

Properties of Equality

Property	Symbols	Numbers
Substitution	If $a = b$, then a may be replaced by b	If $9 + 2 = 11$ then $9 + 2$ may be replaced by 11
Reflexive	$a = a$	$21 = 21$
Symmetric	If $a = b$, then $b = a$	If $10 = 4 + 6$, then $4 + 6 = 10$
Transitive	If $a = b$ and $b = c$, then $a = c$	If $3 + 5 = 8$ and $8 = 2(4)$, then $3 + 5 = 2(4)$

Property	Words	Symbols	Numbers
Additive Identity	When zero is added to any number a , the sum is a	For any number a , $a + 0 = 0 + a = a$	$45 + 0 = 45$ 0 is the identity
Multiplicative Identity	When a number a is multiplied by 1 , the product is a	For any number a , $a \cdot 1 = 1 \cdot a = a$	$12 \cdot 1 = 12$ 1 is the identity
Multiplicative Property of Zero	If 0 is a factor, the product is 0	For any number a , $a \cdot 0 = 0 \cdot a = 0$	$7 \cdot 0 = 0$ $0 \cdot 23 = 0$

**Commutative
Property of
Addition**

Words: The order in which two numbers are added does not change their sum.

Symbols:For any numbers a and b,

$$a + b = b + a$$

Numbers: $5 + 7 = 7 + 5$

**Commutative
Property of
Multiplication**

Words: The order in which two numbers are multiplied does not change their sum.

Symbols:For any numbers a and b,

$$a \cdot b = b \cdot a$$

Numbers: $3 \cdot 10 = 10 \cdot 3$

**Associative
Property of
Addition**

Words: The way in which three numbers are grouped when they are added does not change their sum.

Symbols:For any numbers a, b, and c,

$$(a + b) + c = a + (b + c)$$

Numbers: $(24 + 8) + 2 = 24 + (8 + 2)$

**Associative
Property of
Multiplication**

Words: The way in which three numbers are grouped when they are multiplied does not change their product.

Symbols:For any numbers a, b, and c,

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

Numbers: $(9 \cdot 4) \cdot 25 = 9 \cdot (4 \cdot 25)$

**Closure
Property of
Whole
Numbers**

Words: The way in which three numbers are grouped when they are added does not change their sum.

Symbols: For any numbers a , b , and c ,

$$(a + b) + c = a + (b + c)$$

Numbers: $(24 + 8) + 2 = 24 + (8 + 2)$