

SIMPLIFYING RADICALS

Simplify. Assume that all variables represent positive real numbers.

Example:

a. $\sqrt{48}$
b. $\sqrt{20d^7}$

Solution:

a. $\sqrt{48} = \sqrt{16 \cdot 3}$
 $= \sqrt{16} \cdot \sqrt{3} = 4\sqrt{3}$

b. $\sqrt{20d^7} = \sqrt{4 \cdot 5 \cdot d^6 \cdot d}$
 $= \sqrt{4d^6} \cdot \sqrt{5d} = 2d^3\sqrt{5d}$

1. $\sqrt{44}$ _____

2. $\sqrt{27}$ _____

3. $\sqrt{80}$ _____

4. $\sqrt{150}$ _____

5. $\sqrt{40}$ _____

6. $\sqrt{128}$ _____

7. $\sqrt{54}$ _____

8. $\sqrt{96}$ _____

9. $\sqrt{45}$ _____

10. $\sqrt{50}$ _____

11. $\sqrt{8}$ _____

12. $\sqrt{200}$ _____

13. $\sqrt{24}$ _____

14. $\sqrt{52}$ _____

15. $\sqrt{18}$ _____

16. $\sqrt{125}$ _____

17. $\sqrt{75}$ _____

18. $\sqrt{32}$ _____

19. $6\sqrt{9}$ _____

20. $-4\sqrt{24}$ _____

21. $8\sqrt{32}$ _____

22. $-9\sqrt{8}$ _____

23. $5\sqrt{20}$ _____

24. $-2\sqrt{16}$ _____

25. $2\sqrt{12}$ _____

26. $-3\sqrt{4}$ _____

27. $7\sqrt{18}$ _____

28. $\sqrt{4x^5}$ _____

29. $\sqrt{16y^9}$ _____

30. $\sqrt{x^{13}}$ _____

31. $\sqrt{12x^3y^8}$ _____

32. $\sqrt{27x^9y^3}$ _____

33. $\sqrt{50x^3y^3}$ _____

34. $\sqrt{32x^5y^3}$ _____

35. $\sqrt{56x^9}$ _____

36. $\sqrt{18x^7y^5}$ _____

MULTIPLICATION OF RADICALS

Multiply and simplify.

Example: $\sqrt{12} \cdot \sqrt{2}$

Solution: $\sqrt{12} \cdot \sqrt{2} = \sqrt{4 \cdot 3} \cdot \sqrt{2}$
 $= 2\sqrt{3} \cdot \sqrt{2} = 2\sqrt{6}$

1. $\sqrt{12} \cdot \sqrt{3}$ _____

2. $\sqrt{8} \cdot \sqrt{6}$ _____

3. $\sqrt{5} \cdot \sqrt{5}$ _____

4. $\sqrt{3} \cdot \sqrt{15}$ _____

5. $\sqrt{6} \cdot \sqrt{8}$ _____

6. $\sqrt{20} \cdot \sqrt{5}$ _____

7. $\sqrt{14} \cdot \sqrt{7}$ _____

8. $\sqrt{18} \cdot \sqrt{3}$ _____

9. $\sqrt{7} \cdot \sqrt{5}$ _____

10. $\sqrt{10} \cdot \sqrt{2}$ _____

11. $\sqrt{5} \cdot \sqrt{10}$ _____

12. $\sqrt{3} \cdot \sqrt{7}$ _____

13. $\sqrt{18} \cdot \sqrt{6}$ _____

14. $\sqrt{13} \cdot \sqrt{13}$ _____

15. $\sqrt{2} \cdot \sqrt{30}$ _____

16. $\sqrt{5} \cdot \sqrt{15}$ _____

17. $\sqrt{10} \cdot \sqrt{8}$ _____

18. $\sqrt{5} \cdot \sqrt{6}$ _____

19. $3\sqrt{2} \cdot \sqrt{3}$ _____

20. $2\sqrt{5} \cdot \sqrt{3}$ _____

21. $\sqrt{7} \cdot 2\sqrt{3}$ _____

22. $-4\sqrt{8} \cdot \sqrt{2}$ _____

23. $3\sqrt{3} \cdot 2\sqrt{12}$ _____

24. $5\sqrt{6} \cdot 2\sqrt{2}$ _____

25. $-2\sqrt{5} \cdot \sqrt{5}$ _____

26. $-3\sqrt{3} \cdot -2\sqrt{15}$ _____

27. $7\sqrt{7} \cdot 2\sqrt{21}$ _____

28. $6\sqrt{24} \cdot \sqrt{2}$ _____

QUOTIENTS OF RADICALS

Simplify.

Example: $\sqrt{\frac{3}{16}}$ Solution: $\sqrt{\frac{3}{16}} = \frac{\sqrt{3}}{\sqrt{16}}$
 $= \frac{\sqrt{3}}{4}$

1. $\sqrt{\frac{1}{16}}$ _____ 2. $\sqrt{\frac{5}{25}}$ _____ 3. $\sqrt{\frac{7}{81}}$ _____

4. $\sqrt{\frac{13}{100}}$ _____ 5. $\sqrt{\frac{8}{25}}$ _____ 6. $\sqrt{\frac{9}{49}}$ _____

7. $2\sqrt{\frac{12}{36}}$ _____ 8. $5\sqrt{\frac{18}{121}}$ _____ 9. $6\sqrt{\frac{5}{144}}$ _____

10. $10\sqrt{\frac{5}{36}}$ _____ 11. $9\sqrt{\frac{7}{9}}$ _____ 12. $8\sqrt{\frac{10}{64}}$ _____

Rationalize the denominators and simplify.
 All variables represent positive numbers.

Example: $\frac{7}{\sqrt{6}}$ Solution: $\frac{7}{\sqrt{6}} = \frac{7}{\sqrt{6}} \cdot \frac{\sqrt{6}}{\sqrt{6}}$
 $= \frac{7\sqrt{6}}{6}$

13. $\frac{6}{\sqrt{10}}$ _____ 14. $\frac{10}{\sqrt{2}}$ _____ 15. $\frac{5}{\sqrt{8}}$ _____

16. $\frac{\sqrt{3}}{\sqrt{5}}$ _____ 17. $\frac{\sqrt{7}}{\sqrt{3}}$ _____ 18. $\frac{\sqrt{12}}{\sqrt{7}}$ _____

19. $\frac{3\sqrt{2}}{\sqrt{3}}$ _____ 20. $\frac{5\sqrt{5}}{\sqrt{10}}$ _____ 21. $\frac{4\sqrt{2}}{\sqrt{12}}$ _____

22. $\frac{5}{\sqrt{3x}}$ _____ 23. $\sqrt{\frac{7}{5y}}$ _____ 24. $\sqrt{\frac{3}{6x^3}}$ _____

ADDITION AND SUBTRACTION OF RADICALS

Add or subtract as indicated.

Example: $2\sqrt{3} + 4\sqrt{3} - 3\sqrt{3}$

Solution: $2\sqrt{3} + 4\sqrt{3} - 3\sqrt{3} = (2 + 4 - 3)\sqrt{3}$
 $= 3\sqrt{3}$

1. $3\sqrt{2} - 4\sqrt{2} + 2\sqrt{2}$ _____ 2. $4\sqrt{5} - 3\sqrt{5} - 7\sqrt{5}$ _____

3. $\sqrt{7} + 8\sqrt{7} - 3\sqrt{7}$ _____ 4. $2\sqrt{10} - \sqrt{10} + 3\sqrt{10}$ _____

5. $3\sqrt{3} + 4\sqrt{3} - 9\sqrt{3}$ _____ 6. $\sqrt{11} - 5\sqrt{11} + 7\sqrt{11}$ _____

7. $\sqrt{12} - 4\sqrt{3}$ _____ 8. $3\sqrt{2} + \sqrt{18}$ _____

9. $3\sqrt{6} + \sqrt{24}$ _____ 10. $\sqrt{28} - 5\sqrt{7}$ _____

11. $\sqrt{32} - 5\sqrt{2}$ _____ 12. $2\sqrt{50} + 3\sqrt{2}$ _____

13. $2\sqrt{5} + 3\sqrt{20}$ _____ 14. $\sqrt{48} - 5\sqrt{3}$ _____

15. $\sqrt{20} + \sqrt{45} - \sqrt{5}$ _____ 16. $\sqrt{18} - \sqrt{32} + \sqrt{8}$ _____

17. $2\sqrt{12} - \sqrt{27} + \sqrt{48}$ _____ 18. $3\sqrt{7} + \sqrt{28} - \sqrt{63}$ _____

Simplify.

19. $\sqrt{5}(10 + \sqrt{3})$ _____ 20. $\sqrt{6}(\sqrt{10} + 4)$ _____

21. $\sqrt{7}(8 + \sqrt{12})$ _____ 22. $\sqrt{2}(\sqrt{14} - 9)$ _____

23. $(9 - \sqrt{7})(9 + \sqrt{7})$ _____ 24. $(\sqrt{3} + 8)(\sqrt{3} - 8)$ _____

SIMPLIFYING RADICALS

Simplify. Assume that all variables represent positive real numbers.

Example: a. $\sqrt{48}$
b. $\sqrt{20d^7}$

Solution: a. $\sqrt{48} = \sqrt{16 \cdot 3}$
 $= \sqrt{16} \cdot \sqrt{3} = 4\sqrt{3}$
b. $\sqrt{20d^7} = \sqrt{4 \cdot 5 \cdot d^6 \cdot d}$
 $= \sqrt{4d^6} \cdot \sqrt{5d} = 2d^3\sqrt{5d}$

1. $\sqrt{44}$	$\frac{2\sqrt{11}}{\quad}$	2. $\sqrt{27}$	$\frac{3\sqrt{3}}{\quad}$	3. $\sqrt{80}$	$\frac{4\sqrt{5}}{\quad}$
4. $\sqrt{150}$	$\frac{5\sqrt{6}}{\quad}$	5. $\sqrt{40}$	$\frac{2\sqrt{10}}{\quad}$	6. $\sqrt{128}$	$\frac{8\sqrt{2}}{\quad}$
7. $\sqrt{54}$	$\frac{3\sqrt{6}}{\quad}$	8. $\sqrt{96}$	$\frac{4\sqrt{6}}{\quad}$	9. $\sqrt{45}$	$\frac{3\sqrt{5}}{\quad}$
10. $\sqrt{50}$	$\frac{5\sqrt{2}}{\quad}$	11. $\sqrt{8}$	$\frac{2\sqrt{2}}{\quad}$	12. $\sqrt{200}$	$\frac{10\sqrt{2}}{\quad}$
13. $\sqrt{24}$	$\frac{2\sqrt{6}}{\quad}$	14. $\sqrt{52}$	$\frac{2\sqrt{13}}{\quad}$	15. $\sqrt{18}$	$\frac{3\sqrt{2}}{\quad}$
16. $\sqrt{125}$	$\frac{5\sqrt{5}}{\quad}$	17. $\sqrt{75}$	$\frac{5\sqrt{3}}{\quad}$	18. $\sqrt{32}$	$\frac{4\sqrt{2}}{\quad}$
19. $6\sqrt{9}$	$\frac{18}{\quad}$	20. $-4\sqrt{24}$	$\frac{-8\sqrt{6}}{\quad}$	21. $8\sqrt{32}$	$\frac{32\sqrt{2}}{\quad}$
22. $-9\sqrt{8}$	$\frac{-18\sqrt{2}}{\quad}$	23. $5\sqrt{20}$	$\frac{10\sqrt{5}}{\quad}$	24. $-2\sqrt{16}$	$\frac{-8}{\quad}$
25. $2\sqrt{12}$	$\frac{4\sqrt{3}}{\quad}$	26. $-3\sqrt{4}$	$\frac{-6}{\quad}$	27. $7\sqrt{18}$	$\frac{21\sqrt{2}}{\quad}$
28. $\sqrt{4x^5}$	$\frac{2x^2\sqrt{x}}{\quad}$	29. $\sqrt{16y^9}$	$\frac{4y^4\sqrt{y}}{\quad}$	30. $\sqrt{x^{13}}$	$\frac{x^6\sqrt{x}}{\quad}$
31. $\sqrt{12x^3y^8}$	$\frac{2xy^4\sqrt{3x}}{\quad}$	32. $\sqrt{27x^9y^3}$	$\frac{3x^4y\sqrt{3xy}}{\quad}$	33. $\sqrt{50x^3y^3}$	$\frac{5xy\sqrt{2xy}}{\quad}$
34. $\sqrt{32x^5y^3}$	$\frac{4x^2y\sqrt{2xy}}{\quad}$	35. $\sqrt{56x^9}$	$\frac{2x^4\sqrt{14x}}{\quad}$	36. $\sqrt{18x^7y^5}$	$\frac{3x^3y^2\sqrt{2xy}}{\quad}$

MULTIPLICATION OF RADICALS

Multiply and simplify.

Example: $\sqrt{12} \cdot \sqrt{2}$

Solution: $\sqrt{12} \cdot \sqrt{2} = \sqrt{4 \cdot 3} \cdot \sqrt{2}$
 $= 2\sqrt{3} \cdot \sqrt{2} = 2\sqrt{6}$

- | | | | |
|----------------------------------|--------------------------------|------------------------------------|--------------------------------|
| 1. $\sqrt{12} \cdot \sqrt{3}$ | <u>6</u> | 2. $\sqrt{8} \cdot \sqrt{6}$ | <u>$4\sqrt{3}$</u> |
| 3. $\sqrt{5} \cdot \sqrt{5}$ | <u>5</u> | 4. $\sqrt{3} \cdot \sqrt{15}$ | <u>$3\sqrt{5}$</u> |
| 5. $\sqrt{6} \cdot \sqrt{8}$ | <u>$4\sqrt{3}$</u> | 6. $\sqrt{20} \cdot \sqrt{5}$ | <u>10</u> |
| 7. $\sqrt{14} \cdot \sqrt{7}$ | <u>$7\sqrt{2}$</u> | 8. $\sqrt{18} \cdot \sqrt{3}$ | <u>$3\sqrt{6}$</u> |
| 9. $\sqrt{7} \cdot \sqrt{5}$ | <u>$\sqrt{35}$</u> | 10. $\sqrt{10} \cdot \sqrt{2}$ | <u>$2\sqrt{5}$</u> |
| 11. $\sqrt{5} \cdot \sqrt{10}$ | <u>$5\sqrt{2}$</u> | 12. $\sqrt{3} \cdot \sqrt{7}$ | <u>$\sqrt{21}$</u> |
| 13. $\sqrt{18} \cdot \sqrt{6}$ | <u>$6\sqrt{3}$</u> | 14. $\sqrt{13} \cdot \sqrt{13}$ | <u>13</u> |
| 15. $\sqrt{2} \cdot \sqrt{30}$ | <u>$2\sqrt{15}$</u> | 16. $\sqrt{5} \cdot \sqrt{15}$ | <u>$5\sqrt{3}$</u> |
| 17. $\sqrt{10} \cdot \sqrt{8}$ | <u>$4\sqrt{5}$</u> | 18. $\sqrt{5} \cdot \sqrt{6}$ | <u>$\sqrt{30}$</u> |
| 19. $3\sqrt{2} \cdot \sqrt{3}$ | <u>$3\sqrt{6}$</u> | 20. $2\sqrt{5} \cdot \sqrt{3}$ | <u>$2\sqrt{15}$</u> |
| 21. $\sqrt{7} \cdot 2\sqrt{3}$ | <u>$2\sqrt{21}$</u> | 22. $-4\sqrt{8} \cdot \sqrt{2}$ | <u>-16</u> |
| 23. $3\sqrt{3} \cdot 2\sqrt{12}$ | <u>36</u> | 24. $5\sqrt{6} \cdot 2\sqrt{2}$ | <u>$20\sqrt{3}$</u> |
| 25. $-2\sqrt{5} \cdot \sqrt{5}$ | <u>-10</u> | 26. $-3\sqrt{3} \cdot -2\sqrt{15}$ | <u>$18\sqrt{5}$</u> |
| 27. $7\sqrt{7} \cdot 2\sqrt{21}$ | <u>$98\sqrt{3}$</u> | 28. $6\sqrt{24} \cdot \sqrt{2}$ | <u>$24\sqrt{3}$</u> |

QUOTIENTS OF RADICALS

Simplify.

Example: $\sqrt{\frac{3}{16}}$

Solution: $\sqrt{\frac{3}{16}} = \frac{\sqrt{3}}{\sqrt{16}}$
 $= \frac{\sqrt{3}}{4}$

1. $\sqrt{\frac{1}{16}}$ $\frac{1}{4}$

2. $\sqrt{\frac{5}{25}}$ $\frac{\sqrt{5}}{5}$

3. $\sqrt{\frac{7}{81}}$ $\frac{\sqrt{7}}{9}$

4. $\sqrt{\frac{13}{100}}$ $\frac{\sqrt{13}}{10}$

5. $\sqrt{\frac{8}{25}}$ $\frac{2\sqrt{2}}{5}$

6. $\sqrt{\frac{9}{49}}$ $\frac{3}{7}$

7. $2\sqrt{\frac{12}{36}}$ $\frac{2\sqrt{3}}{3}$

8. $5\sqrt{\frac{18}{121}}$ $\frac{15\sqrt{2}}{11}$

9. $6\sqrt{\frac{5}{144}}$ $\frac{\sqrt{5}}{2}$

10. $10\sqrt{\frac{5}{36}}$ $\frac{5\sqrt{5}}{3}$

11. $9\sqrt{\frac{7}{9}}$ $3\sqrt{7}$

12. $8\sqrt{\frac{10}{64}}$ $\sqrt{10}$

Rationalize the denominators and simplify.
 All variables represent positive numbers.

Example: $\frac{7}{\sqrt{6}}$

Solution: $\frac{7}{\sqrt{6}} = \frac{7}{\sqrt{6}} \cdot \frac{\sqrt{6}}{\sqrt{6}}$
 $= \frac{7\sqrt{6}}{6}$

13. $\frac{6}{\sqrt{10}}$ $\frac{3\sqrt{10}}{5}$

14. $\frac{10}{\sqrt{2}}$ $5\sqrt{2}$

15. $\frac{5}{\sqrt{8}}$ $\frac{5\sqrt{2}}{4}$

16. $\frac{\sqrt{3}}{\sqrt{5}}$ $\frac{\sqrt{15}}{5}$

17. $\frac{\sqrt{7}}{\sqrt{3}}$ $\frac{\sqrt{21}}{3}$

18. $\frac{\sqrt{12}}{\sqrt{7}}$ $\frac{2\sqrt{21}}{7}$

19. $\frac{3\sqrt{2}}{\sqrt{3}}$ $\sqrt{6}$

20. $\frac{5\sqrt{5}}{\sqrt{10}}$ $\frac{5\sqrt{2}}{2}$

21. $\frac{4\sqrt{2}}{\sqrt{12}}$ $\frac{2\sqrt{6}}{3}$

22. $\frac{5}{\sqrt{3x}}$ $\frac{5\sqrt{3x}}{3x}$

23. $\sqrt{\frac{7}{5y}}$ $\frac{\sqrt{35y}}{5y}$

24. $\sqrt{\frac{3}{6x^3}}$ $\frac{\sqrt{2x}}{2x^2}$

ADDITION AND SUBTRACTION OF RADICALS

Add or subtract as indicated.

Example: $2\sqrt{3} + 4\sqrt{3} - 3\sqrt{3}$

Solution: $2\sqrt{3} + 4\sqrt{3} - 3\sqrt{3} = (2 + 4 - 3)\sqrt{3}$
 $= 3\sqrt{3}$

1. $3\sqrt{2} - 4\sqrt{2} + 2\sqrt{2}$ $\sqrt{2}$ 2. $4\sqrt{5} - 3\sqrt{5} - 7\sqrt{5}$ $-6\sqrt{5}$

3. $\sqrt{7} + 8\sqrt{7} - 3\sqrt{7}$ $6\sqrt{7}$ 4. $2\sqrt{10} - \sqrt{10} + 3\sqrt{10}$ $4\sqrt{10}$

5. $3\sqrt{3} + 4\sqrt{3} - 9\sqrt{3}$ $-2\sqrt{3}$ 6. $\sqrt{11} - 5\sqrt{11} + 7\sqrt{11}$ $3\sqrt{11}$

7. $\sqrt{12} - 4\sqrt{3}$ $-2\sqrt{3}$ 8. $3\sqrt{2} + \sqrt{18}$ $6\sqrt{2}$

9. $3\sqrt{6} + \sqrt{24}$ $5\sqrt{6}$ 10. $\sqrt{28} - 5\sqrt{7}$ $-3\sqrt{7}$

11. $\sqrt{32} - 5\sqrt{2}$ $-\sqrt{2}$ 12. $2\sqrt{50} + 3\sqrt{2}$ $13\sqrt{2}$

13. $2\sqrt{5} + 3\sqrt{20}$ $8\sqrt{5}$ 14. $\sqrt{48} - 5\sqrt{3}$ $-\sqrt{3}$

15. $\sqrt{20} + \sqrt{45} - \sqrt{5}$ $4\sqrt{5}$ 16. $\sqrt{18} - \sqrt{32} + \sqrt{8}$ $\sqrt{2}$

17. $2\sqrt{12} - \sqrt{27} + \sqrt{48}$ $5\sqrt{3}$ 18. $3\sqrt{7} + \sqrt{28} - \sqrt{63}$ $2\sqrt{7}$

Simplify.

19. $\sqrt{5}(10 + \sqrt{3})$ $10\sqrt{5} + \sqrt{15}$ 20. $\sqrt{6}(\sqrt{10} + 4)$ $2\sqrt{15} + 4\sqrt{6}$

21. $\sqrt{7}(8 + \sqrt{12})$ $8\sqrt{7} + 2\sqrt{21}$ 22. $\sqrt{2}(\sqrt{14} - 9)$ $2\sqrt{7} - 9\sqrt{2}$

23. $(9 - \sqrt{7})(9 + \sqrt{7})$ 74 24. $(\sqrt{3} + 8)(\sqrt{3} - 8)$ -61