

Exponents: (x)^{Exponent}

- Exponents occur when a number is _____ by itself many times.
ex. $2 \times 2 \times 2 \times 2 \times 2 = 2^5$
- It is a _____ form to avoid writing out all of the numbers.
ex. 2^5

More examples:

- $5 \times 5 = 5^2$
- $6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6 = 6^7$
- $xy^3 = (xy)(xy)(xy)$
- $8 \times 8 \times 8 = 8^3$
- $(y)(y)(y)(y) = y^4$
- $(-9x)^5 = (-9x)(-9x)(-9x)(-9x)(-9x)$

A FEW RULES...

1. Anything to the power of zero is ALWAYS just 1.

ex. $7^0 = 1$ $x^0 = 1$

2. Simplifying LIKE terms:

- * when you are **multiplying like** (the same) terms (x, x)

$$\begin{aligned} &(x^3)(x^4) \\ &= (xxx)(xxxx) \quad \text{or} \quad (x)^m(x)^n \\ &= (xxxxxxxx) \quad \quad \quad = x^{(m+n)} \\ &= x^7 \end{aligned}$$

Example: $(4^3)(4^4)$

$$\begin{aligned} &= (4 \times 4 \times 4)(4 \times 4 \times 4 \times 4) \\ &= 4^7 \\ &= 16384 \end{aligned}$$

* Remember:
Simplify means reduce.
Evaluate means solve.
 $(x^6)(x) = x^7$
because
 $x = x^1$

- * this rule will not work if you are multiplying **unlike** terms (x, y)

Ex. $(x^3)(y^4) = (xxx)(yyyy)$

- * when you are **dividing like** terms (x, x)

ex. $x^{10} \div x^4 = x^{(10-4)} = x^6$

3. Simplifying powers of powers:

$$\begin{aligned} &(x^2)^4 \\ &= (x^2)(x^2)(x^2)(x^2) \quad \text{or: } (x^2)^4 = x^{(2 \times 4)} \\ &= (xx)(xx)(xx)(xx) \\ &= x^8 \end{aligned}$$

Examples:

a) $(xy^2)^3 = (xy^2)(xy^2)(xy^2)$

$$\begin{aligned} &= (xxx)(y^2y^2y^2) \\ &= (xxx)(yyyyy) \\ &= x^3y^6 \quad \text{or: } (x)^3(y^2)^3 \end{aligned}$$

b) $\left(\frac{x}{y}\right)^2 = \frac{x^2}{y^2}$

* note: this multiplication rule does not apply when there are numbers either added or subtracted in the brackets.

Ex. $(3+4)^2$
 $= (7)^2$
 $= 49$

What if you don't know one of the numbers (variables) in the brackets?

- Write it out fully to start...

Ex. $(x-2)^2$
 $= (x-2)(x-2)$

- rule: What is in the first bracket, must be multiplied to the other

Ex. $(x-2)(x-2)$
 $= (x \ x)(-2x)(-2x)(4)$
 $= x^2 - 4x + 4$

Hints to remember...

a) combine like terms into powers. (ex. $xx = x^2$)

b) are you starting above or below zero when you add or subtract? (ex. $-2 + 4 = 2$)

c) if you are multiplying an **ODD** amount of negative numbers, the answer will be negative

ex. $(-3)^3 = -27$

if you are multiplying an **EVEN** amount of negative numbers, the answer will be positive

ex. $(-3)^4 = 81$

① Use the laws of exponents to simplify the following:

a) $2^9 \times 2^5 \times 2^8$

b) $y^5 \times y^8$

c) $z^6 \times z$

d) $3^8 \times 3^7$

e) $4^{12} \times 4^5 \times 4^{10}$

f) $a^2 \times a^6 \times a^2$

g) $a^{10} \times b^7 \times a^{15} \times b^9$

h) $3^3 \times 3$

i) $2 \times 2^2 \times 2^4$

j) $(\frac{1}{2})^3 \times (\frac{1}{2})^2$

k) $(z^4)(z^9)(z)$

l) $(3)^4(3)$

m) $(-2)^4(-2)^2$

n) $(-8)^5(-8)^3$

o) $\frac{(4)^2(4)^3}{(4)}$

p) $\frac{10^8}{10^2}$

q) $(4)^4 \div (4)^4$

r) $12^2 \left(\frac{12^6}{12^5}\right)$

s) $\sqrt[4]{\frac{6}{2}}$

t) $3^8 \div 3^5$

u) $\frac{(-3.02)^4}{(-3.02)^3}$

v) $\frac{a^7}{a^4}$

w) $(y^4)(z^{10})$

x) $\sqrt[4]{\frac{9}{4}}$

② Use the laws of exponents to evaluate the following

a) $2^8 \times 2^2$

b) $\frac{4^7}{4^4}$

c) $(\frac{1}{10})^3 (\frac{1}{10}) (\frac{1}{10})^2$

d) $\frac{(5^6)(5^2)}{(5^5)}$

e) $\frac{(7^{12})(7^{32})}{(7^{41})}$

f) $\frac{(10^5)(10^8)}{(10^{10})}$

g) $\frac{9^{12}}{(9^4)(9^6)}$

h) $4^4 - 2^2$

i) $3^4 + 3^5$

③ Simplify the following:

a) $(10^5)^6$

b) $(3^2)^2$

c) $(12^7)^3$

d) $\left(\frac{10^4}{10^3}\right)^6$

④ Evaluate the following:

a) $(2^4)^8$

b) $(1.5^3)^7$

c) $(\frac{1}{2})^4$

d) $\left(\frac{0.99}{0.78^3}\right)^5$

⑤ Simplify the following:

a) $(xy^4)^9$

b) $(y^8 j^5 k^2)^{10}$

c) $\left(\frac{m^2 r^3 p^1}{s^2 t^2}\right)^3$

l) 2^{23} b) y^{13} c) z^7 d) 3^{15} e) 4^{27}

f) a^{20} g) $(a^{25})(b^{16})$ h) 3^4 i) 2^7

j) $(\frac{13}{23})(\frac{12}{22})$ k) z^{14} l) 3^5 m) $(-2)^6$

n) $(-8)^8$ o) $\frac{4^5}{4^1}$ p) 10^6 q) $\frac{4^4}{4^4} = 4^0 = 1$

r) $12^2 (12)$
 $= 12^3$ s) y^4 t) 3^3 u) -3.02

v) a^3 w) $(y^4)(z^{10})$ x) y^5

2 a) 2^{10}
 $= 1024$ b) 4^3
 $= 64$ c) $(\frac{1}{10})^6 = \frac{1}{10^6} = \frac{1}{1000000}$

d) (5^3)
 $= 125$ e) $\frac{7^{44}}{7^{41}} = 7^3 = 343$ f) $10^3 = 1000$

g) 9^2
 $= 81$ h) $256 - 4$
 $= 252$ i) $81 + 243$
 $= 324$

3 a) (10^{30}) b) (3^4) c) $(12)^{21}$ d) $\frac{10^{24}}{10^{18}} = 10^6$

4 a) 2^{32}
 $= 4294967296$ b) $(1.5)^{21} = 4987.89$ c) $\frac{1^{16}}{2^4} = \frac{1}{16}$

d) $\frac{0.99^5}{0.28^{15}} = \frac{0.95}{0.02} = 47.5$ e)

5 a) $x^9 y^{13}$ b) $y^{80} j^{50} k^{26}$ c) $\frac{m^6 r^9 p^3}{s^6 t^6}$