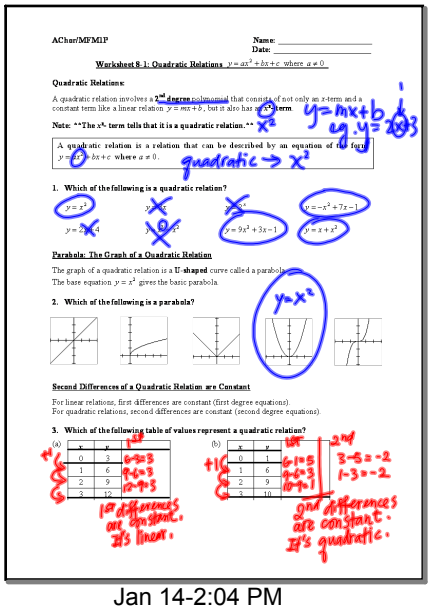

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Worksheet 8-1: Quadratic Relations $y = ax^2 + bx + c$ where $a \neq 0$

Quadratic Relations:

A quadratic relation involves a **2nd degree** polynomial that consists of not only an x-term and a constant term like a linear relation $y = mx + b$, but it also has an x^2 **term**.

Note: **The x^2- term tells that it is a quadratic relation.

A quadratic relation is a relation that can be described by an equation of the form $y = ax^2 + bx + c$ where $a \neq 0$.

1. **Which of the following is a quadratic relation?**

$y = x^2$ $y = x^3$ $y = x^4$ $y = -x^2 + 7x - 1$

$y = 2x - 4$ $y = x^5$ $y = 9x^2 + 3x - 1$ $y = x + x^2$

Parabola: The Graph of a Quadratic Relation

The graph of a quadratic relation is a **U-shaped** curve called a parabola.

The base equation $y = x^2$ gives the basic parabola.

2. **Which of the following is a parabola?**

Second Differences of a Quadratic Relation are Constant

For linear relations, first differences are constant (first degree equations).
For quadratic relations, second differences are constant (second degree equations).

3. **Which of the following table of values represent a quadratic relation?**

(a)

x	y
0	3
1	6
2	9
3	12

(b)

x	y
0	1
1	6
2	9
3	10

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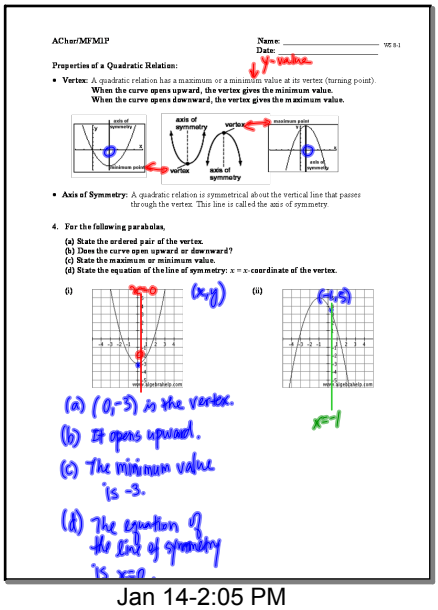

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Properties of a Quadratic Relation:

- **Vertex:** A quadratic relation has a maximum or a minimum value at its vertex (turning point).
  When the curve opens upward, the vertex gives the minimum value.
  When the curve opens downward, the vertex gives the maximum value.

- **Axis of Symmetry:** A quadratic relation is symmetrical about the vertical line that passes through the vertex. This line is called the axis of symmetry.

4. **For the following parabolas,**
(a) State the ordered pair of the vertex.
(b) Does the curve open upward or downward?
(c) State the maximum or minimum value.
(d) State the equation of the line of symmetry: x = x-coordinate of the vertex.

(i) (ii)

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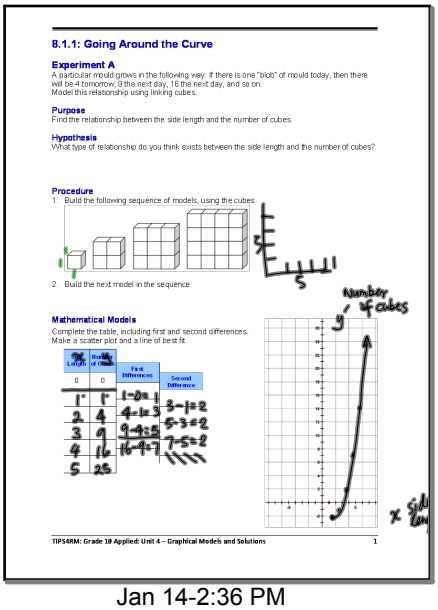

8.1.1: Going Around the Curve

Experiment A
A particular mould grows in the following way: If there is one "blob" of mould today, then there will be 4 tomorrow, 9 the next day, 16 the next day, and so on.
Model this relationship using linking cubes.

Purpose
Find the relationship between the side length and the number of cubes.

Hypothesis
What type of relationship do you think exists between the side length and the number of cubes?

Procedure
1. Build the following sequence of models, using the cubes.

2. Build the next model in the sequence.

Mathematical Models
Complete the table, including first and second differences.
Make a scatter plot and a line of best fit.

Side Length	Number of Cubes	First Differences	Second Difference
0	0		
1	1		
2	4		
3	9		
4	16		
5	25		

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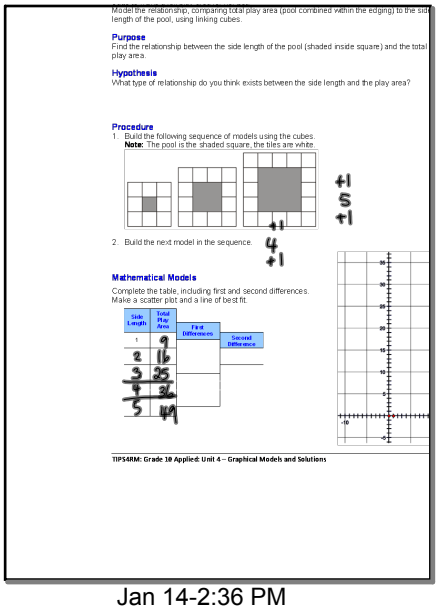

Model the relationship, comparing total play area (pool combined within the edging) to the side length of the pool, using linking cubes.

Purpose
Find the relationship between the side length of the pool (shaded inside square) and the total play area.

Hypothesis
What type of relationship do you think exists between the side length and the play area?

Procedure
1. Build the following sequence of models using the cubes.
Note: The pool is the shaded square, the tiles are white.

2. Build the next model in the sequence.

Mathematical Models
Complete the table, including first and second differences.
Make a scatter plot and a line of best fit.

Side Length	Total Play Area	First Differences	Second Difference
1	9		
2	16		
3	25		
4	36		
5	49		

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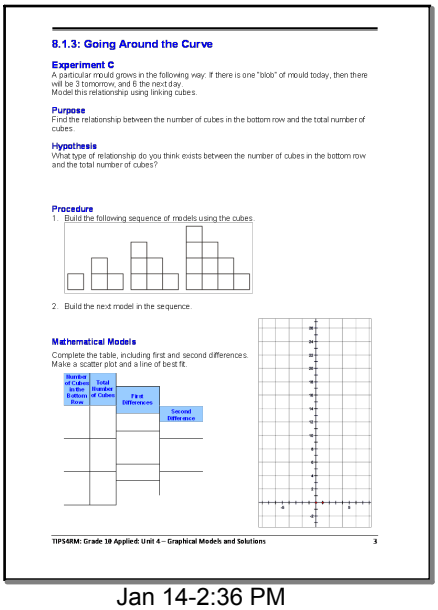

8.1.3: Going Around the Curve

Experiment C
A particular mould grows in the following way: If there is one "blob" of mould today, then there will be 3 tomorrow, and 6 the next day.
Model this relationship using linking cubes.

Purpose
Find the relationship between the number of cubes in the bottom row and the total number of cubes.

Hypothesis
What type of relationship do you think exists between the number of cubes in the bottom row and the total number of cubes?

Procedure
1. Build the following sequence of models using the cubes.

2. Build the next model in the sequence.

Mathematical Models
Complete the table, including first and second differences.
Make a scatter plot and a line of best fit.

Number of Cubes in the Bottom Row	Total Number of Cubes	First Differences	Second Difference

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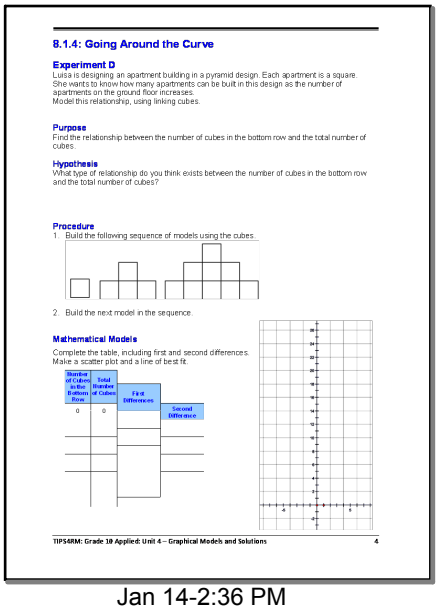

8.1.4: Going Around the Curve

Experiment D
Luisa is designing an apartment building in a pyramid design. Each apartment is a square. She wants to know how many apartments can be built in this design as the number of apartments on the ground floor increases.
Model this relationship, using linking cubes.

Purpose
Find the relationship between the number of cubes in the bottom row and the total number of cubes.

Hypothesis
What type of relationship do you think exists between the number of cubes in the bottom row and the total number of cubes?

Procedure
1. Build the following sequence of models using the cubes.

2. Build the next model in the sequence.

Mathematical Models
Complete the table, including first and second differences.
Make a scatter plot and a line of best fit.

Number of Cubes in the Bottom Row	Total Number of Cubes	First Differences	Second Difference
0	0		

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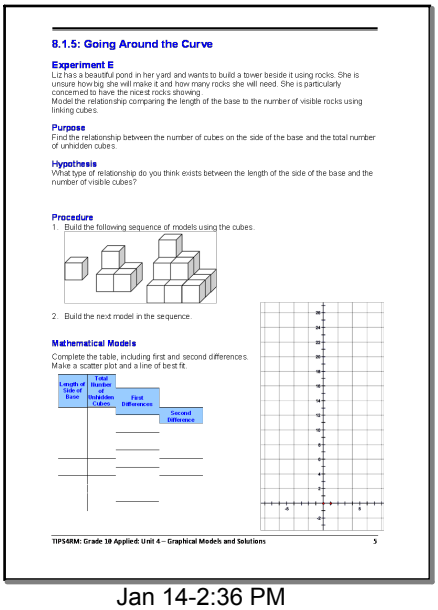

8.1.5: Going Around the Curve

Experiment E

Liz has a beautiful pond in her yard and wants to build a tower beside it using rocks. She is unsure how big she will make it and how many rocks she will need. She is particularly concerned to have the nicest rocks showing.
Model the relationship comparing the length of the base to the number of visible rocks using linking cubes.

Purpose

Find the relationship between the number of cubes on the side of the base and the total number of unhidden cubes.

Hypothesis

What type of relationship do you think exists between the length of the side of the base and the number of visible cubes?

Procedure

1. Build the following sequence of models using the cubes.

2. Build the next model in the sequence.

Mathematical Models

Complete the table, including first and second differences.
Make a scatter plot and a line of best fit.

Length of Side of Base	Total Number of Unhidden Cubes	First Differences	Second Difference

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