**K – Polynomials, Lesson 2, Operations with Polynomials (r. 2018)**

POLYNOMIALS

Operations with Polynomials

|  |  |
| --- | --- |
| **Common Core Standard**  **A-APR.A.1** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. | **Next Generation Standard**  **AI-A.APR.1** Add, subtract, and multiply polynomials and recognize that the result of the operation is also a polynomial. This forms a system analogous to the integers.  **Note: This standard is a fluency recommendation for Algebra I. Fluency in adding, subtracting and multiplying polynomials supports students throughout their work in algebra, as well as in their symbolic work with functions.** |

**LEARNING OBJECTIVES**

Students will be able to:

1) add, subtact, and multiply polynomials.

**Overview of Lesson**

|  |  |
| --- | --- |
| **Teacher Centered Introduction**  **Overview of Lesson**  **- activate students’ prior knowledge**  **- vocabulary**  **- learning objective(s)**  **- big ideas: direct instruction**  **- modeling** | **Student Centered Activities**  **guided practice Teacher: anticipates, monitors, selects, sequences, and connects student work**  **- developing essential skills**  **- Regents exam questions**  **- formative assessment assignment (exit slip, explain the math, or journal entry)** |

**VOCABULARY**

 **Polynomial:** A monomial or the sum of two or more monomials whose exponents are positive.

**Example**: 5*a*2 + *ba* – 3

* **Monomial:** A polynomial with one term; it is a number, a variable, or the product of a number (the coefficient) and one or more variables

Examples: , , , , 

* **Binomial:** An algebraic expression consisting of two terms

Example (5*a* + 6)

* **Trinomial:** A polynomial with exactly three terms.

Example (*a*2 +2*a* – 3)

* **Like Terms:** Like terms must have **exactly the same base and the same exponent**. Their coefficients may be different. Real numbers are like terms.

Example: Given the expression

1*x*2 + 2y + 3*x*2 + 4*x* + 5*x*3 + 6y2 + 7y + 8*x*3 + 9y2,

the following are like terms:

1*x*2 and 3*x*2

2y and 7y

4*x has no other like terms in the expression*

5*x*3 and 8*x*3

6y2 and 9y2

Like terms in the same expression can be combined by adding their coefficients.

1*x*2 and 3*x*2 = 4*x*2

2y and 7y =9y

4*x has no other like terms in the expression = 4x*

5*x*3 and 8*x*3 = 13*x*3

6y2 and 9y2 = 15y2

1*x*2 + 2y + 3*x*2 + 4*x* + 5*x*3 + 6y2 + 7y + 8*x*3 + 9y2 = 4*x*2 + 9y *+ 4x* + 13*x*3 + 15y2

**BIG IDEAS**

**Adding and Subtracting Polynomials**

To add or subtract polynomials, arrange the polynomials one above the other with like terms in the same columns. Then, add or subtract the coefficients of the like terms in each column and write a new expression.

|  |  |
| --- | --- |
| **Addition** Example | **Subtraction** Example |

**Multiplying Polynomials**

To multiply two polynomials, multiply each term in the first polynomial by each term in the second polynomial, then combine like terms.

**Example:**



STEP 1: Multiply the first term in the first polynomial by each term in the second polynomial, as follows:



STEP 2. Multiply the next term in the first polynomial by each term in the second polynomial, as follows:



STEP 3. Multiply the next term in the first polynomial by each term in the second polynomial, as follows:



STEP 4. Combine like terms from each step.



**DEVELOPING ESSENTIAL SKILLS**

1. When  is subtracted from , the difference is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

2. When  is subtracted from , the result is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

3. The sum of  and  is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

4. What is the result when  is subtracted from ?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

5. When  is subtracted from , the difference is

|  |  |  |  |
| --- | --- | --- | --- |
| a. | 0 | c. |  |
| b. |  | d. |  |

6. What is the sum of  and ?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

7. When  is subtracted from , the result is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

8. The sum of  and  is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

9. When  is subtracted from , the result is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

10. The sum of  and  is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

11. What is the result when  is subtracted from ?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

12. When  is subtracted from , the result is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

13. What is the product of  and ?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

14. The expression  is equivalent to

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

15. The expression  is equivalent to

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

16. The length of a rectangle is represented by , and the width is represented by . Express the perimeter of the rectangle as a trinomial. Express the area of the rectangle as a trinomial.

17. What is the product of  and ?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

18. What is the product of and **?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

**Answers**

1. ANS: C

2. ANS: B

3. ANS: C

4. ANS: A

5. ANS: D

6. ANS: A

7. ANS: D

8. ANS: B

9. ANS: A

10. ANS: A

11. ANS: D

12. ANS: B

13. ANS: A

14. ANS: C

15. ANS: C

16. ANS:





17. ANS: C

18. ANS: A

**REGENTS EXAM QUESTIONS (through June 2018)**

A.APR.A.1: Operations with Polynomials

330) If  and , then  equals

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

331) Express the product of  and  in standard form.

332) Fred is given a rectangular piece of paper. If the length of Fred's piece of paper is represented by  and the width is represented by , then the paper has a total area represented by

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

333) Subtract  from . Express the result as a trinomial.

334) If the difference  is multiplied by , what is the result, written in standard form?

335) Which trinomial is equivalent to ?

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

336) When  is subtracted from , the result is

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

337) The expression  is equivalent to

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

338) What is the product of  and ?

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

339) Which expression is equivalent to ?

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

340) Express in simplest form: 

341) Write the expression  as a polynomial in standard form.

342) Which polynomial is twice the sum of  and ?

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 3) |  |
| 2) |  | 4) |  |

**SOLUTIONS**

330) ANS: 2

Strategy: To subtract, change the signs of the subtrahend and add.

|  |  |
| --- | --- |
| Given: | Change the signs and add: |

PTS: 2 NAT: A.APR.A.1 TOP: Addition and Subtraction of Polynomials

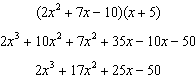
KEY: subtraction

331) ANS:



Strategy: Use the distribution property to multiply polynomials, then simplify.

STEP 1. Use the distributive property



STEP 2. Simplify by combining like terms.

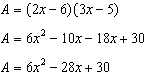


PTS: 2 NAT: A.APR.A.1 TOP: Multiplication of Polynomials

332) ANS: 2

Strategy: Draw a picture and use the area formula for a rectange: .





PTS: 2 NAT: A.APR.A.1 TOP: Multiplication of Polynomials

333) ANS:

Strategy: To subtract, change the signs of the subtrahend and add.

|  |  |
| --- | --- |
| Given: | Change the signs and add: |

PTS: 2 NAT: A.APR.A.1 TOP: Addition and Subtraction of Polynomials

KEY: subtraction

334) ANS:

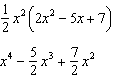


Strategy. First, find the difference between , the use the distributive property to multiply the difference by . Simplify as necessary.

STEP 1. Find the difference between . To subtract polynomials, change the signs of the subtrahend and add.

|  |  |
| --- | --- |
| Given: | Change the signs and add: |

STEP 2. Multiply  by .



PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: multiplication

335) ANS: 4

Strategy: Expand and simplify the expression 

STEP 1 Expand the expression.



STEP 2: Simplify the expanded expression by combining like terms.

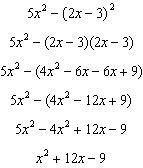


PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: mixed

336) ANS: 3

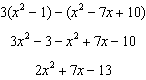
Strategy: Expand the binomial, then subtract it from 5x2.



PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: multiplication

337) ANS: 2

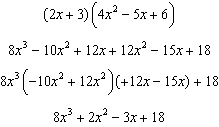


PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: subtraction

338) ANS: 3

Strategy: Use the distributive property



PTS: 2 NAT: A.APR.A.1

339) ANS: 4

|  |  |
| --- | --- |
| Given |  |
| Distributive Property |  |
| Combine Like Terms | -2g-11 |

PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: subtraction

340) ANS:

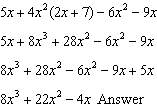




PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: subtraction

341) ANS:



PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: multiplication

342) ANS: 3

STEP 1. Solve for the sum of  and .



STEP 2. Solve for twice the sum of .



PTS: 2 NAT: A.APR.A.1 TOP: Operations with Polynomials

KEY: addition