Transformations of Logarithmic Functions

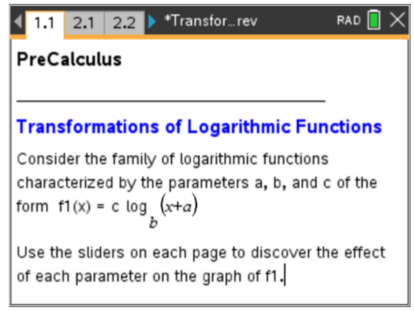
Student Activity

Name ______________

Class ______________

Open the TI-Nspire document *Transformations_of_ Logarithmic_Functions.tns.*

In this activity, you will examine the family of logarithmic functions of the form $f(x) = c\log_b(x+a)$ where a, b, and c are parameters.



The parameter b is the base of the logarithmic function and $b > 0, b \neq 1$. Using the sliders in the left panel of each page, change the value of a parameter, and record the effect of each parameter change on the graph of the corresponding logarithmic function. At the end of this activity, use your results to match each function with its corresponding graph.

Note: The slider for the base b is constructed to use the specific values in the column labeled **blist** in the Lists & Spreadsheets page.

Move to page 2.1.

1. The graph of $y = f1(x) = \log_b x$ is shown in the right panel. Click the arrows 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 $(1,0)$.

   b. For $b > 1$, describe the graph of $y = f1(x) = \log_b x$.

   c. For $0 < b < 1$, describe the graph of $y = f1(x) = \log_b x$.

   d. Find the domain and range of function $f1(x) = \log_b x$ for all possible values of b.

   e. Describe the behavior of the graph of $y = \log_b x$ near the y-axis in words and by writing it in limit notation.

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2. The graph of $y = f1(x) = \log_b(x+a)$ is shown in the right panel. For various (fixed) values of b, click the arrows to change the value of a, and observe the changes in the graph of $f1$. Describe the effect of the parameter a on the graph of $y = \log_b(x+a)$.

Move to page 4.1.

3. The graph of $y = f1(x) = c \cdot \log_b(x+a)$ is shown in the right panel. For various (fixed) values of a and b, click the arrows to change the value of c, and observe the changes in the graph of $f1$. Describe the effect of the parameter c on the graph of $y = c \cdot \log_b(x+a)$.

Move to page 5.1.

4. Consider a logarithmic function of the form $f(x) = \log_b(dx)$ where d is a constant. Use this Graphs Page (without sliders) to interpret the graph of $y = f(x)$ as a common transformation.
   a. Display the graphs of $y = f1(x) = \log_4(x)$ and $y = f2(x) = \log_4(16x)$.
      (i) How is the graph of $f2$ related to the graph of $f1$?

      (ii) Using the properties of logarithms, rewrite the function $f2$ in terms of $f1$ to justify your answer.

      (iii) Describe the two equivalent transformations that $f2(x) = \log_4(16x)$ performs on the parent function $f1(x) = \log_4 x$.

   b. Display the graphs of $y = f1(x) = \log_3(x)$ and $y = f2(x) = \log_3\left(\frac{x}{27}\right)$.
      (i) How is the graph of $f2$ related to the graph of $f1$?

      (ii) Using the properties of logarithms, rewrite the function $f2$ in terms of $f1$ to justify your answer.

(iii) Describe the two equivalent transformations that $f2(x) = \log_3\left(\frac{x}{27}\right)$ performs on the parent function $f1(x) = \log_3 x$.

5. Without using your calculator, match each equation with its corresponding graph below.

(a) $f(x) = \log_3(x+4)$

(b) $f(x) = \log_{1/4}(x)$

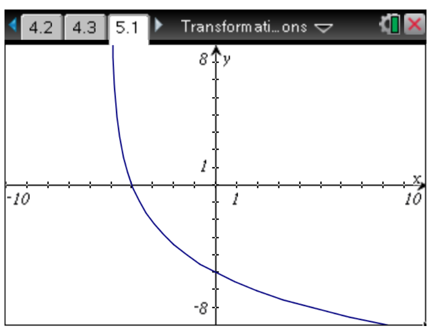
(c) $f(x) = -\log_4(x-2)$

(d) $f(x) = -3\log_{1/2}(x+1)$

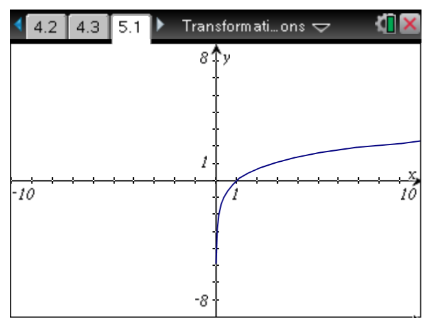
(e) $f(x) = \log_e(x) = \ln x$

(f) $f(x) = 5\log_{1/5}(x+5)$

(i)



(ii)



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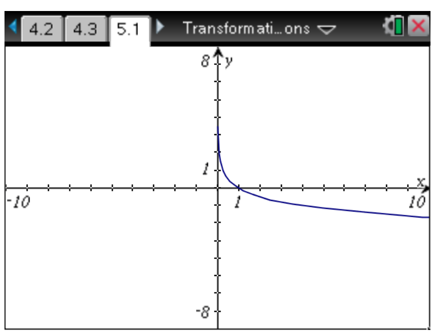

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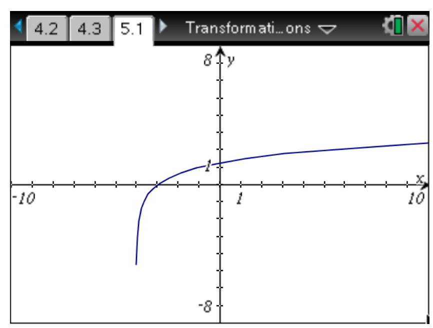

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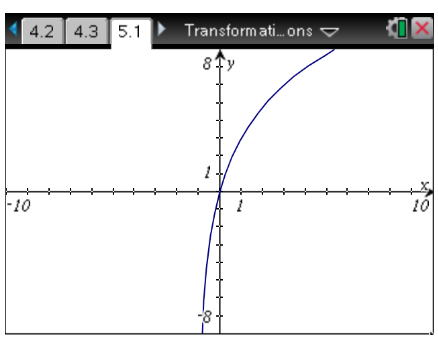

(vi)