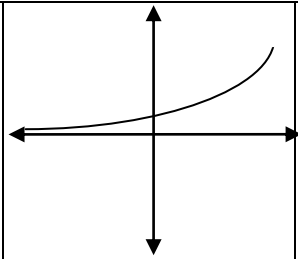
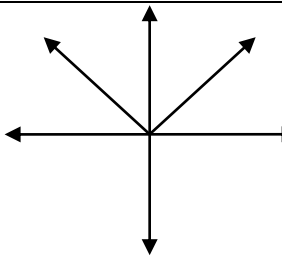
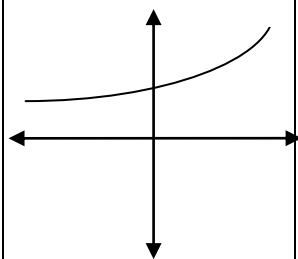
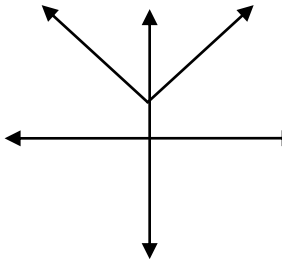
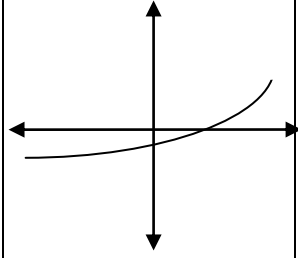
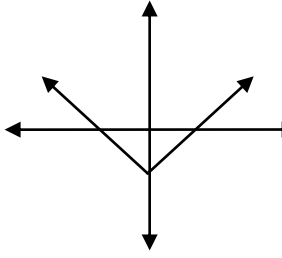
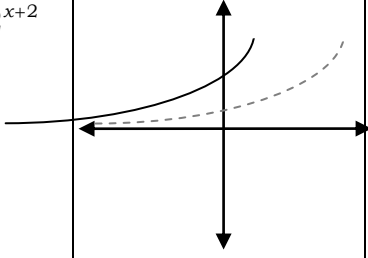
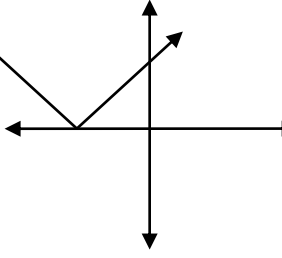
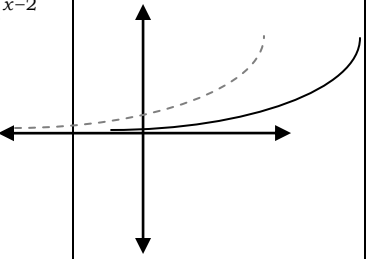
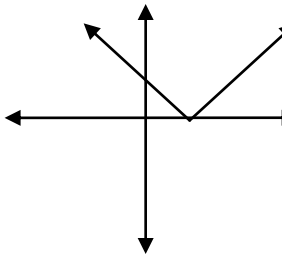


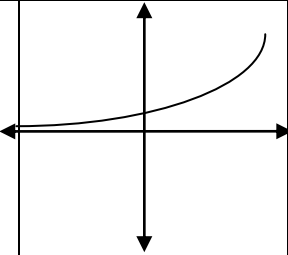
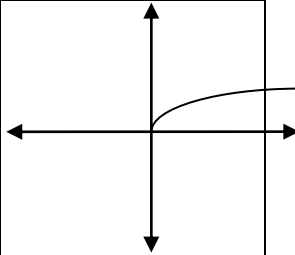
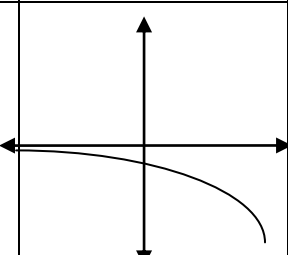
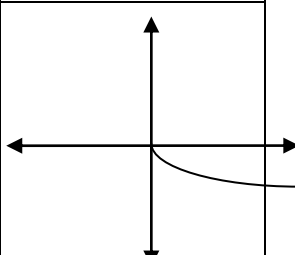
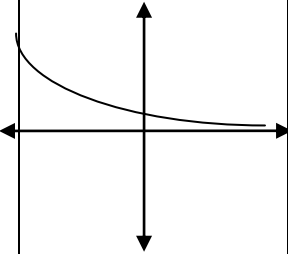
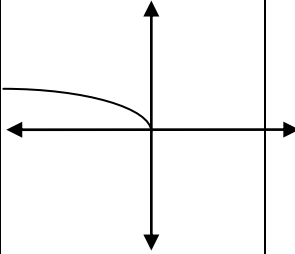
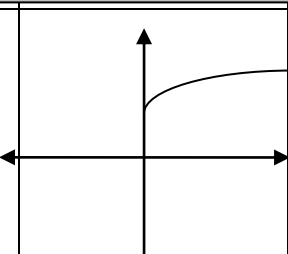
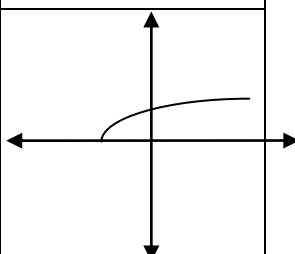
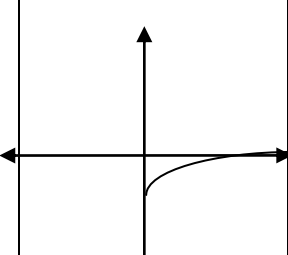
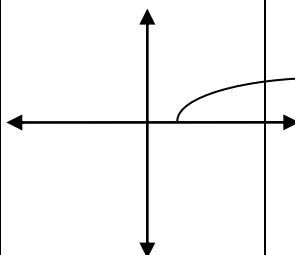
Pre-Calculus Parent Functions I

Translations on Exponential and Absolute Value Functions

$y_1 = f(x) = 2^x$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>$\frac{1}{4}$</td></tr><tr><td>-1</td><td>$\frac{1}{2}$</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>2</td></tr><tr><td>2</td><td>4</td></tr></table> 	x	y	-2	$\frac{1}{4}$	-1	$\frac{1}{2}$	0	1	1	2	2	4	$y_1 = f(x) = x $ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>2</td></tr><tr><td>-1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>2</td></tr></table> 	x	y	-2	2	-1	1	0	0	1	1	2	2
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-1	1																								
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1	1																								
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$y_2 = f(x) + 2 = 2 + 2^x$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>$2\frac{1}{4}$</td></tr><tr><td>-1</td><td>$2\frac{1}{2}$</td></tr><tr><td>0</td><td>3</td></tr><tr><td>1</td><td>4</td></tr><tr><td>2</td><td>6</td></tr></table> 	x	y	-2	$2\frac{1}{4}$	-1	$2\frac{1}{2}$	0	3	1	4	2	6	$y_2 = f(x) + 2 = x + 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>4</td></tr><tr><td>-1</td><td>3</td></tr><tr><td>0</td><td>2</td></tr><tr><td>1</td><td>3</td></tr><tr><td>2</td><td>4</td></tr></table> 	x	y	-2	4	-1	3	0	2	1	3	2	4
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$y_3 = f(x) - 2 = -2 + 2^x$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>-1.75</td></tr><tr><td>-1</td><td>-1.5</td></tr><tr><td>0</td><td>-1</td></tr><tr><td>1</td><td>0</td></tr><tr><td>2</td><td>2</td></tr></table> 	x	y	-2	-1.75	-1	-1.5	0	-1	1	0	2	2	$y_3 = f(x) - 2 = x - 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>0</td></tr><tr><td>-1</td><td>-1</td></tr><tr><td>0</td><td>-2</td></tr><tr><td>1</td><td>-1</td></tr><tr><td>2</td><td>0</td></tr></table> 	x	y	-2	0	-1	-1	0	-2	1	-1	2	0
x	y																								
-2	-1.75																								
-1	-1.5																								
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x	y																								
-2	0																								
-1	-1																								
0	-2																								
1	-1																								
2	0																								
$y_4 = f(x + 2) = 2^{x+2}$ <table><tr><th>x</th><th>y</th></tr><tr><td>-4</td><td>$\frac{1}{4}$</td></tr><tr><td>-3</td><td>$\frac{1}{2}$</td></tr><tr><td>-2</td><td>1</td></tr><tr><td>-1</td><td>2</td></tr><tr><td>0</td><td>4</td></tr></table> 	x	y	-4	$\frac{1}{4}$	-3	$\frac{1}{2}$	-2	1	-1	2	0	4	$y_4 = f(x + 2) = x + 2 $ <table><tr><th>x</th><th>y</th></tr><tr><td>-4</td><td>2</td></tr><tr><td>-3</td><td>1</td></tr><tr><td>-2</td><td>0</td></tr><tr><td>-1</td><td>1</td></tr><tr><td>0</td><td>2</td></tr></table> 	x	y	-4	2	-3	1	-2	0	-1	1	0	2
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x	y																								
-4	2																								
-3	1																								
-2	0																								
-1	1																								
0	2																								
$y_5 = f(x - 2) = 2^{x-2}$ <table><tr><th>x</th><th>y</th></tr><tr><td>0</td><td>$\frac{1}{4}$</td></tr><tr><td>1</td><td>$\frac{1}{2}$</td></tr><tr><td>2</td><td>1</td></tr><tr><td>3</td><td>2</td></tr><tr><td>4</td><td>4</td></tr></table> 	x	y	0	$\frac{1}{4}$	1	$\frac{1}{2}$	2	1	3	2	4	4	$y_5 = f(x - 2) = x - 2 $ <table><tr><th>x</th><th>y</th></tr><tr><td>0</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>0</td></tr><tr><td>3</td><td>1</td></tr><tr><td>4</td><td>2</td></tr></table> 	x	y	0	2	1	1	2	0	3	1	4	2
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0	$\frac{1}{4}$																								
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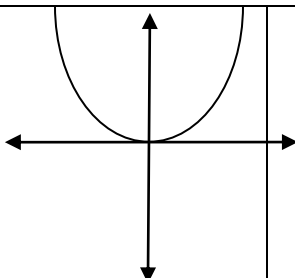
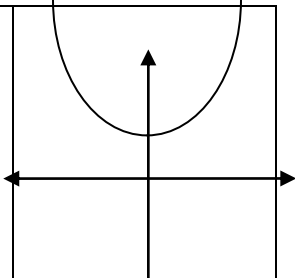
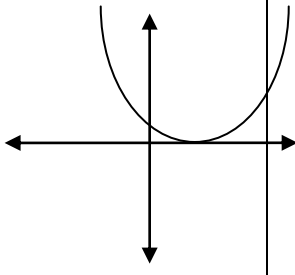
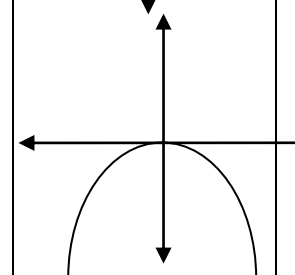
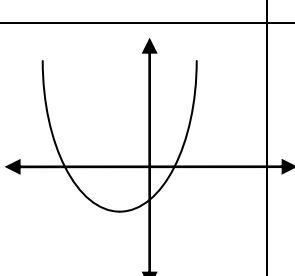
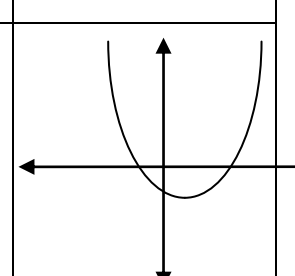
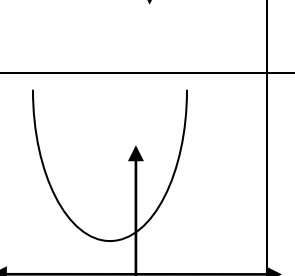
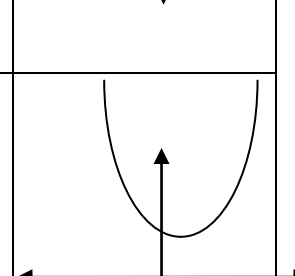
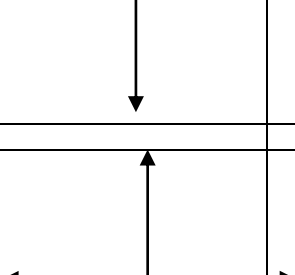
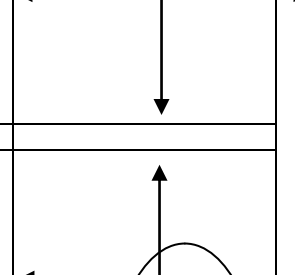
Pre-Calculus Parent Functions II

Reflections on Exponential and Square Root Functions

$y = f(x) = 2^x$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>-2</td><td>$\frac{1}{4}$</td></tr> <tr><td>-1</td><td>$\frac{1}{2}$</td></tr> <tr><td>0</td><td>1</td></tr> <tr><td>1</td><td>2</td></tr> <tr><td>2</td><td>4</td></tr> </table> 	x	y	-2	$\frac{1}{4}$	-1	$\frac{1}{2}$	0	1	1	2	2	4	$y_1 = f(x) = \sqrt{x}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>0</td><td>0</td></tr> <tr><td>$\frac{1}{4}$</td><td>$\frac{1}{2}$</td></tr> <tr><td>1</td><td>1</td></tr> <tr><td>4</td><td>2</td></tr> <tr><td>9</td><td>3</td></tr> </table> 	x	y	0	0	$\frac{1}{4}$	$\frac{1}{2}$	1	1	4	2	9	3
x	y																								
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$\frac{1}{4}$	$\frac{1}{2}$																								
1	1																								
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9	3																								
$y_6 = -f(x) = -2^x$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>-2</td><td>$-\frac{1}{4}$</td></tr> <tr><td>-1</td><td>$-\frac{1}{2}$</td></tr> <tr><td>0</td><td>-1</td></tr> <tr><td>1</td><td>-2</td></tr> <tr><td>2</td><td>-4</td></tr> </table> 	x	y	-2	$-\frac{1}{4}$	-1	$-\frac{1}{2}$	0	-1	1	-2	2	-4	$y_2 = -f(x) = -\sqrt{x}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>0</td><td>0</td></tr> <tr><td>$\frac{1}{4}$</td><td>$-\frac{1}{2}$</td></tr> <tr><td>1</td><td>-1</td></tr> <tr><td>4</td><td>-2</td></tr> <tr><td>9</td><td>-3</td></tr> </table> 	x	y	0	0	$\frac{1}{4}$	$-\frac{1}{2}$	1	-1	4	-2	9	-3
x	y																								
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$y_7 = f(-x) = 2^{-x}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>-2</td><td>4</td></tr> <tr><td>-1</td><td>2</td></tr> <tr><td>0</td><td>1</td></tr> <tr><td>1</td><td>$\frac{1}{2}$</td></tr> <tr><td>2</td><td>$\frac{1}{4}$</td></tr> </table> 	x	y	-2	4	-1	2	0	1	1	$\frac{1}{2}$	2	$\frac{1}{4}$	$y_3 = f(-x) = \sqrt{-x}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>0</td><td>0</td></tr> <tr><td>$-\frac{1}{4}$</td><td>$\frac{1}{2}$</td></tr> <tr><td>-1</td><td>1</td></tr> <tr><td>-4</td><td>2</td></tr> <tr><td>-9</td><td>3</td></tr> </table> 	x	y	0	0	$-\frac{1}{4}$	$\frac{1}{2}$	-1	1	-4	2	-9	3
x	y																								
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$y_4 = 2 + f(x) = 2 + \sqrt{x}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>0</td><td>2</td></tr> <tr><td>$\frac{1}{4}$</td><td>$2\frac{1}{2}$</td></tr> <tr><td>1</td><td>3</td></tr> <tr><td>4</td><td>4</td></tr> <tr><td>9</td><td>5</td></tr> </table> 	x	y	0	2	$\frac{1}{4}$	$2\frac{1}{2}$	1	3	4	4	9	5	$y_5 = f(x+2) = \sqrt{x+2}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>-2</td><td>0</td></tr> <tr><td>-1.75</td><td>$\frac{1}{2}$</td></tr> <tr><td>-1</td><td>1</td></tr> <tr><td>2</td><td>2</td></tr> <tr><td>7</td><td>3</td></tr> </table> 	x	y	-2	0	-1.75	$\frac{1}{2}$	-1	1	2	2	7	3
x	y																								
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$y_6 = -2 + f(x) = -2 + \sqrt{x}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>0</td><td>-2</td></tr> <tr><td>$\frac{1}{4}$</td><td>-1.5</td></tr> <tr><td>1</td><td>-1</td></tr> <tr><td>4</td><td>0</td></tr> <tr><td>9</td><td>1</td></tr> </table> 	x	y	0	-2	$\frac{1}{4}$	-1.5	1	-1	4	0	9	1	$y_7 = f(x-2) = \sqrt{x-2}$ <table> <tr><th>x</th><th>y</th></tr> <tr><td>2</td><td>0</td></tr> <tr><td>$2\frac{1}{4}$</td><td>$\frac{1}{2}$</td></tr> <tr><td>3</td><td>1</td></tr> <tr><td>6</td><td>2</td></tr> <tr><td>11</td><td>3</td></tr> </table> 	x	y	2	0	$2\frac{1}{4}$	$\frac{1}{2}$	3	1	6	2	11	3
x	y																								
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$2\frac{1}{4}$	$\frac{1}{2}$																								
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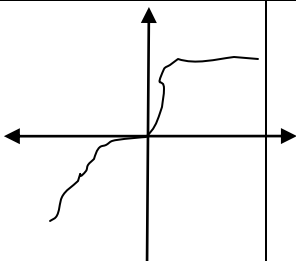
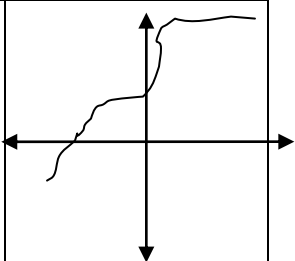
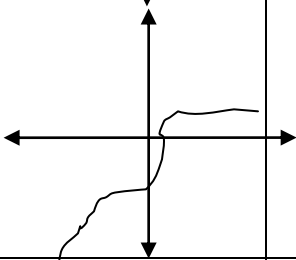
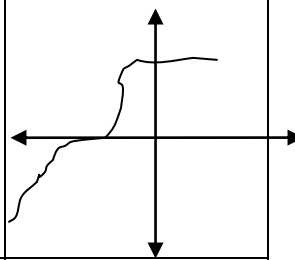
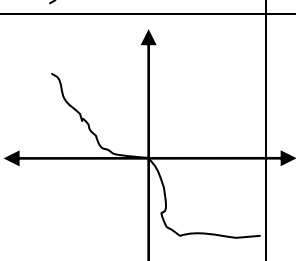
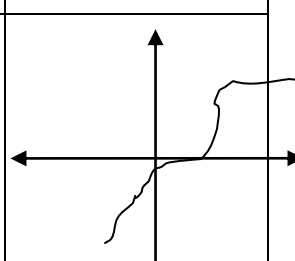
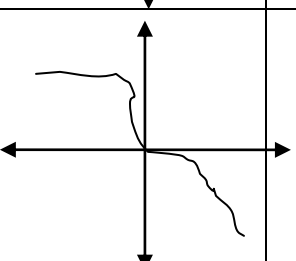
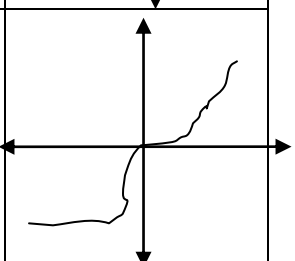
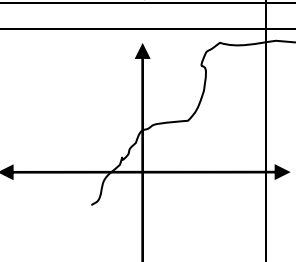
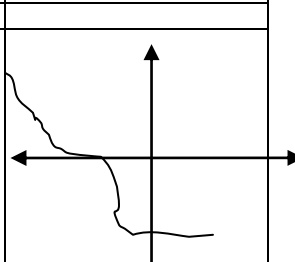
Pre-Calculus Parent Functions III

Translations Combined Parabola Vertices Revisited

$y_1 = f(x) = x^2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>4</td></tr><tr><td>-1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>4</td></tr></table>	x	y	-2	4	-1	1	0	0	1	1	2	4		$y_3 = f(x) + 2 = x^2 + 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>6</td></tr><tr><td>-1</td><td>3</td></tr><tr><td>0</td><td>2</td></tr><tr><td>1</td><td>3</td></tr><tr><td>2</td><td>6</td></tr></table>	x	y	-2	6	-1	3	0	2	1	3	2	6	
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$y_2 = f(x-2) = x-2^2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>2</td></tr><tr><td>-1</td><td>-1</td></tr><tr><td>0</td><td>-2</td></tr><tr><td>1</td><td>-1</td></tr><tr><td>2</td><td>2</td></tr></table>	x	y	-2	2	-1	-1	0	-2	1	-1	2	2		$y_4 = -f(x) = -x^2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-2</td><td>-4</td></tr><tr><td>-1</td><td>-1</td></tr><tr><td>0</td><td>-0</td></tr><tr><td>1</td><td>-1</td></tr><tr><td>2</td><td>-4</td></tr></table>	x	y	-2	-4	-1	-1	0	-0	1	-1	2	-4	
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$y_5 = f(x+1) - 2$ $= x+1^2 - 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-3</td><td>2</td></tr><tr><td>-2</td><td>-1</td></tr><tr><td>-1</td><td>-2</td></tr><tr><td>0</td><td>-1</td></tr><tr><td>1</td><td>2</td></tr></table>	x	y	-3	2	-2	-1	-1	-2	0	-1	1	2		$y_6 = f(x-1) - 2$ $= x-1^2 - 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-1</td><td>2</td></tr><tr><td>0</td><td>-1</td></tr><tr><td>1</td><td>-2</td></tr><tr><td>2</td><td>-1</td></tr><tr><td>3</td><td>2</td></tr></table>	x	y	-1	2	0	-1	1	-2	2	-1	3	2	
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$y_7 = f(x+1) + 2$ $= x+1^2 + 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-3</td><td>6</td></tr><tr><td>-2</td><td>3</td></tr><tr><td>-1</td><td>2</td></tr><tr><td>0</td><td>3</td></tr><tr><td>1</td><td>6</td></tr></table>	x	y	-3	6	-2	3	-1	2	0	3	1	6		$y_8 = f(x-1) + 2$ $= x-1^2 + 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-1</td><td>6</td></tr><tr><td>0</td><td>3</td></tr><tr><td>1</td><td>2</td></tr><tr><td>2</td><td>3</td></tr><tr><td>3</td><td>6</td></tr></table>	x	y	-1	6	0	3	1	2	2	3	3	6	
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$y_9 = -f(x+1) - 2$ $= -x+1^2 - 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-3</td><td>-6</td></tr><tr><td>-2</td><td>-3</td></tr><tr><td>-1</td><td>-2</td></tr><tr><td>0</td><td>-3</td></tr><tr><td>1</td><td>-6</td></tr></table>	x	y	-3	-6	-2	-3	-1	-2	0	-3	1	-6		$y_{10} = -f(x-1) + 2$ $= -x-1^2 + 2$ <table><tr><th>x</th><th>y</th></tr><tr><td>-1</td><td>-2</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>2</td></tr><tr><td>2</td><td>1</td></tr><tr><td>3</td><td>-2</td></tr></table>	x	y	-1	-2	0	1	1	2	2	1	3	-2	
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Pre-Calculus Parent Functions IV

Translations Abstracted

$y_1 = f(x)$		$y_2 = f(x) + 2$	
$y_3 = f(x) - 2$		$y_4 = f(x + 2)$	
$y_5 = -f(x)$		$y_6 = f(x - 2)$	
$y_7 = f(-x)$		$y_8 = -f(-x)$	
$y_9 = f(x - 2) + 2$		$y_{10} = -f(x + 2)$	

Transformations are officially *translation* (“slide”), *reflection* (“flip”), and *rotation* (“spin”).

Graphs of the trigonometric functions (sine, cosine, tangent) will help introduce a fourth, *shear* (shrink/magnify).