8th grade Math Packet

Notes & Assignments for 5.11-5.22

Lesson: 1.3 Powers of Monomials

- p. 25-30
- Work through the lesson: complete Learn- Examples- Check- Apply

Assignment: Practice 1.3 Due Friday 5.15

- P.31-32
- You will need to submit this assignment to your teacher

Lesson: 1.4 Zero & Negative Exponents

- p. 33-40
- Work through the lesson: complete Learn- Examples- Check- Apply

Assignment: Practice 1.4 Due Friday 5.22

- P. 41-42
- You will need to submit this assignment to your teacher

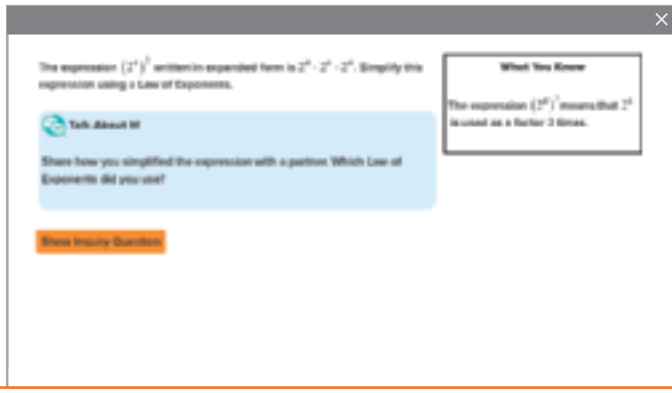
Powers of Monomials

I Can... use the Power of a Power Property and the Power of a Product Property to simplify expressions with integer exponents.

What Vocabulary Will You Learn?
Power of a Power Property
Power of a Product Property

Explore Power of a Power

Online Activity You will explore how to simplify a power raised to another power.



Learn Power of a Power

You can use the rule for finding the product of powers to illustrate how to find the power of a power.

$(6^4)^3 = (6^4)(6^4)(6^4)$	Expand the 3 factors.
$= 6^{4+4+4}$	Product of Powers Property
$= 6^{12}$	Add the exponents.

Notice, that the product of the original exponents, 4 and 3, is the final power, 12. You can simplify a power raised to another power using the **Power of a Power Property.**

Words	Algebra
To find the power of a power, multiply the exponents.	$(a^m)^n = a^{m \cdot n}$
	Numbers
	$(5^2)^3 = 5^{2 \cdot 3}$ or 5^6

Your Notes

Think About It!

How can the Power of a Power Property help you simplify the expression?

See students' responses.

Talk About It!

Describe another method you could use to check your solution.

Sample answer: Write $(8^6)^3$ in expanded form to determine how many factors of 8 are being multiplied together, then write it as a power. For example, $(8^6)^3 = (8^6) \cdot (8^6) \cdot (8^6)$ or 8^{18}.

Example 1 Power of a Power

Simplify $(8^6)^3$.

$(8^6)^3 = 8^{6 \cdot 3}$	Power of a Power Property
$= 8^{18}$	Simplify.

So, $(8^6)^3 = 8^{18}$.

Check

Simplify the expression $(6^3)^5$. **6^{15}**

Show your work here

Example 2 Power of a Power

Simplify $(k^7)^5$.

$(k^7)^5 = k^{7 \cdot 5}$	Power of a Power Property
$= k^{35}$	Simplify.

So, $(k^7)^5 = k^{35}$.

Check

Simplify the expression $(x^4)^7$. **x^{28}**

Show your work here

Go Online You can complete an Extra Example online.

Learn Power of a Product

The following example demonstrates how the Power of a Power Property can be extended to find the power of a product.

$(4a^2)^3 = (4a^2)(4a^2)(4a^2)$	Expand the 3 factors.
$= 4 \cdot 4 \cdot 4 \cdot a^2 \cdot a^2 \cdot a^2$	Commutative Property
$= 4^3 \cdot (a^2)^3$	Definition of power
$= 64 \cdot a^6$ or $64a^6$	Power of a Power Property

Notice, that each factor inside the parentheses is raised to the

third power.

You can simplify a product raised to a power using the **Power of a Product Property.**

Words	Algebra
To find the power of a product, find the power of each factor and multiply.	$(ab)^m = a^m b^m$
	Numbers
	$(2x^3)^4 = (2)^4 \cdot (x^3)^4$ or $16x^{12}$

Example 3 Power of a Product

Simplify $(2p^3)^4$.

$(2p^3)^4 = 2^4 \cdot (p^3)^4$	Power of a Product Property
$= 2^4 \cdot p^{3 \cdot 4}$	Power of a Power Property
$= 16p^{12}$	Simplify.

So, $(2p^3)^4 = 16p^{12}$.

Think About It!

What parts of the monomial, $2p^3$, are raised to the fourth power?

2 and p^3

Talk About It!

Why was the exponent 4 applied to both of the factors in the first step?

Sample answer: Raising $2p^3$ to the fourth power means that each factor is multiplied four times. So, each factor inside of the parentheses is raised to the power of 4.

Check

Simplify the expression $(7w^7)^3$.

Ⓐ $7w^{21}$

Ⓑ $21w^{21}$

Ⓒ $243w^{10}$

Ⓓ $343w^{21}$

Show your work here

Go Online You can complete an Extra Example online.

Think About It!

What parts of the monomial, $(-2m^7n^6)$, are raised to the fifth power?

-2, m^7, and n^6

Talk About It!

Why were the exponents multiplied when simplifying the expression?

Sample answer: Since each factor is raised to the power of 5, the factors that already have an exponent are raised to another power. So, the exponents are multiplied using the Power of a Power Property.

Example 4 Power of a Product

Simplify $(-2m^7n^6)^5$.

$(-2m^7n^6)^5 = (-2)^5 \cdot (m^7)^5 \cdot (n^6)^5$ Power of a Product Property

$= -32m^{35}n^{30}$ Simplify.

So, $(-2m^7n^6)^5 = -32m^{35}n^{30}$.

Check

Simplify the expression $(-5w^2z^8)^3$.

(A) $-125w^5z^{11}$

(B) $-125w^6z^{24}$

(C) $-15w^5z^{11}$

(D) $15w^6z^{24}$

Show your work here

Go Online You can complete an Extra Example online.

Pause and Reflect

Did you ask questions about the properties used in this lesson? Why or why not?

Record your observations here

See students' observations.

Apply Geometry

A square floor has a side length of $8x^3y^2$ units. A square tile has a side length of xy units. How many tiles will it take to cover the floor?

1 What is the task?

Make sure you understand exactly what question to answer or problem to solve. You may want to read the problem three times. Discuss these questions with a partner.

First Time Describe the context of the problem, in your own words.
Second Time What mathematics do you see in the problem?
Third Time What are you wondering about?

2 How can you approach the task? What strategies can you use?

Record your observations here

See students' strategies.

3 What is your solution?

Use your strategy to solve the problem.

Show your work here

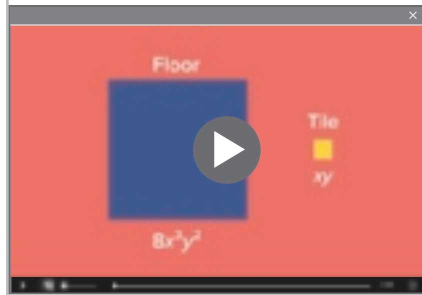
$64x^4y^2$ tiles; See students' work.

4 How can you show your solution is reasonable?

Write About It! Write an argument that can be used to defend your solution.

See students' arguments.

Go Online
Watch the animation.



Talk About It!
To find the number of tiles needed to cover the floor, why do you need to divide the areas?

Sample answer: The area of the floor is equal to the number of tiles needed to cover the floor multiplied by the area of one of the tiles. Since you know the area of the floor and the area of each tile, you can work backward and divide to find the number of tiles needed.

Check

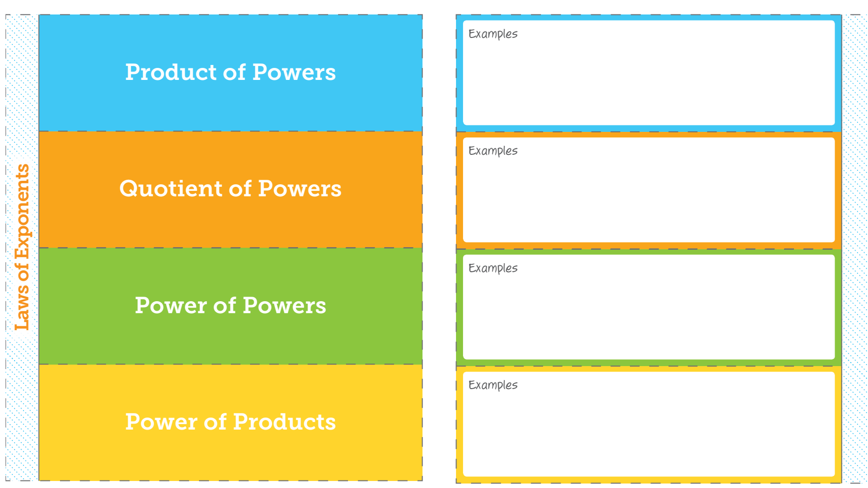
The floor of the commons room at King Middle School is in the shape of a square with side lengths of $3x^2y^3$ feet. New tile is going to be put on the floor of the room. The square tile has side lengths of xy feet. How many tiles will it take to cover the floor?

Show your work here

$9x^2y^4$ tiles

Go Online You can complete an Extra Example online.

Foldables It's time to update your Foldable, located in the Module Review, based on what you learned in this lesson. If you haven't already assembled your Foldable, you can find the instructions on page FL1.



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Practice 1-3: Powers of Monomials Practice

Simplify each expression. (Examples 1-4)

1. $(7^2)^3$ = ________

2. $(8^3)^3$ = ________

3. $(d^7)^6$ = ________

4. $(z^7)^3$ = ________

5. $(2m^5)^6$ = ________

6. $(7a^5b^6)^4$ = ________

7. $(-3w^3z^8)^5$ = ________

8. $(-5r^4s^{10})^4$ = ________

9. Which is greater: 1,000 or $(6^2)^3$? Explain.

10. Multiselect Select all of the expressions that simplify to the same expression.

- ☐ $(x^3y^4)^2$
- ☐ $(x^2y)^2$
- ☐ $(x^3)^2y^6$
- ☐ $x^6(y^4)^2$
- ☐ $(x^3)^2(y^2)^4$

Apply

11. A square floor has a side length of $7x^5y^6$ units. A square tile has a side length of x^2y units. How many tiles will it take to cover the floor?

12. A cube has a side length of $3x^6$ units. A smaller cube has a side length of x^2 units. How many smaller cubes will fit in the larger cube?

13. Make an argument for why $(4^2)^4 = (4^4)^2$.

14. Persevere with Problems Describe all the positive integers that would make $\left[\left(\frac{1}{2}\right)^4\right]^n$ less than $\left(\frac{1}{2}\right)^7$. Explain your reasoning.

15. Without computing, determine which number is greater, $[(-4)^4]^5$ or $-[(4^{12})^3]$. Explain your reasoning.

16. Identify Structure Charlotte states that $(4^3)^3$ can be rewritten as 2^{18}. Explain how she is correct.

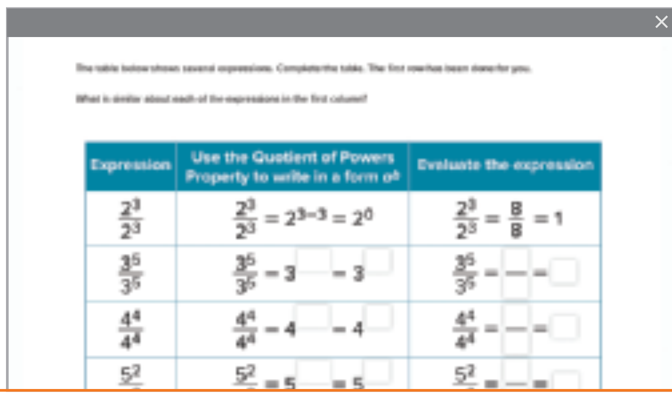
Zero and Negative Exponents

I Can... use the Zero Exponent Rule and the Quotient of Powers Property to simplify expressions with zero and negative integer exponents.

What Vocabulary Will You Learn?
negative exponent
Zero Exponent Rule

Explore Exponents of Zero

Online Activity You will explore how to simplify expressions with exponents of zero and make a conjecture about the value of expressions with exponents of zero.



Learn Exponents of Zero

Use the **Zero Exponent Rule** to simplify expressions containing exponents of zero.

Words
Any nonzero number to the zero power is equivalent to 1.
Algebra
$x^0 = 1, x \neq 0$
Numbers
$5^0 = 1$

(continued on next page)

Your Notes

Complete the pattern in the table to demonstrate that any nonzero number, n, to the zero power is equivalent to 1.

Power	Equivalent Form
n^5	$n \cdot n \cdot n \cdot n \cdot n$
n^4	$n \cdot n \cdot n \cdot n$
n^3	$n \cdot n \cdot n$
n^2	$n \cdot n$
n^1	n
n^0	1

Arrows on the left side of the table: n^{5-1}, n^{4-1}, n^{3-1}, n^{2-1}, n^{1-1}. Arrows on the right side: $\div n$, $\div n$, $\div n$, $\div n$, $\div n$.

The pattern in the table shows that as you decrease the exponent by 1, the value of the power is divided by n each time. By extending the pattern, $n \div n = 1$. So, $n^0 = 1$.

Write the expressions that are equivalent to 1 in the bin.

2^1 1^2 2^0 1^0 0^1 $\left(\frac{1}{2}\right)^0$

Equivalent to 1

2^0 1^0 $\left(\frac{1}{2}\right)^0$ 1^2

Pause and Reflect

Do all powers with any rational number base and an exponent of zero equal 1? Explain.

Record your observations here

See students' observations.

Example 1 Exponents of Zero

Simplify 12^0.

Any nonzero number to the zero power is ___1___.

So, $12^0 = 1$.

Check

Simplify m^0, where $m \neq 0$. **1**

Go Online You can complete an Extra Example online.

Explore Negative Exponents

Online Activity You will use Web Sketchpad to explore how to simplify expressions with negative exponents.

Learn Negative Exponents

A **negative exponent** is the result of repeated division. You can use negative exponents to represent very small numbers.

Complete the table below. Every time you divide by 10, the exponent decreases by one. The pattern in the table shows that 10^{-2} can be defined as $\frac{1}{100}$ or $\frac{1}{10^2}$.

Exponential Form	Standard Form
$10^3 = 10 \cdot 10 \cdot 10$	1,000
$10^2 = 10 \cdot 10$	100
10^1	10
10^0	1
10^{-1}	$\frac{1}{10}$
10^{-2}	$\frac{1}{100}$
10^{-3}	$\frac{1}{1,000}$

÷ 10
÷ 10
÷ 10
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÷ 10

Words

Any nonzero number to the negative *n* power is the multiplicative inverse of its *n*th power.

Algebra

$$x^{-n} = \frac{1}{x^n}, x \neq 0$$

Numbers

$$7^{-3} = \frac{1}{7} \cdot \frac{1}{7} \cdot \frac{1}{7} \text{ or } \frac{1}{7^3}$$

Pause and Reflect

Did you make any errors when completing the Learn? What can you do to make sure you don't repeat that error in the future?

Record your observations here

See students' observations.

Example 2 Negative Exponents

Express 6^{-3} using a positive exponent.

$6^{-3} = \frac{1}{6^3}$ Definition of negative exponent

So, 6^{-3} expressed using a positive exponent is $\frac{1}{6^3}$.

Check

Express a^{-5} using a positive exponent. $\frac{1}{a^5}$

Show your work here

Think About It!

What is the multiplicative inverse of 6?

$\frac{1}{6}$

Talk About It!

Explain how to write x^{-5} using a positive exponent.

Sample answer: Write as a fraction with 1 in the numerator and the power in the denominator with a positive exponent.

Example 3 Negative Exponents

Express the fraction $\frac{1}{c^5}$ using a negative exponent.

$\frac{1}{c^5} = c^{-5}$ Definition of negative exponent

So, $\frac{1}{c^5}$ expressed using a negative exponent is c^{-5}.

Check

Express the fraction $\frac{1}{9^7}$ using a negative exponent. 9^{-7}

Show your work here

Go Online You can complete an Extra Example online.

Think About It!

Will you simplify using the Product of Powers Property first, or will you simplify the negative exponent first?

See students' responses.

Talk About It!

Why is the answer not left as 5^{-2}?

Sample answer: A simplified answer does not contain any negative exponents.

Talk About It!

Both of the original exponents are negative. Why is the exponent in the simplified expression positive?

Sample answer: To subtract the exponents, simplify $-1 - (-4)$. $-1 - (-4) = -1 + 4$, which equals positive 3.

Example 4 Negative Exponents

Simplify $5^3 \cdot 5^{-5}$.

An expression is in simplest form if it contains no like bases and no negative exponents.

$5^3 \cdot 5^{-5} = 5^{3 + (-5)}$ Product of Powers Property

$= 5^{-2}$ Simplify.

$= \frac{1}{5^2}$ Write using positive exponents.

$= \frac{1}{25}$ Simplify.

So, $5^3 \cdot 5^{-5} = \frac{1}{25}$.

Check

Simplify $3^9 \cdot 3^{-4}$. **3^5 or 243**

Show your work here

Example 5 Negative Exponents

Simplify $\frac{w^{-1}}{w^{-4}}$.

$\frac{w^{-1}}{w^{-4}} = w^{-1-(-4)}$ Quotient of Powers Property

$= w^3$ Simplify.

So, $\frac{w^{-1}}{w^{-4}} = w^3$.

Check

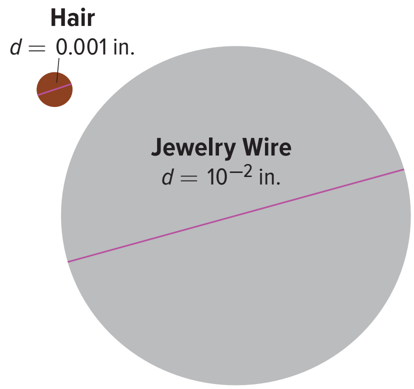
Simplify $\frac{b^{-7}}{b^{-4}}$. $\frac{1}{b^3}$

Show your work here

Go Online You can complete an Extra Example online.

Apply Measurement

One strand of human hair is about 0.001 inch in diameter. The diameter of a certain wire for jewelry is 10^{-2} inch. How many times larger is the diameter of the wire than a strand of hair? Write the decimal as a power of 10.



1 What is the task?

Make sure you understand exactly what question to answer or problem to solve. You may want to read the problem three times. Discuss these questions with a partner.

First Time Describe the context of the problem, in your own words.
Second Time What mathematics do you see in the problem?
Third Time What are you wondering about?

2 How can you approach the task? What strategies can you use?

Record your observations here

See students' strategies.

3 What is your solution?

Use your strategy to solve the problem.

Show your work here

10 times larger; See students' work.

4 How can you show your solution is reasonable?

Write About It! Write an argument that can be used to defend your solution.

See students' arguments.

Talk About It!

Why might writing 0.001 as a fraction be helpful?

Sample answer: To compare the diameters, the values need to be in the same form. In order to write 0.001 using a negative exponent, it is first helpful to write it as a fraction, with 1 in the numerator.

Check

An American green tree frog tadpole is about 0.00001 kilometer in length when it hatches. The largest indoor swimming pool is 10^{-1} kilometer wide. How many times longer is the width of the swimming pool than the length of the green tree frog tadpole?

Show your work here

10^4 or 10,000

Go Online You can complete an Extra Example online.

Pause and Reflect

Where did you encounter struggle in this lesson, and how did you deal with it? Write down any questions you still have.

Record your observations here

See students' observations.

NAME ______________________ DATE ______________ PERIOD ________

Zero and Negative Exponents Practice

Simplify each expression. (Example 1)

1. 46^0 = ________

2. w^0, where $w \neq 0$ ________

Express each using a positive exponent. (Example 2)

3. 8^{-4} = ________

4. y^{-9} = ________

Express each fraction using a negative exponent. (Example 3)

5. $\frac{1}{d^6}$ = ________

6. $\frac{1}{10^5}$ = ________

Simplify each expression. (Examples 4 and 5)

7. $9^4 \bullet 9^{-6}$ = ________

8. $y^{-9} \bullet y^3$ = ________

9. $\frac{x^{-8}}{x^{-12}}$ = ________

10. $\frac{d^{-13}}{d^{-2}}$ = ________

11. Simplify $8^{-7} \bullet 8^7 \bullet 10^4 \bullet 10^{-4}$.

12. **Multiselect** Select all of the expressions that are simplified.

- ☐ n^4
- ☐ $\frac{1}{n^{-5}}$
- ☐ $n^6 \bullet n^{-8}$
- ☐ $n^7 \bullet p^8$
- ☐ $\frac{1}{n^3}$

Apply

13. A dish containing bacteria has a diameter of 0.0001 kilometer. The diameter of a bacterium is 10^{-16} kilometer. How many times larger is the diameter of the dish than the diameter of the bacterium?

14. The table shows the diameters of two objects. How many times larger is the diameter of a pinhead than the diameter of a cloud water droplet?

Object	Diameter (m)
Cloud Water Droplet	10^{-5}
Pinhead	0.001

15. Without evaluating, order 5^{-7}, 5^{4}, and 5^{0} from least to greatest. Explain your reasoning.

16. Persevere with Problems Explain how to find the value of $\left(\frac{1}{3^{-2}}\right)^{-3}$.

17. Determine if the following numerical expressions are equivalent. Explain your reasoning.

$\left[\left(\frac{1}{10^{-2}}\right)^{0}\right]^{3}$ and $[(10^{-4})^{3}]^{0}$

18. Determine if the following statement is *true* or *false*. Explain your reasoning.

If a number between 0 and 1 is raised to a negative power, the result is a number greater than 1.