1 EXAMPLE **Simplify each expression.**

a. $\dfrac{x^4}{x^9} = x^{4-9}$ Subtract exponents when dividing powers with the same base.

$\quad = x^{-5}$ Simplify the exponents.

$\quad = \dfrac{1}{x^5}$ Rewrite using positive exponents.

b. $\dfrac{p^3 j^{-4}}{p^{-3} j^6} = p^{3-(-3)} j^{-4-6}$ Subtract exponents when dividing powers with the same base.

$\quad = p^6 j^{-10}$ Simplify.

$\quad = \dfrac{p^6}{j^{10}}$ Rewrite using positive exponents.

2 EXAMPLE A small dog's heart beats about 64 million beats in a year. If there are about 530 thousand minutes in a year, what is its average heart rate in beats per minute?

$$\frac{64 \text{ million beats}}{530 \text{ thousand min}} = \frac{6.4 \times 10^7 \text{ beats}}{5.3 \times 10^5 \text{ min}}$$ Write in scientific notation.

$$= \frac{6.4}{5.3} \times 10^{7-5}$$ Subtract exponents when dividing powers with the same base.

$$= \frac{6.4}{5.3} \times 10^2$$ Simplify the exponent.

$$\approx 1.21 \times 10^2$$ Divide. Round to the nearest hundredth.

$$= 121$$ Write in standard notation.

The dog's average heart rate is about 121 beats per minute.

3 EXAMPLE Simplify $\left(\dfrac{3}{y^3}\right)^4$.

$$\left(\frac{3}{y^3}\right)^4 = \frac{3^4}{(y^3)^4}$$ Raise the numerator and the denominator to the fourth power.

$$= \frac{3^4}{y^{12}}$$ Multiply the exponent in the denominator.

$$= \frac{81}{y^{12}}$$ Simplify.

4 EXAMPLE   a. Simplify $\left(\dfrac{2}{3}\right)^{-3}$.

$\left(\dfrac{2}{3}\right)^{-3} = \left(\dfrac{3}{2}\right)^{3}$ Rewrite using the reciprocal of $\dfrac{2}{3}$.

$\quad = \dfrac{3^3}{2^3}$ Raise the numerator and the denominator to the third power.

$\quad = \dfrac{27}{8}$ or $3\dfrac{3}{8}$ Simplify.

b. Simplify $\left(-\dfrac{4b}{c}\right)^{-2}$.

$\left(-\dfrac{4b}{c}\right)^{-2} = \left(-\dfrac{c}{4b}\right)^{2}$ Rewrite using the reciprocal of $-\dfrac{4b}{c}$.

$\quad = \left(-\dfrac{c}{4b}\right)^{2}$ Write the fraction with a negative numerator.

$\quad = \dfrac{(-c)^2}{(4b)^2}$ Raise the numerator and denominator to the second power.

$\quad = \dfrac{c^2}{16b^2}$ Simplify.