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Date: ____________
8A Pd ____

The Real Number Properties
Algebra 1

Many of the most important tools of algebra are dependent upon properties that the real numbers (in partnership with the four basic operations of addition, subtraction, multiplication, and division) possess. These properties are shown below.

If a, b, and c are real numbers then the following properties hold:

(1) $a+b=b+a$ and $a \cdot b=b \cdot a$ **Commutative**: order switches
of addition / of multiplication
Change Order

(2) $a+(b+c)=(a+b)+c$ and $a \cdot (b \cdot c)=(a \cdot b) \cdot c$ **Associative** ① same order ② ( ) or grouping is switched
of addition / of multiplication

(3) $a \cdot (b+c)=a \cdot b+a \cdot c$ **Distributive**: term on the outside of the ( ) is multiplied by each term on the inside of the ( )
$a(b-c)=a \cdot b-a \cdot c$

THE REAL NUMBER PROPERTIES

***Exercise* #1:** Which of the following equations illustrates the distributive property?

(1) $(-2)+7=7+(-2)$ C
(3) $5(12)=5(10)+5(2)$
(2) $3+(5+2)=(3+5)+2$ A
(4) $5 \cdot 3=3 \cdot 5$ C

3

***Exercise* #2:** Which of the following properties is illustrated in the equation $(3+5)+7=7+(3+5)$?

(1) Distributive
(3) Commutative
(2) Associative
(4) Inverse

Change order
3

***Exercise* #3:** Give an numerical example to show that subtraction is not a commutative operation.

aka justify ✓

$5-2 \neq 2-5$
$3 \neq -3$

***Exercise* #4:** What other operation, like subtraction, is not commutative? Justify.

Division B/C $\frac{4}{2} \neq \frac{2}{4}$
$2 \neq \frac{1}{2}$

Exercise #5: For each of the following mathematical equations, fill in the number or variable that makes the statement true. Then, identify which property you applied.

(a) $5+(-3)=(-3)+$ 5 Commutative Prop of Addition

(b) $4(2x-5)=8x-$ 20 Dist Prop

(c) $7+(6+2)=(7+$ 6 $)+2$ Assoc. Prop of Addition

Identity Elements and Properties for Addition and Multiplication – For both multiplication and addition there is one number that is unique because it doesn't change another number when operated with. These elements are called **identities**.

Exercise #6:

(a) What is the **identity element for addition**? In other words, what number can be added to a given number without changing that given number? Explain.

0, B/c No matter what # you add to 0, it won't change the value of that # (stays itself)

ex $4+0=4$

(b) What is the **identity element for multiplication**? Explain.

1, B/c anything multiplied by 1 stays the same (is itself)

ex $4 \cdot 1=4$

Exercise #7: Justify each statement shown below with a real number property. ~~This process is called combining like terms.~~

(1) $3x+4y+7x+2y=3x+7x+4y+2y$ (1) Commutative Prop of Add.

(2) $3x+7x+4y+2y=(3+7)x+(4+2)y$ (2) Dist Prop

Real Numbers: Property CHART

	Property (a, b and c are real numbers, variables or algebraic expressions)	Examples	Verbal hints
1.	Distributive Property $a \cdot (b + c) = a \cdot b + a \cdot c$	$3 \cdot (4 + 5) = 3 \cdot 4 + 3 \cdot 5$	"multiplication distributes across addition"
2.	Commutative Property of Addition $a + b = b + a$	$3 + 4 = 4 + 3$	"commute = to get up and move to a new location : switch places"
3.	Commutative Property of Multiplication $a \cdot b = b \cdot a$	$3 \cdot 4 = 4 \cdot 3$	"commute = to get up and move to a new location: switch places"
4.	Associative Property of Addition $a + (b + c) = (a + b) + c$	$3 + (4 + 5) = (3 + 4) + 5$	"regroup - elements do not physically move, they simply group with a new friend."
5.	Associative Property of Multiplication $a \cdot (b \cdot c) = (a \cdot b) \cdot c$	$3 \cdot (4 \cdot 5) = (3 \cdot 4) \cdot 5$	"regroup - elements do not physically move, they simply group with a new friend."
6.	Additive Identity Property $a + 0 = a$	$4 + 0 = 4$	"the value that returns the input unchanged"
7.	Multiplicative Identity Property $a \cdot 1 = a$	$4 \cdot 1 = 4$	"the value that returns the input unchanged"
8.	Additive Inverse Property $a + (-a) = 0$ Rule: - change sign	$4 + (-4) = 0$	"the value that brings you back to the identity element under addition" inverses produce identities
9.	reciprocal Multiplicative Inverse Property $a \cdot \left(\frac{1}{a}\right) = 1$ where $a \neq 0$ - flip fraction - keep sign	$4 \cdot \left(\frac{1}{4}\right) = 1$	"the value that brings you back to the identity element under multiplication"
10.	Zero Property of Multiplication $a \cdot 0 = 0$	$4 \cdot 0 = 0$	"zero times any element is 0"
11.	Closure Property of Addition $a + b$ is a real number	$10 + 5 = 15$ (a real number)	"the sum of any two real numbers is another real number"
12.	Closure Property of Multiplication $a \cdot b$ is a real number	$10 \cdot 5 = 50$ (a real number)	"the product of any two real numbers is another real number"
13.	Reflexive (or Identity) Property of Equality $a = a$	$12 = 12$	"a real number is always equal to itself"
14.	Comm. prop. Symmetric Property of Equality If $a = b$, then $b = a$.	If $3.5 = 3\frac{1}{2}$, then $3\frac{1}{2} = 3.5$.	"quantities that are equal can be read forward or backward"
15.	Transitive Property of Equality If $a = b$ and $b = c$, then $a = c$.	If $2a = 10$ and $10 = 4b$, then $2a = 4b$.	"if two numbers are equal to the same number, then the two numbers are equal to each other"
16.	Law of Trichotomy Exactly ONE of the following holds: $a < b$, $a = b$, $a > b$	If $8 > 6$, then $8 \neq 6$ and 8 is not < 6.	"for two real numbers a and b, a is either equal to b, greater than b, or less than b." (common sense)

More Examples

Rule: change sign

1) Find the additive inverse of:

a) -6 $\boxed{6}$

b) x $\boxed{-x}$

c) -a + b $\boxed{a-b}$

Rule: flip fraction, keep the sign

2) Find the multiplicative inverse of:

a) 3 $\frac{3}{1} \rightarrow \boxed{\frac{1}{3}}$

b) $\frac{1}{4}$ $\frac{1}{4} \rightarrow \frac{4}{1} = \boxed{4}$

c) h $\frac{h}{1} \rightarrow \boxed{\frac{1}{h}}$ $h \neq 0$

3) Which equation demonstrates the multiplicative identity property?

a) $x \cdot 0 = 0$ zero property of multiplication

b) $x \cdot 1 = x$ identity

c) $x \cdot \frac{1}{x} = 1$ Mult. inverse

4) Which equation is an illustration of the additive identity property?

a) $x \cdot 1 = x$ multiplicative identity property

b) $x + 0 = x$

c) $x - x = 0$ additive inverse property

5) A method for solving $5(x-2) - 2(x-5) = 9$ is shown below. Identify the property used to obtain each of the two indicated steps.

Similar to Test Question

$5(x-2) - 2(x-5) = 9$

(1) $5x - 10 - 2x + 10 = 9$ → (1) Dist. Prop

(2) $5x - 2x - 10 + 10 = 9$ → (2) Comm Prop of Addition

$3x + 0 = 9$ → (3) Additive Inverse Prop. b/c it produces 0.

$3x = 9$

$x = 3$

opposite = Inverse