

**A - Numbers, Operations, and Properties, Lesson 1, Identifying Properties (r. 2018)**

**NUMBERS, OPERATIONS AND PROPERTIES**

**Identifying Properties**

<p><b>CC Standard</b></p> <p><b>A-REL.1</b> Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.</p>	<p><b>NG Standard</b></p> <p><b>AI-A.REI.1a</b> Explain each step when solving a <b>linear or quadratic</b> equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.</p>
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**Overview of Lesson**

<p><b>Teacher Centered Introduction</b></p> <p>Overview of Lesson</p> <ul style="list-style-type: none"> <li>- activate students' prior knowledge</li> <li>- vocabulary</li> <li>- learning objective(s)</li> <li>- big ideas: direct instruction</li> <li>- modeling</li> </ul>	<p><b>Student Centered Activities</b></p> <p>guided practice ←Teacher: anticipates, monitors, selects, sequences, and connects student work</p> <ul style="list-style-type: none"> <li>- developing essential skills</li> <li>- Regents exam questions</li> <li>- formative assessment assignment (exit slip, explain the math, or journal entry)</li> </ul>
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**LEARNING OBJECTIVES**

Students will be able to:

- 1) Use academic language to describe each step in solving an equation.
- 2) Use a four column strategy to show and explain each step in solving an equation.

**VOCABULARY**

Commutative Properties of Addition and Multiplication  
 Associative Properties of Addition and Multiplication  
 Distributive Properties of Addition and Multiplication  
 Addition Property of Equality  
 Multiplication Property of Equality  
 Identity Elements of Addition and Multiplication  
 Inverse Properties of Addition and Multiplication

**BIG IDEAS**

**PROPERTIES**

**Commutative Properties of Addition and Multiplication**

**For all real numbers a and b:**

$$a + b = b + a \qquad a \cdot b = b \cdot a$$

**Associative Properties of Addition and Multiplication**

**For all real numbers a, b, and c:**

$$(a + b) + c = a + (b + c) \qquad (a \cdot b) \cdot c = a \cdot (b \cdot c)$$

**Distributive Properties of Addition and Multiplication**

$$a(b + c) = ab + ac \qquad a(b - c) = ab - ac$$

$$(b + c)a = ba + ca \qquad (b - c)a = ba - ca$$

**Addition Property of Equality**

The addition of the same number or expression to both sides of an equation is permitted.

**Multiplication Property of Equality**

The multiplication of both sides of an equation by the same number or expression is permitted.

**IDENTITY ELEMENTS**

**Identity Element:** The **identity element** is always associated with an *operation*. The **identity element** for a given *operation* is the element that preserves the identity of other elements under the given operation.

**Addition**

The **identity element** for addition is the number 0

$$a + 0 = a \text{ and } 0 + a = a$$

The number 0 does not change the value of other numbers under addition.

**Multiplication**

The **identity element** for multiplication is the number 1

$$a \cdot 1 = a \text{ and } 1 \cdot a = a$$

The number 1 does not change the value of other numbers under multiplication.

**Inverse Properties of Addition and Multiplication**

**Inverse:** The **inverse** of a number or expression under a given *operation* will result in the **identity element** for that operation. Therefore, it is necessary to know what the **identity element** of an operation is before finding the **inverse** of a given number or expression.

**Addition**

The additive inverse of a number or expression results in 0 under addition.

$$a + (-a) = 0 \text{ and } (-a) + a = 0$$

$$(x + y) + (-x - y) = 0 \text{ and } (-x - y) + (x + y) = 0$$

**Multiplication**

The multiplicative inverse of a number or expression results in 1 under multiplication.

$$a \times \frac{1}{a} = 1 \text{ and } \frac{1}{a} \times a = 1 \qquad \frac{1}{a} \times a = 1$$

$$(x + y) \left( \frac{1}{(x + y)} \right) = 1 \text{ and } \left( \frac{1}{(x + y)} \right) (x + y) = 1$$

### Four Column Strategy

The four column strategy focuses on organizing and documenting each step in solving an equation or inequality. Emphasis is given to explaining each step and keeping the equal signs (or inequality signs) aligned in a vertical column. The vertical and horizontal lines are simply scaffolds that can be removed as students acquire understanding and skills in solving equations.

Notes	Left Hand Expression	Sign	Right Hand Expression
Given	$2x - 6$	=	2
Add (6) (Addition Property of Equality)	$+ 6$		$+ 6$
	$2x + 0$	=	8
Divide (2) (Multiplication Property of Equality)	$\frac{2x}{2}$	=	$\frac{8}{2}$
Answer	$x$	=	4
Check	$2(4) - 6$	=	2
	$8 - 6$	=	2
	2	=	2

### DEVELOPING ESSENTIAL SKILLS

Use the four column method with academic language to solve the following equations.

A	$2x + 8 = 18$
B	$\frac{3}{4}x - 7 = 2$
C	$3x + 5 = 2x + 10$
D	$4(x + 5) - 12 = 2x + 4$

### REGENTS EXAM QUESTIONS (through June 2018)

## A.REI.A.1: Identifying Properties

- 1) When solving the equation  $4(3x^2 + 2) - 9 = 8x^2 + 7$ , Emily wrote  $4(3x^2 + 2) = 8x^2 + 16$  as her first step. Which property justifies Emily's first step?
  - 1) addition property of equality
  - 3) multiplication property of equality
  - 2) commutative property of addition
  - 4) distributive property of multiplication over addition
  
- 2) When solving the equation  $12x^2 - 7x = 6 - 2(x^2 - 1)$ , Evan wrote  $12x^2 - 7x = 6 - 2x^2 + 2$  as his first step. Which property justifies this step?
  - 1) subtraction property of equality
  - 3) associative property of multiplication

2) multiplication property of equality

4) distributive property of multiplication over subtraction

3) A part of Jennifer's work to solve the equation  $2(6x^2 - 3) = 11x^2 - x$  is shown below.

$$\text{Given: } 2(6x^2 - 3) = 11x^2 - x$$

$$\text{Step 1: } 12x^2 - 6 = 11x^2 - x$$

Which property justifies her first step?

1) identity property of multiplication

2) multiplication property of equality

3) commutative property of multiplication

4) distributive property of multiplication over subtraction

### SOLUTIONS

1) ANS: 1

Strategy: Identify what changed during Emily's first step, then identify the property associated with what changed..

$$4(3x^2 + 2) - 9 = 8x^2 + 7$$

$$4(3x^2 + 2) = 8x^2 + 16$$

Emily moved the  $-9$  term from the left expression of the equation to the right expression of the equation by adding  $+9$  to both the left and right expressions.

Adding an equal amount to both sides of an equation is associated with the addition property of equality.

PTS: 2                      NAT: A.REI.A.1                      TOP: Identifying Properties

2) ANS: 4

Evan's first step was to remove the parentheses from the right expression.

$$12x^2 - 7x = 6 - 2(x^2 - 1)$$

$$12x^2 - 7x = 6 - 2x^2 + 2$$

He removed the parentheses by using the distributive property.

PTS: 2                      NAT: A.REI.A.1                      TOP: Identifying Properties

3) ANS: 4

$$2(6x^2 - 3)$$

$$= 2(6x^2) + 2(-3)$$

$$= 12x^2 - 6$$

This is the distributive property of multiplication over subtraction.

PTS: 2                      NAT: A.REI.A.1                      TOP: Identifying Properties