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Study Guide: Rules of Exponents

	Description	Example
Multiplying Exponents	Add exponents with the same base	$x^8 \cdot x^6 = x^{14}$ $3^2 \cdot 3^5 = 3^7$ (3 is the base)
	Multiply any coefficient terms	$3x^4 \cdot 5x^9 = 15x^{13}$
Raising a Power to a Power	Multiply the exponents	$(x^3)^5 = x^{15}$ $(2x^4)^3 = 2^3 \cdot x^{3\cdot4} = 8x^{12}$
Dividing Exponents	Subtract the exponents with the same base	$\frac{x^{11}}{x^7} = x^4$
	Divide any coefficient terms	$\frac{18x^8}{3x^2} = 6x^6$
Raising a factor to a Power	Raise the numerator and the denominator to the power	$\left(\frac{3x}{5}\right)^3 = \frac{(3x)^3}{5^3} = \frac{27x^3}{125}$
Negative Exponents	When a number is raised to a negative exponent, change the sign of the exponent and use the reciprocal.	$x^{-4} = \frac{1}{x^4}$ $\frac{1}{x^{-5}} = x^5$
Zero as an Exponent	Any number raised to the 0 power equals 1.	$4^0 = 1$ $(3x)^0 = 1$

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INSTRUCTIONS: Complete the problems below and submit prior to our assessment—September 7, 2016. Consult notes and handouts if you get stuck from the first few weeks of school…or come find me.

1. Write an equivalent expression that is the product of unique prime numbers, each raised to an integer power

a. $\frac{15^9 \times 6^{12}}{4^6 \times 9^{10}}$ $= \frac{3^9 \times 5^9 \times 3^{12} \times 2^{12}}{2^6 \times 2^6 \times 3^{10} \times 3^{10}}$ $= \frac{3^{21} \times 5^9 \times 2^{12}}{3^{20} \times 2^{12}}$ $= 3 \times 5^9$	b. $\frac{6^7 \times 8^5}{3^6 \times 2^{22}}$ $= \frac{2^7 \times 3^7 \times 2^5 \times 2^5 \times 2^5}{3^6 \times 2^{22}}$ $= \frac{3^7 \times 2^{22}}{3^6 \times 2^{22}}$ $= 3$
c. $\frac{(3a^2)^6(6b^2)^3}{4 \times (9a^3b)^4}$ $= \frac{3^6(a^2)^6 \times 6^3(b^2)^3}{2^2 \times (3^2)^4(a^3)^4b^4}$ $= \frac{3^6 \times a^{12} \times 2^3 \times 3^3 \times b^6}{2^2 \times 3^8 \times a^{12} \times b^4}$ $= \frac{3^9 \times 2^3 \times a^{12} \times b^6}{3^8 \times 2^2 \times a^{12} \times b^4}$ $= 3 \times 2 \times b^2$ $= 6b^2$	d. $\frac{729 \times 24^7}{4^5 \times 18^6}$ $= \frac{3^6 \times 3^7 \times 2^7 \times 2^7 \times 2^7}{2^5 \times 2^5 \times 2^6 \times 3^6 \times 3^6}$ $= \frac{3^{13} \times 2^{21}}{3^{12} \times 2^{16}}$ $= 3 \times 2^5$

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2. Are these equations true? If you think the equation is true, simplify the left of the equation to match the right side. If you think the equation is false, explain what error you THINK might have been made, and change the right side of the equation to make the equation true.

a. $3^6 \times 9^4 = 27^{10}$ This is NOT a true equation. I think the person messed up by multiplying the bases AND adding the exponents…that's not the right thing to do. $3^6 \times 9^4$ would simplify to $3^6 \times (3 \times 3)^4$ which would equal 3^{14}. Or you could also say this equals 9^7.	b. $4^4 \times 8^4 = 2^{20}$ This is a true equation. Here's one way to simplify the left side of the equation: $4^4 \times 8^4$ $= (2^2)^4 \times (2^3)^4$ $= 2^8 \times 2^{12}$ $= 2^{20}$
c. $3^7 \times 2^8 = 2 \times 6^{14}$ This is NOT a true equation. One possible mistake someone could have made was to split up the 2^8 into 2^7 and 2, and then multiply the different bases with the same exponents AND add the exponents. It looks like $3^7 \times 2^8$ is as simplified as you can get, but if you'd like, you could rewrite as 2×6^7.	d. $8^{-3} \times 6^9 \times 3^9 = 9^9$ This is a true equation, if you can believe it. Let's look at the left side of the equation… $8^{-3} \times 6^9 \times 3^9$ $= (2^3)^{-3} \times 2^9 \times 3^9 \times 3^9$ $= 2^{-9} \times 2^9 \times 3^{18}$ $= 3^{2 \times 9}$ $= (3^2)^9$ $= 9^9$

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Answer the following questions and show your work.

Eloise received $1 for allowance and decided she would invest it in the stock market. Incredibly, after one year, her investment doubled, and she had $2 in her account. Another year went by and he money again doubled to $4. After the third year of investing, she AGAIN doubled her money and had $8. If this continues (however improbable it might be), how many years will it take for Eloise to become a millionaire?

I'm going to make a table to see what patterns emerge…

Years passed (t)	0	1	2	3	4	5
Dollars saved (D)	1	2	4	8	16	32

It looks like this is an example of exponential growth….with the equation being $D = 2^t$. After 10 years, Eloise will have 2^{10} dollars, or $1,024. After 18 years, Eloise will have 2^{18} dollars, or $262,144. A lot of money, but still not enough. After 19 years, she will have $524,288…and finally, after 20 years, that initial one dollar will turn into $1,048,576. Eloise will be a millionaire. Yay for Eloise!

Scientists have been conducting ant censuses every 10 years and have reported the following population counts:

Year *(t)*	1980	1990	2000	2010
Ants *(a)*(in billions)	1	4	16	64

a. If this trend continues, how many ants will be counted in 2020? What about 2030?
In 2020, there will 256 billion ants, and in 2030, there will be 1.024 trillion ants.

b. Let's say the growth trend existed before the first recorded ant count in 1980. How many ants would have been counted in 1970?
In 1970, there would have been $\frac{1}{4}$ billion ants (or 250 million)

c. How many ants would have been counted in 1960?
In 1960, there would have been $\frac{1}{16}$ billion, or 62.5 million ants.

d. How many ants would have been counted in 1950?
In 1950, there would have been $\frac{1}{64}$ billion, or 15,625,000 ants.

e. Can you write an equation to model the population growth. Use a for the ant population and t for the year, with 1980 being the year that $t = 0$. Also, assume that 1990 is when $t = 1$, and so on.
$a = 4^t$ where a is the number of ants in the billions and t is time in decades.