Adding and Subtracting Radical Expressions

Name: ____________ Date: ____________ Score: ______ / 36

Quick Review

Adding radicals follows the same logic as adding x-terms: combine *like* pieces, leave *unlike* pieces alone.

Like radicals. Same index *and* same radicand. $3\sqrt{5}$ and $-2\sqrt{5}$ are like; combine to $(3-2)\sqrt{5} = \sqrt{5}$. $3\sqrt{5}$ and $3\sqrt{2}$ are *not* like — the radicands differ. $3\sqrt{5}$ and $3\sqrt[3]{5}$ are also not like — the indices differ.

Simplify first — then look for like radicals. Most problems hide the like-ness. $\sqrt{12}+\sqrt{27}$ looks like two unrelated radicals until you simplify: $2\sqrt{3}+3\sqrt{3}=5\sqrt{3}$. The expression $4\sqrt{2}+3\sqrt{8}-\sqrt{18}$ shrinks to $4\sqrt{2}+6\sqrt{2}-3\sqrt{2}=7\sqrt{2}$ after every radical is reduced to $\sqrt{2}$ form.

Coefficients add, radicands stay. The arithmetic happens on the coefficients alone: $a\sqrt{r}+b\sqrt{r}=(a+b)\sqrt{r}$. The radicand never sums — it just rides along.

Variable radicals. The same rule applies with x, y inside. Pull out the perfect powers first; check the radicand after simplification. Quick check: $2\sqrt{50x^3}-x\sqrt{18x}=10x\sqrt{2x}-3x\sqrt{2x}=7x\sqrt{2x}$ (for $x \geq 0$).

Common slips. Treating $\sqrt{a}+\sqrt{b}$ as $\sqrt{a+b}$ (wrong — the same trap as in multiplication, just flipped). Adding the radicands instead of the coefficients. Stopping before simplifying each radical and missing a chance to combine.

PRACTICE

Simplify each radical first, then combine like terms. Different radicands or indices don't combine.

1. Simplify $3\sqrt{5}+2\sqrt{5}$. ________
2. Simplify $7\sqrt{3}-4\sqrt{3}$. ________
3. Simplify $\sqrt{12}+\sqrt{27}$. ________
4. Simplify $4\sqrt{2}+3\sqrt{8}-\sqrt{18}$. ________
5. Simplify $5\sqrt{2}+3\sqrt{3}$. ________
6. Simplify $2\sqrt{50x^3}-x\sqrt{18x}$ for $x \geq 0$. ________
7. Simplify $\sqrt{75}+2\sqrt{12}-\sqrt{48}$. ________
8. Mark TRUE or FALSE: $\sqrt{a}+\sqrt{b}=\sqrt{a+b}$. ________
9. Simplify $4\sqrt{20}-3\sqrt{45}+2\sqrt{5}$. ________
10. Simplify $\sqrt{32y^3}+3y\sqrt{18y}-5\sqrt{8y^3}$ for $y \geq 0$. ________

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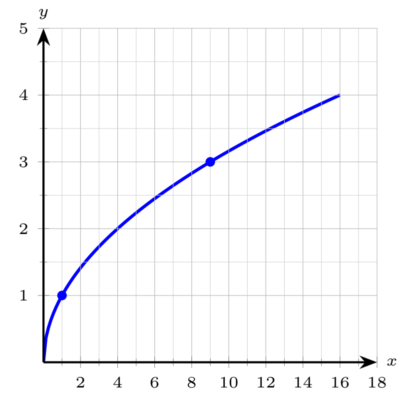
11. The graph shows $f(x) = \sqrt{x}$ with two lattice points marked. Use it to read $f(16)$, the value of $\sqrt{16}$. ________



12. Simplify $5\sqrt{6} - 2\sqrt{6} + \sqrt{6}$. ________

13. Simplify $\sqrt[3]{16} + \sqrt[3]{54}$. ________

14. Mark TRUE or FALSE: $\sqrt{a^2} + \sqrt{b^2} = a + b$ for all real a, b. ________

15. Simplify $3\sqrt{50} + 4\sqrt{8} - \sqrt{18}$. ________

16. Simplify $\sqrt{45} - 2\sqrt{20} + \sqrt{125}$. ________

17. Simplify $2\sqrt{27} + 5\sqrt{75} - \sqrt{12}$. ________

18. Simplify $6\sqrt{x} - 4\sqrt{x} + \sqrt{x}$ for $x \geq 0$. ________

19. The table gives $g(x) = \sqrt{x}$ at several perfect squares. Following the pattern, find $g(100)$. ________

x	16	36	64	81
$g(x)$	4	6	8	9

20. Simplify $a\sqrt{27a} + \sqrt{12a^3}$ for $a \geq 0$. ________

♦ Word Problems

21. A triangle has side lengths $\sqrt{8}$, $\sqrt{32}$, and $\sqrt{50}$ inches. Find its exact perimeter in simplified radical form. ____

22. Three pipes have lengths $\sqrt{75}$ ft, $2\sqrt{48}$ ft, and $\sqrt{27}$ ft. Find their exact total length in simplified radical form. ____

23. A rectangle has dimensions $\sqrt{50}$ by $\sqrt{18}$ feet. Find the exact perimeter in simplified radical form. ____

24. Two streets meet at a right angle. A diagonal shortcut walks $\sqrt{180}$ m, then continues along another diagonal of $\sqrt{45}$ m. A third diagonal of $\sqrt{20}$ m completes the trip. Find the exact total distance walked, 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 $\sqrt{3} \cdot \sqrt{12}$. ________

33. Rationalize $\frac{4}{\sqrt{2}}$. ________

34. Write $x^{3/2}$ using radicals. ________

35. Simplify $(\sqrt{7})^2$. ________

36. Solve $\sqrt{x+1} < 4$. ________

Answer Keys

1. $\boxed{5\sqrt{5}}$
2. $\boxed{3\sqrt{3}}$
3. $\boxed{5\sqrt{3}}$
4. $\boxed{7\sqrt{2}}$
5. $\boxed{5\sqrt{2}+3\sqrt{3}}$
6. $\boxed{7x\sqrt{2x}}$
7. $\boxed{5\sqrt{3}}$
8. FALSE
9. $\boxed{\sqrt{5}}$
10. $\boxed{3y\sqrt{2y}}$
11. $\boxed{4}$
12. $\boxed{4\sqrt{6}}$
13. $\boxed{5\sqrt[3]{2}}$
14. FALSE
15. $\boxed{20\sqrt{2}}$
16. $\boxed{4\sqrt{5}}$
17. $\boxed{29\sqrt{3}}$
18. $\boxed{3\sqrt{x}}$
19. $\boxed{10}$
20. $\boxed{5a\sqrt{3a}}$
21. $\boxed{11\sqrt{2}\text{ in}}$
22. $\boxed{16\sqrt{3}\text{ ft}}$
23. $\boxed{16\sqrt{2}\text{ ft}}$
24. $\boxed{11\sqrt{5}\text{ m}}$

Additional Practice Answers

25. $\boxed{6\sqrt{2}}$
26. $\boxed{3\sqrt{5}}$
27. $\boxed{4}$
28. $\boxed{x=76}$
29. $\boxed{x=49}$
30. $\boxed{x\geq 6}$
31. $\boxed{5\sqrt{5}}$
32. $\boxed{6}$
33. $\boxed{2\sqrt{2}}$
34. $\boxed{\sqrt{x^3}}$
35. $\boxed{7}$
36. $\boxed{-1\leq x<15}$

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

Step-by-Step Explanations

1. Both terms are like radicals — same index, same radicand $\sqrt{5}$ — so add the coefficients and keep the radical unchanged: $(3+2)\sqrt{5}=5\sqrt{5}$. Think of $\sqrt{5}$ as a common unit, just like adding $3x+2x=5x$.

2. Same radicand $\sqrt{3}$ in both terms, so they're like radicals — subtract the coefficients and keep the radical: $(7-4)\sqrt{3}=3\sqrt{3}$. The radicand itself never changes during addition or subtraction.

3. Reduce each first: $\sqrt{12}=2\sqrt{3}$ and $\sqrt{27}=3\sqrt{3}$. Then $2\sqrt{3}+3\sqrt{3}=5\sqrt{3}$. The $\sqrt{3}$ form emerges only after simplifying.

4. Simplify each radical to the same form first: $3\sqrt{8}=3\cdot 2\sqrt{2}=6\sqrt{2}$ and $\sqrt{18}=3\sqrt{2}$, while $4\sqrt{2}$ is already there. Now all three are like radicals: $4\sqrt{2}+6\sqrt{2}-3\sqrt{2}=7\sqrt{2}$.

5. Different radicands; neither simplifies further. The expression is already in simplest form. (Don't merge unlike radicals — the result wouldn't equal the original.)

6. Keep the rule visible: $2\sqrt{50x^3}=2\cdot 5x\sqrt{2x}=10x\sqrt{2x}$. $x\sqrt{18x}=x\cdot 3\sqrt{2x}=3x\sqrt{2x}$. Subtract: $10x\sqrt{2x}-3x\sqrt{2x}=7x\sqrt{2x}$. That gives a quick check on the answer.

7. Reduce every term to $\sqrt{3}$ form: $\sqrt{75}=5\sqrt{3}$, $2\sqrt{12}=2\cdot 2\sqrt{3}=4\sqrt{3}$, and $\sqrt{48}=4\sqrt{3}$. Then combine like radicals: $5\sqrt{3}+4\sqrt{3}-4\sqrt{3}=5\sqrt{3}$. The last two cancel, so only the first term survives.

8. Radicals don't distribute over addition. $\sqrt{9}+\sqrt{16}=3+4=7$, but $\sqrt{9+16}=\sqrt{25}=5$. Different numbers.

9. Simplify each radical to $\sqrt{5}$ form: $4\sqrt{20}=4\cdot 2\sqrt{5}=8\sqrt{5}$ and $3\sqrt{45}=3\cdot 3\sqrt{5}=9\sqrt{5}$; $2\sqrt{5}$ is already simplified. Combine the coefficients: $8-9+2=1$, so the result is $1\sqrt{5}=\sqrt{5}$.

10. Keep the rule visible: $\sqrt{32y^3}=4y\sqrt{2y}$; $3y\sqrt{18y}=9y\sqrt{2y}$; $5\sqrt{8y^3}=10y\sqrt{2y}$. Combine: $(4+9-10)y\sqrt{2y}=3y\sqrt{2y}$. That gives a quick check on the answer.

11. Trace up from $x=16$ to the curve, then across to the y-axis: the height is 4, since $\sqrt{16}=4$. The marked points $(1,1)$ and $(9,3)$ set the scale — the square-root curve keeps climbing but flattens as x grows.

12. All three terms share the radical $\sqrt{6}$, so just combine the coefficients left to right: $5-2+1=4$, giving $4\sqrt{6}$. No simplifying was needed first — the radicals were already alike.

13. Simplify each cube root first: $16=8\cdot 2$ so $\sqrt[3]{16}=2\sqrt[3]{2}$, and $54=27\cdot 2$ so $\sqrt[3]{54}=3\sqrt[3]{2}$. Now both are like radicals (same index 3, same radicand 2), so add the coefficients: $2\sqrt[3]{2}+3\sqrt[3]{2}=5\sqrt[3]{2}$.

14. Keep the rule visible: $\sqrt{a^2}=|a|$, not a. So the left side is $|a|+|b|$. For positive a,b they match; for negatives they don't. That gives a quick check on the answer.

15. One steady path is: $3\sqrt{50}=15\sqrt{2}$; $4\sqrt{8}=8\sqrt{2}$; $\sqrt{18}=3\sqrt{2}$. Combine: $15+8-3=20$, giving $20\sqrt{2}$. That gives a quick check on the answer.

16. Start with the key idea: $\sqrt{45}=3\sqrt{5}$; $2\sqrt{20}=4\sqrt{5}$; $\sqrt{125}=5\sqrt{5}$. Combine: $3-4+5=4$, so $4\sqrt{5}$. That gives a quick check on the answer.

17. A careful way to see it: $2\sqrt{27}=6\sqrt{3}$; $5\sqrt{75}=25\sqrt{3}$; $\sqrt{12}=2\sqrt{3}$. Combine: $6+25-2=29$, so $29\sqrt{3}$. That gives a quick check on the answer.

18. Each term carries the same radical $\sqrt{x}$, so they're like radicals — combine the coefficients: $6-4+1=3$, giving $3\sqrt{x}$. The $x\geq 0$ condition guarantees $\sqrt{x}$ is defined throughout.

19. Each entry maps a perfect square to its root: $g(81)=9$ because $9^2=81$. Since $100=10^2$, the pattern continues to $g(100)=10$. (The table stops short of $x=100$ on purpose — extend the pattern yourself.)

20. Start with the key idea: $a\sqrt{27a}=a\cdot 3\sqrt{3a}=3a\sqrt{3a}$; $\sqrt{12a^3}=2a\sqrt{3a}$. Combine: $3a\sqrt{3a}+2a\sqrt{3a}=5a\sqrt{3a}$. That gives a quick check on the answer.

21. Simplify each side: $\sqrt{8}=2\sqrt{2}$; $\sqrt{32}=4\sqrt{2}$; $\sqrt{50}=5\sqrt{2}$. Perimeter $=2\sqrt{2}+4\sqrt{2}+5\sqrt{2}=11\sqrt{2}$ in. (Decimal sanity: $11\cdot 1.414\approx 15.55$, consistent with three positive lengths.)

22. Keep the rule visible: $\sqrt{75}=5\sqrt{3}$; $2\sqrt{48}=8\sqrt{3}$; $\sqrt{27}=3\sqrt{3}$. Sum: $5+8+3=16$, giving $16\sqrt{3}$ ft. (Reducing each radical first uncovers the common $\sqrt{3}$ — without that, the three lengths look unrelated.) That gives a quick check on the answer.

23. One steady path is: $\sqrt{50}=5\sqrt{2}$; $\sqrt{18}=3\sqrt{2}$. Perimeter $=2(5\sqrt{2}+3\sqrt{2})=2(8\sqrt{2})=16\sqrt{2}$ ft. (Bonus check: the area is $\sqrt{50}\cdot\sqrt{18}=\sqrt{900}=30$ ft^2 exactly.) That gives a quick check on the answer.

24. Simplify each diagonal: $\sqrt{180}=6\sqrt{5}$; $\sqrt{45}=3\sqrt{5}$; $\sqrt{20}=2\sqrt{5}$. Total $=6+3+2=11$, so $11\sqrt{5}$ m. Numerically, $11\cdot 2.236\approx 24.6$ m — reasonable for three short walking diagonals.

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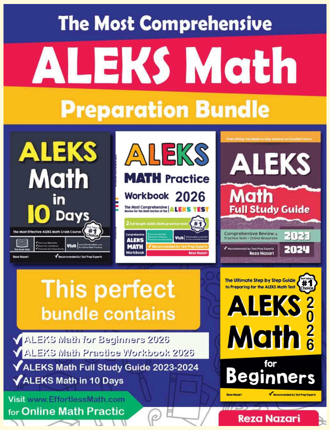

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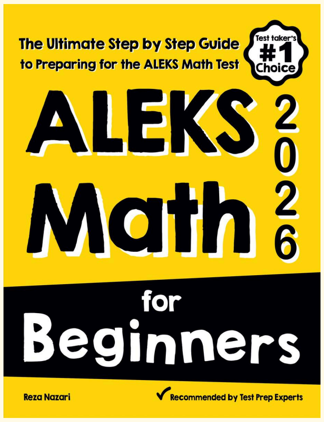

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