MATERIALS**

For the teacher:

- VCR
- Overhead Calculator or white board with calculator if using the calculator activity

For the student:

- One banana and one orange per group of 4 students
- Two 12 ounce cups and paper towels per group of 4 students
- Two pieces of graph paper (included)
- Scissors
- One paper bag per student
- One cylinder per group of four students
- Ruler
- Cube chart (included)
- TI-83 calculator or equivalent for each student
- Nets (foldable flat paper pattern that folds into a particular shape) of a cylinder and rectangular prism. \*Note: Teachers should familiarize themselves with different net patterns prior to the lessons. One source of net patterns is <http://mathforum.org/alejandre/workshops/net.html>
- Cylinders and rectangular prisms of various sizes

## **PREP FOR TEACHERS**

- Place an orange, a banana, graph paper, ruler, scissors and two cups in front of each group of four.
- Place one paper bag per student in front of them.
- Place unifix cubes (a math manipulative) for each person
- Collect cylinders and rectangular prisms of various sizes.
- Set VCR to *Geometry Journeys* - Episode 11
- Bookmark the following websites:  
[http://www.boxermath.com/plp/modules/three\\_d.shtml?&partner=mathforum&userType=student](http://www.boxermath.com/plp/modules/three_d.shtml?&partner=mathforum&userType=student)

<http://gwydir.demon.co.uk/jo/solid/index.htm>

<http://www.shodor.org/interactivate/activities/SurfaceAreaAndVolume/>

## **INTRODUCTORY ACTIVITY: SETTING THE STAGE**

**Say**, “Today we are going to look at surface area and volume. In front of you are a banana and an orange. Which fruit do you think has more peel?” Put the responses on the board.

**Say**, “Now we are going to find out the answer to our question. I want you to peel the orange and flatten it out on the piece of graph paper. Use the scissors to cut the peel into square pieces. Put the fruit into the cup. Then count the number of squares that the orange peel covers. You may need to add some parts of squares to get your answer.”

**Ask**, “How large was your orange peel?” (Answer – accept all answers)

Put responses on the board

**Say**, “Now we are going to find out the answer to our question. I want you to peel the banana and flatten it out on the piece of graph paper. Use the scissors to cut the peel into square pieces. Put the fruit into the cup. Then count the number of squares that the banana peel covers. You may need to add some parts of squares to get your answer.”

**Ask**, “How large was your banana peel?” (Answer – accept all answers)

Put responses on the board

**Ask**, “Which fruit had the larger peel?” (Sample answer – the orange, the banana, some of each)

**Ask**, “In math what do we call the outside area of an object?” (Answer –surface area)

**Ask**, “Why is it sometimes hard to compute the surface area of objects like a banana or an orange?” (Sample answer – the orange is round, the banana changes width, some of each)

## **LEARNING ACTIVITIES**

### **Activity One**

**Say**, “Today we are going to focus on the concept of surface area. First we need to look at what are the characteristics of a prism”

**Focus for media interaction – Say**, “As you watch this clip, be able to state the basic characteristics of a polyhedron.” **Start** video, *Geometry Journeys* at 1:08(visual clue- table of contents for video #11) and pause at 1:51.

Watch segment – stop at the end of the segment

**Ask**: “What are the basic characteristics of a prism?” (Answer – two congruent faces in parallel planes called the bases, the remaining faces are parallelograms,

the intersection of the lateral faces are called the lateral edges, the altitude is perpendicular to the bases and is called the height)

**Focus for media interaction – Say**, “As you watch this clip, be able to state the naming requirements for a prism.” Start video, *Geometry Journeys* at 1:51(immediately where the previous clip ended) and pause at 2:23 (visual clue – shot of a building).

Watch segment – stop at the end of the segment

**Ask**: “What are the naming requirements for a prism?” (Answer –a polyhedron is named according to the number of sides on the base, i.e. if the base is a triangle then the prism is a triangular prism)

Forward the tape to 3:39 (visual clue is table of contents for video #11)

**Say**, “Now we are going to look at another polyhedron, the pyramid.”

**Focus for media interaction – Say**, “As you watch this clip, be able to state the basic characteristics of a pyramid and how they are named” **Start** video, *Geometry Journeys* at 3:39 and pause at 5:36.

Watch segment – stop at the end of the segment

**Ask**: “What are the basic characteristics of a pyramid?” (Answer –a polyhedron whose one base is a polygon and the other faces are triangles and a common vertex, the altitude runs from the vertex to the base, named after its base just like a prism)

**Say**, “Now that we have looked at some of the basic characteristics of polyhedrons, we are going to investigate the concept of surface area.”

**Say**, “I would like each of you to take your paper bag and measure the length, width, and depth of the paper bag to the nearest centimeter.”

Students will measure the length, width, and depth of the paper bag to the nearest centimeter.

**Say**, “I would like each of you to take your paper bag and cut it open so that it is one piece of paper, all connected. Then measure the length and width of each face and label it on the outside of the bag.”

Students will cut the bags open into one piece of paper (a net) and then label each of the faces with the correct measurements.

**Say**, “Are all the nets the same? Look around and see if any of your classmates cut their bags into different nets.”

Accept responses from the group. It is likely that there will be a variety of different nets.

**Ask**, “Since you know how to find the area of a rectangle, how would you find the total area of the paper bag?” (Answer – compute the areas of each of the rectangles and add them together)

**Say**, “Using that information, go ahead now and find the surface area of the entire bag. What answers did you get?”

Accept responses from the group

**Say**, “Since we can’t cut out our figure every time we want the surface area, we use a formula. What is the name of the shape that we have studied in class for the bag?” (Answer – rectangular prism.) “With the person next to you, see if you can come up with a formula for the surface area of a rectangular prism. Come and write it on the board.”

Students collaborate and write their formulas on the board

**Say**, “Mathematicians developed this formula for the area of a prism.”

Write the formula on the board. Surface area –  $2LW + 2[(L+W)H]$

**Ask**, “How were our formulae like the one that mathematicians developed?”

Accept answers.

**Say**, “Now I would like each of you to take your cylinder and measure the height and width of the paper cylinder to the nearest millimeter.”

Students will measure the height and width of the paper cylinder to the nearest millimeter.

**Say**, “I would like each of you to take your cylinder and cut it open so that it is one piece of paper, all connected. Then label each of the faces with the correct area measurements”

Students will cut the cylinder open into a net and then label each of the faces with the correct measurement.

**Say**, “Are all the nets the same? Look around and see if any of your classmates cut their cylinders into different nets.”

Accept responses from the group

**Ask**, “What are the shapes which make up a cylinder?” (Answer – 2 circles and one rectangle)

**Ask**, “What shapes are part of this net?” (Answer – circles and rectangle) “How could we find the length of the rectangle without measuring?” (Answer – the length of the rectangle is the circumference of the circle at the top and the bottom)

\*Note: If necessary, demonstrate with one of the cut cylinders how the length of the rectangle is equal to the circumference of the circle.

**Ask**, “Since you know how to find the area of a rectangle, how would you find the area of the cylinder?” (Answer – compute the areas of each circle and the rectangle and add them together)

**Say**, “Using that information, go ahead now and find the surface area of the cylinder. What answers did you get?”

Accept responses from the group

**Say**, “Since we can’t cut out our figure every time we want the surface area, we use a formula. With the person next to you, see if you can come up with a formula for the surface area of the cylinder. Come and write it on the board.”

Students collaborate and write their formulas on the board.

**Say**, “Mathematicians developed this formula for the area of a cylinder.”

Write the formula on the board. Surface area –  $2\pi R^2 + 2\pi RH$

**Ask**, “How were our formulae like the one that mathematicians developed?”

Accept answers.

## Activity Two

**Say**, “One good way to learn about how something is constructed is to build it yourself. The basic plan for a 3-D shape is called a net. In front of you are two patterns; one for a rectangular prism and one for a cylinder. Using scissors and tape, cut out the nets and fold them into a rectangular prism and a cylinder. Use tape to secure the ends.”

Open your browser to <http://gwydir.demon.co.uk/jo/solid/index.htm>

**Focus for media interaction – Say,** “Nets are patterns for 3-D shapes. I am going to display 11 nets on the screen. As a group, decide which nets will actually make a cube.”

Shows nets on screen and allow time for groups to come to decision.

**Ask,** “Which nets will make a rectangular prism? “

Put responses on the board.

**Say,** “Now I am going to click on the nets. Check to see which ones you answered correctly.”

Click on each net in turn.

**Ask,** “Did any of the answers surprise you? “

Allow for responses.

Open your browser to <http://www.shodor.org/interactivate/activities/SurfaceAreaAndVolume/> Be sure that the dimensions are set to 3 for each side.

**Focus for media interaction – Say,** “Now we are going to take a look at how changing one dimension affects the surface area of the shape. I’ve set the dimensions to 3 units each. What is the current surface area?” (Answer – 54 square units). “What would happen if we increase the dimension by 1?”

Increase each dimension by 1.

**Ask,** “What happened to the surface area?” (Answer – increased from 42 to 96)

**Focus,** “What would happen if we increase the dimension by 1 again?”

Increase each dimension by 1.

**Ask,** “What happened to the surface area?” (Answer – increased from 54 to 150)

**Focus,** “What would happen if we increase the dimension by 1 again?”

Increase each dimension by 1.

**Ask,** “What happened to the surface area?” (Answer – increased from 66 to 216)

**Say**, “Do you see a pattern in the increases? If so, can you predict how another increase would affect the surface area?”

Accept responses

**Focus**, “Let’s test out our prediction.”

Increase each dimension by 1.

**Ask**, “What surface area did we form?” (Answer – 294 square units) “Did we predict correctly? “

Discuss results.

### **Activity Three (optional – uses graphing calculator)**

**Say**, “In this next activity, we are going to look at how changes in the size of a prism affect the surface area. In your area there are one centimeter cubes. Place one of them in front of you. ”

**Ask**, “What is special about a cube?” (Answer – all of the sides are equivalent)

**Say**, “As we work on building these cubes and increasing their size, please be sure to record your information in the chart that I gave you. Begin with filling in the first row.”

**Ask**, “What answers did you get?” (Answer – 1 unit in each dimension and 6 square units for the surface area.)

**Say**, “Now I want you to build the next cube.”

**Ask**, “How many unit cubes will it contain?” (Answer – 4 unit cubes)

**Say**, “Complete the chart for 4 cubes. Then build the next 2 cubes (9 units and 16 units) and also complete the chart.”

The completed chart should look like this☺

Length	Width	Height	Surface Area of one face	Total surface area - cm
1	1	1	1	6
2	2	2	4	24
3	3	3	9	54
4	4	4	16	96

**Say**, "We are now going to enter our data into our graphing calculators. Turn on your calculators. Press the Stat key. Press Enter."

The calculator screen should look like this. If there is data present, use the clear button to remove it .

L1	L2	L3	1
████████	-----	-----	
L1(1)=			

**Say**, "Now enter your data in the lists. Column one should go into L1. Column 2 into L2 and so forth. Leave L4 blank."

Students enter their data. Finished screen should look like this.

L3	L4	#	L5	#	5
1	1		6		
2	4		24		
3	9		54		
4	16		96		
20	400		2400		
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L5(1)=6					

**Ask**, "We could just enter the data into L4 but instead we want to use a formula. What could we type in L4 which would give us the same answer?." (Answer – L1 times L2) "How could we write that as a formula?" (Answer – "L1\*L2" )

\*Note – Be sure to type the formula with L4 highlighted at the top of the row and in quotes to make it interactive. See the chart below.

L2	L3	L4	#	4
1	1	"L1*L2"		
2	4			
3	9			
4	16			
-----	-----	-----		
L4 = "L1*L2"				

**Say**, "Now we want the calculator to compute the surface area."

**Ask**, “What could we type in L5 to compute the surface area of the cube? “  
 (Answer –  $L4 * 6$ ) Go ahead and type the formula into L5 and check to see that each row equals the correct sum.”

Students enter the formula into L5.

L3	L4	#	L5	#
1	1		6	
2	4		24	
3	9		54	
4	16		96	
-----	-----		-----	
L5 = "6*L4"				

**Say**, “Now we want to predict what would happen if we were to create a cube with 20 on a side. Use your calculator to predict what the surface area would be in that case.”

Students enter their data

**Ask**, “What answer did you get? (Answer is 2400 square units)

### CULMINATING ACTIVITY:

**Say**, “Today you have a challenge to complete. In front of you is a rectangular prism or a cylinder, a ruler and some scrap paper. I will divide you into groups of 3. You will have 10 minutes to work with it before I remove it from you. Your task is to create a net and lay it out on paper that I will give you. After you are finished, I will return your form to you and you will try and cover the form with the paper without making any adjustments.”

**Ask**, “What information do we need from our form to make a correct net?”  
 (Answer – dimensions of each part as well as the layout of the shape)

Pass out the shapes to each group. After ten minutes remove the shapes and give each group a sheet of wrapping paper. When each group is finished, return the form to them. Have them wrap it up.

**Ask**, “How did your net work? What problems did you have? What could you have done better?” Let participants respond.

### CROSS-CURRICULAR EXTENSIONS:

Science – explore the relationship between surface area and heat loss, surface area and lift.

Art – explore the visual effects of different types of surfaces on esthetics.

**COMMUNITY CONNECTIONS:**

Meet with a contractor to discuss how surface area affects heat loss and building considerations.