Suppose a car is traveling at a speed of 55 miles per hour over a stretch of highway. You can find the distance the car will travel in 3 hours by multiplying: \( \frac{55 \text{ miles}}{\text{hour}} \cdot 3 \text{ hours} = 165 \text{ miles} \).

In general, distance, rate, and time are related by the equation:

\[
\text{distance} = \text{rate} \cdot \text{time}.
\]

In short,

\[
d = r \cdot t.
\]

**Using the Formula** \( d = r \cdot t \)**

**Example 1**

A car is traveling at a rate of 55 miles per hour. Find how far the car has traveled after 0 hours, 1 hour, 1.5 hours, 3 hours, 4.75 hours, and \( x \) hours.

**Solution** Make a table. Put the time in hours in the first column, the expression rate \( \cdot \) time in the second column, and the distance in miles in the third column. Because \( d = r \cdot t \), evaluating the expression in the second column for \( r = 55 \) and each value of \( t \) will give you the value for distance.

<table>
<thead>
<tr>
<th>time (hr) ( t )</th>
<th>rate ( \cdot ) time ( 55 \cdot t )</th>
<th>distance (mi) ( d )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>55 \cdot 0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>55 \cdot 1</td>
<td>55</td>
</tr>
<tr>
<td>1.5</td>
<td>55 \cdot 1.5</td>
<td>82.5</td>
</tr>
<tr>
<td>3</td>
<td>55 \cdot 3</td>
<td>165</td>
</tr>
<tr>
<td>4.75</td>
<td>55 \cdot 4.75</td>
<td>261.25</td>
</tr>
<tr>
<td>( x )</td>
<td>55 \cdot ( x )</td>
<td>55( x )</td>
</tr>
</tbody>
</table>

**QY1**

How far will the car described above travel in 3.25 hours?

**Vocabulary**

- independent variable
- dependent variable

**Using Division**
Example 2

Suppose a car is traveling at a given rate for 3 hours. Copy and complete the table to show how far the car travels for the given rates (in miles per hour).

Solution

<table>
<thead>
<tr>
<th>rate (mph)</th>
<th>rate ( \cdot ) time</th>
<th>distance (mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>40 ( \cdot ) 3</td>
<td>?</td>
</tr>
<tr>
<td>45</td>
<td>? ( \cdot ) 3</td>
<td>?</td>
</tr>
<tr>
<td>50</td>
<td>? ( \cdot ) ?</td>
<td>?</td>
</tr>
<tr>
<td>( y )</td>
<td>? ( \cdot ) ?</td>
<td>?</td>
</tr>
</tbody>
</table>

In Example 1, the table shows the distance traveled in certain periods of time. In Example 2, you found the distance traveled for various rates. Once you know the value of one variable, you can find the value of the other variable. Thus, you can think of the first variable as determining the value of the second variable. For this reason, the first variable is called the independent variable, and the second variable is called the dependent variable.

QY2

Using a Graph

Consider again the car traveling at 55 miles per hour. With a graphing calculator, or other graphing utility, you can graph the pairs of values \( d \) and \( t \). Most graphing calculators use only the variables \( x \) and \( y \) to graph. When \( x \) and \( y \) are the variables, \( x \) is usually the independent variable and \( y \) is usually the dependent variable.

Activity

MATERIALS graphing calculator

Graph the pairs of values that satisfy \( d = 55 \cdot t \).

Step 1 Identify the variables. The variable \( x \) on the calculator is the variable for which we substitute values, and the variable \( y \) is the result of calculations using \( x \). In this case, the time \( t \) is \( x \) and the distance \( d \) is \( y \), so you will be graphing \( y = 55 \cdot x \).

Which variable, \( x \) or \( y \), is the independent variable? Which is the dependent variable?
Step 2  
Set the window. Because the trip begins at time 0, the minimum value for \( x \) is 0. So, use 0 for \( X_{\text{min}} \). A reasonable maximum amount of time for the trip is 10 hours, so use 10 for \( X_{\text{max}} \). When \( x = 0 \), what is the value of \( y \)? Thus, what should you use for \( Y_{\text{min}} \)? When \( x = 10 \), what is the value of \( y \)? So, what should you use for \( Y_{\text{max}} \)?

Step 3  
Enter the equation. Find the \([Y=]\) key and enter \( Y_1 = 55 \cdot X \). Press \([\text{GRAPH}]\) and you should see that the graph is a line.

Step 4  
Check your work. Use the \([\text{TRACE}]\) key to see that points on the graph satisfy the equation \( y = 55 \cdot x \). For example, while tracing, type 1.5 and then press \([\text{ENTER}]\). You should get the same value for \( y \) as you obtained for \( d \) in Example 1.

**Example 3**

Marc’s sister, Sue, is 4 years younger than he is.

a. Copy and complete the table at the right to show Sue’s age for each of the given ages for Marc.

b. Suppose Marc’s age is \( m \), and Sue’s age is \( s \). Write an equation to describe their ages.

c. Which variable, \( m \) or \( s \), is the independent variable? Justify your answer.

d. Treating the values in the table as ordered pairs \((m, s)\), plot the points and sketch a graph of the equation in Part b.

e. How old will Sue be when Mark is 19?

f. Describe what happens to Sue’s age as Marc’s age increases.

**Solution**

a. Sue is 4 years younger than Marc, so when Marc is 5, Sue is \( 5 - 4 = \_ \); when Marc is 6, Sue is \( 6 - 4 = \_ \); when Marc is \( 7 \frac{1}{2} \), Sue is \( 7 \frac{1}{2} - 4 = \_ \).

b. When Marc is \( m \) years old Sue is \( m - \_ \) years old. \( s = m - \_ \).

c. Because Marc’s age is used to determine his sister’s age, the independent variable is \_.

d. The points are \((4, 0), (5, \_), (6, \_), (7 \frac{1}{2}, \_))

   The graph is at the right.

e. Use mental math, the equation, or the graph. When \( m = 19 \), \( s = \_ \).

f. Look at the values in the table or what is happening in the graph. As Marc’s age increases, Sue’s age \_?
Questions

COVERING THE IDEAS

1. a. In Example 1, how far will the car travel in \(4\frac{1}{2}\) hours?
   b. In Example 2, how far will the car travel if the rate is 60 miles per hour?

2. **Multiple Choice** Which of the following cannot be used to describe the relationship between an independent variable and a dependent variable?
   A) a table
   B) a graph
   C) an equation
   D) All of A–C can be used.

3. A vendor at a ballgame is paid $0.75 for each of the \(h\) hotdogs, sold, so the earnings, \(e\), made at each game is the product of $0.75 and \(h\).
   a. Copy and complete the table to show how much money the vendor will earn selling the given number of hot dogs.

<table>
<thead>
<tr>
<th>(h)</th>
<th>(0.75 \cdot h)</th>
<th>(e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>$0.75 \cdot 50)</td>
<td>?</td>
</tr>
<tr>
<td>100</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>150</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

   b. In the above situation, which variable is used to determine the other?
   c. Write an equation to describe how much money the vendor earns, \(e\), if \(h\) hot dogs are sold.
   d. **Fill in the Blanks** In Parts a–c, \(h\) is the _____?_____ variable, and \(e\) is the _____?_____ variable.
   e. **Fill in the Blank** As the vendor sells more hot dogs, the vendor makes ____?____ money.
4. In a simple computer program, a number is input, the number is multiplied by 2, then 5 is subtracted, and the resulting value is returned as output.

   a. Copy and complete the table below showing values output by the computer program.

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>-8</td>
<td>-21</td>
</tr>
<tr>
<td>-5</td>
<td>7</td>
</tr>
<tr>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>?</td>
</tr>
</tbody>
</table>

   b. Write an equation in the form \( y = \) ? for the program, where \( x \) is the input and \( y \) is the output.

   c. Which is the independent variable, the input \( x \), or the output \( y \)?

   d. As greater and greater values for input are used, how would you describe the output?

5. The sign at the right appeared at a parking garage.

   a. Give three different lengths of time where parking at this garage would cost $6.

   b. How much would it cost to park for \( 2\frac{1}{2} \) hours?

   c. Suppose \( t \) stands for time and \( c \) stands for cost. Which variable is the independent variable, and which is the dependent variable?
6. An equation for converting a temperature in degrees Celsius to a temperature in degrees Fahrenheit is given below.
\[ F = 1.8 \cdot C + 32 \]

a. Copy and complete the table to show values of \( F \) for the given values of \( C \).

<table>
<thead>
<tr>
<th>Temperature in Degrees Celsius (C)</th>
<th>Temperature in Degrees Fahrenheit (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>212</td>
</tr>
<tr>
<td>50</td>
<td>?</td>
</tr>
<tr>
<td>37</td>
<td>?</td>
</tr>
<tr>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>-40</td>
<td>?</td>
</tr>
</tbody>
</table>

b. Which variable is the independent variable?

c. Make a graph that represents Fahrenheit temperatures when given Celsius temperatures.

d. What is the temperature in degrees Fahrenheit when the temperature is 40 degrees Celsius?

e. Describe what happens to the temperature in degrees Fahrenheit for lower and lower temperatures in degrees Celsius.

7. Suppose you go to an amusement park with $30. You spend $2 for each ride you go on. The equation below models the situation, where \( r \) is the number of rides you go on, and \( m \) is how much money you have after you go on \( r \) rides.
\[ m = 30 - 2 \cdot r \]

a. Make a table of values to show how much money you have after going on 0 rides, 5 rides, and 10 rides.

b. Name the independent and dependent variables.

c. **Fill in the Blanks** As you go on more and more rides, the amount you have spent ____?____, while the amount you have left ____?____.