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Math 48B, Lesson 12: Exponential Functions

In Math 48B Lessons 11, 12, and 13, we study exponential functions:

$$y = b^x$$

To begin our exploration, let's recall the rules of powers/exponents.

1. WHAT ARE RULES OF POWERS/EXPONENTS?

Powers vs exponents: $y = x^n$ $y = b^x$

Product Rule: $b^n \cdot b^m$

Quotient Rule: $\frac{b^n}{b^m}$

Zero Power: $1 = \frac{b}{b} = \frac{b^1}{b^1}$

Negative Powers: $\frac{1}{b^n}$

Power to a Power: $(b^n)^p$

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2. WHAT IS EXPONENTIAL GROWTH?

2A. Fill in the table below. To the best of your ability, fill this table out by hand.

x	$f(x) = 2^x$	$g(x) = 4^x$	$h(x) = 5^x$	$j(x) = 10^x$
-4				
-3				
-2				
-1				
0				
1				
2				
3				
4				

2B. Graph the functions $f(x)$, $g(x)$, $h(x)$, and $j(x)$ from problem 2A above.

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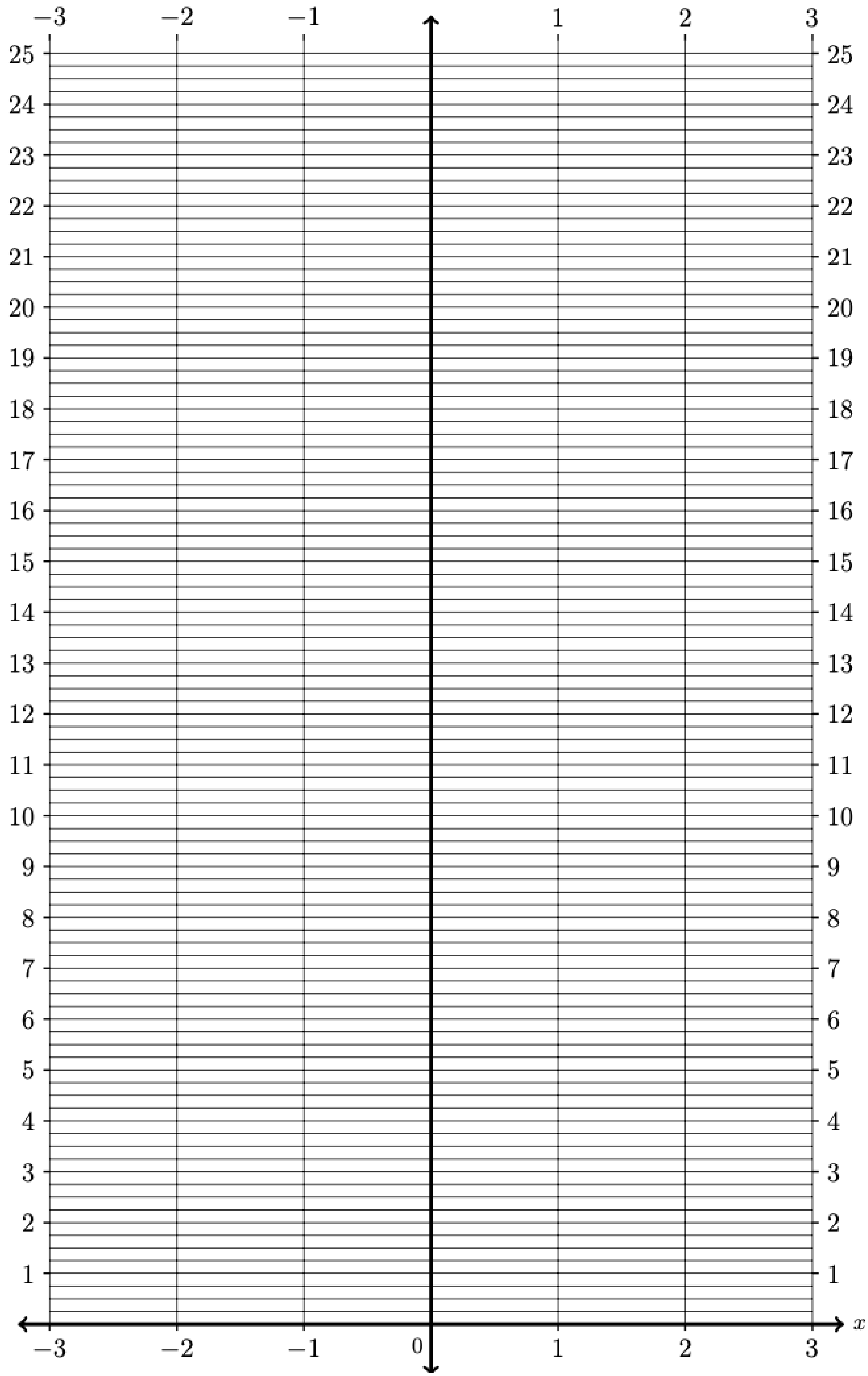

2C. Identify patterns in the graphs of the functions $f(x)$, $g(x)$, $h(x)$, and $j(x)$ from problems 2AB above. Make a conjecture about the general behavior of the graph of the function

$$y = b^x \qquad \text{for} \qquad 1 < b$$

In your conjecture, identify the domain, range, y-intercept, and the end behavior as $x \to -\infty$ as well as $x \to +\infty$.

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3. WHAT IS EXPONENTIAL DECAY?

3A. Fill in the table below. To the best of your ability, fill this table out by hand.

x	$F(x) = \left(\frac{1}{2}\right)^x$	$G(x) = \left(\frac{1}{4}\right)^x$	$H(x) = \left(\frac{1}{5}\right)^x$	$J(x) = \left(\frac{1}{10}\right)^x$
-4				
-3				
-2				
-1				
0				
1				
2				
3				
4				

3B. Graph the functions $F(x)$, $G(x)$, $H(x)$, and $J(x)$ from problem 3A above.

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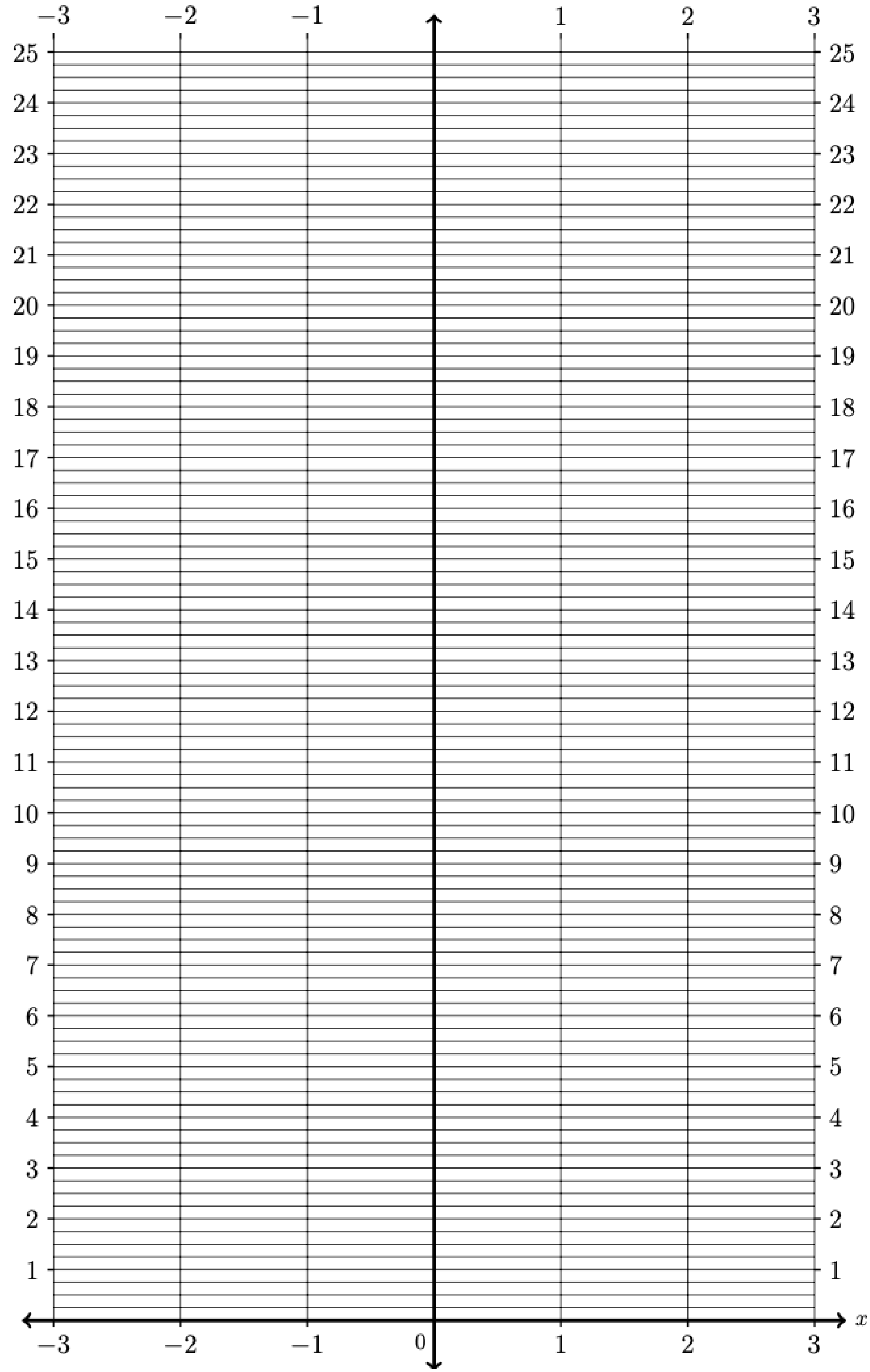

3C. Identify patterns in the graphs of the functions $F(x)$, $G(x)$, $H(x)$, and $J(x)$ from problems 3AB above. Make a conjecture about the general behavior of the graph of the function

$$y = b^x \qquad \text{for} \qquad 0 < b < 1$$

In your conjecture, identify the domain, range, y-intercept, and the end behavior as $x \to -\infty$ as well as $x \to +\infty$.

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4. TRANSFORMATIONS OF EXPONENTIAL FUNCTIONS?

4A. For exponential function $y = a \cdot b^{x-h} + k$, what do parameters a ,h, and k do to the graph of $y = b^x$?

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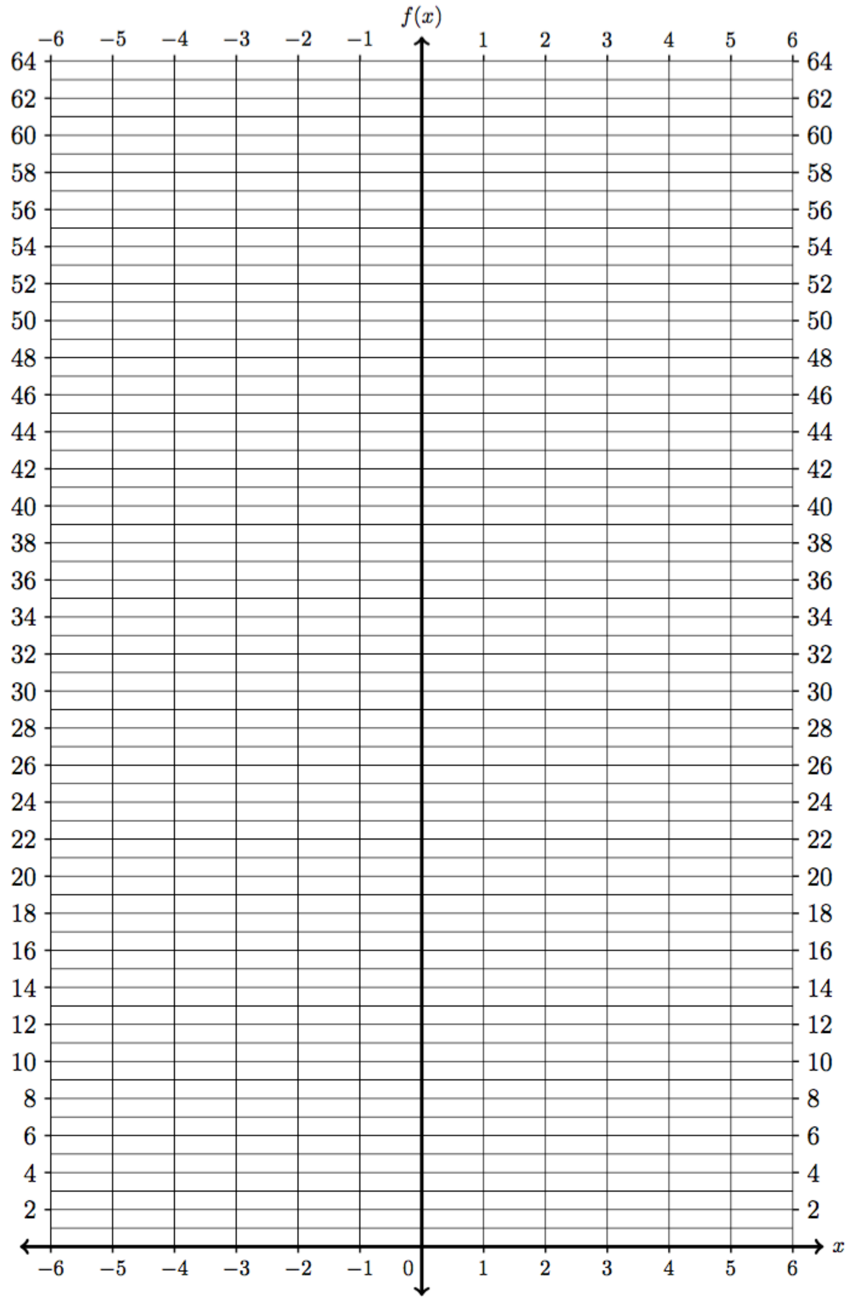
4B. Test your hypothesis from Problem 4A above by graphing the function below.

x	$f(x) = 2^x$	$g(x) = 2^{x+2}$
-4		
-3		
-2		
-1		
0		
1		
2		
3		
4		
5		
6		
7		



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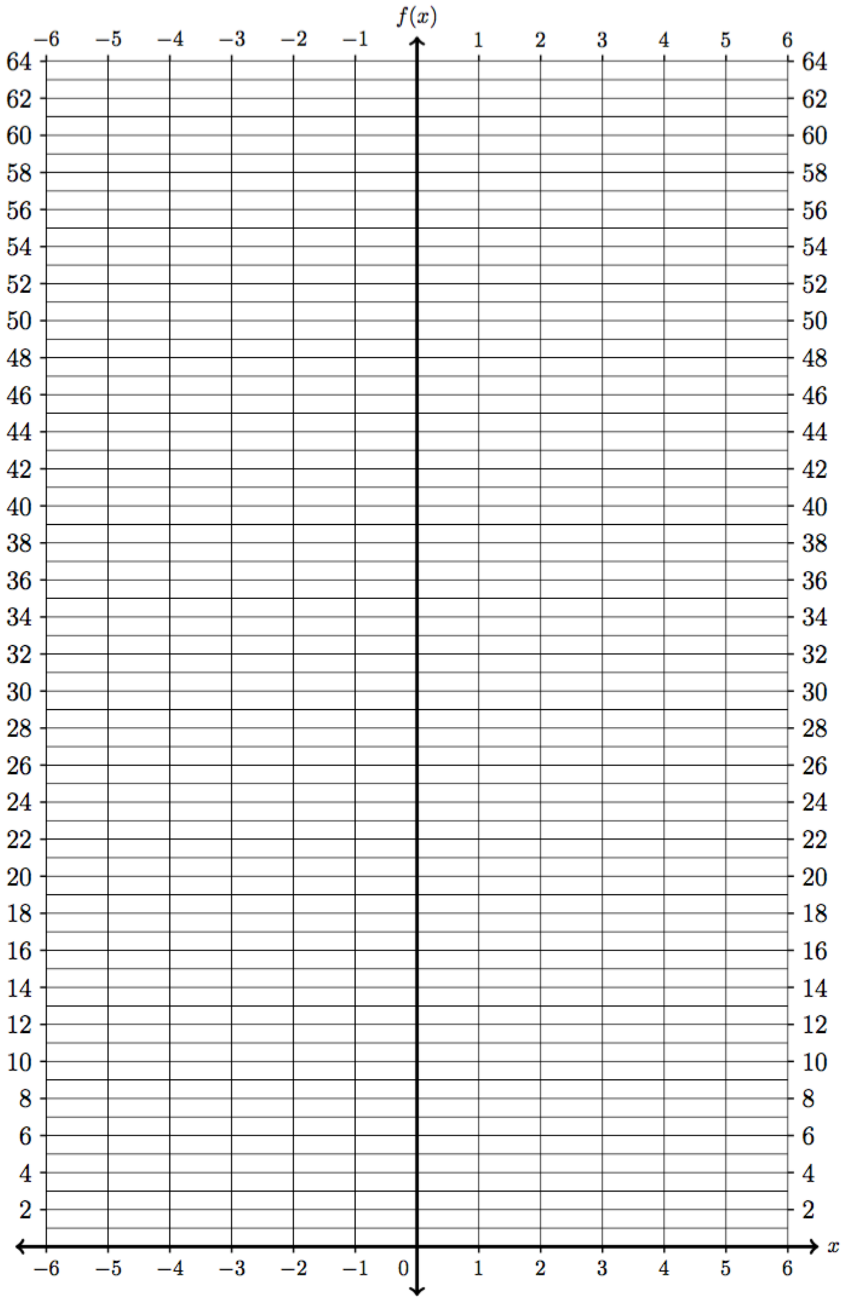
4C. Test your hypothesis from Problem 4A above by graphing the function below.

x	$f(x) = 2^x$	$g(x) = 2^x + 6$
-4		
-3		
-2		
-1		
0		
1		
2		
3		
4		
5		
6		
7		



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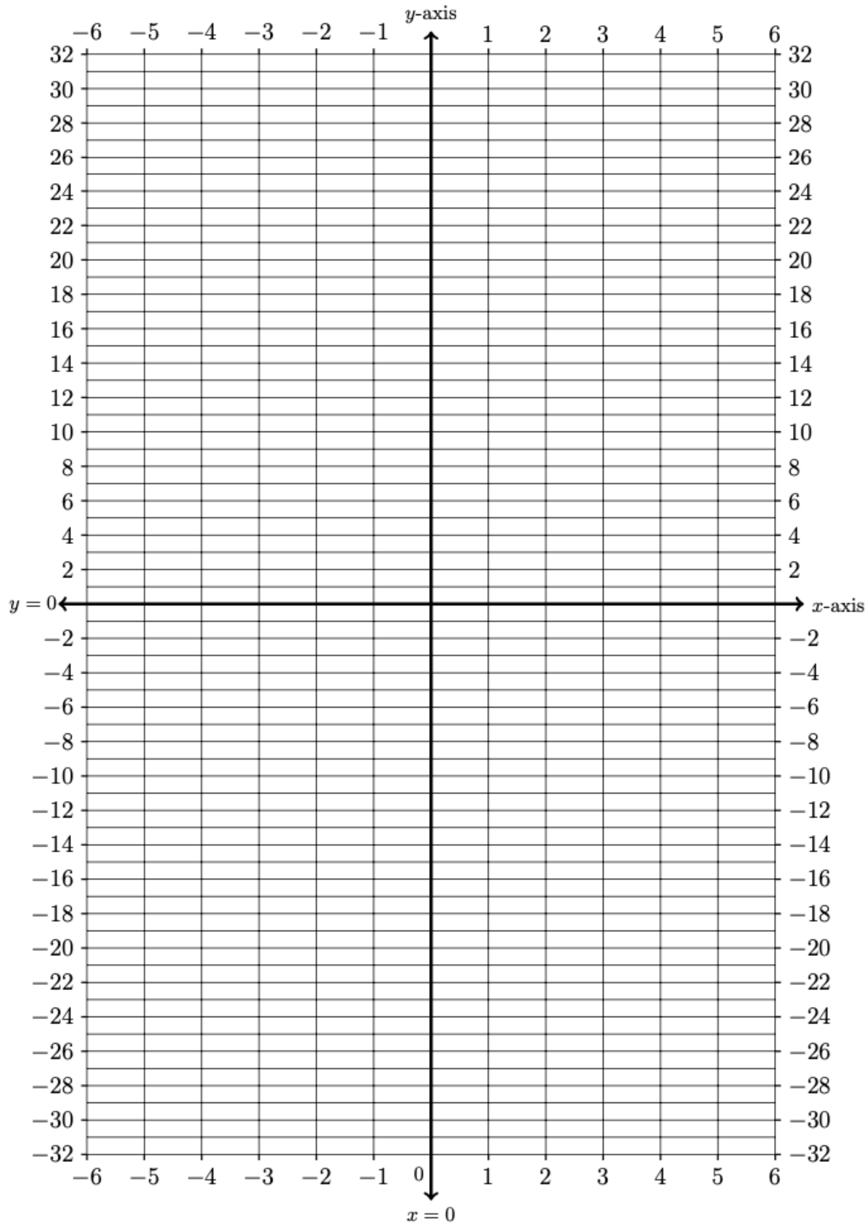
4D. Test your hypothesis from Problem 4A above by graphing the function below.

x	$f(x) = 2^x$	$g(x) = -2^x$
-4		
-3		
-2		
-1		
0		
1		
2		
3		
4		
5		
6		
7		



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4E. How is your work on problems 4ABC related to the general transformations:

$$g(x) = a\,f(x-h)+k$$

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5. QUADRATIC VERSUS EXPONENTIAL GROWTH?

5A. Fill out the table below

x	$f(x) = x^2$	$f(x+1) - f(x)$
0		
1		
2		
3		
4		
5		
6		

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5B. Fill out the table below

x	$g(x) = 2^x$	$g(x+1) - g(x)$
0		
1		
2		
3		
4		
5		
6		

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5C. Graph $f(x) = x^2$ and $g(x) = 2^x$ below. What behavior do you notice? Which one is growing more quickly well as $x \to +\infty$.