



# Transformation of Exponential Functions

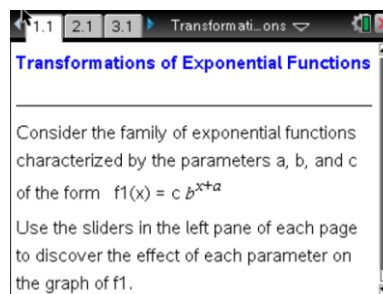
## Student Activity

Name \_\_\_\_\_

Class \_\_\_\_\_

Open the TI-Nspire document *Transformations\_of\_Exponential\_Functions.tns*.

The purpose of this activity is to examine the family of exponential functions of the form  $f(x) = c b^{x+a}$  where  $a$ ,  $b$ , and  $c$  are parameters. At the end of this activity, you will use your results to match each function with its corresponding graph.



Note: The parameter  $b$  is the base of the exponential function and  $b > 0, b \neq 1$ .

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Press **ctrl** and **ctrl** to navigate through the lesson.

1. The graph of  $y = f1(x) = b^x$  is shown in the right panel. Click the arrows in the left panel to change the value of  $b$ , and observe the changes in the graph of  $f1$ .
  - a. Explain why for every value of  $b$ , the graph of  $f1$  passes through the point  $(0,1)$ .
  - b. For  $b > 1$ , describe the graph of  $y = f1(x) = b^x$ .
  - c. For  $0 < b < 1$ , describe the graph of  $y = f1(x) = b^x$ .
  - d. Find the domain and range of function  $f1(x) = b^x$ .
  - e. Does the graph of  $y = b^x$  intersect the  $x$ -axis? Explain why or why not.



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2. The graph of  $y = f1(x) = b^{x+a}$  is shown in the right panel. For a specific value of  $b$ , click the arrows to change the value of  $a$  and observe the changes in the graph of  $f1$ . Repeat this process for other values of  $b$ .
  - a. Describe the effect of the parameter  $a$  on the graph of  $y = b^{x+a}$ . Discuss the effects of both positive and negative values of  $a$ .

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3. The graph of  $y = f1(x) = c \cdot b^{x+a}$  is shown in the right panel. For specific values of  $a$  and  $b$ , click the arrows to change the value of  $c$ , and observe the changes in the graph of  $f1$ . Repeat this process for other values of  $a$  and  $b$ .
  - a. Describe the effect of the parameter  $c$  on the graph of  $y = c \cdot b^{x+a}$ . Discuss the effects of both positive and negative values of  $c$ .

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4. Display the graphs of  $y = f1(x) = 3^{x+2}$  and  $y = f2(x) = 9 \cdot 3^x$ .
  - a. Describe the similarities between these two graphs. Use the properties of exponents to justify your answer.
  - b. Insert a new problem, and display the graph of  $y = f1(x) = 3^{x-2}$ . Use the properties of exponents to find a function of the form  $f2(x) = c \cdot 3^x$  such that the graphs of  $f1$  and  $f2$  are the same. Verify your answer.
  - c. Use your answers to parts (a) and (b) to explain the relationship between a horizontal translation and a vertical stretch of the graph of an exponential function.



5. Match each equation with its corresponding graph.

(a)  $f(x) = 3^{x-4}$

(b)  $f(x) = -\left(\frac{1}{3}\right)^x$

(c)  $f(x) = (0.7)^{x-4}$

(d)  $f(x) = -2(0.1)^{x+3}$

(e)  $f(x) = e^x$

(f)  $f(x) = -\left(\frac{1}{2}\right) \cdot \pi^x$

Note: The function in part (e) is the “natural” exponential function and involves the number  $e \approx 2.71828\dots$

