

# Variables Expressions and Properties

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 24

## Q 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. $3(x + 4)$                                  | _____ | 11. $4(x + 1) + 3(x - 2)$       | _____ |
| 2. $2(5a - 1)$                                 | _____ | 12. $7 \cdot \frac{1}{7}$       | _____ |
| 3. $7 + x = x + 7$                             | _____ | 13. $5(x - 2) + 10$             | _____ |
| 4. $4 \cdot (3 \cdot y) = (4 \cdot 3) \cdot y$ | _____ | 14. $-(3x - 7)$                 | _____ |
| 5. $6(2n + 3)$                                 | _____ | 15. $(a + b) + c = a + (b + c)$ | _____ |
| 6. $-3(4 - 2x)$                                | _____ | 16. $x \cdot 1 + 0$             | _____ |
| 7. $5m + 0$                                    | _____ | 17. $2(x + y) + 3(x + y)$       | _____ |
| 8. $8 + (x + 2) = (8 + x) + 2$                 | _____ | 18. $4 \cdot 0 \cdot x$         | _____ |
| 9. $9(a - 5) + 2$                              | _____ | 19. $6 + (-6) + x$              | _____ |
| 10. $-2(3x + 4) - x$                           | _____ | 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.

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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

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

### Step-by-Step Tutor Notes

- 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  $3x + 12$ .
- Distribute the 2 to both pieces inside. 2 times  $5a$  is  $10a$ , and 2 times  $-1$  is  $-2$ . Put them together:  $10a - 2$ .
- 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.)
- 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.
- Hand the 6 to each piece inside the parentheses.  $6 \cdot 2n = 12n$ , and  $6 \cdot 3 = 18$ . So  $12n + 18$ .
- This one's a sign-watching exercise.  $-3$  times 4 is  $-12$ . Then  $-3$  times  $-2x$ : two negatives make a positive, so  $+6x$ . Final:  $-12 + 6x$ .
- Adding zero is like adding nothing —  $5m$  stays  $5m$ . That's the Identity Property of Addition: zero is the do-nothing number for +.
- Same three things, just regrouped — the Associative Property of Addition. The order didn't change; only which two got grouped first did.
- 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:  $9a - 43$ .
- 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:  $-7x - 8$ .
- 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:  $7x - 2$ .
- 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.
- 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.)
- 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:  $-3x + 7$ .
- Same letters, same order, different parentheses — that's the Associative Property of Addition. It says you can regroup an addition any way you like.
- Two identity properties stacked on one expression. Multiplying by 1 leaves  $x$  alone, and adding 0 leaves it alone again. Just  $x$ .
- 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.
- Anything multiplied by zero is zero — it doesn't matter how many other factors there are. The whole product is just 0.
- 6 and  $-6$  are additive inverses, so they cancel to 0. Then  $0 + x = x$  (the Identity Property of Addition). Clean answer: just  $x$ .
- 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.)
- 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.
- 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.
- 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.
- 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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