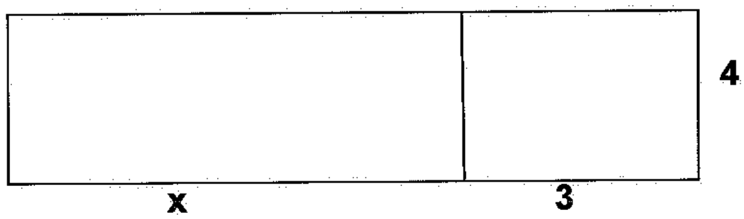
Section 4.1 The Distributive Property and Algebraic Expressions

1. Review of the Distributive Property: If a, b and c are any numbers then it is true that

$$\mathbf{a(b + c) = ab + ac \quad \text{and} \quad a(b - c) = ab - ac.}$$

This property can be modeled geometrically by examining the area of the figure below.



Looking at the figure as one piece, we see that it has a length of $x + 3$ and a width of 4, thus $A = 4(x + 3)$

Looking at the figure as two pieces, one of which has a length of x and a width of 4 and the other of which has a length of 3 and a width of 4, we see that $A = 4(x) + 4(3)$.

Since the two areas are of the same figure, they must be equal, so

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

Example 1: Use the distributive property to simplify.

a. $3(x+5) = 3\cdot(x) + 3\cdot(5)$
$= 3x + 15$

b. $3(x-5) = 3\cdot(x) + 3\cdot(-5)$
$= 3x + (-15)$
$= 3x - 15$

c. $-3(x+5) = -3\cdot(x) + (-3)(5)$
$= -3x + (-15)$
$= -3x - 15$

Note: Portions of this document are excerpted from the textbook *Prealgebra*, 7th ed. by Charles McKeague

2. Similar Terms: Recall that two terms (addends in an addition expression) are similar if their variable parts are identical. Such terms can be added or subtracted by applying the distributive property. In the answer, the common variable part remains unchanged, but the numbers in front of the variable parts are added or subtracted.

Example 2: Simplify each of the following.

a. $4x + 3x = (4 + 3)x = 7x$

b. $8a + 10a = (8 + 10)a$
$= 18a$

c. $3a - 5a = (3 - 5)a = -2a$

d. $3a + 17 + 5a = (3a + 5a) + 17$
$= (3 + 5)a + 17$
$= 8a + 17$

3. The Value of an Algebraic Expression: To find the value of an algebraic expression, you must be given the expression and a value of the unknown(s) to substitute into the algebraic expression. After substituting the known value into the expression for the appropriate variable(s), simplify.

Example 3: Find the value of the given expression for the given value of the variable.

a. $7x + 2$, for $x = 3$
$7x + 2 = 7(3) + 2$
$= 21 + 2$
$= 23$

b. $7x - 2$, for $x = -3$
$7x - 2 = 7(-3) - 2$
$= -21 - 2$
$= -23$

c. $x^2 - 3x + 2$, for $x = -2$
$x^2 - 3x + 2 = (-2)^2 - 3(-2) + 2$
$= 4 + 6 + 2$
$= 12$

scratchwork

$(-2)^2 = (-2)(-2)$
$= 4$

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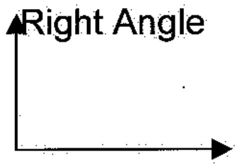
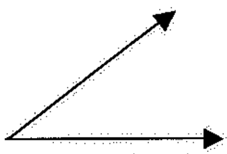
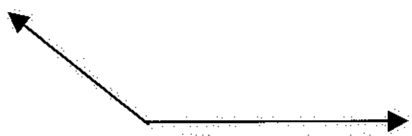
4. Angles: An angle is formed by two rays that have the same endpoint. The endpoint is called the vertex of the angle and the rays are the sides of the angle. Angles are measured in degrees. The angle formed by rotating a ray through one complete rotation is 360°. Thus, one-half of a full rotation forms a 180° angle (called a straight angle) and one-fourth of a full rotation forms a 90° angle (called a right angle).


Right Angle


Straight Angle

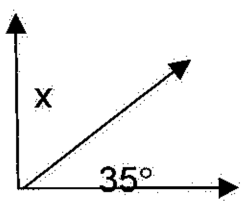
An acute angle is an angle whose measure is between 0° and 90°. An obtuse angle is an angle whose measure is between 90° and 180°.


Acute Angle


Obtuse Angle

Two angles are complementary if their sum is 90°. Two angles are supplementary if their sum is 180°.

Example 4: Find the missing angle.



$x + 35 = 90$

$-35 + x + 35 = -35 + 90$

$x = 55$

ANS: The missing angle is 55°.

check

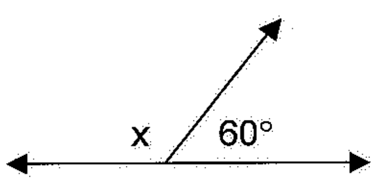
$(55°) + 35° = 90°$

$90° = 90°$

TRUE!

Practice Problems:

a. Find the missing angle.



$x + 60° = 180$

$-60 + x + 60 = -60 + 180$

$x = 120$

ANS: The missing angle is 120°.

check

$(120°) + 60° = 18$

$180° = 180°$

TRUE!

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b. Simplify: $11a - 15a$ $= (11-15)a$

$= -4a$

Evaluate each expression for the given value of x.

c. $-3x+2$, for $x=2$

$-3x+2 = -3(2)+2$

$= -6+2$

$= -4$

d. $-3x-5$, for $x=-4$

$-3x-5 = -3(-4)-5$

$= 12-5$

$= 7$

Answers to Practice Problems:

a. {120°}; b. –4a; c. –4; d. 7

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Section 4.2 The Addition Property of Equality

1. Definition of Solution: A solution for an equation is a number that when used in place of the variable makes the equation a true statement.

Example 1: Check to see if the number to the right of each of the following equations is a solution for the equation.

a. $3x+5=14$; 3

$3(3)+5=14$
$9+5=14$
$14=14$
TRUE!

Yes, 3 is a solution.

b. 4x+3=7; 1

$4(1)+3=7$
$4+3=7$
$7=7$
True!

Yes, 1 is a solution.

c. $4x+5=2x-1$; -6

$4(-6)+5=2(-6)-1$
$-24+5=-12-1$
$-19=-13$
False!

No, -6 is not a solution.

2. Addition Property of Equality: Let A, B, and C represent algebraic expressions.

If A = B
then A + C = B + C

Adding the same quantity to both sides of an equation never changes the solution for the equation. Because subtraction is defined as the addition of the opposite, this property can be extended to subtraction.

If A = B
then A − C = B − C

We use the addition property of equals to solve equations. When solving an equation, we want to end up with an expression of the form

x = a number

If the side of the equation that contains the x has a number that is subtracted from the x, we can add that number from both sides of the equation to get the x by itself.

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If the side of the equation that contains the x has a number that is added to the x, we can subtract that number from both sides of the equation to get the x by itself.

Example 2: Solve each of the following.

a. $x + 3 = 15$

$-3 + x + 3 = -3 + 15$
$x = 12$

The solution is 12.

check
$(12) + 3 = 15$
$15 = 15$
TRUE!

b. $a + 9 = -12$

$-9 + a + 9 = -9 + (-12)$
$a = -21$

The solution is -21.

check
$(-21) + 9 = -12$
$-12 = -12$
TRUE!

c. $x - 7 = -8$

$7 + x - 7 = 7 + (-8)$
$x = -1$

The solution is -1.

check
$(-1) - 7 = -8$
$-8 = -8$
TRUE!

d. $x - 6 = 1$

$6 + x - 6 = 6 + 1$
$x = 7$

The solution is 7.

check
$(7) - 6 = 1$
$1 = 1$
TRUE!

3. Simplifying Before You Solve: Always simplify equations fully before you start solving them. Look for similar terms that can be combined and operations that can be carried out using the distributive property.

Example 3: Solve each of the following. Simplify fully before you begin to solve.

a. $5a + 6 - 4a = 4$

$a + 6 = 4$
$-6 + a + 6 = -6 + 4$
$a = -2$

The solution is -2.

check
$5(-2) + 6 - 4(-2) = 4$
$-10 + 6 + 8 = 4$
$-4 + 8 = 4$
$4 = 4$
TRUE!

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b. $4(2a-1)-7a=9-5$

$4\cdot 2a+4(-1)-7a=4$

$8a-4-7a=4$

$a-4=4$

$4+a-4=4+4$

$a=8$

The solution is 8.

check

$4[2(8)-1]-7(8)=9-5$

$4[16-1]-56=4$

$4\cdot 15-56=4$

$60-56=4$

$4=4$

TRUE!

4. Solving Equations That Involve Fractions: Some equations involve fractions. You may use the rules for adding or subtracting fractions along with the Addition Property of Equality to solve these equations. Some equations have answers that are fractions. Leave those answers as fractions in lowest form.

Example 4: Solve the given equations.

a. $a-\frac{3}{4}=\frac{7}{8}$

$\frac{3}{4}+a-\frac{3}{4}=\frac{3}{4}+\frac{7}{8}$

$a=\frac{3}{4}\cdot\frac{2}{2}+\frac{7}{8}$

$a=\frac{6}{8}+\frac{7}{8}$

$a=\frac{13}{8}$

The solution is $\frac{13}{8}$.

check

$\left(\frac{13}{8}\right)-\frac{3}{4}=\frac{7}{8}$

$\frac{13}{8}-\frac{3}{4}\cdot\frac{2}{2}=\frac{7}{8}$

$\frac{13}{8}-\frac{6}{8}=\frac{7}{8}$

$\frac{7}{8}=\frac{7}{8}$ TRUE!

b. $x-\frac{3}{5}=-\frac{5}{8}$

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

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

$x=\frac{-25}{40}+\frac{24}{40}$

$x=\frac{-1}{40}$

The solution is $\frac{-1}{40}$.

check

$\left(-\frac{1}{40}\right)-\frac{3}{5}=-\frac{5}{8}$

$\frac{-1}{40}-\frac{3}{5}\cdot\frac{8}{8}=\frac{-5}{8}\cdot\frac{5}{5}$

$\frac{-1}{40}-\frac{24}{40}=\frac{-25}{40}$

$\frac{-25}{40}=\frac{-25}{40}$

TRUE!

c. $a+2=\frac{7}{8}$

$-2+a+2=-2+\frac{7}{8}$

$a=-\frac{2}{1}\cdot\frac{8}{8}+\frac{7}{8}$

$a=\frac{-16}{8}+\frac{7}{8}$

$a=-\frac{9}{8}$

The solution is $\frac{-9}{8}$.

check

$\left(-\frac{9}{8}\right)+2=\frac{7}{8}$

$\frac{-9}{8}+\frac{2}{1}\cdot\frac{8}{8}=\frac{7}{8}$

$\frac{-9}{8}+\frac{16}{8}=\frac{7}{8}$

$\frac{7}{8}=\frac{7}{8}$

TRUE!

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5. Using Equations to Solve Applied Problems: To solve applied problems:

- Identify the unknown and represent it with a variable. Write a statement or draw a diagram that tells what quantity the variable stands for.
- Write the equation that models the problem.
- Substitute in known values
- Solve the equation.
- Write your answer in English words.

If the equation does not involve a geometry formula for perimeter, area or volume, you may combine the second and third steps, writing the equation and substituting in the known values in one step.

Example 5: Solve the given applied problems.

a. Two angles are complementary. One angle is 34°. Find the other angle.

Let x be the unknown angle.	(Identify the unknown.)
$x + 34° = 90°$	(Write the equation substituting in the known value)
$x + 34° - 34° = 90° - 34°$ $x = 56°$	(Solve the equation)
The missing angle is 56°.	(Write your answer in English words.)

b. Two angles are supplementary. One angle is 108°. Find the other angle.

Let x be the unknown angle.

$x + 108° = 180°$

$-108° + x + 108° = -108° + 180°$

$x = 72°$

check

$(72°) + 108° = 180°$

$180° = 180°$

TRUE!

The missing angle is 72°.

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Practice Problems: Solve each equation. Show all steps.

a. $x-6=-8$

$x-6+6=-8+6$

$x=-2$

The solution is -2.

check

$(-2)-6=-8$

$-8=-8$

TRUE!

b. $2-6=a-1$

$-4=a-1$

$-4+1=a-1+1$

$-3=a$

The solution is -3.

check

$2-6=(-3)-1$

$-4=-4$

TRUE!

c. $7a-6-6a=-3+1$

$a-6=-2$

$a-6+6=-2+6$

$a=4$

The solution is 4!

check

$7(4)-6-6(4)=-3+1$

$28-6-24=-2$

$22-24=-2$

$-2=-2$

TRUE!

d. $a+\frac{1}{4}=-\frac{3}{4}$

$-\frac{1}{4}+a+\frac{1}{4}=-\frac{1}{4}+\left(\frac{-3}{4}\right)$

$a=\frac{-4}{4}$

$a=-1$

The solution is -1.

check

$(-1)+\frac{1}{4}=-\frac{3}{4}$

$\frac{-1}{1}\cdot\frac{4}{4}+\frac{1}{4}=\frac{-3}{4}$

$\frac{-4}{4}+\frac{1}{4}=\frac{-3}{4}$

$\frac{-3}{4}=\frac{-3}{4}$

TRUE!

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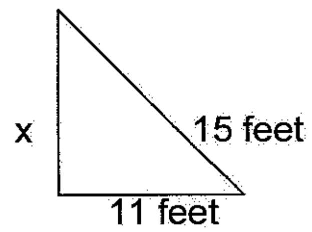
e. Find the value for x given that the perimeter is 30 feet.



Perimeter = x + 11 + 15

30 = x + 26

−26 + 30 = x + 26 + (−26)

4 = x

check

Perimeter = 30 feet

30 = (4) + 11 + 15

30 = 15 + 15

30 = 30

TRUE!

The missing value is 4 ft.

Answers to Practice Problems:

a. {−2}
b. {−3}
c. {4}
d. {−1}
e. {4 ft.}

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Section 4.3 The Multiplication Property of Equality

1. Multiplication Property of Equality: Let A, B, and C represent algebraic expressions.

If A = B
then AC = BC

Multiplying both sides of an equation by the same nonzero quantity does not change the solution for the equation. Because division is defined as multiplication by the reciprocal, the Multiplication Property can be extended to division (as long as you don't divide by zero.)

If A = B
then $\frac{A}{C} = \frac{B}{C}$

We use the Multiplication Property of Equality to solve equations. When solving an equation, we want to end up with an expression of the form

x = a number (1x = a number)

The number that multiplies the x-term is called the coefficient of x. In your solution, the coefficient of x must be 1. If the x-term has a coefficient other than 1, we can divide both sides by that number to make the coefficient of x be 1.

Example 1: Solve each of the following.

a. $2x = 12$

$\frac{1}{2} \cdot \frac{2x}{1} = \frac{1}{2} \cdot \frac{12}{1}$

$x = \frac{2 \cdot 2 \cdot 3}{2 \cdot 1}$

$x = 6$

check
$2(6) = 12$
$12 = 12$
TRUE!

The solution is 6

b. $7a = -14$

$\frac{1}{7} \cdot \frac{7a}{1} = \frac{1}{7} \cdot \frac{(-14)}{1}$

$a = \frac{-2 \cdot 7}{7 \cdot 1}$

$a = -2$

check
$7(-2) = -14$
$-14 = -14$
TRUE

The solution is -

c. $-2x = -10$

$-\frac{1}{2} \cdot \left(\frac{-2x}{1}\right) = \frac{-1}{2} \cdot \frac{(-10)}{1}$

$x = \frac{2 \cdot 5}{2 \cdot 1}$

$x = 5$

check
$-2(5) = -10$
$-10 = -10$
TRUE!

The solution is 5.

2. The Multiplication Property and Fractions: The Multiplication Property involves dividing both sides of an equation by a number. If that number happens to be a fraction, instead of dividing you can multiply both sides of the equation by the reciprocal of the fraction (since dividing is the same as multiplying by the reciprocal.) If the solution for an equation is a fraction, reduce the fraction to lowest terms.

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Example 2: Solve each of the following.

a. $\frac{1}{3}x = 7$

$\frac{3}{1} \cdot \frac{1}{3}x = \frac{3}{1} \cdot \frac{7}{1}$

$x = 21$

The solution is 21.

check

$\frac{1}{3}\left(\frac{21}{1}\right) = 7$

$\frac{1 \cdot \cancel{3} \cdot 7}{\cancel{3} \cdot 1} = 7$

$7 = 7$

TRUE!

SDWK

21

3 7

b. $\frac{1}{5}x = -6$

$\frac{5}{1} \cdot \frac{1}{5}x = \frac{5}{1} \cdot \frac{(-6)}{1}$

$x = -30$

The solution is -30.

check

$\frac{1}{5}\left(\frac{-30}{1}\right) = -6$

$-\frac{2 \cdot 3 \cdot \cancel{5}}{\cancel{5} \cdot 1} = -6$

$-6 = -6$

TRUE!

SDWK

30

3 10

2 5

c. $\frac{2}{3}x = 14$

$\frac{3}{2} \cdot \frac{2}{3}x = \frac{3}{2} \cdot \frac{14}{1}$

$x = \frac{3 \cdot \cancel{2} \cdot 7}{\cancel{2} \cdot 1}$

$x = 21$

check

$\frac{2}{3}(21) = 14$

$\frac{2}{\cancel{3}}\left(\frac{\cancel{3} \cdot 7}{1}\right) = 14$

$2 \cdot 7 = 14$

$14 = 14$ TRUE!

SDWK

14

2 7

The solution is 21.

3. Solving Equations Using Both the Addition and the Multiplication Property of Equality: If the x-term in an equation has a quantity added to it or subtracted from it, you must use the Addition Property of Equality to eliminate the added or subtracted term. If the x-term has a coefficient other than 1, you must use the Multiplication Property of Equality to make the coefficient 1. In some equations the x-term has both a quantity added to it or subtracted from it **and** a coefficient other than 1, and you must use both Properties to solve. In such equations, use the Addition Property first and the Multiplication Property second.

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Example 3: Solve the given equations.

a. $3x-5=-26$

$5+3x-5=5+(-26)$

$3x=-21$

$\frac{1}{3}\cdot\frac{3x}{1}=\frac{1}{3}\cdot\left(\frac{-21}{1}\right)$

$x=-\frac{3\cdot 7}{3}$

$x=-7$

The solution is -7.

check

$3(-7)-5=-26$

$-21-5=-26$

$-26=-26$

TRUE!

SDWK

$21 = 3 \cdot 7$

b. $-\frac{2}{5}a+6=14$

$-\frac{2}{5}a+6+(-6)=14+(-6)$

$-\frac{2}{5}a=8$

$-\frac{5}{2}\cdot\left(-\frac{2}{5}a\right)=\frac{-5}{2}\cdot\left(\frac{8}{1}\right)$

$a=-\frac{5\cdot\cancel{2}\cdot 2\cdot 2}{\cancel{2}\cdot 1}$

$a=-20$

The solution is -20.

check

$-\frac{2}{5}\left(\frac{-20}{1}\right)+6=14$

$\frac{2\cdot 2\cdot 2\cdot\cancel{5}}{\cancel{5}\cdot 1}+6=14$

$8+6=14$

$14=14$

TRUE!

SDWK

$8 = 2\cdot 4 = 2\cdot 2\cdot 2$

$20 = 5\cdot 4 = 5\cdot 2\cdot 2$

4. Solving Equations That Require Simplification: If an equation can be simplified, then simplify it before you begin solving it.

Example 4: Solve the given equation.

$2(x-1)-3x=\frac{3}{5}$

$2\cdot x+2\cdot(-1)-3x=\frac{3}{5}$

$2x-2-3x=\frac{3}{5}$

$-x-2=\frac{3}{5}$

$-x-2+2=\frac{3}{5}+2$

$-x=\frac{3}{5}+\frac{2}{1}\cdot\frac{5}{5}$

$-x=\frac{3}{5}+\frac{10}{5}$

$-x=\frac{13}{5}$

$-1\cdot(-x)=-1\cdot\left(\frac{13}{5}\right)$

$x=-\frac{13}{5}$

The solution is $\frac{-13}{5}$.

check

$2\cdot\left[\left(-\frac{13}{5}\right)-1\right]-\frac{3}{1}\left(\frac{-13}{5}\right)=\frac{3}{5}$

$2\cdot\left[\frac{-13}{5}-\frac{5}{5}\right]+\frac{39}{5}=\frac{3}{5}$

$\frac{2}{1}\cdot\left[\frac{-18}{5}\right]+\frac{39}{5}=\frac{3}{5}$

$\frac{-36}{5}+\frac{39}{5}=\frac{3}{5}$

$\frac{3}{5}=\frac{3}{5}$

TRUE!

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Practice Problems: Solve each of the following problems. Show all steps.

a. $-\frac{1}{2}x = -4$

$-\frac{2}{1} \cdot \left(-\frac{1}{2}x\right) = -\frac{2}{1} \cdot \left(\frac{-4}{1}\right)$

$x = 8$

The solution is 8.

check

$-\frac{1}{2}\left(\frac{8}{1}\right) = -4$

$-\frac{1 \cdot \cancel{2} \cdot 2 \cdot 2}{\cancel{2} \cdot 1} = -4$

$-4 = -4$

TRUE!

SDWK

8

2 4

2 2

b. $-\frac{4}{7}x = \frac{2}{3}$

$-\frac{7}{4} \cdot \left(-\frac{4}{7}x\right) = -\frac{7}{4} \cdot \frac{2}{3}$

$x = \frac{-7 \cdot \cancel{2}}{2 \cdot \cancel{2} \cdot 3}$

$x = \frac{-7}{6}$

The solution is $-\frac{7}{6}$.

check

$-\frac{4}{7} \cdot \left(\frac{-7}{6}\right) = \frac{2}{3}$

$\frac{2 \cdot \cancel{2} \cdot \cancel{7}}{\cancel{7} \cdot \cancel{2} \cdot 3} = \frac{2}{3}$

$\frac{2}{3} = \frac{2}{3}$

TRUE!

SDWK

4 6

2 2 2 3

c. $7x - 5 = -40$

$7x - 5 + 5 = -40 + 5$

$7x = -35$

$\frac{1}{7} \cdot \frac{7x}{1} = \frac{1}{7} \cdot \left(\frac{-35}{1}\right)$

$x = -\frac{5 \cdot \cancel{7}}{\cancel{7}}$

$x = -5$

The solution is -5.

check

$7(-5) - 5 = -40$

$-35 - 5 = -40$

$-40 = -40$

TRUE!

SDWK

35

5 7

d. $\frac{1}{2}x + 2 = -7$

$-2 + \frac{1}{2}x + 2 = -2 + (-7)$

$\frac{1}{2}x = -9$

$\frac{2}{1} \cdot \left(\frac{1}{2}x\right) = \frac{2}{1} \cdot \left(\frac{-9}{1}\right)$

$x = -18$

The solution is -18.

check

$\frac{1}{2}\left(\frac{-18}{1}\right) + 2 = -7$

$-\frac{1 \cdot \cancel{2} \cdot 3 \cdot 3}{\cancel{2} \cdot 1} + 2 = -7$

$-9 + 2 = -7$

$-7 = -7$

TRUE!

SDWK

18

2 9

3 3

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e. $4x+8x-2x=15-10$

$12x-2x=5$

$10x=5$

$\frac{1}{10}\cdot\frac{10x}{1}=\frac{1}{10}\cdot\frac{5}{1}$

$x=\frac{1\cdot\cancel{5}}{2\cdot\cancel{5}}$

$x=\frac{1}{2}$

The solution is $\frac{1}{2}$.

check

$4\left(\frac{1}{2}\right)+8\left(\frac{1}{2}\right)-2\left(\frac{1}{2}\right)=15-10$

$\frac{\cancel{2}\cdot 2}{\cancel{2}}+\frac{\cancel{2}\cdot2\cdot2}{\cancel{2}}-\frac{2}{2}=5$

$2+4-1=5$

$6-1=5$

$5=5$

TRUE!

scwk

$4 = 2\cdot 2$, $8 = 2\cdot 4 = 2\cdot 2\cdot 2$

$10 = 2\cdot 5$

Answers to Practice Problems:

a. $\{8\}$ b. $\left\{-\frac{7}{6}\right\}$ c. $\{-5\}$ d. $\{-18\}$ e. $\left\{\frac{1}{2}\right\}$

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

Section 4.4 Linear Equations in One Variable

1. Definition of a Linear Equation in One Variable: A linear equation in one variable contains only one variable and that variable is always raised to the first power and never appears in a denominator.

Example 1: Identify which of the following are linear equations in one variable.

a. $2x-7=4x-15$; linear equation

b. $x^2-2x+3=0$; not a linear equation

c. $2x-5=x^3$; not a linear equation

d. $\frac{2}{x}+1=15$; not a linear equation

e. $2x+4=\sqrt{x}$ (Note: $\sqrt{x}=x^{\frac{1}{2}}$) ; not a linear equation

2. Steps to Solve a Linear Equation:

- Simplify each side of the equation as much as possible. Combine similar terms and use the distributive property.
- Use the addition property of equality to get all variable terms on one side of the equation and all constant terms on the other, and then combine similar terms. A variable term is any term that contains the variable. A constant term is any term that contains only a number.
- Use the multiplication property of equality to get the coefficient of the variable term to be 1.
- Check your solution in the original equation.

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

Example 2: Solve the given equations.

a. $3y + 5 = 9y + 8$

$-3y + 3y + 5 = -3y + 9y + 8$

$5 = 6y + 8$

$-8 + 5 = -8 + 6y + 8$

$-3 = 6y$

$\frac{1}{6} \cdot \left(\frac{-3}{1}\right) = \frac{1}{6} \cdot \frac{6y}{1}$

$-\frac{1 \cdot 3}{2 \cdot 3} = y$

$-\frac{1}{2} = y$

The solution is $-\frac{1}{2}$.

check

$3\left(-\frac{1}{2}\right) + 5 = 9\left(-\frac{1}{2}\right) + 8$

$-\frac{3}{2} + \frac{5}{1} \cdot \frac{2}{2} = -\frac{9}{2} + \frac{8}{1} \cdot \frac{2}{2}$

$-\frac{3}{2} + \frac{10}{2} = -\frac{9}{2} + \frac{16}{2}$

$\frac{7}{2} = \frac{7}{2}$

TRUE!

scwk

6

2 3

b. $10a + 3 = 4(a - 1) + 1$

$10a + 3 = 4 \cdot a + 4 \cdot (-1) + 1$

$10a + 3 = 4a - 4 + 1$

$10a + 3 = 4a - 3$

$-4a + 10a + 3 = -4a + 4a - 3$

$6a + 3 = -3$

$-3 + 6a + 3 = -3 + (-3)$

$6a = -6$

$\frac{1}{6} \cdot \frac{6a}{1} = \frac{1}{6} \cdot \left(\frac{-6}{1}\right)$

$a = -1$

The solution is -1.

check

$10(-1) + 3 = 4[(-1) - 1] + 1$

$-10 + 3 = 4 \cdot [-2] + 1$

$-7 = -8 + 1$

$-7 = -7$

TRUE!

3. Solving Equations That Contain Fractions: If the equation contains only one fraction, you may be able to solve it easily by applying the Addition and/or Multiplication Properties. If the equation has several fractions, it is easier to use the method of clearing fractions to solve the equation. In this method, you find the LCD for all of the fractions in the equation, but instead of adjusting all of the fractions so that they have the LCD, you multiply both sides of the equation by the LCD, using the distributive property if needed. The resulting equations will no longer contain any fractions.

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

Example 3: Solve the given equations by clearing fractions.

$LCD = 4$

a. $\frac{x}{2} - \frac{x}{4} = 3$

$\frac{4}{1}\left[\frac{x}{2} - \frac{x}{4}\right] = \frac{4}{1} \cdot \frac{3}{1}$

$\frac{4}{1} \cdot \frac{x}{2} + \frac{4}{1} \cdot \left(\frac{-x}{4}\right) = 12$

$2x - x = 12$

$x = 12$

The solution is 12.

check

$\frac{(12)}{2} - \frac{(12)}{4} = 3$

$6 - 3 = 3$

$3 = 3$

TRUE!

SDWK

$LCD = 2 \cdot 2 = 4$

$2 = 2$

$4 = 2 \cdot 2$

$\frac{4x}{2} = \frac{\cancel{2} \cdot 2 \cdot x}{1 \cdot \cancel{2}} = \frac{2x}{1} = 2x$

$\frac{4}{1} \cdot \left(\frac{-x}{4}\right) = \frac{-\cancel{2} \cdot \cancel{2} \cdot x}{1 \cdot \cancel{2} \cdot \cancel{2}} = -x$

$LCD = 5x$

b. $\frac{3}{x} - \frac{4}{5} = -\frac{1}{5}$

$\frac{5x}{1} \cdot \left[\frac{3}{x} - \frac{4}{5}\right] = \frac{5x}{1} \cdot \left(-\frac{1}{5}\right)$

$\frac{5x}{1} \cdot \frac{3}{x} + \frac{5x}{1} \cdot \left(\frac{-4}{5}\right) = -x$

$15 - 4x = -x$

$4x + 15 - 4x = 4x + (-x)$

$15 = 3x$

$\frac{1}{3} \cdot \frac{15}{1} = \frac{1}{3} \cdot \frac{3x}{1}$

$\frac{1 \cdot 3 \cdot 5}{1 \cdot 3} = x$

$5 = x$

The solution is 5.

check

$\frac{3}{(5)} - \frac{4}{5} = -\frac{1}{5}$

$\frac{3-4}{5} = \frac{-1}{5}$

$\frac{-1}{5} = \frac{-1}{5}$

TRUE!

SDWK

$LCD = 5 \cdot x = 5x$

$5 = 5$

$x = x$

$\frac{5x}{1} \cdot \frac{3}{x} = \frac{5 \cdot 3 \cdot x}{1 \cdot x} = \frac{5 \cdot 3}{1} = 15$

$\frac{5x}{1} \cdot \left(\frac{-4}{5}\right) = \frac{-2 \cdot 2 \cdot \cancel{5} \cdot x}{1 \cdot \cancel{5}} = -4x$

Practice Problems. Solve each equation. Show all steps.

a. 6y+9=4y − 3

$-4y + 6y + 9 = -4y + 4y - 3$

$2y + 9 = -3$

$-9 + 2y + 9 = -9 + (-3)$

$2y = -12$

$\frac{1}{2} \cdot \frac{2y}{1} = \frac{1}{2}\left(\frac{-12}{1}\right)$

$y = \frac{-1 \cdot \cancel{2} \cdot 2 \cdot 3}{\cancel{2} \cdot 1}$

$y = -6$

The solution is −6.

check

$6(-6) + 9 = 4(-6) - 3$

$-36 + 9 = -24 - 3$

$-27 = -27$

TRUE!

SDWK

12

2 6

2 3

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SDWK

10 = 2 · 5, 50 = 5 · 10 = 5 · 5 · 2

b. $5(2x-4)+8=38$

$5 \cdot 2x + 5(-4) + 8 = 38$

$10x - 20 + 8 = 38$

$10x - 12 = 38$

$12 + 10x - 12 = 12 + 38$

$10x = 50$

$\frac{1}{10} \cdot \frac{10x}{10} = \frac{1}{10} \cdot \frac{50}{1}$

$x = \frac{\cancel{2} \cdot \cancel{5} \cdot 5}{\cancel{2} \cdot \cancel{5} \cdot 1}$

$x = 5$

Check

$5 \cdot [2(5)-4]+8=38$

$5 \cdot [10-4]+8=38$

$5 \cdot [6]+8=38$

$30+8=38$

$38=38$

TRUE!

The solution is 5.

LCD=4

c. $3x+\frac{1}{2}=\frac{1}{4}$

$\frac{4}{1} \cdot \left[\frac{3x}{1}+\frac{1}{2}\right]=\frac{4}{1} \cdot \frac{1}{4}$

$\frac{4}{1} \cdot \frac{3x}{1} + \frac{4}{1} \cdot \frac{1}{2} = 1$

$12x + 2 = 1$

$-2 + 12x + 2 = -2 + 1$

$12x = -1$

$\frac{1}{12} \cdot \frac{12x}{1} = \frac{1}{12}\left(\frac{-1}{1}\right)$

$x = -\frac{1}{12}$

Check

$\frac{3}{1}\left(-\frac{1}{12}\right) + \frac{1}{2} = \frac{1}{4}$

$-\frac{1 \cdot \cancel{3}}{2 \cdot 2 \cdot \cancel{3}} + \frac{1}{2} = \frac{1}{4}$

$-\frac{1}{4} + \frac{1}{2} = \frac{1}{4}$

$-\frac{1}{4} + \frac{1}{2} \cdot \frac{2}{2} = \frac{1}{4}$

$-\frac{1}{4} + \frac{2}{4} = \frac{1}{4}$

$\frac{1}{4} = \frac{1}{4}$

TRUE!

SDWK

$LCD = 2 \cdot 2 = 4$

$2 = 2$

$4 = 2 \cdot 2$

$\frac{4}{1} \cdot \frac{1}{2} = \frac{2 \cdot \cancel{2} \cdot 1}{1 \cdot \cancel{2}} = 2$

12 = 2 · 6 = 2 · 2 · 3

The solution is $-\frac{1}{12}$.

LCD=6

d. $\frac{1}{2}x+\frac{4}{3}=-\frac{2}{3}$

$\frac{6}{1} \cdot \left[\frac{1}{2}x + \frac{4}{3}\right] = \frac{6}{1} \cdot \left[\frac{-2}{3}\right]$

$\frac{6}{1} \cdot \frac{1}{2}x + \frac{6}{1} \cdot \frac{4}{3} = -\frac{2 \cdot \cancel{3} \cdot 2}{1 \cdot \cancel{3}}$

$\frac{\cancel{2} \cdot 3 \cdot x}{1 \cdot \cancel{2}} + \frac{2 \cdot \cancel{3} \cdot 2 \cdot 2}{1 \cdot \cancel{3}} = -4$

$3x + 8 = -4$

$-8 + 3x + 8 = -8 + (-4)$

$3x = -12$

$\frac{1}{3} \cdot \frac{3x}{1} = \frac{1}{3} \cdot \left(\frac{-12}{1}\right)$

$x = -\frac{1 \cdot 2 \cdot 2 \cdot \cancel{3}}{\cancel{3} \cdot 1}$

$x = -4$

Check

$\frac{1}{2}\left(\frac{-4}{1}\right) + \frac{4}{3} = \frac{-2}{3}$

$\frac{-2 \cdot 2}{2 \cdot 1} + \frac{4}{3} = \frac{-2}{3}$

$-\frac{2}{1} \cdot \frac{3}{3} + \frac{4}{3} = \frac{-2}{3}$

$\frac{-6}{3} + \frac{4}{3} = \frac{-2}{3}$

$\frac{-2}{3} = \frac{-2}{3}$

TRUE!

SDWK

$LCD = 2 \cdot 3 = 6$

$2 = 2$

$3 = 3$

6 = 2 · 3, 4 = 2 · 2, 12 = 2 · 6 = 2 · 2 · 3

$\frac{6}{1} \cdot \frac{1}{2}x = \frac{2 \cdot 3 \cdot x}{1 \cdot 2} = 3x$

$\frac{6}{1} \cdot \frac{4}{3} = \frac{2 \cdot \cancel{3} \cdot 2 \cdot 2}{1 \cdot \cancel{3}} = \frac{2 \cdot 2 \cdot 2}{1} =$

$\frac{6}{1} \cdot \left(\frac{-2}{3}\right) = \frac{-2 \cdot \cancel{3} \cdot 2}{1 \cdot \cancel{3}} = -4$

Answers to Practice Problems:

a. $\{-6\}$; b. $\{5\}$; c. $\left\{-\frac{1}{12}\right\}$; d. $\{-4\}$

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

Section 4.5 Applications

1. **Blueprint for Problem Solving:** Follow these steps for solving applied problems.

Step 1 Read the problem, and then mentally list the items that are known and the items that are unknown.

Step 2 Assign a variable to one of the unknown items. (In most cases this will amount to letting x equal the item that is asked for in the problem.) Then translate the other information in the problem to expressions involving the variable.

Step 3 Reread the problem, and then write an equation, using the items and variables listed in Steps 1 and 2, that describes the situation.

Step 4 Solve the equation found in Step 3.

Step 5 Write your answer using a complete sentence.

Step 6 Reread the problem, and check your solution with the original words in the problem.

When solving an applied problem, you must show the following steps:

- Write a statement telling what quantity your variable(s) represent.
- Write an equation that describes the situation given in the problem.
- Solve the equation, showing steps.
- Write your solution to the applied problem using the correct units and in English words.

Each of the steps above is worth points on a test. Leaving out any step will result in the loss of the points for that step.

2. **Number Problems:** To solve number problems,

- Let x stand for the number that you are looking for.
- Translate the given problem into an equation using mathematical symbols for the words in the problem.
- Solve the equation.
- Write your solution in English words.

Example 1: Solve the given number problems.

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

subtraction "="

a. The difference of a number and 10 is –15. Find the number.

Let x = unknown number

$(x) - (10) = -15$

$x - 10 = -15$

$x - 10 + 10 = -15 + 10$

$x = -5$

The unknown number is -5.

check

$(-5) - 10 = -15$

$-15 = -15$

TRUE!

Addition "="

b. Four times the sum of twice a number and 6 is –8. Find the number.

Let x = unknown number

$4 \cdot (\text{sum}) = -8$

$4 \cdot (2x + 6) = -8$

$4 \cdot 2x + 4 \cdot 6 = -8$

$8x + 24 = -8$

$-24 + 8x + 24 = -24 + (-8)$

$8x = -32$

$\frac{1}{8} \cdot \frac{8x}{1} = \frac{1}{8} \cdot \left(-\frac{32}{1}\right)$

$x = -\frac{\cancel{2} \cdot \cancel{2} \cdot \cancel{2} \cdot 2 \cdot 2}{\cancel{2} \cdot \cancel{2} \cdot \cancel{2} \cdot 1}$

$x = -4$

The unknown number is -4.

check

$4 \cdot [2(-4) + 6] = -8$

$4 \cdot [-8 + 6] = -8$

$4[-2] = -8$

$-8 = -8$

TRUE!

SDWK

32

2 16

2 8

2 4

2 2

8

2 4

2 2

c. The product of a number and –4 is –21. Find the number.

Let x = unknown number

$(x) \cdot (-4) = -21$

$-4x = -21$

$-\frac{1}{4} \cdot \left(\frac{-4x}{1}\right) = -\frac{1}{4} \cdot \left(\frac{-21}{1}\right)$

$x = \frac{21}{4}$

check

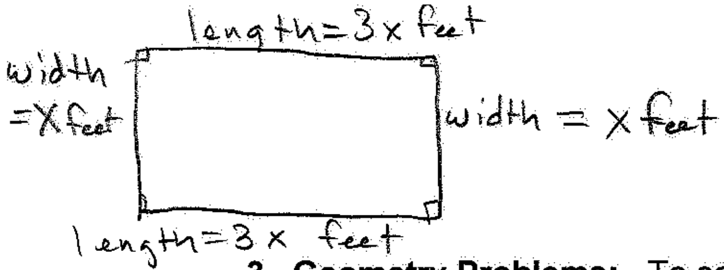
$\frac{-4}{1}\left(\frac{21}{4}\right) = -21$

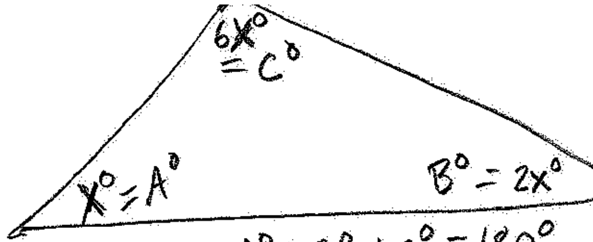
$-21 = -21$

TRUE!

Note: Portions of this document are excerpted from the textbook *Prealgebra*, 7th ed. by Charles McKeague

The unknown number is $\frac{21}{4}$.





$A^\circ + B^\circ + C^\circ = 180^\circ$

3. Geometry Problems: To solve a geometry problem:

- Draw a figure if needed.
- Then label your unknown with a statement or by labeling it on your figure.
- Recall the geometry formula that is called for in the problem. This formula becomes your equation. Plug in any known values.
- Solve the equation.
- Write your solution in English words using proper units.

The problems in this section use geometry formulas that we have learned in previous sections as well as one new formula.

New formula: In any triangle, the sum of the angles is 180°.

Example 2: Solve the following geometry problem.

a. The length of a rectangle is three times the width. The perimeter is 80 feet. Find the length and the width.

Let x = width of rectangle

Perimeter = 80 feet

$80 = 3x + x + 3x + x$

$80 = 8x$

$\frac{1}{8} \cdot \frac{80}{1} = \frac{1}{8} \cdot \frac{8x}{1}$

$\frac{\cancel{2} \cdot \cancel{2} \cdot \cancel{2} \cdot 2 \cdot 5}{\cancel{2} \cdot \cancel{2} \cdot \cancel{2} \cdot 1} = x$

$10 = x$

width = 10 feet

length = 3 x
= 3(10 feet)
= 30 feet

Check

$80 = 3 \cdot (10) + (10) + 3 \cdot (10) + (10)$

$80 = 30 + 10 + 30 + 10$

$80 = 80$

TRUE!

SPWK

80 = 10 · 8; 10 = 2 · 5; 8 = 2 · 4; 4 = 2 · 2

8 = 2 · 4; 4 = 2 · 2

The length of the rectangle is 30 feet and the width is 10 feet.

b. One angle in a triangle measures twice the smallest angle, while the largest angle is six times the smallest angle. Find the measures of all three angles.

Let x = measure of the smallest angle = 20°

2x = measure of "one angle" = $2 \cdot (20^\circ) = 40^\circ$

6x = measure of "largest angle" = $6 \cdot (20^\circ) = 120^\circ$

$(x) + (2x) + (6x) = 180$

$9x = 180$

$\frac{1}{9} \cdot \frac{9x}{1} = \frac{1}{9} \cdot \frac{180}{1}$

$x = \frac{2 \cdot 2 \cdot \cancel{3} \cdot \cancel{3} \cdot 5}{\cancel{3} \cdot \cancel{3} \cdot 1}$

$x = 20$

Check

$(20^\circ) + 2 \cdot (20^\circ) + 6(20^\circ) = 180^\circ$

$20^\circ + 40^\circ + 120^\circ = 180^\circ$

$180^\circ = 180^\circ$

TRUE!

SPWK

180 = 10 · 18; 10 = 2 · 5; 18 = 2 · 9; 9 = 3 · 3

9 = 3 · 3

Note: Portions of this document are excerpted from the textbook *Prealgebra*, 7th ed. by Charles McKeague

The angles in this triangle have measure 20°, 40°, and 120°.

SDWK

$$58 \to 2 \cdot 29$$

4. **Age Problems:** To solve age problems:
   - Set up a chart with the names of the people involved along the rows and the "now" and "years ago (or years in the future) as the columns.
   - Label one of the boxes "x", and fill in the other boxes appropriately.
   - Read the problem and use the information in the problem to write an equation using quantities in some of the boxes.
   - Solve the equation.
   - Write your solution(s) in English words.

   Example 3: Solve the following age problem.
   Diane is 23 year older than her daughter Amy. In 5 years, the sum of their ages will be 91. How old are they now?

Person	Age Now	Age in 5 years
Diane	$(x+23)$ years old	$(x+28)$ years old
Amy	x years old	$(x+5)$ years old
Total	—NA—	91 years

Let x = Amy's Age Now

Diane's age Now $= x+23$
$= (29)+23$
$= 52$

$$(x+28)+(x+5)=91$$

$$2x+33=91$$

$$-33+2x+33=-33+91$$

$$2x=58$$

$$\frac{1}{2}\cdot\frac{2x}{1}=\frac{1}{2}\cdot\frac{58}{1}$$

$$x=\frac{2\cdot 29}{2\cdot 1}$$

$$x=29$$

Check

$$[(29)+28]+[(29)+5]=91$$

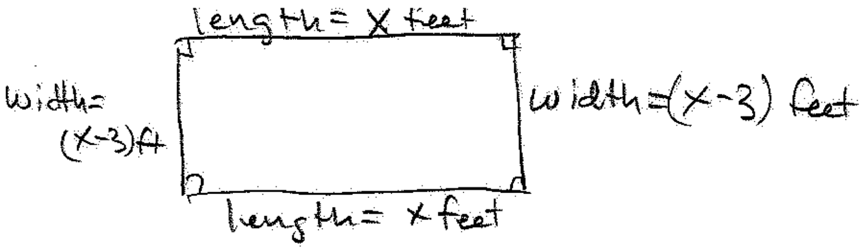
$$57+34=91$$

$$91=91$$

TRUE!

Diane is 52 years old now and Amy is 29 years old now.

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague



Practice Problems. Solve the given word problems. When solving an applied problem, you must show the following steps:

- Write a statement telling what quantity your variable(s) represent.
- Write an equation that describes the situation given in the problem.
- Solve the equation, showing steps.
- Write your solution to the applied problem using the correct units and in English words.

a. The sum of twice a number and –7 is 29. Find the number.

Let x = unknown number

$(2x) + (-7) = 29$

$2x - 7 = 29$

$2x - 7 + 7 = 29 + 7$

$2x = 36$

$\frac{1}{2} \cdot \frac{2x}{1} = \frac{1}{2} \cdot \frac{36}{1}$

$x = \frac{1 \cdot 2 \cdot 2 \cdot 3 \cdot 3}{2 \cdot 1}$

$x = 18$

Check

$2(18) + (-7) = 29$

$36 + (-7) = 29$

$29 = 29$

TRUE!

SDWK

36 = 6 · 6 = 2 · 3 · 2 · 3

The unknown number is 18.

b. The width of a rectangle is 3 feet less than its length. If the perimeter is 22 feet, what is the width?

Let x = length of rectangle

Perimeter = 22 feet

length = 7 feet

width = $x - 3$

$= (7) - 3$

$= 4$ feet

SDWK

28 = 4 · 7 = 2 · 2 · 7

$22 = (x) + (x-3) + (x) + (x-3)$

$22 = 4x - 6$

$6 + 22 = 4x - 6 + 6$

$28 = 4x$

$\frac{1}{4} \cdot \frac{28}{1} = \frac{1}{4} \cdot \frac{4x}{1}$

$\frac{1 \cdot 2 \cdot 2 \cdot 7}{1 \cdot 2 \cdot 2} = x$

$7 = x$

Check

$22 = (7) + [(7) - 3] + (7) + [(7) - 3]$

$22 = 7 + 4 + 7 + 4$

$22 = 11 + 11$

$22 = 22$

TRUE!

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

The length of the rectangle is 7 feet and the width is 4 feet.

c. Pat is 2 years younger than his wife, Wynn. Ten years ago the sum of their ages was 48. How old are they now?

Let x = Wynn's age Now

Person	Age Now	Age Ten years ago
Pat	$(x-2)$ years old	$(x-12)$ years old
Wynn	x years old	$(x-10)$ years old
Total	– NA –	48 years

Pat's age Now $= x-2$
$=(35)-2$
$=33$

$$(x-12)+(x-10)=48$$

$$2x-22=48$$

$$2x-22+22=48+22$$

$$2x=70$$

$$\frac{2x}{2}=\frac{70}{2}$$

$$x=35$$

SPWK

$$\begin{array}{r} 35 \\ 2\overline{)70} \\ -6 \\ \hline 10 \\ -10 \\ \hline 0 \end{array}$$

check

$$[(35)-12]+[(35)-10]=48$$

$$23+25=48$$

$$48=48$$

TRUE!

Pat is 33 years old now and Wynn is 35 years old now.

Answers to Practice Problems:
a. The number is 18. b. The width is 4 ft.
c. Pat is 33 and Wynn is 35.

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Section 4.6 Evaluating Formulas

1. What is a Formula? A formula is an equation that contains more than one variable.

Example: Can you recognize what each of the following formulas represents?

a. $A = lw$ Area of a rectangle

b. $V = lwh$ Volume of a rectangular prism

c. $A = \frac{1}{2}bh$ Area of a triangle

d. $x + y = 180°$ Supplementary angles sum to 180°

2. Evaluating a Formula: To evaluate a formula:

- Substitute all known values into the formula. You should have only one variable remaining.
- Solve this linear equation in one variable by the methods of the previous sections.

Example: Evaluate the given formulas for the given values of the variables.

a. $I = P \bullet R \bullet T$ where P=\$2000, $R = \frac{6}{100}$ and $T = 2\frac{1}{2}$ *yrs.*

$I = (\$2{,}000) \cdot \left(\frac{6}{100}\right)\left(2\frac{1}{2}\right)$

$I = \left(\frac{\$2{,}000}{1}\right) \cdot \left(\frac{6}{100}\right)\left(\frac{5}{2}\right)$

$I = \$\frac{2 \cdot 2 \cdot 5 \cdot \cancel{2} \cdot \cancel{5} \cdot \cancel{2} \cdot \cancel{5} \cdot \cancel{2} \cdot 3 \cdot 5}{\cancel{2} \cdot \cancel{5} \cdot \cancel{2} \cdot \cancel{5} \cdot \cancel{2}}$

$I = \$\, 2 \cdot 2 \cdot 5 \cdot 3 \cdot 5$

$I = \$300$

SDWK

$2\frac{1}{2} = \frac{2 \cdot 2 + 1}{2} = \frac{5}{2}$

6 → 2, 3

100 → 10, 10 → 2, 5, 2, 5

2,000 → 2, 1000 → 10, 100 → 2, 5, 10, 10 → 2, 5, 2, 5

Note: Portions of this document are excerpted from the textbook *Prealgebra,* 7th ed. by Charles McKeague

SDWK

18
2 9
3 3

b. P=2L+2W where P=30 in. and W=6 in.

$(30\text{ in}) = 2L + 2(6\text{ in})$

$30\text{ in} = 2L + 12\text{ in}$

$-12\text{ in} + 30\text{ in} = -12\text{ in} + 2L + 12\text{ in}$

$18\text{ in} = 2L$

$\frac{1}{2} \cdot \frac{18\text{ in}}{1} = \frac{1}{2} \cdot \frac{2L}{1}$

$\frac{2 \cdot 3 \cdot 3\text{ in}}{2 \cdot 1} = L$

$9\text{ in} = L$

check

$(30\text{ in}) = 2(9\text{ in}) + 2(6\text{ in})$

$30\text{ in} = 18\text{ in} + 12\text{ in}$

$30\text{ in} = 30\text{ in}$

TRUE!

c. $F = \frac{9}{5}C + 32$ where C=120°

$F = \frac{9}{5}\left(\frac{120}{1}\right) + 32$

$F = \frac{3 \cdot 3 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot \cancel{5}}{1 \cdot \cancel{5}} + 32$

$F = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3 + 32$

$F = 216 + 32$

$F = 248°$

SDWK

120
12 10
2 6 2 5
2 3

$2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$
$= 4 \cdot 6 \cdot 9$
$= 24 \cdot 9$
$= 216$

check

$(248°) = \frac{9}{5}(120°) + 32°$

$248° = \frac{1080°}{5} + 32°$

$248° = 216° + 32°$

$248° = 248°$

TRUE!

$24 \times 9 = 216$

$120 \times 9 = 1{,}080$

$1080 \div 5 = 216$: $1080 - 10 = 8$, $8 - 5 = 30$, $30 - 30 = 0$

Note: Portions of this document are excerpted from the textbook *Prealgebra*, 7th ed. by Charles McKeague