Check-Up Time... $\Rightarrow 4 \quad 9 \quad \underline{16} \quad 25 \quad 36 \quad 49 \quad 64 \quad 81 \quad 100 \quad 121 \quad 144$

$\Rightarrow 8 \quad 27 \quad 64 \quad 125$

$2^4 = 16$

$3^4 = 81$

1. Express each of the following as a MIXED radical in SIMPLEST form:

$(a)\sqrt{48}$

$\sqrt{16 \times 3}$

$\sqrt{16} \times \sqrt{3}$

$4\sqrt{3}$

$(b)\sqrt[3]{24}$

$\sqrt[3]{8} \times \sqrt[3]{3}$

$2\sqrt[3]{3}$

$(c)\sqrt[3]{-81}$

$\sqrt[3]{-27} \cdot \sqrt[3]{3}$

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

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

$(d)5\sqrt[4]{162}$

$5 \times \sqrt[4]{81} \times \sqrt[4]{2}$

$5 \times 3 \times \sqrt[4]{2}$

$15\sqrt[4]{2}$

2. Express each of the following as an ENTIRE radical:

$(a)3\sqrt{5}$

$= \sqrt{3^2 \cdot 5}$

$\sqrt{45}$

$(b)-4\sqrt{3}$

$-\sqrt{4^2 \cdot 3}$

$-\sqrt{48}$ ✓

$\cancel{\sqrt{-48}}$

$\cancel{\sqrt{48}}$

$(c)2\sqrt[3]{9}$

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

$\sqrt[3]{72}$

$(d)2\sqrt[5]{27}$

$\sqrt[5]{2^5 \cdot 27}$

$\sqrt[5]{864}$

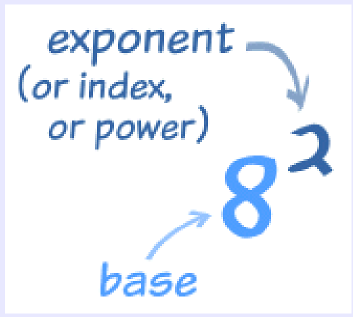
How am I doing so far???

- Shall we find out...

Summative Review
Page 221

#1, 3, 4, 7, 9, 11

Laws of Exponents



The exponent of a number says **how many times to multiply** the number.

In this example: $\mathbf{8^2 = 8 \times 8 = 64}$

- In words: 8^2 could be called "8 to the second power", "8 to the power 2" or simply "8 squared"

Product Law:

The law that $x^m x^n = x^{m+n}$

With $x^m x^n$, how many times will you end up multiplying "x"? *Answer:* first "m" times, then **by another** "n" times, for a total of "m+n" times.

Example: $\mathbf{x^2x^3 = (xx) \times (xxx) = xxxxx = x^5}$

So, $x^2x^3 = x^{(2+3)} = x^5$

The multiplication law states that when multiplying two powers with the same base we add the exponents.

$$3^2 \cdot 3^{10} = 3^{12}$$

$$\cancel{9^{12}}$$

$$(y^3)(y^2) = y^5$$

These have the same base.

$$(y^3)(y^2) = y^5$$

The five comes from the addition of three and two... (2 + 3 = 5)

Why Add?

$$(y \cdot y \cdot y) \cdot (y \cdot y) = y^5$$

1. Simplify the following using the multiplication law.

a. $(x^2)(x^3)$

$= x^5$

b. $(2x^4)(3x^2)$

$= 6x^6$

c. $(-2x^2)(4x^3)(2x^4)$

$= -16x^9$

Quotient Law:

The law that $x^m/x^n = x^{m-n}$

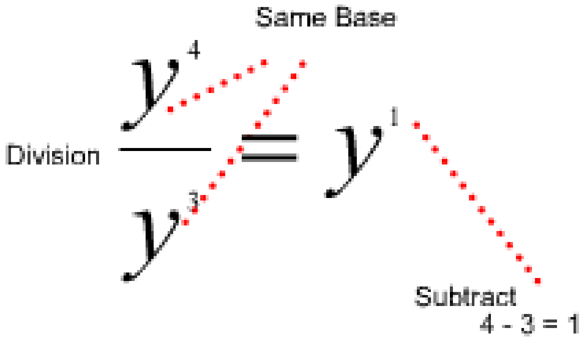
Like the previous example, how many times will you end up multiplying "x"? Answer: "m" times, then **reduce that** by "n" times (because you are dividing), for a total of "m-n" times.

Example: $x^{4-2} = x^4/x^2 = (xxxx) / (xx) = xx = x^2$

(Remember that x/x = 1, so every time you see an x "above the line" and one "below the line" you can cancel them out.)

The division law states that when dividing powers with the same base we subtract the exponents.

$$\frac{\cancel{y}\cdot\cancel{y}\cdot\cancel{y}\cdot\boxed{y}}{\cancel{y}\cdot\cancel{y}\cdot\cancel{y}}$$



Why does this work?

$$\frac{12^{16}}{12^8} = 12^8 \qquad \frac{12^5}{12^7} = 12^{-2}$$

$$\frac{12^{13}}{12^7} = 12^6 \qquad \frac{14^7}{14^3} = 14^4 \qquad \frac{12^4}{12^2} = 12^2$$

$$\frac{\cancel{12 \times 12} \times 12 \times 12}{\cancel{12 \times 12}} = 12^2$$

2. Simplify each of the following using the division law.

a. $\dfrac{x^8}{x^5}$ $= x^3$

b. $\dfrac{y^7}{y^9}$ $= y^{-2}$

c. $\dfrac{15x^5}{3x^2}$ $= 5x^3$

d. $\dfrac{100x^{13}}{25x^7}$ $= 4x^6$

What about these?

$\dfrac{15m^9}{4m^3}$

$= 3.75m^6$

OR

$= \dfrac{15}{4}m^6$

$\dfrac{(4x^3)(3x^4)}{4x^2}$

$= \dfrac{12x^7}{4x^2}$

$= 3x^5$

$\dfrac{24a^{10}b^6}{4a^2b^{12}}$

$= 6a^8b^{-6}$

Power Law of Exponents

The power of a power rule states that when a power is placed to an exponent we multiply the two exponents.

Exponent

$$(y^3)^2 = y^3 \cdot y^3 = y^6$$

Power

$$(x^{10})^7 = x^{20}$$

$$(y^3)^2 = y^6$$

Multiply 3 x 2 = 6

Why does this work?

$$(2^4)^5 = 2^{20}$$