Grade 9 Academic   Lesson: **55**

Unit/Chapter: <u>**Measurement**</u>   **Topic:** <u>**Optimizing Surface Area and Volume**</u>

⧮ *homework check:* <u>**NPM 9**</u> **p. 470 # 3, 5 – 9, 11, 13, 14**

⧮ *note:* <u>**Optimizing Surface Area and Volume**</u>

Investigating optimum measurements usually involves formulas, charts, and graphs. Formulas specific to the measurements given are needed and used to find the missing dimension. Sometimes, several calculations and charts must be constructed to find the optimum measurement. We may have to rearrange formulas for the measurement needed using provided information. For instance, if the area of a trapezoid is 400 cm^2 with a base of 35 cm, rearrange the trapezoid formula for the unknown side *a*.

$$A = \left(\frac{a+b}{2}\right)h$$

$$400 = \left(\frac{a+35}{2}\right)(h)$$

$$\frac{400}{h} = \frac{a+35}{2}$$

$$\frac{40(2)}{h} = a+35$$

$$\frac{80}{h} - 35 = a$$

This formula could be used as one variable in a chart of measurements to find the optimum area of a trapezoid.

⧮ *handout:* **Using Your Graphing Calculator to Investigate**
            ***read through the investigation together, mimicking key strokes if necessary**

⧮ *handout:* **Maximizing Volume and Minimizing Surface Area**
            ***work through the first investigation together as a class**
            ***reminder that quotation marks cannot be used here (too many variables)**
            ***write a complete hypothesis**
            ***use organized charts and mathematical processes**
            ***include reasons for changes and show work for rearranging of any formulas**

⧮ *homework assignment:* **Maximizing Volume and Minimizing Surface Area - Part B**
            ***quotation marks can be used here (only two variables)**

Using Your Graphing Calculator to Investigate

The graphing calculator is a great device for an investigation that involves systematic changing of measurements of one or more variables.

For example, if we wanted to investigate what happens to area as length changes, we could create a sequence in list one of our graphing calculator that represents the length. If we have a perimeter of 30 m that must be constant, we can use that value to help create a width formula in list two. In list three, we can create a formula that represents the area of our rectangle.

In the title of list one, press enter to place the cursor by L1. Type **[alpha] [+]** to place quotation marks around your sequence. The quotation marks will hold the sequence so that any of the lists that rely on list one will change automatically. Type **[2nd] [stat]** and arrow right to open the ops menu.   We want a sequence of numbers, so toggle down to **5:seq**. Press enter. Type **[x] [,] [x] [,] [1] [,] [15] [,] [1] [ )]** to enter a request that asks the calculator to write a sequence that starts at 1 and goes to 15 counting by 1. Type **[alpha] [+]** to close the quotation marks. Press enter to have the sequence appear in list one.
Note: Any sequence can be formed using the idea of formula(x), variable(x), starting value (#), ending value (#), step size (#).

In the title of list two, press enter to place the cursor by L2. Type **[alpha] [+]** to place quotation marks. Type the width formula **[15] [-] [L1]** and close the quotation marks typing **[alpha] [+].**

In the title of list three, press enter to place the cursor by L3. Type **[alpha] [+]** to place quotation marks. Type the area formula **[L1] [*] [L2]** and close the quotation marks by typing **[alpha] [+].**

Since we are investigating the optimum area, we look at the values in list three. We find that the maximum area of 56 m^2 occurs when the length is 7 m and width 8m or the length is 8 m and width 7m. We realize that the maximum area must be somewhere between these values.

Since all of our formulas are saved by the quotation marks, we can go back to list one and change the sequence. Because all of our lists depend on list one, the other lists will change automatically.

Press enter in the name of list one to place the cursor. Toggle over to the start number and change it to **7**. Change the end number to **8** and the step size to **0.1**. Press enter to change the sequence and watch as the other lists change.

Look at the values in list three that represent area. The max area is 56.25 m^2 with a length and width of 7.5 m just as we suspected.

Maximizing Volume and Minimizing Surface Area

Part A:
Problem: You have been given the task of designing a new toy jack-in-the-box. The toy must be able to hold a minimum of 640 cm^3 but be packaged at a minimum cost. (This means that the surface area of the box must be minimized.)

Solution: As part of the solution, you will investigate the relationship between the volume and surface area of various box shaped containers. You may use your graphing calculator for the investigation, but keep detailed records of the dimensions and changes that lead you to your conclusions as to the best container for the toy. Explanations must be included in your report so that you investigation can be duplicated. Be sure to state the best dimensions and a reason for your choices.

Part B:
Problem: A new toy snake-in-a-can is being added to the toy store shelves for Christmas. You have been called upon to help design the container. The can must hold no less than 475 cm^3 and be packaged at a minimum cost.

Solution: Again, as part of your solution, you will investigate the relationship between the volume of a cylinder and the surface area. Your final recommendation should include tables, charts, graphs, and explanations as to the best dimensions for the container.