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# **Fundamentals of Algebra**



# 2.4 Introduction to Equations

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# What You Will Learn

- Check whether a given value is a solution of an equation.
- Use properties of equality to form equivalent equations.
- Lice a verbal model to write an algebraic equation

equations.

Use a verbal model to write an algebraic equation.

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## **Checking Solutions of Equations 1**

An **equation** is a statement that two algebraic expressions are equal.

For instance, the following are equations:

$$x = 3$$
,  $5x - 2 = 8$ ,  $\frac{x}{4} = 7$ , and  $x^2 - 9 = 0$ ,  $x^2 - 9 = 0$ ,  $x = 10$ ,  $x$ 

To **solve** an equation involving the variable *x* means to find all values of *x* for which the equation is true.

Such values are called solutions



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## **Checking Solutions of Equations 2**

For instance, x = 2 is a solution of the equation

$$5x - 2 = 8$$

$$5x - 2 = 8$$

because

$$5(2) - 2 = 8$$

is a true statement.

The solutions of an equation are said to satisfy the equation.



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### Example 1 - Checking Solutions of an Equation

Determine whether (a) x = -2 and (b) x = 2 are solutions of  $x^2 - 5 = 4x + 7$ .

### Solution:

a. 
$$x^2 - 5 = 4x + 7$$
  
 $-2 - 5 \stackrel{?}{=} 4(-2) + 7$   
 $-1 - -1$ 

Write original equation.

Substitute -2 for x.

Simplify.

See if solution checks.





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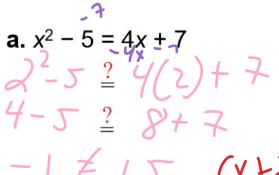
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Example 1 - Checking Solutions of an Equation cont'd

### Example 1 – Checking Solutions of an Equation cont'd



Write original equation.

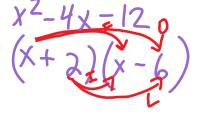
Substitute 2 for x.

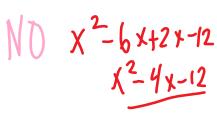
Simplify.



See if solution checks.









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### Example 2 - Comparing Equations and Expressions

Make a table that compares algebraic expressions and algebraic equations.

#### Solution:

Algebraic Expression	Algebraic Equation
• Example: 4(x - 1)	• Example: 4(x − 1) = 12
Contains no equal sign	Contains an equal sign and is true for only certain values of the variable
Can be evaluated for any real number for which the expression is defined (example *substitute the variable x for 3 and evaluate)      (3-1) = (3-	• Solution is found by forming equivalent equations using the properties of equality:  4(x-1) = 12  4x - 4 = 12  + 4x - 4 = 12
<ul> <li>Can sometimes be simplified to an equivalent form: 4(x - 1) simplifies to</li> </ul>	4x=16 (x=4)

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## Forming Equivalent Equations 1

#### Forming Equivalent Equations: Properties of Equality

An equation can be transformed into an **equivalent equation** using one or more of the following procedures.

Original	Equivalent
Equation	Equation(s)
3x - x = 8	2x = 8

- 1. Simplify either side: Remove symbols of grouping, combine like terms, or simplify fractions on one or both sides of the equation.
- 2. Apply the Addition Property of Equality: Add (or subtract) the same quantity to (from) each side of the equation.
- 3. Apply the Multiplication Property of Equality: Multiply (or divide) each side of the equation by the same nonzero quantity.
- **4.** Interchange the two sides of the equation.

x - 2 = 5 x - 2 + 2 = 5 + 2

$$x = 7$$

- 3x = 9  $\frac{3x}{3} = \frac{3}{3}$   $x = \frac{3}{3}$
- $7 = x \qquad \qquad x = 7$



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# Example 4 – Identifying Properties of Equality 1

Identify the property of equality used to solve each equation.

a. 
$$\begin{array}{c} x - 5 = 0 \\ + 5 + 5 \end{array}$$

**b.** 
$$5\left(\frac{x}{5} = -2\right)$$

c. 
$$\frac{4x}{7} = 9$$

$$6x = 3$$





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### Example 5 – Using a Verbal Model to Write an Equation

Write an algebraic equation for the following problem.

The total income that an employee received in a year was \$40,950. How much was the employee paid each week? Assume that each weekly paycheck contained the same amount and that the year consisted of 52 x=747.5 weeks.



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#### Example 5 - Using a Verbal Model to Write an Equation cont'd

#### Solution:

Verbal Model: Income for year = Number of weeks in a year · Weekly pay

Labels: Income for year = 40,950 (dollars)

Weekly pay = x (dollars per week)

Number of weeks = 52 (weeks)

Equation: 40,950 = 52x

52 52

Equation: 40,950 = 52x

52 52

Solve:

X=787.50



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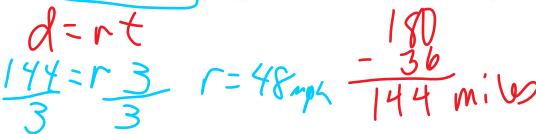
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### Example 6 – Using a Verbal Model to Write an Equation

Write an algebraic equation for the following problem.

Returning to college after spring break, you travel 3 hours and stop for lunch. You know that it takes 45 minutes to complete the last 36 miles of the 180-mile trip. What was the average speed during the first 3 hours of the trip?





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### Example 6 – Using a Verbal Model to Write an Equation cont'd

#### Solution:

Verbal Model: Distance = Rate · Time

Labels: Distance = 180 - 36 = 144 (miles)

Rate = r (miles per hour)

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Rate = r(miles per hour)

Time = 3(weeks)

Equation:

Solve:

r=48 mph



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### Example 7 – Using a Verbal Model to Write an Equation

Write an algebraic equation for the following problem.

Tickets for a concert cost \$175 for each floor seat and \$95 for each stadium seat. There were 2500 seats on the main floor, and these were sold out. The total revenue from ticket sales was \$865,000. How many stadium seats were sold?

175(2500) + 95x = 865,000437,500 + 95x = 865,000



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#### Example 7 – Using a Verbal Model to Write an Equation cont'd

#### Solution:

Verbal Model: Total revenue = Revenue from floor seats + Revenue from stadium seats

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Verbal Model: Total revenue = Revenue from floor seats + Revenue from stadium seats

Labels: Total Revenue = 865,000 (dollars)

Price per floor seat = 175 (dollars per seat)

Number of floor seats = 2500 (seats)

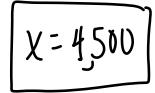
Price per stadium seat = 95 (dollars per seat)

Number of stadium seats = x (seats)

Equation: 865,000 = 175(2500) + 95x

Solve:

 $865,000 = 437,500 + 95 \times -437,500 - 437,500 - 45 \times -437,500 = 45 \times -437,500$ 





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