

# 6.1 Roots and Radical Expressions

Warm-Up	Perfect Squares: $1, 4, 9, 16, 25, 36, 49, 64, 81, 100 \dots$																			
	Perfect Cubes: $1, 8, 27, 64, 125, \overset{216}{\cancel{108}}, 343, 512, 729, 1000 \dots$																			
	Perfect Fourths: $1, 16, 81, 256, 625, \overset{1296}{\cancel{136}}, 2401, 4096, 6561, 10000 \dots$																			
Parts of a Radical	<p>The <b>n</b>th root of a real number, <b>a</b>, can be written as the radical expression <math>\sqrt[n]{a}</math></p> <p><b>**If there is no index, it is assumed that the index is two (square root)</b></p>																			
Number of Roots	<p><b>Give ALL POSSIBLE ROOTS to the radicals below</b></p> <p> <math>\sqrt{16} = \pm 4</math>      <math>\sqrt{121} = \pm 11</math>      <math>\sqrt[4]{289} = \pm 7</math>      <math>\sqrt{\frac{4}{25}} = \pm \frac{2}{5}</math>  <math>\sqrt[3]{8} = 2</math>      <math>\sqrt[3]{343} = 7</math>      <math>\sqrt[3]{-125} = -5</math>      <math>\sqrt[3]{-\frac{1}{27}} = -\frac{1}{3}</math>  <math>\sqrt{1} = \pm 1</math>      <math>\sqrt[4]{2401} = \pm 7</math>      <math>\sqrt[4]{4096} = \pm 8</math>      <math>\sqrt[4]{\frac{81}{16}} = \pm \frac{3}{2}</math> </p>																			
	<table border="1"> <thead> <tr> <th>Index</th> <th>Radicand</th> <th>Type of Roots</th> <th># of Roots</th> </tr> </thead> <tbody> <tr> <td>Even</td> <td>Positive</td> <td>real</td> <td>2 (<math>\pm</math>)</td> </tr> <tr> <td>Odd</td> <td>Positive</td> <td>real</td> <td>1 (+)</td> </tr> <tr> <td>Odd</td> <td>Negative</td> <td>real</td> <td>1 (-)</td> </tr> <tr> <td>*Even</td> <td>Negative</td> <td>imaginary</td> <td>2 (<math>\pm</math>)</td> </tr> </tbody> </table>	Index	Radicand	Type of Roots	# of Roots	Even	Positive	real	2 ( $\pm$ )	Odd	Positive	real	1 (+)	Odd	Negative	real	1 (-)	*Even	Negative	imaginary
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Simplifying Radicals	<p><b>*If a radical has more than one root, the radical sign indicates only the principal or positive root.</b></p> <p>1. <math>\sqrt{117}</math>  <math>\sqrt{9} \sqrt{13}</math>  <math>3\sqrt{13}</math></p>																			
	<p>2. <math>4\sqrt{320}</math>  <math>4 \sqrt{64} \sqrt{5}</math>  <math>4 \cdot 8 \sqrt{5}</math>  <math>32\sqrt{5}</math></p>																			

$$3. 2\sqrt[3]{48}$$

$$2 \sqrt[3]{8} \sqrt[3]{6}$$

$$2 \cdot 2 \sqrt[3]{6}$$

$$4 \sqrt[3]{6}$$

$$4. 6\sqrt[3]{-2}$$

$$6 \sqrt[3]{-1} \sqrt[3]{2}$$

$$6 \cdot -1 \sqrt[3]{2}$$

$$-6 \sqrt[3]{2}$$

$$5. 3\sqrt[3]{162}$$

$$3 \sqrt[3]{81} \sqrt[3]{2}$$

$$3 \cdot 3 \sqrt[3]{2}$$

$$9 \sqrt[3]{2}$$

$$6. 5\sqrt[3]{2592}$$

$$5 \sqrt[3]{1296} \sqrt[3]{2}$$

$$5 \cdot 6 \sqrt[3]{2}$$

$$30 \sqrt[3]{2}$$

**Square Roots**  
Exponents must be multiples of 2

**Cube Roots**  
Exponents must be multiples of 3

**4<sup>th</sup> Roots**  
Exponents must be multiples of 4

$$7. \sqrt{32x^4y^9}$$

$$\sqrt{16 \cdot 2}$$

$$4x^2y^4 \sqrt{2y}$$

$$8. \sqrt[3]{321a^3b^7}$$

$$\sqrt[3]{3 \cdot 1a^3b^6} \sqrt{ab}$$

$$\sqrt[3]{3} ab^2 \sqrt{ab}$$

$$9. \sqrt[3]{216m^3n^6}$$

$$8mn^2$$

$$10. \sqrt[3]{56r^8s^4}$$

$$\sqrt[3]{8r^6s^3} \sqrt[3]{7r^2s}$$

$$2r^2s \sqrt[3]{7r^2s}$$

**Radicals with Variables**

$$11. \sqrt[3]{-64x^{10}y^{21}}$$

$$\sqrt[3]{-64x^9y^{21}} \sqrt[3]{x}$$

$$-4x^3y^7 \sqrt[3]{x}$$

$$12. \sqrt[3]{-81p^2q^{12}}$$

$$\sqrt[3]{-27q^{12}} \sqrt[3]{3p^2}$$

$$-3q^4 \sqrt[3]{3p^2}$$

$$13. \sqrt[4]{w^4v^{17}}$$

$$\sqrt[4]{w^4v^{16}} \sqrt[4]{v}$$

$$wv^4 \sqrt[4]{v}$$

$$14. \sqrt[4]{48m^8n^3}$$

$$\sqrt[4]{16m^8} \sqrt[4]{3n^3}$$

$$2m^2 \sqrt[4]{3n^3}$$

$$15. \sqrt[4]{625c^{20}d^{11}}$$

$$\sqrt[4]{625c^{20}d^8} \sqrt[4]{c^3d^3}$$

$$5c^5d^2 \sqrt[4]{c^3d^3}$$

$$16. \sqrt[4]{(y+3)^8}$$

$$(y+3)^2$$

$$y^2+6y+9$$