

Applications

1. Ms. Chang's class decides to use the *Cool Tee's* company to make their T-shirts. The following equation represents the relationship between the cost C and the number of T-shirts n .

$$C = 2n + 20$$

- The class wants to buy 25 T-shirts from *Cool Tee's*. Describe how you can use a table and a graph to find the cost for 25 T-shirts.
- Suppose the class has \$80 to spend on T-shirts. Describe how you can use a table and a graph to find the number of T-shirts the class can buy.

- c. Taleah writes the following equation in her notebook:

$$C = 2(15) + 20$$

What information is Sophia looking for?

- Keisha uses the coordinates (30, 80) to find information about the cost of the T-shirts. What information is she looking for?
2. Mary uses the following equations to find some information about three walkathon pledge plans.

Plan 1

$$14 = 2x$$

Plan 2

$$y = 3.5(10) + 10$$

Plan 3

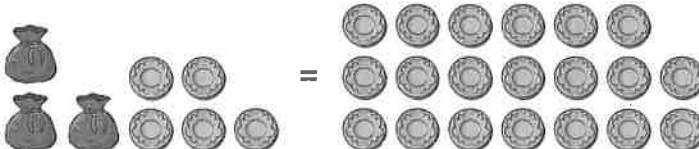
$$100 = 1.5x + 55$$

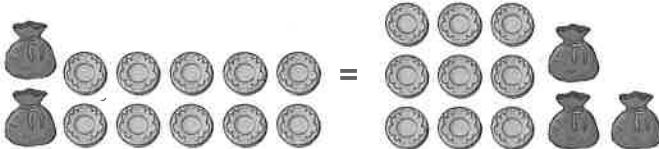
In each equation, y is the amount donated in dollars, and x is the number of kilometers walked. For each equation:

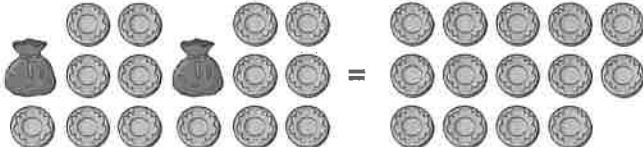
- What information is Mary trying to find?
 - Describe how you could find the information.
3. Find the solution (the value of the variable) for each equation.
- $y = 3(10) + 15$
 - $24 = x + 2$
 - $10 = 2x + 4$
4. Consider the equation $y = 5x - 15$.
- Find y if $x = 1$.
 - Find x if $y = 50$.
 - Describe how you can use a table or a graph to answer parts (a) and (b).

For each situation in Exercises 5–8, find the number of coins in each pouch. Each pouch contains the same number of \$1 gold coins, and the total number of coins on each side of the equation is the same.

5.  =

6.  =

7.  =

8.  =

9. For each equation, sketch a picture using pouches and coins. Then, determine how many coins are in a pouch.

a. $3x = 12$

b. $2x + 5 = 19$

c. $4x + 5 = 2x + 19$

d. $x + 12 = 2x + 6$

e. $3(x + 4) = 18$

10. Gilberto's grandfather gives him \$5 for his birthday and then 50¢ for each math question he answers correctly on his math exams for the year.
- Write an equation that represents the amount of money that Gilberto receives during a school year. Explain what the variables and numbers mean.
 - Use the equation to find the number of correct answers Gilberto needs to buy a new shirt that costs \$25. Show your work.
 - Gilberto answered all 12 problems correctly on his first math exam. How much money is he assured of receiving for the year? Show your work.
11. For parts (a) and (b), find the mystery number and explain your reasoning.
- If you add 15 to 3 times the mystery number, you get 78. What is the mystery number?
 - If you subtract 27 from 5 times the mystery number, you get 83. What is the mystery number?
 - Make up clues for a riddle whose mystery number is 9.
12. Use properties of equality and numbers to solve each equation for x . Check your answers.
- $7 + 3x = 5x + 13$
 - $3x - 7 = 5x + 13$
 - $7 - 3x = 5x + 13$
 - $3x + 7 = 5x - 13$
13. **Multiple Choice** Which of the following is a solution to the equation $11 = -3x - 10$?
- A. 1.3 B. $-\frac{1}{3}$ C. -7 D. 24
14. Solve each equation for x . Check your answers.
- $3x + 5 = 20$
 - $3x - 5 = 20$
 - $3x + 5 = -20$
 - $-3x + 5 = 20$
 - $-3x - 5 = -20$
15. Determine whether each expression is *always*, *sometimes*, or *never* equal to $-2(x - 3)$.
- $-2x + 6$
 - $-2x - 6$
 - $2x + 6$
 - $-2x - 3$
 - $-2(x + 3)$
 - $2(3 - x)$

- 16.** For each equation in Group 1, find a matching equation in Group 2 that has the same solution. Write down any strategies you used.

Group 1

A: $3x + 6 = 12$

B: $3x - 6 = 12$

C: $-3x + 6 = 12$

D: $3x + 6 = -12$

E: $6x - 3 = 12$

Group 2

F: $x = 6$

G: $3(2 - x) = 12$

H: $3x = 6$

J: $x - \frac{1}{2} = 2$

K: $x + 2 = -4$

- 17.** Solve each equation. Check your answers.

a. $3(x + 2) = 12$

c. $3(x + 2) = 2x$

b. $3(x + 2) = x - 18$

d. $3(x + 2) = -15$

- 18.** Solve each equation for x .

a. $5 - 2(x - 1) = 12$

c. $5 - 2(x + 2) = 12$

b. $5 + 2(x - 1) = 12$

d. $5 - 2x + 2 = 12$

- 19.** Solve each equation for x .

a. $2x + 6 = 6x + 2$

c. $2x - 6 = -6x + 2$

b. $2x + 6 = 6x - 2$

d. $-2x - 6 = -6x - 2$

For Exercises 20 and 21, use the equation $y = 4 - 3x$.

- 20.** Find y when:

a. $x = 4$

d. $x = -\frac{4}{3}$

b. $x = -3$

e. $x = 0$

c. $x = 2$

- 21.** Find x when:

a. $y = 0$

b. $y = 21$

c. $y = -15$

d. $y = 3.5$

- 22.** Explain how the information you found for Exercises 20 and 21 relates to locating points on a line representing $y = 4 - 3x$.

23. In each part below, identify the equations that have the same solution.

a. A: $x = 8$

B: $-x = 8$

C: $x + 3x = 8$

D: $1x = 8$

E: $8 = 4x$

F: $8 = -1x$

b. G: $x - 1 = 6$

H: $x - 1 = -6$

J: $-x + 1 = -6$

K: $-x + 1 = 6$

L: $6 = 1 - x$

M: $-1 + x = 6$

c. N: $x - \frac{1}{2} = 4$

O: $\frac{1}{2}x = -4$

P: $x = 4 + \frac{1}{2}$

Q: $-\frac{1}{2}x = 4$

R: $\frac{1}{2} - x = 4$

S: $-x + \frac{1}{2} = 4$

24. Two students' solutions to the equation $6(x + 4) = 3x - 2$ are shown below. Both students made an error. Find the errors and give a correct solution.

Student 1

$$\begin{aligned} 6(x+4) &= 3x-2 \\ x+4 &= 3x-2-6 \\ x+4 &= 3x-8 \\ x+4+8 &= 3x-8+8 \\ x+12 &= 3x \\ 12 &= 2x \\ x &= 6 \end{aligned}$$

Student 2

$$\begin{aligned} 6(x+4) &= 3x-2 \\ 6x+4 &= 3x-2 \\ 3x+4 &= -2 \\ 3x+4-4 &= -2-4 \\ 3x &= -6 \\ x &= -2 \end{aligned}$$

25. Two students' solutions to the equation $58.5 = 3.5x - 6$ are shown below. Both students made an error. Find the errors and give a correct solution.

Student 1

$$\begin{aligned} 58.5 &= 3.5x - 6 \\ 58.5 - 6 &= 3.5x \\ 52.5 &= 3.5x \\ 52.5 &= x \\ 3.5 &= x \\ \text{so, } x &= 15 \end{aligned}$$

Student 2

$$\begin{aligned} 58.5 &= 3.5x - 6 \\ 58.5 + 6 &= 3.5x - 6 + 6 \\ 64.5 &= 3.5x \\ 64.5 &= 3.5x \\ 3.5 &= 3.5x \\ \text{so, } x &\approx 1.84 \end{aligned}$$

- 30.** The expenses E and income I for making and selling T-shirts with a school logo are given by the equations $E = 535 + 4.50n$ and $I = 12n$, where n is the number of T-shirts.
- How many T-shirts must be made and sold to break even? Explain.
 - Suppose only 50 shirts are sold. Is there a profit or a loss? Explain.
 - Suppose the income is \$1,200. Is there a profit or a loss? Explain.
 - For each equation, find the coordinates of a point that lies on the graph of the equation.
 - What information does this point give you?
 - Describe how to use the equation to show that the point lies on the graph.
- 31.** The International Links long-distance phone company charges no monthly fee but charges 18 cents per minute for long-distance calls. The World Connections' long-distance company charges \$50 per month plus 10 cents per minute for long-distance calls. Compare the World Connections long-distance plan to that of International Links.
- Under what circumstances is it cheaper to use International Links? Explain your reasoning.
 - Write an inequality that describes when each company is cheaper. Represent the solution to the inequality on a graph.
- 32.** Two cell-phone providers have different charges per month for text-messaging plans. Driftless Region Telephone has a plan charging $1\frac{1}{2}$ cents per text, with a monthly rate of \$10. Walby Communications charges \$16 per month for unlimited texting.
- If you were paying for a plan, which one would you purchase? Explain.
 - Would you make the same recommendation for anyone else?
 - Write an inequality that would help someone decide which plan to purchase. Then, represent the solution on a graph.

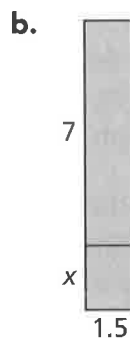
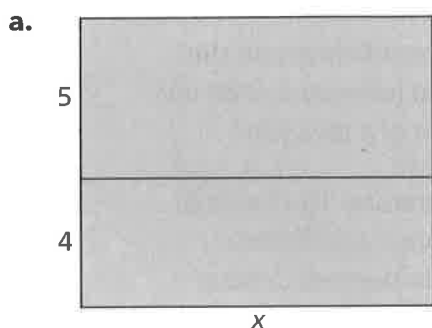
- 33.** Students at Hammond Middle School are raising money for the end-of-year school party. They decide to sell roses for Valentine's Day. The students can buy the roses for 50 cents each from a wholesaler. They also need \$60 to buy ribbon and paper to protect the roses as well as materials for advertising the sale. They sell each rose for \$1.30.
- How many roses must they sell to break even? Explain.
 - What is the students' profit if they sell 50 roses? 100 roses? 200 roses?
- 34.** Ruth considers buying a cell phone from two different companies. Company A has a cost plan given by the equation $C_A = 32n$, where n is the number of months she has the phone and C_A is the total cost. Company B has a cost plan represented by the equation $C_B = 36 + 26n$, where n is the number of months she is on the plan and C_B is the total cost.
- Graph both equations on the same set of axes.
 - What is the point of intersection of the two graphs? What information does this give you?





Connections

- 35.** Describe what operations are indicated in each expression. Then, write each expression as a single number.
- $-8(4)$
 - $-2 \cdot 4$
 - $6(-5) - 10$
 - $2(-2) + 3(5)$
- 36.** Find each quotient.
- $\frac{12}{-3}$
 - $\frac{-12}{3}$
 - $\frac{-12}{-3}$
 - $\frac{0}{-10}$
 - $\frac{-5}{5}$
 - $\frac{5}{-5}$
 - $\frac{-5}{-5}$
- 37.** Decide whether each pair of quantities is equal. Explain your reasoning.
- $6(5) + 2$ and $6(5 + 2)$
 - $8 - 3x$ and $3x - 8$
 - $4 + 5$ and $5 + 4$
 - $-2(3)$ and $3(-2)$
 - $3 - 5$ and $5 - 3$
 - 2 quarters and 5 dimes
 - 1.5 liters and 15 milliliters
 - 2 out of 5 students prefer wearing sneakers to school and 50% of the students prefer wearing sneakers to school

38. a. Use fact families to write a related sentence for $n - (-3) = 30$. Does this related sentence make it easier to find the value for n ? Why or why not?
- b. Use fact families to write a related sentence for $5 + n = -36$. Does this related sentence make it easier to find the value for n ? Why or why not?
- c. Solve the equations in parts (a) and (b) using properties of equality. How does this method compare to using the fact families?
39. Write two different expressions to represent the area of each rectangle.



40. Find the value of x that makes each equation true.
- a. $3\frac{1}{2}x = \frac{3}{4}$ b. $3\frac{1}{2} = \frac{3}{4}x$
- c. $\frac{7}{8}x = \frac{1}{8}$ d. $\frac{5}{6} = \frac{3}{4}x$
41. Fill in the missing representation for each inequality.

	In Symbols	On a Number Line	In Words
a.	$x > -4$		<input type="checkbox"/>
b.	$x \leq 2$	<input type="checkbox"/>	all numbers less than or equal to 2
c.	$3 < x$	<input type="checkbox"/>	<input type="checkbox"/>
d.	<input type="checkbox"/>		<input type="checkbox"/>
e.	<input type="checkbox"/>	<input type="checkbox"/>	all numbers greater than negative 3

42. The number of times a cricket chirps in a minute is related to the temperature. You can use the formula

$$n = 4t - 160$$

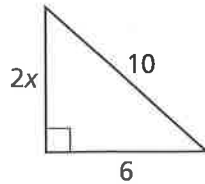
to determine the number of chirps n a cricket makes in a minute when the temperature is t degrees Fahrenheit. If you want to estimate the temperature by counting cricket chirps, you can use the following form of the equation:

$$t = \frac{1}{4}n + 40$$

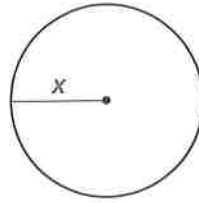
- At 60°F, how many times does a cricket chirp in a minute?
 - What is the temperature if a cricket chirps 150 times in a minute?
 - At what temperature does a cricket stop chirping?
 - Sketch a graph of the equation with number of chirps on the x -axis and temperature on the y -axis. What information do the y -intercept of the graph and the coefficient of n give you?
43. The higher the altitude, the colder the temperature. The formula $T = t - \frac{d}{150}$ is used to estimate the temperature T at different altitudes, where t is the ground temperature in degrees Celsius and d is the altitude in meters.
- Suppose the ground temperature is 0 degrees Celsius. What is the temperature at an altitude of 1,500 meters?
 - Suppose the temperature at 300 meters is 26 degrees Celsius. What is the ground temperature?
44. The sum S of the angles of a polygon with n sides is $S = 180(n - 2)$. Find the angle sum of each polygon.
- triangle
 - quadrilateral
 - hexagon
 - decagon (10-sided polygon)
 - icosagon (20-sided polygon)
45. Suppose the polygons in Exercise 44 are regular polygons. Find the measure of an interior angle of each polygon.
46. How many sides does a polygon have if its angle sum is
- 540 degrees?
 - 1,080 degrees?

47. The perimeter of each shape is 24 cm. Find the value of x .

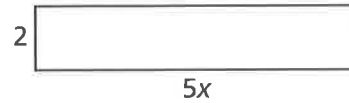
a.



b.



c.



d. Find the area of the triangle in part (a) and the rectangle in part (c).

48. World Connections long-distance phone company charges \$50 per month plus 10 cents per minute for each call.

- Write an equation for the total monthly cost C for t minutes of long-distance calls.
- Dwayne makes $10\frac{1}{2}$ hours of long-distance calls in a month. How much is his bill for that month?
- If Andrea receives a \$75 long-distance bill for last month's calls, how many minutes of long-distance calls did she make?
- Should the solution to part (c) be written as an equality or inequality? Is it possible that the total number of minutes Andrea was charged was not equal to the amount of time she actually talked on the phone? Explain.

49. As a person ages beyond 30, his or her height can start to decrease by approximately 0.06 centimeter per year.

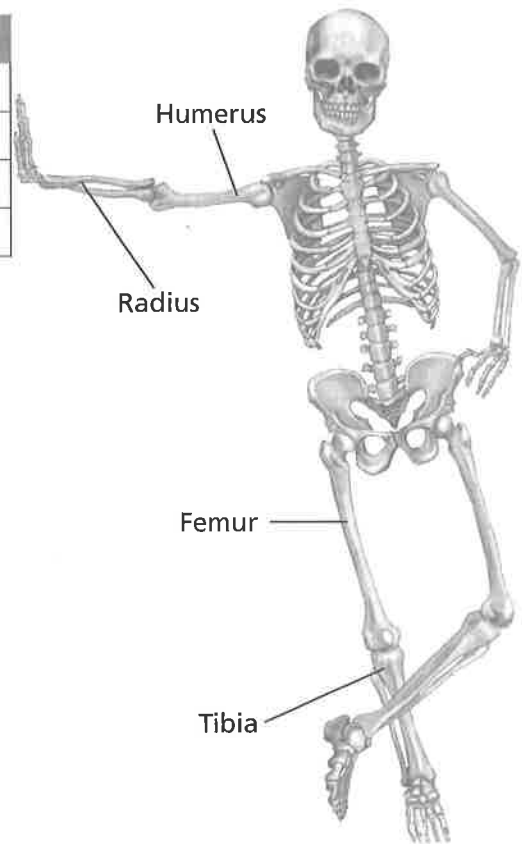
- Write an equation that represents a person's height h after the age of 30. Let t be the number of years beyond 30 and H be the height at age 30.
- A 60-year-old female is 160 centimeters tall. About how tall was she at age 30? Explain how you found your answer.
- Suppose a basketball player is 6 feet, 6 inches tall on his thirtieth birthday. About how tall will he be at age 80? Explain. (Remember, 1 inch \approx 2.54 centimeters.)
- Jena says that in part (a), the equation should actually be written as an inequality. Why might Jena use an inequality to represent this relationship? What inequality do you think Jena has in mind?

- 50.** Forensic scientists can estimate a person's height by measuring the length of certain bones, including the femur, the tibia, the humerus, and the radius.

The table below gives equations for the relationships between the length of each bone and the estimated height of males and females. These relationships were found by scientists after much study and data collection. In the table, F represents the length of the femur, T the length of the tibia, H the length of the humerus, R the length of the radius, and h the person's height. All measurements are in centimeters.

Bone	Male	Female
Femur	$h = 69.089 + 2.238F$	$h = 61.412 + 2.317F$
Tibia	$h = 81.688 + 2.392T$	$h = 72.572 + 2.533T$
Humerus	$h = 73.570 + 2.970H$	$h = 64.977 + 3.144H$
Radius	$h = 80.405 + 3.650R$	$h = 73.502 + 3.876R$

- About how tall is a female if her femur is 46.2 centimeters long?
- About how tall is a male if his tibia is 50.1 centimeters long?
- Suppose a woman is 152 centimeters tall. About how long is her femur? Her tibia? Her humerus? Her radius?
- Suppose a man is 183 centimeters tall. About how long is his femur? His tibia? His humerus? His radius?
- Describe generally what the graph would look like for each equation without drawing the specific graph. What do the x - and y -intercepts represent in this problem? Does this make sense? Why?



Extensions



- 51.** The maximum weight allowed in an elevator is 1,500 pounds.
- The average weight per adult is 150 pounds, and the average weight per child is 40 pounds. Write an equation for the number of adults A and the number of children C the elevator can hold.
 - Suppose ten children are in the elevator. How many adults can get in?
 - Suppose six adults are in the elevator. How many children can get in?
- 52.** Solve each equation. Explain what your answers might mean.
- $2(x + 3) = 3x + 3$
 - $2(x + 3) = 2x + 6$
 - $2(x + 3) = 2x + 3$
- 53.** Frank thinks he can solve inequalities the same way he can solve equations. He uses the method shown below.

$$2x + 6 < 16$$

First, I subtract 6 from both sides. Then I divide by 2.

This simplifies the inequality to $x < 5$.

My last step is to check my answer.

$$x = 4 \qquad 2(4) + 6 = 14 \qquad 14 < 16$$

$$x = 6 \qquad 2(6) + 6 = 18 \qquad 18 \not< 16$$

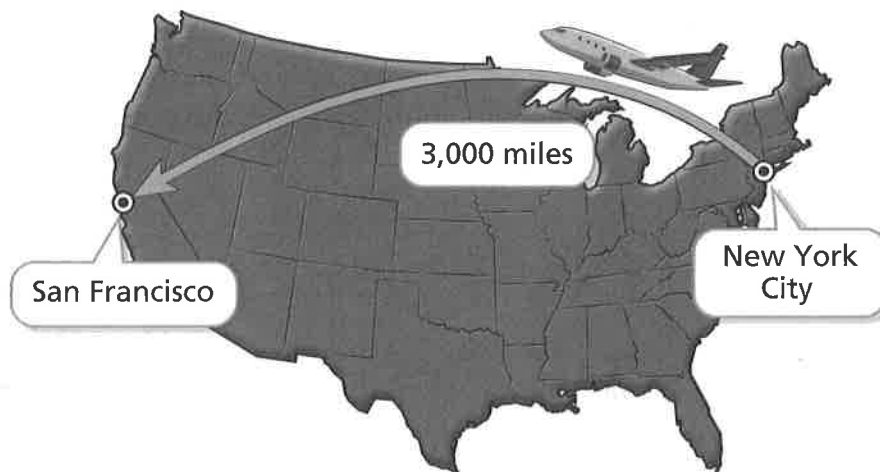
- Does Frank's method work in general for other inequalities?
- Frank runs into some difficulties trying to solve the following problem:

$$-2x + 1 > 5$$

$$-2x > 4$$

He thinks the answer is $x > -2$. He knows that if this is true, then $x = 0$ should be a solution, because $0 > -2$. But when he checks his work, he notices that $-2(0) + 1 \not> 5$. What numbers should be solutions for the original inequality?

- 54.** Wind can affect the speed of an airplane. Suppose a plane is flying round-trip from New York City to San Francisco. The plane has a cruising speed of 300 miles per hour. The wind is blowing from west to east at 30 miles per hour. When the plane flies into (in the opposite direction of) the wind, its speed decreases by 30 miles per hour. When the plane flies with (in the same direction as) the wind, its speed increases by 30 miles per hour.



- a.** Make a table that shows the total time the plane has traveled after each 200-mile interval on its trip from New York City to San Francisco and back.

Airplane Flight Times

Distance (mi)	NYC to SF Time (h)	SF to NYC Time (h)
0	■	■
200	■	■
400	■	■
600	■	■
■	■	■

- b.** For each direction, write an equation for the distance d traveled in t hours.
- c.** On the same set of axes, sketch graphs of the time and distance data for travel in each direction.
- d.** How long does it take a plane to fly 5,000 miles against a 30-mile-per-hour wind? With a 30-mile-per-hour wind? Explain how you found your answers.

55. Students in Mr. Rickman's class are asked to solve the equation $\frac{2}{3}(6x - 9) + \frac{1}{3}(6x - 9) = 3$. Look at the three solutions below. Are they correct? Explain which method makes the most sense to you.

Jess's Solution

I began by distributing the numbers outside the parentheses on the left side.

$$\begin{aligned}\frac{2}{3}(6x - 9) + \frac{1}{3}(6x - 9) &= 3 \\ 4x - 6 + 2x - 3 &= 3 \\ 6x - 9 &= 3 \\ 6x &= 12 \\ x &= 2\end{aligned}$$

Terri's Solution

I began by multiplying each side of the equation by 3.

$$\begin{aligned}3\left[\frac{2}{3}(6x - 9) + \frac{1}{3}(6x - 9)\right] &= 3(3) \\ 2(6x - 9) + 1(6x - 9) &= 9 \\ 12x - 18 + 6x - 9 &= 9 \\ 18x - 27 &= 9 \\ 18x &= 36 \\ x &= 2\end{aligned}$$

Brian's Solution

I knew that $\frac{2}{3} + \frac{1}{3} = 1$, so I simplified the right side to $6x - 9$.

$$\begin{aligned}\frac{2}{3}(6x - 9) + \frac{1}{3}(6x - 9) &= 3 \\ 1(6x - 9) &= 3 \\ 6x - 9 &= 3 \\ 6x &= 12 \\ x &= 2\end{aligned}$$

56. **Multiple Choice** Dorine solves the equation $3x + 3 = 3x + 9$ and is trying to make sense of her answer.

$$\begin{array}{r} 3x + 3 = 3x + 9 \\ -3x - 3 \quad -3x - 3 \\ \hline 0 = 6 \end{array}$$

Which of the following should Dorine say is the correct solution?

- A. $x = 6$, because 6 is the final number in the equation.
- B. $x = 6$ or $x = 0$, because both of these numbers are in the last equation.
- C. There is no solution, because each value of x will lead to $0 = 6$, which is not true.
- D. The solution is all numbers, because x will satisfy the equation.

57. **Multiple Choice** Flora solves an equation similar to Dorine's:


$$3(x + 1) = 3x + 3$$

Flora uses the following method.

$$\begin{array}{r} 3(x + 1) = 3x + 3 \\ 3x + 3 = 3x + 3 \\ \underline{-3x - 3} \quad \underline{-3x - 3} \\ 0 = 0 \end{array}$$

Which of the following should Flora say is the correct solution?

- A. $x = 0$, since $0 = 0$ is the last line of the equation.
 B. No solution, because x does not show up in the equation $0 = 0$.
 C. Any number x will work.
58. Fill in the missing representation for each inequality.

	In Symbols	On a Number Line	In Words
a.	■		all positive numbers
b.	$x^2 < 9$	■	all numbers whose squares are less than 9
c.	■	■	all numbers whose absolute values are greater than or equal to 2
d.	$x^3 > x$	■	all numbers for which the cube of the number is greater than the number itself
e.	$x + \frac{1}{x} > 1$	■	all numbers for which the sum of the number and its reciprocal is greater than 1

59. The Small World long-distance phone company charges 55¢ for the first minute of a long-distance call and 23¢ for each additional minute.
- Write an equation for the total cost C of an m -minute long-distance call. Explain what your variables and numbers mean.
 - How much does a 10-minute long-distance call cost?
 - Suppose a call costs \$4.92. How long does the call last?