Part 1 - Product of Powers (Multiplication Rule)

The first law of exponents deals with multiplying powers. What happens when you multiply powers with the same base? Look for a pattern as you fill in the chart below. Use a calculator to evaluate each example, before and after you simplify it.

Example	Evaluate	Write in Expanded Form	Rewrite using Exponents	Evaluate
$2^3 \cdot 2^4$	$=8 \cdot 16$ $=128$	$2\times2\times2\times2\times2\times2\times2$	2^7	128
$3^4 \cdot 3^1$	$=81 \cdot 3$ $=243$	$3\times3\times3\times3\times3$	3^5	243
$5^4 \cdot 5^5$	$=625 \cdot 3125$ $=1953125$	$5\times5\times5\times5\times5\times5\times5\times5\times5$	5^9	1953125
$7^2 \cdot 7^3$	$=49 \cdot 343$ $=16807$	$7\times7\times7\times7\times7$	7^5	16807
$(-2)^2 \cdot (-2)^3$	$=4 \cdot -8$ $=-32$	$(-2)(-2)(-2)(-2)(-2)$	$(-2)^5$	-32
$0.5^3 \cdot 0.5^2$	$=0.125\times0.25$ $=0.03125$	$(0.5)(0.5)(0.5)(0.5)(0.5)$	$(0.5)^5$	0.03125
$\left(\frac{1}{2}\right)^3 \cdot \left(\frac{1}{2}\right)^4$	$=0.125\times0.0625$ $=0.0078125$	$\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$	$\left(\frac{1}{2}\right)^7$	$=0.0078125$
$x^m \cdot x^n$			x^{m+n}	

What patterns did you notice as you filled in the chart? What "shortcut" could you use for multiplying powers with the same base?

When powers with the same base multiplied, you can keep the base and add the exponents.

e.x. $4^7 \times 4^{-3} = 4^{7+(-3)} = 4^{7-3} = 4^4 = 256$

power

Part 2 - Quotient of Powers (Division Rule)

The second law of exponents deals with dividing powers. What happens when you divide powers with the same base? Look for a pattern as you fill in the chart below. Use a calculator to evaluate each example, before and after you simplify it.

Example	Evaluate	Write in Expanded Form	Rewrite using Exponents	Evaluate
$\frac{2^6}{2^4}$	$\frac{64}{16}=4$	$\frac{\cancel{2}\times\cancel{2}\times\cancel{2}\times\cancel{2}\times 2\times 2}{\cancel{2}\times\cancel{2}\times\cancel{2}\times\cancel{2}}$	2^2	4
$\frac{5^7}{5^2}$	$\frac{78125}{25}$ $=3125$	$\frac{\cancel{5}\times\cancel{5}\times 5\times 5\times 5\times 5\times 5}{\cancel{5}\times\cancel{5}}$	5^5	3125
$\frac{8^4}{8^2}$	$\frac{4096}{64}$ $=64$	$\frac{\cancel{8}\times\cancel{8}\times 8\times 8}{\cancel{8}\times\cancel{8}}$	8^2	64
$\frac{7^8}{7^3}$	$\frac{5764801}{343}$ $=16807$	$\frac{\cancel{7}\times\cancel{7}\times\cancel{7}\times 7\times 7\times 7\times 7\times 7}{\cancel{7}\times\cancel{7}\times\cancel{7}}$	7^5	16807
$\frac{(-2)^9}{(-2)^3}$	$\frac{-512}{-8}$ $=64$	$\frac{\cancel{(-2)}\cancel{(-2)}\cancel{(-2)}(-2)(-2)(-2)(-2)(-2)(-2)}{\cancel{(-2)}\cancel{(-2)}\cancel{(-2)}}$	$(-2)^6$	64
$3^6 \div 3^1$	$\frac{729}{3}$ $=243$	$\frac{\cancel{3}\times 3\times 3\times 3\times 3\times 3}{\cancel{3}}$	3^5	243
$\frac{x^m}{x^n}$			x^{m-n}	

What patterns did you notice as you filled in the chart? What "shortcut" could you use for dividing powers with the same base?

I noticed that when you subtract the exponents then evaluate, you get the same answer as evaluating in the evaluation column.

Part 3 - Power of a Power

The next law of exponents deals with raising a power to a power. What happens when you raise a power to another power? Look for a pattern as you fill in the chart below.

Example	Write in Expanded Form	Rewrite Using Exponents
$(2^3)^2$	$(2^3)(2^3) = (2\cdot2\cdot2)(2\cdot2\cdot2)$	2^6
$(3^2)^4$	$(3^2)(3^2)(3^2)(3^2)$	$3^{2+2+2+2}$ $= 3^8$ repeated addition
$(5^4)^3$	$(5^4)(5^4)(5^4)(5^4)$	5^{12}
$(7^2)^2$	$(7^2)(7^2)$	7^4
$\left[\left(\frac{1}{2}\right)^2\right]^5$	$\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^2$	$\left(\frac{1}{2}\right)^{10}$
$(x^m)^n$		$x^{m\cdot n}$

1. What patterns did you notice as you filled in the chart?

When you write exponent in expanded form, it turns into multiplication of powers with the same base.

2. How do you think you can use these patterns to make an inference about the rule for raising a power to a power? Explain your thinking.

I can multiply the exponents

MULTIPLYING POWERS	DIVIDING POWERS	POWER of a POWER
When finding the **product** of powers with the **same base** , keep the base add exponents $a^m . a^n = a^{m+n}$	When finding the **quotient** of powers with the **same base,** keep the base subtract exponents $\frac{a^m}{a^n} = a^{m-n}$	When you **raise a power to a power,** keep the base and multiply the exponents $(a^m)^n = a^{m\cdot n}$

Practice: Exponent Rules

Simplify, but do not evaluate

a. $8^3 \times 8^6$

$= 8^{3+6}$
$= 8^9$

b. $y^3 \times y^4 \times y$

$= y^{3+4+1}$
$= y^8$

c. $(-6)^2 \times (-6)^4$

$= (-6)^{2+4}$
$= (-6)^6$

d. $2^3 \times 4^2 \times 4 \times 2^5$

$= 2^{3+5} \times 4^{2+1}$
$= 2^8 \times 4^3$
$= 2^8 \times (2^2)^3$
$= 2^8 \times 2^6 = \boxed{2^{14}}$

e. $5^3 \div 5^2 \times 5^8$

$= 5^{3-2} \times 5^8$
$= 5^1 \times 5^8$
$= 5^{1+8}$
$= 5^9$

f. $8^4 \times 8^3 \div 8^5$

$= 8^{4+3} \div 8^5$
$= 8^7 \div 8^5$
$= 8^{7-5}$
$= \boxed{8^2}$

g. $\left(\frac{3}{2}\right)^2 \times \left(\frac{3}{2}\right)^5$

$= \left(\frac{3}{2}\right)^{2+5}$
$= \left(\frac{3}{2}\right)^7$

h. $\dfrac{2^2 \times 3^2 \times 2^4 \times 3}{2^5 \times 3}$

$= \dfrac{2^{2+4} \times 3^{2+1}}{2^5 \times 3}$
$= \dfrac{2^6 \times 3^3}{2^5 \times 3}$
$= 2^{6-5} \times 3^{3-1} = 2 \times 3^2$

i. $(5^2)^3$

$= (5^2)(5^2)(5^2)$
$= 5^{2+2+2}$
$= 5^6$

j. $(a^3 b)^2$

$= a^{3\times2} \cdot b^{1\times2}$
$= a^6 b^2$

k. $\dfrac{a^3 b^6}{ab^2}$

$= a^{3-1} \cdot b^{6-2}$
$= a^2 \cdot b^4$

l. $(m^2 n)^2$

$= m^{2\times2} \cdot n^{1\times2}$
$= m^4 n^2$

Find the missing exponent:

m. $10^6 \times 10^x = 10^{10}$

if $10^{6+x} = 10^{10}$
then $6+x = 10$
$x = 10-6$
$\boxed{x=4}$

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

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

o. $3^x \times 3^3 = 3^7$

if $3^{x+3} = 3^7$
then $x+3 = 7$
$x = 7-3$
$\boxed{x=4}$

p. $\dfrac{(-2)^8}{(-2)^x} = (-2)$

if $(-2)^{8-x} = (-2)^1$
then $8-x = 1$
$-x = 1-8$
$-x = -7$
$\boxed{x=7}$

ANSWERS: a) 8^9, b) y^8, c) $(-6)^6$, d) $2^8 x 4^3$, e) 5^9, f) 8^2, g) $(3/2)^7$, h) $2x3^2$, i) 5^6, j) a^6b^2, k) a^2b^4, l) m^4n^2,
m) x = 4, n) x = 5, o) x = 4, p) x = 7

Complete: p.114 #5; p.126 #1-8