Simplify the following radicals:
1. $\sqrt{125}$
2. $\sqrt{54}$
3. $\sqrt{80}$

**Simplifying Radicals with Coefficients**

When we put a coefficient in front of the radical, we are *multiplying* it by our answer after we simplify.

If we take Warm up question #1 and put a 6 in front of it, it looks like this:

\[
6 \sqrt{125} \\
\downarrow \\
6 \cdot \sqrt{25} \sqrt{5} \\
\downarrow \\
6 \cdot 5 \sqrt{5} \\
\downarrow \\
30 \sqrt{5}
\]

We keep bringing down each piece and multiply at the end.

1. $2 \sqrt{18}$
2. $-4 \sqrt{12}$
3. $6 \sqrt{72}$
Examples

1. $\frac{1}{2}\sqrt{20}$  
2. $10\sqrt{32}$  
3. $-2\sqrt{48}$

4. $-\sqrt{44}$  
5. $3\sqrt{13}$  
6. $5\sqrt{500}$

Practice

7. $3\sqrt{250}$  
8. $-5\sqrt{24}$  
9. $\frac{4}{5}\sqrt{50}$

10. $3\sqrt{27}$  
11. $-\sqrt{45}$  
12. $12\sqrt{60}$
Adding / Subtracting Radicals

1) Simplify $\sqrt{50}$

2) Simplify $\sqrt{90}$

Important Points to know:
- Make sure the radicals are in ___________ _______ before you add or subtract.
- In order to add or subtract radicals, the number inside the radicals must be the ________. This is called the ____________.
- When the radicands are the same, then, you can add or subtract only the numbers in ________ of the radicals (______________). The radicands are treated kind of like variables.

Already-Simplified Radicals:

Example 1: $\sqrt{2} + \sqrt{2}$

$x + x$

$1\sqrt{2} + 1\sqrt{2}$

$1x + 1x$

$= 2\sqrt{2}$

$= 2x$

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

Example 3: $6\sqrt{5} - 4\sqrt{5}$

Practice

1) $7\sqrt{6} + 2\sqrt{6}$

2) $\sqrt{13} + 5\sqrt{13}$

3) $4\sqrt{11} - \sqrt{11}$

4) $2\sqrt{3} - 6\sqrt{3}$

5) $-10\sqrt{2} + 3\sqrt{2}$

6) $-8\sqrt{15} - 9\sqrt{15}$

NOTE:
- These numbers can be “added” because the radicands are the same.
- However, only the numbers in front, which are 1’s, are added. Nothing happens to the $\sqrt{2}$. It is almost like an $x$.
Un-Simplified Radicals:

When the radicals are NOT in simplified form, we must use the method learned the last couple of days to simplify them!

Example 4: $\sqrt{3} + \sqrt{27}$

\[
\begin{align*}
\sqrt{3} + \sqrt{27} & = \\
\sqrt{3} + \sqrt{9 \sqrt{3}} & = \\
\sqrt{3} + 3\sqrt{3} & =
\end{align*}
\]

NOTE: The $\sqrt{3}$ is simplified already, but the $\sqrt{27}$ must still be simplified.

Example 5: $4\sqrt{2} + 3\sqrt{50}$

Example 6: $3\sqrt{20} - 2\sqrt{5}$

Practice

1) $2\sqrt{3} + 4\sqrt{12}$
2) $3\sqrt{5} - 2\sqrt{45}$
3) $7\sqrt{5} - \sqrt{15}$

4) Find the perimeter of a rectangle whose length is $3\sqrt{5}$ and width is $2\sqrt{7}$. [Draw a picture!]
Perform the indicated operation (Add or Subtract):

1) \( \sqrt{3} + 8\sqrt{3} \)  
2) \( 3\sqrt{5} - 7\sqrt{5} \)  
3) \( \sqrt{11} - \sqrt{11} \)

4) The sum of \( \sqrt{12} \) and \( 5\sqrt{3} \) is?  
5) Find the difference of \( 12\sqrt{11} \) and \( \sqrt{44} \).

6) Simplify: \( \sqrt{200} - 3\sqrt{2} \)  
7) Express the sum of \( \sqrt{18} + 5\sqrt{2} \) in simplest radical form.

8) \( 5\sqrt{3} + \sqrt{27} \)  
9) \( 5\sqrt{3} + 2\sqrt{3} - 6\sqrt{3} \)

10) Find the **perimeter** of a rectangle whose length is \( 4\sqrt{5} \) and width is \( 3\sqrt{7} \).  
    [Draw a picture!]
Adding/Subtracting Radicals continued

1) $\sqrt{3} + 2\sqrt{3}$

2) $\sqrt{18} + \sqrt{24}$

Sometimes we need to simplify more that one radical in order to be able to add or subtract them.

**Example 1:**

$\sqrt{18} + \sqrt{32}$

$\sqrt{9} \sqrt{2} + \sqrt{16} \sqrt{2}$

$3 \sqrt{2} + 4 \sqrt{2}$  We have the same radicands so we can perform addition!

**Example 2:**

$\sqrt{48} - \sqrt{27}$

**Example 3:**

$2\sqrt{80} + \sqrt{45}$

We need to simplify both terms to see if we have the same radicands!!

Let’s do some example that might *not* have the same radicands in the end.

**Example 4:**

$\sqrt{32} - \sqrt{54}$

**Example 5:**

$\sqrt{72} + 3\sqrt{20}$
More Examples:

1. \(\sqrt{12} + \sqrt{108}\) 
2. \(-\sqrt{24} - \sqrt{96}\) 
3. \(2\sqrt{8} + \sqrt{27}\)

Practice:
Simplify the following expressions.

1. \(9\sqrt{50}\) 
2. \(\sqrt{28} + \sqrt{63}\) 
3. \(4\sqrt{14} - 6\sqrt{14}\)

4. \(\sqrt{7} + \sqrt{175}\) 
5. \(\frac{1}{2}\sqrt{40}\) 
6. \(\sqrt{80} - \sqrt{20}\)

7. \(\sqrt{27} + \sqrt{32}\) 
8. \(4\sqrt{22}\)
1. $\sqrt{18} + \sqrt{50}$  
2. $-\sqrt{80} - \sqrt{45}$  
3. $-\sqrt{8} + \sqrt{32}$  

4. $11\sqrt{45}$  
5. $\sqrt{50} + \sqrt{98}$  
6. $9\sqrt{7} + 6\sqrt{7}$  

7. $\sqrt{5} + \sqrt{125}$  
8. $\frac{1}{4}\sqrt{32}$  
9. $\sqrt{24} - \sqrt{54}$  

10. $\sqrt{32} + \sqrt{75}$  
11. $-8\sqrt{13}$  

12. Find the **perimeter** of a rectangle whose length is $3\sqrt{10}$ and width is $4\sqrt{2}$.  
[Draw a picture!]