Recall: The simplest quadratic relation is  $y = x^2$ 

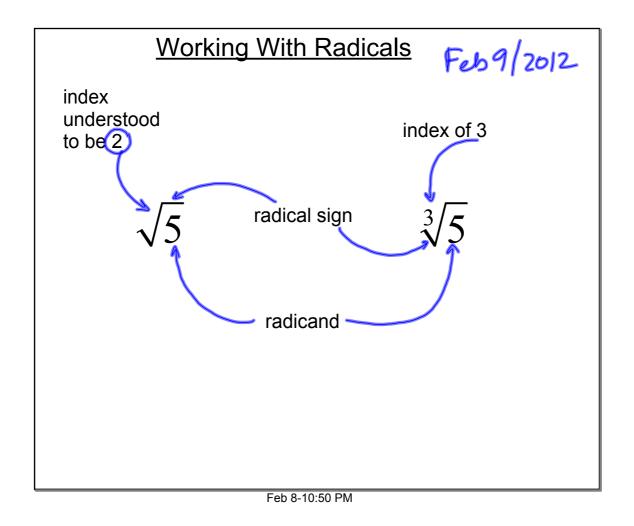
On rearranging, it is possible to get answers in the form  $x = \pm \sqrt{y}$ 

With actual values, we might see results such as

$$\sqrt{5}$$
  $3\sqrt{2}$   $\frac{\sqrt{3}}{2}$ 

It is often required to keep answers in this exact form.

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### Multiplying & Dividing Radicals

In general, 
$$\sqrt{a} \times \sqrt{b} = \sqrt{ab}$$

and 
$$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$$
 where  $b \neq 0$ 

Ex.1
(a) 
$$\sqrt{27}$$
(b)  $\sqrt{\frac{16}{9}}$ 
(a)  $\sqrt{3}$  (9)
$$= \sqrt{3} \cdot 9$$

$$= \sqrt{27}$$

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# **Simplifying Radicals**

A radical is in its simplest form when:

- the radicand has no perfect square factors (other than 1)

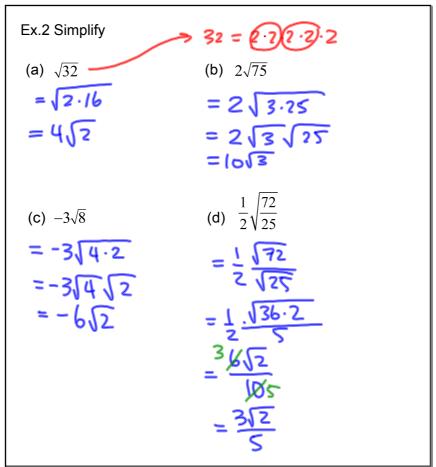
$$\sqrt{8} = \sqrt{4}\sqrt{2} = 2\sqrt{2}$$

- the radicand contains no fractions

$$\sqrt{\frac{1}{4}} = \frac{1}{2}$$

- no radical appears in the denominator

$$\frac{2}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$$



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Homework:

#### **Adding & Subtracting Radicals**

To add or subtract radicals, they must have the same <u>radicand</u>. It is advisable to simplify radicals to ensure all like terms (same radicand) are revealed.

Ex.3 Simplify

(a) 
$$4\sqrt{3} - 2\sqrt{5} + 6\sqrt{3} + 5\sqrt{5}$$
  $4x - 2y + 6x + 5y$   
=  $10\sqrt{3} + 3\sqrt{5}$  =  $10x + 3y$ 

(b) 
$$2\sqrt{12} - 5\sqrt{27} + 3\sqrt{48}$$
  
=  $2\sqrt{4 \cdot 3} - 5\sqrt{9 \cdot 3} + 3\sqrt{16 \cdot 3}$   
=  $4\sqrt{3} - 15\sqrt{3} + 12\sqrt{3}$   
=  $\sqrt{3}$ 

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# **Binomial Multiplication of Radicals**

Recall: 
$$(a+b)(c+d) = ac + ad + bc + bd$$

## Ex.4 Expand & Simplify

$$(3\sqrt{5}+2)(2\sqrt{5}-3)$$
=  $(3\sqrt{5}+2)(2\sqrt{5}) + (3\sqrt{5})(-3) + (2)(2\sqrt{5}) + (2)(-3)$ 
=  $6\sqrt{25} - 9\sqrt{5} + 4\sqrt{5} - 6$ 
=  $30 - 9\sqrt{5} + 4\sqrt{5} - 6$ 
=  $24 - 5\sqrt{5}$ 

#### Rationalizing the Denominator

A radical is not permitted in the denominator. If the denominator is a binomial, multiply by the <u>conjugate</u> of the denominator.

Given  $a\sqrt{b} + c\sqrt{d}$ , the conjugate would be  $a\sqrt{b} - c\sqrt{d}$ Given  $a\sqrt{b} - c\sqrt{d}$ , the conjugate would be  $a\sqrt{b} + c\sqrt{d}$ 

### Ex.5 Find the conjugate of each radical

(a) 
$$\sqrt{5} - \sqrt{2}$$

(b) 
$$3\sqrt{5} + 2\sqrt{10}$$

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Ex.6 Rationalize the denominator

$$\frac{4\sqrt{3}-2\sqrt{2}}{\sqrt{3}-\sqrt{2}} \times \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}+\sqrt{2}} = \exp (a)$$

$$= (4/3)(3) + (4/3)(2) + (-2/2)(3) + (-2/2)(2)$$

$$= (4/3)(3) + (4/3)(2) + (-5/2)(3) + (-5/2)(2)$$

$$= 4/9 + 4/6 - 2/6 - 2/4$$

$$= 9/4 + 2/6 - 4$$

$$= 8/4 + 2/6$$

$$= 8/4 + 2/6$$

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$$P.139 #7$$
(j)  $(2\sqrt{7}+\sqrt{5})$   $(3\sqrt{7}+2\sqrt{5})$ 

$$= \frac{6(7)+4\sqrt{35}+3\sqrt{35}+2(5)}{9(7)+6\sqrt{35}-6\sqrt{35}-4(5)}$$