Secondary I – Unit 8 Linear vs Exponential Name _____

Day 1 Notes: Properties of Exponents

m ← Exponent (operation)
Superscript
a ← Base
s ← (Subscript Name)

Product of Powers Property

Complete the table below.

Expression	E·X·P·A·N·D·E·D Form	Exponential Form
$3^2 \cdot 3^5$	$3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$	3^7
$2^1 \cdot 2^6$	$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$	2^7
$b^5 \cdot b^8$	$b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b$	b^{13}

1. Look at the table above. Compare the first and third column. Describe, using words, the relationship that you see between them.

$-4^2 \stackrel{?}{\neq} (-4)^2$

$-16 \neq 16$

$$a^m \cdot a^n = a^{m+n}$$

2. Use your observations from above to fill in a generalized form:
3. The rule you discovered is called the "**product of powers**." Use it to simplify the expressions below.
   a. $2^6 \cdot 2^8$ b. $(-7)^3 \cdot (-7)^1 \cdot (-7)^5$ c. $m^7 \cdot m^4 \cdot m^6$

$2^{6+8} = 2^{14}$ $(-7)^{3+1+5} = (-7)^9$ m^{7+4+6} m^{17}

Power of a Power Property

Complete the table below.

Expression	E·X·P·A·N·D·E·D Form	Exponential Form
$(5^2)^3$	$5^2 \cdot 5^2 \cdot 5^2$	5^6
$(8^5)^2$	$8^5 \cdot 8^5$	8^{10}
$(x^3)^4$	$x^3 \cdot x^3 \cdot x^3 \cdot x^3$	x^{12}

4. Look at the table above. Compare the first and third column. Describe, using words, the relationship that you see between them.

5. Use your observations from above to fill in a generalized form:

$$(a^m)^n = a^{m \cdot n}$$

6. The rule you discovered is called the "**power of a power**." Use it to simplify the expressions below.
   a. $(7^4)^9$ b. $(k^{17})^2$ c. $(w^{100})^5$

$7^{4 \cdot 9} = 7^{36}$ $k^{17 \cdot 2} = k^{34}$ w^{500}

Quotient of Powers Property

Complete the table below.

Expression	E·X·P·A·N·D·E·D Form	Exponential Form
$\frac{6^9}{6^4}$	$\frac{6\cdot6\cdot6\cdot6\cdot6\cdot6\cdot6\cdot6\cdot6}{6\cdot6\cdot6\cdot6}$	6^5
$\frac{100^5}{100^2}$	$\frac{100\cdot100\cdot100\cdot100\cdot100}{100\cdot100}$	100^3
$\frac{t^{15}}{t^8}$		t^7

7. Look at the table above. Compare the first and third column. Describe, using words, the relationship that you see between them.

8. Use your observations from above to fill in a generalized form:

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

9. The rule you discovered is called the "**quotient of powers.**" Use it to simplify the expressions below.

a. $\frac{16^7}{16^3}$ $16^{7-3} = 16^4$

b. $\frac{w^{25}}{w^{10}}$ w^{25-10} w^{15}

c. $\frac{4^3\cdot4^7}{4^5} = \frac{4^{10}}{4^5}$ $= 4^5$

Zero Powers Property

Complete the table below.

Expression	E·X·P·A·N·D·E·D Form	Answer
5^4	$5\cdot5\cdot5\cdot5$	$625/5$
5^3	$5\cdot5\cdot5$	$125/5$
5^2	$5\cdot5$	$25/5$
5^1	5	$5/5$
5^0		1

10. Look at the table above. What is the pattern in the third column? Describe, using words, how that pattern helps you find 5^0?

Expression	E·X·P·A·N·D·E·D Form	Answer
3^4	$3 \cdot 3 \cdot 3 \cdot 3$	81
3^3	$3 \cdot 3 \cdot 3$	27
3^2	$3 \cdot 3$	9
3^1	3	3
3^0		1

11. Use your observations from above to fill in a generalized form:

$$a^0 = 1$$

12. The rule you discovered is called the "**zero power property**." Use it to simplify the expressions below.

a. $(x^1 \cdot x^2 \cdot x^9)^0$ $(x^{12})^0 = x^{12 \cdot 0} = x^0 = 1$

b. $\left(\frac{3^4}{3^0}\right)^2$ $(3^{4-0})^2 = (3^4)^2 = 3^8$

c. $(128{,}917{,}654^5)^0$ 1

Negative Powers Property

Complete the table below.

Expression	E·X·P·A·N·D·E·D Form	Answer
4^2	$4 \cdot 4$	16
4^1	4	4
4^0		1
4^{-1}		$\frac{1}{4}$
4^{-2}		$\frac{1}{16}$
4^{-3}		$\frac{1}{64}$

multiply by 4 ↑ ↓ Divide by 4

13. In order to work up in exponents, you are increasing the number of times that you are _____ the number (or variable).
If you are decreasing the exponent (the exponent is getting more negative) then you are Smaller by the number (or variable).

$\frac{x^3}{x^{-2}} = x^{3+2} = x^5$

14. Use your observations from above to fill in a generalized form:

$$\frac{a^{-m}}{1} = \frac{1}{a^m} \qquad \frac{1}{a^{-m}} = \frac{a^m}{1} = a^m$$

15. The rule you discovered is called the "**negative power property**." Use it to simplify the expressions below.

a. $\frac{y^{-5}}{1} = \frac{1}{y^5}$

b. $(x^2)^{-5}$ $x^{2 \cdot -5} = x^{-10} = \frac{1}{x^{10}}$

c. $\left(\frac{z^0}{z^2 \cdot z^4}\right)^{-2}$ $\left(\frac{1}{z^6}\right)^{-2} = \frac{1^{-2}}{z^{-12}} = \frac{1}{z^{-12}} = z^{12}$