Name: _____ Date: _____

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Exponents Teaching Tips:

- This lesson on the properties of exponents is designed to help students think and explore exponents in a way that will {hopefully} make sense to them and help them remember these useful properties.
- This lesson only covers a handful of properties, so that is may be used in a middle or high school setting.
- Before you start the investigation, be sure to remind students that exponents are a way to denote **repeated multiplication**, a fact that they will need to use to complete the lesson. Depending on the age of your students, you may need to review exponents before starting.
- As students work through the problems, they will likely have no trouble with the math and seeing patterns, but encourage them to try to express their ideas in their own words. This will help them "talk it out" in a way that makes sense to them and will help them remember.
- Remind students that (as in the examples) the goal is not to find the "answer" (i.e. $3^2 = 9$) but to look for the patterns in the exponents.
- At the end of each page, students are asked to write a "math rule" using what they have discovered. Even if they cannot correctly or precisely write the property using "math symbols," encourage them to try. It's important that they begin to see the connection between the pattern they observed, how it was expressed in words and then how it can be expressed in a mathematical way, especially if they are beginning algebra students.
- Be sure that students note that the first two properties only apply when the **base is the same**. Have them work out a similar example with different bases so they can see why it is no longer true.
- At the end of the lesson I have included a reference page where all the properties (and space for examples) are on one handy, useful piece of paper. If you would like you students to have this as a reference, do not give it out until the lesson has been completed and discussed, so that students can wrestle with the properties and come to their own ideas and conclusions first.

Best of Luck! ☺

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Understanding Exponent "Rules"

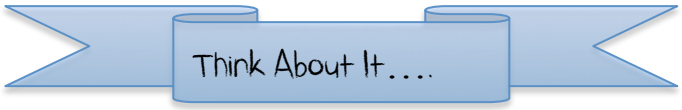
Work through the following problems using what you *already* know about exponents, then try to generalize your observations into a math "rule" that is always true.

1. Write each of the following in expanded form, then simplify using a single exponent:

Ex. $5^2 \times 5^6 = (5 \times 5) \times (5 \times 5 \times 5 \times 5 \times 5 \times 5) = \mathbf{5^8}$

Now You Try:

A. $10^3 \times 10^4 =$ **B**. $(-2)^4 \times (-2)^4 =$ **C**. $(\frac{1}{4})^3 \times (\frac{1}{4})^7 =$



- What do you notice about the **base** in each of the problems above?

  _____

- What do you notice about the **solution** to each of the problems above?

  _____

- Use what you have learned to write a "rule" for **multiplying exponents**:

  _____

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2. Write the numerator and denominator of each of the following in expanded form. Then simplify each and rewrite using a single exponent:

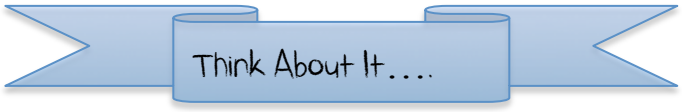
Ex. $\frac{4^5}{4^2} = \frac{4\times4\times4\times4\times4}{4\times4} = \frac{4^3}{1} = \mathbf{4^3}$

Now You Try:

A. $\frac{6^8}{6^3} =$

B. $\frac{15^6}{15^2} =$

C. $\frac{(-8)^7}{(-8)^5} =$



- What do you notice about the **base** in each of the problems above?

  _____

- What do you notice about the **solution** to each of the problems above?

  _____

- Use what you have learned to write a "rule" for **dividing exponents**:

  _____

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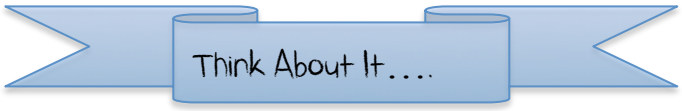
3. Write each of the following in expanded form, then simplify using what you have learned about exponents and rewrite using a single exponent:

Ex. $(3^2)^3 = (3^2) \times (3^2) \times (3^2) = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6$

Now You Try:

A. $(5^3)^4 =$ **B**. $(-8^2)^6 =$ **C**. $(x^5)^5 =$



- How would you describe the **use of exponents** in the above problems? How are they different than the problems you looked at in #2?

  _____

- What do you notice about the **solution** to each of the problems above?

  _____

- Use what you have learned to write a new "rule" for **exponents**:

  _____

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4. Write each of the following in **expanded** form and simplify:

$$\textbf{Ex}.\ \frac{5^6}{5^6} = \frac{5\times5\times5\times5\times5\times5}{5\times5\times5\times5\times5\times5} = \frac{1}{1} = 1$$

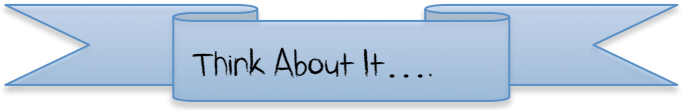
Now You Try:

A. $\frac{3^2}{3^2} =$ **B.** $\frac{(-4)^8}{(-4)^8} =$ **C.** $\frac{x^4}{x^4} =$

Now apply the rule you learned about **dividing** with exponents to simplify each of the following using a single exponent:

$$\textbf{Ex}.\ \frac{5^6}{5^6} = 5^{6-6} = 5^0$$

A. $\frac{3^2}{3^2} =$ **B.** $\frac{(-4)^8}{(-4)^8} =$ **C.** $\frac{x^4}{x^4} =$



- Based on what you observed in the problems above, what can you conclude about raising something to the "zero" power?

  _____

- What can you do to solve a problem if you do not remember this property?

  _____

- Use what you have learned to write a new "rule" for **zero exponents**:

  _____

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Properties of Exponents Reference Guide:

Exponents are a way to write _____ _____.

Property:	Example:
1. $a^m \cdot a^n =$	
2. $\frac{a^m}{a^n} =$	
3. $(a^m)^n =$	
4. $a^0 =$	

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Understanding Exponent "Rules"

Work through the following problems using what you *already* know about exponents, then try to generalize your observations into a math "rule" that is always true.

1. Write each of the following in expanded form, then simplify using a single exponent:

Ex. $5^2 \times 5^6 = (5 \times 5) \times (5 \times 5 \times 5 \times 5 \times 5 \times 5) = \mathbf{5^8}$

Now You Try:

A. $10^3 \times 10^4 =$

10^7

B. $(-2)^4 \times (-2)^4 =$

$(-2)^6$

C. $(\frac{1}{4})^3 \times (\frac{1}{4})^7 =$

$(\frac{1}{4})^{10}$

Think About It....

- What do you notice about the **base** in each of the problems above?

  _____The base is always the same_____

- What do you notice about the **solution** to each of the problems above?

  _____The solution is the sum of the exponents_____

- Use what you have learned to write a "rule" for **multiplying exponents**:

  _____$a^m \times a^n = a^{m+n}$_____

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2. Write the numerator and denominator of each of the following in expanded form. Then simplify each and rewrite using a single exponent:

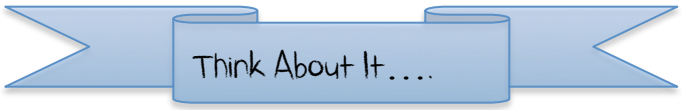
Ex. $\frac{4^5}{4^2} = \frac{4\times4\times4\times4\times4}{4\times4} = \frac{4^3}{1} = 4^3$

Now You Try:

A. $\frac{6^8}{6^3} =$ 6^5

B. $\frac{15^6}{15^2} =$ 15^4

C. $\frac{(-8)^7}{(-8)^5} =$ $(-8)^2$



- What do you notice about the **base** in each of the problems above?

  _____ The base is always the same _____

- What do you notice about the **solution** to each of the problems above?

  _____The exponent is the difference between the exponents____

- Use what you have learned to write a "rule" for **dividing with exponents**:

  _____ $\frac{a^m}{a^n} = a^{m-n}$ _____

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3. Write each of the following in expanded form, then simplify using what you have learned about exponents and rewrite using a single exponent:

Ex. $(3^2)^3 = (3^2) \times (3^2) \times (3^2) = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6$

Now You Try:

A. $(5^3)^4 =$

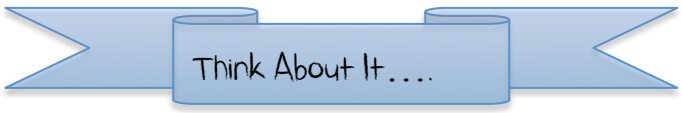
5^{12}

B. $(-8^2)^6 =$

$(-8)^{12}$

C. $(x^5)^5 =$

x^{25}



- How would you describe the **use of exponents** in the above problems? How are they different than the problems you looked at in #2?

  _____A power to a power, There's only one base, etc._____

- What do you notice about the **solution** to each of the problems above?

  _____The exponent is the product of the exponents_____

- Use what you have learned to write a new "rule" for **exponents**:

  _____$(a^m)^n = a^{m \times n}$_____

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4. Write each of the following in **expanded** form and simplify:

$$\textbf{Ex.}\ \frac{5^6}{5^6} = \frac{5\times5\times5\times5\times5\times5}{5\times5\times5\times5\times5\times5} = \frac{1}{1} = 1$$

Now You Try:

A. $\frac{3^2}{3^2} =$ 1

B. $\frac{(-4)^8}{(-4)^8} =$ 1

C. $\frac{x^4}{x^4} =$ 1

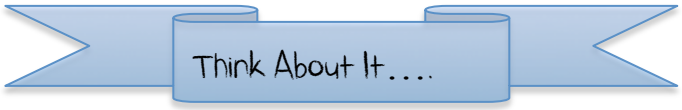
Now apply the rule you learned about **dividing** with exponents to simplify each of the following using a single exponent:

$$\textbf{Ex.}\ \frac{5^6}{5^6} = 5^{6-6} = 5^0$$

A. $\frac{3^2}{3^2} =$ 3^0

B. $\frac{(-4)^8}{(-4)^8} =$ $(-4)^0$

C. $\frac{x^4}{x^4} =$ x^0



- Based on what you observed in the problems above, what can you conclude about raising something to the "zero" power?

  _____The answer is always 1_____

- What can you do to solve a problem if you do not remember this property?

  _____Set up a division example that gives the exponent 0_____

- Use what you have learned to write a new "rule" for **zero exponents**:

  _____$a^0 = 1$_____