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2.1 Transformers: Shifty y's

A Develop Understanding Task

Optima Prime is designing a robot quilt for her new grandson. She plans for the robot to have a square face. The amount of fabric that she needs for the face will depend on the area of the face, so Optima decides to model the area of the robot's face mathematically. She knows that the area A of a square with side length x units (which can be inches or centimeters) is modeled by the function, $A(x) = x^2$ square units.

1. What is the domain of the function $A(x)$ in this context?
2. Match each statement about the area to the function that models it:

Matching Equation (A,B, C, or D)	Statement	Function Equation
	The length of each side is increased by 5 units.	A $A(x) = 5x^2$
	The length of each side is multiplied by 5 units.	B $A = (x + 5)^2$
	The area of a square is increased by 5 square units.	C $A = (5x)^2$
	The area of a square is multiplied by 5.	D $A = x^2 + 5$

Optima started thinking about the graph of $y = x^2$ (in the domain of all real numbers) and wondering about how changes to the equation of the function like adding 5 or multiplying by 5 affect the graph. She decided to make predictions about the effects and then check them out.

3. Predict how the graphs of each of the following equations will be the same or different from the graph of $y = x^2$.

	Similarities to the graph of $y = x^2$	Differences from the graph of $y = x^2$
$y = 5x^2$	Same vertex / Dom	narrower / Skinnier
$y = (x + 5)^2$	Same size / vertex on x-axis	Slide to the left
$y = (5x)^2$		
$y = x^2 + 5$		up 5

Stretch =>

4. Optima decided to test her ideas using technology. She thinks that it is always a good idea to start simple, so she decides to go with $y = x^2 + 5$. She graphs it along with $y = x^2$ in the same window. Test it yourself and describe what you find.

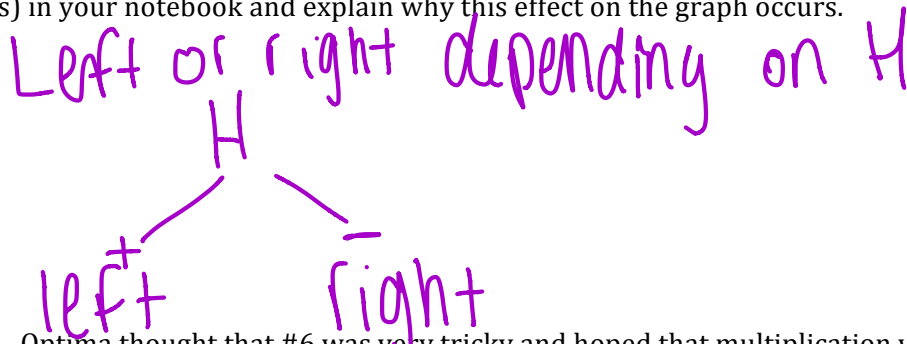
up 5

5. Knowing that things make a lot more sense with more representations, Optima tries a few more examples like $y = x^2 + 2$ and $y = x^2 - 3$, looking at both a table and a graph for each. What conclusion would you draw about the effect of adding or subtracting a number to $y = x^2$? Carefully record the tables and graphs of these examples in your notebook and explain why your conclusion would be true for any value of k , given $y = x^2 + k$.

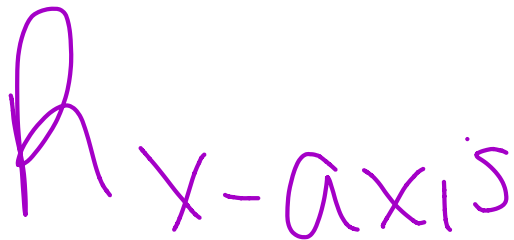
up or down depending on sign of k

+ up
- down

6. After her amazing success with addition in the last problem, Optima decided to look at what happens with addition and subtraction inside the parentheses, or as she says it, “adding to the x before it gets squared”. Using your technology, decide the effect of h in the equations: $y = (x + h)^2$ and $y = (x - h)^2$. (Choose some specific numbers for h .) Record a few examples (both tables and graphs) in your notebook and explain why this effect on the graph occurs.



7. Optima thought that #6 was very tricky and hoped that multiplication was going to be more straightforward. She decides to start simple and multiply by -1, so she begins with $y = -x^2$. Predict what the effect is on the graph and then test it. Why does it have this effect?



8. Optima is encouraged because that one was easy. She decides to end her investigation for the day by determining the effect of a multiplier, a , in the equation: $y = ax^2$. Using both positive and negative numbers, fractions and integers, create at least 4 tables and matching graphs to determine the effect of a multiplier.

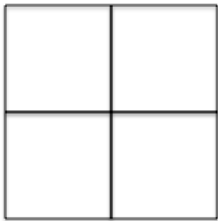
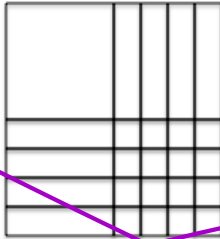
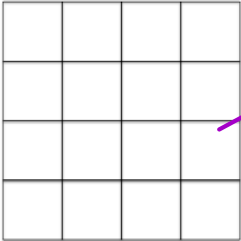



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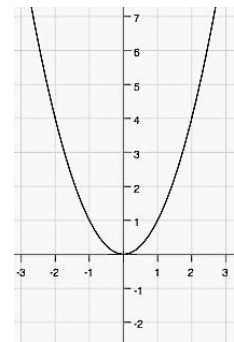
Topic: Transformations on quadratics

Matching: Choose the area model that is the best match for the equation.

- ___11. $x^2 + 4$ ___12. $(x + 4)^2$ ___13. $(4x)^2$ ___14. $4x^2$

<p>a.</p> 	<p>b.</p> 
<p>c.</p> 	<p>d.</p> 

A table of values and the graph for $f(x) = x^2$ is given. Compare the values in the table for $g(x)$ to those for $f(x)$. Identify what stays the same and what changes. a) Use this information to write the vertex form of the equation of $g(x)$. b) Graph $g(x)$. c) Describe how the graph changed from the graph of $f(x)$. Use words such as right, left, up, and down. d) Answer the question.

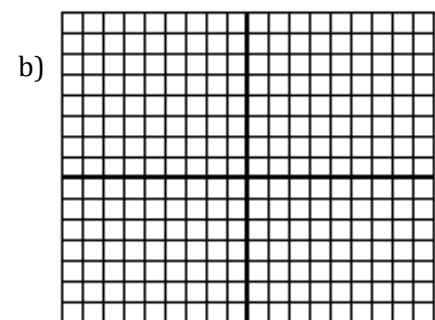


x	-3	-2	-1	0	1	2	3
$f(x) = x^2$	9	4	1	0	1	4	9

15 a) $g(x) =$

x	-3	-2	-1	0	1	2	3
$g(x)$	2	-3	-6	-7	-6	-3	2

- c) In what way did the graph move?
d) What part of the equation indicates this move?



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2.2 Transformers: More Than Meets the y's

A Solidify Understanding Task

Write the equation for each problem below. Use a second representation to check your equation.

1. ~~The area of a square with side length x , where the side length is decreased by 3, the area is multiplied by 2 and then 4 square units are added to the area.~~

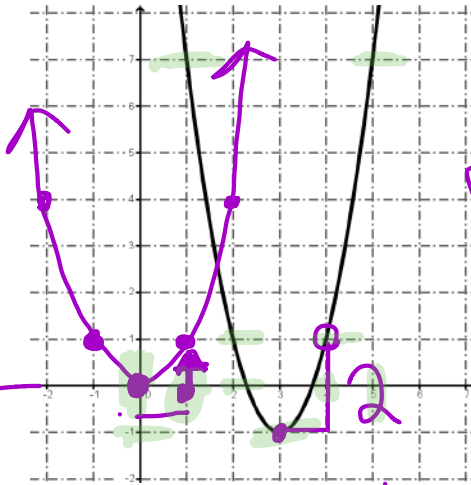
left dilate up

$$y = 2(x+3)^2 + 4$$

$$y = 2x^2 - 12x + 17$$

- 2.

x	y
1	7
2	1
3	-1
4	1
5	7



$$y = 2(x-3)^2 - 1$$

over 1 up 1
one 1 up 2

$$|x-2| \quad |x-2|$$

$$2(x^2 - 6x + 9)$$

$$2x^2 - 12x + 18$$

$$2x^2 - 12x + 17$$



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3.

x	f(x)
-4	7
-3	2
-2	-1
-1	-2
0	-1
1	2
2	7
3	14
4	23

Handwritten notes for problem 3:

- Vertical arrows on the left indicate intervals: 3 units from x = -4 to x = -1, and 5 units from x = -1 to x = 4.
- Between the table and the parabola, differences are calculated:
 - Between x = -4 and -3: -5
 - Between x = -3 and -2: -3
 - Between x = -2 and -1: -1
 - Between x = -1 and 0: $+1$
 - Between x = 0 and 1: $+3$
 - Between x = 1 and 2: $+5$
 - Between x = 2 and 3: $+7$
 - Between x = 3 and 4: $+9$
- Between the differences and the parabola, second differences are calculated:
 - Between -5 and -3: $+2$
 - Between -3 and -1: $+2$
 - Between -1 and 1: $+2$
 - Between 1 and 3: $+2$
 - Between 3 and 5: $+2$
- Vertex identified as $(-1, -2)$.
- Vertex form equation: $y = (x+1)^2 - 2$
- Standard form equation: $y = x^2 + 2x - 1$
- Intermediate form: $x^2 + 2x + 1 - 2$
- Another intermediate form: $x^2 + 2x - 1$

4.

Handwritten notes for problem 4:

- Equation in vertex form: $y = -0.5(x+3)^2 + 4$
- Vertex coordinates: $(-3, 4)$

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Graph each equation without using technology. Be sure to have the exact vertex and at least two correct points on either side of the line of symmetry.

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

6. $g(x) = (x + 2)^2 - 5$

changes

7. $h(x) = 3(x - 1)^2 + 2$

8. Given: $f(x) = a(x - h)^2 + k$

- a. What point is the vertex of the parabola?
 - b. What is the equation of the line of symmetry?
 - c. How can you tell if the parabola opens up or down?
 - d. How do you identify the dilation?
9. Does it matter in which order the transformations are done? Explain why or why not.