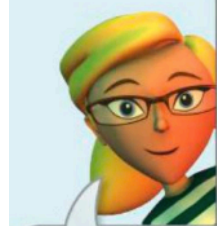


2-3

Solving Multi-Step Equations



Try some numbers to help you construct a pattern for this problem.



Getting Ready!

You are buying movie tickets online for a group of your friends. You have to enter the number of tickets you want on the screen shown. You are using a debit card to pay for the tickets and have a total of \$45 to spend. How many tickets can you buy? Explain your answer.

$x = \# \text{ tickets}$

Number of tickets you would like to purchase:			
Ticket price	Processing fee	Service charge	Total
\$9.00 x number of tickets	+\$1.00 x number of tickets	+\$5.00	= \$45

4 tickets

$$9x + 1x + 5 = 45$$

$$10x + 5 = 45$$

$$10x = 40$$

$$x = 4$$

To solve multi-step equations, you form a series of simpler equivalent equations. To do this, use the properties of equality, inverse operations, and properties of real numbers. You use the properties until you isolate the variable.

SOLVING EQUATIONS

1. Simplify, if possible
2. If there are variables on both sides, eliminate one (Lesson 2-4)
3. Undo addition or subtraction (eliminates any constant)
4. Undo multiplication or division
5. Check your solution - value(s) of the variable that makes the equation true.

PROBLEM 1: SOLVING MULTI-STEP EQUATIONS

Solve each equation. Check your solutions.

a) $5 = 5m - 23 + 2m$

$$\begin{aligned} 5 &= 7m - 23 \\ +23 & \quad +23 \\ 28 &= 7m \\ \frac{28}{7} &= \frac{7m}{7} \\ 4 &= m \end{aligned}$$

Check:
 $5 = 5(4) - 23 + 2(4)$
 $5 = 20 - 23 + 8$
 $5 = -3 + 8$
 $5 = 5$ ✓

e) $12 = 5 + 3b - 13$

$$\begin{aligned} 12 &= -8 + 3b \\ +8 & \quad +8 \\ 20 &= 3b \\ \frac{20}{3} &= \frac{3b}{3} \\ \frac{20}{3} &= b \end{aligned}$$

b) $x + 2 + x = 22$

$$\begin{aligned} 2x + 2 &= 22 \\ -2 & \quad -2 \\ 2x &= 20 \\ \frac{2x}{2} &= \frac{20}{2} \\ x &= 10 \end{aligned}$$

f) $11m - 8 - 6m = 22$

$$\begin{aligned} 5m - 8 &= 22 \\ +8 & \quad +8 \\ 5m &= 30 \\ \frac{5m}{5} &= \frac{30}{5} \\ m &= 6 \end{aligned}$$

c) $b - 9 + 6b = 30$

$$\begin{aligned} 7b - 9 &= 30 \\ +9 & \quad +9 \\ 7b &= 39 \\ \frac{7b}{7} &= \frac{39}{7} \\ b &= \frac{39}{7} \end{aligned}$$

g) $-2y + 5 + 5y = 14$

$$\begin{aligned} 3y + 5 &= 14 \\ -5 & \quad -5 \\ 3y &= 9 \\ \frac{3y}{3} &= \frac{9}{3} \\ y &= 3 \end{aligned}$$

d) $-23 = -2a - 10 + a$

$$\begin{aligned} -23 &= -a - 10 \\ +10 & \quad +10 \\ -13 &= -a \\ 13 &= a \end{aligned}$$

h) $7 - y - y = -1$

$$\begin{aligned} 7 - 2y &= -1 \\ -7 & \quad -7 \\ -2y &= -8 \\ \frac{-2y}{-2} &= \frac{-8}{-2} \\ y &= 4 \end{aligned}$$

PROBLEM 2: REAL-WORLD PROBLEM SOLVING

a) Martha takes her niece and nephew to a concert. She buys t-shirts and bumper stickers for them. The bumper stickers cost \$1 each. Martha's niece wants 1 shirt and 4 bumper stickers, and her nephew wants 2 shirts but no bumper stickers. If Martha's total is \$67, what is the cost of one shirt?

Let c = cost of one shirt

$$c + 4(1) + 2c = 67$$

$$3c + 4 = 67$$

$$\begin{array}{r} 3c + 4 = 67 \\ -4 \quad -4 \\ \hline 3c = 63 \end{array}$$

$$\begin{array}{r} 3c = 63 \\ \hline c = 21 \end{array} \checkmark$$

\$21/shirt

b) Noah and Kate are shopping for new guitar strings in a music store. Noah buys 2 packs of strings. Kate buys 2 packs of strings and a music book. The book costs \$16. Their total cost is \$72. How much is one pack of strings?

Let c = cost of one pack of strings

$$2c + 2c + 16 = 72$$

$$4c + 16 = 72$$

$$\begin{array}{r} 4c + 16 = 72 \\ -16 \quad -16 \\ \hline 4c = 56 \end{array}$$

$$\begin{array}{r} 4c = 56 \\ \hline c = 14 \end{array} \checkmark$$

\$14/pack of strings

c) You have a part-time job. You work for 3 hours on Friday and 6 hours on Saturday. You also receive an allowance of \$20 per week. You earned \$92 this week. How much do you earn per hour at your part-time job?

Let x = pay per hour

$$3x + 6x + 20 = 92$$

$$9x + 20 = 92$$

$$\begin{array}{r} 9x + 20 = 92 \\ -20 \quad -20 \\ \hline 9x = 72 \end{array}$$

$$\begin{array}{r} 9x = 72 \\ \hline x = 8 \end{array} \checkmark$$

\$8/hour

d) A family buys airline tickets online. Each ticket costs \$167. The family buys travel insurance with each ticket that cost \$19 per ticket. The Web site charges a fee of \$16 for the entire purchase. The family is charged a total of \$1132. How many tickets did the family buy?

Let t = tickets

$$167t + 19t + 16 = 1132$$

$$186t + 16 = 1132$$

$$\begin{array}{r} 186t + 16 = 1132 \\ -16 \quad -16 \\ \hline 186t = 1116 \end{array}$$

$$\begin{array}{r} 186t = 1116 \\ \hline t = 6 \end{array} \checkmark$$

6 tickets

PROBLEM 3: SOLVING AN EQUATION USING THE DISTRIBUTIVE PROPERTY

Solve each equation. Check your solution.

$$\begin{aligned} \text{a) } -8(2x - 1) &= 36 \\ -16x + 8 &= 36 \\ -16x &= 28 \\ x &= -\frac{7}{4} \end{aligned}$$

$$\begin{aligned} \text{b) } 2(8 + 4c) &= \frac{32}{2} \\ 8 + 4c &= 16 \\ 4c &= 8 \\ c &= 2 \end{aligned}$$

$$\begin{aligned} \text{c) } 15 &= -2(2t - 1) \\ 15 &= -4t + 2 \\ -2 &= -4t \\ \frac{13}{-4} &= \frac{-4t}{-4} \\ -\frac{13}{4} &= t \end{aligned}$$

$$\begin{aligned} \text{d) } 26 &= 6(5 - 4f) \\ 26 &= 30 - 24f \\ -30 &= -24f \\ -4 &= -24f \\ -\frac{1}{6} &= f \end{aligned}$$

$$\begin{aligned} \text{e) } 18 &= 3(2x - 6) \\ 18 &= 6x - 18 \\ +18 &= +18 \\ 36 &= 6x \\ 6 &= x \end{aligned}$$

$$\begin{aligned} \text{f) } 5(2x - 3) &= 15 \\ 10x - 15 &= 15 \\ +15 &= +15 \\ 10x &= 30 \\ \frac{10x}{10} &= \frac{30}{10} \\ x &= 3 \end{aligned}$$

$$\begin{aligned} \text{g) } 5(2 + 4z) &= \frac{85}{5} \\ 2 + 4z &= 17 \\ -2 &= -2 \\ 4z &= 15 \\ \frac{4z}{4} &= \frac{15}{4} \\ z &= \frac{15}{4} \end{aligned}$$

$$\begin{aligned} \text{h) } -4(r + 6) &= -63 \\ -4r - 24 &= -63 \\ +24 &= +24 \\ -4r &= -39 \\ \frac{-4r}{-4} &= \frac{-39}{-4} \\ r &= \frac{39}{4} \end{aligned}$$

PROBLEM 4: SOLVING AN EQUATION THAT INVOLVES FRACTIONS

Solve each equation. Check your solution.

$$\begin{aligned} \text{a) } \frac{3x}{4} - \frac{x}{8} &= 10 \\ 9x - 4x &= 120 \\ 5x &= 120 \\ x &= 24 \end{aligned}$$

$$\begin{aligned} \text{b) } \frac{b}{13} - \frac{3b}{13} &= \frac{8}{13} \\ b - 3b &= 8 \\ -2b &= 8 \\ \frac{-2b}{-2} &= \frac{8}{-2} \\ b &= -4 \end{aligned}$$

$$\begin{aligned} \text{c) } \frac{n}{10} - \frac{3n}{10} &= \frac{1}{5} \\ 10n - 9n &= 6 \\ n &= 6 \end{aligned}$$

$$\begin{aligned} \text{d) } \frac{2}{3} + \frac{3m}{5} &= \frac{31}{15} \\ 10 + 9m &= 31 \\ -10 &= -10 \\ 9m &= 21 \\ \frac{9m}{9} &= \frac{21}{9} \\ m &= \frac{7}{3} \end{aligned}$$

$$\begin{aligned} \text{e) } \frac{2b}{5} + \frac{3b}{4} &= 3 \\ 8b + 15b &= 60 \\ 23b &= 60 \\ b &= \frac{60}{23} \end{aligned}$$

$$\begin{aligned} \text{f) } \frac{1}{9} - \frac{5}{6} &= \frac{m}{3} \\ 2 = 15 - 6m \\ -15 &= -15 \\ -13 &= -6m \\ \frac{-13}{-6} &= \frac{-6m}{-6} \\ \frac{13}{6} &= m \end{aligned}$$

$$\begin{aligned} \text{g) } \frac{11z}{16} + \frac{7z}{8} &= \frac{5}{16} \\ 11z + 14z &= 5 \\ 25z &= 5 \\ \frac{25z}{25} &= \frac{5}{25} \\ z &= \frac{1}{5} \end{aligned}$$

$$\begin{aligned} \text{h) } \frac{x}{3} - \frac{7x}{12} &= \frac{2}{3} \\ 4x - 7x &= 8 \\ -3x &= 8 \\ \frac{-3x}{-3} &= \frac{8}{-3} \\ x &= -\frac{8}{3} \end{aligned}$$

PROBLEM 5: SOLVING AN EQUATION THAT CONTAINS DECIMALS

Solve each equation. Check your solution.

a) $3.5g - 0.02x = 1.24$

$$\begin{array}{r} 350 - 2x = 124 \\ -350 \quad -350 \\ \hline -2x = -226 \\ \frac{-2x}{-2} = \frac{-226}{-2} \\ \hline x = 113 \end{array}$$

b) $1.06g - 3 = 0.71$

c) $0.11k + 1.5 = 2.49$

$$\begin{array}{r} -1.5 \quad -1.5 \\ \hline .11k = 0.99 \\ \frac{.11k}{.11} = \frac{0.99}{.11} \\ \hline k = 9 \end{array}$$

d) $1.025v + 2.458 = 7.583$

e) $1.12 + 1.25g = 8.62$

$$\begin{array}{r} -1.12 \quad -1.12 \\ \hline 1.25g = 7.5 \end{array}$$

$$\frac{1.25g}{1.25} = \frac{7.5}{1.25}$$

$$g = 6$$

f) $25.24 = 5g + 3.89$

$$\begin{array}{r} -3.89 \quad -3.89 \\ \hline 21.35 = 5g \end{array}$$

$$\frac{21.35}{5} = \frac{5g}{5}$$

$$4.27 = g$$

Homework

Evans & 7, 15