

Multiplying Radical Expressions

Name: _____ Date: _____ Score: _____ / 32

Q Quick Review

Multiplying radicals leans on one rule, then FOIL handles the rest.

The product rule. For $a, b \geq 0$, $\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$. Coefficients sit outside and multiply on their own: $(2\sqrt{5})(3\sqrt{2}) = 6\sqrt{10}$. The rule extends to the same index for any radical: $\sqrt[3]{a} \cdot \sqrt[3]{b} = \sqrt[3]{ab}$. (Different indices don't combine directly — $\sqrt{2} \cdot \sqrt[3]{2}$ needs a rational-exponent rewrite.)

Distribute / FOIL with radicals. Treat each radical like any other algebraic term and distribute or FOIL: $\sqrt{2}(\sqrt{2}+1) = (\sqrt{2})^2 + \sqrt{2} = 2 + \sqrt{2}$. With binomials use FOIL exactly as you would for $(x+a)(x+b)$, then simplify each radical product.

Two patterns to memorize. Square of a radical sum: $(\sqrt{a}+b)^2 = a + 2b\sqrt{a} + b^2$. Conjugate pair (difference of squares): $(\sqrt{a}-\sqrt{b})(\sqrt{a}+\sqrt{b}) = a - b$. The middle terms cancel and the radicals vanish — this is why the conjugate strategy works for rationalizing.

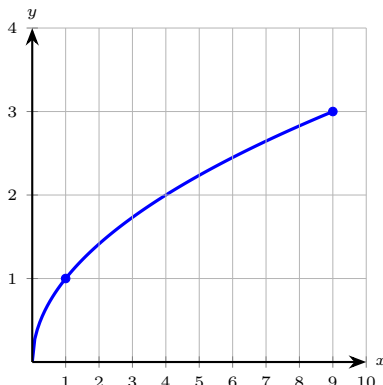
Always simplify the result. The radical you get from multiplying often still hides a perfect square: $\sqrt{6} \cdot \sqrt{8} = \sqrt{48} = 4\sqrt{3}$. Stop only when every radical's radicand is square-free.

Common slips. Adding radicands instead of multiplying ($\sqrt{a} \cdot \sqrt{b} \neq \sqrt{a+b}$). Forgetting that $(\sqrt{a})^2 = a$, not a^2 . Skipping the final simplify after a successful FOIL.

PRACTICE

Multiply and simplify. Combine radicands under one radical, then pull out perfect squares.

1. First multiply $\sqrt{2} \cdot \sqrt{8}$ to get a single number N . Then use the graph of $f(x) = \sqrt{x}$ below to read $f(N)$. _____



- 2. Multiply: $\sqrt{2}(\sqrt{2} + 1)$. _____
- 3. Multiply: $(2\sqrt{5})(3\sqrt{2})$. _____
- 4. FOIL: $(\sqrt{3} + 2)(\sqrt{3} - 5)$. _____
- 5. Expand: $(\sqrt{5} + 1)^2$. _____
- 6. Multiply: $(\sqrt{7} - \sqrt{3})(\sqrt{7} + \sqrt{3})$. _____
- 7. Expand: $(2\sqrt{6} - \sqrt{3})(\sqrt{6} + 4\sqrt{3})$. _____
- 8. Mark TRUE or FALSE: $\sqrt{a} \cdot \sqrt{b} = \sqrt{a+b}$ for $a, b \geq 0$. _____
- 9. Multiply: $(4 + \sqrt{11})(4 - \sqrt{11})$. _____
- 10. Expand: $(3\sqrt{2} + \sqrt{5})(2\sqrt{2} - 4\sqrt{5})$. _____
- 11. Multiply: $\sqrt{6} \cdot \sqrt{8}$. _____



12. The table gives $g(x) = \sqrt{x}$ at several perfect squares. Use the pattern to find $g(81)$. _____

x	9	16	49	64
$g(x)$	3	4	7	8

13. Multiply: $\sqrt{3}(\sqrt{12} - \sqrt{27})$. _____

14. Expand: $(\sqrt{x} + 2)(\sqrt{x} - 3)$ for $x \geq 0$. _____

15. Multiply: $2\sqrt{6} \cdot 5\sqrt{15}$. _____

16. Expand: $(\sqrt{a} - \sqrt{b})^2$ for $a, b \geq 0$. _____

17. Multiply: $(\sqrt{10} + 3)(\sqrt{10} - 3)$. _____

18. Multiply: $\sqrt[3]{4} \cdot \sqrt[3]{6}$. _____

19. Mark TRUE or FALSE: $(\sqrt{a})^2 = a$ for $a \geq 0$. _____

20. Multiply: $(2 + \sqrt{3})(5 - \sqrt{3})$. _____

◆ Word Problems

21. A rectangle has length $\sqrt{18}$ cm and width $\sqrt{50}$ cm. Find the exact area in simplified radical form. _____

22. A square has side length $\sqrt{5} + 2$ inches. Find the exact area in simplified radical form. _____

23. Two segments have lengths $\sqrt{7} + \sqrt{3}$ and $\sqrt{7} - \sqrt{3}$. Find their product, in simplified form. _____

24. A pendulum's period (seconds) is roughly $T = 2\pi\sqrt{\frac{L}{g}}$. Two pendulums have lengths $L_1 = 2$ m and $L_2 = 8$ m. Find the exact ratio T_2/T_1 in simplified radical form. _____

Additional Practice

25. Simplify $\sqrt{72}$. _____

26. Simplify $\sqrt{45}$. _____

27. Simplify $\sqrt[3]{64}$. _____

28. Solve $\sqrt{x+5} = 9$. _____

29. Solve $\sqrt{x} - 3 = 4$. _____

30. Domain of $y = \sqrt{x-6}$. _____

31. Add $3\sqrt{5} + 2\sqrt{5}$. _____

32. Multiply $\sqrt{3} \cdot \sqrt{12}$. _____



Answer Keys

1. $f(4) = 2$

2. $2 + \sqrt{2}$

3. $6\sqrt{10}$

4. $-7 - 3\sqrt{3}$

5. $6 + 2\sqrt{5}$

6. 4

7. $21\sqrt{2}$

8. FALSE

9. 5

10. $-8 - 10\sqrt{10}$

11. $4\sqrt{3}$

12. 9

Additional Practice Answers

25. $6\sqrt{2}$

26. $3\sqrt{5}$

27. 4

28. $x = 76$

13. -3

14. $x - \sqrt{x} - 6$

15. $30\sqrt{10}$

16. $a - 2\sqrt{ab} + b$

17. 1

18. $2\sqrt[3]{3}$

19. TRUE

20. $7 + 3\sqrt{3}$

21. 30 cm^2

22. $9 + 4\sqrt{5} \text{ in}^2$

23. 4

24. 2

29. $x = 49$

30. $x \geq 6$

31. $5\sqrt{5}$

32. 6

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. Combine radicands: $\sqrt{2} \cdot \sqrt{8} = \sqrt{16} = 4$, so $N = 4$. Trace the curve at $x = 4$: the height is 2, i.e. $f(4) = \sqrt{4} = 2$. (The marks (1, 1) and (9, 3) calibrate the square-root shape so the read is exact.)

2. Distribute the $\sqrt{2}$ to each term inside: $\sqrt{2} \cdot \sqrt{2} + \sqrt{2} \cdot 1$. The first product is $(\sqrt{2})^2 = 2$ (a square root squared returns its radicand), and the second stays $\sqrt{2}$, so the result is $2 + \sqrt{2}$. These are unlike terms, so they don't combine further.

3. Multiply the coefficients together and the radicands together, separately: $2 \cdot 3 = 6$ on the outside, and $\sqrt{5} \cdot \sqrt{2} = \sqrt{10}$ by the product rule. Combine to $6\sqrt{10}$, and since 10 is square-free it's already simplest.

4. F: $\sqrt{3} \cdot \sqrt{3} = 3$. O: $\sqrt{3} \cdot (-5) = -5\sqrt{3}$. I: $2 \cdot \sqrt{3} = 2\sqrt{3}$. L: $2 \cdot (-5) = -10$. Combine: $(3 - 10) + (-5 + 2)\sqrt{3} = -7 - 3\sqrt{3}$.

5. Use $(a + b)^2 = a^2 + 2ab + b^2$ with $a = \sqrt{5}$ and $b = 1$: $(\sqrt{5})^2 + 2(\sqrt{5})(1) + 1^2 = 5 + 2\sqrt{5} + 1 = 6 + 2\sqrt{5}$. Don't drop the middle term $2\sqrt{5}$ — that's the classic squaring-a-sum slip.

6. Conjugates: $(\sqrt{7})^2 - (\sqrt{3})^2 = 7 - 3 = 4$. The middle terms cancel — that's the whole point of the conjugate pattern.

7. FOIL: $12 + 8\sqrt{18} - \sqrt{18} - 12 = 7\sqrt{18}$. Then $\sqrt{18} = 3\sqrt{2}$, so the answer is $21\sqrt{2}$. (Notice the rational parts cancelled — a sign you FOILed correctly.)

8. The product rule turns $\sqrt{a}\sqrt{b}$ into \sqrt{ab} , not $\sqrt{a+b}$. Counter: $\sqrt{4}\sqrt{9} = 2 \cdot 3 = 6$ and $\sqrt{4+9} = \sqrt{36} = 6$. But $\sqrt{4+9} = \sqrt{13} \neq 6$.

9. These are conjugates, so use the difference-of-squares pattern $(a+b)(a-b) = a^2 - b^2$ with $a = 4$, $b = \sqrt{11}$: $4^2 - (\sqrt{11})^2 = 16 - 11 = 5$. The middle terms cancel and the radical disappears, leaving a clean integer.

10. FOIL: $(3\sqrt{2})(2\sqrt{2}) = 12$; $(3\sqrt{2})(-4\sqrt{5}) = -12\sqrt{10}$; $(\sqrt{5})(2\sqrt{2}) = 2\sqrt{10}$; $(\sqrt{5})(-4\sqrt{5}) = -20$. Combine: $12 - 12\sqrt{10} + 2\sqrt{10} - 20 = -8 - 10\sqrt{10}$.

11. Combine under one radical by the product rule: $\sqrt{6} \cdot \sqrt{8} = \sqrt{48}$. Then simplify — the largest perfect square in 48 is 16, so $\sqrt{48} = \sqrt{16 \cdot 3} = 4\sqrt{3}$. Multiplying first often produces a radicand that still needs simplifying.

12. Each x is a perfect square sent to its root: $g(64) = 8$ since $8^2 = 64$. Because $81 = 9^2$, the pattern gives $g(81) = 9$. (The value at $x = 81$ is left out on purpose — continue the pattern.)

13. Distribute the $\sqrt{3}$ across both terms: $\sqrt{3} \cdot \sqrt{12} = \sqrt{36} = 6$ and $\sqrt{3} \cdot \sqrt{27} =$

$\sqrt{81} = 9$. Then subtract: $6 - 9 = -3$. Each product happened to land on a perfect square, so the radicals vanished entirely.

14. FOIL just as you would with binomials, treating \sqrt{x} as the variable: $F = \sqrt{x} \cdot \sqrt{x} = x$, $O = -3\sqrt{x}$, $I = 2\sqrt{x}$, $L = -6$. Combine the like middle terms $-3\sqrt{x} + 2\sqrt{x} = -\sqrt{x}$, giving $x - \sqrt{x} - 6$.

15. One steady path is: Coefficients: $2 \cdot 5 = 10$. Radicals: $\sqrt{6}\sqrt{15} = \sqrt{90} = 3\sqrt{10}$. Combine: $10 \cdot 3\sqrt{10} = 30\sqrt{10}$. That gives a quick check on the answer.

16. Apply $(p - q)^2 = p^2 - 2pq + q^2$ with $p = \sqrt{a}$ and $q = \sqrt{b}$: $(\sqrt{a})^2 - 2\sqrt{a}\sqrt{b} + (\sqrt{b})^2 = a - 2\sqrt{ab} + b$, using $\sqrt{a}\sqrt{b} = \sqrt{ab}$. The middle term is the piece students most often forget.

17. A conjugate pair, so use difference of squares with $a = \sqrt{10}$, $b = 3$: $(\sqrt{10})^2 - 3^2 = 10 - 9 = 1$. The radical cancels out cleanly.

18. Keep the rule visible: $\sqrt[3]{4 \cdot 6} = \sqrt[3]{24}$. Now $24 = 8 \cdot 3$, so $\sqrt[3]{24} = 2\sqrt[3]{3}$. (Same-index radicals combine; different indices need rational exponents.) That gives a quick check on the answer.

19. Squaring a principal square root returns the radicand — the radical and the square are inverses on non-negative inputs.

20. FOIL each pair: $F = 2 \cdot 5 = 10$, $O = 2 \cdot (-\sqrt{3}) = -2\sqrt{3}$, $I = \sqrt{3} \cdot 5 = 5\sqrt{3}$, $L = \sqrt{3} \cdot (-\sqrt{3}) = -3$. Combine the rational parts $10 - 3 = 7$ and the radical parts $-2\sqrt{3} + 5\sqrt{3} = 3\sqrt{3}$, giving $7 + 3\sqrt{3}$.

21. Area = $\sqrt{18} \cdot \sqrt{50} = \sqrt{900} = 30 \text{ cm}^2$. (The radicands multiplied to a perfect square, so the area is a clean integer. When you see two radicals whose radicands share prime factors, expect that.)

22. Area = $(\sqrt{5} + 2)^2 = 5 + 4\sqrt{5} + 4 = 9 + 4\sqrt{5} \text{ in}^2$. Use $(a + b)^2 = a^2 + 2ab + b^2$ with $a = \sqrt{5}$, $b = 2$ — don't fall for the lazy $(\sqrt{5})^2 + 2^2$ trap that drops the middle term.

23. Conjugate pair: $(\sqrt{7})^2 - (\sqrt{3})^2 = 7 - 3 = 4$. The product is a clean integer because the radicals cancel. (Whenever you spot a conjugate pair, the difference-of-squares pattern guarantees the radicals will vanish.)

24. Start with the key idea: $\frac{T_2}{T_1} = \frac{2\pi\sqrt{L_2/g}}{2\pi\sqrt{L_1/g}} = \sqrt{\frac{L_2}{L_1}} = \sqrt{\frac{8}{2}} = \sqrt{4} = 2$. The

constants 2π and g cancel, leaving a clean ratio. Quadrupling the length doubles the period — a classic physics-class fact that falls out of one radical step. That gives a quick check on the answer.



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