Open the TI-Nspire document *Exponential_Transformations.tns*.

The graph of any function can be moved on the x- and y-axes by following a few rules. In this activity, you will discover these rules for exponential functions.

\[ y = a \cdot \text{base}^{(x-h)} + k \]

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For this activity, the function used is \( y = a \cdot 3^{(x-h)} + k \). This activity’s investigations also work for any base \( b \) such that \( b > 0 \) and \( b \neq 1 \).

1. a. What effect does dragging the \( k \)-value have on the parent function \( y = 3^x \)? What happens algebraically to the point \((0, 1)\) in terms of \( k \) as the graph is translated up or down?

   b. Name the transformation, including its distance and direction, when the function \( y = 3^x \) changes to \( y = 3^x + 2 \). How does the point \((0, 1)\) change?

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2. Change the \( h \)-value by grabbing and dragging the slider.
   a. What happens to the equation and graph when \( h > 0 \)?

   b. Christina says that the point \((0, 1)\) on the parent function translates to \((-2, 1)\) when she drags the \( h \)-value to \(-2 \) because the \( y \)-value is being multiplied by \(-2 \). Is her explanation mathematically correct? Explain. Change the \( h \)-value and confirm your explanation by grabbing and dragging the slider.

   c. Name the transformation, including its distance and direction, when the function \( y = 3^x \) changes to \( y = 3^{x-2} \).
3. Change the $a$-value by clicking on the arrows.
   a. When the $a$-value is 0.5, explain why the point (1, 3) becomes the transformed point (1, 1.5).

   b. What happens to the point (1, 3) when the function changes from $y = 3^x$ to $y = 2 \cdot 3^x$? What transformation occurred?

4. Change the $b$-value by clicking on the arrows.
   a. When $b < 0$, what happens to the point (0, 1)? If $b < 0$, what happens to the graph?

   b. What other effects does the $b$-value have on the graph?

   c. Suppose the function changes from $y = 3^x$ to $y = 3^{2x}$. Describe the transformation that occurs.

5. Apply what you have learned and change the values of $h$ and $k$ (by dragging their sliders) and of $a$ and $b$ (by clicking their arrows) so that in the displayed domain, the solid graph is transformed to the dashed graph. It will say Correct! when you have done it correctly.

Write the function you arrived at here. Describe your thought process of getting to the answer.
6. David says that positive $a$-values greater than 1 cause the function to stretch vertically. Is he correct? Explain.

7. Leon says that changing $y = 3^x$ to $y = 3^{x+4}$ results in its graph having a horizontal translation of 4 units to the right. Is Leon correct? Why or why not?

8. a. Write the function that transforms $y = \sqrt{x}$ horizontally to the left 5 units and has a vertical dilation factor of 3.

b. Write the function that transforms $y = |x|$ with a vertical translation up 3 units.