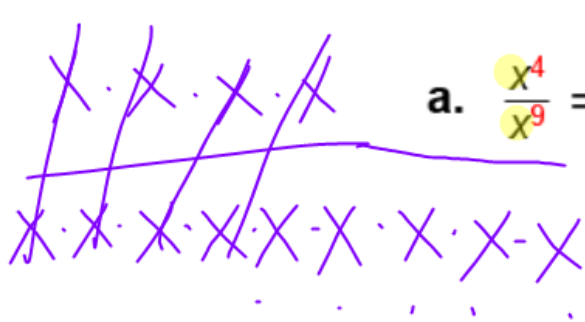




**1 EXAMPLE** Simplify each expression.



$$\text{a. } \frac{x^4}{x^9} = x^{4-9} = x^{-5} = \frac{1}{x^5}$$

$$\text{b. } \frac{p^{3j-4}}{p^{-3j}j^6}$$

$3 - (-3) \cdot -4 = 6$

$$\frac{p^6}{j^{10}}$$

$$\frac{2^3 x^7}{2^1 x^4} = 2^{3-1} x^{7-4}$$
$$2^2 x^3$$
$$\boxed{4x^3}$$

**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?

$$64,000,000 \div 530,000$$

$$\frac{6.4 \times 10^7}{5.3 \times 10^5} = \frac{1.2 \times 10^2 \text{ beats}}{1 \text{ min.}}$$

$$\frac{9 \times 10^{17}}{3 \times 10^5}$$

$$3 \times 10^{12}$$

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

$$(y^3)^4$$

$$\frac{3^4}{y^{12}} = \frac{81}{y^{12}}$$

$$(X^5)^3$$

$$\left( \frac{3^2 X}{X^5} \right)^3$$

$$(3^2)^3$$

$$\frac{3^6 X^3}{X^{15}}$$

$$= \frac{729 X^3}{X^{15}}$$

$$X^{3-15}$$

$$= \frac{729 X^{-12}}{1}$$

$$\boxed{\frac{729}{X^{12}}}$$

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

$$\frac{2^{-3}}{3^{-3}}$$

$$\frac{3^3}{2^3}$$

$$\left(\frac{3}{2}\right)^3$$

$$\frac{3^3}{2^3} = \boxed{\frac{27}{8}}$$

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

$$\left(\frac{-c}{4b}\right)^2$$

$$= \frac{(-c)^2}{4^2 b^2} = \boxed{\frac{c^2}{16b^2}}$$



$$\left( \frac{x^{-2}}{2y^{-6}} \right)^{-1} = \left( \frac{2y^{-6}}{x^{-2}} \right)^1 = \frac{2y^{-6}}{x^{-2}} = \frac{2x^2}{y^6}$$

Homework: pg. 456 #4, 10, 12, 14, 18, 24, 28, 32, 43, 56, 98

$$4) \frac{5^3 5^2}{5^2 5^3} = \boxed{5^0} = 1$$

$$10) \frac{x^{13} y^2}{x^{13} y} = x^0 y^1 = \boxed{y}$$

$$12) \frac{3^2 3^3 t^6}{3^5 m^7 t^{-5}} = 3^{2-5} m^{3-7} t^{6-(-5)} = 3^{-3} m^{-4} t^{11} = \frac{t^{11}}{3^3 m^4} = \boxed{\frac{t^{11}}{27 m^4}}$$

$$14) 0.3 \times 10^{-4-1} = \boxed{3 \times 10^{-5}}$$

$$32) \left(-\frac{2}{3}\right)^{-3}$$

$$\frac{(-2)^{-3}}{3^{-3}} = \frac{3^3}{(-2)^3} = \boxed{\frac{27}{-8}}$$

$$18) 7 \times 10^{-3} \quad 0.7$$

$$24) \frac{81 a^4}{16 b^4}$$

$$43) \left(\frac{2m^5}{m^2}\right)^{-4} = \frac{2^{-4} m^{-20}}{m^{-8}} = \frac{m^8}{2^4 m^{20}}$$

$$\frac{m^8}{16 m^{20}} = \boxed{\frac{1}{16 m^{12}}}$$

$$28) \frac{2^3 p^3}{5^3} = \boxed{\frac{8 p^3}{125}}$$

$$56) \left(\frac{p^{-2} q^4 r}{p^3 q^5}\right)^5 = \frac{p^{-10} q^{20} r^5}{p^{15} q^{25}} = \frac{p^{-10-15} q^{20-25} r^5}{p^{-25} q^{-5} r^5} = \boxed{\frac{r^5}{p^{25} q^5}}$$

$$98) (\text{mm})^0 = \boxed{1}$$