

Polynomial Foundations Worksheet

Vocabulary, standard form, like terms, and evaluation.

Algebra I-II · Grades 8-12 No calculator required unless your teacher says otherwise

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Fast reference: A **term** is separated by + or -. The **coefficient** is the number multiplying the variable part. The **degree** of a one-variable polynomial is its largest exponent after simplification. **Standard form** runs from highest power to lowest.

1. For $5x^4 - 3x^2 + 7x - 9$, list the terms, leading coefficient, constant term, and degree.

2. Classify $-4x^3 + 2x$ by number of terms and by degree.

3. Write in standard form: $7 - 2x^3 + 5x - x^4$.

4. Write in standard form, then identify the leading coefficient: $3x - 8 + 6x^4 - x^2$.

5. Combine like terms: $6x^2 - 3x + 8 + 5x - 2x^2 - 11$.

6. Combine like terms: $3a^3 + 7a - 2a^3 + 4 - 5a + 9$.

Polynomial Foundations Worksheet

Evaluation and reasoning.

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7. Let $P(x)=2x^3-5x+1$. Find $P(-2)$.

8. Let $Q(t)=-t^2+4t-6$. Find $Q(3)$.

9. Let $R(x)=x^4-3x^2+2$. Find $R(-1)$.

10. Complete the table for $f(x)=x^2-2x+3$.

x	-2	0	3
f(x)			

11. Why are $4x^2$ and $-7x$ not like terms? Write one sentence.

12. A student writes $3x^2 + 5x = 8x^3$. What did the student incorrectly combine? Give the corrected expression.

Before moving on: If #5-6 were hard, keep like terms lined up by variable and exponent. If #7-10 were hard, substitute with parentheses first, especially for negative inputs.

Adding & Subtracting Polynomials

Line up like powers. When subtracting, distribute the negative to the entire second polynomial.

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1. $(3x^2 + 5x - 4) + (2x^2 - 7x + 9)$

2. $(4a^3 - a + 6) + (-2a^3 + 5a - 11)$

3. $(6m^4 - 3m^2 + 8) + (m^4 + 7m^2 - 2)$

4. Rewrite with placeholders, then add: $(3x^5 - 2x^2 + 4) + (x^4 + 6x - 9)$

5. $(5x^2 + 2x - 7) - (3x^2 - 6x + 4)$

6. $(2y^3 - y^2 + 4y - 9) - (-3y^3 + 5y^2 - 2y + 1)$

Adding & Subtracting Polynomials

Mixed practice and error analysis.

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7. $(7p^4 - 2p + 3) - (4p^4 + 5p^2 - p - 8)$

8. $(x^5 - 4x^2 + 3) - (2x^4 + x^2 - 7x + 1)$

9. A triangle has side lengths $2x+3$, x^2-1 , and $3x^2-x+5$. Write its perimeter in standard form.

10. Maya changes $(3x^2-4x+2) - (-x^2+5x-6)$ into $3x^2-4x+2 + x^2+5x-6$. Circle the signs that should change, then simplify correctly.

11. A polynomial $A(x)$ satisfies $A(x) + (2x^2 + x - 7) = 5x^2 - 3x - 5$. Find $A(x)$.

12. Write two different polynomial pairs whose difference is $2x^2 - 6x + 6$. Check your answer.

Sign check: In subtraction problems, rewrite the second parentheses with every sign reversed before combining like terms. That one line prevents most mistakes.

Four Ways to Multiply Polynomials

Same multiplication. Four layouts. One distributive idea.

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The idea to keep: FOIL is not a separate multiplication law. It is a memory device for the four products in a binomial-by-binomial distribution. Box and vertical methods organize those same products differently.

Distributive property
GENERAL RULE
 $(x + 3)(x - 2)$
 $x(x - 2) + 3(x - 2)$
 $= x^2 - 2x + 3x - 6$
 $= x^2 + x - 6$
Every term in one factor multiplies every term in the other. This still works when a factor has three or more terms.

FOIL
2 × 2 SHORTCUT
First $x \cdot x = x^2$
Outer $x \cdot (-2) = -2x$
Inner $3 \cdot x = 3x$
Last $3 \cdot (-2) = -6$
 $x^2 - 2x + 3x - 6 = x^2 + x - 6$
FOIL names the four products created when both factors are binomials. It is distribution in a fixed 2 × 2 case.

Box method
AREA MODEL

	x	-2
x	x^2	$-2x$
3	$3x$	-6

 $x^2 - 2x + 3x - 6 = x^2 + x - 6$
The grid makes skipped products easy to spot. Add like terms after every box is filled.

Vertical multiplication
ORGANIZED PARTIAL PRODUCTS
$$\begin{array}{r} x + 3 \\ \times x - 2 \\ \hline -2x - 6 \\ +x^2 + 3x \\ \hline x^2 + x - 6 \end{array}$$
Each row is one distribution. Line up like powers before adding the partial products.

Method	Best use	What can go wrong
Distributive property	Any polynomial sizes	Skipping a term when there are several products
FOIL	Two binomials only	Trying to force FOIL onto a trinomial
Box method	Visual organization; larger products	Forgetting to combine like terms after the grid
Vertical multiplication	Longer polynomials; familiar arithmetic layout	Misaligning powers or omitting zero placeholders

Polynomial Multiplication Methods Worksheet

Use distribution, FOIL, a box, or vertical multiplication. The products should agree.

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FOIL has a narrow job: it names the four term products in a binomial $\times$ binomial. For anything larger, use the distributive property, a box, or vertical multiplication.

1. Multiply: $(3x^2)(-4x^5)$

2. Distribute: $-2a^3(5a^2-3a+4)$

3. Distribute: $4m(m^2+2m-5)$

4. Multiply: $(x+4)(x-6)$

5. Multiply: $(2x-3)(x+5)$

6. Use a 2×2 box for $(3x+2)(2x-7)$. Show all four products.

Polynomial Multiplication Methods Worksheet

Bigger products.

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7. Use vertical multiplication: $(x-5)(x^2+2x+3)$.

8. Use the distributive property: $(2x+1)(x^2-3x+4)$.

9. Use a method of your choice: $(x^2+x-2)(x+3)$.

10. Challenge: $(2x^2-3x+1)(x^2+x-4)$.

11. Why does FOIL not directly organize $(x+2)(x^2-3x+4)$? Name one method that does.

12. Before combining like terms, list the four products created by $(2x-1)(x+4)$.

Four Ways, Same Product

Compare the layouts before the last two questions.

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Distributive property

GENERAL RULE

$$(x + 3)(x - 2)$$

$$x(x - 2) + 3(x - 2)$$

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

$$= x^2 + x - 6$$

Every term in one factor multiplies every term in the other. This still works when a factor has three or more terms.

FOIL

2 × 2 SHORTCUT

First $x \cdot x = x^2$

Outer $x \cdot (-2) = -2x$

Inner $3 \cdot x = 3x$

Last $3 \cdot (-2) = -6$

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

FOIL names the four products created when both factors are binomials. It is distribution in a fixed 2 × 2 case.

Box method

AREA MODEL

	x	-2
x	x^2	$-2x$
3	$3x$	-6

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

The grid makes skipped products easy to spot. Add like terms after every box is filled.

Vertical multiplication

ORGANIZED PARTIAL PRODUCTS

$$\begin{array}{r}
 x + 3 \\
 \times x - 2 \\
 \hline
 -2x - 6 \\
 +x^2 + 3x \\
 \hline
 x^2 + x - 6
 \end{array}$$

Each row is one distribution. Line up like powers before adding the partial products.

13. Use **two different methods** to multiply $(2x+3)(x-4)$. Your final answers should match.

14. Choose the method you would use for $(x^2+2x-1)(2x^2-3x+5)$. Explain your choice in one sentence. You do not need to expand it.

Polynomial Special Products Worksheet

Recognize the structure first. Then expand or factor.

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Patterns: $(a+b)^2=a^2+2ab+b^2$ · $(a-b)^2=a^2-2ab+b^2$ · $(a+b)(a-b)=a^2-b^2$

1. Expand: $(x+5)^2$

2. Expand: $(x-7)^2$

3. Expand: $(2x+3)^2$

4. Expand: $(3y-4)^2$

5. Expand: $(x+6)(x-6)$

6. Expand: $(5a+2)(5a-2)$

Polynomial Special Products Worksheet

Patterns in both directions.

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7. Expand: $(2m-9)(2m+9)$

8. Factor as a special product: $x^2+18x+81$

9. Jordan writes $(x-4)^2=x^2+16$. What term is missing? Write the correct expansion.

10. Complete the identity: $(x+ \underline{\hspace{1cm}})^2=x^2+14x+ \underline{\hspace{1cm}}$.

11. Without multiplying every term, simplify $(3x+10)(3x-10)$.

12. Which is faster for $(x+12)^2$: FOIL or the perfect-square pattern? Explain what both methods are doing underneath.

Common miss: $(a-b)^2$ is not a^2-b^2 . Squaring a binomial creates a middle term. Difference of squares comes from multiplying conjugates, $(a+b)(a-b)$.

Polynomial Operations Answer Key

Foundations worksheet.

Teacher key · Foundations No calculator required unless your teacher says otherwise

Name _____

Date _____

1. **Terms:** $5x^4$, $-3x^2$, $7x$, -9 ; leading coefficient **5**; constant **-9**; degree **4**.
2. **Binomial; cubic (degree 3).**
3. $-x^4 - 2x^3 + 5x + 7$
4. $6x^4 - x^2 + 3x - 8$; leading coefficient **6**.
5. $4x^2 + 2x - 3$
6. $a^3 + 2a + 13$
7. $P(-2) = 2(-2)^3 - 5(-2) + 1 = -16 + 10 + 1 = -5$.
8. $Q(3) = -9 + 12 - 6 = -3$.
9. $R(-1) = 1 - 3 + 2 = 0$.
10. $f(-2) = 11$, $f(0) = 3$, $f(3) = 6$.
11. They have different variable parts: x^2 and x . Like terms need the same variables raised to the same powers.
12. The student added coefficients and exponents across unlike terms. $3x^2 + 5x$ is already simplified.

Polynomial Operations Answer Key

Adding and subtracting.

Teacher key · Add/Subtract No calculator required unless your teacher says otherwise

Name _____

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1. $5x^2 - 2x + 5$
2. $2a^3 + 4a - 5$
3. $7m^4 + 4m^2 + 6$
4. With placeholders: $(3x^5+0x^4+0x^3-2x^2+0x+4)+(0x^5+x^4+0x^3+0x^2+6x-9)$
 $3x^5+x^4-2x^2+6x-5.$
5. $2x^2 + 8x - 11$
6. $5y^3 - 6y^2 + 6y - 10$
7. $3p^4 - 5p^2 - p + 11$
8. $x^5 - 2x^4 - 5x^2 + 7x + 2$
9. $4x^2 + x + 7$
10. The second polynomial must become $+x^2-5x+6$. Result: $4x^2-9x+8$.
11. $A(x)=(5x^2-3x-5)-(2x^2+x-7)=3x^2-4x+2.$
12. Answers vary. Example: $(3x^2-2x+5)-(x^2+4x-1)=2x^2-6x+6.$

Polynomial Operations Answer Key

Multiplication methods.

Teacher key · Multiplication No calculator required unless your teacher says otherwise

Name _____

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1. $-12x^7$
2. $-10a^5 + 6a^4 - 8a^3$
3. $4m^3 + 8m^2 - 20m$
4. $x^2 - 2x - 24$
5. $2x^2 + 7x - 15$
6. Box entries: $6x^2$, $-21x$, $4x$, -14 ; result $6x^2 - 17x - 14$.
7. $x^3 - 3x^2 - 7x - 15$
8. $2x^3 - 5x^2 + 5x + 4$
9. $x^3 + 4x^2 + x - 6$
10. $2x^4 - x^3 - 10x^2 + 13x - 4$
11. FOIL names four products, which assumes two terms in each factor. Here there are $2 \times 3 = 6$ products.
Distribution, a 2×3 box, or vertical multiplication works.
12. $2x^2$, $8x$, $-x$, -4 ; after combining: $2x^2 + 7x - 4$.
13. $(2x+3)(x-4) = 2x^2 - 5x - 12$. Any two correct methods earn full credit.
14. Answers vary. Box or vertical multiplication is usually easiest to audit because a 3×3 product creates nine term products before combining.

Method note: For #13, students do not need two different final expressions. They need two different layouts that produce the same final polynomial.

Polynomial Operations Answer Key

Special products.

Teacher key · Special products No calculator required unless your teacher says otherwise

Name _____

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1. $x^2 + 10x + 25$
2. $x^2 - 14x + 49$
3. $4x^2 + 12x + 9$
4. $9y^2 - 24y + 16$
5. $x^2 - 36$
6. $25a^2 - 4$
7. $4m^2 - 81$
8. $(x+9)^2$
9. Missing term: $-8x$. Correct expansion: $x^2 - 8x + 16$.
10. $(x+7)^2 = x^2 + 14x + 49$.
11. $9x^2 - 100$
12. The perfect-square pattern is faster once recognized. FOIL still computes the same four products: x^2 , $12x$, $12x$, 144 .

Scoring suggestion: 1 point per item on foundations/add-subtract/special products. For multiplication #6, #7, #10, and #13, require visible organization or term products for full credit.