

For each of the following, apply the given rule. If more than one rule applies, apply all that are appropriate. Write all answers in simplest radical form unless otherwise specified.

Multiplication of Like Bases: $b^x \cdot b^y = b^{x+y}$

1. $5^2 \cdot 5^4$ 5^6	2. $2^3 \cdot 2^6$ 2^9	3. $x^7 \cdot x$ x^8	4. $x^3(x^2)$ x^5
5. $5^{1/2} \cdot 5^{3/2}$ 5^2	6. $2^{3/4} \cdot 2^{1/4}$ 2^1	7. $x^{8/5} \cdot x^{2/5}$ x^2	8. $x^{3/2}(x^{5/2})$ x^4
9. $5^{1/3} \cdot 5^{3/2}$ $5^{11/6}$	10. $2^{3/4} \cdot 2^{1/2}$ $2^{5/4}$	11. $x^{8/5} \cdot x^{3/4}$ $x^{47/20}$	12. $x^{3/2}(x^{5/3})$ $x^{19/6}$

Power of a Power: $(b^x)^y = b^{xy}$

1. $(5^2)^6$ 5^{12}	2. $(2^3)^2$ 2^6	3. $(x^7)^2$ x^{14}	4. $(y^5)^5$ y^{25}
5. $(5^2)^{1/6}$ $5^{1/3}$	6. $(2^3)^{1/2}$ $2^{3/2}$	7. $(x^{7/2})^2$ x^7	8. $(y^{1/5})^{1/2}$ $y^{1/10}$
9. $(5^{3/2})^{1/6}$ $5^{1/4}$	10. $(2^{3/4})^{1/2}$ $2^{3/8}$	11. $(x^{7/2})^{2/7}$ x	12. $(y^{1/5})^{5/2}$ $y^{1/2}$

Power of a Product: $(ab)^x = a^x b^x$

1. $(5x)^2$ $25x^2$	2. $(xy)^3$ $x^3 y^3$	3. $(16y)^2$ $16^2 y^2$	4. $(25 \cdot 64)^{\frac{1}{2}}$ $25^{\frac{1}{2}} \cdot 64^{\frac{1}{2}}$ $5 \cdot 8 = 40$
5. $(5x)^{\frac{1}{2}}$ $5^{\frac{1}{2}} x^{\frac{1}{2}}$	6. $(xy)^{\frac{1}{3}}$ $x^{\frac{1}{3}} y^{\frac{1}{3}}$	7. $(16y)^{\frac{1}{2}}$ $16^{\frac{1}{2}} y^{\frac{1}{2}}$ $4 y^{\frac{1}{2}}$	8. $(8 \cdot 27)^{\frac{1}{3}}$ $8^{\frac{1}{3}} \cdot 27^{\frac{1}{3}}$ $2 \cdot 3 = \boxed{6}$
9. $(125x)^{\frac{1}{3}}$ $125^{\frac{1}{3}} \cdot x^{\frac{1}{3}}$ $5 \cdot x^{\frac{1}{3}}$	10. $((a)(b))^5$ $a^5 b^5$	11. $(25 \cdot w)^{\frac{3}{2}}$ $25^{\frac{3}{2}} w^{\frac{3}{2}}$	12. $(81 \cdot 16)^{\frac{1}{4}}$ $81^{\frac{1}{4}} 16^{\frac{1}{4}}$ $3 \cdot 2 = \boxed{6}$

Power of a Quotient: $\left(\frac{a}{b}\right)^x = \frac{a^x}{b^x}$

1. $\left(\frac{x}{5}\right)^2$ $\frac{x^2}{25}$	2. $\left(\frac{x}{y}\right)^3$ $\frac{x^3}{y^3}$	3. $\left(\frac{y}{16}\right)^2$ $\frac{y^2}{16^2}$	4. $\left(\frac{25}{64}\right)^{\frac{1}{2}}$ $\frac{5}{8}$
5. $\left(\frac{5}{x}\right)^{\frac{1}{2}}$ $\frac{5^{\frac{1}{2}}}{x^{\frac{1}{2}}}$	6. $\left(\frac{x}{y}\right)^{\frac{1}{3}}$ $\frac{x^{\frac{1}{3}}}{y^{\frac{1}{3}}}$	7. $\left(\frac{y}{16}\right)^{\frac{1}{2}}$ $\frac{y^{\frac{1}{2}}}{4}$	8. $\left(\frac{8}{27}\right)^{\frac{1}{3}}$ $\frac{8^{\frac{1}{3}}}{27^{\frac{1}{3}}} = \frac{2}{3}$
9. $\left(\frac{x}{125}\right)^{\frac{1}{3}}$ $\frac{x^{\frac{1}{3}}}{125^{\frac{1}{3}}} = \frac{x^{\frac{1}{3}}}{5}$	10. $\left(\frac{64}{x}\right)^{\frac{1}{2}}$ $\frac{8}{x^{\frac{1}{2}}}$	11. $\left(\frac{w}{25}\right)^{\frac{3}{2}}$ $\frac{w^{\frac{3}{2}}}{25^{\frac{3}{2}}}$	12. $\left(\frac{81}{16}\right)^{\frac{1}{4}}$ $\frac{81^{\frac{1}{4}}}{16^{\frac{1}{4}}} = \frac{3}{2}$

Quotients with Like Bases: $\frac{b^x}{b^y} = b^{x-y}$

1. $\left(\frac{x^2}{x^5}\right)$ $\frac{1}{x^3}$	2. $\left(\frac{x^3}{x}\right)$ x^2	3. $\left(\frac{m^7}{m^8}\right)$ $\frac{1}{m}$	4. $\frac{y}{y^2}$ $\frac{1}{y}$
5. $\frac{5^4}{5^2}$ $5^2 = 25$	6. $\frac{9^3}{9^5}$ $\frac{1}{9^2}$	7. $\frac{6^3}{6^{-1}}$ 6^4	8. $\frac{x^3}{x^{-2}}$ x^5
9. $\frac{y^{-2}}{y^{-5}}$ $\frac{y^5}{y^2} = y^3$	10. $\frac{11^{4/5}}{11^{2/5}}$ $11^{2/5}$	11. $\frac{25^{3/2}}{25^{1/2}} = 25^{1/2}$ $= 5$	12. $\frac{81^{3/4}}{81^{1/4}} = 81^{2/4}$ $= 81^{1/2}$ $= 9$

Zero Exponent: $b^0 = 1$

1. x^0 1	2. 25^0 1	3. $(y)^0$ 1	4. $(1)^0$ 1
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Negative Exponent: $b^{-x} = \frac{1}{b^x}$ or $\frac{1}{b^{-x}} = b^x$

1. x^{-3} $\frac{1}{x^3}$	2. $25^{-1/2}$ $\frac{1}{5}$	3. $\left(\frac{1}{x}\right)^{-2}$ $\frac{x^2}{1^2}$	4. $\frac{7}{x^{-1}}$ $7x$
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Rewrite Radicals as Rational Exponents:

$$\sqrt[n]{b^x} = b^{x/n}$$

1. $x^{2/3}$ $\sqrt[3]{x^2}$	2. $\sqrt[3]{x^3}$ $x^{3/2}$	3. $\sqrt[4]{y^1}$ $y^{1/4}$	4. $x^{1/2}$ $\sqrt{x^1}$
5. $\sqrt[5]{x^{15}}$ $x^{15/5} = x^3$	6. $\sqrt[3]{y^9}$ $y^{9/3} = y^3$	7. $\sqrt[5]{m^{20}}$ $m^{20/5} = m^4$	8. $\sqrt[8]{y^2}$ $y^{2/8} = y^{1/4}$
9. $b^{12/3}$ $b^4 =$	10. $y^{2/5}$ $\sqrt[5]{y^2}$	11. $w^{3/2}$ $\sqrt[2]{w^3} = w\sqrt{w}$	12. $m^{1/3}$ $\sqrt[3]{m^1}$

Evaluate Without a Calculator: 1st take root of the denominator, 2nd raise to numerator

1. $27^{1/3}$ $\sqrt[3]{27} = 3$	2. $1000^{1/2}$ $\sqrt{1000} = 10\sqrt{10}$ <small>1000 100 10</small>	3. $16^{1/4}$ $\sqrt[4]{16} = 2$	4. $1^{1/2}$ $\sqrt{1} = 1$
5. $81^{3/2}$ $\sqrt[2]{81 \cdot 81 \cdot 81} = 9 \cdot 9 \cdot 9$ $(729) = 9^3$	6. $81^{3/4}$ $\sqrt[4]{9 \cdot 9 \cdot 9 \cdot 9}$ (27) <small>3 3 3 3</small>	7. $32^{3/5}$ $\sqrt[5]{32 \cdot 32 \cdot 32} = 8$ <small>4 2 2 4</small>	8. $25^{3/2}$ $\sqrt{25 \cdot 25 \cdot 25} = 125$ <small>5 5 5 5 5</small>
9. $49^{3/2}$ $\sqrt{49 \cdot 49 \cdot 49}$ (343) <small>7 7 7 7 7</small>	10. $8^{3/2}$ $\sqrt{8 \cdot 8 \cdot 8} = 16$ <small>2 2 2 2</small>	11. $121^{3/2}$ $\sqrt{121 \cdot 121 \cdot 121}$ (1331) <small>11 11 11</small>	12. $625^{3/4}$ $\sqrt[4]{625 \cdot 625 \cdot 625}$ (125) <small>5 5 5 5 5 5 5 5 5</small>

Rationalize a denominator

$1. \frac{5}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{5\sqrt{2}}{2}$	$2. \frac{x}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{x\sqrt{3}}{3}$	$3. \frac{x+2}{\sqrt{x}} \cdot \frac{\sqrt{x}}{\sqrt{x}} = \frac{x\sqrt{x} + 2\sqrt{x}}{x}$	$4. \frac{6}{\sqrt[3]{7}} \cdot \frac{\sqrt[3]{7^2}}{\sqrt[3]{7^2}} = \frac{6\sqrt[3]{49}}{7}$
$5. \frac{1}{\sqrt[3]{2}} \cdot \frac{\sqrt[3]{2^2}}{\sqrt[3]{2^2}} = \frac{\sqrt[3]{4}}{2}$	$6. \frac{2}{\sqrt[3]{3}} \cdot \frac{\sqrt[3]{3^2}}{\sqrt[3]{3^2}} = \frac{2\sqrt[3]{9}}{3}$	$7. \frac{2}{\sqrt{x}} \cdot \frac{\sqrt{x^3}}{\sqrt{x^3}} = \frac{2x\sqrt{x}}{x}$	$8. \frac{7}{\sqrt[3]{9}} \cdot \frac{\sqrt[3]{9^2}}{\sqrt[3]{9^2}} = \frac{7\sqrt[3]{81}}{9}$ <p style="text-align: right;"> $\sqrt[3]{81} = \frac{21\sqrt{3}}{9} = \frac{7\sqrt{3}}{3}$ </p>
$9. \frac{1}{\sqrt[8]{x^5}} \cdot \frac{\sqrt[8]{x^3}}{\sqrt[8]{x^3}} = \frac{\sqrt[8]{x^3}}{x}$	$10. \frac{1}{2+\sqrt{3}} \cdot \frac{2-\sqrt{3}}{2-\sqrt{3}} = \frac{2-\sqrt{3}}{4-2\sqrt{3}+2\sqrt{3}-3} = \frac{2-\sqrt{3}}{1}$	$11. \frac{5}{\sqrt{x}-1} \cdot \frac{\sqrt{x}+1}{\sqrt{x}+1} = \frac{5\sqrt{x}+5}{x+\sqrt{x}-\sqrt{x}-1} = \frac{5\sqrt{x}+5}{x-1}$	$12. \frac{x}{\sqrt{x}+3} \cdot \frac{\sqrt{x}-3}{\sqrt{x}-3} = \frac{x\sqrt{x}-3x}{x-3\sqrt{x}+3\sqrt{x}-9} = \frac{x\sqrt{x}-3x}{x-9}$

Multiple Rules Practice - Rewrite each in simplest radical form.

<p>1. $4^2 \cdot 8^2$ $2^{2(2)} \cdot 2^{3(2)} = 2^4 \cdot 2^6$ 2^{10}</p>	<p>2. $27^{1/4} \cdot 9^{1/4}$ $3^{3(1/4)} \cdot 3^{2(1/4)}$ $3^{3/4} \cdot 3^{2/4} = 3^{5/4}$</p>	<p>3. $16^{2/3} \cdot 8^{1/2}$ $2^{4(2/3)} \cdot 2^{3(1/2)}$ $2^{8/3} \cdot 2^{3/2} = 2^{25/6}$</p>	<p>4. $36^{1/2} \cdot 216^{1/2}$ $6^{2(1/2)} \cdot 6^{3(1/2)}$ $6^{5/2}$</p>
<p>5. $5^3 \cdot 25^2$</p>	<p>6. $3^3 \cdot 9$</p>	<p>7. $27^{1/4} \cdot 3^{1/4}$</p>	<p>8. $36^{1/2} \cdot 6^4$</p>
<p>9. $\left(\frac{125}{64}\right)^{-1/3}$ $\frac{4}{5}$</p>	<p>10. $\left(\frac{w^3}{32w}\right)^{2/5}$ $\frac{\sqrt[5]{w^4}}{4}$</p>	<p>11. $\left(\frac{y^5}{y^{1/2} \cdot y^{3/4}}\right)$ $y^3 \cdot \sqrt[4]{y^3}$</p>	<p>12. $\left(\frac{16c^{-8}d^3}{c^4d^5}\right)^{1/2}$ $\frac{4}{c^6d}$</p>
<p>13. $\sqrt{\frac{40x^2}{x^{10}}}$ $\frac{2\sqrt{10}}{x^4}$</p>	<p>14. $\sqrt{\frac{25}{y^{12}}}$ $\frac{5}{y^6}$</p>	<p>15. $\sqrt[4]{\frac{162d^{21}}{2d^2}}$ $3d^4 \sqrt[4]{d^3}$</p>	<p>16. $7\sqrt{3} - \sqrt{12}$ $5\sqrt{3}$</p>
<p>17. $2\sqrt{63} - 11\sqrt{28} + 5\sqrt{21}$ $6\sqrt{7} - 22\sqrt{7} + 5\sqrt{21}$ $-16\sqrt{7} + 5\sqrt{21}$</p>	<p>18. $15xy\sqrt{9xy} - \sqrt{9x^5y^5}$ $14xy\sqrt{9xy}$</p>	<p>19. $(81x^{8/3}y^4)^{3/4}$ $27x^2y^3$</p>	<p>20. $(4ab^3)^{3/2}$ $8ab^4\sqrt{ab}$</p>
<p>21. $\left(\frac{a^{12}b^5}{27b^2}\right)^{-1/3}$ $\frac{3}{a^4b}$</p>	<p>22. $\sqrt[5]{x^{20}} \cdot \sqrt[4]{x^{12}}$ x^7</p>	<p>23. $\sqrt[3]{\sqrt{x^4}}$ $\sqrt[3]{x^2}$</p>	<p>24. $\sqrt[3]{25} \cdot \sqrt[6]{25}$ $25^{1/3} \cdot 25^{1/6} = 25^{2/6} \cdot 25^{1/6} = 25^{3/6} = 25^{1/2} = \sqrt{25} = 5$</p>
<p>25. $a^{2/3}b^{9/6}c^{3/2}$ $bc\sqrt[6]{a^4b^3c^3}$</p>	<p>26. $\frac{\sqrt[5]{y^{15}}}{\sqrt[3]{32y^8} \cdot \sqrt[2]{y^2}} = \frac{\sqrt[5]{y^{15}}}{\sqrt[3]{32y^{10}}}$ $\frac{y}{2}$</p>	<p>27. $\left(\frac{125x^{1/3}y}{64x^{10/3}y^4}\right)^{-1/3}$ $\frac{4xy}{5}$</p>	<p>28. $\left(\frac{\sqrt{x^5}}{\sqrt{4x}}\right)^{1/2} = \left(\frac{\sqrt{x^4}}{\sqrt{4}}\right)^{1/2}$ $= \left(\frac{x^2}{2}\right)^{1/2}$ $= \frac{x}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$</p>

$\sqrt{\frac{x\sqrt{2}}{2}} \cdot 6$