Mrs. Ballard

# Exponents

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

$12x^4$ → exponent/power
↳ 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

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Power of a Power

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

## Dividing Powers with the same base

## Power of a Power

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

Ex 1) $3^0 = 1$

Ex 2) $(-0.25)^0 = 1$

Ex 3) $(-7)^0 = 1$

Ex 4) $-4^0 = (-1)(1) = -1$

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

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

## Zero Exponents

## Negative Exponents

## Multiplying Powers with the same base

## 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 → denominator (bottom), negative exponent in denominator → 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!

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

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

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

## Negative Exponents

## Multiplying Powers with the same base

## Dividing Powers with the same base

## Power of a Power

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

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

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) $16 \cdot 16^{-7} = 16^1 \cdot 16^{-7} = 16^{1+-7} = 16^{-6} = \frac{16^{-6}}{1} = \boxed{\frac{1}{16^6}}$

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

*Not like bases, just follow order of operations.

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

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

Multiplying Powers with the same base

Dividing Powers with the same base

Power of a Power

$$\frac{6^5}{6^3} = \frac{6\cdot6\cdot6\cdot6\cdot6}{6\cdot6\cdot6}$$

Rule: ① Keep the base
② subtract the exponents

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

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

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

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

Ex 5) $\frac{x^{-3}}{x^5}$

* Change position of negative exponents first!

$\frac{x^{-3}}{x^5} = \frac{1}{x^3 \cdot x^5} = \frac{1}{x^{3+5}} = \boxed{\frac{1}{x^8}}$

Ex 6) $\frac{4d^{-2}g^5}{2d^6g^{-4}} = \frac{4}{2}\cdot\frac{d^{-2}}{d^6}\cdot\frac{g^5}{g^{-4}}$

$= 2\cdot d^{-2-6}\cdot g^{5--4}$

$= 2d^{-8}g^9$

$= \frac{2d^{-8}g^9}{1}$

$= \boxed{\frac{2g^9}{d^8}}$

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!

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

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

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

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

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

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

Ex 7) $(4a^2b^3)^2 =$
$(4^1 a^2 b^3)^2$
$= 4^{1 \cdot 2} a^{2 \cdot 2} b^{3 \cdot 2}$
$= 4^2 a^4 b^6$
$= \boxed{16a^4b^6}$

Power of a Power