

### Section 1.4: Exponents and Radicals

Let  $n$  be a natural number. Then the exponential expression  $x^n$  is defined by  $x^n = x * x * x * \dots * x$ .

$x^n$  is read as “ $x$  to the  $n$ th power”.

**Examples:**  $2^4 = 2*2*2*2 = 16$ ,  $(-3)^2 = (-3)(-3) = 9$

$$4^3 = \quad \quad \quad (-5)^2 = \quad \quad \quad -5^2 =$$

#### Rules for Exponents:

Multiplying Powers:

$$a^m \times a^n = a^{m+n}$$

Dividing Powers:

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

Negative Powers:

$$a^{-m} = \frac{1}{a^m} \text{ and } \frac{1}{a^{-n}} = a^n$$

Power Rule:

$$(a^m)^n = a^{mn}$$

Zero Power Rule:

$$a^0 = 1$$

*Note:* If no power is shown, then the exponent is 1.

**Examples:** Simply having no negative exponents.

1.  $(4)(4^3)$

2.  $(c^3d^4)(c^5d^2)$

3.  $\frac{a^5b^{16}c^7}{a^9b^8c^{12}}$

4.  $6x^{-3}$

5.  $\frac{30e^{-4}f^3}{5(f^4)^{-1}}$

6.  $\frac{3}{5^{-2}}$

7.  $\frac{y^{-6}}{y^{-8}}$

8.  $\left(\frac{3}{7}\right)^{-1}$

9.  $\frac{12x^3y^0z^{-4}}{18x^3y^{-3}z^4}$

10.  $\left(\frac{4x^4}{16x^3y}\right)^{-1}$

11.  $\left(\frac{24x^3y^{-8}z^4}{476x^{-3}y^2z^4}\right)^0$

12.  $(3^24^3)^8$

13.  $(6a^2b^{-2}c^4)^2$

14.  $\frac{(mn^3)^{-2}}{(n^4)^2}$

### Simplifying Radicals

A number  $y$  is called the **square root** of a number  $x$  if  $y^2 = x$ .

$(-4)^2 = 4^2 = 16$ . So, 4 and -4 are both square roots of 16.

In general, if  $x > 0$ , then  $x$  has two square roots. However, we use the symbol  $\sqrt{x}$  for the “principal square root”, which is the positive square root of  $x$ .

**Examples:** Simplify the following.

1.  $\sqrt{36}$

2.  $\sqrt{121}$

3.  $\sqrt{18}$

4.  $\sqrt{75}$

5.  $\sqrt{10^2}$

6.  $\sqrt{64} - 2^2$

**Notation:**  $x^{1/2} = \sqrt{x}$

7.  $81^{1/2}$

8.  $144^{1/2} + 49^{1/2} - \sqrt{169}$