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

1. $5^2 \cdot 5^5 = 5^{2+5} = 5^7$
2. $(-3)^8 \cdot (-3)^2 = (-3)^{8+2} = (-3)^{10}$
3. $(7^2)^3 = 7^2 \cdot 7^2 \cdot 7^2 = 7^{2+2+2} = 7^6$
4. $(y^3)^4 = y^3 \cdot y^3 \cdot y^3 \cdot y^3 = y^{3+3+3+3} = y^{12}$
5. $(3x)^3 = 3x \cdot 3x \cdot 3x$

   $= (3 \cdot 3 \cdot 3) \cdot (x \cdot x \cdot x)$

   $= 3^3 \cdot x^3$

   $= 27x^3$

Application Example

6. 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.

   Total number of bytes = Number of bytes in a gigabyte · Number of gigabytes

   $= 2^{30} \cdot 2^7$

   $= 2^{30+7}$

   $= 2^{37}$

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

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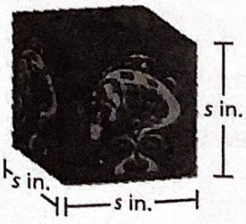
Simplify the expression. Write your answer as a power.

7. $8^3 \cdot 8^6 =$ 8^9
8. $3^4 \cdot 3^2 =$ 3^6
9. $6^7 \cdot 6^5 =$ 6^{12}
10. $(-5)^3 \cdot (-5)^7 =$ $(-5)^{10}$
11. $(-10)^6 \cdot (-10)^2 =$ $(-10)^8$
12. $(-2)^4 \cdot (-2)^5 =$ $(-2)^9$
13. $(9^4)^3 =$ 9^{12}
14. $(4^5)^3 =$ 4^{15}
15. $(12^3)^2 =$ 12^6
16. $(z^3)^3 =$ z^9
17. $(n^5)^2 =$ n^{10}
18. $(w^2)^4 =$ w^8

Simplify the expression.

19. $(9y)^2 =$ $9^2y^2 = 81y^2$
20. $(3b)^4 =$ $3^4b^4 = 81b^4$
21. $(2a)^5 =$ $2^5a^5 = 32a^5$

22. **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. $(4s)^3 = 64s^3$



volume of cube is $l \cdot w \cdot h$

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

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

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

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

$$= (-4)^2$$

Skill Examples

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

Application Example

4. 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.

$$\text{People per square mile} = \frac{4 \cdot 5^6}{5^4}$$

$$= 4 \cdot \frac{5^6}{5^4}$$

$$= 4 \cdot 5^2$$

$$= 100$$

∴ There are about 100 people per square mile.

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Simplify the expression. Write your answer as a power.

5. $\frac{9^5}{9^4} =$ 9^1
6. $\frac{4^6}{4^2} =$ 4^4
7. $\frac{2^7}{2^5} =$ 2^2
8. $\frac{(-6)^7}{(-6)^3} =$ $(-6)^4$
9. $\frac{(-3)^8}{(-3)^5} =$ $(-3)^3$
10. $\frac{(-8)^4}{(-8)^3} =$ $(-8)^1$
11. $\frac{n^9}{n^5} =$ n^4
12. $\frac{b^8}{b^2} =$ b^6
13. $\frac{y^{12}}{y^7} =$ y^5
14. $\frac{6^5 \cdot 6^2}{6^6} =$ $\frac{6^7}{6^6} = 6^1$
15. $\frac{5^4 \cdot 5^5}{5^7} =$ $\frac{5^9}{5^7} = 5^2$
16. $\frac{a^8}{a^2 \cdot a^4} =$ $\frac{a^8}{a^6} = a^2$
17. $\frac{3^{10}}{3^4} \cdot \frac{3^7}{3^5} =$ $3^6 \cdot 3^2 = 3^8$
18. $\frac{8^5}{8^2} \cdot \frac{8^7}{8^3} =$ $8^3 \cdot 8^4 = 8^7$
19. $\frac{w^{14}}{w^3} \cdot \frac{w^6}{w^4} =$ $w^{11} \cdot w^2 = w^{13}$

20. **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? _____

$$\frac{10^{11}}{10^7} = 10^4$$