**CAUTION**

Many errors can be made in applying the properties of exponents as a result of forgetting the exact form of the properties. The first column below contains examples of some common errors. The second column contains the corrected statements.

| Incorrect | Correct |
|---|---|
| $x^2x^5 = x^{10}$ | $x^2x^5 = x^{2+5} = x^7$ |
| $2^42^3 = 4^7$ | $2^42^3 = 2^{4+3} = 2^7$ |
| $(3+4)^2 = 3^2 + 4^2$ | $(3+4)^2 = 7^2$ |
| $(x^2+3y)^{-1} = \frac{1}{x^2} + \frac{1}{3y}$ | $(x^2+3y)^{-1} = \frac{1}{x^2+3y}$ |
| $(3x)^2 = 3x^2$ | $(3x)^2 = 3^2x^2 = 9x^2$ |
| $\frac{x^5}{x^{-2}} = x^3$ | $\frac{x^5}{x^{-2}} = x^{5-(-2)} = x^7$ |

**c.** $\dfrac{\left(-2x^3y^{-1}\right)^{-3}}{\left(18x^{-3}\right)^0\left(xy\right)^{-2}} = \dfrac{\left(-2\right)^{-3}x^{-9}y^3}{x^{-2}y^{-2}}$

Begin by applying Property 4 in the numerator, Property 5 in the denominator.

$= \left(-2\right)^{-3}x^{-9-(-2)}y^{3-(-2)}$

Then simplify using Property 2.

$= \left(-2\right)^{-3}x^{-7}y^5$

$= \dfrac{y^5}{-8x^7}$

Unlike the previous example, Property 3 gets applied at the very end.

$= -\dfrac{y^5}{8x^7}$

**d.** $\left(7xz^{-2}\right)^2\left(5x^2y\right)^{-1} = \dfrac{49x^2z^{-4}}{5x^2y}$

$= \dfrac{49}{5yz^4}$

Note that the variable $x$ no longer appears in the expression.

## 0.3 EXERCISES

### PRACTICE

Simplify each of the following expressions, writing your answer with only positive exponents. See Examples 1 and 2.

**1.** $\left(-2\right)^4$ **2.** $-2^4$ **3.** $-3^2$ **4.** $\left(-3\right)^2$

**5.** $3^2 \cdot 3^2$ **6.** $2^3 \cdot 3^2$ **7.** $4 \cdot 4^2$ **8.** $\left(-3\right)^3$

**9.** $\dfrac{8^2}{4^3}$ **10.** $2^2 \cdot 2^3$ **11.** $\dfrac{7^4}{7^5}$ **12.** $n^2 \cdot n^5$

**13.** $\dfrac{x^5}{x^2}$ **14.** $\dfrac{y^3 \cdot y^8}{y^2}$ **15.** $\dfrac{3^7}{3^4s^{-10}}$

Use the properties of exponents to simplify each of the following expressions, writing your answer with only positive exponents. See Examples 1, 2, and 3.

**16.** $\dfrac{3t^{-2}}{t^3}$ **17.** $-2y^0$ **18.** $\dfrac{1}{7x^{-5}}$

**19.** $9^0x^3y^0$ **20.** $\dfrac{2n^3}{n^{-5}}$ **21.** $\dfrac{11^{21}}{11^{19}x^{-7}}$

**22.** $\dfrac{x^7y^{-3}z^{12}}{x^{-1}z^9}$ **23.** $\dfrac{x^4\left(-x^{-3}\right)}{-y^0}$ **24.** $\dfrac{s^3}{s^{-2}}$

**25.** $\dfrac{x^{-1}}{x}$ **26.** $x^{(y^0)}x^9$ **27.** $\dfrac{x^2y^{-2}}{x^{-1}y^{-5}}$

**28.** $\dfrac{s^5 y^{-5} z^{-11}}{s^8 y^{-7}}$

**29.** $\dfrac{2^7 s^{-3}}{2^3}$

**30.** $\dfrac{3^{-5}}{\left(3^{-4} x^5 y^4\right)^2}$

**31.** $\dfrac{-9^0 \left(x^2 y^{-2}\right)^{-3}}{3x^{-4} y}$

**32.** $\left[\left(2x^{-1} z^3\right)^{-2}\right]^{-1}$

**33.** $\dfrac{\left(3yz^{-2}\right)^0}{3y^2 z}$

**34.** $\left(12a^2 - 3b^4\right)^0$

**35.** $\dfrac{3^{-1}}{\left(3^2 xy^2\right)^{-2}}$

**36.** $\left[9m^2 - \left(2n^2\right)^3\right]^{-1}$

**37.** $\left[\left(12x^{-6} y^4 z^3\right)^5\right]^0$

**38.** $\dfrac{x\left(x^{-2} y^3\right)^3}{\left(2x^4\right)^{-2} y}$

**39.** $\dfrac{(-3a)^{-2}\left(bc^{-2}\right)^{-3}}{a^5 c^4}$

**40.** $\left[\left(5m^4 n^{-2}\right)^{-1}\right]^{-2}$

**41.** $\left(9x^{-1} z\right)^2 \left(2xy^{-3}\right)^{-1}$

**42.** $\left(4^{-2} x^5 y^{-3} z^4\right)^{-2}$

**43.** $\left[\left(4a^2 b^{-5}\right)^{-1}\right]^{-3}$

**44.** $\left[\left(2^{-3} m^{-6} n^3\right)^3\right]^{-1}$

**45.** $\left[\left(3^{-1} x^{-1} y\right)\left(x^2 y\right)^{-1}\right]^{-3}$

**46.** $\left[\dfrac{100^0 \left(x^{-1} y^3\right)^{-1}}{x^2 y}\right]^{-3}$

**47.** $\left(5z^6 - \left(3x^3\right)^4\right)^{-1}$

**48.** $\left[\dfrac{y^6 \left(xy^2\right)^{-3}}{3x^{-3} z}\right]^{-2}$

## WRITING & THINKING

**49.** In your own words, explain why $a^0 = 1$.

Apply the definition of integer exponents to demonstrate the following properties.

**50.** $a^n \cdot a^m = a^{n+m}$

**51.** $\left(a^n\right)^m = a^{nm}$

**52.** $(ab)^n = a^n b^n$