7.1 Exponent Rules

A Multiplication notation

Multiplication notation is shortcut for repetitive addition.

Examples:

a) $10 + 10 + 10 = 3(10)$

b) $x + x + x + x = 4x$

c) ☺+☺+☺=3☺

Example 1. Use the multiplication notation to simplify.

a) $5 + 5 + 5 + 5 + 5 + 5 = 6(5) = 30$

b) $y + y + y + y + y + y + y + y = 8y$

c) ☺+☺+☺+☺+☺+☺+☺+☺+☺= 9 

B Exponential notation is a shortcut for repetitive multiplication.

Examples:

a) $10 \times 10 \times 10 \times 10 \times 10 = 10^5$

b) $x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x = x^7$

c) ■ × ■ × ■ × ■ × ■ = $■^4$

Example 2. Use the exponential notation to simplify.

a) $4 \times 4 \times 4 \times 4 = 4^4$

b) $a \cdot a \cdot a \cdot a \cdot a \cdot a = a^6$

c) $\Delta \times \Delta \times \Delta \times \Delta \times \Delta \times \Delta \times \Delta =$ Δ^7

$x \rightarrow$ times

$\cdot \nearrow$

$xxx = x \cdot x \cdot x$

$= x \times x \times x$

$= x^3$

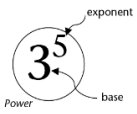
C Understanding the exponential notation

a^n

$a \Rightarrow$ base

$n \Rightarrow$ exponent

$a^n \Rightarrow$ power



D Multiplying powers with the same base

Example 3. Write as a single power and develop a rule.

$a^4a^3 = a \cdot a \cdot a \cdot a \cdot a \cdot a \cdot a = a^7$ $\Rightarrow$ $a^4 \cdot a^3 = a^{4+3} = a^7$

Conclusion:

$$a^m \times a^n = a^{m+n} \quad (1)$$

To multiply powers with the same base, keep the base the same and add the exponents.

Example 4. Write as a single power (simplify). Do not evaluate.

a) $10^5 \times 10^3 = 10^{5+3} = 10^8$

b) $7^4 \times 7^5 = 7^{4+5} = 7^9$

c) $3^{10} \times 3^{21} = 3^{10+21} = 10^{31}$

d) $x^2 \times x^6 = x^{2+6} = x^8$

e) $2^2 \times 2^3 \times 2^4 = 2^{2+3+4} = 2^9$

f) $a^3 \times a^4 \times a^1 \times a^5 = a^{3+4+1+5} = a^{13}$

Note. $a^1 = a$

E Dividing powers with the same base

Example 5. Write as a single power and develop a rule.

$a^4 \div a^3 = \frac{a^4}{a^3} = \frac{a \cdot a \cdot a \cdot a}{a \cdot a \cdot a} = a = a^1 = a^{4-3}$ (1)

$a \div b = \frac{a}{b}$

$\frac{a}{a} = 1$

Note. $a \div b = \frac{a}{b}$

Conclusion:

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

To divide powers with the same base, keep the base the same and subtract the exponents.

Example 6. Write as a single power (simplify). Do not evaluate.

a) $10^5 \div 10^3 = 10^{5-3} = 10^2$

b) $7^4 \div 7^5 = 7^{4-5} = 7^{-1} = \frac{1}{7}$

c) $3^{10} \div 3^2 = 3^{10-2} = 3^8$

d) $x^{10} \div x^6 = x^{10-6} = x^4$

F Power of a Power

Example 5. Write as a single power and develop a rule.

$(a^2)^3 =$ $a^2 \cdot a^2 \cdot a^2 = (a \cdot a)(a \cdot a)(a \cdot a) = a^6 = a^{2 \cdot 3}$

3 times

Conclusion:

$$(a^m)^n = a^{m \times n}$$

To simplify a power of a power, keep the base the same and multiply the exponents.

Example 6. Write as a single power (simplify). Do not evaluate.

$a)$ $(10^3)^4 =$ $10^{3 \cdot 4} = 10^{12}$

b) $(7^2)^6 =$ $7^{2 \cdot 6} = 7^{12}$

c) $(a^5)^2 =$ $a^{5 \cdot 2} = a^{10}$

d) $(x^3)^2 =$ $x^{3 \cdot 2} = x^6$

e) $(x^2)^3 =$ $x^{2 \cdot 3} = x^6$

$(x^3)^2 = (x^2)^3$

$3 \cdot 2 = 2 \cdot 3$

Example 7. Write as a single power (simplify). (Challenge)

a) $5^3 \times \frac{5^6}{5^2} =$ $5^3 \times 5^{6-2} = 5^3 \times 5^4 = 5^{3+4} = 5^7$

b) $3^5 \times (3^2)^4 =$ $3^5 \times 3^{2 \cdot 4} = 3^5 \times 3^8 = 3^{5+8} = 3^{13}$

c) $(7^4)^4 \div (7^3)^3$ $= 7^{4 \cdot 4} \div 7^{3 \cdot 3}$

$= 7^{16} \div 7^9$

$= 7^{16-9}$

$= 7^7$

Notes: Textbook Pages 356-360

Homework: Textbook Pages 360 #1abc, 2abc, 3ab, 5abcd

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