

REVIEW: Quotient of Powers Property

Name _____

Key Concept and Vocabulary

Quotient of Powers Property

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

Numbers: $\frac{3^6}{3^4} = 3^{6-4} = 3^2$

Algebra: $\frac{a^m}{a^n} = a^{m-n}, a \neq 0$



Visual Model

$$\frac{3^6}{3^4} = \frac{\overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{3}} \cdot 3 \cdot 3}{\underset{1}{\cancel{3}} \cdot \underset{1}{\cancel{3}} \cdot \underset{1}{\cancel{3}} \cdot \underset{1}{\cancel{3}}} = 3 \cdot 3 = 3^2$$

$$\begin{aligned} \frac{(-4)^4}{(-4)^2} &= \frac{(\overset{1}{\cancel{-4}}) \cdot (\overset{1}{\cancel{-4}}) \cdot (-4) \cdot (-4)}{(\underset{1}{\cancel{-4}}) \cdot (\underset{1}{\cancel{-4}})} \\ &= (-4) \cdot (-4) \\ &= (-4)^2 \end{aligned}$$

Skill Examples

- $\frac{7^5}{7^2} = 7^{5-2} = 7^3$
- $\frac{(-5)^9}{(-5)^4} = (-5)^{9-4} = (-5)^5$
- $\frac{x^8}{x^6} = x^{8-6} = x^2$

Application Example

- The population of a city is about $4 \cdot 5^6$. The land area is about 5^4 square miles. Find the average number of people per square mile.

$$\begin{aligned} \text{People per square mile} &= \frac{4 \cdot 5^6}{5^4} \\ &= 4 \cdot \frac{5^6}{5^4} \\ &= 4 \cdot 5^2 \\ &= 100 \end{aligned}$$



- ∴ There are about 100 people per square mile.

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Check your answers at BigIdeasMath.com.

Simplify the expression. Write your answer as a power.

- | | | |
|--|---|--|
| 5. $\frac{9^5}{9^4} =$ _____ | 6. $\frac{4^6}{4^2} =$ _____ | 7. $\frac{2^7}{2^5} =$ _____ |
| 8. $\frac{(-6)^7}{(-6)^3} =$ _____ | 9. $\frac{(-3)^8}{(-3)^5} =$ _____ | 10. $\frac{(-8)^4}{(-8)^3} =$ _____ |
| 11. $\frac{n^9}{n^5} =$ _____ | 12. $\frac{b^8}{b^2} =$ _____ | 13. $\frac{y^{12}}{y^7} =$ _____ |
| 14. $\frac{6^5 \cdot 6^2}{6^6} =$ _____ | 15. $\frac{5^4 \cdot 5^5}{5^7} =$ _____ | 16. $\frac{a^8}{a^2 \cdot a^4} =$ _____ |
| 17. $\frac{3^{10}}{3^4} \cdot \frac{3^7}{3^5} =$ _____ | 18. $\frac{8^5 \cdot 8^7}{8^2 \cdot 8^3} =$ _____ | 19. $\frac{w^{14}}{w^3} \cdot \frac{w^6}{w^4} =$ _____ |

- SOUND INTENSITY** The sound intensity of busy street traffic is 10^7 times greater than the quietest noise a person can hear. The sound intensity of the front rows at a rock concert is 10^{11} times greater than the quietest noise a person can hear. How many times more intense is the sound in the front rows of a rock concert than the sound of busy street traffic? _____

REVIEW: Product of Powers Property

Name _____

Key Concept and Vocabulary

Product of Powers Property

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

Numbers: $2^3 \cdot 2^4 = 2^{3+4} = 2^7$

Algebra: $a^m \cdot a^n = a^{m+n}$



Visual Model

$$2^3 \cdot 2^4 = (2 \cdot 2 \cdot 2) \cdot (2 \cdot 2 \cdot 2 \cdot 2) = 2^7$$

$$(-4)^2 \cdot (-4)^3 = [(-4) \cdot (-4)][(-4) \cdot (-4) \cdot (-4)] = (-4)^5$$

Skill Examples

- $5^2 \cdot 5^5 = 5^{2+5} = 5^7$
- $(-3)^8 \cdot (-3)^2 = (-3)^{8+2} = (-3)^{10}$
- $(7^2)^3 = 7^2 \cdot 7^2 \cdot 7^2 = 7^{2+2+2} = 7^6$
- $(y^3)^4 = y^3 \cdot y^3 \cdot y^3 \cdot y^3 = y^{3+3+3+3} = y^{12}$
- $(3x)^3 = 3x \cdot 3x \cdot 3x$
 $= (3 \cdot 3 \cdot 3) \cdot (x \cdot x \cdot x)$
 $= 3^3 \cdot x^3$
 $= 27x^3$

Application Example

- A gigabyte of computer storage space is 2^{30} bytes. A computer has a total storage space of 128 gigabytes. How many bytes of total storage space does the computer have? Write your answer as a power.

Notice that 128 can be written as a power, 2^7 .

$$\begin{aligned} \text{Total number of bytes} &= \text{Number of bytes in a gigabyte} \cdot \text{Number of gigabytes} \\ &= 2^{30} \cdot 2^7 \\ &= 2^{30+7} \\ &= 2^{37} \end{aligned}$$

- ∴ The computer has 2^{37} bytes of total storage space.



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Simplify the expression. Write your answer as a power.

- $8^3 \cdot 8^6 =$ _____
- $3^4 \cdot 3^2 =$ _____
- $6^7 \cdot 6^5 =$ _____
- $(-5)^3 \cdot (-5)^7 =$ _____
- $(-10)^6 \cdot (-10)^2 =$ _____
- $(-2)^4 \cdot (-2)^5 =$ _____
- $(9^4)^3 =$ _____
- $(4^5)^3 =$ _____
- $(12^3)^2 =$ _____
- $(2^3)^3 =$ _____
- $(n^5)^2 =$ _____
- $(w^2)^4 =$ _____

Simplify the expression.

- $(9y)^2 =$ _____
- $(3b)^4 =$ _____
- $(2a)^5 =$ _____

- ARTIFACT** A display case for the artifact is in the shape of a cube. Each side of the display case is four times the side length of the artifact. Write and simplify an expression for the volume of the case. _____

