

Exponents

- 1) $(-1)(-1)(-1)$
 2) $8 \cdot 8 \cdot 8 \cdot 6 \cdot 6 \cdot 6 \cdot 6$
 3) $(-1)(-1)(-1)$
 4) $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

Examples:

coefficients

↑

15x

Expanded Form and Exponential Form

Simplifying Powers

Evaluating Expressions

Zero Exponents

Negative Exponents

Multiplying Powers with the same base

Dividing Powers with the same base

Power of a Power

$12x^4 \rightarrow$ exponent/power
 $\downarrow \rightarrow$ base

coefficient

Examples:

Expanded Form	Exponential Form
1) $5 \cdot 5 \cdot 5 \cdot 5 \cdot 5$	$= 5^5$
2) $(-4)(-4)(-4)$	$= (-4)^3$
3) $8 \cdot 8 \cdot 8 \cdot p \cdot p \cdot p \cdot p$	$= 8^3 p^4$
4) $(\frac{1}{2})(\frac{1}{2})(\frac{1}{2})z \cdot z \cdot z \cdot z$	$= (\frac{1}{2})^3 z^4$

Ex 1) $3^4 = 3 \cdot 3 \cdot 3 \cdot 3 = \underline{81}$

Ex 2) $(\frac{1}{4})^2 = (\frac{1}{4})(\frac{1}{4}) = \frac{1}{16}$

Ex 3) $(-8)^2 = (-8)(-8) = 64$

Ex 4) $-2^3 = (-1) \cdot 2 \cdot 2 \cdot 2 = -8$

Ex 5) $3^2 u^6 = 3 \cdot 3 \cdot u \cdot u \cdot u \cdot u \cdot u \cdot u = 9u^6$

Ex 6) $(-6)^3 = (-6)(-6)(-6) = -216$

Simplifying Powers

Evaluating Expressions

Zero Exponents

Negative Exponents

Multiplying Powers with the same base ⁽ⁿ⁾

Dividing Powers with the same base

Power of a Power

Ex 1) $(-3)^2 = (-3)(-3) = 9$
 Ex 2) $(-3)^3 = (-3)(-3)(-3) = -27$
 Ex 3) $(-8)^2 = (-8)(-8) = 64$
 Ex 4) $(\frac{1}{2})^3 = (\frac{1}{2})(\frac{1}{2})(\frac{1}{2}) = \frac{1}{8}$
 Ex 5) $3^4 = 3 \cdot 3 \cdot 3 \cdot 3 = 81$

Step 1: Plug in all given numbers into the variables... use parenthesis!

Step 2: Solve using order of Operations

Ex 1) b^2 for $b = -7$
 $(-7)^2 = (-7)(-7) = \boxed{49}$

Ex 2) $x \div y^z$ for $x=9$ $y=3$
 and $z=2$
 $(9) \div (3)^2$
 $9 \div 9$
 $= \boxed{1}$

Ex 3) $x - y(z \cdot y^z)$ for $x=20$,
 $y=4$,
 and $z=2$
 $(20) - (4)((2) \cdot (4)^2)$
 $(20) - (4)(2 \cdot 16)$
 $(20) - (4)(32)$
 $20 - 128 = \boxed{-108}$

Evaluating Expressions

Zero Exponents

Negative Exponents

Multiplying Powers with the same base ¹ $n+1$

Dividing Powers with the same base

Power of a Power

* Any number or variable to the zero power equals 1!!

$$\text{Ex 1) } 3^0 = 1$$

$$\text{Ex 2) } (-0.25)^0 = 1$$

$$\text{Ex 3) } (-7)^0 = 1$$

$$\text{Ex 4) } -4^0 = (-1)(1) = -1$$

$$\text{Ex 5) } 3^0 \cdot 4 = 1 \cdot 4 = 4$$

$$\text{Ex 6) } 3a^0 = 3 \cdot 1 = 3$$

Zero Exponents

Negative Exponents

Multiplying Powers with the same base ¹ ^[n+]

Dividing Powers with the same base

* You cannot have a negative exponent!

- If there is a negative exponent, change the position (negative exponent in numerator \rightarrow denominator (bottom), negative exponent in denominator \rightarrow numerator (top))

- When you change the position, the exponent becomes positive.

* If it's not a fraction, put a 1 in the denominator and then move it!

$$\text{Ex 1) } 10^{-4} = \frac{10^{-4}}{1} = \frac{1}{10^4} \text{ or } \frac{1}{10,000}$$

$$\text{Ex 2) } 2^{-3} = \frac{2^{-3}}{1} = \frac{1}{2^3} = \frac{1}{8}$$

$$\text{Ex 3) } a^{-2}b^4 = \frac{a^{-2}b^4}{1} = \frac{b^4}{a^2}$$

Negative Exponents

Multiplying Powers with the same base ¹ ^[n⁺]

Dividing Powers with the same base

Power of a Power

$$5^3 \cdot 5^7 = 5^{3+7} = 5^{10}$$

$$5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 = 5^{10}$$

Rule: ① Keep the base
 ② Add the exponents
 Write in exponential form.

Ex 1) $5^4 \cdot 5^5 = 5^{4+5} = 5^9$

Ex 2) $b^{12} \cdot b^{12} = b^{12+12} = b^{24}$

Ex 3) $16 \cdot 16^{-7} = 16^1 \cdot 16^{-7} = 16^{1+(-7)} = 16^{-6} = \frac{1}{16^6}$

Ex 4) $4^2 \cdot 3^2 = 16 \cdot 9 = 144$

* Not like bases, just follow order of operations.

Ex 5) $a^2 b^4 \cdot a^7 b^3 = a^2 a^7 b^4 b^3 = a^{2+7} b^{4+3} = a^9 b^7$

Ex 6) $5h y^{-3} \cdot 7h^{-5} y^3 = 5 \cdot 7 \cdot h \cdot h^{-5} y^{-3} y^3$
 $= 35 h^{1+(-5)} y^{-3+3}$
 $= 35 h^{-4} y^0 = \frac{35 h^{-4} \cdot 1}{1} = \frac{35}{h^4}$

Multiplying Powers with the same base

Dividing Powers with the same base

Power of a Power

$$\frac{6^5}{6^3} = \frac{6 \cdot 6 \cdot 6 \cdot 6 \cdot 6}{6 \cdot 6 \cdot 6}$$

Rule: ① Keep the base
 ② subtract the exponents

$$\text{Ex 1)} \frac{6^9}{6^4} = 6^{9-4} = 6^5$$

$$\text{Ex 2)} \frac{b^m}{b^n} = b^{m-n}$$

$$\text{Ex 3)} \frac{10^8}{10^5} = 10^{8-5} = \boxed{10^3 \text{ or } 1000}$$

$$\text{Ex 4)} \frac{x^4}{x^9} = x^{4-9} = x^{-5} = \frac{1}{x^5}$$

$$\text{Ex 5)} \frac{x^{-3}}{x^5} = \frac{1}{x^3 \cdot x^5} = \frac{1}{x^{3+5}} = \frac{1}{x^8}$$

* Change position of negative exponents first!

$$\begin{aligned} \text{Ex 6)} \frac{4d^{-2}g^5}{2d^6g^{-4}} &= \frac{4}{2} \cdot \frac{d^{-2}}{d^6} \cdot \frac{g^5}{g^{-4}} \\ &= 2 \cdot d^{-2-6} \cdot g^{5-(-4)} \\ &= 2d^{-8}g^9 \\ &= \frac{2g^9}{d^8} \end{aligned}$$

Dividing Powers with the same base

Power of a Power

$$(3^2)^4 = (3^2)(3^2)(3^2)(3^2) = 3^{2+2+2+2} = 3^8$$

Rule: ① Keep the base

② Multiply the exponents (distribute)

③ Remember: There cannot be a negative exponent in the final answer!

$$\text{Ex 1) } (9^4)^5 = 9^{4 \cdot 5} = 9^{20}$$

$$\text{Ex 7) } (4a^2b^3)^2 =$$

$$\begin{aligned} & (4^1 a^2 b^3)^2 \\ &= 4^{1 \cdot 2} a^{2 \cdot 2} b^{3 \cdot 2} \\ &= 4^2 a^4 b^6 \\ &= \boxed{16a^4b^6} \end{aligned}$$

$$\text{Ex 2) } (b^m)^n = b^{m \cdot n} = b^{mn}$$

$$\text{Ex 3) } (7^5)^{-3} = 7^{5 \cdot -3} = 7^{-15} = \frac{1}{7^{15}}$$

$$\text{Ex 4) } (-2^2)^3 = -2^{2 \cdot 3} = -2^6 = \boxed{-64}$$

$$\text{Ex 5) } (2^{-7})^{-2} = 2^{-7 \cdot -2} = \boxed{2^{14}}$$

$$\text{Ex 6) } (3m^4)^3 = (3^1 m^4)^3 = 3^{1 \cdot 3} m^{4 \cdot 3} = 3^3 m^{12} = \boxed{27m^{12}}$$

Power of a Power