Fill in the Table and look for any patterns

	Quotient of Powers	Expanded Form	Simplify: Write answer using a positive exponent	Rewrite with a negative exponent
a)	$\frac{5^2}{5^3}$	$\frac{5 \cdot 5}{5 \cdot 5 \cdot 5}$	$\frac{1}{5}$	$(5)^{-1}$
b)	$\frac{5^3}{5^2}$	$\frac{5 \cdot 5 \cdot 5}{5 \cdot 5}$	$\frac{5}{1} = 5$	$\frac{1}{5^{-1}}$ or $\left(\frac{1}{5}\right)^{-1}$
c)	$\frac{x^5}{x^2}$			
d)	$\frac{x^2}{x^5}$			
e)	$\frac{x^{23}}{x^{14}}$			
f)	$\frac{x^{14}}{x^{23}}$			
g)	$\frac{x^{94}}{x^{36}}$			
Rule:				

Quotient of Powers

Standards:

2.0 Understand and use the rules of exponents

10.0 Divide monomials. Solve multi-step problems, including word problems, by using this technique(Develop)

Objective: Today I will divide powers with the same base and raise a quotient to a power.

Lesson Opener:

Activity can be done as a class or students can fill in the chart in partners/groups.

Debrief:

"Did you notice any patterns?" [Answers will vary]

- same bases
- all had same coefficient
- Do not need to expand each expression. When you divide powers with the same base, subtract their exponents
- Negative exponent is the reciprocal of the base

to write using positive exponents:

- When there are more factors in the numerator than denominator: x^n n is positive
- When there are more factors in the denominator than numerator: $\frac{1}{x^n}$

Quotient of Powers Property: Dividing powers with the same base

For every non-zero number a and integers m and n

$$\frac{a^m}{a^n} = a^{m-n} \quad \text{where } a \neq 0$$

Ex 1) Simplify each expression.(write using positive exponents)

a)

$$\frac{4^4}{4} = \frac{4 \cdot 4 \cdot 4 \cdot 4}{4} = 4^3$$

$$\frac{4^4}{4} = 4^{4-1} = 4^3$$

b)

$$\frac{2^5}{2^6} = \frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2} = \frac{1}{2}$$

$$\frac{2^5}{2^6} = 2^{5-6} = 2^{-1} = \frac{1}{2}$$

c)

$$\frac{z^7}{z^3} = \frac{z \cdot z \cdot z \cdot z \cdot z \cdot z \cdot z}{z \cdot z \cdot z} = z^4$$

$$\frac{z^7}{z^3} = z^{7-3} = z^4$$

d)

$$\frac{x^4y^2}{x^2y^3} = \frac{x \cdot x \cdot x \cdot x \cdot y \cdot y}{x \cdot x \cdot y \cdot y \cdot y} = \frac{x^2}{y}$$

$$\frac{x^4y^2}{x^2y^3} = x^{4-2}y^{2-3} = x^2y^{-1} = \frac{x^2}{y}$$

You try!
Simplify

a) $\dfrac{x^3}{x^5}$

$= \dfrac{x \bullet x \bullet x}{x \bullet x \bullet x \bullet x \bullet x}$

$= \dfrac{1}{x^2}$

$\dfrac{x^3}{x^5}$

$= x^{3-5}$

$= x^{-2}$

$= \dfrac{1}{x^2}$

b) $\dfrac{3x^6}{x^3}$

$= \dfrac{3 \bullet x \bullet x \bullet x \bullet x \bullet x \bullet x}{x \bullet x \bullet x}$

$= 3x^3$

$\dfrac{3x^6}{x^3}$

$= 3x^{6-3}$

$= 3x^3$

Ex 2) Simplify

$\dfrac{3x^5 \bullet x^2}{6x^3}$

$= \dfrac{3 \bullet x \bullet x \bullet x \bullet x \bullet x \bullet x \bullet x}{2 \bullet 3 \bullet x \bullet x \bullet x}$

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

$\dfrac{3x^5 \bullet x^2}{6x^3}$

$= \dfrac{3x^{5+2}}{6x^3}$

$= \dfrac{3x^7}{2 \bullet 3 \bullet x^3}$

$= \dfrac{x^{7-3}}{2}$

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

You Try!
Simplify

a) $\dfrac{z^4 \bullet 10z^3}{z^2}$

$= \dfrac{10z^{4+3}}{z^2}$

$= 10z^{7-2}$

$= 10z^5$

$\dfrac{z^4 \bullet 10z^3}{z^2}$

$= z^4 \bullet 10z^{3-2}$

$= z^4 \bullet 10z^1$

$= 10z^{4+1}$

$= 10z^5$

b) $\dfrac{x \bullet 7x^5}{9x^4}$

$= \dfrac{7x^{5+1}}{9x^4}$

$= \dfrac{7x^6}{9x^4}$

$= \dfrac{7x^{6-4}}{9}$

$= \dfrac{7x^2}{9}$

$\dfrac{x \bullet 7x^5}{9x^4}$

$= \dfrac{x \bullet 7x^{5-4}}{9}$

$= \dfrac{x \bullet 7x}{9}$

$= \dfrac{7x^2}{9}$

Ex 3) Simplify by using repeated multiplication

a) $\left(\frac{x}{y}\right)^2$

$= \frac{x}{y} \bullet \frac{x}{y}$

$= \frac{x \bullet x}{y \bullet y}$

$= \frac{x^2}{y^2}$

b) $\left(\frac{a}{b}\right)^3$

$= \frac{a}{b} \bullet \frac{a}{b} \bullet \frac{a}{b}$

$= \frac{a \bullet a \bullet a}{b \bullet b \bullet b}$

$= \frac{a^3}{b^3}$

" Do you see a pattern? Another way of simplifying without using repeated addition?"
[Answers will vary]

Raising a quotient to a power property:
For every non-zero number *a* and *b* and integer *n*,

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}, \text{ where } b \neq 0$$

Note: Distribution is over addition/subtraction only. The exponent is **NOT** being distributed

You try!
Simplify

a) $\left(\frac{-3}{y}\right)^3$

$\left(\frac{-3}{y}\right)^3$

$= \frac{-3}{y} \bullet \frac{-3}{y} \bullet \frac{-3}{y}$

$= \frac{-3(-3)(-3)}{y^3}$

$= \frac{-27}{y^3}$

$\left(\frac{-3}{y}\right)^3$

$= \frac{(-3)^3}{y^3}$

$= \frac{-3(-3)(-3)}{y^3}$

$= \frac{-27}{y^3}$

b) $\left(\frac{2m}{n}\right)^4$

$\left(\frac{2m}{n}\right)^4$

$= \frac{2m}{n} \bullet \frac{2m}{n} \bullet \frac{2m}{n} \bullet \frac{2m}{n}$

$= \frac{2(2)(2)(2)m^4}{n^4}$

$= \frac{16m^4}{n^4}$

$\left(\frac{2m}{n}\right)^4$

$= \frac{2^4 m^4}{n^4}$

$= \frac{2(2)(2)(2)m^4}{n^4}$

$= \frac{16m^4}{n^4}$

Simplify. Write your answer using only positive exponents.

Ex 4) $\left(\frac{2m}{n}\right)^{-4}$ *Remind students that a negative exponent is the reciprocal of the base

$$\left(\frac{2m}{n}\right)^{-4}$$
$$=\left(\frac{n}{2m}\right)^{4}$$
$$=\frac{n}{2m}\cdot\frac{n}{2m}\cdot\frac{n}{2m}\cdot\frac{n}{2m}$$
$$=\frac{n^4}{2(2)(2)(2)m^4}$$
$$=\frac{n^4}{16m^4}$$

$$\left(\frac{2m}{n}\right)^{-4}$$
$$=\left(\frac{n}{2m}\right)^{4}$$
$$=\frac{n^4}{2^4m^4}$$
$$=\frac{n^4}{2(2)(2)(2)m^4}$$
$$=\frac{n^4}{16m^4}$$