



MATH

STUDENT BOOK

▶ **9th Grade | Unit 4**

Math 904

Polynomials

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Author:

Arthur C. Landrey, M.A.Ed.

Editor-In-Chief:

Richard W. Wheeler, M.A.Ed.

Editor:

Robin Hintze Kreutzberg, M.B.A.

Consulting Editor:

Robert L. Zenor, M.A., M.S.

Revision Editor:

Alan Christopherson, M.S.

Westover Studios Design Team:

Phillip Pettet, Creative Lead

Teresa Davis, DTP Lead

Nick Castro

Andi Graham

Jerry Wingo



804 N. 2nd Ave. E.

Rock Rapids, IA 51246-1759

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Polynomials

INTRODUCTION


In this LIFE PAC® you will continue your study in the mathematical system known as *algebra* by learning about a special classification of algebraic expressions—polynomials. In arithmetic, after becoming familiar with the whole numbers, you learned to perform the four basic operations (addition, subtraction, multiplication, and division) with them; later, you did the same with fractions, with decimals, and with integers. Now, in algebra, you will follow the same procedure again with polynomials: become familiar with what they are and then find their sums, differences, products, and quotients.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFE PAC. When you have finished this LIFE PAC, you should be able to:

1. Identify and combine like terms.
2. Identify a polynomial by its number of terms.
3. Arrange the terms of a polynomial in ascending or descending powers of a variable.
4. Add polynomials.
5. Subtract polynomials.
6. Multiply polynomials.
7. Divide polynomials.
8. Simplify polynomial expressions having mixed operations.
9. Simplify polynomial expressions requiring the removal of grouping symbols.

Survey the LIFE PAC. Ask yourself some questions about this study and write your questions here.

A large rectangular area with horizontal red lines for writing. The lines are evenly spaced and extend across the width of the box, providing a template for handwritten notes or questions.

1. ADDITION

The first operation to be considered is addition, and in this section you will learn to add like terms and to add polynomials. Before that, however, you should become familiar with some basic definitions.

OBJECTIVES

When you have completed this section, you should be able to:

1. Identify and combine like terms.
2. Identify a polynomial by its number of terms.
3. Arrange the terms of a polynomial in ascending or descending powers of a variable.
4. Add polynomials.

VOCABULARY

Term (or monomial)—a number or a variable, or an indicated product of a number and variable(s).

SUMS OF TERMS

Models:

- ▶ xy , 0.3 , $-7a$, $\frac{4}{9}pq^2$, and t are terms.
 $\frac{x}{y}$ is not a term under the definition since it is an indicated quotient of variables.

Like terms—terms that have the same variable(s), including the same exponent with each variable.

Models:

- ▶ $5x$, $-2x$, and $-\frac{5}{3}x$ are like terms.
 $8m$, $8n$, and $8p$ are not like terms.
 $3a^2b^3$ and $-4.7a^2b^3$ are like terms.
 $6x^2y$ and $6xy^2$ are not like terms.

Constant terms—terms that have no variables.

Models:

- ▶ 70 , $\frac{2}{3}$, and -1.25 are like terms; they are called *constant terms* since they contain no variables.



Write true or false.

- 1.1 _____ $6a$ and $-60a$ are like terms.
- 1.2 _____ $2wxy$ and $2wxz$ are like terms.
- 1.3 _____ a^3b^2c , a^3bc^2 , and a^2b^3c are like terms.
- 1.4 _____ $-5x^4$ and $-5x^4$ are like terms.
- 1.5 _____ $2x^3$, $2x^2$, and $2x$ are like terms.
- 1.6 _____ $\frac{1}{3}mn$, $0.58mn$, and $-4mn$ are like terms.
- 1.7 _____ -46 and 5.2 are like terms.
- 1.8 _____ -46 and 5.2 are constant terms.
- 1.9 _____ $7k$, $-2k$, and $-\frac{1}{5}k$ are like terms.
- 1.10 _____ $7k$, $-2k$, and $-\frac{1}{5}k$ are constant terms.

The distributive property is used to add like terms.

PROPERTY

The *distributive property* states that $BA + CA = (B + C)A$.

Models:

- ▶ $4x + 2x = (4 + 2)x = 6x$
 $-4y^3 + 5y^3 = (-4 + 5)y^3 = 1y^3 = y^3$
 $7abc^2 + (-1.5abc^2) + abc^2 =$
 $[7 + (-1.5) + 1]abc^2 = 6.5abc^2$

Notice in the models that the answer is obtained by adding the numerical parts (or *coefficients*) of the like terms, and then by multiplying that sum by the common variable(s). This same procedure is used for addition problems written in a vertical format.

VOCABULARY

Coefficient—the numerical part of a term.

Models:	$8a$ $-5a$ $\frac{-7a}{-4a}$	$-\frac{3}{5}x^2$ $\frac{\frac{3}{5}x^2}{0x^2} = 0$	$0.2m^3n$ $0.3m^3n$ $-0.1m^3n$ $\frac{m^3n (= 1.0m^3n)}{1.4m^3n}$
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Find each sum of like terms.

1.11 $7y + 2y$

1.12 $-3x^4 + 8x^4$

1.13 $5.2ab + (-3.4ab)$

1.14 $-4m + 3m + (-2m)$

1.15 $\frac{2}{9}h + (-\frac{1}{3}h) + \frac{1}{9}h$

1.16 $4c^3d^2 + 3c^3d^2 + c^3d^2$

1.17 $-\frac{1}{6}xy + (-\frac{2}{3}xy)$

1.18 $-11k + 8k + 4k$

1.19

$$\begin{array}{r} -7abc \\ 3abc \\ \hline 2abc \end{array}$$

1.20

$$\begin{array}{r} 4.3pq^2 \\ -2.5pq^2 \\ -3.8pq^2 \\ \hline pq^2 \end{array}$$

SUMS OF POLYNOMIALS

A *polynomial* is a term or a sum of terms. Polynomials can be one-term, two-term, three-term, and so on.

VOCABULARY

Polynomial—a term or a sum of terms.

Monomial—a one-term polynomial.

Binomial— a two-term polynomial.

Trinomial—a three-term polynomial.

Models:

- ▶ $-3abc$ is a one-term polynomial (a *monomial*).
- ▶ $5n + 3$ is a two-term polynomial (a *binomial*).
- ▶ $4x^2 + x + 1$ is a three-term polynomial (a *trinomial*).
- ▶ $-5x - 2y + 3z - 8$ is a four term polynomial; the terms are $-5x$, $-2y$, $3z$ and -8 since it could be written as $-5x + (-2y) + 3z + (-8)$.



Label each polynomial as monomial, binomial, or trinomial; or if the polynomial has more than three terms, write the number of terms that the polynomial contains.

1.21 $a^2 + bcd^3$ _____

1.22 $a^2 + b - cd^3$ _____

1.23 a^2bcd^3 _____

1.24 $a^2b - cd^3$ _____

1.25 $a^2 - b + c - d^3$ _____

The terms of a polynomial are usually arranged in an order of either *ascending powers* of one variable or *descending powers* of one variable.

You will see as you progress through this LIFEPAK that working with polynomials can be simplified by having them all in the same order.

Model: The polynomial $5xy^3 + 3 + 2x^2y - 4x^3y^2$, when written in ascending powers of y , becomes
 $3 + 2x^2y - 4x^3y^2 + 5xy^3$;
 in descending powers of x , it becomes descending
 $-4x^3y^2 + 2x^2y + 5xy^3 + 3$.



Write each polynomial in ascending powers of x .

1.26 $-3x + 5x^3 + 1 + x^2$

1.27 $4ax^5 + 5bx^2 - 3$

1.28 $-x^4y^2 + 7x^3y^3 - 3xy^5 + 2x^2y^4$

1.29 $-5x + 2$

1.30 $-5 + 2x$

Write each polynomial in descending powers of p .

1.31 $p + p^3 + p^2 + p^4$

1.32 $-5p^4q^2 - 2p^6 + 3q^6$

1.33 $2.4 - 1.6p - 0.8p^3 + p^2$

1.34 $3 - 7p$

1.35 $3p - 7$

To add polynomials, first arrange their terms in the same order. Then, using a vertical format (as shown in the following models), write the

polynomials so that like terms are in the same column. Finally, use the distributive property to add any like terms in each column.

Model 1: Add the polynomials $5x - 2 + y$ and $-3y + 5x + 2$.

Solution:

$$\begin{array}{r} 5x + y - 2 \text{ (or you may write } 5x + 1y - 2) \\ 5x - 3y + 2 \\ \hline 10x - 2y + 0 \end{array} = 10x - 2y, \text{ the answer.}$$

Model 2: Find the sum of $-7a^3b + 4a^2b^2 - 2$, $5 + 3a^2b^2$, $4a^3b + 1 - 8a^2b^2$, and $a^3b + \frac{1}{2}$.

Solution:

$$\begin{array}{r} -7a^3b + 4a^2b^2 - 2 \\ \quad \quad \quad + 3a^2b^2 + 5 \\ 4a^3b - 8a^2b^2 + 1 \\ \quad \quad \quad a^3b \quad \quad + \frac{1}{2} \\ \hline -2a^3b - a^2b^2 + \frac{9}{2}, \text{ the answer.} \end{array}$$

Model 3: Add $m + n - p$, $n + p - q$, and $p + q - r$.

Solution:

$$\begin{array}{r} m + n - p \\ \quad \quad \quad n + p - q \\ \quad \quad \quad \quad \quad p + q - r \\ \hline m + 2n + p + 0q - r = m + 2n + p - r, \text{ the answer} \end{array}$$



Set up each addition using a vertical format and find each sum of the given polynomials.

1.36 $4a^2 + 3a$ and $7a^2 - 2a$

1.37 $7b + 3$, $-4b + 5$, and $-3b + 2$

1.38 $3x^2 + 2x - 5$ and $-4 + 7x^2$

1.39 $p + 3$, $q - 3$, and $p - q$

1.40 $2mn + 4n^2$ and $5m^2 - 7mn$

1.41 $a - b + c$, $b - c + d$, and $c - d + e$

1.42 $3j + 2.5k$ and $-0.2j - k$

1.43 $\frac{1}{4}m + 2$, $-4 + \frac{2}{3}m$, and $2 - \frac{1}{3}m$

1.44 $y^2 - 3y + 7$, $11 + y$, and $y^2 + 2y$

1.45 $ab + \frac{1}{2}ac - bc$ and $-3ab + bc - 0.5ac$



Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific area where restudy is needed for mastery.

SELF TEST 1

Write true or false (each answer, 1 point).

1.01 _____ $2a$, $3a$, and $4a$ are like terms.

1.02 _____ a^2 , a^3 , and a^4 are like terms.

Find each sum of like terms (each answer, 3 points).

1.03 $4n^5 + 3.5n^5 + (-2.1n^5)$ _____

1.04 $-3xy^3 + 7xy^3 + (-xy^3) + (-3xy^3)$ _____

1.05 $2a^2 + 4a^2 + (-6a^2) + 8a^2$ _____

Label each polynomial as a monomial, binomial, or trinomial (each answer, 3 points).

1.06 x^3y^3 _____

1.07 x^3y^2z _____

1.08 $x^3 - y^2 + z$ _____

Write the following polynomials as directed (each answer, 3 points).

1.09 Write $-7a + 5a^3 - 3 - a^2$ in descending powers of a .

1.010 Write $-4r^3s + 2rs^3 - 3r^2 - 5$ in ascending powers of r .

1.011 Write $4x^2 + x^4 + 3x^3 + 2x$ in descending powers of x .

Find each sum of the given polynomials using a vertical format (each answer, 3 points).

1.012 $5m + 2n$, $n - 3m$, and $7 - 3n$

1.013 $\frac{1}{2}x^2 + \frac{2}{3}y^2$ and $\frac{1}{3}y^2 - xy + 3x^2$

1.014 $ax + by + c$, $2ax - 3by + c$, and $by - c$

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804 N. 2nd Ave. E.
Rock Rapids, IA 51246-1759

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