Unit 2: Day 4: All together now!

MCT 4C

Minds On: 15 Action: 50 Consolidate:10 Total=75 min	**Math Learning Goals:** • Identify functions as polynomial functions. • Consolidate understanding of properties of functions that include: linear, quadratic, cubic, quartic, exponential and sinusoidal. • Make connections between different types of polynomial and non-polynomial functions	**Materials** • BLM 2.4.1 cut into cards • BLM 2.4.2-2.4.4

			Assessment Opportunities
	Minds On…	**Pairs → Game** Provide one *I Have, Who Has?* card to each pair of students. The top of each card contains one vocabulary term preceded by the words "I have". The bottom of each card lists a definition, *unrelated to the term at the top of the card,* in the form of a question "Who has". Ask the pair with the card that contains an asterisk to start the activity. This pair will read out only the bottom question portion to start the game. Ask participants to focus and listen carefully to decide whether the definition read matches their vocabulary term. The pair who has the word being defined calls out "I have" followed by the word and then reads the "Who has" portion on their card. Time may be spent after each definition to discuss each match. The process continues until all the definitions have been read. The cards have been designed so that the pair who began the activity will have the final term. **Curriculum Expectations/Observation/Mental note:** Listen to students as they respond to determine appropriate vocabulary.	**Note**: All cards are required. If there are too many cards have some pairs take an additional card until all cards are distributed Vocabulary could be placed on a word wall
	Action!	**Pairs → Activity** Place the chart (BLM 2.4.2) on the overhead and have students compare and contrast the examples and non-examples of polynomial functions. Ask students to identify three attributes of every polynomial function that distinguish them from non-polynomial functions. Summarize findings on board or chart paper. Possible responses to attributes of a polynomial : whole number exponents only; may not be written in rational form unless the denominator is a constant; exponents must be constants, not variables; are of the form $y = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0$ where n is a whole number and $a_n, a_{n-1}, \ldots, a_1, a_0$ are real numbers. Whole Class → Individual → Pairs → Share Use Linear Function on BLM 2.4.3 to serve as a model for the rest of the functions. Each student completes remaining BLM 2.4.3 for each function. Students check with a partner to ensure that each of the verbal/visual organizers is complete.	Organizers on BLM2.4.3 not completed in class can be assigned for home activity. A large copy of each organizer can be posted in the room for reference throughout the unit.
	Consolidate Debrief	**Whole Class → Discussion** Share responses from students to each function type. Address misconceptions and ensure that students have correct information on each organizer. **Mathematical Process Focus: Reflecting/Journal Entry:** Students **reflect** on their understanding of different functions.	
	Reflection Concept Practice	**Home Activity or Further Classroom Consolidation** Journal: • Describe how to recognize a polynomial function. • What did you like about today's lesson? • What did you find challenging about today's lesson? • What is still confusing for you? Complete BLM 2.4.4 – Polynomial or Not?	

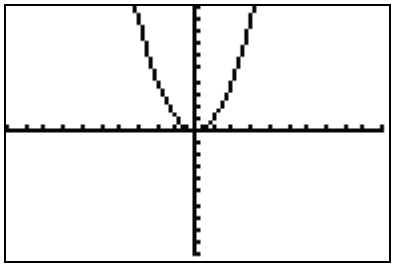
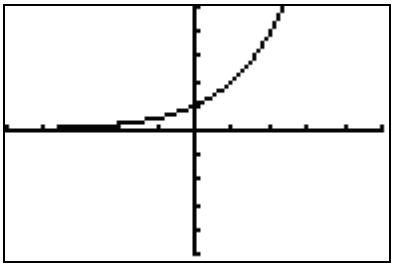
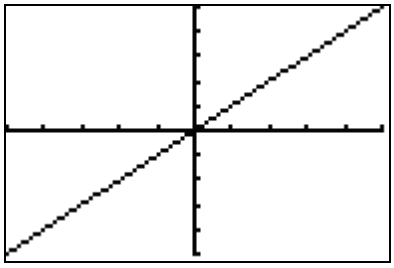
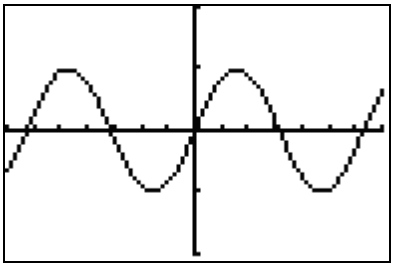
2.4.1: I Have, Who Has?

* I have **exponential function.** A function that models various physical situations that fluctuate and have cyclical patterns.	I Have, Who Has? (20 cards)	I have **quartic function.** A line that is approached by a curve.
I have **linear function.** A function of degree three.	I have **quadratic function.** A function that models only population growth, compound interest growth and bacterial growth.	I have **cubic function.** The rate of change or change of y divided by the changed in x.
I have **sinusoidal.** A function that contains a rate of change and an initial value.	I have **slope.** A function that is used to model the motion of projectiles.	I have **growth function.** The set of all second coordinates of the ordered pair of a relation.

2.4.1: I Have, Who Has? (continued)

I have **decay function.** The set of all first coordinates of the ordered pairs of a function. Domain	I have **domain.** This function has degree 4 and sometimes looks like a quadratic function.	I have **range.** This function is used to model depreciation and radioactive decay.
I have **half life.** The maximum or minimum point of a parabola.	I have **asymptote.** One of four regions formed by the intersection of the x-axis and y-axis.	I have **vertex.** A rule that assigns to each element in the domain a single element in the range
I have **quadrant.** The x-coordinate of the point where a curve crosses the x-axis.	I have **x-intercept.** The period of time during which a given amount of radioactive material decays until one-half of it is left.	I have **y-intercept.** The number of times the base repeats in a power.
I have **logarithm.** The y-coordinate of the point where a curve crosses the y-axis.	I have **exponent.** A function that models both growth and decay and has a horizontal asymptote.	I have **function.** I am the opposite or inverse operation of an exponent.

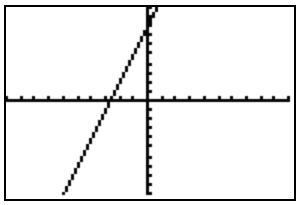
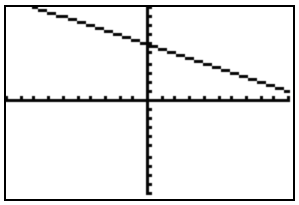
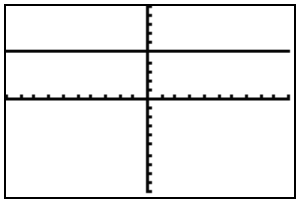
2.4.2: Polynomial Concept Attainment Activity

Examples	Non-Examples
$y = x$	$y = \sqrt{x}$
$y = 2x - 1$	$y = 3x \quad - x$
$y = x\,(x^2 - 4)(x + 2)$	$x = -6$
$y = x^2$	$x^2 + y^2 = 16$
$y = (x - 2)^2 + 1$	$h(x) = \sqrt[3]{x}$
$y = -x^4 + \quad x^2 - 3$	$y = \sin \beta$
$y = -0.2\,(4x - 3)(x + 3)$	$y =$
$y = x^3 + 2x^2 - x + 11$	$y = 2^x$
$y = 4$	$y = \dfrac{x - 1}{x^2 - x + 1}$
	
	

2.4.3: Do you see what I see?

Vocabulary Term . **Linear function**	Picture
Your Definition	Real Life Connection

2.4.3: Do you see what I see? – Sample Solution

Vocabulary Term	Picture
. **Linear function**	  
Your Definition *A relation between two variables that appears as a line when graphed.* *The equation relating the two variables has degree one.*	Real Life Connection *The relationship between earnings and number of hours worked for a person paid per hour.* *The relationship between cost and the number of litres of gas purchased at a gas station.*

2.4.3: Do you see what I see? (continued)

Vocabulary Term	Picture
Quadratic function	
Your Definition	Real Life Connection

2.4.3: Do you see what I see? (continued)

Vocabulary Term **Exponential function**	Picture
Your Definition	Real Life Connection

2.4.3: Do you see what I see? (continued)

Vocabulary Term **Cubic function**	Picture
Your Definition	Real Life Connection

2.4.3: Do you see what I see? (continued)

Vocabulary Term	Picture
Quartic function	
Your Definition	Real Life Connection

2.4.3: Do you see what I see? (continued)

Vocabulary Term **Sinusoidal function**	Picture
Your Definition	Real Life Connection

2.4.4: Polynomial or Not?

Determine if each of the following equations/graphs represents a polynomial function or not. Justify your reasoning.

a) $f(x) = 2x^3 + x^2 - 5$

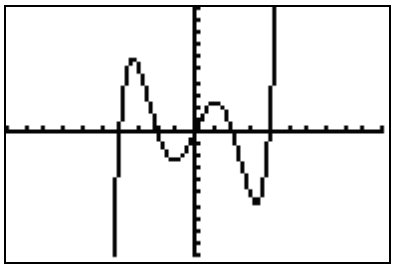
b) $f(x) =$

c) $f(x) = \cos x$

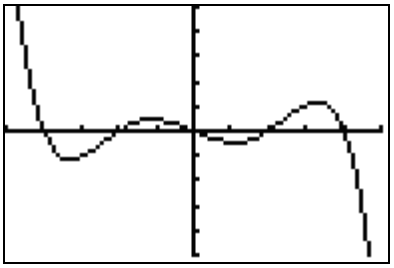
d) $f(x) =$

e) $f(x) = x(x - 1)^4$

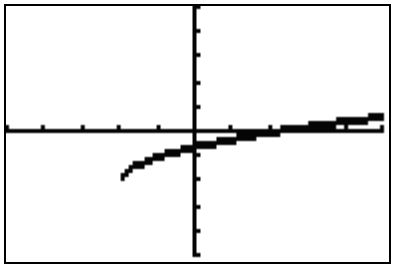
f)



g)



h)



Unit 2: Day 7: The Box Building

MCT 4C

Minds On: 5

Action: 60

Consolidate:10

Total=75 min

Math Learning Goals:

- Substitute and evaluate functions stated in function notation
- Identify domain and range and restrictions for a real-world application of functions
- Make connections between graphical representations to algebraic representations of the input and output of a function

Materials

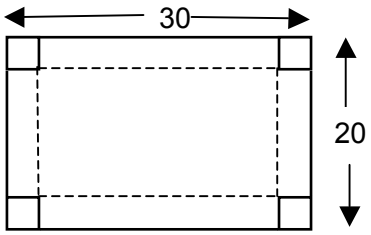
- BLM 2.7.1
- Graphing calculators
- Grid paper (1 per student)
- scissors

			Assessment Opportunities
Minds On…	**Whole Class → Activity** Write the function $h(t) = -5.25(t-4)^2 + 86$ on the board or overhead transparency. Assign each or a selection of students a value within the domain ($0 \leq t \leq 8$) and outside the domain. Ask students to determine the value of h at their given value. Ask students to post the value given to them and the value they calculated on board or chart paper. A table of values should be created to facilitate this data gathering. Pose the following questions for students to consider or discuss: • What is the domain and range of the function? • What real-world application could this function model? • Would the domain and range be affected by the application? If so, how?		**Optional**: Points can be plotted as well as posted on chart paper or overhead transparency or students can generate scatter plot on graphing calculator.
Action!	**Groups of 4 → Activity** Distribute copies of BLM 2.7.1 and one sheet of grid paper to each student. Introduce the activity and review instructions. Students should share results for #2, the volume function expressed in terms of x, to ensure that this is consistent for all groups for the remainder of the investigation [i.e., $V(x) = x(20-2x)(30-2x)$]. **Learning Skills/Teamwork/Checkbric:** Observe students' group work habits.		A teacher lead demonstration can be used to model the process students will be following in groups.
Consolidate Debrief	**Whole Class → Discussion** Discussion of domain and range, and connection between graphical and algebraic models. What is the optimal value for volume? (x = 3.92 and volume is 1056.3 cubic units) Discuss the benefits of the graphical model and the limitations of function notation. Discuss how the domain and range would change if we were not considering the box problem [(i.e., if we were just considering the graph itself or the function $V(x) = x(20-2x)(30-2x)$].		Students could use graphing technology to determine the maximum value of the function
Application *Concept Practice*	**Home Activity or Further Classroom Consolidation** Provide questions for students to answer where they would need to evaluate functions graphically and verifying using function notation.		

2.7.1: If You Build It…

1. Each member of your group should
   - ❑ cut out a 20 by 30 rectangle using grid paper,
   - ❑ cut 4 equal squares from each corner of the rectangle
     (one person could cut a 1 × 1 piece out of each corner; another use 2 × 2, etc.)

   NOTE: Each member of your group should have a different size of square that is being cut from the four corners,
   - ❑ fold the paper to create an open box (fold along dotted lines),
   - ❑ determine the dimensions of their box and record the information in the table.



2. Gather the data from the group and record your results in the table below.

Side Length of Square	Length of Box	Width of Box	Height of Box	Volume of Box
x				

3. Express the volume as a function of its side length

   V(x) = _____

4. Enter the function as Y1 in a graphing calculator.

5. Which of the following would be the best choice for Xmin and Xmax? Justify your choices.

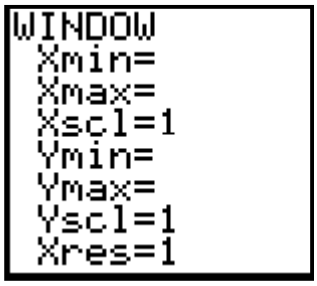
Xmin	Xmax	Justification
❒ -200	❒ -200	
❒ -10	❒ -10	
❒ 20	❒ 20	

6. Which of the following would be the best choice for Ymin and Ymax? Justify your choices.

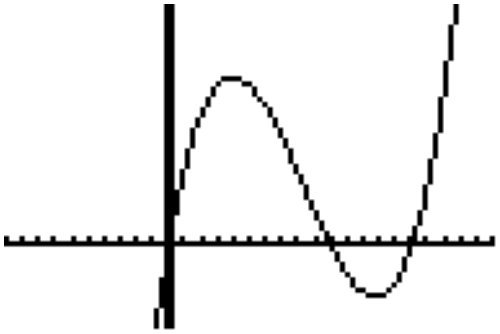
Ymin	Ymax	Justification
❒ -500	❒ -500	
❒ 10	❒ 10	
❒ 1500	❒ 1500	

2.7.1: If You Build It… (continued)

7. Fill in the values for Xmin, Xmax, Ymin and Ymax into the window at right.



8. The graph produced should appear as below. Label your axes using words and variables.



9. What limitations are there on the size of the square that you can cut from each corner?

10. State the domain and range of the volume function V(x) = _____

    Domain: _____ Range: _____

How are the restrictions evident from the	Domain	Range
box you are constructing?		
equation of the function?		
graph of the function?		

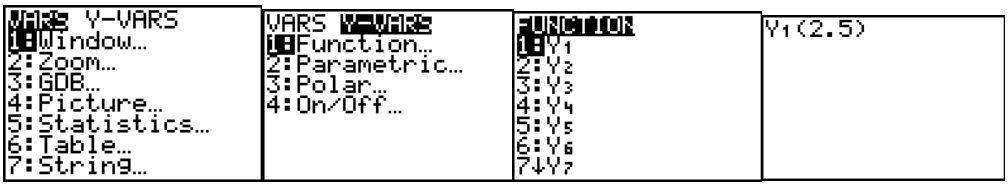
11. From which model in #10 do you find easiest to identify the domain and range? Support your choice.

2.7.1: If You Build It… (continued)

12. The volume function from #10 is expressed in **function notation**.
In this scenario V(2.5) means to determine the volume of the box when x = 2.5. This is done by substituting 2.5 for every occurrence of x. Use your function in question #10 to evaluate the function when x = 2.5. Show all of your work.

V(2.5) =

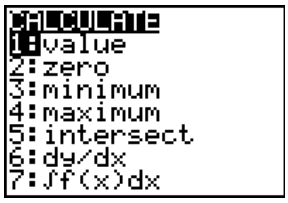
13. Follow the steps below to have the calculator evaluate the function when x = 2.5.



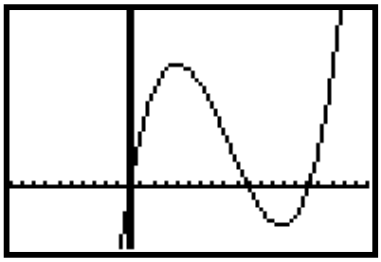
a) What is the value of the function when x = 2.5? _____

b) What do both of these values represent in the context of the box?

14. Graph the function and use the VALUE option in the CALC menu to determine the value of the function when x = 2.5.



How is this represented on the graph of the function?



15a. Complete the following table.

Side Length	Point on Graph	Value of function V(x) =
$x = 0.5$	(0.5, ___)	V(0.5) =
$x = 4.5$		
$x = 2.7$		

2.7.1: If You Build It… (continued)

15b. Compare the points on the graph with the values of the volume found using substitution.

16. What are the dimensions that maximize the volume?

Maximum Volume	
Height of box at maximum	
Length of box at maximum	
Width of box at maximum	

17. Using the graph, how do you know this is the maximum value?

18. How could you use the Volume function for V(x) to show that the maximum occurs at the point you found?

19. If the initial dimensions of the box were doubled (i.e. 40 by 60), what do you think the maximum volume would be and the height of the box that gives that maximum? Support your work by using a function and a graph.

Unit 2: Day 8: Zeros in math are good!

MCT 4C

Minds On: 5

Action: 50

Consolidate:20

Total=75 min

Math Learning Goals:

- Make connections between a polynomial function in factored form and the x-intercepts of its graph
- Sketch the graph of a polynomial function given in factored form using its key features
- Connecting graphical and algebraic representations of cubic and quartic functions

Materials

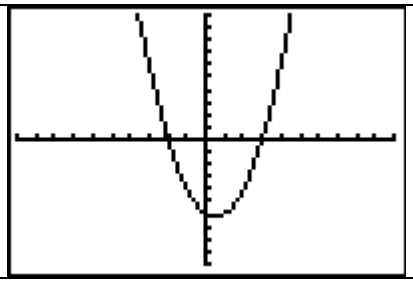
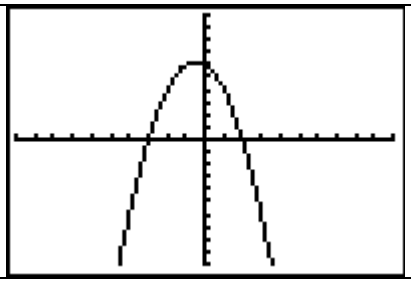
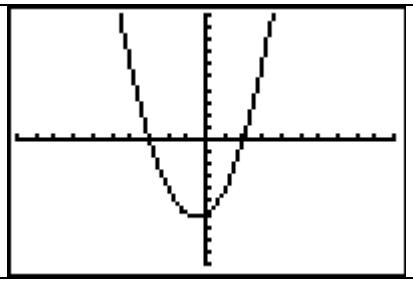
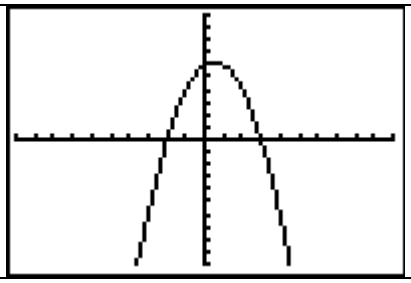
- BLM 2.8.1-2.8.3
- Graphing calculators

			Assessment Opportunities
Minds On…	**Pairs → Activity** Students work through BLM 2.8.1 in pairs using a graphing calculator to observe the need for factored form. A works with quadratics in standard form; B with quadratics in factored form. The Key Feature to identify after BLM 2.8.1 is the zeros.		
Action!	**Whole Class → Discussion** Prompts to start discussion: • If we were graphing a function, would the location of the zeros be enough to provide an accurate sketch of the function? • What other types of features would provide a more accurate sketch? • How could we determine those features using the algebraic representation of the function? **Individual → Investigation** Students use graphing calculators to complete BLM 2.8.2. In addition to identifying zeros to graph cubic and quartic functions other key features will also be used. **Learning Skills/Teamwork/Checkbric:** Observe work habits and initiative as students work through the investigation individually. **Mathematical Process Focus: Selecting Tools** – Students **select** the most appropriate tool or strategy to investigate graphing polynomial functions.		Work through the first row with students to ensure they understand the headings (e.g., end behaviour). Provide questions to have students examine the regions between intercepts (e.g. How do we know the shape of the function between two zeros?). A quick review of factoring strategies may be appropriate.
Consolidate Debrief	**Whole Class → Discussion** Summarize the key features [e.g., intercepts, end behaviour, locating positive and negative regions using test values, multiplicity of factors (touching versus crossing the x-axis)] used to sketch the graph of a polynomial function in factored form. Again, stress the importance of expressing in factored form.		
Concept Practice *Skill Practice*	**Home Activity or Further Classroom Consolidation** BLM 2.8.3 is provided for students to practice sketching.		Factor using common factoring, difference of squares, and trinomial factoring only. No factor theorem.

2.8.1: Remembering The Beloved Quadratic

Column A - Function In Standard Form	Column B - Function In Factored Form
$y = x^2 + x - 6$	$y = (x - 3)(x + 2)$
$y = x^2 - x - 6$	$y = -(x + 3)(x - 2)$
$y = -x^2 - x + 6$	$y = -(x - 3)(x + 2)$
$y = -x^2 + x + 6$	$y = (x + 3)(x - 2)$

1. Fill in the missing blanks below. Partner A works with the functions in standard form from column A. Partner B works with the functions in factored form from column B. Use a graphing calculator to graph your set of four functions. As a pair, determine the zeros of each graph.

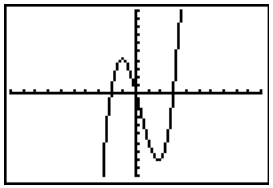
	
Factored form	Factored form
Standard form	Standard form
Zeros are _____ and _____	Zeros are _____ and _____
	
Factored form	Factored form
Standard form	Standard form
Zeros are _____ and _____	Zeros are _____ and _____

2. If you did not have a graphing calculator would it be easier to identify the zeros of each quadratic function using factored form or standard form? (check one)

❒ standard form ❒ factored form

KEY FEATURES are used to sketch functions.
What KEY FEATURE did you use to match the graphs with their equations?

2.8.2: The *Key* to Graphing Cubics and Quartics



1. Another KEY FEATURE of a graph is its end behaviour.

Example: In the graph shown the end behaviour on the left is described **as $x \to -\infty$, $y \to -\infty$** and the end behaviour on the right is described **as $x \to \infty$, $y \to \infty$.**

2. Use a graphing calculator to complete the following table. **Sketch** each function on a separate piece of paper.

	Equation	Degree	Type Of Polynomial	Zeros	Left Behaviour as $x \to -\infty$, $y \to$(check one)	Right Behaviour As $x \to \infty$, $y \to$(check one)
A)	$y = (x-2)(x-3)(x+1)$	3	cubic		❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
B)	$y = -(x-2)(x-3)(x+1)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
C)	$y = x(x+2)(x-1)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
D)	$y = -x(x+2)(x-1)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
E)	$y = (x-1)^2(x+2)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
F)	$y = (x-1)(x-2)(x+3)(x-4)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
G)	$y = -(x-1)(x-2)(x+3)(x-4)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
H)	$y = x(x-2)(x+3)(x-4)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
I)	$y = -x(x-2)(x+3)(x-4)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$
J)	$y = x(x+1)^2(x-3)$				❒ ∞ or ❒ $-\infty$	❒ ∞ or ❒ $-\infty$

3. Compare and contrast the shapes of the cubic and quartic functions.

2.8.3: You Have the Key (features) to Sketching Graphs

List four KEY FEATURES that you can use to sketch a graph of a polynomial function.

1. _____

2. _____

3. _____

4. _____

5. Factor where necessary. Determine the key features of each function.

a) $y = x^3 + 3x^2 + 2x$

b) $y = (x - 4)^2(x - 9)$

c) $y = x(x + 2) - 4(x + 2)$

d) $y = -x(x - 1)^2$

e) $y = -x(2x + 1) - 3(2x + 1)$

f) $y = x(2x^2 - 5x - 3) + (2x^2 - 5x - 3)$

6. Use the key features to ***sketch*** the graphs of the functions in question #4.

Unit 2: Day 9: The "Standard"s of Polynomial Functions

MCT 4C

Minds On: 15
Action: 40
Consolidate:20
Total=75 min

Math Learning Goals:

- Verify the zeros of cubics and quartics are correct by graphing with technology
- Describe and sketch the graph of a function from its key properties (i.e. zeros, end behaviour, the shape of the graph)
- Expand the factored form of a function to verify it is the same as the function in standard form
- Connecting the zeros of the function with the x-intercepts of the graph

Materials

- BLM 2.9.1-2.9.3
- Scissors
- Envelopes

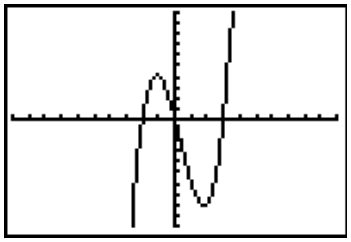
		Assessment Opportunities
Minds On…	**Individual → Activity** Students work through Anticipation Guide on BLM 2.9.1 using prior knowledge and understanding of polynomial functions to this point. Listen to students as they work and note any questions/misconceptions that arise from this initial activity.	Literacy strategy: Anticipation guide (Think Literacy: Mathematics, Grade 7-9; pp.10-14) This activity requires some advance preparation for preparing materials. If possible, laminating the cells of BLM 2.9.2 **Optional**: Graphing calculators can be provided to assist students. Also, the last column in the template doesn't need to be included. However, CAS can be used to assist in expanding the expressions.
Action!	**Pairs or Groups of 3 → Activity** Teacher provides student groups with an envelope of cut out cards from BLM 2.9.2. Students work with materials provided to complete BLM 2.9.3. Each student should have their own copy of BLM 2.9.3 to fill in. **Learning Skills/Teamwork/Checkbric:** Observe work habits and initiative as students work through activity as a group.	
Consolidate Debrief	**Individual → Activity** Students revisit their Anticipation Guide on BLM 2.9.1 completing the right hand column reflecting on the work completed. **Whole Class → Discussion** Discuss answers to anticipation guide and try to resolve any issues that may have arisen when they completed the anticipation guide at the start of class. Ask students to share their strategies for matching the pieces of each function.	
Concept Practice *Skill Practice* *Reflection*	**Home Activity or Further Classroom Consolidation** Complete BLM 2.9.4. Journal entry: Summarize the end behaviours of functions with an odd degree and functions with an even degree. Include examples in your summary.	Access to graphing technology can be provided to verify solutions.

2.9.1: To Agree or Disagree…

Anticipation Guide

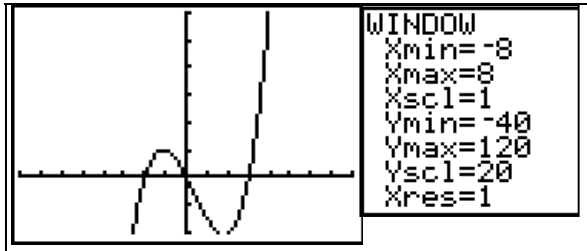
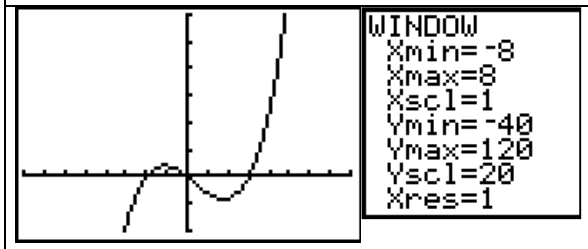
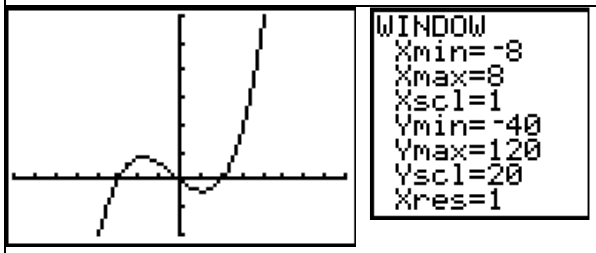
Instructions:

- Check "Agree" or "Disagree" beside each statement ***before*** you start the task on BLM 2.9.3..
- Compare your choice and explanation with a partner.
- Revisit your choices after completing the task on BLM 2.9.3. Compare the choices you made before the task and after the task.

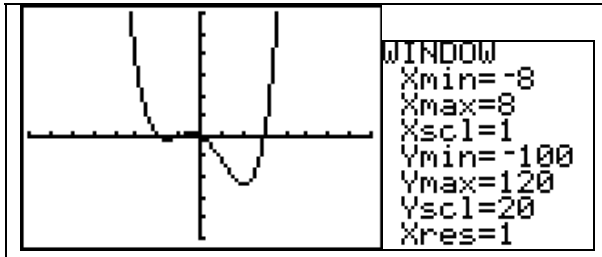
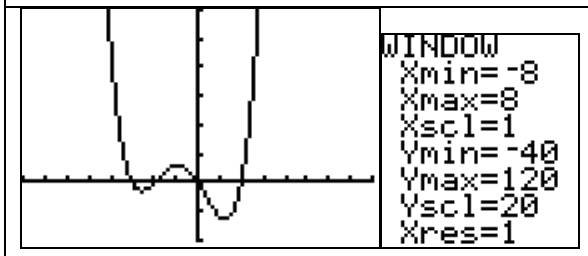
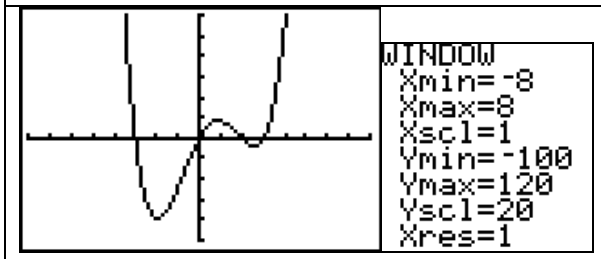
Before		Statement	After	
Agree	**Disagree**		**Agree**	**Disagree**
		1. The x-intercepts of the function $y = 2(x + 1)(x – 3)(x – 4)$ are -1, 2, 3, 4.		
		2. If the end behaviour of a function is **as $x \to \infty$, $y \to \infty$,** the function has a positive leading coefficient.		
		3. The function $y = 2(x – 1)(x + 2)(x – 3$ has the same x-intercepts as $y = -5(x – 1)(x + 2)(x – 3)$.		
		4. The function shown can be expressed in the form  $y = ax^4 + bx^3 + cx^2 + dx + e$		
		5. There are an infinite number of cubic functions that have x-intercepts of -2, 0, and 3.		
		6. The zeros of the functions $y = x^4 - 5x^2 + 4$ and $y = (x+1)(x-1)(x+2)(x-2)$ are the same.		

2.9.2: "Expanding" Your Understanding of Functions – Teacher Template

Teacher Instructions: Photocopy the charts; 1/group. Cut up the charts into its cells. The last column is optional as expanding will be covered in Unit 3. Give each group an envelope containing all of the cut out information. Students will use the templates from BLM 2.9.3 to fill in their own individual charts.

Graph of Function	Zeros	End Behaviours	Defining Equation in Factored Form	Defining Equation in Standard Form (Optional)
	-2, 0, 3	as $x \to -\infty$, $y \to -\infty$ and as $x \to \infty$, $y \to \infty$	$y = 5x(x - 3)(x + 2)$	$y = 5x^3 - 5x^2 - 30x$
	-2, 0, 3	as $x \to -\infty$, $y \to -\infty$ and as $x \to \infty$, $y \to \infty$	$y = 2x(x - 3)(x + 2)$	$y = 2x^3 - 2x^2 - 12x$
	-3, 0, 2	as $x \to -\infty$, $y \to -\infty$ and as $x \to \infty$, $y \to \infty$	$y = 2x(x + 3)(x - 2)$	$y = 2x^3 + 2x^2 - 12x$

2.9.2: "Expanding" Your Understanding of Functions – Teacher Template (continued)

Graph of Function	Zeros	End Behaviours	Defining Equation in Factored Form	Defining Equation in Standard Form (Optional)
	-2, -1, 0, 3	as $x \rightarrow -\infty$, $y \rightarrow \infty$ and as $x \rightarrow \infty$, $y \rightarrow \infty$	$y = 5x(x - 3)(x + 2)$	$y = 2x^4 - 14x^2 - 12x$
	-3, -2, 0, 2	as $x \rightarrow -\infty$, $y \rightarrow \infty$ and as $x \rightarrow \infty$, $y \rightarrow \infty$	$y = 2x(x - 3)(x + 2)$	$y = 2x^4 + 6x^3 - 8x^2 - 24x$
	-3, 0, 2, 3	as $x \rightarrow -\infty$, $y \rightarrow \infty$ and as $x \rightarrow \infty$, $y \rightarrow \infty$	$y = 2x(x + 3)(x - 2)$	$y = 2x^4 - 4x^3 - 18x^2 + 36x$

2.9.3: "Expanding" Your Understanding of Functions

Student Instructions: In your groups, match the graph of the six functions given in the envelope with the zeros, end behaviour, and defining equation in factored form. *Optional*: Also match the defining equation in standard form.

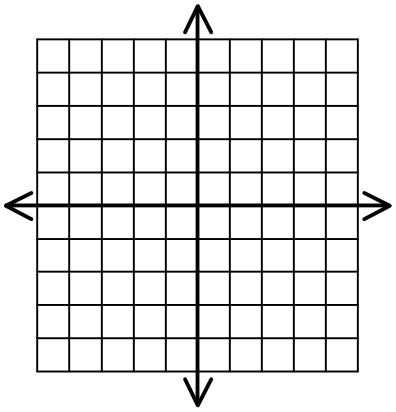
Graph of Function	Zeros	End Behaviours	Defining Equation in Factored Form	Defining Equation in Standard Form (Optional)

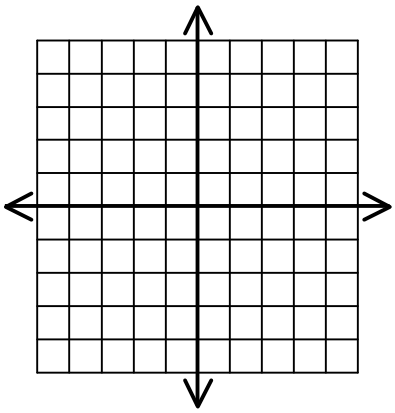
2.9.3: "Expanding" Your Understanding of Functions (continued)

Graph of Function	Zeros	End Behaviours	Defining Equation in Factored Form	Defining Equation in Standard Form (Optional)

2.9.4: Are There Any "*Standard*"s Anymore?

1. Sketch any quartic function with x-intercepts of -3, -1, 1, and 2.





2. Sketch a second quartic function with the same x-intercepts and opposite end behaviour.

3. How many quartic functions have x-intercepts of -3, -1, 1, and 2?

4. A given cubic function has zeros at -2, 1 and 2. The general equation for such a function can be written as $y = a(x + 2)(x - 1)(x - 2)$. If we let $a = 1$, then the equation becomes $y = (x + 2)(x - 1)(x - 2)$. Suppose that the cubic passes through the point (3, 20). Determine the value of a.

5. For each of the following, determine the equation of the polynomial function.

   a) Cubic with zeros at -3, -2 and 2 passing through (-4, 24).

   b) Quartic with zeros at -3, -1, 1 and 3 passing through (2, -30).

   c) Cubic with zeros at -2, -1 and 1 passing through (3, -120).

   d) Quartic with zeros at -2, 1, 2 and 3 passing through (-1, 96).

   e) Cubic with zeros at -1, -1, and 1 passing through (4, -150).

   f) Quartic with zeros at -2, -2, 2 and 2 passing through (1, 27).

6. Use a graphing calculator or other technology to verify that the equations you generated in question 5 have the given zeros and pass through the given points.