Vocabulary

1. An ordered pair \((a, b)\) is a __________ of an equation in terms of \(x\) and \(y\) if the equation becomes a true statement when \(a\) is substituted for \(x\) and \(b\) is substituted for \(y\).
2. The __________ of an equation is the set of all solutions of the equation.
3. The __________ of an equation in two variables is the set of points that correspond to all solutions of the equation.
4. The graph of an equation of the form \(y = mx + b\), where \(m\) and \(b\) are constants is a __________.
5. The graph of an equation of the form \(y = mx + b\) has __________ \((0, b)\).
6. If \(a\) and \(b\) are constants, then the graph of \(y = b\) is a __________ and the graph of \(x = a\) is a __________.
7. Suppose that a quantity \(y\) changes steadily from \(y_1\) to \(y_2\) as a quantity \(x\) changes steadily from \(x_1\) to \(x_2\). Then the __________ of \(y\) with respect to \(x\) is the ratio of the change in \(y\) to the change in \(x\), denoted by \(\frac{y_2 - y_1}{x_2 - x_1}\).
8. A constant rate of change of one variable with respect to another implies an __________ between the variables.
9. Assume \((x_1, y_1)\) and \((x_2, y_2)\) are two distinct points of a non-vertical line. The __________ of the line is the rate of change of \(y\) with respect to \(x\). In symbols: \(m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{rise}}{\text{run}}\).
10. An increasing line has __________ slope, a decreasing line has __________ slope, a horizontal line has a slope equal to __________, and a vertical line has __________ slope.
11. The __________ of a linear equation is \(y = mx + b\).
12. The __________ of a relation is the set of all values of the explanatory variable.
13. The __________ of the relation is the set of all values of the response variable.
14. Each member of the domain is an __________, and each member of the range is an __________.
15. A __________ is a relation in which each input leads to exactly one output.
16. A relation is a function if and only if each vertical line intersects the graph of the relation at no more than one point. We call this requirement the __________.
17. A __________ is a relation whose equation can be put into the form \(y = mx + b\) where \(m\) and \(b\) are constants.
18. The response variable of a function \(f\) can be represented by the expression formed by writing the explanatory variable name within the parentheses of \(f(\ )\). We call this representation __________.
19. For a data point \((x, y)\), the __________ is \(y\) and the __________ (written \(\hat{y}\)) is the value obtained by using a model to predict \(y\).
20. For a given data point \((x, y)\), the __________ is the difference of the observed value of \(y\) and the predicted value of \(y\). (Observed value of \(y\) - Predicted value of \(y = y - \hat{y}\) )
21. Suppose some data points are modeled by a line. A data point on the line has __________. A data point above the line has __________. A data point below the line has __________.
22. We measure how well a line fits some data points by calculating the __________ function with the least sum of squared residuals. Its graph is called the __________ and its equation is called the __________.
23. For a group of data points, the __________ is the linear regression function for a group of data points.
24. The __________ is the linear regression function for a group of data points.
25. A __________ is a graph that compares data values of the explanatory variable with the data points’ residuals.
26. If the slope of a regression line is greatly affected by the removal of a data point, we say the data point is an ___________________________.

27. ___________________________ tend to be influential points when they are horizontally far from the other data points.

28. The ________________ is the proportion of the variation in the response variable that is explained by the regression line.

29. A ___________________________ is an equation that contains two or more variables.

30. For a ___________________________ number c, if a < b, then ac < bc.

31. For a ___________________________ number c, if a < b, then ac > bc.

32. A ___________________________ is an inequality that can be put into a form mx + b < 0 where m and b are constants and \( m \neq 0 \).

**Exercises**

1. Find the y-intercept and graph the equation by hand for \( y = 4x - 1 \).

2. Worldwide sales of iPhones are shown in the table below for the last three months of various years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Worldwide Sales (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>8.7</td>
</tr>
<tr>
<td>2010</td>
<td>16.2</td>
</tr>
<tr>
<td>2011</td>
<td>37.0</td>
</tr>
<tr>
<td>2012</td>
<td>47.8</td>
</tr>
<tr>
<td>2013</td>
<td>51.0</td>
</tr>
</tbody>
</table>

Let \( s \) be worldwide iPhone sales (in millions) for the last three months of the year that is \( t \) years since 2005.

a. Identify the explanatory and response variables.

b. Construct a scatterplot by hand.

c. Graph the model \( s = 11.6t - 37.6 \) by hand on the scatterplot. Does the line come close to the data points?

d. Use the model to estimate worldwide sales of iPhones for the last three months of 2011. Did you perform interpolation or extrapolation?

e. Compute the error in the estimation you made in part (d).

f. Use the model to estimate worldwide sales of iPhones for the last three months of 2014. Did you perform interpolation or extrapolation?

3. For the 60 players picked in the 2014 draft for NBA basketball, let \( h \) be the height (in inches) of a player and let \( w \) be the weight (in pounds) of a player. For heights between 72 and 87 inches, inclusive, a reasonable model is \( w = 6.54h - 301.81 \).

a. What is the slope? What does it mean in this situation?

b. What is the w-intercept? What does it mean in this situation?

c. Graph the model by hand.

d. Predict the weight of draft-pick Shabazz Napier, who is 6 feet tall.

4. For fall semester 2014, part-time students at Centenary College paid $575 per credit for tuition and paid a mandatory part-time student fee of $15 per semester (Source: Centenary College). Let \( T \) be the total cost (in dollars) of tuition and the fee when taking \( c \) credits of courses.
a. Identify the explanatory and response variables.
b. Find the slope of a linear model. What does it mean in this situation?
c. Find an equation of the model.
d. Graph the model by hand.
e. What was the total one-semester cost of tuition plus part-time student fee for 9 credits of classes?

5. For \( f(x) = -2x + 5 \); \( g(x) = \frac{3x - 2}{4x + 1} \); \( h(x) = -2x^2 + 3x \), find the following.
   a. \( f(-4) \)
   b. \( f(3) \)
   c. \( h(2) \)
   d. \( h(-1) \)
   e. \( g(1) \)
   f. \( g(-2) \)

6. a. Find \( f(-2) \).
   b. Find \( f(4) \).
   c. Find \( x \) when \( f(x) = 0 \).
   d. Find \( x \) when \( f(x) = -1 \).
   e. Find the domain of \( f \).
   f. Find the range of \( f \).

7. a. Find \( f(2) \).
   b. Find \( f(-4) \).
   c. Find \( x \) when \( f(x) = 4 \).
   d. Find \( x \) when \( f(x) = 3 \).
   e. Find \( x \) when \( f(x) = 0 \).
   f. Find the domain of \( f \).
   g. Find the range of \( f \).

8. Let \( n \) be the number of drive-in movie sites in the United States at \( t \) years since 2009. The function \( n = -4.9t + 381 \) models the situation well for the period 2009-2014.
   a. Rewrite the equation \( n = -4.9t + 381 \) using the function name \( f \).
   b. Find \( f(3) \). What does it mean in this situation?
   c. Find \( f(0) \). What does it mean in this situation?
9. The mean number of viewers of Fox prime-time TV shows was 9.1 million viewers in 2010 and decreased by about 0.8 million viewers until 2014 (Source: Nielsen). Let \( f(t) \) be the mean number (in millions) of Fox prime-time viewers at \( t \) years since 2010.

a. Find an equation of \( f \).
b. Find \( f(3) \). What does it mean in this situation?
c. Estimate the percentage of Americans who were Fox prime-time viewers in 2012. The U.S. population was 312.8 million in that year.

10. Find an equation of the line that has \( m = \frac{1}{2} \) and contains (5,4). Write the equation in slope-intercept form.

11. Find an equation of the line that contains the two given points. Write the equation in slope-intercept form. Round the slope and the constant term to two decimal places in needed.
   a. (-5, -4) and (-2, -10)
   b. (4.5, 2.2) and (1.2, 7.5)

12. Let \( E \) be the enrollment (in thousands of students) at a college \( t \) years after the college opens. Some pairs of values of \( t \) and \( E \) are listed in the table below.

<table>
<thead>
<tr>
<th>Age of College (years)</th>
<th>Enrollment (thousands of students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t )</td>
<td>( E )</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>12</td>
<td>29</td>
</tr>
</tbody>
</table>

a. Construct a scatterplot.
b. Describe the four characteristics of the association.
c. Find an equation that describes the association between \( t \) and \( E \).
d. Graph the equation you found in part (c) on the scatterplot.
e. Find the \( E \)-intercept. What does it mean in this situation?
f. What is the slope? What does it mean in this situation?

13. The prices of ski rental packages from Gold Medal Sports® are shown in the table below for various numbers of days. Let \( p(n) \) be the price (in dollars) of a ski rental package for \( n \) days.

<table>
<thead>
<tr>
<th>Number of Days</th>
<th>Price of Package (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>56</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>78</td>
</tr>
</tbody>
</table>

a. Construct a scatterplot.
b. Describe the four characteristics of the association. Compute and interpret \( r \) as part of your analysis.
c. Graph \( p(n) = 12.74n + 4.40 \) on your scatterplot.
d. Find $p(8)$. What does it mean in this situation?

e. Find $n$ when $p(n) = 130$. What does it mean in this situation?

14. A racquetball is dropped from various heights, and the bounce height is recorded each time. Let $f(x)$ be the bounce height (in inches) of the racquetball after it is dropped from an initial height of $x$ inches.

<table>
<thead>
<tr>
<th>Drop Height (inches)</th>
<th>Bounce Height (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5.0</td>
</tr>
<tr>
<td>12</td>
<td>9.3</td>
</tr>
<tr>
<td>18</td>
<td>15.0</td>
</tr>
<tr>
<td>24</td>
<td>19.6</td>
</tr>
<tr>
<td>30</td>
<td>24.0</td>
</tr>
<tr>
<td>36</td>
<td>27.6</td>
</tr>
<tr>
<td>42</td>
<td>32.8</td>
</tr>
<tr>
<td>48</td>
<td>38.0</td>
</tr>
</tbody>
</table>

Source: J. Lehmann

a. Construct a scatterplot.
b. Find the linear regression equation for $f$. Does the graph of $f$ come close to the data points?
c. Find the sum of squared residuals for the regression line.
d. Find $f(18)$. What does it mean in this situation?
e. Find the residual for the prediction you made in part (c). What does it mean in this situation?
f. Find $x$ when $f(x) = 30$. What does it mean in this situation?

15. Solve the formula for the specified variable.

a. $x = \mu + z\sigma$ (Solve for $z$)  
   b. $\sigma_x = \frac{\sigma}{\sqrt{n}}$ (Solve for $\sigma$)  
   c. $y - y_i = m(x - x_i)$ (Solve for $x_i$)

16. The price of an adult one-day ticket to Walt Disney World was $46 in 2000, and it increased by about $3.75 per year until 2012 (Source: The Walt Disney Company). Let $p$ be the price (in dollars) of a ticket at $t$ years since 2000.

a. Find an equation of a linear model to describe the situation.
b. Solve the equation found in part (a) for $t$.
c. Use the equation found in part (b) to estimate in which years the prices of tickets were $70, $75, $80, $85, and $90.

17. Substitute the given values for the variables in the compound inequality.

a. $\bar{x} - t \cdot \frac{s}{\sqrt{n}} < \mu < \bar{x} + t \cdot \frac{s}{\sqrt{n}}$; $\bar{x} = 26.9$, $t = 2.528$, $s = 4.9$, $n = 20$

b. $\hat{p} - z \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} < p < \hat{p} + z \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$; $\hat{p} = 0.45$, $z = 1.645$, $n = 930$

18. Solve the inequality. Describe the solution set as an inequality, in interval notation, and on a graph.

a. $-15 \leq 2x - 5 \leq 7$  
   b. $\frac{1}{3} \leq 4 - \frac{2}{3}x < 2$