Variables Expressions and Properties

Name: _____	Date: _____	Score: _____ / 24

Quick Review

A **variable** is just a letter standing in for a number we don't know yet — something like x or n. The number multiplied by that variable is its **coefficient**, so in $7x$ the coefficient is 7. A plain number with no variable attached is a **constant**; in $7x + 5$, the constant is 5. Each piece separated by a $+$ or $-$ sign is its own **term**. The **properties of real numbers** are the rewriting rules that never change a value: the **Commutative** property lets you swap order ($a + b = b + a$ and $ab = ba$); the **Associative** property lets you regroup ($(a+b)+c = a+(b+c)$); the **Distributive** property multiplies across a sum ($a(b+c) = ab+ac$); the **Identity** properties leave a number alone ($a + 0 = a$, $a \cdot 1 = a$); and the **Inverse** properties undo a number back to its identity ($a + (-a) = 0$ and $a \cdot \frac{1}{a} = 1$).

PRACTICE

Simplify each expression, or name the property shown.

1. $3(x + 4)$ _____

2. $2(5a - 1)$ _____

3. $7 + x = x + 7$ _____

4. $4 \cdot (3 \cdot y) = (4 \cdot 3) \cdot y$ _____

5. $6(2n + 3)$ _____

6. $-3(4 - 2x)$ _____

7. $5m + 0$ _____

8. $8 + (x + 2) = (8 + x) + 2$ _____

9. $9(a - 5) + 2$ _____

10. $-2(3x + 4) - x$ _____

11. $4(x + 1) + 3(x - 2)$ _____

12. $7 \cdot \frac{1}{7}$ _____

13. $5(x - 2) + 10$ _____

14. $-(3x - 7)$ _____

15. $(a + b) + c = a + (b + c)$ _____

16. $x \cdot 1 + 0$ _____

17. $2(x + y) + 3(x + y)$ _____

18. $4 \cdot 0 \cdot x$ _____

19. $6 + (-6) + x$ _____

20. $\frac{1}{2}(8x + 12)$ _____

Word Problems

21. A movie ticket costs $\$d$ and a bag of popcorn costs $\$3$ less than the ticket. Write an expression for the total cost of 2 tickets and 2 bags of popcorn, then simplify using the distributive property.

_____

22. Jasmine says $3(x + 5)$ and $3x + 5$ are equivalent because she "moved the parentheses." Are the expressions equivalent? Simplify $3(x + 5)$ and decide.

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23. A school store sells p pencils at $\$0.50$ each and n notebooks at $\$2.00$ each. Write an expression for the total cost, then find the cost of 6 pencils and 4 notebooks.

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24. Show that $2(3 + 4)$ and $2 \cdot 3 + 2 \cdot 4$ give the same value. What property does this demonstrate?

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Answer Keys

1. $3x + 12$
2. $10a - 2$
3. Commutative $(+)$
4. Associative $(\times)$
5. $12n + 18$
6. $-12 + 6x$
7. $5m$
8. Associative $(+)$
9. $9a - 43$
10. $-7x - 8$
11. $7x - 2$
12. 1
13. $5x$
14. $-3x + 7$
15. Associative $(+)$
16. x
17. $5x + 5y$
18. 0
19. x
20. $4x + 6$
21. $\$(4d - 6)$
22. No; $3(x + 5) = 3x + 15$
23. $0.50p + 2n$; $\$11.00$
24. Both equal 14; Distributive

Step-by-Step Tutor Notes

1. The 3 outside the parentheses wants to multiply *everything* inside, not just the first thing. So hand a 3 to the x and a 3 to the 4: $3x$ and 12. Same $+$ sign in the middle, so you get $3x + 12$.
2. Distribute the 2 to both pieces inside. 2 times $5a$ is $10a$, and 2 times -1 is -2. Put them together: $10a - 2$.
3. The same two things got added, just in opposite order. That's the Commutative Property of Addition — $a + b = b + a$. (Easy check: if you can swap them like socks, it's commutative.).
4. The three numbers stayed in the same order; only the *parentheses* moved. That's the Associative Property of Multiplication — regrouping a product never changes it.
5. Hand the 6 to each piece inside the parentheses. $6 \cdot 2n = 12n$, and $6 \cdot 3 = 18$. So $12n + 18$.
6. This one's a sign-watching exercise. -3 times 4 is -12. Then -3 times $-2x$: two negatives make a positive, so $+6x$. Final: $-12 + 6x$.
7. Adding zero is like adding nothing — $5m$ stays $5m$. That's the Identity Property of Addition: zero is the do-nothing number for $+$.
8. Same three things, just regrouped — the Associative Property of Addition. The order didn't change; only which two got grouped first did.
9. Distribute first: $9 \cdot a = 9a$ and $9 \cdot (-5) = -45$, giving $9a - 45$. Then the $+2$ at the end combines with the -45: $-45 + 2 = -43$. Final: $9a - 43$.
10. Distribute the -2: $-6x - 8$. Now bring in the $-x$ at the end. The x-terms combine: $-6x$ and $-x$ are like terms, so $-6x + (-x) = -7x$. The -8 has no partner. Final: $-7x - 8$.
11. Distribute each parenthesis separately: $4(x + 1) = 4x + 4$ and $3(x - 2) = 3x - 6$. Now combine like terms: $4x + 3x = 7x$ for the variable parts, and $4 - 6 = -2$ for the constants. Together: $7x - 2$.
12. Any nonzero number times its own reciprocal lands you at 1. That's the Inverse Property of Multiplication — the reciprocal is what undoes the original number.
13. Distribute: $5x - 10$. Then the loose $+10$ at the end cancels out the -10. What's left? Just $5x$. (When you see constants that cancel, double-check — it usually means the problem was designed to give a clean answer.).
14. A minus sign by itself in front of parentheses works like multiplying by -1. Hand a -1 to each piece: $-1 \cdot 3x = -3x$ and $-1 \cdot (-7) = +7$. The two flips on the -7 turn it back to $+7$. Final: $-3x + 7$.
15. Same letters, same order, different parentheses — that's the Associative Property of Addition. It says you can regroup an addition any way you like.
16. Two identity properties stacked on one expression. Multiplying by 1 leaves x alone, and adding 0 leaves it alone again. Just x.
17. Here's a neat shortcut. Treat $(x + y)$ as one chunk. You have 2 of that chunk and 3 of that chunk, so $2 + 3 = 5$ chunks. Then distribute: $5(x + y) = 5x + 5y$. Saves you from distributing twice.
18. Anything multiplied by zero is zero — it doesn't matter how many other factors there are. The whole product is just 0.
19. 6 and -6 are additive inverses, so they cancel to 0. Then $0 + x = x$ (the Identity Property of Addition). Clean answer: just x.
20. Distribute the $\frac{1}{2}$ to both terms. Half of $8x$ is $4x$, and half of 12 is 6. So $4x + 6$. (When the coefficient is a friendly fraction, expect friendly results inside.).
21. Each popcorn costs $\$3$ less than a ticket, so a popcorn costs $d - 3$ dollars. Two tickets is $2d$, and two popcorns is $2(d - 3)$. Add them up: $2d + 2(d - 3)$. Distribute the second 2: $2d + 2d - 6$. Combine the d-terms: $4d - 6$ dollars.
22. Jasmine made the most common distributive-property mistake: she only multiplied the 3 by the x and forgot to multiply by the 5. The actual distribution is $3 \cdot x + 3 \cdot 5 = 3x + 15$. Since $3x + 15 \neq 3x + 5$, the two expressions are not the same. The 3 has to reach every piece inside the parentheses — no exceptions.
23. Cost per pencil times number of pencils gives $0.50p$; same idea for notebooks gives $2n$. Add them for the total: $0.50p + 2n$. Now substitute $p = 6$ and $n = 4$: $0.50(6) + 2(4) = 3 + 8 = 11$. So $\$11.00$. The expression is reusable for any combination — that's the power of using variables.
24. Compute both sides. Left side: $2(3 + 4) = 2(7) = 14$. Right side: $2 \cdot 3 + 2 \cdot 4 = 6 + 8 = 14$. Same answer both ways. That's the Distributive Property in action: $a(b + c) = ab + ac$. You can either add first then multiply, or multiply each piece and then add. Same result every time.

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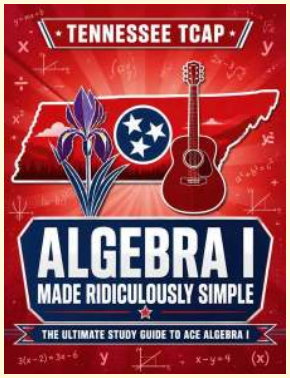

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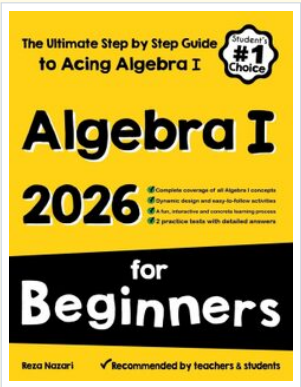

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