

# 6.1 Solving Two Step Equations

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## 6.1 SOLVING TWO STEP EQUATIONS

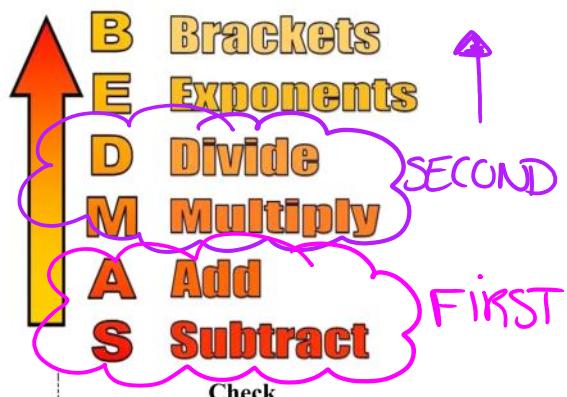
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### A) SOLVING TWO STEP EQUATIONS:

**Example #2:** Solve each equation. Check your solution by substituting into the original equation and seeing if the left side equals the right side of the equation.

To isolate the variable we use reverse (BEDMAS)  
order of operations.



- a.  
① ADD/SUBTRACT  
② MULTIPLY/DIVIDE

$$\begin{aligned} 5x + 8 &= -47 \\ -8 &\quad -8 \\ 5x &= -55 \\ \hline 5 &\quad 5 \\ x &= -11 \end{aligned}$$

$$\begin{aligned} 5x + 8 &= -47 \\ 5(-11) + 8 &= -47 \\ -55 + 8 &= -47 \\ -47 &= -47 \end{aligned}$$

b.

$$\begin{aligned} -2x - 3 &= -38 \\ +3 &\quad +3 \\ -2x &= -35 \\ \hline -2 &\quad -2 \\ x &= 17.5 \end{aligned}$$

$$\begin{aligned} -2x - 3 &= -38 \\ -2(17.5) - 3 &= -38 \\ -35 - 3 &= -38 \\ -38 &= -38 \end{aligned}$$

c.

$$\begin{aligned} 5 + 4x &= 11 \\ -5 &\quad -5 \\ 4x &= 6 \\ \hline 4 &\quad 4 \\ x &= \frac{6}{4} = \frac{3}{2} = 1.5 \end{aligned}$$

$$\begin{aligned} 5 + 4x &= 11 \\ 5 + 4(1.5) &= 11 \\ 5 + 6 &= 11 \\ 11 &= 11 \end{aligned}$$

d.

cancel  
sign  
and  
3.

$$\begin{aligned} 9 - 3x &= -18 \\ -9 &\quad -9 \\ -3x &= -27 \\ \hline -3 &\quad -3 \\ x &= 9 \end{aligned}$$

$$\begin{aligned} 9 - 3x &= -18 \\ 9 - 3(9) &= -18 \\ 9 - 27 &= -18 \\ -18 &= -18 \end{aligned}$$

\*NOTE\* Let "a number" =  $x$

## B) TRANSLATING ENGLISH TO MATHEMATICS

"means +, -, ×, ÷"

Complete the table below by filling in the English words that imply each operation.

Addition	Subtraction
"The <u>sum</u> of ...."    "...added to"	"....less than...."    "decreased by...."
"...increased by...."    "... more than"	".... minus ...."
	(quotient = answer when dividing)
Multiplication	Division
"...times...."    "...the <u>product</u> of"	"Half of...."
"Twice..."    "percent of..."	"The <u>quotient</u> of two and a number" $\frac{a}{x}$
"Double..."	"The <u>quotient</u> of a number and two" $\frac{x}{2}$

Understanding the English to math translation will help to set up equations when given word problems.

Examples:  $+4$      $3x$

A. 4 more than 3 times a number is 16. What is the number?  $= 16$

$$3x + 4 = 16$$

$$\begin{array}{r} -4 \\ \hline 3x = 12 \\ \hline x = 4 \end{array}$$

check:  
 $3(4) + 4 = 16$   
 $12 + 4 = 16 \checkmark$

**PRACTICE**

B. 3 less than 4 times a number is 20. What is the number?  $= 20$

$$4x - 3 = 20$$

$$\begin{array}{r} +3 \\ \hline 4x = 23 \\ \hline x = 5.75 \end{array}$$

check:  
 $4x - 3 = 20$   
 $4(5.75) - 3 = 20$   
 $23 - 3 = 20 \checkmark$

C. Find 3 consecutive integers such that sum of two times the smallest number and three times the largest number is 76. What are the numbers?

$$2x + 3 \cdot (x+2) = 76$$

$$\begin{array}{r} 2x + 3x + 6 = 76 \\ \hline 5x + 6 = 76 \\ \hline 5x = 70 \\ \hline x = 14 \end{array}$$

\*must have collected like terms BEFORE you can solve for x

1st #, 2nd #, 3rd #  
 $x, x+1, x+2$   
 $14, 14+1, 14+2$   
 $14, 15, 16$

Write an equation and solve the equation.

84. A number is multiplied by  $-x$  (negative two and then decreased by five and the result is twenty-nine. Find the number.

$$\begin{array}{r} -2x - 5 = 29 \\ +5 +5 \\ \hline -2x = 34 \\ \hline x = -17 \end{array}$$

85. The sum of three times a number and three is negative twenty-seven. Find the number.

$$\begin{array}{r} 3x + 3 = -27 \\ -3 -3 \\ \hline 3x = -30 \\ \hline x = -10 \end{array}$$

86. Three times the opposite of a positive number  $\Rightarrow -x$  increased by five is +5 negative twenty-five. Find the number.

$$\begin{array}{r} -3x + 5 = -25 \\ -5 -5 \\ \hline -3x = -30 \\ \hline x = 10 \end{array}$$

13 and

1. A husband is two years older than his wife, and their son is half the age of his mother. If the sum of all three of their ages is 97, how old is the son?

*mother =  $x$*   
*father =  $x + 2$*   
 $x + (x + 2) + \frac{1}{2}x = 97$   
 $\frac{5}{2}x + 2 = 97$   
 $\frac{5}{2}x + 2 - (2) = 97 - (2)$   
 $\frac{5}{2}x = 95$   
 $(\frac{5}{2}x)(\frac{2}{5}) = (95)(\frac{2}{5})$   
 $x = 38$   
 $\text{son} = \frac{1}{2}x = \frac{1}{2}(38) = 19$

9. Translate each verbal sentence into an equation.

a) The sum of a number and three is twelve.

$$x + 3 = 12$$

c) The product of a number and five is twice the number plus eight.

$$5x = 2x + 8$$

e) The quotient of a number and five is seven.

$$\frac{x}{5} = 7$$

2. A board 70 cm in length is cut into two pieces. One piece is 8 cm shorter than three times the length of the other piece. Find the length of the two pieces.

Let the length of the shorter piece be  $x$ .  
The length of the longer piece is  $3x - 8$ .

$$\begin{aligned} x + 3x - 8 &= 70 \\ 4x - 8 &= 70 \\ 4x - 8 + (8) &= 70 + (8) \\ 4x &= 78 \\ \frac{4x}{4} &= \frac{78}{4} \\ x &= 19\frac{1}{2} \end{aligned}$$

1st      2nd      3rd  
 $x + (\underline{x+2}) + (\underline{x+4}) + \underline{13} = 43$   
 $3x + 19 = 43$   
 $3x + 19 - (19) = 43 - (19)$   
 $3x = 24$   
 $(3x)\left(\frac{1}{3}\right) = (24)\left(\frac{1}{3}\right)$   
 $x = 8$   
 $\rightarrow 2 + 4$

The three integers are: 8, 10, and 12.

(don't have to solve)

b) If twice a number is decreased by five, the result is fifteen.

$$2x - 5 = 15$$

d) The quotient of a number and three added to twice the number is ten.

$$\frac{x}{3} + 2x = 10$$

f) The sum of a number and three times the number is twelve.

$$x + 3x = 12$$

## 6) SOLVING TWO STEP EQUATIONS WITH FRACTIONS:

### Method 1:

STEP 1 Add or subtract the fraction to get the term containing the variable isolated.

STEP 2 Then multiply or divide to solve for x.

get  $x$  by itself!

Solution	Check
<p>a.</p> <p><i>move fraction to other side</i></p> $\begin{aligned} \frac{1}{2} + \frac{x}{3} &= 4 \\ -\frac{1}{2} & \quad \quad \quad -\frac{1}{2} \\ \frac{x}{3} &= \left[\frac{4}{1}\right] - \frac{1}{2} \quad \text{common denominators!} \\ \frac{x}{3} &= \frac{8}{2} - \frac{1}{2} \\ \frac{x}{3} &= \frac{7}{2} \\ x &= \frac{7}{2} \times 3 \quad \boxed{\frac{21}{2}} = 10.5 \\ x &= \frac{21}{2} \end{aligned}$ <p>Solve <math>\rightarrow</math> for <math>x</math></p>	$\begin{aligned} \frac{1}{2} + \frac{x}{3} &= 4 \\ \frac{1}{2} + \frac{(10.5)}{3} &= 4 \\ 0.5 + 3.5 &= 4 \\ 4 &= 4 \checkmark \end{aligned}$

## PRACTICE

### Solution

a.

$$\begin{aligned} \frac{2}{3}x - \frac{1}{6} &= \frac{3}{4}x \\ 12x - 1 &= 12x \\ -1 &= 0 \\ -2 &= x \end{aligned}$$

$$\begin{aligned} +\frac{2}{3}x - \frac{1}{6} &= \frac{3}{4}x \\ -\frac{2}{3}x &= \frac{3}{4}x - \frac{1}{6} \\ -\frac{1}{6} &= \frac{3}{4}x - \frac{2}{3}x \\ -\frac{1}{6} &= \frac{9}{12}x - \frac{8}{12}x = \frac{1}{12}x \\ x \cdot 12 &= \frac{1}{12}x \cdot 12 \\ -2 &= x \end{aligned}$$

### Check

$$\begin{aligned} \frac{2}{3}(-2) - \frac{1}{6} &= \frac{3}{4}(-2) \\ \frac{2}{3} \cdot -2 &= \frac{3}{4} \cdot -2 \\ -\frac{4}{3} &= -\frac{3}{4} \\ -\frac{16}{12} &= -\frac{9}{12} \\ -\frac{16}{12} - \frac{9}{12} &= -\frac{16-9}{12} = -\frac{7}{12} = \frac{1}{12} \end{aligned}$$

**Method 2:** You may prefer to work with integers than to perform operations with fractions.

Change from fractions to integers by multiplying by a common multiple of the denominators in the equation.

### Lcm / LCD

### Solution

a.

$$\begin{aligned} \frac{1}{2} + \frac{x}{3} &= 4 \\ (\frac{1}{2} \cdot 6) + (\frac{1}{3} \cdot 6) &= 6 \cdot 4 \\ \frac{6}{2} + \frac{6x}{3} &= 24 \\ 3 + 2x &= 24 \\ -3 &= 2x \\ x &= \frac{21}{2} = 10.5 \end{aligned}$$

### Check

$$\begin{aligned} \frac{1}{2} + \frac{x}{3} &= 4 \\ \frac{1}{2} + \frac{(10.5)}{3} &= 4 \\ 0.5 + 3.5 &= 4 \\ 4 &= 4 \end{aligned}$$

## PRACTICE

### Solution

a.

$$\begin{aligned} 12x &\\ \frac{2}{3}x - \frac{1}{6} &= \frac{3}{4}x \\ (\frac{12}{1} \cdot \frac{2}{3}x) - (\frac{12}{1} \cdot \frac{1}{6}) &= (\frac{12}{1} \cdot \frac{3}{4}x) \\ \frac{24}{3}x - \frac{12}{6} &= \frac{36}{4}x \\ 8x - 2 &= 9x \\ +2 &+2 \\ 8x &= 9x + 2 \\ -9x &-9x \\ -x &= 2 \\ x &= -2 \end{aligned}$$

Lcm of  
3, 6 and 4  
= 12

### Check

$$\begin{aligned} \frac{2}{3}x - \frac{1}{6} &= \frac{3}{4}x \\ \frac{2}{3}(-2) - \frac{1}{6} &= \frac{3}{4}(-2) \\ -\frac{4}{3} - \frac{1}{6} &= -\frac{6}{4} \\ -1.33 - 0.166 &= -1.5 \\ -1.5 &= -1.5 \end{aligned}$$

4

Use the **method of your choice** from above to solve the following equations:

a)  $\left( \frac{x}{6} + \frac{1}{3} = \frac{1}{2} \right) \times 6$

$$\begin{aligned} \frac{6}{6}x + \frac{6}{3} &= \frac{6}{2} \\ x + 2 &= 3 \\ -2 &\quad -2 \\ x &= 1 \end{aligned}$$

b)  $\left( \frac{x}{6} - \frac{1}{3} = \frac{1}{2} \right) \times 6$

$$\begin{aligned} \frac{6}{6}x - \frac{6}{3} &= \frac{6}{2} \\ x - 2 &= 3 \\ +2 &\quad +2 \\ x &= 5 \end{aligned}$$

c)  $\left( \frac{x}{8} + \frac{1}{6} = \frac{7}{24} \right) \times 24$

$$\begin{aligned} \frac{24}{8}x + \frac{24}{6} &= \frac{168}{24} \\ 3x + 4 &= 7 \\ -4 &\quad -4 \\ 3x &= 3 \\ \cancel{3}x &= \cancel{3} \\ x &= 1 \end{aligned}$$

d)  $\left( \frac{x}{8} - \frac{1}{6} = -\frac{7}{24} \right) \times 24$

e)  $\left( \frac{x}{4} + \frac{1}{3} = \frac{7}{12} \right) \times 12$

f)  $\left( \frac{x}{6} + \frac{x}{8} = 7 \right) \times 24$

#### D) SOLVING TWO STEP EQUATIONS WITH DECIMALS:

**STEP 1** Multiply both sides of the equation by the LCD (lowest common denominator) to eliminate any decimals.

$$0.4 = \frac{4}{10} \leftarrow$$

$$0.04 = \frac{4}{100} \leftarrow$$

$$0.004 = \frac{4}{1000} \leftarrow$$

**STEP 2** Then multiply or divide to solve for x.

Solution

a.  $\frac{4}{100}x = \frac{8}{10}$   
Lowest common denominator = 100

$$\begin{aligned} 0.04x &= 0.8 \\ 4x &= 80 \\ \cancel{4}x &= \cancel{80} \\ x &= 20 \end{aligned}$$

Check

$$0.04x = 0.8$$

$$\begin{aligned} 0.04(20) &= 0.8 \\ 0.8 &= 0.8 \checkmark \end{aligned}$$



Solution

b.

$$\left( 3.2y - 9.6 = 16 \right) \times 10$$

$$\begin{aligned} 10(3.2y) - 10(9.6) &= 10(16) \\ 32y - 96 &= 160 \\ +96 &\quad +96 \\ 32y &= 256 \end{aligned}$$

$$y = 8$$

Check

$$3.2y - 9.6 = 16$$

$$\begin{aligned} 3.2(8) - 9.6 &= 16 \\ 25.6 - 9.6 &= 16 \\ 16 &= 16 \checkmark \end{aligned}$$

b)  $0.4x = 0.08$

f)  $2.1y - 2.8 = 5.6$

g)  $0.4y + 17 = -3y$

c)  $0.1x + 0.01x = 0.11$

d)  $0.2x + 0.22x = 0.84$

h)  $1.2y = -0.05y - 3.75$

**E) PERCENT:**

"Percent" means out of 100. Therefore, when we are converting percents to decimals we divide by 100

**Warm Up:** Change each percent to a decimal

$$\text{a) } \frac{51}{100} = 51 \div 100 = 0.51 \quad \text{b) } \frac{5}{100} = 0.05 \quad \text{c) } \frac{6.7}{100} = 0.067 \quad \text{d) } \frac{0.1}{100} = 0.001$$

**Example:** Solve and check.

a) 25% of a number  $x$  is 8. What is the number?

$$\begin{aligned} 25\% \times x &= 8 \\ \left(\frac{25}{100}\right)x &= 8 \quad \times 100 \\ 25x &= 800 \\ x &= 32 \end{aligned}$$

b) 7% of a number is 56.7. What is the number?

$$\begin{aligned} x &= 56.7 \\ 7\% \times x &= 56.7 \\ \left(\frac{7}{100}\right)x &= 56.7 \quad \times 100 \\ 0.07x &= 56.7 \\ 7x &= 5670 \\ x &= 810 \end{aligned}$$



Assignment #6.1 pg 213 - 215

Required

# 1, 2aceg, 3, 4,  
5, 8, 10, 11, 13, 14,  
15, 19a

Extra Practice

# 2bdh, 6, 7, 9,  
12, 16, 19bc

Extension

17, 18