Section 9.1 Multiplication Properties of Exponents

1. **Property One for Exponents**: If \( r \) and \( s \) are any two whole numbers and \( a \) is an integer, then it is true that:
\[
a^r \cdot a^s = a^{r+s}
\]
Example 1: Simplify each of the following.
   a. \( x^2 x^4 \)
   b. \( x^3 x^5 \)
   c. \( 2x^2 \cdot 3x^4 \)

2. **Property Two for Exponents**: If \( r \) and \( s \) are any two whole numbers and \( a \) is an integer, then it is true that:
\[
(a^r)^s = a^{rs}
\]
Example 2: Simplify each of the following.
   a. \( (x^3)^4 \)
   b. \( 2(x^3)^5 \)

3. **Property Three for Exponents**: If \( r \) is a whole number and \( a \) and \( b \) are integers, then it is true that:
\[
(ab)^r = a^r b^r
\]
Example 3: Simplify each of the following.

a. \((2x)^3\)

b. \((4x^5)^2\)

4. Simplifying Using More Than One Property: Use the order of operations agreement and the three multiplication properties of exponents to simplify.

Example 4: In each of the following identify the property used in each step.

a. \((2x^2y^3)(3x^5y^4) = (2 \cdot 3)(x^2x^5)(y^3y^4)\)
   
   \[= 6x^7y^7\]

b. \((3x^3y^2)^4 = 3^4 \cdot (x^3)^4 \cdot (y^2)^4\)
   
   \[= 81x^{12}y^8\]

Example 5: Simplify each of the following.

a. \((4x^3y^5)^2\)

b. \((3x^2y)^2(2x^3y^2)^3\)
Practice Problems. Use the Multiplication Properties of Exponents to simplify each of the following:

a. \(4x^3 \cdot 5x^5\)

b. \((a^4)^5\)

c. \((5x)^3\)

d. \((2x^3)^2 (4x^5)\)

e. \((2xy^2)(5x^3y^4)\)

Answers to Practice Problems
a. \(20x^8\); b. \(x^{20}\); c. \(125x^3\); d. \(16x^{11}\); e. \(10 x^4 y^6\)

Note: Portions of this document are excerpted from the textbook *Prealgebra*, 7th ed. by Charles McKeague