Activity

6-1 Key Features of Exponential Functions

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EXPLORE & REASON

Margaret investigates three functions: $y = 3x$, $y = x^3$, and $y = 3^x$. She is interested in the differences and ratios between consecutive y-values. Here is the table she started for $y = 3x$.

Investigating $y = 3x$			
x	y	Difference between y-values	Ratio between y-values
1	3		
2	6	$6 - 3 = 3$	$\frac{6}{3} = 2$
3	9	$9 - 6 = 3$	$\frac{9}{6} = 1.5$
4	12	$12 - 9 = 3$	$\frac{12}{9} \approx 1.33$

A. Create tables like Margaret's for all three functions and fill in more rows.

B. Which functions have a constant difference between consecutive y-values? Constant ratio?

C. **Reason** Which of these three functions will have y-values that increase the fastest as x increases? Why? MP.2

HABITS OF MIND

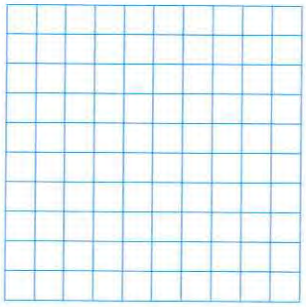
Generalize Let b represent a whole number. For $b > 1$, which function do you think will increase at a faster rate as x increases, $f(x) = b^x$ or $g(x) = x^b$? Explain. MP.8

Notes

Assess

EXAMPLE 1 **Try It! Identify Key Features of Exponential Functions**

1. Graph $f(x) = 4(0.5)^x$. What are the domain, range, intercept, asymptote, and the end behavior for this function?



EXAMPLE 2 **Try It! Graph Transformations of Exponential Functions**

2. How do the asymptote and intercept of the given function compare to the asymptote and intercept of the function $f(x) = 5^x$?

   a. $g(x) = 5^{x+3}$

   b. $h(x) = 5^{-x}$

HABITS OF MIND

Reason What kinds of transformations will affect the asymptote or the intercept(s) of an exponential function? Explain. MP.2

Notes

Assess

EXAMPLE 3 **Try It! Model with Exponential Functions**

3. A factory purchased a 3D Printer in 2010. The value of the printer is modeled by the function $f(x) = 30(0.93)^x$, where x is the number of years since 2010.
   a. What is the value of the printer after 10 years?

   b. Does the printer lose more of its value in the first 10 years or in the second?

EXAMPLE 4 **Try It! Interpret an Exponential Function**

4. Two-hundred twenty hawks were released into a region in 2016. The function $f(x) = 220(1.05)^x$ can be used to model the number of red-tailed hawks in the region x years after 2016.
   a. Is the population increasing or decreasing? Explain.

   b. In what year will the number of hawks reach 280?

HABITS OF MIND

Use Structure How can you determine the growth or decay factor by looking at an exponential function? The growth or decay rate? MP.7

EXAMPLE 5 **Try It! Compare Two Exponential Functions**

5. In Example 5, will the value of the painting ever surpass the value of the sculpture according to the models? Explain.

HABITS OF MIND

Reason For two functions $f(x) = b^x$ and $g(x) = b^{x+n}$, where $n > 0$, is it possible that the two graphs will intersect? Explain. MP.2

Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** How do graphs and equations reveal key features of exponential growth and decay functions?

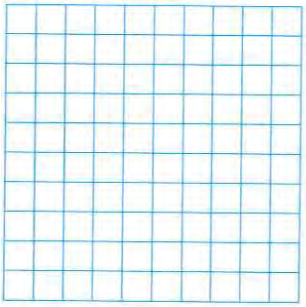
2. **Vocabulary** How do *exponential functions* differ from polynomial and rational functions?

3. **Error Analysis** Charles claimed the function $f(x) = \left(\frac{3}{2}\right)^x$ represents exponential decay. Explain the error Charles made. MP.3

4. **Communicate Precisely** How are exponential growth functions similar to exponential decay functions? How are they different? MP.6

Do You KNOW HOW?

5. Graph the function $f(x) = 4 \times 3^x$. Identify the domain, range, intercept, asymptote, and describe the end behavior.



6. The exponential function $f(x) = 2500(0.4)^x$ models the amount of money in Zachary's savings account over the last 10 years. Is Zachary's account balance increasing or decreasing? Write the base in terms of the rate of growth or decay.

7. Describe how the graph of $g(x) = 4(0.5)^{x-3}$ compares to the graph of $f(x) = 4(0.5)^x$.

8. Two trucks were purchased by a landscaping company in 2016. Their values are modeled by the functions $f(x) = 35(0.85)^x$ and $g(x) = 46(0.75)^x$ where x is the number of years since 2016. Which function models the truck that is worth the most after 5 years? Explain.