

Unit 18
**Polynomial Addition,
 Subtraction, and
 Multiplication**

Math Essentials

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Simplify **Warm-up**

1. $x^2 \cdot x^3$
2. $\frac{x^3}{x^2}$
3. $(x^2)^3$
4. x^1
5. x^0

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Practice 18.1

Simplify

1. $2^2 \cdot 2^3$
2. $3a \cdot a^4$

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Product Rule for Exponents

- For any number a and any integers m and n ,

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

(If the bases are the same, multiplying corresponds to adding the exponents)

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Evaluate

Practice 18.2

1. $(8x^3)(-6x^7)$
2. $3^2 \times 3^0$
3. $2^2 \cdot 2^{-3}$
4. $\frac{2^3}{2^2}$

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Quotient Rule for Exponents

- For any nonzero numbers a and any integers m and n ,

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

(If the bases are the same, dividing corresponds to **subtracting** the exponents)

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Simplify

Practice 18.3

1. $\frac{9^{12}}{9^5}$

2. $\frac{8x^7y^5}{4x^2y}$

3. $\frac{6^5}{6^5}$

4. $\frac{x^2}{x^3}$

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0 and Negative Exponents

- If a is any nonzero real number, then

$$a^0 = 1$$

- For any natural number n and any nonzero real number a ,

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

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Simplify

Practice 18.4

1. $\frac{9^2}{9^5}$

2. $-(-2)^0$

3. $(2^3)^2$

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Power Rule for Exponents

For any real number a and any integers m and n ,

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

(To raise a power to a power, multiply the exponents)

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Practice 18.5

Evaluate

1. $(y^2)^{-3}$

2. $(-3x^5)^2$

3. $(\frac{2}{y^3})^5$

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What makes something a polynomial?

Polynomials	Not Polynomials
$5x + 1$	$\frac{1}{2x}y^2 - x + 1$
$12xy + 3y^2 - 9$	$\sqrt{x} - 7$
$a^7 - b^3 + ab - 10 + 6b^3$	$19y^{-2}$
$\frac{1}{2}x^2 - 2x + 1$	$\frac{3}{a+b}$
$-99m^3n^7$	$y^{\frac{1}{3}} - xy + 100$

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Define Polynomials

A polynomial is a term or a finite sum of terms of the form ax^n , where a is a real number, x is a variable, and the exponent n is a **whole number**.

$\{0, 1, 2, 3, 4, \dots\}$

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Define Polynomials

"n" is the **degree**

$$ax^n$$

"a" is the **coefficient**

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Term ax^n	Numerical Coefficient	Degree
$12x^9$		
$3x$		
-6		
$-x^4$		
$\frac{x^2}{3}$		

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Define Polynomials

- **Monomial:** polynomial with just one term (Ex: $3x^2$)
- **Binomial:** polynomial with two terms (Ex: $3x^2 + 1$)
- **Trinomial:** polynomial with three terms (Ex: $3x^2 + 4x + 1$)
- **Degree of a polynomial:** greatest degree of each of the terms
- **Leading Coefficient:** coefficient of the term with the greatest degree

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Type of Polynomial	Example	Degree
Monomial	7	
	$5x^3y^7$	
Binomial	$6 + 2x^3$	
	$11y + 8$	
Trinomial	$t^2 + 11t + 4$	
	$-3 + 2k^5 + 9z^4$	
	$x^3y^9 + 12xy^4 + 7xy$	

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Practice 18.6

Classify the following polynomials and give their degree. Write in descending powers

1. $5x + 1$
2. $7b - b^2 + 3b^3$
3. $a^7 - b^3 + ab - 10 + 6b^3$
4. $-99m^6n$

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Practice 18.7

What are the degree and leading coefficient of the polynomials?

1. $-w^7 + 1 - 8w^6 - 20w^2$
2. $9u^3w^2y^2 - 3 - 2w^8 + yu^6$

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Practice 18.8

Combine like terms.

1. $8x^3 + 6x^3 - 4x + 1 - x^3$
2. $6x + 4y - x + 2y$
3. $(8a^3 - 7ab) + (a^3 + 2ab)$
4. $(a^2 + b) - (3a^2 + b)$

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Add and Subtract Polynomials

- To find the **sum** of two polynomials, combine like terms.
- To find the **difference** of two polynomials, add the first with the negative of the second polynomial. Combine like terms.
 - Don't forget to distribute the negative!!

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Practice 18.9

Add or subtract.

1. $(4k^3 + k^2 + k) + (2k^3 - 4k^2 - 3k)$
2. $(4k^3 + k^2 + k) - (2k^3 - 4k^2 - 3k)$
3. $(q^4 - 2q^2 + 1) + (2q^3 - q^2 + 5)$
4. $(q^4 - 2q^2 + 1) - (2q^3 - q^2 + 5)$

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Practice 18.10

Simplify.

$$(4w^2 + 1) + (2w^2 - 3w - 7)$$

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Practice 18.11

Simplify.

$$\begin{aligned} &(-3x^2 - 6x - 9) - (7x^2 - 2x - 8) \\ &+ (4x^2 + 4x + 9) \end{aligned}$$

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Practice 18.12

Simplify.

$$(5x^2y^3 + 2x^3y^2 - y^2) - (-7x^3y^2 - 3x^2y^3 + 4y^2)$$

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Practice 18.13

Multiply to remove the parentheses. Simplify your answer.

1. $8k^3y(9ky^3)$
2. $-2r(9r - 5)$
3. $4b^5(9 - 8b^4)$

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Practice 18.14

Rewrite without parentheses. Simplify your answer.

1. $-8v^4(7 + 4v^2 - 8)$
2. $(8c^3d^6 - 2c^5)(-5cd^4)$

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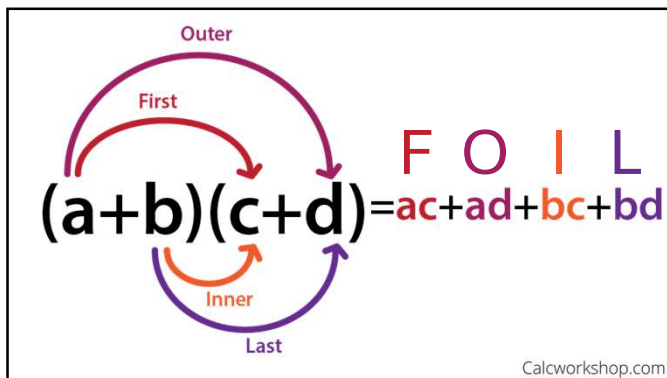
Practice 18.15

Multiply the following expressions.

1. $(x + 1)(x + 2)$

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Practice 18.15

Multiply the following expressions.

1. $(x + 1)(x + 2)$

2. $(y + 5)(y + 4)$

3. $(x - 6)(x - 6)$

4. $(b - 3)^2$

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