

## Exponent Rules

### A. Exploring Exponential Patterns

Studying the patterns that are found in expressions with exponents can help you remember the rules for evaluating expressions with integer exponents.

$$\left. \begin{aligned} 3^4 &= 3 \cdot 3 \cdot 3 \cdot 3 = 81 \\ 3^3 &= 3 \cdot 3 \cdot 3 = 27 \\ 3^2 &= 3 \cdot 3 = 9 \\ 3^1 &= 3 \\ 3^0 &= 1 \\ 3^{-1} &= \frac{1}{3} \\ 3^{-2} &= \frac{1}{3 \cdot 3} = \frac{1}{9} \\ 3^{-3} &= \frac{1}{3 \cdot 3 \cdot 3} = \frac{1}{27} \\ 3^{-4} &= \frac{1}{3 \cdot 3 \cdot 3 \cdot 3} = \frac{1}{81} \end{aligned} \right\}$$

**Positive exponents:** The answer is the base multiplied by itself the number of times identified by the exponent.

**Zero exponent:** The answer is always 1 (if the base is not 0;  $0^0$  is undefined).

**Negative exponents:** The answer is the *reciprocal* of the same expression with a positive exponent.

\*Rules are the same when the base is a variable. For example:

$$b^3 = b \cdot b \cdot b \qquad g^0 = 1 \qquad k^{-5} = \frac{1}{k^5} \qquad \frac{1}{m^{-3}} = m^3$$

### B. Exponential Formulas

$$a^0 = 1$$

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

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

$$a^{-n} = \frac{1}{a^n}$$

$$\frac{1}{a^{-n}} = a^n$$

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

$$(ab)^n = a^n b^n$$

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$$

## Exponent Properties ~ Notes

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Simplify completely. There should be no negative exponents in final answers.

$$1) \frac{(xy^{-1})^2 \cdot x^0}{x^3} =$$

$$2) \left( \frac{3x^{-2}y^0}{x^{-2}} \right)^3 =$$

$$3) \frac{(ab^{-10})^0}{10^{-1} \cdot ab} =$$

$$4) (3m^{-3}n^2) (-4mn^{-4}) =$$

**Simplify. Your answer should contain only positive exponents.**

1)  $2n^2 \cdot n$

2)  $3p^2 \cdot p^0$

3)  $k^2 k^{-3}$

4)  $(x^3)^{-2}$

5)  $(2m^3)^3$

6)  $(3b^3)^{-2}$

7)  $\frac{3n^3}{3n}$

8)  $\frac{k^3}{2k^{-2}}$

9)  $\frac{3x^3}{x^{-2}}$

10)  $\left(\frac{3b^0}{3b^0 \cdot 3b^2}\right)^3$

11)  $\frac{2r^{-1} \cdot (r^3)^{-3}}{2r^{-3}}$

12)  $\frac{3a^2 \cdot 2a^{-3}}{(3a^{-3})^{-3}}$

**Exponent Property Word Problems**      **Name:** \_\_\_\_\_

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Keep your answers in exponential form.

#1

A plot of land has  $6^{14}$  blades of grass. If the plot of land has been evenly divided into  $6^3$  sections, how many blades of grass are in each section of grass? Leave your answer in the form  $a^b$

#2

The population of the Vatican is  $10^{-4}$  million, and the population of India is  $10^3$  million. How many times more is the population of India than the Vatican? Leave your answer in the form  $a^b$

#3

When a caterpillar larvae hatches, it weighs only  $10^{-2}$  grams. However, each day it is able to eat  $10^4$  times its initial body weight. How many grams of food can the larvae eat each day? Leave your answer in the form  $a^b$ .

#4

A seed on a dandelion flower weighs  $10^{-3}$  grams. A dandelion itself can weigh up to  $10^3$  grams. How many times heavier is a dandelion than its seeds? Leave your answer in the form  $a^b$

#5

A student spends  $\$10^{-1}$  every day. How much will he spend in  $10^3$  days?