Simplifying Square Roots and Cube Roots

<table>
<tr><th colspan="2">Square Roots</th><th colspan="2">Cube Roots</th></tr>
<tr><td colspan="2">We know:
$\sqrt{4}=2,$ since $2^2=4$ and $\sqrt{9}=3,$ since $3^2=9.$
We also know that $\sqrt{8}$ won't come out to a whole number, but we can simplify it using $\sqrt{4}$ (because it comes out to a whole number) in the following way:
$\sqrt{8}=\sqrt{4\cdot 2}$
$=\sqrt{4}\sqrt{2}$
$=\ 2\sqrt{2}$
We use this same principle (with other perfect square numbers) in order to simplify other square roots. Here are some other examples:</td><td colspan="2">We know:
$\sqrt[3]{8}=2,$ since $2^3=8$ and $\sqrt[3]{27}=3,$ since $3^3=27.$
We also know that $\sqrt[3]{16}$ won't come out to a whole number, but we can simplify it using $\sqrt[3]{8}$ (because it comes out to a whole number) in the following way:
$\sqrt[3]{16}=\sqrt[3]{8\cdot 2}$
$=\sqrt[3]{8}\sqrt[3]{2}$
$=\ 2\sqrt[3]{2}$
We use this same principle (with other perfect cube numbers) in order to simplify other cube roots. Here are some other examples:</td></tr>
<tr><td>$\sqrt{20}=\sqrt{4\cdot 5}$
$=\sqrt{4}\sqrt{5}$
$=\ 2\sqrt{5}$</td><td>$\sqrt{18}=\sqrt{9\cdot 2}$
$=\sqrt{9}\sqrt{2}$
$=\ 3\sqrt{2}$</td><td>$\sqrt[3]{32}=\sqrt[3]{8\cdot 4}$
$=\sqrt[3]{8}\sqrt[3]{4}$
$=\ 2\sqrt[3]{4}$</td><td>$\sqrt[3]{54}=\sqrt[3]{27\cdot 2}$
$=\sqrt[3]{27}\sqrt[3]{2}$
$=\ 3\sqrt[3]{2}$</td></tr>
<tr><td>$\sqrt{12}=\sqrt{4\cdot 3}$
$=\sqrt{4}\sqrt{3}$
$=\ 2\sqrt{3}$</td><td>$\sqrt{45}=\sqrt{9\cdot 5}$
$=\sqrt{9}\sqrt{5}$
$=\ 3\sqrt{5}$</td><td>$\sqrt[3]{40}=\sqrt[3]{8\cdot 5}$
$=\sqrt[3]{8}\sqrt[3]{5}$
$=\ 2\sqrt[3]{5}$</td><td>$\sqrt[3]{81}=\sqrt[3]{27\cdot 3}$
$=\sqrt[3]{27}\sqrt[3]{3}$
$=\ 3\sqrt[3]{3}$</td></tr>
<tr><td>$\sqrt{40}=\sqrt{4\cdot 10}$
$=\sqrt{4}\sqrt{10}$
$=\ 2\sqrt{10}$</td><td>$\sqrt{27}=\sqrt{9\cdot 3}$
$=\sqrt{9}\sqrt{3}$
$=\ 3\sqrt{3}$</td><td>$\sqrt[3]{48}=\sqrt[3]{8\cdot 6}$
$=\sqrt[3]{8}\sqrt[3]{6}$
$=\ 2\sqrt[3]{6}$</td><td>$\sqrt[3]{135}=\sqrt[3]{27\cdot 5}$
$=\sqrt[3]{27}\sqrt[3]{5}$
$=\ 3\sqrt[3]{5}$</td></tr>
<tr><td>$\sqrt{88}=\sqrt{4\cdot 22}$
$=\sqrt{4}\sqrt{22}$
$=\ 2\sqrt{22}$</td><td>$\sqrt{99}=\sqrt{9\cdot 11}$
$=\sqrt{9}\sqrt{11}$
$=\ 3\sqrt{11}$</td><td>$\sqrt[3]{88}=\sqrt[3]{8\cdot 11}$
$=\sqrt[3]{8}\sqrt[3]{11}$
$=\ 2\sqrt[3]{11}$</td><td>$\sqrt[3]{297}=\sqrt[3]{27\cdot 11}$
$=\sqrt[3]{27}\sqrt[3]{11}$
$=\ 3\sqrt[3]{11}$</td></tr>
<tr><td>$\sqrt{32}=\sqrt{16\cdot 2}$
$=\sqrt{16}\sqrt{2}$
$=\ 4\sqrt{2}$</td><td>$\sqrt{50}=\sqrt{25\cdot 2}$
$=\sqrt{25}\sqrt{2}$
$=\ 5\sqrt{2}$</td><td>$\sqrt[3]{250}=\sqrt[3]{125\cdot 2}$
$=\sqrt[3]{125}\sqrt[3]{2}$
$=\ 5\sqrt[3]{3}$</td><td>$\sqrt[3]{128}=\sqrt[3]{64\cdot 2}$
$=\sqrt[3]{64}\sqrt[3]{2}$
$=\ 4\sqrt[3]{2}$</td></tr>
<tr><td>$\sqrt{605}=\sqrt{121\cdot 5}$
$=\sqrt{121}\sqrt{5}$
$=\ 11\sqrt{5}$</td><td>$\sqrt{432}=\sqrt{144\cdot 3}$
$=\sqrt{144}\sqrt{3}$
$=\ 12\sqrt{3}$</td><td>$\sqrt[3]{625}=\sqrt[3]{125\cdot 5}$
$=\sqrt[3]{125}\sqrt[3]{5}$
$=\ 5\sqrt[3]{5}$</td><td>$\sqrt[3]{768}=\sqrt[3]{64\cdot 12}$
$=\sqrt[3]{64}\sqrt[3]{12}$
$=\ 4\sqrt[3]{12}$</td></tr>
</table>

For radicals with an index higher than three, it can be helpful to write down a short list of integers raised to the power of the index you are trying to simplify. For example when dealing with a fourth root:

$2^4=16,\ 3^4=81,\ 4^4=256,\ 5^4=625,\ \ldots$