Simplify.

1. 7^1 = 7
2. $(-1)^2$ = 1
3. $(1.2)^3$ 1.728
4. $(1.4)^3 \cdot 2^4$ 43.904
5. $(-3)(-1)$ 3
6. $(-1) \cdot 1^4 \cdot (-4)^3$ $-1 \cdot 1 \cdot -64$ $-1 \cdot -64$ 64

Warm Up 1-3

- review order of operations
- Students due as warmup
  - review as class
- watch signs
- exponent effect the base. make sure you know where the base is.

do Now
15 minutes

Graph the linear equation.

1. $y = 3$
2. $x = -2$
3. $x - 4y = 12$
4. $-3x - 7y = -14$
5. $2x + 7y = 1$
6. $6x - 8y = 32$

Cumulative Warm Up

- work on graphing ⇒ individual warm up
- review together as a class

Essential Question

How can you write general rules involving properties of exponents?

Essential Question

what you will learn:

- use zero and negative exponents
- use properties of exponents
- solve real life problems involving exponents

Work with a partner.

a. What happens when you multiply two powers with the same base? Write the product of the two powers as a single power. Then write a *general rule* for finding the product of two powers with the same base.

i. $(2^2)(2^3) =$ ii. $(4^1)(4^5) =$

iii. $(5^3)(5^5) =$ iv. $(x^2)(x^6) =$

b. What happens when you divide two powers with the same base? Write the quotient of the two powers as a single power. Then write a *general rule* for finding the quotient of two powers with the same base.

i. $\frac{4^3}{4^2} =$ ii. $\frac{2^5}{2^2} =$

iii. $\frac{x^6}{x^3} =$ iv. $\frac{3^4}{3^4} =$

Exploration 1a-b

- Partner work
- write expanded form
- look at patterns
- be prepared to talk about it

c. What happens when you find a power of a power? Write the expression as a single power. Then write a *general rule* for finding a power of a power.

i. $(2^2)^4 =$ ii. $(7^3)^2 =$

iii. $(y^3)^3 =$ iv. $(x^4)^2 =$

d. What happens when you find a power of a product? Write the expression as the product of two powers. Then write a *general rule* for finding a power of a product.

i. $(2 \cdot 5)^2 =$ ii. $(5 \cdot 4)^3 =$

iii. $(6a)^2 =$ iv. $(3x)^2 =$

Exploration 1c-d

- all slides done in partners and share out in 10 minutes
- no help

e. What happens when you find a power of a quotient? Write the expression as the quotient of two powers. Then write a *general rule* for finding a power of a quotient.

i. $\left(\frac{2}{3}\right)^2 =$ ii. $\left(\frac{4}{3}\right)^3 =$

iii. $\left(\frac{x}{2}\right)^3 =$ iv. $\left(\frac{a}{b}\right)^4 =$

Exploration 1e

Core Concept

Zero Exponent

Words For any nonzero number a, $a^0 = 1$. The power 0^0 is undefined.

Numbers $4^0 = 1$ **Algebra** $a^0 = 1$, where $a \neq 0$

Negative Exponents

Words For any integer n and any nonzero number a, a^{-n} is the reciprocal of a^n.

Numbers $4^{-2} = \frac{1}{4^2}$ **Algebra** $a^{-n} = \frac{1}{a^n}$, where $a \neq 0$

Core Concept

- review rules
- Use table to review zero exponents and negative exponents
- practice writing!

Evaluate each expression.

a. 6.7^0 b. $(-2)^{-4}$

Example 1

*Student practice

Simplify the expression $\frac{4x^0}{y^{-3}}$. Write your answer using only positive exponents.

Example 2

- Simplify using exponent rules
- Simplify numerators and denominators

Evaluate the expression.

1. $(-9)^0$ 2. 3^{-3} 3. $\frac{-5^0}{2^{-2}}$

4. Simplify the expression $\frac{3^{-2}x^{-5}}{y^0}$. Write your answer using only positive exponents.

Monitoring Progress 1-4

- Student practice

Core Concept

Product of Powers Property

Let a be a real number, and let m and n be integers.

Words To multiply powers with the same base, add their exponents.

Numbers $4^6 \cdot 4^3 = 4^{6+3} = 4^9$ **Algebra** $a^m \cdot a^n = a^{m+n}$

Quotient of Powers Property

Let a be a nonzero real number, and let m and n be integers.

Words To divide powers with the same base, subtract their exponents.

Numbers $\frac{4^6}{4^3} = 4^{6-3} = 4^3$ **Algebra** $\frac{a^m}{a^n} = a^{m-n}$, where $a \neq 0$

Power of a Power Property

Let a be a real number, and let m and n be integers.

Words To find a power of a power, multiply the exponents.

Numbers $(4^6)^3 = 4^{6 \cdot 3} = 4^{18}$ **Algebra** $(a^m)^n = a^{mn}$

Core Concept

- additional exponent rules → use expanded notation to show rules

Simplify each expression. Write your answer using only positive exponents.

a. $3^2 \cdot 3^6$ b. $\frac{(-4)^2}{(-4)^7}$ c. $(z^4)^{-3}$

Example 3

- Student practice → guided

Simplify the expression. Write your answer using only positive exponents.

5. $10^4 \cdot 10^{-6}$

6. $x^9 \cdot x^{-9}$

7. $\frac{-5^8}{-5^4}$

8. $\frac{y^6}{y^7}$

9. $(6^{-2})^{-1}$

10. $(w^{12})^5$

Monitoring Progress 5-10

- additional student practice

Core Concept

Power of a Product Property

Let a and b be real numbers, and let m be an integer.

Words To find a power of a product, find the power of each factor and multiply.

Numbers $(3 \cdot 2)^5 = 3^5 \cdot 2^5$ **Algebra** $(ab)^m = a^m b^m$

Power of a Quotient Property

Let a and b be real numbers with $b \neq 0$, and let m be an integer.

Words To find the power of a quotient, find the power of the numerator and the power of the denominator and divide.

Numbers $\left(\frac{3}{2}\right)^5 = \frac{3^5}{2^5}$ **Algebra** $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$, where $b \neq 0$

Core Concept

- exponent rules: use expanded notation to show

Simplify each expression. Write your answer using only positive exponents.

a. $(-1.5y)^2$

b. $\left(\frac{a}{-10}\right)^3$

c. $\left(\frac{3d}{2}\right)^4$

d. $\left(\frac{2x}{3}\right)^{-5}$

Example 4

- Practice - Guided

Simplify the expression. Write your answer using only positive exponents.

11. $(10y)^{-3}$

12. $\left(-\frac{4}{n}\right)^5$

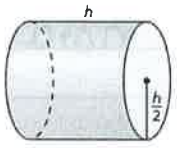
13. $\left(\frac{1}{2k^2}\right)^5$

14. $\left(\frac{6c}{7}\right)^{-2}$

Monitoring Progress 11-14

· Student practice

Which of the expressions shown represent the volume of the cylinder, where r is the radius and h is the height?



Volume = ?

$2\pi r^3$ | $\pi h^2 2^{-2}$ | $\pi h 4^{-1}$

$\frac{\pi h^2}{4}$ | $\frac{\pi h^3}{4}$ | $\frac{\pi h^3}{2}$

$V = \pi r^2 h$

$= \pi \left(\frac{h}{2}\right)^2 h$

$= \pi \frac{h^2}{4}(h)$

$= \frac{\pi h^3}{4}$

Example 5

· word problems

A jellyfish emits about 1.25×10^8 particles of light, or photons, in 6.25×10^{-4} second. How many photons does the jellyfish emit each second?

Write your answer in scientific notation and in standard form.

$\frac{1.25 \times 10^8}{6.25 \times 10^{-4}} = \frac{1.25}{6.25} \times \frac{10^8}{10^{-4}}$

$= 0.2 \times 10^{12}$

move decimal

Example 6 $= 2 \times 10^{11}$

· word Problems

15. Write two expressions that represent the area of a base of the cylinder in Example 5.

16. It takes the Sun about 2.3×10^8 years to orbit the center of the Milky Way. It takes Pluto about 2.5×10^2 years to orbit the Sun. How many times does Pluto orbit the Sun while the Sun completes one orbit around the center of the Milky Way? Write your answer in scientific notation.

Monitoring Progress 15-16

- Student practice

• **Response Logs:** Select from "What is confusing me the most is ..." or "I was successful in ...."

Closure

5 minute reflection done on google docs.