Quadratic Functions
Chapter 4 Lesson 8
Determine whether each table represents a linear or nonlinear function. Explain.

1. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 1 & 8 & 27 & 64 \\
\end{array}
\]

2. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 3 & 3\frac{1}{2} & 4 & 4\frac{1}{2} \\
\end{array}
\]

3. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 7 & 16 & 31 & 52 \\
\end{array}
\]

4. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 12 & 6 & 4 & 3 \\
\end{array}
\]

5. √ TEST PRACTICE Which table represents a nonlinear function?

- A. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 8 & 11 & 14 & 17 \\
\end{array}
\]

- B. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 5 & 4 & 3\frac{2}{3} & 3\frac{1}{2} \\
\end{array}
\]

- C. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 4\frac{1}{2} & 5 & 5\frac{1}{2} & 6 \\
\end{array}
\]

- D. \[
\begin{array}{c|c|c|c|c|}
  x & 1 & 2 & 3 & 4 \\
  y & 1 & \frac{1}{3} & \frac{1}{3} & -1 \\
\end{array}
\]
Answers to Quick Check

1. Nonlinear; the rate of change is not constant.
2. Linear; the rate of change is $-\frac{1}{2}$.
3. Nonlinear; the rate of change is not constant.
4. Nonlinear; the rate of change is not constant.
5. B
Objective

❖ Students will learn to graph quadratic functions.
In the previous lesson, you learned about nonlinear functions. A special type of a nonlinear function is a quadratic function. A **quadratic function** is a function in which the greatest power of the variable is 2. Its graph is U-shaped, opening upward or downward.
Why is it called a quadratic?

Because quadratum is the Latin word for square, and since the area of a square of side length $x$ is given by $x^2$, a polynomial equation having exponent two is known as a quadratic ("square-like") equation.
A quadratic function can be written in the form \( y = ax^2 + bx + c \), where \( a \neq 0 \). The graph of a quadratic function is called a parabola. The graph opens upward if the coefficient of the variable that is squared is positive, downward if it is negative.

Video – 6 mins
Real-World Link

Read this problem and draw out the pattern on the soccer ball. Does this represent a linear function? Explain.

During soccer practice, Kris kicked a soccer ball straight into the air. The height $h$ in feet of the ball after $t$ seconds can be determined by using the equation $h = -16t^2 + 40t + 2$. What is the height of the ball after 1.5 seconds?

$h = -16(1.5)^2 + 40(1.5) + 2$

26ft
1. Graph $y = x^2$.

To graph a quadratic function, make a table of values, plot the ordered pairs, and connect the points with a smooth curve.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$x^2$</th>
<th>$y$</th>
<th>$(x, y)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-2$</td>
<td>$-(2)^2$</td>
<td>4</td>
<td>$(-2, 4)$</td>
</tr>
<tr>
<td>$-1$</td>
<td>$-(1)^2$</td>
<td>1</td>
<td>$(-1, 1)$</td>
</tr>
<tr>
<td>0</td>
<td>$(0)^2$</td>
<td>0</td>
<td>$(0, 0)$</td>
</tr>
<tr>
<td>1</td>
<td>$(1)^2$</td>
<td>1</td>
<td>$(1, 1)$</td>
</tr>
<tr>
<td>2</td>
<td>$(2)^2$</td>
<td>4</td>
<td>$(2, 4)$</td>
</tr>
</tbody>
</table>
2. Graph $y = -x^2 + 4$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-x^2 + 4$</th>
<th>$y$</th>
<th>$(x, y)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>$-(2)^2 + 4$</td>
<td>0</td>
<td>$(-2, 0)$</td>
</tr>
<tr>
<td>-1</td>
<td>$-(1)^2 + 4$</td>
<td>3</td>
<td>$(-1, 3)$</td>
</tr>
<tr>
<td>0</td>
<td>$-(0)^2 + 4$</td>
<td>4</td>
<td>$(0, 4)$</td>
</tr>
<tr>
<td>1</td>
<td>$-(1)^2 + 4$</td>
<td>3</td>
<td>$(1, 3)$</td>
</tr>
<tr>
<td>2</td>
<td>$-(2)^2 + 4$</td>
<td>0</td>
<td>$(2, 0)$</td>
</tr>
</tbody>
</table>

2. 

![Graph of $y = -x^2 + 4$](image)

$y = -x^2 + 4$
Now you try!

1. Graph $y = 5x^2$.

2. Graph $y = -x^2 - 2$. 
Answers to Practice Problems

1.

2.
3. The function \( d = 4t^2 \) represents the distance \( d \) in feet that a race car will travel over \( t \) seconds with a constant acceleration of 8 feet per second. Graph the function. Then use the graph to find how much time it will take for the race car to travel 200 feet.

1. Time cannot be negative, so only use positive values of \( t \).

<table>
<thead>
<tr>
<th>( t )</th>
<th>( d = 4t^2 )</th>
<th>(( t, d ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4(0)^2 = 0</td>
<td>(0, 0)</td>
</tr>
<tr>
<td>1</td>
<td>4(1)^2 = 4</td>
<td>(1, 4)</td>
</tr>
<tr>
<td>2</td>
<td>4(2)^2 = 16</td>
<td>(2, 16)</td>
</tr>
<tr>
<td>3</td>
<td>4(3)^2 = 36</td>
<td>(3, 36)</td>
</tr>
<tr>
<td>4</td>
<td>4(4)^2 = 64</td>
<td>(4, 64)</td>
</tr>
<tr>
<td>5</td>
<td>4(5)^2 = 100</td>
<td>(5, 100)</td>
</tr>
<tr>
<td>6</td>
<td>4(6)^2 = 144</td>
<td>(6, 144)</td>
</tr>
</tbody>
</table>

2. Locate 200 on the vertical axis. Move over to the graph and locate the corresponding value for the time.

3. The car will travel 200 feet after about 7 seconds.
4. The function \( h = 0.66d^2 \) represents the distance \( d \) in miles you can see from a height of \( h \) feet. Graph this function. Then use the graph to estimate how far you could see from a hot air balloon 1,000 feet in the air.

Distance cannot be negative, so use only positive values of \( d \).

<table>
<thead>
<tr>
<th>( d )</th>
<th>( h = 0.66d^2 )</th>
<th>( (d, h) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>( 0.66(0)^2 = 0 )</td>
<td>( (0, 0) )</td>
</tr>
<tr>
<td>10</td>
<td>( 0.66(10)^2 = 66 )</td>
<td>( (10, 66) )</td>
</tr>
<tr>
<td>20</td>
<td>( 0.66(20)^2 = 264 )</td>
<td>( (20, 264) )</td>
</tr>
<tr>
<td>25</td>
<td>( 0.66(25)^2 = 412.5 )</td>
<td>( (25, 412.5) )</td>
</tr>
<tr>
<td>30</td>
<td>( 0.66(30)^2 = 594 )</td>
<td>( (30, 594) )</td>
</tr>
<tr>
<td>35</td>
<td>( 0.66(35)^2 = 808.5 )</td>
<td>( (35, 808.5) )</td>
</tr>
<tr>
<td>40</td>
<td>( 0.66(40)^2 = 1,056 )</td>
<td>( (40, 1,056) )</td>
</tr>
</tbody>
</table>

At a height of 1,000 feet, you could see approximately 39 miles.
Work with a partner on these problems. Be ready to explain.

1. The function $d = 16t^2$ represents the distance $d$ in feet that a skydiver falls in $t$ seconds. Graph the equation. Then use the graph to find how much time it will take for the skydiver to fall 400 feet.

2. The equation $d = 16.065t^2$ describes the distance $d$ in feet that a stone falls off a cliff during time $t$. Graph this function. Then use the graph to estimate how long it would take a stone to fall 200 feet.
How did you do?

1.  
2.  

Answer: 5 s;  

Answer: about 3.5 s;
Explain the steps you would use to graph a quadratic function.
Homework

❖ Pg 339-342 1-37 odds