Instruction

Guided Practice 1.3.2

Example 1

If a pendulum swings to 90% of its height on each swing and starts out at a height of 60 cm, what is the equation that models this scenario? What is its graph?

1. Read the problem statement and then reread the scenario, identifying the known quantities.

   Initial height = 60 cm

   Decay rate = 90% or 0.90

2. Substitute the known quantities into the general form of the exponential equation $y = ab^x$, where a is the initial value, b is the rate of decay, x is time (in this case swings), and y is the final value.

   $a = 60$

   $b = 0.90$

   $y = ab^x$

   $y = 60(0.90)^x$

3. Create a table of values.

x	y
0	60
1	54
2	48.6
3	43.74
5	35.43
10	20.92
20	7.29
40	0.89

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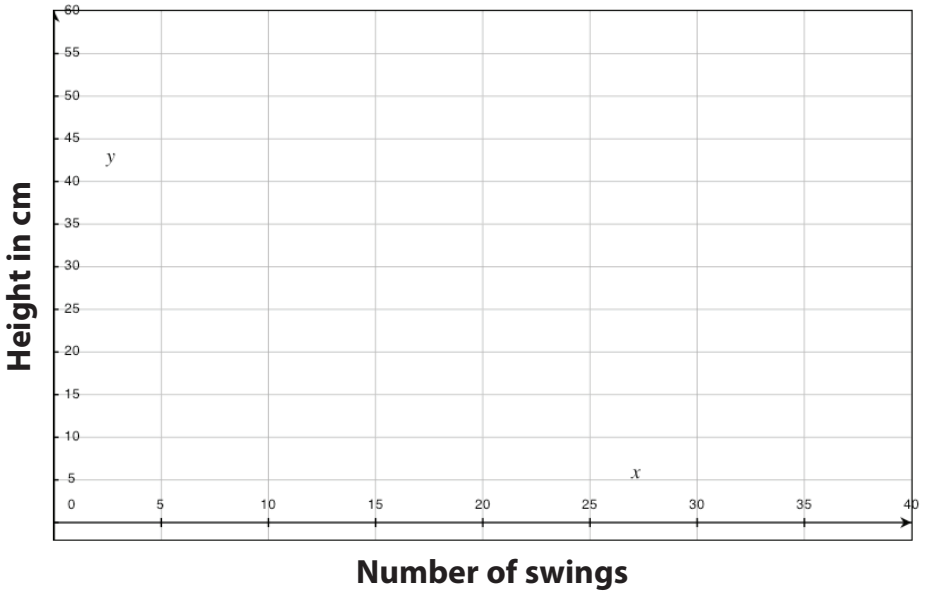
4. Set up the coordinate plane.

   Determine the labels by reading the problem again. The independent variable is the number of swings. That will be the label of the *x*-axis. The *y*-axis label will be the height. The height is the dependent variable because it depends on the number of swings.

   To determine the scales, examine the table of values. The *x*-axis needs a scale that goes from 0 to 40. Counting to 40 in increments of 1 would cause the axis to be very long. Use increments of 5. For the *y*-axis, start with 0 and go to 60 in increments of 5. This will make plotting numbers like 43.74 a little easier than if you chose increments of 10.



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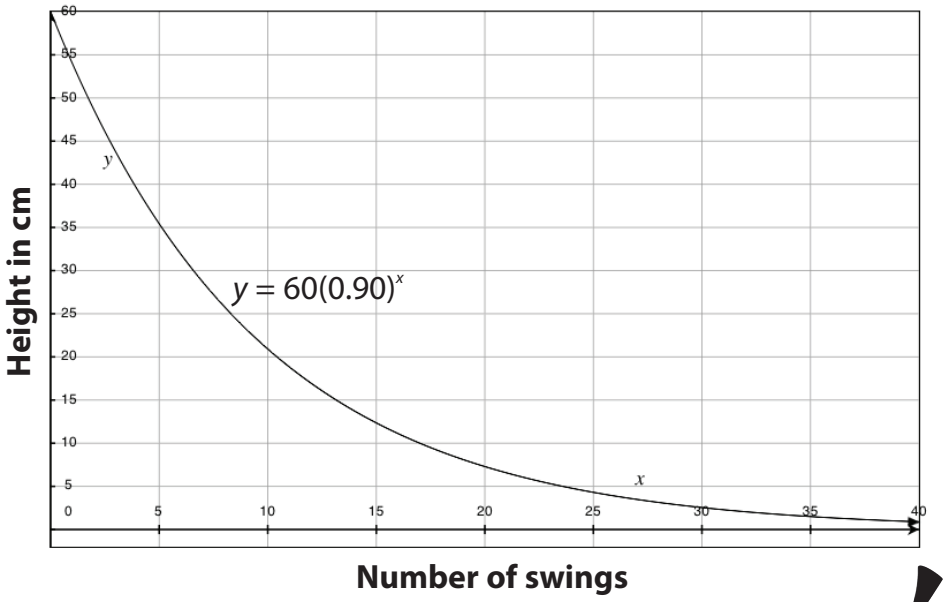
5. Plot the points on the coordinate plane and connect the points with a line (curve).

   When the points do not lie on a grid line, use estimation to approximate where the point should be plotted. Add an arrow to the right end of the line to show that the curve continues in that direction toward infinity.



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Example 2

The bacteria *Streptococcus lactis* doubles every 26 minutes in milk. If a container of milk contains 4 bacteria, write an equation that models this scenario and then graph the equation.

1. Read the problem statement and then reread the scenario, identifying the known quantities.

   Initial bacteria count = 4

   Base = 2

   Time period = 26 minutes

2. Substitute the known quantities into the general form of the exponential equation $y = ab^x$, for which a is the initial value, b is the base, x is time (in this case, 1 time period is 26 minutes), and y is the final value. Since the base is repeating in units other than 1, use the equation $y=ab^{\frac{x}{t}}$, where $t = 26$.

   $a = 4$

   $b = 2$

   $y=ab^{\frac{x}{26}}$

   $y=4(2)^{\frac{x}{26}}$

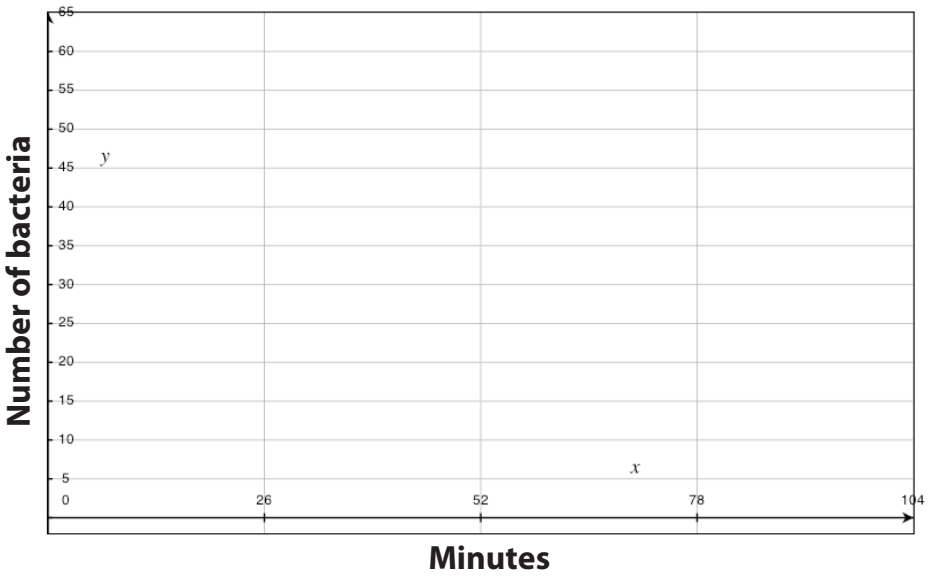
3. Create a table of values.

x	y
0	4
26	8
52	16
78	32
104	64

4. Set up the coordinate plane.

   Determine the labels by reading the problem again. The independent variable is the number of time periods. The time periods are in number of minutes. Therefore, "Minutes" will be the *x*-axis label. The *y*-axis label will be the "Number of bacteria." The number of bacteria is the dependent variable because it depends on the number of minutes that have passed.

   The *x*-axis needs a scale that reflects the time period of 26 minutes and the table of values. The table of values showed 4 time periods. One time period = 26 minutes and so 4 time periods = 4(26) = 104 minutes. This means the *x*-axis scale needs to go from 0 to 104. Use increments of 26 for easy plotting of the points. For the *y*-axis, start with 0 and go to 65 in increments of 5. This will make plotting numbers like 32 a little easier than if you chose increments of 10.



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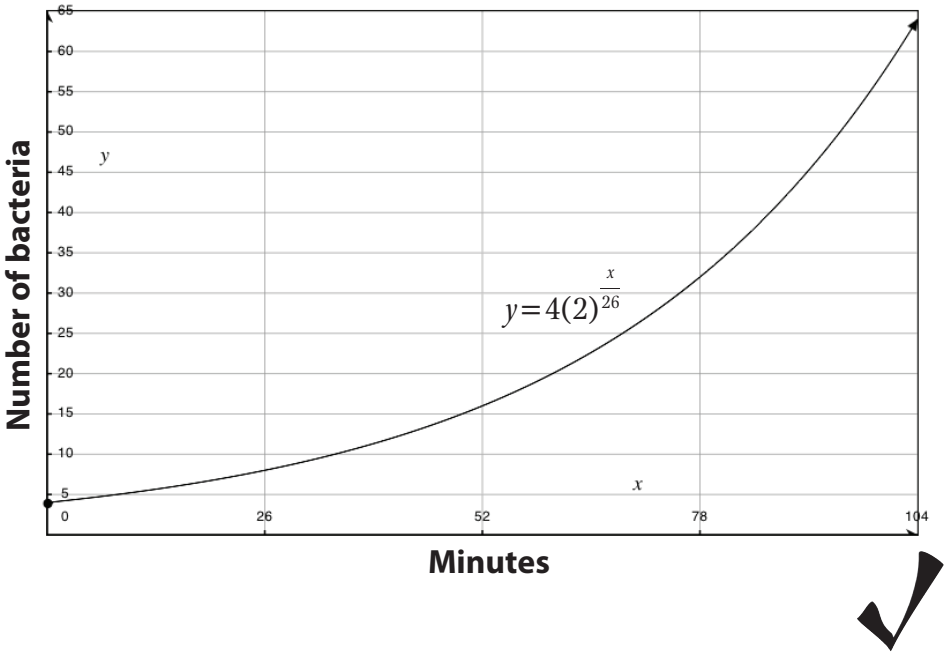
5. Plot the points on the coordinate plane and connect the points with a line (curve).

   When the points do not lie on a grid line, use estimation to approximate where the point should be plotted. Add an arrow to the right end of the line to show that the curve continues in that direction toward infinity.



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Example 3

An investment of $500 is compounded monthly at a rate of 3%. What is the equation that models this situation? Graph the equation.

1. Read the problem statement and then reread the scenario, identifying the known quantities.

   Initial investment = $500

   r = 3%

   Compounded monthly = 12 times a year

2. Substitute the known quantities into the general form of the compound interest formula, $A = P\left(1 + \frac{r}{n}\right)^{nt}$, for which P is the initial value, r is the interest rate, n is the number of times the investment is compounded in a year, and t is the number of years the investment is left in the account to grow.

   $P = 500$

   $r = 3\% = 0.03$

   $n = 12$

   $A = P\left(1 + \frac{r}{n}\right)^{nt}$

   $A = 500\left(1 + \frac{0.03}{12}\right)^{12t}$

   $A = 500(1.0025)^{12t}$

   Notice that, after simplifying, this form is similar to $y = ab^x$. To graph on the x- and y-axes, put the compounded interest formula into this form, where $A = y$, $P = a$, $\left(1 + \frac{r}{n}\right) = b$, and $t = x$.

   $A = 500(1.0025)^{12t}$ becomes $y = 500(1.0025)^{12x}$.

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3. Graph the equation using a graphing calculator.

On a TI-83/84:

Step 1: Press [Y=].

Step 2: Type in the equation as follows: [500][×][1.0025][^][12][X, T, θ, *n*]

Step 3: Press [WINDOW] to change the viewing window.

Step 4: At Xmin, enter [0] and arrow down 1 level to Xmax.

Step 5: At Xmax, enter [10] and arrow down 1 level to Xscl.

Step 6: At Xscl, enter [1] and arrow down 1 level to Ymin.

Step 7: At Ymin, enter [500] and arrow down 1 level to Ymax.

Step 8: At Ymax, enter [700] and arrow down 1 level to Yscl.

Step 9: At Yscl, enter [15].

Step 10: Press [GRAPH].

On a TI-Nspire:

Step 1: Press the [home] key.

Step 2: Arrow over to the graphing icon and press [enter].

Step 3: At the blinking cursor at the bottom of the screen, enter in the equation [500][×][1.0025][^][12x] and press [enter].

Step 4: To change the viewing window: press [menu], arrow down to number 4: Window/Zoom, and click the center button of the navigation pad.

Step 5: Choose 1: Window settings by pressing the center button.

Step 6: Enter in the appropriate XMin value, [0], and press [tab].

Step 7: Enter in the appropriate XMax value, [10], and press [tab].

Step 8: Leave the XScale set to "Auto." Press [tab] twice to navigate to YMin and enter [500].

Step 9: Press [tab] to navigate to YMax. Enter [700]. Press [tab] twice to leave YScale set to "Auto" and to navigate to "OK."

Step 10: Press [enter].

Step 11: Press [menu] and select 2: View and 5: Show Grid.

Note: To determine the *y*-axis scale, show the table to get an idea of the values for *y*. To show the table, press [ctrl] and then [T]. To turn the table off, press [ctrl][tab] to navigate back to the graphing window and then press [ctrl][T] to turn off the table.

4. Transfer your graph from the screen to graph paper.

   Use the same scales that you set for your viewing window.

   The *x*-axis scale goes from 0 to 10 years in increments of 1 year.

   The *y*-axis scale goes from \$500 to \$700 in increments of \$15. You'll need to show a break in the graph from 0 to 500 with a zigzag line.