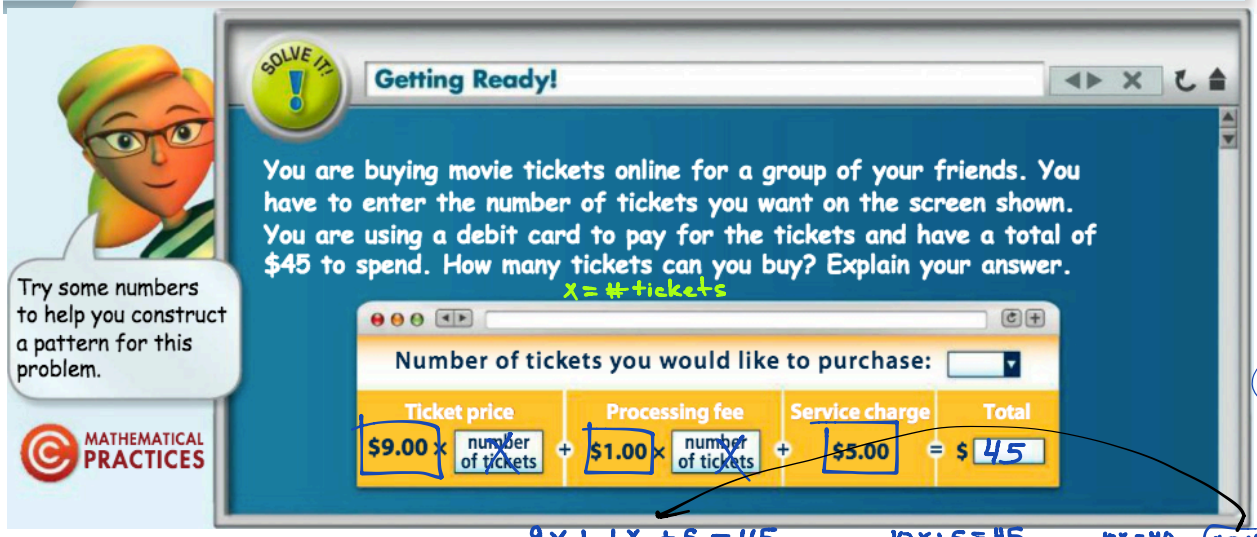
2-3 Solving Multi-Step Equations



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

$5 = 7m - 23$
$+23 \quad +23$
$\frac{28}{7} = \frac{7m}{7}$
$4 = m$

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

b) $x + 2 + x = 22$

$2x + 2 = 22$
$-2 \quad -2$
$\frac{2x}{2} = \frac{20}{2}$
$x = 10$ ✓

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

$7b - 9 = 30$
$+9 \quad +9$
$\frac{7b}{7} = \frac{39}{7}$
$b = \frac{39}{7}$ ✓

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

$-23 = -a - 10$
$+10 \quad +10$
$-13 = -a$
$13 = a$ ✓

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

$12 = -8 + 3b$
$+8 \quad +8$
$\frac{20}{3} = \frac{3b}{3}$
$\frac{20}{3} = b$ ✓

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

$5m - 8 = 22$
$+8 \quad +8$
$\frac{5m}{5} = \frac{30}{5}$
$m = 6$ ✓

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

$3y + 5 = 14$
$-5 \quad -5$
$\frac{3y}{3} = \frac{9}{3}$
$y = 3$ ✓

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

$7 - 2y = -1$
$-7 \quad -7$
$\frac{-2y}{-2} = \frac{-8}{-2}$
$y = 4$ ✓

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

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

$$3c + 4 = 67$$
$$-4 \quad -4$$
$$\frac{3c}{3} = \frac{63}{3}$$
$$c = 21 \checkmark$$

$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

$$2c + 2c + 16 = 72$$
$$4c + 16 = 72$$
$$-16 \quad -16$$
$$\frac{4c}{4} = \frac{56}{4}$$
$$c = 14 \checkmark$$

$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

$$3x + 6x + 20 = 92$$
$$9x + 20 = 92$$
$$-20 \quad -20$$
$$\frac{9x}{9} = \frac{72}{9}$$
$$x = 8 \checkmark$$

$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

$$167t + 19t + 16 = 1132$$
$$186t + 16 = 1132$$
$$-16 \quad -16$$
$$\frac{186t}{186} = \frac{1116}{186}$$
$$t = 6 \checkmark$$

6 tickets

PROBLEM 3: SOLVING AN EQUATION USING THE DISTRIBUTIVE PROPERTY

Solve each equation. Check your solution.

a) $-8(2x-1)=36$

$-16x+8=36$

$-8 \quad -8$

$\frac{-16x}{-16}=\frac{28}{-16}=-\frac{7}{4}$

$x=-\frac{7}{4}$ ✓

b) $\frac{2(8+4c)}{2}=\frac{32}{2}$

$8+4c=16$

$-8 \quad -8$

$\frac{4c}{4}=\frac{8}{4}$

$c=2$ ✓

c) $15=-2(2t-1)$

$15=-4t+2$

$-2 \quad -2$

$\frac{13}{-4}=\frac{-4t}{-4}$

$-\frac{13}{4}=t$ ✓

d) $26=6(5-4f)$

$26=30-24f$

$-30 \quad -30$

$\frac{-4}{-24}=\frac{-24f}{-24}$

$\frac{1}{6}=f$ ✓

e) $18=3(2x-6)$

$18=6x-18$

$+18 \quad +18$

$\frac{36}{6}=\frac{6x}{6}$

$6=x$ ✓

OR

$\frac{18}{3}=\frac{3(2x-6)}{3}$

$6=2x-6$

$+6 \quad +6$

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

$6=x$

f) $5(2x-3)=15$

$10x-15=15$

$+15 \quad +15$

$\frac{10x}{10}=\frac{30}{10}$

$x=3$ ✓

g) $\frac{5(2+4z)}{5}=\frac{85}{5}$

$2+4z=17$

$-2 \quad -2$

$\frac{4z}{4}=\frac{15}{4}$

$z=\frac{15}{4}$ ✓

h) $-4(r+6)=-63$

$-4r-24=-63$

$+24 \quad +24$

$\frac{-4r}{-4}=\frac{-39}{-4}$

$r=\frac{39}{4}$ ✓

PROBLEM 4: SOLVING AN EQUATION THAT INVOLVES FRACTIONS

Solve each equation. Check your solution.

a) $\frac{3x}{4}-\frac{x}{3}=10$ (LCD = 12)

$9x-4x=120$

$\frac{5x}{5}=\frac{120}{5}$

$x=24$ ✓

b) $\frac{b}{13}-\frac{3b}{13}=\frac{8}{13}$ (LCD = 13)

$b-3b=8$

$\frac{-2b}{-2}=\frac{8}{-2}$

$b=-4$ ✓

c) $\frac{n}{3}-\frac{3n}{10}=\frac{1}{5}$ (LCD = 30)

$10n-9n=6$

$n=6$ ✓

d) $\frac{2}{3}+\frac{3m}{5}=\frac{31}{15}$ (LCD = 15)

$10+9m=31$

$-10 \quad -10$

$\frac{9m}{9}=\frac{21}{9}=\frac{7}{3}$

$m=\frac{7}{3}$ ✓

e) $\frac{2b}{5}+\frac{3b}{4}=3$ (LCD = 20)

$8b+15b=60$

$\frac{23b}{23}=\frac{60}{23}$

$b=\frac{60}{23}$ ✓

f) $\frac{1}{9}=\frac{5}{6}-\frac{m}{3}$ (LCD = 18)

$2=15-6m$

$-15 \quad -15$

$\frac{-13}{-6}=\frac{-6m}{-6}$

$\frac{13}{6}=m$ ✓

g) $\frac{11z}{16}+\frac{7z}{8}=\frac{5}{16}$ (LCD = 16)

$11z+14z=5$

$\frac{25z}{25}=\frac{5}{25}$

$z=\frac{1}{5}$ ✓

h) $\frac{x}{3}-\frac{7x}{12}=\frac{2}{3}$ (LCD = 12)

$4x-7x=8$

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

$x=-\frac{8}{3}$ ✓

PROBLEM 5: SOLVING AN EQUATION THAT CONTAINS DECIMALS

Solve each equation. Check your solution.

a) $3.5 - 0.02x = 1.24$

100 100 100

$350 - 2x = 124$

$-350 \quad -350$

$\frac{-2x}{-2} = \frac{-226}{-2}$

$x = 113$ ✓

b) $1.06g - 3 = 0.71$

c) $0.11k + 1.5 = 2.49.$

$-1.5 \quad -1.5$

$\frac{.11k}{.11} = \frac{0.99}{.11}$

$k = 9$

d) $1.025v + 2.458 = 7.583$

e) $1.12 + 1.25g = 8.62$

$-1.12 \quad -1.12$

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

$g = 6$ ✓

f) $25.24 = 5g + 3.89$

$-3.89 \quad -3.89$

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

$4.27 = g$

Homework
Evens & 7, 15