

Division Properties of Exponents

Learning Target: I can simplify exponential expressions using the Quotient of Powers Property.

Fill in the table below and write down any patterns you see.

Expression	Expanded expression	Simplified expression
$\frac{x^5}{x^3}$	$\frac{\cancel{x \cdot x \cdot x \cdot x \cdot x}}{\cancel{x \cdot x \cdot x}} = x \cdot x$	x^2
$\frac{r^2}{r^8}$	$\frac{\cancel{r \cdot r}}{\cancel{r \cdot r \cdot r \cdot r \cdot r \cdot r \cdot r \cdot r}} = \frac{1}{r \cdot r \cdot r \cdot r \cdot r \cdot r}$	$= \frac{1}{r^6}$
$\frac{3^9 \cdot 3^2}{3^6}$	$\frac{\cancel{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3} \cdot 3 \cdot 3}{\cancel{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3}}$	3^5
$\frac{5^4}{5^7} \cdot x^2$	$\frac{\cancel{5 \cdot 5 \cdot 5 \cdot 5}}{\cancel{5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5}} \cdot \frac{x \cdot x}{1} = \frac{1}{5 \cdot 5 \cdot 5} \cdot x \cdot x$	$\frac{1}{5^3} \cdot x^2 = \frac{x^2}{5^3}$

Describe the pattern you see: Subtract the exponents when dividing

Quotient of Powers Property

$$\frac{a^m}{a^n} = a^{m-n}, \text{ which means:}$$

Subtract the exponents when dividing

Examples: Simplify the expression.

$$1. \frac{4^4}{4^2} = 4^{4-2} = 4^2 = 16$$

$$* 2. \frac{a^3}{a^{11}} = a^{3-11} = a^{-8} = \frac{1}{a^8}$$

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a · a · a · a · a · a · a · a · a · a

$$3. \frac{1}{y^4} \cdot y^{10} = \frac{y^{10}}{y^4} = y^{10-4} = y^6$$

$$4. \frac{x^2 \cdot x^4}{x^5} = \frac{x^6}{x^5} = x^{6-5} = x$$

$$5. \frac{1}{b^5} \cdot b^2 = \frac{b^2}{b^5} = b^{-3} = \frac{1}{b^3}$$

$$6. \frac{r^2}{r^5 \cdot r^4} = \frac{r^2}{r^9} = r^{2-9} = r^{-7} = \frac{1}{r^7}$$

$$(x^3)^3$$

Learning Target: I can simplify exponential expressions using the Power of a Quotient Property.

Fill in the table below and write down any patterns you see.

Expression	Expanded expression	Simplified expression
$\left(\frac{3}{4}\right)^3$	$\left(\frac{3}{4}\right)\left(\frac{3}{4}\right)\left(\frac{3}{4}\right)$	$\frac{3^3}{4^3}$
$\left(\frac{a}{b}\right)^4$	$\left(\frac{a}{b}\right)\left(\frac{a}{b}\right)\left(\frac{a}{b}\right)\left(\frac{a}{b}\right)$	$\frac{a^4}{b^4}$
$\left(\frac{2}{x^2}\right)^2$	$\left(\frac{2}{x^2}\right)\left(\frac{2}{x^2}\right)$	$\frac{2^2}{x^4}$
$\left(\frac{x}{y}\right)^5$	$\left(\frac{x}{y}\right)\left(\frac{x}{y}\right)\left(\frac{x}{y}\right)\left(\frac{x}{y}\right)\left(\frac{x}{y}\right)$	$\frac{x^5}{y^5}$

Describe the pattern you see: exponent goes on numerator + denominator

Power of a Quotient Property

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}, \text{ which means:}$$

exponent goes to both numerator + denominator

Examples: Simplify the expression.

$$7. \left(\frac{x}{y}\right)^4 = \frac{x^4}{y^4}$$

$$8. \left(\frac{a}{b^2}\right)^3 = \frac{a^3}{b^6}$$

$$9. \left(\frac{-4}{x}\right)^2 = \frac{(-4)^2}{x^2} = \frac{16}{x^2}$$

$$10. \left(\frac{x^3}{y}\right)^5 = \frac{x^{15}}{y^5}$$

$$11. \left(\frac{f^2}{g}\right)^5 = \frac{f^{10}}{g^5}$$

$$12. \left(\frac{-3}{n^4}\right)^3 = \frac{(-3)^3}{n^{12}} = \frac{-27}{n^{12}}$$

Learning Target: I can simplify exponential expressions any of the product or quotient properties.

Putting it all together...

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2/11

More Examples: Simplify the expression.

$$13. \left(\frac{4x^2}{5y}\right)^3 = \frac{4^3 x^6}{5^3 y^3}$$

$$\boxed{\frac{64 x^6}{125 y^3}}$$

$$14. \left(\frac{a^2}{b}\right)^5 \cdot \frac{1}{4a^2}$$

$$\frac{a^{10}}{b^5} \cdot \frac{1}{4a^2} = \frac{1a^{10}}{4a^2 b^5}$$

$$\frac{1 \cdot a^8}{4 b^5} = \boxed{\frac{a^8}{4b^5}}$$

$$15. \frac{3x^2y}{4x} \cdot \frac{12x^2y^2}{y^4}$$

$$\frac{36x^4y^3}{4x y^4} = \boxed{\frac{9x^3}{y}}$$

$$16. \left(\frac{3x^4}{y^6}\right)^5$$

$$\frac{3^5 x^{20}}{y^{30}} = \boxed{\frac{243 x^{20}}{y^{30}}}$$

$$17. \left(\frac{2m^5}{3n^9}\right)^5$$

$$\frac{2^5 m^{25}}{3^5 n^{45}} = \boxed{\frac{32 m^{25}}{243 n^{45}}}$$

$$18. \frac{5cd^3}{4c} \cdot \frac{16c^5d^3}{d^4}$$

$$\frac{80c^6d^6}{4c d^4} = \boxed{20c^5d^2}$$

$$19. (x^2)^5 \cdot \left(\frac{4x^2}{x^3y}\right)^3$$

$$\frac{x^{10} \cdot 4^3 x^6}{1 x^9 y^3} =$$

$$\frac{4^3 \cdot x^{16}}{x^9 y^3} =$$

$$\boxed{\frac{64 x^7}{y^3}}$$

$$20. \left(\frac{m^2}{n^4}\right)^3 \cdot \frac{1}{5m^2}$$

$$\frac{m^6}{n^{12}} \cdot \frac{1}{5m^2} =$$

$$\frac{m^6}{n^{12} \cdot 5m^2} =$$

$$\frac{1 m^4}{5 m^2 n^{12}} = \boxed{\frac{m^4}{5 n^{12}} = \frac{1 m^4}{5 n^{12}}}$$

$$21. \frac{3u^2v^4}{(2v)^3} \cdot \frac{24u^2v^2}{u^4}$$

$$\frac{72u^4v^6}{8u^4v^3} = 9v^3$$