You should know perfect squares when you see them.

$\sqrt{4} =$ ______	$\sqrt{121} =$ ______	$\sqrt{9} =$ ______	$\sqrt{36} =$ ______
$\sqrt{64} =$ ______	$\sqrt{144} =$ ______	$\sqrt{25} =$ ______	$\sqrt{100} =$ ______
$\sqrt{1} =$ ______	$\sqrt{225} =$ ______	$\sqrt{81} =$ ______	$\sqrt{256} =$ ______
$\sqrt{49} =$ ______	$\sqrt{16} =$ ______	$\sqrt{169} =$ ______	$\sqrt{196} =$ ______

Example 1: $\sqrt{3} \bullet \sqrt{7} = \sqrt{3 \bullet 7} = \boxed{\sqrt{\mathbf{21}}}$

Example 2: $\sqrt{5} \bullet \sqrt{11} = \sqrt{5 \bullet 11} = \boxed{\sqrt{\mathbf{55}}}$

YOU #1: $\sqrt{2} \bullet \sqrt{13} =$ ________

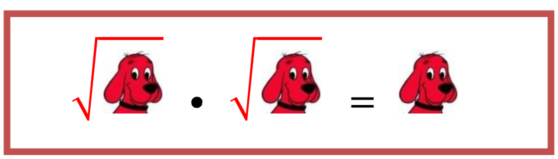
YOU #2: $\sqrt{6} \bullet \sqrt{7} =$ ________

YOU #3: $\sqrt{3} \bullet \sqrt{5} =$ ________

Example 3: $\sqrt{3} \bullet \sqrt{3} = \sqrt{9} = \boxed{\mathbf{3}}$

Example 4: $\sqrt{7} \bullet \sqrt{7} = \sqrt{49} = \boxed{\mathbf{7}}$

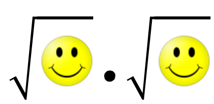
DO YOU SEE A PATTERN? We can cut out the middle step, because…



YOU #4: $\sqrt{5} \bullet \sqrt{5} =$ ________

YOU #5: $\sqrt{101} \bullet \sqrt{101} =$ ________

YOU #6: $\sqrt{3248} \bullet \sqrt{3248} =$ ________

YOU #7:  = ________

To simplify a radical, you must factor out all perfect squares.

Square Roots – Product Property

$$\sqrt{a \bullet b} = \sqrt{a} \bullet \sqrt{b}$$

<u>Example 5:</u> $\sqrt{18} = \sqrt{9} \bullet \sqrt{2} = \boxed{\mathbf{3\sqrt{2}}}$

perfect sqaure

<u>Example 6:</u> $\sqrt{72} = \sqrt{36} \bullet \sqrt{2} = \boxed{\mathbf{6\sqrt{2}}}$

perfect sqaure

Remember that you are looking for **perfect square factors**. For instance, in Example 5, you might notice that the number 6 goes into 18, but in square root land, no one cares about 6 because it isn't a perfect square! You care about 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, etc.

YOU #8: $\sqrt{27} = \sqrt{\quad} \bullet \sqrt{\quad} =$ ______

YOU #9: $\sqrt{98} = \sqrt{\quad} \bullet \sqrt{\quad} =$ ______

YOU #10: $\sqrt{128} =$ __________

YOU #11: $\sqrt{24} =$ __________

YOU #12: $\sqrt{300} =$ __________

YOU #13: $\sqrt{128} =$ __________

YOU #14: $\sqrt{75} =$ __________

YOU #15: $\sqrt{12} =$ __________

<u>Example 7:</u> $5\sqrt{32} = 5 \bullet \sqrt{16} \bullet \sqrt{2} = 5 \bullet 4\sqrt{2} = \boxed{\mathbf{20\sqrt{2}}}$

YOU #16: $7\sqrt{8} =$ __________

YOU #17: $6\sqrt{50} =$ __________

YOU #18: $9\sqrt{40} =$ __________

YOU #19: $3\sqrt{48} =$ __________

Example 8: $(5\sqrt{6})^2 = 5\sqrt{6} \bullet 5\sqrt{6} = 25 \bullet 6 = \boxed{\mathbf{150}}$

YOU #20: $(2\sqrt{3})^2 =$ ________

YOU #21: $(7\sqrt{10})^2 =$ ________

YOU #22: $(6\sqrt{2})^2 =$ ________

YOU #23: $(4\sqrt{8})^2 =$ ________

Square Roots – Quotient Property

$$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$$

Example 9: $\sqrt{\frac{8}{9}}$

Use the quotient property to "split" the radical into two radicals.

$$\sqrt{\frac{8}{9}} = \frac{\sqrt{8}}{\sqrt{9}} = \frac{\sqrt{4}\bullet\sqrt{2}}{3} = \boxed{\frac{\mathbf{2\sqrt{2}}}{\mathbf{3}}}$$

YOU #24: $\sqrt{\frac{25}{4}} =$ ________

YOU #25: $\sqrt{\frac{80}{49}} =$ ________

YOU #26: $\sqrt{\frac{14}{200}} =$ ________

(TIP: Reduce inside fraction first)

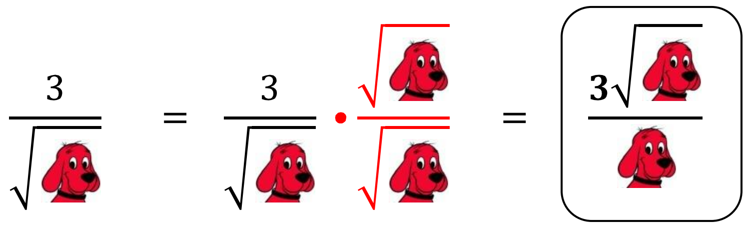
YOU #27: $\frac{8\sqrt{3}}{2\sqrt{12}} =$ ________

(TIP: Outsides can reduce each other; insides can reduce each other)

A radical (square root) is completely simplified when…

1. There are no perfect squares in the $\sqrt{}$ - see Examples 5 & 6
2. There are no fractions in the $\sqrt{}$ - see Example 9
3. There are no $\sqrt{}$ in the denominator of a fraction – let's look at eliminating $\sqrt{}$ in the denominators of a fractions

The general procedure looks like this…



Example 10: Simplify $\sqrt{\frac{5}{24}}$

$$\sqrt{\frac{5}{24}} = \frac{\sqrt{5}}{\sqrt{24}} = \frac{\sqrt{5}}{\sqrt{4}\bullet\sqrt{6}} = \frac{\sqrt{5}}{2\sqrt{6}} = \frac{\sqrt{5}}{2\sqrt{6}} \bullet \frac{\sqrt{6}}{\sqrt{6}} = \frac{\sqrt{30}}{2\bullet 6} = \boxed{\frac{\sqrt{30}}{12}}$$

Easier if you take care of perfect squares first

Multiply top and bottom by the same thing (then it's like multiplying by 1!)

YOU #28: $\frac{\sqrt{7}}{\sqrt{3}} =$ __________

YOU #29: $\frac{\sqrt{12}}{\sqrt{10}} =$ __________
(TIP: Can you reduce first?)

YOU #30: $\sqrt{\frac{11}{32}} =$ __________

YOU #31: $\frac{9}{\sqrt{5}} =$ __________

You probably learned about the Pythagorean Theorem in an Algebra class. This chapter is about right triangles, so we will see it again. Let's review how to solve equations in the form

$$\square^2 + \square^2 = x^2 \quad \text{or} \quad x^2 + \square^2 = \square^2 \; .$$

Step 1 – Get x^2 by itself on one side of the equation and combine like terms
Step 2 – Take the square root of both sides of the equation
Step 3 – Simplify the resulting radical. We will only consider the positive solution (don't use $\pm$) as distance is never negative in geometry.

Example 11: Solve for x $\quad 3^2 + 6^2 = x^2$

Step 1 – Get x^2 by itself on one side of the equation and combine like terms

$$3^2 + 6^2 = x^2$$
$$9 + 36 = x^2$$
$$45 = x^2$$

Step 2 – Take the square root of both sides of the equation

$$45 = x^2$$
$$\sqrt{45} = \sqrt{x^2}$$

Step 3 – Simplify the resulting radical. We will only consider the positive solution (don't use $\pm$) as distance is never negative in geometry.

$$\sqrt{9} \bullet \sqrt{5} = x$$

$$\boxed{\mathbf{3\sqrt{5} = x}}$$

Solve for x:

YOU #32: $2^2 + 4^2 = x^2$ $\quad x =$ ______

YOU #33: $5^2 + 10^2 = x^2$ $\quad x =$ ______

YOU #34: $3^2 + 4^2 = x^2$ $\quad x =$ ______

YOU #35: $6^2 + 7^2 = x^2$ $\quad x =$ ______

<u>Example 12</u>: Solve for x $x^2 + 6^2 = 8^2$

Step 1 – Get x^2 by itself on one side of the equation and combine like terms

$$x^2 + 6^2 = 8^2$$
$$x^2 = 8^2 - 6^2$$
$$x^2 = 64 - 36$$
$$x^2 = 28$$

Step 2 – Take the square root of both sides of the equation

$$x^2 = 28$$
$$\sqrt{x^2} = \sqrt{28}$$

Step 3 – Simplify the resulting radical. We will only consider the positive solution (don't use $\pm$) as distance is never negative in geometry.

$$x = \sqrt{4} \bullet \sqrt{7}$$

$$\boxed{\boldsymbol{x = 2\sqrt{7}}}$$

Solve for x:

YOU #36: $x^2 + 3^2 = 4^2$ $x =$ ______

YOU #37: $5^2 + x^2 = 13^2$ $x =$ ______

YOU #38: $x^2 + 5^2 = 10^2$ $x =$ ______

YOU #39: $4^2 + x^2 = (4\sqrt{3})^2$ $x =$ ______