9.1 – Exponential Growth  

If the variable is not in the ______________, then it is _____ an exponential function.

\[ y = a(b)^x \]

Condition 1: \( a \neq 0 \)
Condition 2: The base \( b \) is a positive number other than 1.

Identify if the following functions are exponential. If they are, state the initial value and the growth/decay factor. If they’re not, explain why not.

\[
\begin{align*}
\text{Is it exponential?} & \quad a = \quad b = \\
f(x) &= 2^x & \text{(Is it exponential?)} \\
f(x) &= 4x^{-2} & \text{(Is it exponential?)} \\
f(x) &= -3(2.6)^x & \text{(Is it exponential?)} \\
f(x) &= 10(6)^{-x} & \text{(Is it exponential?)} \\
f(x) &= 2(5)^e & \text{(Is it exponential?)}
\end{align*}
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\end{align*}
\]

EXponential Growth FUNCTIONS:

If ________ , then the graph will “grow” away from the asymptote as you move left to right.

The x-axis \((y = 0)\) is an ______________ of the graph. An asymptote is an imaginary line that a graph approaches more and more _________.

Domain: 
Range:
9.1 – Exponential Growth

Are the following graphs exponential growth functions?

1. Graph \( y = \frac{1}{2} \cdot 2^x \)

   - Domain: 
   - Range: 

2. Graph \( y = \frac{1}{2} \cdot 3^x \)

3. Graph \( y = -(2)^x \)

For exponential functions that are in the form \( y = a(b)^x \), the graph will go through:

   \[(0, y_0)\) and \((x, y)\)

and have an asymptote on the \(x\)-axis (that’s the line \( y = 0 \))

Try these examples on your own:

2. Graph \( y = \frac{1}{2} \cdot 3^x \)

   - Domain: 
   - Range: 

3. Graph \( y = -(2)^x \)

   - Domain: 
   - Range:
9.1 – Exponential Growth

TRANSFORMATIONS

\[ y = ab^x - h + k \]

To graph the function above, identify points for the graph of \( y = a(b)^x \), and then translate the graph horizontally (left/right) by ___ units and vertically (up/down) by ___ units.

4. Graph \( y = 2 \cdot 3^{x - 1} - 4 \)

\[ \text{Domain: } \quad \text{Range: } \]

Algebra Skills:

1. Below are graphs of \( f(x) = x^2 \) (thin line) and its translation (bold line). Write an equation of the translation.

2. Simplify the fraction by rationalizing the denominator.

2. \[ \frac{1}{\sqrt{2}} \]

3. \[ \frac{3}{2\sqrt{3}} \]

4. Solve by factoring.

4. \( x^3 - 7x^2 + 12x = 0 \)

5. \( 6x^2 + 13x - 5 = 0 \)
9.1 Practice – Exponential Growth

Name: ____________________

No graphing calculator for these problems!

Next to each function, write “yes” if it is an exponential function. If the answer is “no”, write an explanation why not.

1) \( y = -6(3)^x \)  
2) \( y = 3 \left( \frac{5}{2} \right)^{-x} \)  
3) \( y = 7x^{-3} \)  
4) \( y = 3(-4)^x \)  

5) \( y = 92x^{103} \)  
6) \( y = 14(-8)^x \)  
7) \( y = -5(12)^{2x} \)  
8) \( y = 13(32)^{-2x} \)  

For 9 -17, sketch the graph of each exponential function by doing the following: Sketch the asymptote, label at least two distinct coordinate points on each graph, and write the domain and range of each function.

9. \( y = 2(4)^x \)  
10. \( y = -(3)^x \)  
11. \( y = -2(3)^x \)  

12. \( y = 4(2)^x - 3 \)  
13. \( y = -3(2)^{x-1} \)  
14. \( y = 3(3)^{x+2} - 4 \)
15. \( y = (2)^{x+4} + 1 \)  
16. \( y = -2(2)^{x-2} + 2 \)  
17. \( y = 2(3)^{x+1} - 5 \)

**SAT Prep:**

1. Simplify: \((3^{2x+3})(3^{x-6})\)  
   (A) \(3^{3x-3}\)  
   (B) \(3^{2x^2-18}\)  
   (C) \(9^{2x^2-9x-18}\)  
   (D) \(9^{3x-3}\)

2. If \( f(x) = 4(3)^{x-1} + 2 \), find \( f(0) \).

**9.1 Application and Extension**

1. Is the following an exponential function? If no, why not?  
   \[ y = 6(-3)^{2x} \]

2. Write down three coordinate points for the graph of \( f(x) = 3(2)^{x-1} + 2 \)
Recall from your notes that \( y = a(b)^x \) represents an exponential function where the initial value is \( a \) and the growth factor is \( b \).

**Example:** Mr. Kelly had 2 friends at the start of 9th grade. This grew by 3% every month (which means a growth factor of 1.03). The model that represents this function is: \( F = 2(1.03)^m \)

3. The student body at K-Town high school is raising money for the “Get Sully a Date” campaign. The Algebros contribute $50 to get things started. After that, the students increase the balance by 45% a week (a growth factor of 1.45).
   a. Write a model that represents this situation.
   b. Using your model from part a, how much money will the students raise after a semester (18 weeks)?

4. Mr. Brust has played in a recent Faculty vs. Student basketball game. During the first quarter, he had 6 turnovers. His total number of turnovers increased by 13% each quarter (a growth factor of 1.13).
   a. Write a model that represents this situation.
   b. Using the model, calculate how many turnovers he will have halfway through the 4th quarter.
   c. How many quarters would he have to play to have 100 turnovers? (Hint: You have not learned how to solve for a variable in the exponent yet. Instead, graph the line \( y = 100 \) with a graphing calculator and see where it intersects your model.)

5. After www.flippedmath.com was created, the number of hits was tracked. The table shows the number of hits in each of the first 10 months where \( x \) is the month number.

<table>
<thead>
<tr>
<th>( x )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>22</td>
<td>39</td>
<td>70</td>
<td>126</td>
<td>227</td>
<td>408</td>
<td>735</td>
<td>1322</td>
<td>2380</td>
<td>4285</td>
</tr>
</tbody>
</table>

a. Enter the values into two separate lists on a graphing calculator.
   STEP 1: Hit \( \text{STAT} \) and then option 1.
   STEP 2: Enter \( x \)-values into List 1.
   STEP 3: Enter \( y \)-values into List 2.

b. Calculate an exponential model and write the equation below. (Round to 3 decimals.)
   STEP 1: Hit \( \text{STAT} \), then right for the “CALC” menu.
   STEP 2: Scroll down until you can choose “ExpReg”
   STEP 3: Hit Enter and calculate the “\( a \)” and “\( b \)”.

\[
y = \______________________________
\]

c. According to your model from part b, how many hits do you expect in the 12th month?

d. According to your model in part b, how many hits would there be in the 41st month? What is wrong with this number?