Multiplying Binomials

Name: _____	Date: _____	Score: _____ / 24

Quick Review

To multiply two binomials, multiply each term of the first by each term of the second. The classic **FOIL** mnemonic — *First, Outer, Inner, Last* — names the four multiplications: $(a+b)(c+d) = ac + ad + bc + bd$. Combine the middle terms $(ad + bc)$ when they're like.

Special products are worth memorizing because they appear constantly:

- *Square of a sum:* $(a+b)^2 = a^2 + 2ab + b^2$. The middle term $2ab$ is the spot students forget — $(2x+3)^2 = 4x^2 + 12x + 9$, not $4x^2 + 9$.
- *Square of a difference:* $(a-b)^2 = a^2 - 2ab + b^2$. Same pattern, middle term flips sign.
- *Difference of squares:* $(a-b)(a+b) = a^2 - b^2$. The cross terms $-ab$ and $+ab$ cancel exactly.
- *Cube of a sum:* $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ (and the difference version flips the middle two signs).

Common traps: $(a+b)^2 \neq a^2 + b^2$ — always include the middle term. $a^2 + b^2$ does *not* factor over the reals; it's a sum of squares, not a difference. $(a+b)^3 \neq a^3 + b^3$ — the cube of a sum has four terms, not two. To check any product, FOIL it back out.

PRACTICE

Multiply each pair. Write each result in standard form.

1. Use the FOIL box to expand $(x+2)(x+3)$: fill the four cells, then combine like terms. _____

$\times$	x	3
x		
2		

2. $(x-4)(x+5)$ _____

3. $(2x+3)^2$ _____

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

5. $(2x+y)(x-3y)$ _____

6. $(x+2)^3$ _____

7. $(3x-2)(2x^2+x-5)$ _____

8. $(x+6)(x-2)$ _____

9. Use the FOIL box to expand $(2x-3)(x+5)$. _____

$\times$	x	5
$2x$		
-3		

10. $(x-4)^2$ _____

11. $(5x+1)(5x-1)$ _____

12. $(3a+2b)(a-b)$ _____

13. $(x-3)(x+3)$ _____

14. $(2x-1)^2$ _____

15. $(x+4)(x^2-2x+1)$ _____

16. $(x-1)^3$ _____

17. $(4x-3)(2x+5)$ _____

18. $(x^2+3)(x^2-3)$ _____

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19. A rectangle has sides $(x+6)$ and $(x-2)$. Use the area (FOIL) box to find its area. _____

$\times$	x	-2
x		
6		

20. If $(x+a)(x-5)$ has x-coefficient 2, find a _____

♦ Word Problems

21. A rectangle has length $(x+6)$ units and width $(x-2)$ units. Write a polynomial for its area in standard form. ____

22. A square garden has side $(2x+5)$ feet. Write a simplified polynomial for its area. ____

23. Two consecutive even integers are $(2n)$ and $(2n+2)$. Write a simplified polynomial for their product. ____

24. A box has a square top of side $(2x+1)$ inches. Write a simplified polynomial for the area of the top. ____

Answer Keys

1. $x^2 + 5x + 6$
2. $x^2 + x - 20$
3. $4x^2 + 12x + 9$
4. $9x^2 - 16$
5. $2x^2 - 5xy - 3y^2$
6. $x^3 + 6x^2 + 12x + 8$
7. $6x^3 - x^2 - 17x + 10$
8. $x^2 + 4x - 12$
9. $2x^2 + 7x - 15$
10. $x^2 - 8x + 16$
11. $25x^2 - 1$
12. $3a^2 - ab - 2b^2$
13. $x^2 - 9$
14. $4x^2 - 4x + 1$
15. $x^3 + 2x^2 - 7x + 4$
16. $x^3 - 3x^2 + 3x - 1$
17. $8x^2 + 14x - 15$
18. $x^4 - 9$
19. $x^2 + 4x - 12$
20. $a = 7$
21. $x^2 + 4x - 12$
22. $4x^2 + 20x + 25$ square feet
23. $4n^2 + 4n$
24. $4x^2 + 4x + 1$ square inches

Step-by-Step Explanations

1. The cells are $x \cdot x = x^2$, $x \cdot 3 = 3x$, $2 \cdot x = 2x$, $2 \cdot 3 = 6$. Combine the two middle cells: $3x + 2x = 5x$, so the product is $x^2 + 5x + 6$.

2. Keep the rule visible: $x^2 + 5x - 4x - 20 = x^2 + x - 20$. Watch the sign on the inner product: $-4 \cdot x = -4x$. That gives a quick check on the answer.

3. Use $(a + b)^2 = a^2 + 2ab + b^2$ with $a = 2x, b = 3$: $4x^2 + 2(2x)(3) + 9 = 4x^2 + 12x + 9$. Forgetting the middle term $12x$ is the classic error.

4. Start with the key idea: Difference of squares: $(3x)^2 - 4^2 = 9x^2 - 16$. The cross terms $-12x + 12x = 0$. That gives a quick check on the answer.

5. A careful way to see it: $2x \cdot x = 2x^2$, $2x \cdot (-3y) = -6xy$, $y \cdot x = xy$, $y \cdot (-3y) = -3y^2$. Combine middle: $-6xy + xy = -5xy$. That gives a quick check on the answer.

6. Use $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ with $a = x, b = 2$: $x^3 + 3x^2(2) + 3x(4) + 8 = x^3 + 6x^2 + 12x + 8$.

7. Distribute each term of $(3x - 2)$ across the trinomial. $3x(2x^2 + x - 5) = 6x^3 + 3x^2 - 15x$. $-2(2x^2 + x - 5) = -4x^2 - 2x + 10$. Combine: $6x^3 + (3 - 4)x^2 + (-15 - 2)x + 10 = 6x^3 - x^2 - 17x + 10$.

8. FOIL: First $x \cdot x = x^2$, Outer $x \cdot (-2) = -2x$, Inner $6 \cdot x = 6x$, Last $6 \cdot (-2) = -12$. Combine the middle pair: $-2x + 6x = 4x$, so $x^2 + 4x - 12$.

9. Cells: $2x \cdot x = 2x^2$, $2x \cdot 5 = 10x$, $-3 \cdot x = -3x$, $-3 \cdot 5 = -15$. Combine the middles: $10x - 3x = 7x$, giving $2x^2 + 7x - 15$.

10. Keep the rule visible: $(a - b)^2 = a^2 - 2ab + b^2$ with $a = x, b = 4$: $x^2 - 8x + 16$. Middle term is $-8x$, not $+8x$. That gives a quick check on the answer.

11. One steady path is: Difference of squares: $(5x)^2 - 1^2 = 25x^2 - 1$. This is the part to check before moving on, because it keeps the answer tied to the original question.

12. Start with the key idea: $3a \cdot a = 3a^2$, $3a \cdot (-b) = -3ab$, $2b \cdot a = 2ab$, $2b \cdot (-b) = -2b^2$. Combine middle: $-3ab + 2ab = -ab$. That gives a quick check on the answer.

13. A careful way to see it: Difference of squares: $x^2 - 9$. This is the part to check before moving on, because it keeps the answer tied to the original question.

14. Keep the rule visible: $(2x)^2 - 2(2x)(1) + 1 = 4x^2 - 4x + 1$. Middle term flips sign because the binomial has a minus. That gives a quick check on the answer.

15. One steady path is: $x(x^2 - 2x + 1) = x^3 - 2x^2 + x$. $4(x^2 - 2x + 1) = 4x^2 - 8x + 4$. Combine: $x^3 + (-2 + 4)x^2 + (1 - 8)x + 4 = x^3 + 2x^2 - 7x + 4$. That gives a quick check on the answer.

16. Start with the key idea: $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$ with $a = x, b = 1$: $x^3 - 3x^2 + 3x - 1$. The middle signs alternate $-, +, -$. That gives a quick check on the answer.

17. A careful way to see it: $4x \cdot 2x = 8x^2$, $4x \cdot 5 = 20x$, $-3 \cdot 2x = -6x$, $-3 \cdot 5 = -15$. Combine middle: $20x - 6x = 14x$. That gives a quick check on the answer.

18. Keep the rule visible: Difference of squares with $a = x^2$ and $b = 3$: $(x^2)^2 - 3^2 = x^4 - 9$. That gives a quick check on the answer.

19. Area is the product $(x + 6)(x - 2)$. Cells: x^2, $-2x$, $6x$, -12. Combine: $-2x + 6x = 4x$, so the area is $x^2 + 4x - 12$.

20. Expand: $(x + a)(x - 5) = x^2 - 5x + ax - 5a = x^2 + (a - 5)x - 5a$. Set the x-coefficient $a - 5 = 2$: $a = 7$. The product is then $x^2 + 2x - 35$.

21. Area is $(x + 6)(x - 2)$. FOIL: $x^2 - 2x + 6x - 12 = x^2 + 4x - 12$. (For the dimensions to be positive, we need $x > 2$.)

22. Area is side squared: $(2x + 5)^2 = (2x)^2 + 2(2x)(5) + 5^2 = 4x^2 + 20x + 25$. Don't forget the middle term $20x$ — the most common slip on squared binomials.

23. One steady path is: $(2n)(2n + 2) = 4n^2 + 4n$. (For $n = 3$, the integers are 6 and 8, and their product is $48 = 4(9) + 4(3) = 36 + 12$. Sanity-check passes.) That gives a quick check on the answer.

24. Area $= (2x + 1)^2 = (2x)^2 + 2(2x)(1) + 1^2 = 4x^2 + 4x + 1$. At $x = 3$, the side is 7 inches and the area is 49; the polynomial gives $4(9) + 4(3) + 1 = 36 + 12 + 1 = 49$. Sanity check passes.

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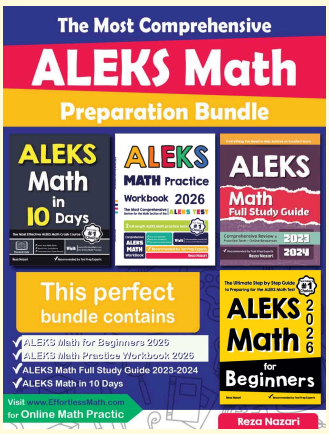

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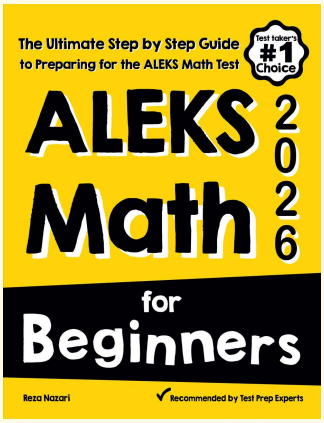

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