Bell Work

Evaluate each expression.

1. $\mathbf{5 \cdot 4(10-8)+20}$

2. $\dfrac{\mathbf{2^5 - 6 \cdot 2}}{\mathbf{3^3 - 5 \cdot 3 - 2}}$

Evaluate each expression if $\mathrm{a}=4, \mathrm{b}=5,$ and $\mathrm{c}=10.$

1. $\dfrac{\mathbf{ac^2 - 8b}}{\mathbf{ab}}$

2. $\mathbf{b^3 + ac - b}$

Lesson 1.3
Properties of Numbers

- Objectives:
  - Recognize the properties of equality and identity.
  - Recognize the Commutative and Associative Properties.

PROPERTIES OF EQUALITY

KeyConcept Properties of Equality

Property	Words	Symbols	Examples
Reflexive Property	Any quantity is equal to itself.	For any number a, $a = a$.	$5 = 5$ $4 + 7 = 4 + 7$
Symmetric Property	If one quantity equals a second quantity, then the second quantity equals the first.	For any numbers a and b, if $a = b$, then $b = a$.	If $8 = 2 + 6$, then $2 + 6 = 8$.
Transitive Property	If one quantity equals a second quantity and the second quantity equals a third quantity, then the first quantity equals the third quantity.	For any numbers a, b, and c, if $a = b$ and $b = c$, then $a = c$.	If $6 + 9 = 3 + 12$ and $3 + 12 = 15$, then $6 + 9 = 15$.
Substitution Property	A quantity may be substituted for its equal in any expression.	If $a = b$, then a may be replaced by b in any expression.	If $n = 11$, then $4n = 4 \cdot 11$

a. Can you think of a number that can be added to any number to keep that number the same?

b. Can you think of a number that can be multiplied by any number to keep that number the same?

Addition Properties

- Additive Identity: 0 (the sum of any number and 0 is equal to that number)

KeyConcept Addition Properties

Property	Words	Symbols	Examples
Additive Identity	For any number *a*, the sum of *a* and 0 is *a*.	$a + 0 = 0 + a = a$	$2 + 0 = 2$ $0 + 2 = 2$
Additive Inverse	A number and its opposite are additive inverses of each other.	$a + (-a) = 0$	$3 + (-3) = 0$ $4 - 4 = 0$

Multiplication Properties

- Multiplicative Identity: 1 (the product of any number and 1 is equal to that number)

KeyConcept Multiplication Properties

Property	Words	Symbols	Examples
Multiplicative Identity	For any number a, the product of a and 1 is a.	$a \cdot 1 = a$ $1 \cdot a = a$	$14 \cdot 1 = 14$ $1 \cdot 14 = 14$
Multiplicative Property of Zero	For any number a, the product of a and 0 is 0.	$a \cdot 0 = 0$ $0 \cdot a = 0$	$9 \cdot 0 = 0$ $0 \cdot 9 = 0$
Multiplicative Inverse	For every number $\frac{a}{b}$, where $a, b \neq 0$, there is exactly one number $\frac{b}{a}$ such that the product of $\frac{a}{b}$ and $\frac{b}{a}$ is 1.	$\frac{a}{b} \cdot \frac{b}{a} = 1$ $\frac{b}{a} \cdot \frac{a}{b} = 1$	$\frac{4}{5} \cdot \frac{5}{4} = \frac{20}{20}$ or 1 $\frac{5}{4} \cdot \frac{4}{5} = \frac{20}{20}$ or 1

Ex 1. Evaluate Using Properties

Evaluate $\frac{1}{4}(12-8)+3(15\div 5-2)$.

Name the property used in each step.

$\frac{1}{4}(12-8)+3(15\div 5-2)=\frac{1}{4}(4)+3(15\div 5-2)$

Substitution: 12 – 8 = 4

$=\frac{1}{4}(4)+3(3-2)$

Substitution: 15 ÷ 5 = 3

$=\frac{1}{4}(4)+3(1)$

Substitution: 3 – 2 = 1

$=\frac{1}{4}(4)+3$

Multiplicative Identity: 3(1) = 3

$=1+3$

Multiplicative Inverse: $\frac{1}{4}(4)=1$

= 4 Substitution: 1 + 3 = 4

Answer: 4

Practice

GuidedPractice

Name the property used in each step.

1A. $2 \cdot 3 + (4 \cdot 2 - 8)$

$= 2 \cdot 3 + (8 - 8)$ ___?___ Substitution

$= 2 \cdot 3 + (0)$ ___?___ Additive Inverse

$= 6 + 0$ ___?___ Substitution

$= 6$ ___?___ Additive Identity

1B. Substitution; Additive Inverse; Multiplicative Inverse; Multiplicative Property of Zero; Additive Identity

1B. $7 \cdot \frac{1}{7} + 6(15 \div 3 - 5)$

$= 7 \cdot \frac{1}{7} + 6(5 - 5)$ ___?___

$= 7 \cdot \frac{1}{7} + 6(0)$ ___?___

$= 1 + 6(0)$ ___?___

$= 1 + 0$ ___?___

$= 1$ ___?___

Evaluate $\frac{1}{3}(10 - 7) + 4(18 \div 9 - 1)$.

Commutative Property

Commutative Property – the order in which you add or multiply numbers does not change their sum or product

	Addition	Multiplication
Symbols	a + b = b + a	a • b = b • a
Examples	4 + 8 = 8 + 4	7 • 11 = 11 • 7

NOTE – This property does NOT work for subtraction and division.

Associative Property

Associative Property – the way you group 3 or more numbers when adding or multiplying does not change their sum or product

	Addition	Multiplication
Symbols	(a + b) + c = a + (b + c)	(ab)c = a(bc)
Examples	(3 + 5) + 7 = 3 + (5 + 7)	(2 • 6) • 9 = 2 • (6 • 9)

NOTE – This property does NOT work for subtraction and division.

Ex 2. Evaluate Using Properties

Evaluate 2 ● 8 ● 5 ● 7 using properties of numbers.
Name the property used in each step.

You can rearrange and group the factors to make mental calculations easier.

2 ● 8 ● 5 ● 7	= 2 ● 5 ● 8 ● 7	Commutative (×)
	= (2 ● 5) ● (8 ● 7)	Associative (×)
	= 10 ● 56	Substitution
	= 560	Substitution

Answer: 560

Practice

Example 3 Use Multiplication Properties

Evaluate $5 \cdot 7 \cdot 4 \cdot 2$ using the properties of numbers. Name the property used in each step.

$5 \cdot 7 \cdot 4 \cdot 2 = 5 \cdot 2 \cdot 7 \cdot 4$	Commutative (×)
$= (5 \cdot 2) \cdot (7 \cdot 4)$	Associative (×)
$= 10 \cdot 28$	Substitution
$= 280$	Substitution