Commutative Properties: **Addition** $\rightarrow$ $a+b = b+a$

Multiplication $\rightarrow$ $a \cdot b = b \cdot a$

$4+6=6+4$ $x+5=5+x$ $(10)(8)=(8)(10)$ $(-2)(n)=(n)(-2)$ $x+(5+w)=x+(w+5)$

$3+5a=5a+3$ $xy-4=yx-4$ $6+(5-m)=(5-m)+6$ $10(4x+6)-1=(4x+6)(10)-1$

Does not work for Subtraction or Division: $5 - 9 \neq 9 - 5$ $20 \div 5 \neq 5 \div 20$

Associative Properties: **Addition** $\rightarrow$ $(a+b)+c = a+(b+c)$

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

$(2+5)+10=2+(5+10)$ $(4 \cdot 2) \cdot 6 = 4 \cdot (2 \cdot 6)$ $3+(x+9)=(3+x)+9$ $8 \cdot (xy)=(8x) \cdot y$

Does not work for Subtraction or Division: $(12-5) - 3 \neq 12 - (5-3)$

$(50 \div 10) \div 5 \neq 50 \div (10 \div 5)$

Distributive Property of Multiplication over Addition or Subtraction:

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

$5\,(x-2) = 5x-10$ $6\,(10+x) = 60 + 6x$

$-4\,(2n+3) = -8n - 12$ $-3\,(5-3y) = -15 + 9y$

$-(a+c-5)=-a-c+5$ $-(-4-w+12x)=4+w-12x$

Identity Property of Addition: $a+0=a \ \ and \ \ 0+a=a$

0 is the Identity Element for Addition

Identity Property of Multiplication: $a \cdot 1=a \ \ and \ \ 1 \cdot a=a$

1 is the Identity Element for Multiplication

Inverse Properties of Addition and Multiplication: $a+(-a)=0$ $a \cdot \dfrac{1}{a} = 1, \ \ a \neq 0$

a *and* $-a$ are called "additive inverses" or "opposites"

a *and* $\dfrac{1}{a}$ are called "multiplicative inverses" or "reciprocals"

Use the Distributive Property to simplify each expression:

1. $10(m+n)$ **2.** $12(y-3)$ **3.** $5(4x-2)$ **4.** $6(3a+2c)$ **5.** $-(8m-15)$

6. $-3(m-5n)$ **7.** $-9(2x+5y)$ **8.** $20(a+3c-4)$ **9.** $-(2a-5c+11)$ **10.** $-6(-2x+5y-z)$

11. $3(6x+4)-8$ **12.** $5(-2m+10)+3$ **13.** $-2(8m+3)+10$ **14.** $-9(6m-1)-5$

Use the Distributive Property to factor each sum into a multiplication expression.

Example: $4a+4c \implies 4(a+c)$

15. $10n+10\cdot4 \implies$ 16, $-8w+{}^-8y \implies$

Name the property illustrated by each statement.

17. $11+5 = 5+11$

18. $5(x+4) = 5x+5\cdot4$

19. $10(xy) = (10x)y$

20. $7+(n+3) = (n+3)+7$

21. $6x+6z = 6(x+z)$

22. $x+8 = x+8\cdot1$

23. $3(xc) = 3(cx)$

24. $\left(10\cdot\dfrac{1}{10}\right)w = 1\cdot w$

25. $a+(n+8) = (a+n)+8$

26. $(-5+5)N = 0\cdot N$

27. $A+C = (A+0)+C$