Negative Bases

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Hugs will keep us together

$(-1)^4 = (-1)(-1)(-1)(-1) = 1$

The negative is only attached to

$-1^4 = -(1 \cdot 1 \cdot 1 \cdot 1) = -1$

the base number if there are parenthesis around it.

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Lesson 2: Multiplication of Numbers in Exponential Form

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Classwork

In general, if x is any number and m, n are positive integers, then

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

because

$$x^m \times x^n = \underbrace{x \cdots x}_{m \text{ times}} \times \underbrace{x \cdots x}_{n \text{ times}} = \underbrace{x \cdots x}_{m+n \text{ times}} = x^{m+n}.$$

Exercise 1

$14^{23} \times 14^{8} =$ $14^{23+8} = 14^{31}$

Exercise 2

$(-72)^{10} \times (-72)^{13} =$ $(-72)^{23}$

Exercise 3

$5^{94} \times 5^{78} =$ 5^{172}

Exercise 4

$(-3)^{9} \times (-3)^{5} =$ $(-3)^{14}$

$(-3)(-3)(-3)(-3)(-3)(-3)(-3)(-3)(-3) \cdot (-3)(-3)(-3)(-3)(-3)$

Exercise 5

Let a be a number.

$a^{23} \cdot a^{8} =$ $a^{23+8} = a^{31}$

Exercise 6

Let f be a number.

$f^{10} \cdot f^{13} =$ f^{23}

Exercise 7

Let b be a number.

$b^{94} \cdot b^{78} =$ b^{172}

Exercise 8

Let x be a positive integer. If $-3^{9} \times -3^{x} = -3^{14}$, what is x?

$x = 5$

Division

Multiplication

the bases are the same, we can a

What would happen if there were more terms with the same base? Write an equivalent expression for each problem.

Exercise 9

$9^4 \times 9^6 \times 9^{13} =$ $9^{4+6+13} = 9^{23}$

Exercise 10

$2^3 \times 2^5 \times 2^7 \times 2^9 =$ $2^{3+5+7+9} = 2^{24}$

$2^3 \cdot 2^3 = 2^6$

Can the following expressions be simplified? If so, write an equivalent expression. If not, explain why not.

Exercise 11

$6^5 \times 4^9 \times 4^3 \times 6^{14} =$ $6^{19} \cdot 4^{12}$

Exercise 12

$(-4)^2 \cdot 17^5 \cdot (-4)^3 \cdot 17^7 =$ $(-4)^5 \cdot 17^{12}$

Exercise 13

$15^2 \cdot 7^2 \cdot 15^1 \cdot 7^4 =$ $15^3 \cdot 7^6$

Exercise 14

$2^4 \times 8^2 = 2^4 \times 2^6 =$ 2^{10}

$2^4 \times (2^3)^2$

Exercise 15

$3^7 \times 9 = 3^7 \times 3^2 =$ 3^9

Exercise 16

$5^4 \times 2^{11} =$

Exercise 17

Let x be a number. Simplify the expression of the following number:

$(2x^3)(17x^7) = 34x^{10}$

$= 2 \cdot x^3 \cdot 17 \cdot x^7$

$= (2 \cdot 17) \cdot (x^3 \cdot x^7)$ commutative & associative

Exercise 18

Let a and b be numbers. Use the distributive law to simplify the expression of the following number:

$a\ a + b\ =$

$(6x^2)(4x^2) = 24x^4$

$$(x^2 y^3)(x^3 y^4) = x^5 y^7$$

$$(5a^4b)(-2a^6b^{10}) = -10a^{10}b^{11}$$

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

$$(2a^{x}b^{y})(-a^{z}b^{m})$$

$$= -2a^{x+z}b^{y+m}$$

Exercise 19

Let a and b be numbers. Use the distributive law to simplify the expression of the following number:

$b\ a+b\ =$

Exercise 20

Let a and b be numbers. Use the distributive law to simplify the expression of the following number:

$a+b\ \ a+b\ =$

In general, if x is nonzero and m, n are positive integers, then

$$\frac{x^m}{x^n} = x^{m-n}, \text{ if } m > n.$$

Exercise 21

$\frac{7^9}{7^6} =$

Exercise 22

$\frac{-5^{\ 16}}{-5^{\ 7}} =$

Exercise 23

$\frac{\frac{8}{5}^{\ 9}}{\frac{8}{5}^{\ 2}} =$

Exercise 24

$\frac{13^5}{13^4} =$

Exercise 25

Let a, b be nonzero numbers. What is the following number?

$$\frac{\frac{a}{b}^{9}}{\frac{a}{b}^{2}} =$$

Exercise 26

Let x be a nonzero number. What is the following number?

$$\frac{x^5}{x^4} =$$

Can the following expressions be simplified? If yes, write an equivalent expression for each problem. If not, explain why not.

Exercise 27

$$\frac{2^7}{4^2} = \frac{2^7}{2^4} =$$

Exercise 28

$$\frac{3^{23}}{27} = \frac{3^{23}}{3^3} =$$

Exercise 29

$$\frac{3^5 \cdot 2^8}{3^2 \cdot 2^3} =$$

Exercise 30

$$\frac{-2^{\,7} \cdot 95^5}{-2^{\,5} \cdot 95^4} =$$

Exercise 31

Let x be a number. Simplify the expression of each of the following numbers:

a. $\frac{5}{x^3}\ 3x^8 =$

b. $\frac{5}{x^3}\ -4x^6 =$

c. $\frac{5}{x^3}\ 11x^4 =$

Exercise 32

Anne used an online calculator to multiply $2{,}000{,}000{,}000 \times 2{,}000{,}000{,}000{,}000$. The answer showed up on the calculator as $4e + 21$, as shown below. Is the answer on the calculator correct? How do you know?

Problem Set

1. A certain ball is dropped from a height of x feet. It always bounces up to $\frac{2}{3}x$ feet. Suppose the ball is dropped from 10 feet and is caught exactly when it touches the ground after the 30^{th} bounce. What is the total distance traveled by the ball? Express your answer in exponential notation.

Bounce	Computation of Distance Traveled in Previous Bounce	Total Distance Traveled (in feet)
1		
2		
3		
4		
30		
n		

2. If the same ball is dropped from 10 feet and is caught exactly at the highest point after the 25^{th} bounce, what is the total distance traveled by the ball? Use what you learned from the last problem.

3. Let a and b be numbers and $b \neq 0$, and let m and n be positive integers. Simplify each of the following expressions as much as possible:

$-19^{5} \cdot -19^{11} =$	$2.7^{5} \times 2.7^{3} =$
$\frac{7^{10}}{7^{3}} =$	$\left(\frac{1}{5}\right)^{2} \cdot \left(\frac{1}{5}\right)^{15} =$
$\left(-\frac{9}{7}\right)^{m} \cdot \left(-\frac{9}{7}\right)^{n} =$	$\frac{ab^{3}}{b^{2}} =$

4. Let the dimensions of a rectangle be $(4 \times 871209^{5} + 3 \times 49762105)$ ft. by $7 \times 871209^{3} - 49762105^{4}$ ft. Determine the area of the rectangle. No need to expand all the powers.

5. A rectangular area of land is being sold off in smaller pieces. The total area of the land is 2^{15} square miles. The pieces being sold are 8^{3} square miles in size. How many smaller pieces of land can be sold at the stated size? Compute the actual number of pieces.