# Exponents and Monomials – Quick Reference

| | |
|---|---|
| $4^2$ | This expression is read as "4 to the second power" OR "4 squared". |
| $4^2 = 4 \cdot 4$ | It means that we multiply 4 by itself 2 times. |
| $4^2 = 16$ | $4 \cdot 4 = 16$ |

**Tip!**

Whenever you have a **negative base** and the **exponent** is **even**, your answer will always be **positive!**

Whenever you have a **negative base** and the **exponent** is **odd**, your answer will always be **negative!**

| | |
|---|---|
| $(-3)^3$ | This expression is read as -3 to the third power. |
| $(-3)^3 = -3 \cdot -3 \cdot -3$ | It means that we multiply -3 by itself 3 times. |
| $(-3)^3 = -27$ | $-3 \cdot -3 \cdot -3 = -27$ <br> $9 \cdot (-3) = -27$ |

## LAWS of EXPONENTS

### Multiplying Powers with the Same Base

**Property:** When multiplying powers with the same base, **add the exponents.**

$y^3 \cdot y^4 = \mathbf{y^7}$ Since the bases are the same (y), you can add the exponents: 3+4 = 7.

### Power of a Power Property

**Property:** To find the power of a power, **multiply the exponents.**

$(a^3)^5 = \mathbf{a^{15}}$ Multiply the exponents.

### Power of a Product Property

**Property:** To find the power of a product, **find the power of each factor and multiply.**

**Think of it as distributing the exponent to each factor!**

$(2xy)^3 = 2^3x^3y^3 = \mathbf{8\,x^3y^3}$ ($2^3 = 8$. $x^3y^3$ cannot be combined because the bases are not the same.)

$8\,x^3y^3$

### Power of Quotient Property

**Property:** To find the power of a quotient, **raise the numerator to the power, and the denominator to the power. Then divide.**

$$\left(\frac{2}{3}\right)^2 = \frac{2^2}{3^2} = \frac{4}{9}$$



### Zero Exponents

**Any number (except 0) to the zero power is equal to 1.**

$4^0 = 1$ $10^0 = 1$ $22^0 = 1$ $y^0 = 1$

**The Rule for Negative Exponents:**

The expression $a^{-n}$ is the reciprocal of $a^n$

$3x^{-2} = \frac{3}{x^2}$

**In this problem, only the x contains the negative exponent, so we only take the reciprocal of $x^2$.

### Multiplying Monomials Example

| | |
|---|---|
| $(3x^2y^3z)^2\,(-3xy^4z)$ | Original Problem |
| $(3x^2y^3z)^2\,(-3xy^4z)$ <br> $(9x^4y^6z^2)\,(-3xy^4z)$ | The first monomial is raised to the second power. Every constant and variable must be raised to the second power. **The second monomial is not raised to a power, so leave it as is! |
| $(9x^4y^6z^2)\,(-3xy^4z) = -27$ | Multiply your coefficients. |
| $(9x^4y^6z^2)\,(-3xy^4z) = -27x^5y^{10}z^3$ | Multiply the variables with like bases. (Add the exponents.) |
| $(3x^2y^3z)^2\,(-3xy^4z) = \mathbf{-27x^5y^{10}z^3}$ | Final Answer. |

### Simplifying Monomials Example

| | | |
|---|---|---|
| $\frac{2x^2y^3}{3x} \cdot \frac{9x^2y^2}{y^4} =$ | | Original Problem |
| $\frac{2x^2y^3}{3x} \cdot \frac{9x^2y^2}{y^4} =$ | $\frac{18x^4y^5}{\square}$ | Step 1: Multiply the numerators. Add the exponents of like bases. |
| $\frac{2x^2y^3}{3x} \cdot \frac{9x^2y^2}{y^4} =$ | $\frac{18x^4y^5}{3xy^4}$ | Step 2: Multiply the denominators. **There are no like bases, so we can't add the exponents. |
| $\frac{18x^4y^5}{3xy^4} =$ | $\frac{6}{\square}$ | Step 3: Divide the coefficients, if possible. |
| $\frac{18x^4y^5}{3xy^4} =$ | $\frac{6x^3y}{\square}$ | Step 4: Subtract the exponents of like bases. $\frac{x^4}{x} = x^3$ and $\frac{y^5}{y^4} = y$ |
| $\frac{2x^2y^3}{3x} \cdot \frac{9x^2y^2}{y^4} =$ | $6x^3y$ | Final Answer! |

Scientific notation must always be written with the same components as the following model:

$1.5876 \times 10^6$

- 1.5876: A number in the ones' place.
- decimal: As many numbers as necessary after the decimal
- $\times 10^?$: (Any positive or negative exponent.)

# Polynomials – Quick Reference

## What is a Polynomial?

Polynomials can also be classified according to the number of terms. Let's take a look!

| | | |
|---|---|---|
| $2x$ | Monomial | Monomials consist of 1 term |
| $2x + 3y$ (1 2) | Binomial | Binomials consist of 2 terms |
| $2x^2 + 3x + 5$ (1 2 3) | Trinomial | Trinomials consist of 3 terms. |
| $3x^3 + 2x^2 - 6x + 2$ (1 2 3 4) | Polynomial | If there are more than 3 terms, use the term polynomial. |

## What is the Degree of a Polynomial?

Let's take a look at one more definition! The **degree** of a polynomial **with one variable** is the **highest power** to which the variable is raised. Take a look!

**Degree of Polynomials**

| | |
|---|---|
| $6x^3 - 2x^2 + 2x - 1$ Largest power is 3 | A polynomial of degree 3 |
| $2x - 9$ **When there is no exponent, it is assumed to be 1; therefore this is a degree of 1. | A binomial of degree 1 |
| $-8x^5$ The exponent is 5 | A monomial of degree 5 |

## Adding Polynomials

You must remember that you can only add terms that are **like terms.**

**$(3a^4 + 2a^3 - 2a^2 + a + 5) + (4a^4 - a^3 + 5a^2 - 2a - 4)$**

$3a^4 + 4a^4 + 2a^3 - a^3 - 2a^2 + 5a^2 + a - 2a + 5 - 4$ — Rewrite with like terms together.

**$7a^4 + a^3 + 3a^2 - a + 1$** — Combine like terms.

**Solution:** **$7a^4 + a^3 + 3a^2 - a + 1$** — **This is the solution.**

**F** irst Terms
**O** utside Terms
**I** nside Terms
**L** ast Terms

## Squaring a Binomial

$$(x+y)^2 = x^2 + 2xy + y^2$$

$$(x-y)^2 = x^2 - 2xy + y^2$$

## Subtracting Polynomials

You must remember to use Keep Change Change.

If you have a **subtraction** sign **preceding** a set of **parenthesis**, then you must rewrite the problem as an addition problem. We are going to **ADD the OPPOSITE**

Subtraction sign & parenthesis

$(2x - 6) - (3x^2 + 2x - 6)$ Rewritten as: **$(2x - 6) + (-3x^2 - 2x + 6)$**

**$(2x - 6)$** Keep the same → **$(2x - 6)$**

**$-$** Change to Addition → **$+$**

**$(3x^2 + 2x - 6)$** Change the sign of every term → **$-3x^2 - 2x + 6$**

**You must change the sign of every term (to its' opposite sign) inside the set of parenthesis that follows the subtraction sign.

## Multiplying Polynomials

**We must use our laws of exponents in order to multiply polynomials.**

**$2a^2b^2(a^3 + 3ab - b^3)$** — **Original Problem**

$2a^2b^2(a^3) + 2a^2b^2(3ab) + 2a^2b^2(-b^3)$

$2a^5b^2 + 6a^3b^3 - 2a^2b^5$

Distribute $2a^2b^2$ throughout the parenthesis.

Multiply the coefficients and add the exponents of like bases for each term.

**Solution:**
**$2a^5b^2 + 6a^3b^3 - 2a^2b^5$**

## Using FOIL

$(3x - 4)(2x + 1)$ — Original Problem

$(3x - 4)(2x + 1)$ — Multiply the First terms: $(3x)(2x) = 6x^2$

$6x^2$

$(3x - 4)(2x + 1)$ — Multiply the Outside terms: $(3x)(1) = 3x$

$6x^2 + 3x$

$(3x - 4)(2x + 1)$ — Multiply the Inside terms: $(-4)(2x) = -8x$

$6x^2 + 3x - 8x$

$(3x - 4)(2x + 1)$ — Multiply the Last terms: $(-4)(1) = -4$

$6x^2 + 3x - 8x - 4$

**$6x^2 - 5x - 4$** — Combine like terms: $3x - 8x = -5x$
*Notice how this step is the same as the 4th step of Example 1.

**$6x^2 - 5x - 4$** — Solution.

**Helpful YouTube videos:**

**1)** https://www.youtube.com/watch?v=kITJ6qH7jS0
**2)** https://www.youtube.com/watch?v=rEtuPhl6930
**3)** https://www.youtube.com/watch?v=JnpqlXN9Whw
**4)** https://www.youtube.com/watch?v=LrWbdg23nSw
**5)** https://www.youtube.com/watch?v=cy5O1Yu0UFk