A. Lesson Context

BIG PICTURE of this UNIT:	• What NEW IDEAS & NEW CONCEPTS can we now explore with specific references to POLYNOMIAL FUNCTIONS AND RATIONAL FUNCTIONS? • How can we extend our knowledge of FUNCTIONS, given our BASIC understanding of Functions and quadratic functions? • How can we use Polynomial Functions to model real world situations?		
CONTEXT of this LESSON:	Where we've been In Unit 3, you worked with quadratic functions in vertex, standard, and factored forms.	Where we are HOW do we apply the concepts of quadratics to better understand higher order polynomials?	Where we are heading How do we extend our knowledge & skills of polynomials given what we know about quadratics functions?

B. Lesson Objectives

a. Introduce cubic functions through a 3D box building modeling investigation

C. Fast Five (Skills Review/Preview Focus)

1(a). Evaluate P(2) if $P(x) = x^3 – x^2 + 2x – 3$

1(b). Evaluate P(-1) if $P(x) = -2x^3 + 2x – 5$

2(a). Expand and simplify $(x + y)^3$

2(b). Expand and simplify $(x – y)^3$

3(a). Expand and simplify $(x – 2)(x + 2)(x – 1)$. Verify your expansion using WolframAlpha.

3(b). Multiply and then simplify $-3(x + 2)(x – 1)(2x + 3)$. Verify your expansion using WolframAlpha.

D. Making an Open-Topped Box – Instructions

Materials Needed

- 2 A4 Pieces of Paper 21.5 x 28 cm
- Pair of Scissors
- Tape
- Ruler measuring cm
- Brain

Phase 1: The FIRST "Model" Box

Step 1: Get a sheet of 21.5 x 28 cm coloured paper.
Step 2: In one corner, draw a square measuring 2 cm x 2 cm.
Step 3: Cut this square out.
Step 4: Go to the other three corners and measure & cut identical 2 cm x 2 cm squares.
Step 5: You should now have 4 "flaps" that you will fold over (in order to make the sides of a box)
Step 6: Tape these flaps together to complete the box.

Step 7: Measure the height, length and width of your box.
Step 8: Calculate the volume of this box.
Step 9: You now have one ordered pair in our volume modeling investigation ➔ (2 cm, 830ish cm^3), where *x* will represent the dimensions of the corner you cut out and *V* will represent the volume of the resultant box.

Volume of Box w/ 2 x 2 cm square cut out of the corners: _______________

Phase 2: Creating Class Data

Now we will repeat this box construction, wherein every student chooses/is assigned a different sized square to cut out of each corner.

Step 1: Construct your box, measure the three dimensions & calculate the volume .

Step 2: Record your data on the google doc.

Step 3: Construct a graph, showing the relationship between corner size and volume. Prepare the graph electronically (TI-84 or EXCEL) or do it by hand on another sheet of paper. Please label your axes.

Step 4: Looking at your scatterplot, what type of function could we use to model our relationships in this investigation? Justify your choice(s).____

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Step 5: Use your TI-84 (or EXCEL) to determine an ***equation*** for the curve of best fit.

Volume Equation: V(x) =____

Working with the function, y = V(x):

Evaluate V(6.25) =	Solve for x when V(x) = 1000 cm^3

1. Use your model to predict the size of the corner that you should cut out in order to ***optimize the volume*** of the box.

2. Determine the ***domain and range*** for your model, explaining WHY you've decided upon your domain and range.

3. EXTENTION: Can you PREDICT what the equation for the model should be, simply given the construction instructions?

4. EXTENTION: Boxes with reinforced sides → to construct a box with reinforced sides, use your original box (2 cm corners cut) and make one adjustment on the four side "flaps" → fold this flap TWICE (once at the 2 cm mark and a second time at the 1 cm side), so that your sides are now twice as thick. Again, determine the volume of this box. Then, as before, predict an equation for an equation modeling the relationship between corner size and volume.

5. EXTENSION: Cylinder??

Data Table for Exploration

Enter your data on this google doc →