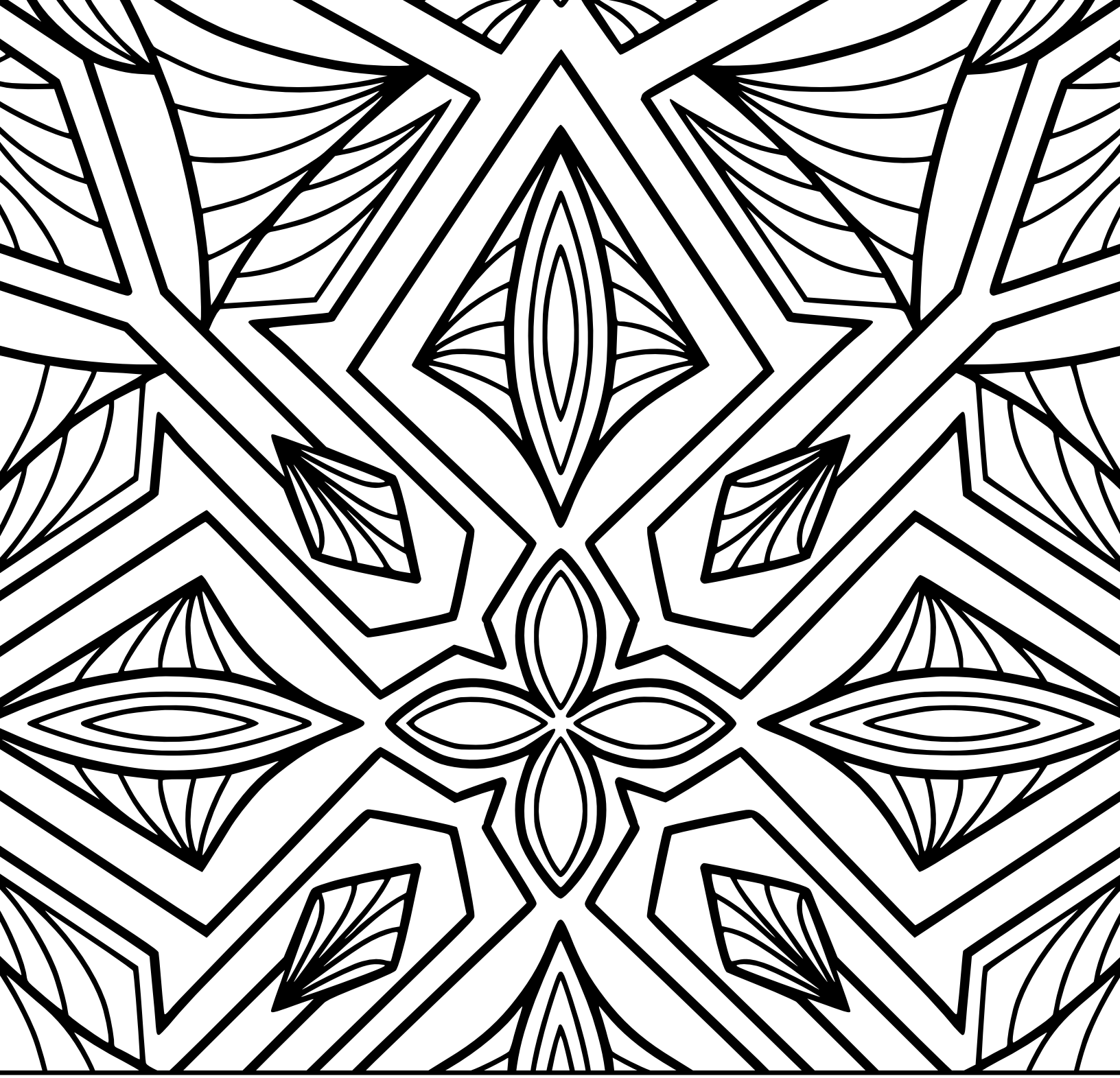


LAWS OF EXPONENTS

Products of Exponents

Write out x^3 in expanded form. Next, to this, write out x^5 in expanded form with a multiplication dot between them. This expanded form represents $x^3 \cdot x^5$.

Now write this expanded form using only one base: $x^3 x^5$ =

Write out $x^{12} x^9$ in expanded form.

Now write this expanded form using only one base: $x^{12} \cdot x^9$ =

Using this knowledge, simplify $x^{30} x^{25} x^{10}$ without writing in expanded form (using only one base).

Verbal Definition: When multiplying like bases,
Algebraic Definition: $x^a \cdot x^b$ =

You try!

$3^4 \bullet 3^5 =$ $\quad$ $d^7 \bullet d =$ $\quad$ $a \bullet a \bullet a^4 =$

$x + x =$ $\quad$ $x \bullet x =$

Product of Powers (with coefficients other than 1)

1) Write out $3x^3 \cdot 2x^2$ in expanded form, then use the commutative property to group the coefficients and the like bases together.

Lastly, multiply the coefficients with each other. Then, rewrite the variables using one base:

$3x^3 \cdot 2x^2 =$

2) Write out $-2x^7 \cdot -3x^5 \cdot 4x$ in expanded form, then use the commutative property to group the coefficients and the like bases together.

Simplify and write this back into exponent form: $-2x^7 \cdot -3x^5 \cdot 4x =$

Verbal Definition: When multiplying like bases with coefficients other than 1,
Algebraic Definition: $Cx^a \cdot Dx^b =$

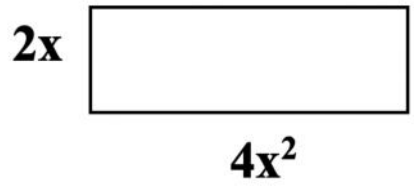
You try!

$(-4y)^2 \bullet -7y^3 =$

$2x^3 \bullet 6x \bullet -2x^4 =$

$2d^5 \bullet -3d^3 \bullet d \bullet 7d^2 =$

Find the perimeter and area



Power to Power Exponents

Like Bases

1) Write $\left(3x^3\right)^2$ in expanded form. Make sure you write all terms in expanded form. You may have to expand twice.

Group the coefficients and the like bases.

After grouping the like bases and coefficients use your new knowledge of multiplication and rewrite in simplified exponent form: $\left(3x^3\right)^2$ =

2) Write out $\left(3x^2y^3\right)^3$ in expanded form. Make sure you write all terms in expanded form.

Group the coefficients and the like bases and rewrite in simplified exponent form.

Verbal Definition: When raising a power to a power,
Algebraic Definition: $(Cx^a)^b$ =

You try!

$(2v)^2 \cdot 2v^2$

$\mathbf{(-4y)^2 \bullet -7y^3 =}$

Unlike Bases

1) Write $x^3 \cdot y^4$ in expanded form.

   Rewrite back into one exponent form. What do you notice about $x^3 \cdot y^4$?

2) Write $2x^3 \cdot 4y^5$ in expanded form and group the coefficients and the like bases.

   Now simplify and write in exponent form: $2x^3 \cdot 4y^5$ =

3) Simplify $\left(-4x^{10}\right)\left(6y^2\right)^2$ without writing in expanded form.

Verbal Definition: When multiplying terms with unlike bases,
Algebraic Definition: $Cx^a \cdot Dy^b$ =

You try!

$3mn^3 \cdot 8m^6n^7$ $\qquad$ $(2a^2b^3)^5$ $\qquad$ $(-2x^3y^4)^2$

Quotients of Exponents

1) Write $\frac{x^5}{x^2}$ in expanded form.

After writing in expanded form, simplify like bases. Therefore, $\frac{x^5}{x^2}$ =

2) Write $\frac{ab^7}{a^9b^5}$ in expanded form and simplify like bases.

Therefore, $\frac{ab^7}{a^9b^5}$ =

Verbal Definition: When dividing terms with like bases,
Algebraic Definition: $\frac{a^m}{a^n}$ =

You try!

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

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

What about finding the Power of a Quotient?

1) $\left(\frac{3}{2}\right)^4$

2) $\left(\frac{p^4}{s^3}\right)^2$

3) $\left(\frac{-7}{x}\right)^2$

4) $\left(\frac{ax^4}{4y^3}\right)^2$

5) $\left(\frac{7x^3y}{2y^5}\right)^2$

6) $\left(\frac{2f^2g^3h}{3fg}\right)^2$

Verbal Definition: When finding the power of a quotient,
Algebraic Definition: $\left(\frac{a}{b}\right)^m =$

Zero Power Exponents

$\frac{4}{4} =$

$\frac{-8}{-8} =$

$\frac{100}{100} =$

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

$r^0 =$

$\frac{y^0}{w^0} =$

$\left(r^0 + z^0 + w^0\right)^2 =$

$3^0 =$

$2(w+1)^0 =$

Verbal Definition: Any number or variable raised to the zero power……
Algebraic Definition: $a^0 =$ _____ $\frac{a^m}{a^n} =$

You try!

$\frac{x}{(2x^0)^2}$

$x^4y^3 \cdot (2y^2)^0$

Negative Exponents

1) Use your division rule to simplify $\frac{x^3y^4}{x^{-2}y}$.

2) While the division rule works nicely on problems like this, it is much easier to use this rule: **When dividing by a base with a negative exponent, simply move the base across the fraction line.**

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

$3x^{-2}y^{-5} =$

$\frac{5q^{-1}r^2s^{-4}}{q^{-4}r^{-1}s}$

$\left(3xy^5\right)^{-2}$

$\frac{16}{(x^{-3}y^4)^{-2}}$

$\frac{12a^{-2}b^{12}c^{-15}}{4}$

$\left(x^{-2}x^{-3}\right)^4$

$\frac{2m^{-4}}{\left(2m^{-4}\right)^3}$

Mixed Problems

1) $\dfrac{3x^{-3}}{-6x^{4}}$

2) $2(6a^{2}b)^{0}(a^{2}b^{4})^{-3}$

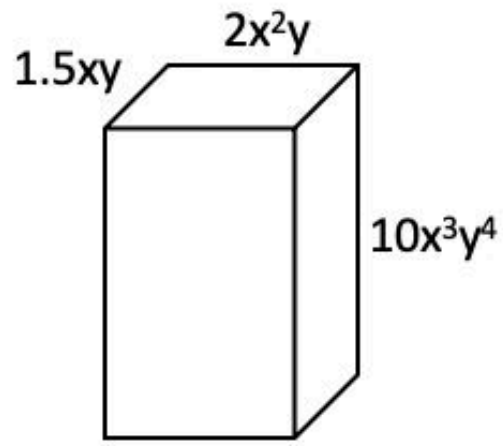
3) $\dfrac{-5r^{5}s^{-4}}{4r^{5}s^{-6}t^{-4}}$

4) $\dfrac{4(x^{-5}y^{3})^{-3}}{(-3x^{-3}y^{7})^{2}}$

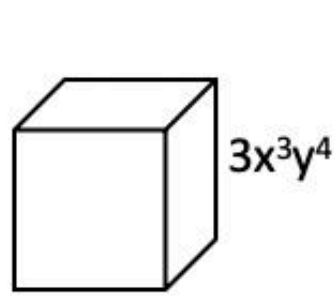
5) $\dfrac{(q^{5}r^{8})^{-3}(3qr^{2})^{3}}{\left(q^{4}r^{10}\right)^{0}(-5q^{-6})^{2}}$

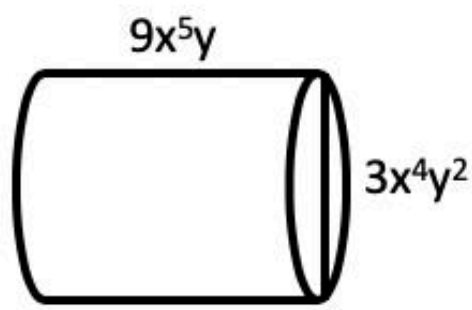
Application of Exponents

1) Find the volume.

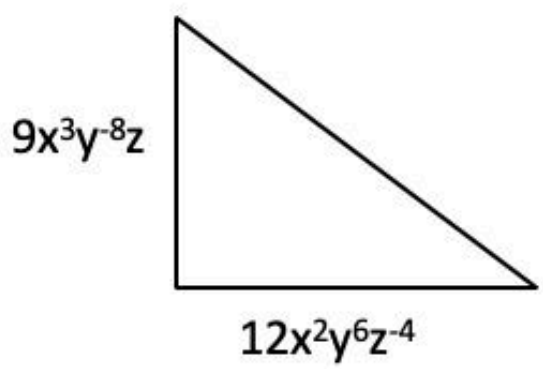


2) Find the ratio of the volume of the cube to the volume of the cylinder.





3) Find the area of the triangle.



More Application Problems

1) Find the area of a rectangle with a length of $7a^4b^3$ units and a width of $5ab^{-1}c$ units.

2) Find the expression for the volume of a cylinder with a radius of $10x^3y^2z$ units and a height of $12x^2y^4z$ units.

3) The volume of a triangular prism is $V_p = (2x^2y^2)^3(3x)$. The volume of a cylinder is $V_c = \pi(3x^2y)^2$. Find the simplified ratio of the volume of the prism to the volume of the cylinder.

Unit: Exponents and Polynomials
Student Handout 3

Name _____
Date _____Pd_____

RATIONAL EXPONENTS

While exponents are often integers, exponents can also include _____ numbers such as fractions. In A and B, apply the power of a product property to find the product. Then answer the questions that follow.

A

$9^{\frac{1}{2}} \cdot 9^{\frac{1}{2}} = 9^{\square} =$ _____

B

$16^{\frac{1}{2}} \cdot 16^{\frac{1}{2}} = 16^{\square} =$ _____

- Based on example A, what is the value of $9^{\frac{1}{2}}$?
- Based on example B, what is the value of $16^{\frac{1}{2}}$?

- Based on both A and B, we can conclude that raising a number to the power of $\frac{1}{2}$ is the same as taking its _____ _____. This can be explained with the rational exponent law shown below. Use the law to rewrite each exponent in a-d in radical form and then evaluate.

RATIONAL EXPONENT PROPERTY

$a^{\frac{x}{y}} =$ _____	If x = 1, the expression is equivalent to _____

a. $100^{\frac{1}{2}} =$ _____ = _____

b. $81^{\frac{1}{4}} =$ _____ = _____

c. $216^{\frac{1}{3}} =$ _____ = _____

d. $8^{\frac{2}{3}} =$ _____ = _____

Apply the rational exponent property to simplify each expression.

1. $b^{\frac{1}{4}}$ _____	2. $6y^{\frac{1}{2}} \cdot y^{\frac{1}{2}}$ _____	3. $(81x^6)^{\frac{1}{2}}$ _____
4. $(x^{-q})^{\frac{1}{3}}$ _____	5. $(x^3)^4(4x^{10})^{\frac{1}{2}}$ _____	

6. Work with a partner to apply the properties of exponents below. Take turns rolling a number cube and simplify the expression in the table that corresponds with the number rolled.

ROLL	EXPRESSION	SIMPLIFY
1	$\frac{(x^4)^{\frac{1}{2}}}{x^{-3}}$	
2	$(y^{-3})(27y^{12}z^3)^{\frac{1}{3}}$	
3	$\frac{(b^4)^{-2}}{b^{-16}}$	
4	$(h^3)^{-3} \cdot (h^5)^2$	
5	$\frac{24a^{-2}b^5}{3a^6bc^0}$	
6	$(6x^{-4}y^qz^2)^0$	

SHOW WORK HERE:

Show all work as you solve each problem below.

7. Ryan's chessboard is square-shaped with an area of $64x^6y^8$ square units. Using the formula for the area of a square, $A = s^2$, write an expression to represent the side length of the board. (Hint: $S = A^{\frac{1}{2}}$)

8. Mrs. Thornberry asked her students to write an expression using an exponent that is equivalent to $\sqrt{50x}$. Circle the name of the student who correctly completed the task.

CARSON	CEDRIC
$50x^{\frac{1}{2}}$	$(50x)^{\frac{1}{2}}$

9. Luna believes that if $8^x > 0$, then the value of x must be greater than 0. Do you agree? Justify your response.

10. Loretta simplified the expression below as shown. Explain Loretta's error and correct her work.

$(16m^2n^{20})^{\frac{1}{2}} = 8mn^{10}$

Unit: Exponents and Polynomials
Homework 3

Name _____

Date _____Pd_____

RATIONAL EXPONENTS

Apply your knowledge of exponent properties to answer each of the questions below.

1. In the table at the right, write each exponent as a radical and then evaluate.

EXPONENT	RADICAL	EVALUATE
$400^{\frac{1}{2}}$		
$243^{\frac{1}{5}}$		
$64^{\frac{2}{3}}$		

Simplify each expression in 2-6 and use the answer bank to check your work. Not all choices will be used.

$\frac{1}{x^8}$	x	$4x^{15}$	$\frac{1}{x^3}$	$\sqrt[4]{x}$	$8x^{15}$	0	$\sqrt[3]{x}$	1	$\frac{1}{x^4}$

2. $x^{\frac{1}{3}}$

_____

3. $(x^{-16})^{\frac{1}{4}}$

_____

4. $(x^2)^5(16x^{10})^{\frac{1}{2}}$

_____

5. $(x^5)^{-3} \cdot (x^4)^4$

_____

6. $\frac{(x^2)^{-2}}{x^4}$

_____

7. Mr. Magee wrote the expression shown below on the board. If the expression has a value of 8, which of the following is the value of n?

$512^{\frac{1}{n}}$

a. 2

b. -3

c. 4

d. 3

8. Denise dusted a square tabletop with an area of $36x^{16}y^4$ square units. Write an expression to represent one side length of the tabletop.

_____