

Practice

Rules and Examples

<p>Ex 1: $7a + -8a$ Ex 2: $9x + 2x - 5x^2 + x^2$ $(7+(-8))a = -1a$ Ex 3: $3x + 4y + 2 - 7 - 3x^2 + 9y$</p>	<p><u>Combining Like Terms:</u> When adding monomials that have the same base and same exponent, <u>add the coefficients</u>. <u>exponents unchanged</u> $m \cdot x + n \cdot x = (m+n) \cdot x$ $6x + 2x = (6+2)x = 8x$ $(x+x+x+x+x+x) + (x+x)$</p>
<p>Ex 1: $x^3 \cdot x^8$ Ex 2: $2^4 \cdot 2^2$ Ex 2: $(2x^2y)(-3x^3y^4)$ $2 \cdot -3 \cdot x^{2+3} \cdot y^{1+4} \rightarrow -6x^5y^5$</p>	<p><u>Product Rule:</u> When multiplying monomials that have the same base, <u>add the exponents.</u> $x^m \cdot x^n = x^{m+n}$ $x^6 \cdot x^2 = x^{6+2} = x^8$ $(x \cdot x \cdot x \cdot x \cdot x \cdot x) \cdot (x \cdot x)$</p>
<p>Ex 1: $\frac{3^5}{3^3}$ Ex 2: $\frac{x^2y^5}{xy^3}$ Ex 3: $\frac{36m^3n^5}{-9mn^4}$ $\frac{36}{-9} m^{3-1} n^{5-4} = -4mn$</p>	<p><u>Quotient Rule:</u> When dividing monomials that have the same base, <u>subtract the exponents.</u> $\frac{x^m}{x^n} = x^{m-n}$ $\frac{x^6}{x^2} = x^{6-2} = x^4$ $\frac{x \cdot x \cdot x \cdot x \cdot x \cdot x}{x \cdot x}$</p>
<p>Ex 1: $(x^3)^2$ Ex 2: $(3^5)^4$ Ex 3: $(z^5)^8$</p>	<p><u>Power Rule:</u> When raising monomials to powers, write the base and <u>multiply the exponents</u> $(x^m)^n = x^{m \cdot n}$ $(x^6)^2 = x^{6 \cdot 2} = x^{12}$ $(x \cdot x \cdot x \cdot x \cdot x \cdot x)(x \cdot x \cdot x \cdot x \cdot x \cdot x)$</p>
<p>Ex 1: $(2a)^5$ Ex 2: $(6x^3)^2$ Ex 3: $(2x^3yz^2)^3$ $6^2 x^{3 \cdot 2} = 36x^6$</p>	<p><u>Power of a Product Rule:</u> When raising monomials to powers, write the base and multiply the exponents. $(y^p x^m)^n = x^{m \cdot n} \cdot y^{p \cdot n}$ $(2x^2y^3)^4 = 2^{1 \cdot 4} x^{2 \cdot 4} y^{3 \cdot 4} = 16x^8y^{12}$ $2x^2y^3 \cdot 2x^2y^3 \cdot 2x^2y^3 \cdot 2x^2y^3$</p>
<p>Ex 1: $(\frac{x^2}{y})^4$ Ex 2: $(\frac{2x}{3y^2})^3$</p>	<p><u>Power of a Quotient Rule:</u> When raising monomials to powers, write the base and <u>multiply the exponents.</u> <u>Quotient</u> $(\frac{x}{y})^m = \frac{x^m}{y^m}$ $(\frac{3m^2n^7}{m})^5 = (3^{1(5)} m^{2(5)-1(5)} n^{7(5)}) = 3^5 m^{10-5} n^{35} = 243m^5n^{35}$</p>
<p>Ex 1: 4^{-2} Ex 2: $-4x^5y^{-2}$ Ex 3: $\frac{a^{-2}b^3}{c^{-4}d^{-1}}$ Ex 4: $(\frac{x^2}{y})^{-3}$</p>	<p><u>Negative Exponents:</u> If a factor in the numerator or denominator is moved across the fraction bar, the <u>sign of the exponent is changed.</u> $x^{-m} = \frac{1}{x^m}$ $\frac{1}{x^{-m}} = x^m$ $(\frac{x}{y})^{-n} = (\frac{y}{x})^n$ <u>Flip Fraction</u> $x^{-3} = \frac{1}{x^3}$ CAUTION: $-x \neq \frac{1}{x}$ For example: $-3 \neq \frac{1}{3}$</p>
<p>Ex 1: 7^0 Ex 2: $(5x^4y^0z^3z^{-3})^2$</p>	<p><u>Zero Exponent:</u> If a factor is raised to the power of 0, the result is 1 $x^0 = 1$ $(3x^3y^2)^0 = 1$ $\frac{x}{x} = 1$</p>

Practice

Rules and Examples

<p>Ex 1: $7a + -8a$ Ex 2: $9x + 2x - 5x^2 + x^2$ $(7+(-8))a \rightarrow -1a$ $11x - 4x^2$ Ex 3: $3x + 4y + 2 - 7 - 3x^2 + 9y$ $-3x^2 + 3x + 13y - 5$</p>	<p><u>Combining Like Terms:</u> When adding monomials that have the same base and same exponent, <u>add the coefficients</u>. <u>exponents unchanged</u> $m \cdot x + n \cdot x = (m+n) \cdot x$ $6x + 2x = (6+2)x = 8x$ $(x+x+x+x+x+x) + (x+x)$</p>
<p>Ex 1: $x^3 \cdot x^8$ Ex 2: $2^4 \cdot 2^2$ $x^{3+8} \rightarrow x^{11}$ $2^{4+2} \rightarrow 2^6 \rightarrow 64$ Ex 2: $(2x^2y)(-3x^3y^4)$ $2 \cdot -3 \cdot x^{2+3} \cdot y^{1+4} \rightarrow -6x^5y^5$</p>	<p><u>Product Rule:</u> When multiplying monomials that have the same base, <u>add the exponents.</u> $x^m \cdot x^n = x^{m+n}$ $x^6 \cdot x^2 = x^{6+2} = x^8$ $(x \cdot x \cdot x \cdot x \cdot x \cdot x) \cdot (x \cdot x)$</p>
<p>Ex 1: $\frac{3^5}{3^3}$ Ex 2: $\frac{x^2y^5}{xy^3}$ $\frac{3^{5-3}}{3^2} \rightarrow \frac{3^2}{3^2} \rightarrow 9$ $\frac{x^{2-1}y^{5-3}}{x^1y^2} \rightarrow \frac{x^1y^2}{x^1y^2}$ Ex 3: $\frac{36m^3n^5}{-9mn^4}$ $\frac{36}{-9} m^{3-1} n^{5-4} \rightarrow -4mn$</p>	<p><u>Quotient Rule:</u> When dividing monomials that have the same base, <u>subtract the exponents.</u> $\frac{x^m}{x^n} = x^{m-n}$ $\frac{x^6}{x^2} = x^{6-2} = x^4$ $\frac{x \cdot x \cdot x \cdot x \cdot x \cdot x}{x \cdot x}$</p>
<p>Ex 1: $(x^3)^2$ Ex 2: $(3^5)^4$ $x^{3 \cdot 2} \rightarrow x^6$ $3^{5 \cdot 4} \rightarrow 3^{20}$ Ex 3: $(z^5)^8$ $z^{5 \cdot 8} \rightarrow z^{40}$</p>	<p><u>Power Rule:</u> When raising monomials to powers, write the base and <u>multiply the exponents</u> $(x^m)^n = x^{m \cdot n}$ $(x^6)^2 = x^{6 \cdot 2} = x^{12}$ $(x \cdot x \cdot x \cdot x \cdot x \cdot x)(x \cdot x \cdot x \cdot x \cdot x \cdot x)$</p>
<p>Ex 1: $(2a)^5$ Ex 2: $(6x^3)^2$ $2^5 a^5 \rightarrow 32a^5$ $6^2 x^{3 \cdot 2} \rightarrow 36x^6$ Ex 3: $(2x^3yz^3)^3$ $2^3 x^{3 \cdot 3} y^{1 \cdot 3} z^{3 \cdot 3} \rightarrow 8x^9y^3z^9$</p>	<p><u>Power of a Product Rule:</u> When raising monomials to powers, write the base and multiply the exponents. $(y^p(x^m)^n)^r = x^{m \cdot n \cdot r} \cdot y^{p \cdot r}$ $(2x^2y^3)^4 = 2^{1 \cdot 4} x^{2 \cdot 4} y^{3 \cdot 4} = 16x^8y^{12}$ $2x^2y^3 \cdot 2x^2y^3 \cdot 2x^2y^3 \cdot 2x^2y^3$</p>
<p>Ex 1: $(\frac{x^2}{y})^4$ $\frac{x^{2 \cdot 4}}{y^{1 \cdot 4}} \rightarrow \frac{x^8}{y^4}$ Ex 2: $(\frac{2x}{3y^2})^3$ $\frac{2^3 \cdot x^{1 \cdot 3}}{3^3 y^{2 \cdot 3}} \rightarrow \frac{8x^3}{27y^6}$</p>	<p><u>Power of a Quotient Rule:</u> When raising monomials to powers, write the base and <u>multiply the exponents.</u> <u>Quotient</u> $(\frac{x}{y})^m = \frac{x^m}{y^m}$ $(\frac{3m^2n^7}{m^1})^5 = (3^{1(5)} m^{2(5)-1(5)} n^{7(5)}) = 3^5 m^{10-5} n^{35} = 243m^5n^{35}$</p>
<p>Ex 1: 4^{-2} Ex 2: $-4x^5y^{-2}$ $\frac{1}{4^2}$ $\frac{-4x^5}{y^2}$ Ex 3: $\frac{a^{-2}b^3}{c^{-4}d^{-1}}$ Ex 4: $(\frac{x^2}{y})^{-3}$ $\frac{b^3c^4d}{a^2}$ $\frac{y^3}{x^6}$ $\frac{x^{2 \cdot -3}}{y^{1 \cdot -3}} \rightarrow \frac{x^{-6}}{y^{-3}}$</p>	<p><u>Negative Exponents:</u> If a factor in the numerator or denominator is moved across the fraction bar, the <u>sign of the exponent is changed.</u> $x^{-m} = \frac{1}{x^m}$ $\frac{1}{x^{-m}} = x^m$ $(\frac{x}{y})^{-n} = (\frac{y}{x})^n$ <u>Flip Fraction</u> $x^{-3} = \frac{1}{x^3}$ CAUTION: $-x \neq \frac{1}{x}$ For example: $-3 \neq \frac{1}{3}$</p>
<p>Ex 1: 7^0 Ex 2: $(5x^4y^0z^3z^{-3})^2$ 1 $25x^8$</p>	<p><u>Zero Exponent:</u> If a factor is raised to the power of 0, the result is 1 $x^0 = 1$ $(3x^3y^2)^0 = 1$ $\frac{x}{x} = 1$</p>

Exponent Rules

Combining Like Terms:

$$m \cdot x + n \cdot x = (m+n) \cdot x$$

Product Rule:

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

Quotient Rule:

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

Power Rule:

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

Power of a Product Rule:

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

Power of a Product Rule:

$$\left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$$

Negative Exponents:

$$x^{-m} = \frac{1}{x^m} \quad \frac{1}{x^{-m}} = x^m \quad \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^n$$

CAUTION: $-x \neq \frac{1}{x}$ For example: $-3 \neq \frac{1}{3}$

Zero Exponent: $x^0 = 1$

Name: _____

Role Play

Group Roles Practice

Exponent Laws Assignment**Group Member Grade***on a scale of 1 - 10 how well did your partner perform their role?**what could they do to improve in their group role for next time?***Task Reader:** We are now working on number ____

Member Name:

We need to write each expression as a single power and then evaluate _____

Rating:

Needs to improve on:

Questioner: What operation symbols do we see?

What exponent laws do we see at play?

What is the rule that applies to that law?

What do we do with the exponents?

Are there any other variables that need to be simplified/combined using exponent laws?

Do we have any coefficients that need to be simplified and evaluated?

Member Name:

Rating:

Needs to improve on:

Solution Confirmer: Did we simplify the entire expression?

Member Name:

The new expression as a single power and evaluated is _____

Rating:

Needs to improve on:

Do we see this answer as an option on the board?

Does everyone have this written down?

Teacher Liason: Our group is having trouble with number ____.

Member Name:

We discussed it and think ____, but could you explain ____?

Rating:

Needs to improve on:

Hi Mrs. Theo, we are currently working on number ____, we are doing fine/need help.


Handwritten diagram illustrating the relationship between powers of 2:

$$\begin{array}{l} 2^3 = 8 \\ 2^2 = 4 \\ 2^1 = 2 \\ 2^0 = 1 \\ 2^{-1} = \frac{1}{2} \\ 2^{-2} = \frac{1}{2 \cdot 2} = \frac{1}{4} \\ 2^{-3} = \frac{1}{2^3} = \frac{1}{8} \end{array}$$

Arrows indicate the operations used to move between adjacent powers:

- From 2^3 to 2^2 : $\cdot 2$ (multiplication)
- From 2^2 to 2^1 : $\cdot 2$ (multiplication)
- From 2^1 to 2^0 : $\div 2$ (division)
- From 2^0 to 2^{-1} : $\div 2$ (division)
- From 2^{-1} to 2^{-2} : $\div 2$ (division)
- From 2^{-2} to 2^{-3} : $\div 2$ (division)


You bored? Ok, Board Work time!

19) $\frac{(x^{-3})^4 x^4}{2x^{-3}}$ 

$$\frac{1 \cdot x^{-12} \cdot x^4}{2 \cdot x^{-3}}$$

$$\frac{1}{2} \cdot x^{-12+4+3}$$

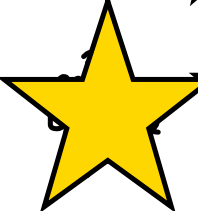

$$\frac{1}{2} \cdot x^{-5}$$

$\frac{1}{2x^5}$ 

20) $\frac{(2x^3z^2)^3}{x^3y^4z^2 \cdot x^{-4}z^3}$

$$\frac{2^3 x^9 z^6}{x^{-1} y^4 z^5}$$

$$8 x^{9-1} y^{0-4} z^{6-5}$$

$\frac{8x^8 y^{-4} z^1}{1}$  

21) $\frac{(2pm^{-1}q^0)^{-4} \cdot 2m^{-1}p^3}{2pq^2}$

22) $\frac{(2hj^2k^{-2} \cdot h^4j^{-1}k^4)^0}{2h^{-3}j^{-4}k^{-2}}$

Exponent Rules Review

Name _____

Per _____

Multiplication

Part 1: Simplify each expression.

- 1.) $2^3 \cdot 2^4$ 2.) $8^1 \cdot 8^3$ 3.) $t^4 \cdot t^4$ 4.) $x^5 \cdot x^9$
- 5.) $3^4 \cdot x^3 \cdot x^5$ A.) $(0.5^3)(0.5^2)$ B.) $(\frac{1}{2})(\frac{1}{2})^3$

Part 2: Find the product of the expressions.

- 6.) $(6x^2)(4x^2)$ 7.) $(3x^3y^2)(-6y^5)$ 8.) $(5p^3)(-m^8p^2)$
- 9.) $(10g^3h^8v^6)(11gh^8)$ 10.) $(4f^9h^3)(-5f^6)(-3h^2)$

- 11.) $(-2^2x^3y^4)((-3)^2x^4y^4)$ 12.) *Challenge: $(3x^a y^b z^c)(-y^f z^g)$
- Handwritten work for 11: $-1 \cdot 2^2 \cdot (-3)^2 \cdot x^3 \cdot x^4 \cdot y^4 \cdot y^4$
 $-1 \cdot 4 \cdot 9 \cdot x^{3+4} \cdot y^{4+4}$
 $-36 x^7 y^8$*

Power to a Power

Part 1: Find the product. Expand if it helps you.

- 13.) $(p^2)^5$ 14.) $(x^m)^2$
- 15.) $(2x)^2$ 16.) $(10^2)^3$
- 17.) $(2^3x)^2$ 18.) $2(3a^2)^3$
- Handwritten work for 18: $2 \cdot 3^3 \cdot a^{2 \cdot 3}$
 $2 \cdot 27 \cdot a^6$ $54a^6$*
- 19.) $(-3^2x^6)^5$ 20.) $(7j^2)^3$
- 21.) $\left(\frac{8x^2}{2x^2}\right)^2$ 22.) $\left(\frac{3x^2}{2y^2}\right)^5$

Division

Part 1: Simplify to find the quotients.

23.) $\frac{a^8}{a^3}$

24.) $\frac{7^{11}}{7^8}$

25.) $\frac{7 \cdot b^5}{b^4}$

26.) $\frac{x^{10}}{x^4}$

27.) $\frac{12 \cdot g^8 \cdot h^4}{g^3 \cdot h^5}$

28.) $\frac{4 \cdot p^{11}}{8 \cdot p^6}$

29.) $\frac{c^9}{6c^4}$

30.) $\frac{2 \cdot x^3 \cdot y^6}{4 \cdot y^2}$

31.) $\frac{3x^{14}y^{11}}{18x^2}$

Handwritten work for problem 27:
 $12 \cdot g^{8-3} \cdot h^{4-5}$
 $12 \cdot g^5 \cdot h^{-1}$
 $\frac{12g^5}{h^1}$

Handwritten work for problem 28:
 $\frac{4}{8} p^{11-6}$

Negative and Zero Exponents

Rewrite **without negative exponents** and simplify.

32.) $6 \cdot c^3 \cdot d^{-2}$

33.) $6x^4x^{-10}$

34.) $(2^0 \cdot x^{-3})^4$

36.) $\frac{a^{12}b^{-3}}{a^5b^5}$

37.) $\left(\frac{5x^{13}y^5z^2}{3 \cdot 5^2}\right)^0$

38.) $(g^3 \cdot g^{-2})^4$

39.) $\left(\frac{4c^{-5}}{8d^0}\right)^3$

40.) $\left(\frac{x^{-8}}{y^{11}}\right)^{-2}$

Handwritten work for problem 41:
 $41.) \frac{(2x^3) \cdot (x^4)^2}{8x^{11}}$
 $\frac{2}{8} \cdot x^{3+4 \cdot 2-11}$
 $\frac{1}{4} x^0 \rightarrow \frac{1}{4} \cdot 1$
 $\boxed{\frac{1}{4}}$

Look and Find the Answers! If you can't find it, you made a mistake!

4096	t^8	128	0.03125	$81x^8$	x^{14}	$\frac{1}{16}$		
$-5m^8p^5$	$-3x^9y^{b+f}z^{c+g}$	$60f^{15}h^5$	$-18x^3y^7$	$24x^4$	$-36x^7y^8$	$110g^4h^{16}v^6$		
p^{10}	$\frac{243x^{10}}{32y^{10}}$	$4x^2$	1,000,000	$64x^2$	$54a^6$	16		
x^6	$\frac{p^5}{2}$	$\frac{12g^5}{h}$	$\frac{x^{12}y^{11}}{6}$	343	a^5	$\frac{x^3y^6}{2}$	$\frac{c^5}{6}$	$7b$
$\frac{a^7}{b^8}$	$\frac{6c^3}{d^2}$	$\frac{1}{8c^{15}}$	$x^{16}y^{22}$	$\frac{6x^4}{x^{10}}$	$\frac{1}{x^{12}}$	1	g^4	$\frac{1}{4}$