4.6 Transformations of Exponential Functions

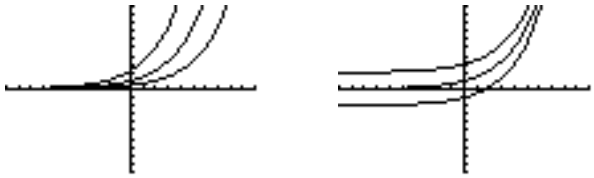
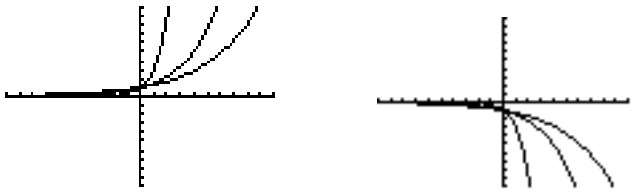
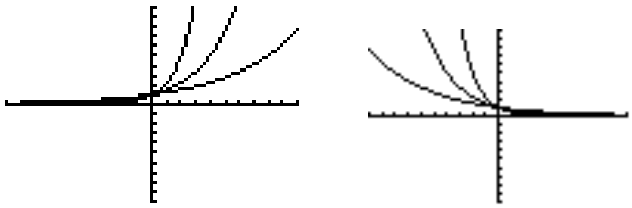
Once you understand the basic shape of an exponential function, you can apply your understanding of transformations to easily graph a variety of related curves.

You should be familiar with the following types of transformations:

$$y = ab^{k(x-d)} + c$$

- c and d → translate
- a and k → stretch/compress/reflect

- Exponential functions can be transformed in the same way as other functions.
- The graph of $y = ab^{k(x-d)} + c$ can be found by performing the following transformations on the graph of the base $y = b^x$:

Horizontal and Vertical Translations - If d > 0, translate right d units; If d < 0, translate left. - If c > 0, translate up c units; If c < 0, translate down.	
Vertical Stretches, Compressions, and Reflections - If a > 1, stretch vertically by a factor of a. - If 0 < a < 1, compress vertically by a factor of a. - If a < 0, reflect in the x-axis and stretch or compress.	
Horizontal Stretches, Compressions, and Reflections - If k > 1, compress horizontally by a factor of $\frac{1}{k}$ - If 0 < k < 1, stretch horizontally by a factor of $\frac{1}{k}$ - If k < 0, reflect in the y-axis and stretch or compress.	

- Some exponential functions can easily be written using different bases. For example, $y = 2^{4x}$ is equivalent to $y = 16^x$.

1. Describe the transformations that map the function $y = 2^x$ onto each of the following functions.

a) $y = 2^x - 2$ **b)** $y = 2^{x+3}$ **c)** $y = 4^x$ **d)** $y = 3(2^{x-1}) + 1$

2. Create a graph for each equation in question 1.

3. a) Graph the function $y = 16^x$.

b) For this graph, identify the

i) domain and range

ii) *x*-and *y*-intercepts, if any exist

iii) equation of the asymptote

4. Consider the function $y = 16^x$.

a) Write the function using a base of 4.

b) Write the function using a base of 2.

c) Explain how you can determine if these functions are the same equation.

5. a) Write an equation for a transformed exponential function with a *y*-intercept of 4 and an asymptote of $y = 1$.

b) Is this function the only possible function with the given properties? Explain.

6. For the function $y = -3(5^{x+1}) - 3$, Rayanna takes the function $y = 5^x$ and moves it to the left 1 unit, moves it down 3 units, increases the *y*-values by a factor of 3, and then reflects the result in the *x*-axis.

a) Is Rayanna's graph correct? Explain why or why not.

b) Is there only one order in which to apply the transformations that will result in a correct graph? Explain.

7. a) Give an example of a transformed graph involving at least three transformations and indicate the order in which the transformations must be applied to obtain the graph.

b) Provide a graph of the base function and, on the same axes, a graph for each resulting function after each transformation has been applied.

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