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Section 1-1 Linear Equations and Inequalities

Goal: To solve linear equation and linear inequalities**Equality Properties:**1. If $x = y$ and a is any real number, then $x \pm a = y \pm a$.2. If $x = y$ and a is any nonzero real number, then $ax = ay$ and $\frac{x}{a} = \frac{y}{a}$.**Inequality Properties:**1. If $x > y$ and a is any real number, then $x \pm a > y \pm a$.2. If $x > y$ and a is any positive real number, then $ax > ay$ and $\frac{x}{a} > \frac{y}{a}$.3. If $x > y$ and a is any negative real number, then $ax < ay$ and $\frac{x}{a} < \frac{y}{a}$.**Interval Notation:**

A bracket,] or [, is used if the endpoint is included.

A parentheses,) or (, is used if the endpoint is not included.

Infinity, either positive or negative, always uses a parentheses.

In Problems 1–3, solve for the variable:

1. $7x + 8 = 2x + 28$

$$7x + 8 - 2x = 2x + 28 - 2x$$
$$5x + 8 = 28$$
$$5x + 8 - 8 = 28 - 8$$
$$5x = 20$$
$$\frac{5x}{5} = \frac{20}{5}$$
$$x = 4$$

$$\begin{aligned}
2. \quad & 7y + 3(6y - 11) = 167 \\
& 7y + 18y - 33 = 167 \\
& 25y - 33 = 167 \\
& 25y - 33 + 33 = 167 + 33 \\
& 25y = 200 \\
& \frac{25y}{25} = \frac{200}{25} \\
& y = 8
\end{aligned}$$

$$\begin{aligned}
3. \quad & \frac{m}{6} + 8 = \frac{m}{3} + 10 \\
& \frac{6m}{6} + 8(6) = \frac{6m}{3} + 10(6) \\
& m + 48 = 2m + 60 \\
& 48 = m + 60 \\
& -12 = m
\end{aligned}$$

In Problems 4–6, solve for the variable and place the final answer in interval notation.

$$\begin{aligned}
4. \quad & 9x + 4 > 22 \\
& 9x > 18 \\
& x > 2 \\
& (2, \infty)
\end{aligned}$$

$$\begin{aligned}
5. \quad & -5 < -2x + 1 \leq 13 \\
& -6 < -2x \leq 12 \\
& 3 > x \geq -6 \\
& -6 \leq x < 3 \\
& [-6, 3)
\end{aligned}$$

$$\begin{aligned}
6. \quad & \frac{u}{3} + \frac{3}{4} < \frac{u}{2} - \frac{5}{4} \\
& \frac{12u}{3} + \frac{3(12)}{4} < \frac{12u}{2} - \frac{5(12)}{4} \\
& 4u + 9 < 6u - 15 \\
& 24 < 2u \\
& 12 < u \\
& (12, \infty)
\end{aligned}$$

7. *Break-even Analysis.* A publisher for a promising new novel figures fixed costs (overhead, advances, promotion, copyediting, typesetting, and so on) at \$87,000 and variable costs (printing, paper, binding, shipping) at \$4.50 for each book produced. If the book is sold to distributors for \$28 each, how many must be produced and sold for the publisher to break even?

Let x = the number of books produced. Since the break-even point is the point when cost is the same as the revenue:

$$28x = 87,000 + 4.50x$$

$$23.50x = 87,000$$

$$x = 3702.12766$$

Therefore, the publisher must produce 3703 books to break even.

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Section 1-2 Graphs and Lines

Goal: To find the equations of lines, x -intercepts, and y -intercepts

Slope of a Line: $m = \frac{y_2 - y_1}{x_2 - x_1}$, where $P_1 : (x_1, y_1)$ and $P_2 : (x_2, y_2)$

Slope-Intercept Form of a Line: $y = mx + b$, where m is the slope and $(0, b)$ is the y -intercept.

Equation of a line in standard form: $Ax + By = C$, where A and B are not both zero.

Horizontal Line: $y = b$, slope is zero.

Vertical Line: $x = a$, slope is undefined.

y -intercept: $(0, b)$

x -intercept: $(a, 0)$

In Problems 1–12, write the equation of the line in slope-intercept form with the given characteristics:

1. Slope is 8 and y -intercept is $(0, 3)$.

Since the slope and y -intercept are given, $y = 8x + 3$.

2. Slope is -5 and y -intercept is $(0, -6)$.

Since the slope and y -intercept are given, $y = -5x - 6$.

3. Slope is $\frac{3}{7}$ and passes through the point $(-14, 2)$.

$$y - y_1 = m(x - x_1)$$

$$y - 2 = \frac{3}{7}(x - (-14))$$

$$y - 2 = \frac{3}{7}x + 6$$

$$y = \frac{3}{7}x + 8$$

4. Slope is $\frac{-4}{5}$ and passes through the point $(2, -3)$.

$$y - y_1 = m(x - x_1)$$

$$y - (-3) = \frac{-4}{5}(x - 2)$$

$$y + 3 = \frac{-4}{5}x + \frac{8}{5}$$

$$y = \frac{-4}{5}x - \frac{7}{5}$$

5. Passes through the points $(4, 8)$ and $(8, 4)$.

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 8}{8 - 4} = \frac{-4}{4} = -1$$

$$y - y_1 = m(x - x_1)$$

$$y - 8 = -1(x - 4)$$

$$y - 8 = -x + 4$$

$$y = -x + 12$$

6. Passes through the points $(-1, 4)$ and $(2, -2)$.

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 4}{2 - (-1)} = \frac{-6}{3} = -2$$

$$y - y_1 = m(x - x_1)$$

$$y - 4 = -2(x - (-1))$$

$$y - 4 = -2x - 2$$

$$y = -2x + 2$$

7. Passes through the points (0, 6) and (5, 0).

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - 6}{5 - 0} = \frac{-6}{5}$$

$$y - y_1 = m(x - x_1)$$

$$y - 0 = \frac{-6}{5}(x - 5)$$

$$y = \frac{-6}{5}x + 6$$

8. Passes through the points (0, -6) and (1, 0).

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-6 - 0}{0 - 1} = \frac{-6}{-1} = 6$$

$$y - y_1 = m(x - x_1)$$

$$y - 0 = 6(x - 1)$$

$$y = 6x - 6$$

9. A horizontal line that passes through the point (-2, 8).

A horizontal line is parallel to the x -axis and in the form $y = b$, therefore, the equation is $y = 8$.

10. A horizontal line that passes through the point (2, -5).

A horizontal line is parallel to the x -axis and in the form $y = b$, therefore, the equation is $y = -5$.

11. A vertical line that passes through the point (-2, 7).

A vertical line is parallel to the y -axis and in the form $x = a$, therefore, the equation is $x = -2$.

12. A vertical line that passes through the point (2, -8).

A vertical line is parallel to the y -axis and in the form $x = a$, therefore, the equation is $x = 2$.

In Problems 13–17, find the x -intercept and the y -intercept.

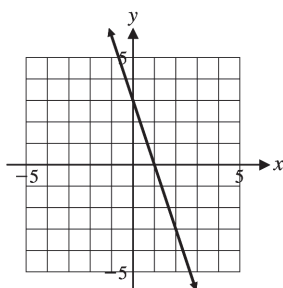
Solutions for the x -intercept will be found by setting $y = 0$, and the y -intercepts will be found by setting $x = 0$.

13. $y = -3x + 3$	14. $y = -2x - 2$	15. $y = \frac{1}{2}x - 1$
$y = -3(0) + 3$	$y = -2(0) - 2$	$y = \frac{1}{2}(0) - 1$
$y = 3$	$y = -2$	$y = -1$
$(0, 3)$ y -intercept	$(0, -2)$ y -intercept	$(0, -1)$ y -intercept
$0 = -3x + 3$	$0 = -2x - 2$	$0 = \frac{1}{2}x - 1$
$3x = 3$	$2x = -2$	$-\frac{1}{2}x = -1$
$x = 1$	$x = -1$	$x = 2$
$(1, 0)$ x -intercept	$(-1, 0)$ x -intercept	$(2, 0)$ x -intercept

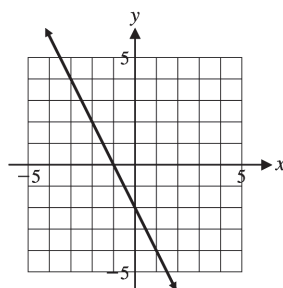
16. $y = \frac{4}{3}x - 4$	17. $x - 3y = -3$
$y = \frac{4}{3}(0) - 4$	$0 - 3y = -3$
$y = -4$	$y = 1$
$(0, -4)$ y -intercept	$(0, 1)$ y -intercept
$0 = \frac{4}{3}x - 4$	$x - 3(0) = -3$
$-\frac{4}{3}x = -4$	$x = -3$
$x = 3$	
$(3, 0)$ x -intercept	$(-3, 0)$ x -intercept

18. Graph each line in Problems 13–17.

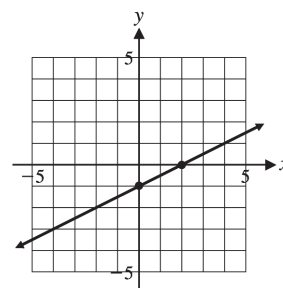
Graph for 13



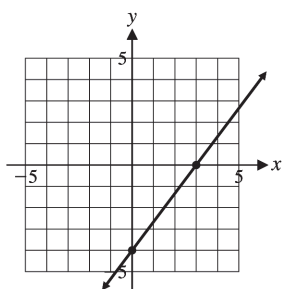
Graph for 14



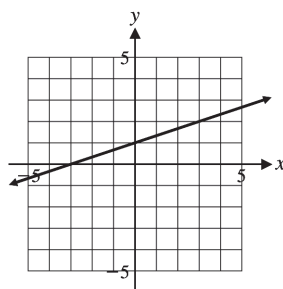
Graph for 15



Graph for 16



Graph for 17



19. A piece of equipment used in a landfill has an original value of \$200,000. After two years of use, the piece of equipment is valued at \$150,000.
- a) If the depreciation of the equipment is assumed to be linear, find an equation to relate the value (V) of the equipment over time (t).
- b) What would the value of the piece of equipment be after 6 years?
- c) In how many years would the value of the piece of equipment be \$0?

Solution:

- a) Since the value started at \$200,000 and after two (2) years it was worth \$150,000, the equipment depreciated as follows:

$$m = \frac{150,000 - 200,000}{2} = \frac{-50,000}{2} = -25,000$$

Since the slope is $-25,000$ and the equipment had a starting value of \$200,000, the equation is

$$V = -25,000t + 200,000.$$

- b) Substitute 6 in for t :

$$V = -25,000t + 200,000$$

$$V = -25,000(6) + 200,000$$

$$V = -150,000 + 200,000$$

$$V = 50,000$$

Therefore, the equipment will be worth \$50,000 after 6 years.

- c) Find the value of t when $V = 0$.

$$V = -25,000t + 200,000$$

$$0 = -25,000t + 200,000$$

$$25,000t = 200,000$$

$$t = 8$$

Therefore, the value will be \$0 after 8 years.

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Section 1-3 Linear Regression

Goal: To interpret slopes and find linear regression equations**Solving Real-World Problems**

1. Construct a mathematical model.
2. Solve the mathematical model.
3. Interpret the solution.

Linear Regression on a Graphing Calculator

1. Enter the data in columns L_1 and L_2 .
2. In the “STAT” mode, find the “LinReg” function.
3. Read the display to find the values of the slope and the y -intercept.

In Problems 1–3, use the given information to answer the questions.

1. *Depreciation.* A new car worth \$45,000 is depreciating in value by \$5000 per year.
 - a) Find the linear model for the current value of the car, v , and the number of years, y , after it was purchased.
 - b) Interpret the slope of the model.
 - c) If the car is 3 years old, what does the model predict for its value?
 - d) After how many years will the car be worth nothing?

Solution:

- a) $v = -5000y + 45,000$
- b) The value of the car decreases \$5000 for every year after it was purchased.
- c) $v = -5000y + 45,000$
 $v = -5000(3) + 45,000$
 $v = -15,000 + 45,000$
 $v = 30,000$
The car is worth \$30,000 after it is 3 years old.

d) $v = -5000y + 45,000$

$$0 = -5000y + 45,000$$

$$5000y = 45,000$$

$$y = 9$$

The car will be worth nothing after 9 years.

2. *Health Club Membership.* A health club offers membership for a fee of \$59 plus a monthly fee of \$15 per month.

- a) Find the linear model for the membership fee, f , and the number of months, m , since you have been a member.
- b) Interpret the slope of the model.
- c) If you have been a member for 24 months, what does the model predict for the fee you have paid so far?
- d) After how many months will you have paid the health club \$329?

Solution:

a) $f = 15m + 59$

b) The fee will increase by \$15 for every additional month of membership.

c) $f = 15m + 59$

$$f = 15(24) + 59$$

$$f = 360 + 59$$

$$f = 419$$

The fee after 24 months will be \$419.

d) $f = 15m + 59$

$$329 = 15m + 59$$

$$270 = 15m$$

$$18 = m$$

After 18 months, you will have paid \$329 for your membership.

3. *Stress.* The table below shows the relationship between a stress test score and the diastolic blood pressure for 8 patients. A linear regression model for this data is

$$y = 0.56x + 41.71,$$

where x represents the stress test score and y represents the blood pressure.

Stress Test Score, x	55	62	58	78	92	88	75	80
Blood Pressure, y	70	85	72	85	96	90	82	85

- Interpret the slope of the model.
- Use the model to predict the blood pressure for a person with a stress test score of 75
- Use the model to estimate the stress test score for if the diastolic blood pressure was 90.

Solution:

- For every 1 point increase in the stress test score, the diastolic blood pressure will increase by 0.56 points.
- $$y = 0.56x + 41.71$$

$$y = 0.56(75) + 41.71$$

$$y = 42 + 41.71$$

$$y = 83.71$$

A person with a stress test score of 75 will have an approximate diastolic blood pressure of 84.
- $$y = 0.56x + 41.71$$

$$90 = 0.56x + 41.71$$

$$48.29 = 0.56x$$

$$86.23 = x$$

A person with a diastolic blood pressure of 90 will have a stress test score of approximately 86.

