Grade Level/Course: A

Lesson Day 1

Think

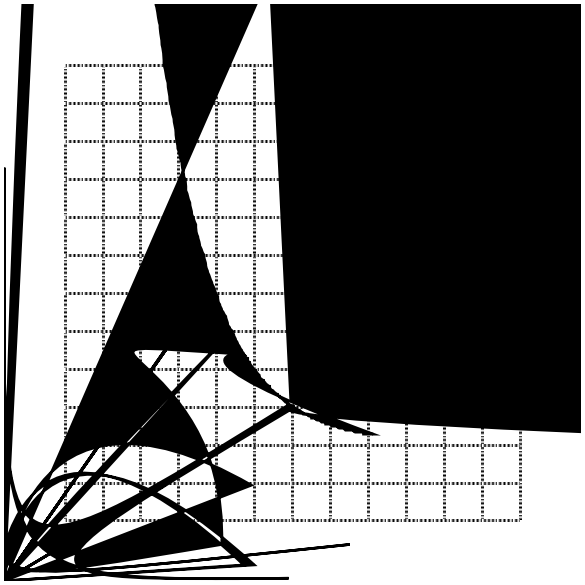
An exponential function

Try: Partner A: $f(x) = 3^x$ Partner B:

Think-Pair: What kind of functions are they? Explain.
Predict what each graph is going to look like.
Each partner graphs their function.
Partners exchange papers, graph their function on partner's paper. Compare and contrast.

Example 2: Graph the function $g(x) = \left(\frac{1}{2}\right)^x$.

x	$f(x) = \left(\frac{1}{2}\right)^x$	$x, f(x)$
1		1, 2
0	$f(0) = \left(\frac{1}{2}\right)^0 = 1$	0, 1
1	$f(1) = \left(\frac{1}{2}\right)^1 = \frac{1}{2}$	$1, \frac{1}{2}$



How are the functions $g\ x \quad \frac{1}{2}^{\ x}$ and related?

They are exponential functions of the form $f\ x \quad b^x$.

Their graphs have the same shape, *y*-intercept and asymptote at $y \quad 0$.

Their bases are reciprocals.

Their

Generalize: The graph of $f(x) = b^x$ goes through the points $(1, \frac{1}{b})$, $(0, 1)$, and $(1, b)$. So knowing the shape of the graph, these three points are sufficient to graph the function.

Key Features of $f(x) = b^x$:

Domain:	All Real Numbers x or
Range:	All Positive Real Numbers $f(x) > 0$ or $\{y \mid y > 0\}$
Intercept(s):	No x-intercept, y-intercept is $(0, 1)$
Asymptote:	$y = 0$

Recommended: Revisit graphs. Write/discuss the key features of each.

Example 3: Write the function whose graph is given.

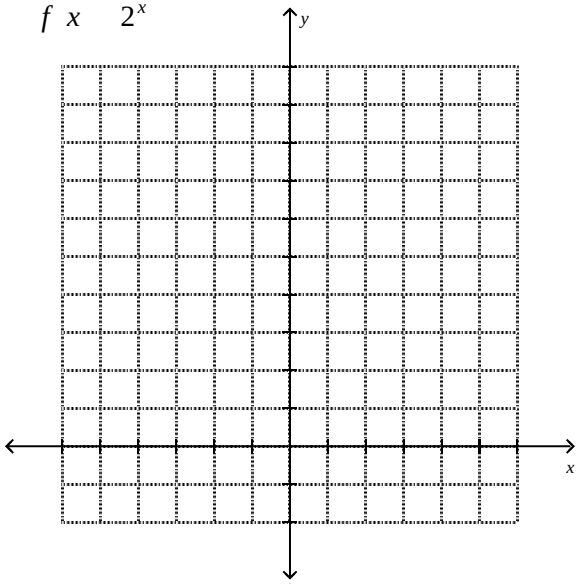
Think-Pair: What kind of function does the graph represent?
Make a conjecture about the b value in $f(x) = b^x$.
Identify a point or points on the graph.

Solution: This is going to be an exponential function like those in example 1, where $b > 1$. Two points on the graph are $(1, 10)$ and $(2, 100)$. Notice that we can write the points as $(1, 10^1)$ and $(2, 10^2)$. I predict that any point on the graph is $(x, 10^x)$. Therefore, the graph could be modeled by the function $f(x) = 10^x$.

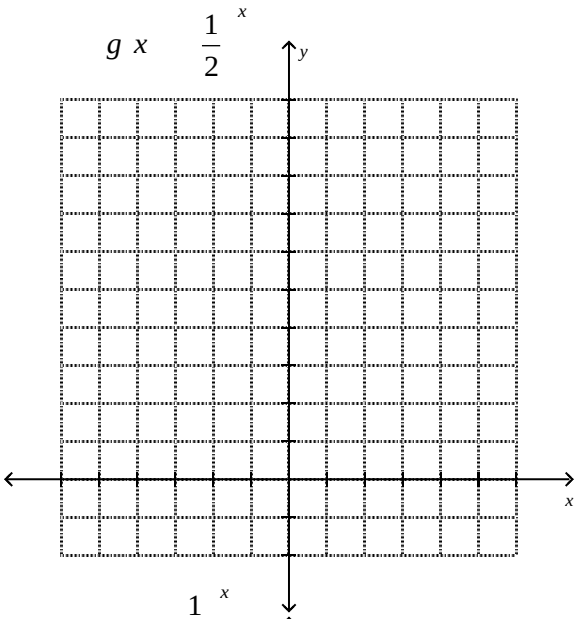
EXIT TICKET: Identify the key features of the graph of $f(x) = \left(\frac{1}{5}\right)^x$.

Graphing Exponential Functions (Day 1)

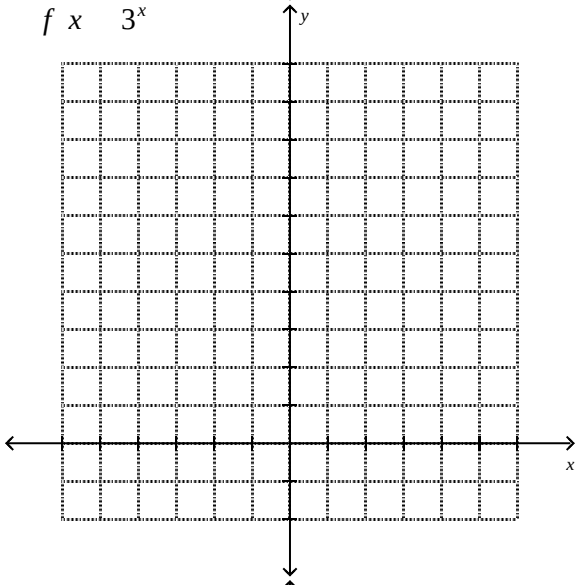
$f(x) = 2^x$



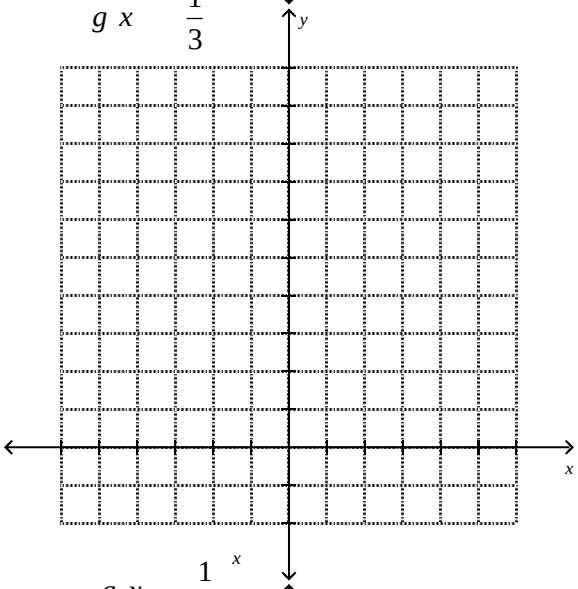
$g(x) = \left(\frac{1}{2}\right)^x$

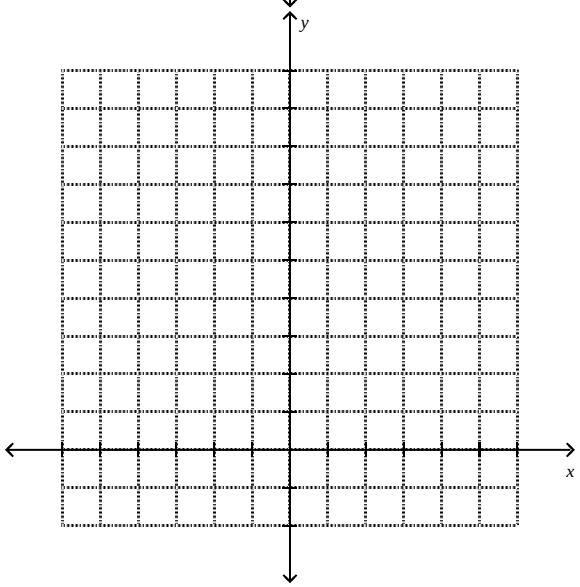


$f(x) = 3^x$

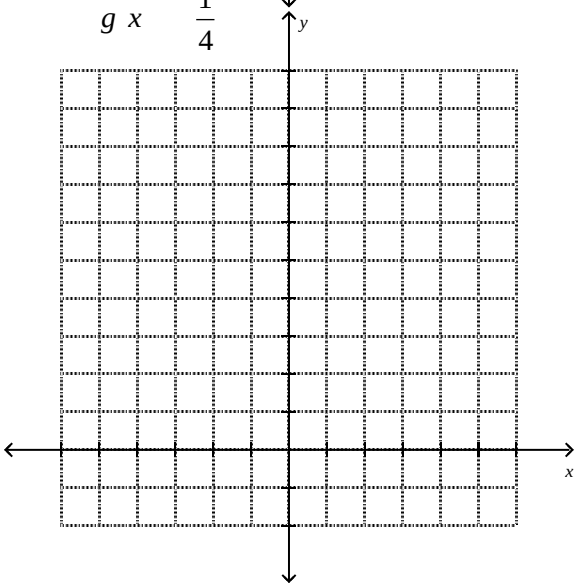


$g(x) = \left(\frac{1}{3}\right)^x$

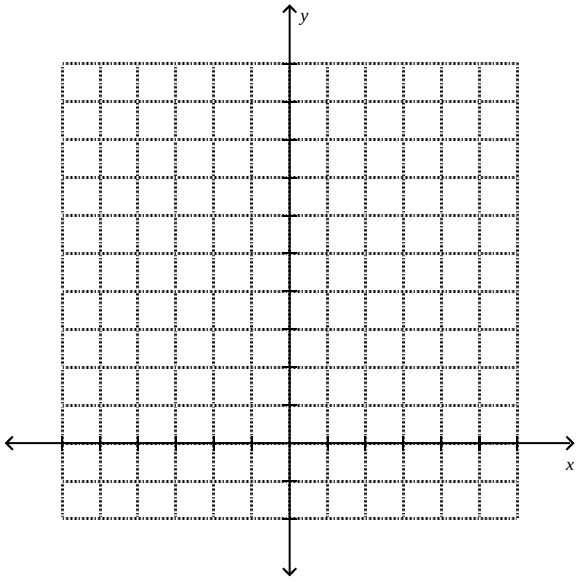


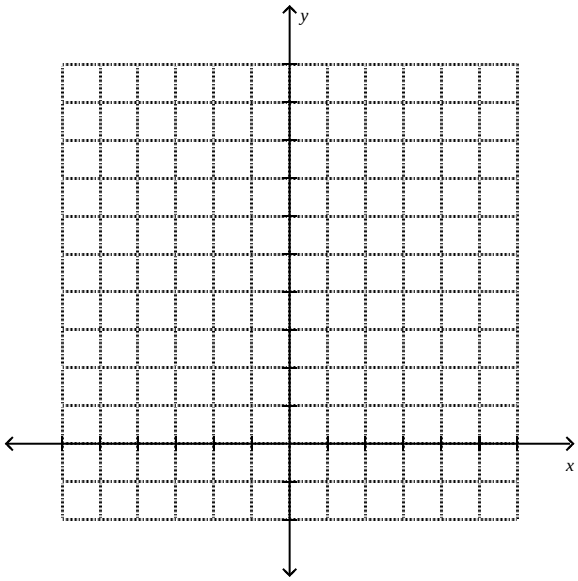


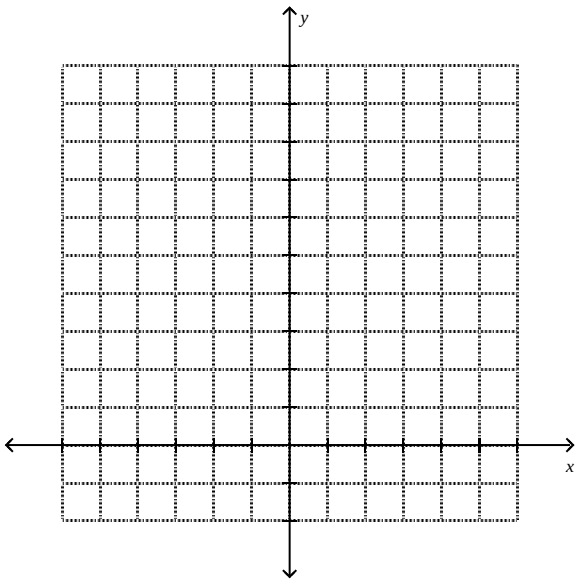
$g(x) = \left(\frac{1}{4}\right)^x$



Graphing Exponential Functions (Day 1)







Lesson Day 2

Think-Pair-Share: Review the graphs from Day 1. Compare the functions $f\ x$ and $g\ x$.

How would you classify (or name) the functions $f\ x$?

How would you classify (or name) the functions $g\ x$?

Similarities between the functions $f\ x$

Example 1: Graph the function $h\ x \quad 3\ 2^{x}$.

Think-Pair: What kind of function is $h\ x$? Explain.

Predict what the graph is going to look like.

How is the 3 going to affect the graph?

$f\ x \quad 2^{x}$

x	2^{x}
2	$\frac{1}{4}$
1	$\frac{1}{2}$
0	1
1	2
2	4

$h\ x \quad 3\ 2^{x}$

x	$3\ 2^{x}$	$x, h\ x$
2	$3\ \frac{1}{4} \quad \frac{3}{4}$	$2, \frac{3}{4}$
1	$3\ \frac{1}{2} \quad \frac{3}{2}$	$1, \frac{3}{2}$
0	$3\ 1 \quad 3$	$0, 3$
1	$3\ 2 \quad 6$	$1, 6$
2	$3\ 4 \quad 12$	

Example 3: Graph the function $f(x) = 4\left(\frac{1}{2}\right)^x$:

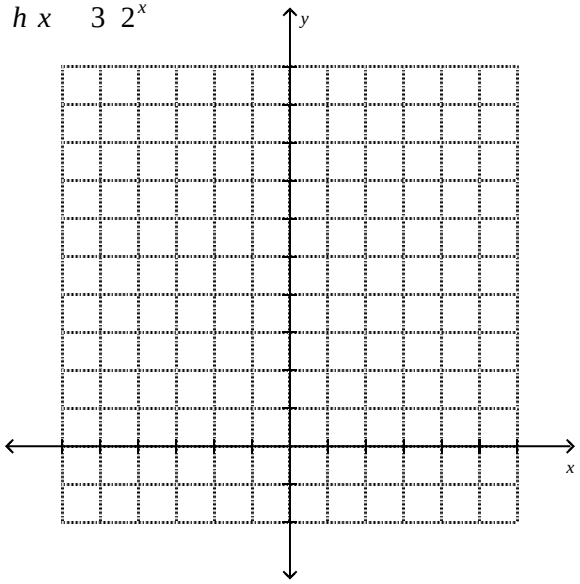
a) Identify and find function values of the parent function.
b) Identify the points of the transformed function.
c) Determine how to draw and label axes.

Try: Partner A: $f(x) = \frac{1}{3}(6^x)$ Partner B: $f(x) = 5\left(\frac{1}{5}\right)^x$

Think-Pair:

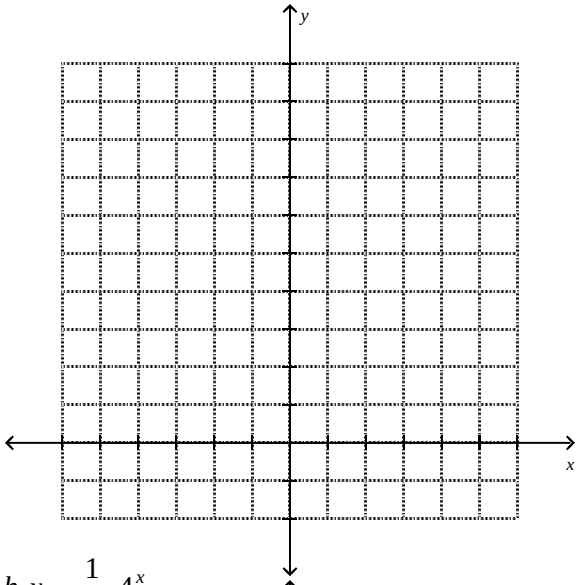
Graphing Exponential Functions (Day 2)

$h(x) = 3 \cdot 2^x$



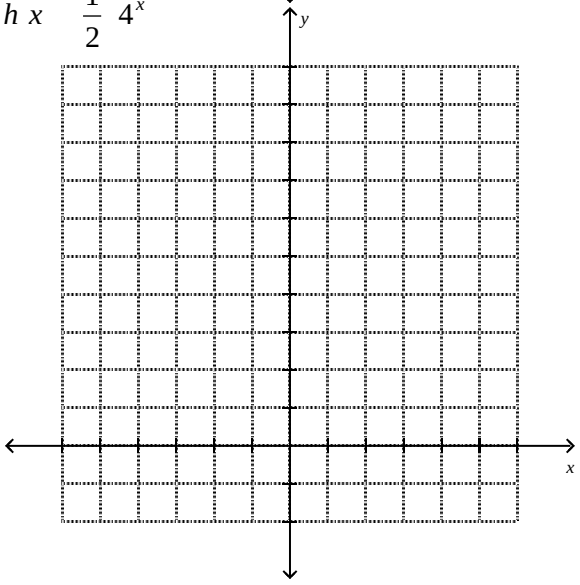
$g(x) = 3 \cdot 2^x$

$h(x) = 4 \cdot 3^x$



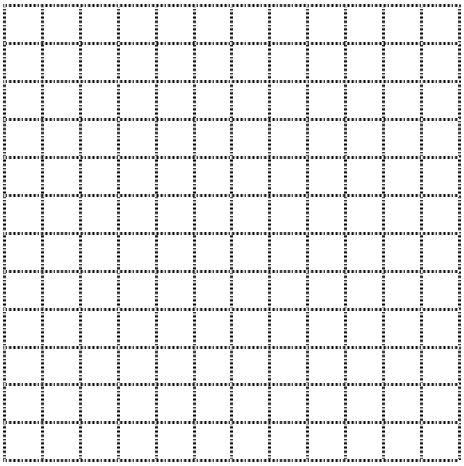
$g(x) = 4 \cdot 3^x$

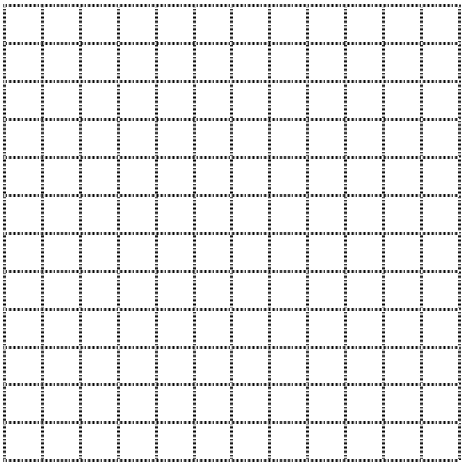
$h(x) = \frac{1}{2} \cdot 4^x$

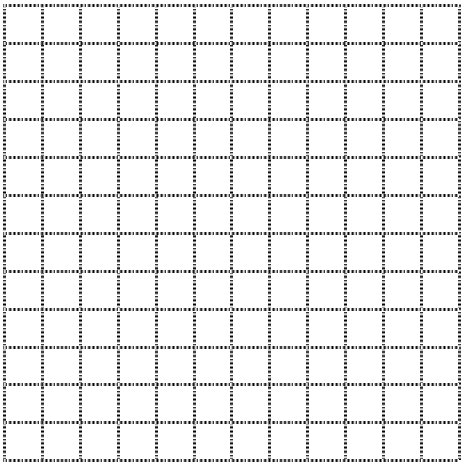


$g(x) = \frac{1}{2} \cdot 4^x$

Graphing Exponential Functions (Day 2)







Lesson Day 3

Think-Pair-Share: Each graph below can be written as a function of the form $f(x) = a \cdot b^x$.
What can you determine about the values of *a* and *b* for each graph?

[redacted]

Think-Pair:

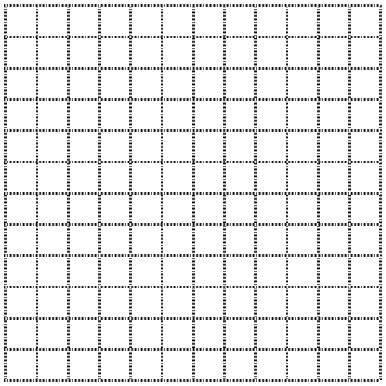
What kind of function is $h(x)$

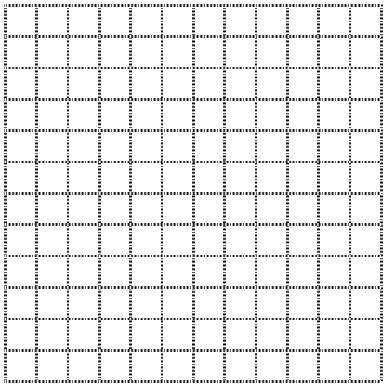
[redacted]

Try: Choose a method and graph the functions.
Method #1- Use an input-output table.
Method #2- Translate the graph of the parent function.

Partner A: $g(x) = 2^{x-2}$ Partner B: $g(x) = 3^{x-2}$

Think-Pair: What kind of functions are they? Explain.
Identify the parent function.
How will you graph the functions?
Each partner graphs their function.
Partners exchange papers, graph their function on partner's paper. Compare and contrast.





Think-Pair-Share: In general, for $f(x) = a\,b^{x-h}$, which of the following are affected when $h \neq 0$?

Domain: [No] **Range:** [No] **Intercept(s):** [Yes] **Asymptotes:** [No]

Discuss:

How does the value of *h* affect the graph of $f(x) = a\,b^{x-h}$?

The value of *h* is the horizontal shift left or right of the parent function *h* units.

If $h < 0$, then the graph shifts right *h* units. If $h > 0$, then the graph shifts left *h* units.

Generalize: To graph the exponential function $f(x) = b^{x-h} + k$, graph the parent function $f(x) = b^x$ and translate the graph horizontally *h* units and vertically *k* units.

Example 3: Graph the function $f(x) = \left(\frac{1}{2}\right)^{x-2} + 3$:

Method 1: Make an input-output table. Start with the *x*-value that makes the exponent zero, then

Method 2: Translate the graph of the parent function.

a) Identify and find points on the parent function.

The parent function is $g(x) = \left(\frac{1}{2}\right)^x$.

b) Identify the vertical and horizontal shift of the parent function.

Find h and k by comparing $f(x) = a\,b^{x-h} + k$ and $f(x) = \left(\frac{1}{2}\right)^{x+2} - 3$.

Since $h = -2$, the horizontal shift is 2 units left and $k = -3$, the vertical shift is 3 units up.

c) Graph $f(x) = \left(\frac{1}{2}\right)^{x+2} - 3$ by translating the points of $f(x) = \left(\frac{1}{2}\right)^x$ 2 units left and 3 units up.

x	$x, \left(\frac{1}{2}\right)^x$	$x-2, \left(\frac{1}{2}\right)^{x+2} - 3$	$f(x) = \left(\frac{1}{2}\right)^{x+2} - 3$
2	2, 4	2 − 2, 4 − 3	4, 7
1	1, 2	1 − 2, 2 − 3	3, 5

Try: Partner A: $f(x) = \left(\frac{1}{3}\right)^{x+2} - 1$ Partner B: $f(x) = 3^{x-1} + 2$

Think-Pair: What kind of functions are they? Explain.
Identify the parent functions.
How will you graph the functions? Choose a method:
Method #1- Use an input-output table.
Method #2- Translate the graph of the parent function.
Each partner graphs their function.

Exit Ticket 1: Identify the key features of the graph of $f(x) = \left(\frac{1}{5}\right)^x$.

Domain:

Range:

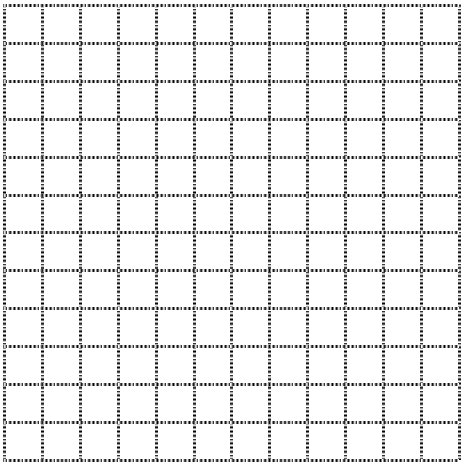
Intercept(s):

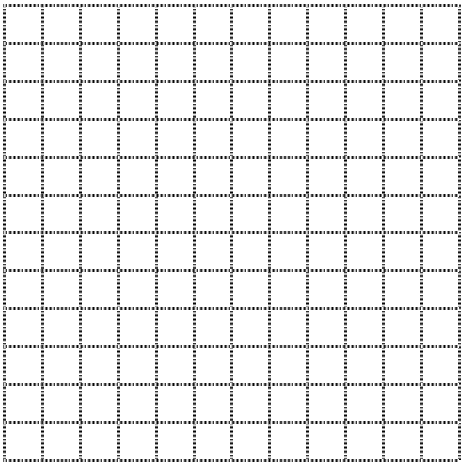
End Behavior:

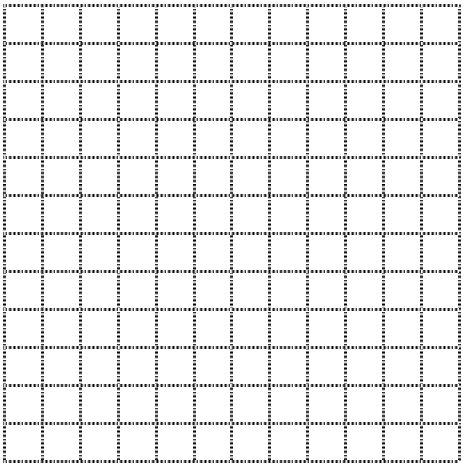
Asymptote:

Exit Ticket 2:

Graphing Exponential Functions (Day 3)







CCSS: N-RN.2

CCSS: F-IF.7a: