Ch 8.4 Powers to Powers

Activity: Powers of Powers

You can use what you learned in the previous lesson to find a shortcut for simplifying expressions with powers. Copy and complete each statement.

1. $(3^6)^2 = 3^6 \cdot 3^6 = 3^{\blacksquare + \blacksquare} = 3^{6 \cdot \blacksquare} = 3^{\blacksquare}$
2. $(5^4)^3 = 5^4 \cdot 5^4 \cdot 5^4 = 5^{\blacksquare + \blacksquare + \blacksquare} = 5^{4 \cdot \blacksquare} = 5^{\blacksquare}$
3. $(2^7)^4 = 2^7 \cdot 2^7 \cdot 2^7 \cdot 2^7 = 2^{\blacksquare + \blacksquare + \blacksquare + \blacksquare} = 2^{7 \cdot \blacksquare} = 2^{\blacksquare}$
4. $(a^3)^2 = a^3 \cdot a^3 = a^{\blacksquare + \blacksquare} = a^{3 \cdot \blacksquare} = a^{\blacksquare}$
5. $(g^4)^3 = g^4 \cdot g^4 \cdot g^4 = g^{\blacksquare + \blacksquare + \blacksquare} = g^{4 \cdot \blacksquare} = g^{\blacksquare}$
6. $(c^3)^4 = c^3 \cdot c^3 \cdot c^3 \cdot c^3 = c^{\blacksquare + \blacksquare + \blacksquare + \blacksquare} = c^{3 \cdot \blacksquare} = c^{\blacksquare}$

7. a. **Make a Conjecture** What pattern do you see in your answers to Questions 1–6?
   b. Use your pattern to simplify $(8^6)^3$.

Property **Raising a Power to a Power**

For every nonzero number a and integers m and n, $(a^m)^n = a^{mn}$.

Examples $(5^4)^2 = 5^{4 \cdot 2} = 5^8$ $(x^2)^5 = x^{2 \cdot 5} = x^{10}$

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1 EXAMPLE Simplifying a Power Raised to a Power

Simplify $(x^3)^6$.

$(x^3)^6 =$

$=$

1 Simplify $(a^4)^7$ and $(a^{-4})^7$.

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2 EXAMPLE Simplifying an Expression With Powers

Simplify $c^5(c^3)^{-2}$.

$c^5(c^3)^{-2} =$ [redacted]

2 Simplify each expression. a. $t^2(t^7)^{-2}$ b. $(a^4)^2 \cdot (a^2)^5$

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You can use repeated multiplication to simplify expressions like $(5y)^3$.

$(5y)^3 = 5y \cdot 5y \cdot 5y$ or $5y \cdot 5y \cdot 5y$

$= 5 \cdot 5 \cdot 5 \cdot y \cdot y \cdot y$

$= 5^3y^3$

$= 125y^3$

Notice that $(5y)^3 = 5^3y^3$. This illustrates another property of exponents.

Property **Raising a Product to a Power**

For every nonzero number a and b and integer n, $(ab)^n = a^nb^n$.

Example $(3x)^4 = 3^4x^4 = 81x^4$

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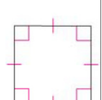
3 EXAMPLE Simplifying a Product Raised to a Power

Multiple Choice Which expression represents the area of the square?

(A) $8x^4$ (B) $2x^8$ (C) $4x^6$ (D) $4x^8$



$2x^4$

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4 EXAMPLE Simplifying a Product Raised to a Power

Simplify $(x^{-2})^2(3xy^2)^4$.

$(x^{-2})^2(3xy^2)^4 =$ [redacted]

4 Simplify each expression.

a. $(c^2)^3(3c^5)^4$ b. $(2a^3)^5(3ab^2)^3$ c. $(6mn)^3(5m^{-3})^2$

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5 EXAMPLE **Real-World Problem Solving**

Physical Science All objects, even resting ones, contain energy. A raisin has a mass of 10^{-3} kg. The expression $10^{-3} \cdot (3 \times 10^8)^2$ describes the amount of resting energy in joules the raisin contains. Simplify the expression.

$$10^{-3} \cdot (3 \times 10^8)^2 = 10^{-3} \cdot 3^2 \cdot (10^8)^2$$
$$= 10^{-3} \cdot 3^2 \cdot 10^{16}$$
$$= 3^2 \cdot 10^{-3} \cdot 10^{16}$$
$$= 3^2 \cdot 10^{-3+16}$$
$$= 9 \times 10^{13}$$

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5 **Energy** An hour of television use consumes 1.45×10^{-1} kWh (kilowatt-hour) of electricity. Each kilowatt-hour of electric use is equivalent to 3.6×10^6 joules of energy.

a. Simplify the expression $(1.45 \times 10^{-1})(3.6 \times 10^6)$ to find how many joules a television uses in 1 hour.

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