Lesson 1: Properties of Exponents

- Let’s use integer exponents.

1.1: Which One Doesn’t Belong: Exponents and Equations

A. $2^3 = 9$

B. $9 = 3^2$

C. $2 \cdot 2 \cdot 2 \cdot 2 = 16$

D. $a \cdot 2^0 = a$

1.2: Name That Power

Find the value of each variable that makes the equation true. Be prepared to explain your reasoning.

1. $2^3 \cdot 2^5 = 2^a$
2. $3^b \cdot 3^7 = 3^{11}$
3. $\frac{4^3}{4^2} = 4^c$
4. $\frac{5^8}{5^d} = 5^2$
5. $6^m \cdot 6^m \cdot 6^m = 6^{21}$
6. $(7^n)^4 = 7^{20}$
7. $2^4 \cdot 3^4 = 6^s$
8. $5^3 \cdot t^3 = 50^3$

1.3: The Power of Zero

1. Use exponent rules to write each expression as a single power of 2. Find the value of the expression. Record these in the table. The first row is done for you.

expression	power of 2	value
$\frac{2^5}{2^1}$	2^4	16
$\frac{2^5}{2^2}$		
$\frac{2^5}{2^3}$		
$\frac{2^5}{2^4}$		
$\frac{2^5}{2^5}$		
$\frac{2^5}{2^6}$		
$\frac{2^5}{2^7}$		

2. What is the value of 5^0?

3. What is the value of 3^{-1}?

4. What is the value of 7^{-3}?

Are you ready for more?

Explain why the argument used to assign a value to the expression 2^0 does not apply to make sense of the expression 0^0.

1.4: Matching Exponent Expressions

Sort expressions that are equal into groups. Some expressions may not have a match, and some may have more than one match. Be prepared to explain your reasoning.

2^{-4} $\quad \frac{1}{2^4}$ $\quad -2^4$ $\quad -\frac{1}{2^4}$ $\quad 4^2$ $\quad 4^{-2}$ $\quad -4^2$ $\quad -4^{-2}$

$2^7 \cdot 2^{-3}$ $\quad \frac{2^7}{2^{-3}}$ $\quad 2^{-7} \cdot 2^3$ $\quad \frac{2^{-7}}{2^{-3}}$ $\quad (-4)^2$

Lesson 1 Summary

Exponent rules help us keep track of a base's repeated factors. Negative exponents help us keep track of repeated factors that are the *reciprocal* of the base. We can define a number to the power of 0 to have a value of 1. These rules can be written symbolically as:

$$b^m \cdot b^n = b^{m+n}$$
$$(b^m)^n = b^{m \cdot n}$$
$$\frac{b^m}{b^n} = b^{m-n}$$
$$b^{-n} = \frac{1}{b^n}$$
$$b^0 = 1$$
$$a^n \cdot b^n = (a \cdot b)^n$$

Here, the base b can be any positive number, and the exponents n and m can be any integer.

Lesson 1 Practice Problems

1. Find the value of each variable that makes the equation true.

   a. $2^5 \cdot 2^3 = 2^a$

   b. $\frac{7^4}{7^b} = 7^{-2}$

   c. $8^c = \frac{1}{64}$

2. Select **all** the expressions equivalent to $7^{-2} \cdot 7^5 \cdot 7^{-3}$.

   A. 0

   B. 1

   C. $\frac{1}{7}$

   D. 7^0

   E. 7^{10}

3. Which expression is equal to $\frac{3^8}{3^2}$?

   A. 1^6

   B. 3^{-6}

   C. 3^4

   D. 3^6

4. Find the value of each variable that makes the equation true.

a. $\frac{5^6}{5^m} = 5^9$

b. $2^3 \cdot 4^n = 2^{11}$

c. $(7^4)^k = 7^{-8}$

5. a. Evaluate the expression $\frac{6^3}{6^3}$.

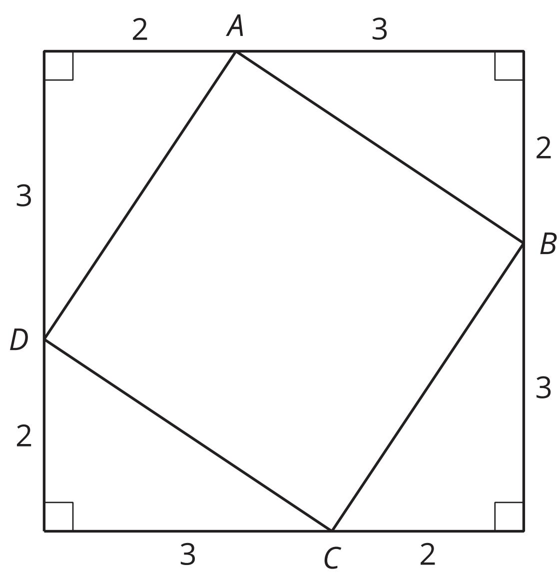
b. Explain how this helps show why $6^0 = 1$.

Lesson 2: Square Roots and Cube Roots

- Let’s think about square and cube roots.

2.1: It’s a Square

Find the area of square $ABCD$.



2.2: Squares and Their Side Lengths

1. Complete the table with the area of each square in square units, and its exact side length in units.

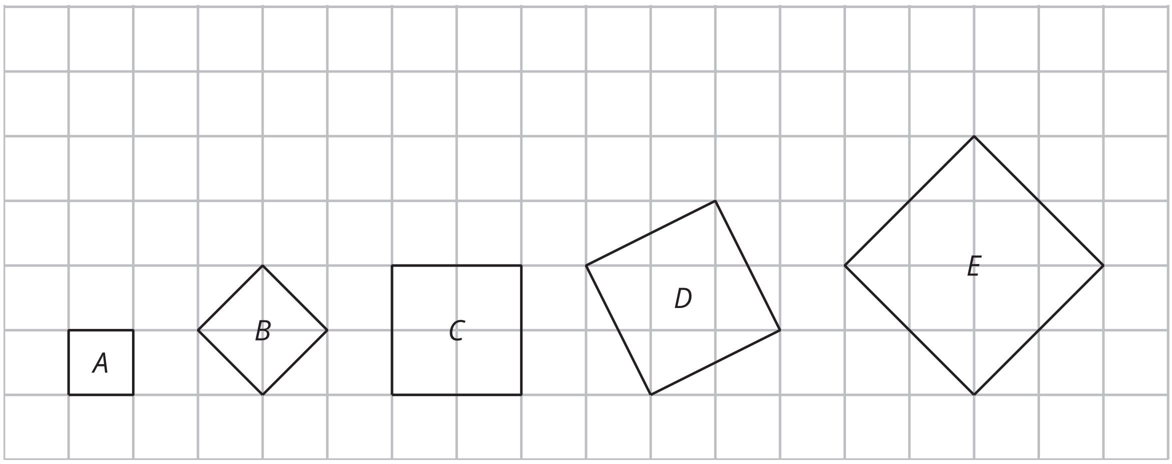


figure	A	B	C	D	E
area					
side length					

2. This table includes areas in square units and side lengths in units of some more squares. Complete the table.

area	9		23		89
side length		4		6.4	

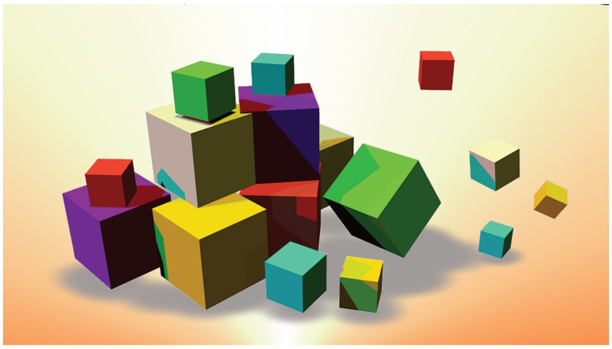
Are you ready for more?

In the first question, all of the squares have vertices at grid points.

1. Is there a square whose vertices are at grid points and whose area is 7 square units? Explain how you know.

2. Is there a square whose vertices are at grid points and whose area is 10 square units? Explain how you know.

2.3: Cube It



1. A cube has edge length 3 units. What is the volume of the cube?

2. A cube has edge length 4 units. What is the volume of the cube?

3. A cube has volume 8 units. What is the edge length of the cube?

4. A cube has volume 7 units. What is the edge length of the cube?

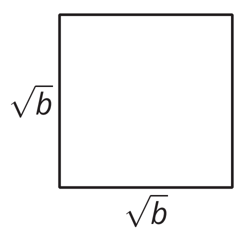
5. $\sqrt[3]{1{,}200}$ is between 10 and 11 because $10^3 = 1{,}000$ and $11^3 = 1{,}331$. Determine the whole numbers that each of these cube roots lies between:

$\sqrt[3]{5}$ $\sqrt[3]{10}$ $\sqrt[3]{50}$ $\sqrt[3]{100}$ $\sqrt[3]{500}$

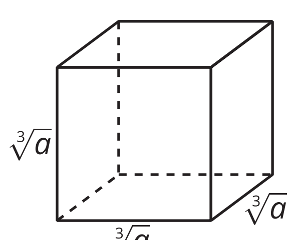
between	1 and 2	2 and 3	3 and 4	4 and 5	5 and 6	6 and 7	7 and 8	8 and 9

Lesson 2 Summary

If a square has side length s, then the area is s^2. If a square has area A, then the side length is $\sqrt{A}$. For a positive number b, the square root of b is defined as the positive number that squares to make b, and it is written as $\sqrt{b}$. In other words, $\left(\sqrt{b}\right)^2 = b$. We can also think of $\sqrt{b}$ as a solution to the equation $x^2 = b$. This square has an area of b because its sides have length $\sqrt{b}$:



Similarly, if a cube has edge length s, then the volume is s^3. If a cube has volume V, then the edge length is $\sqrt[3]{V}$. The number $\sqrt[3]{a}$ is defined as the number that cubes to make a. In other words, $\left(\sqrt[3]{a}\right)^3 = a$. We can also think of $\sqrt[3]{a}$ as a solution to the equation $x^3 = a$. This cube has a volume of a because its sides have length $\sqrt[3]{a}$:



Lesson 2 Practice Problems

1. Rewrite the following expression as a number with no exponents. Explain or show your reasoning.

$$\frac{7^{-3}}{7^{-5}}$$

(From Unit 3, Lesson 1.)

2. Find the value of each variable that makes the equation true.

    a. $(2^d)^4 = 2^{12}$

    b. $3^5 \cdot 7^5 = e^5$

    c. $5^0 \cdot 5^f = 5^4$

(From Unit 3, Lesson 1.)

3. A square has area 9 cm^2. How long are its sides?

    A. 3 cm

    B. 4.5 cm

    C. 9 cm

    D. 81 cm

4. The table shows the side length and area of several different squares. Complete the table using exact values.

side length (cm)	5		$\sqrt{63}$			$\sqrt{125}$
area (cm^2)		49		98	102	

5. Find the two whole numbers that are the closest to $\sqrt{42}$. Explain your reasoning.