

# Unit 8 Operations on Polynomials

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## **Title Section**

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## **Department of Curriculum and Instruction**



**Belleville Public Schools**

**Curriculum Guide**

**MATH ESSENTIALS GRADES 11-12**

**UNIT 8 OPERATIONS ON POLYNOMIALS**

**Belleville Board of Education**

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## **Unit Overview**

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### Unit 8: Operations with Polynomials

In this unit, students should be able to add and subtract polynomials, use the distributive property to multiply a polynomial by a monomial. use FOIL and the Distributive Property to Multiply polynomials, factor polynomials by taking out the GCF, factor trinomials in the form  $x^2 + bx + c$ , factor binomials in the form  $x^2 - c^2$ , and solve quadratic equations by using the Zero Product Property.

## **Enduring Understanding**

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- Monomials can be used to form larger expressions called polynomials.
- Polynomials are written in their simplest form when there are no like terms.
- The properties of real numbers are used when performing operations on polynomials.
- Area models can be used to multiply and factor polynomials.
- Multiplying and factoring polynomials are related operations.
- When operating on polynomials, you can use the properties of real numbers, such as the Distributive Property.
- When factoring polynomials, we use the rules of factoring integers.

- The real solutions of a quadratic equation are the x-intercepts of the related function.

## Essential Questions

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- Can two expressions that appear to be different be equivalent?
- How are the properties of real numbers related to polynomials?
- How are polynomials added and subtracted?
- How can finding patterns help in the process of multiplying polynomials?
- How are adding and multiplying polynomial expressions different from each other?
- What visual aids are available to assist in multiplying polynomials?
- How do you factor a monomial from a polynomial?
- How do you know which factoring method to use?
- How can factoring polynomials help to solve real-life problems?
- Once a polynomial is factored, how can we determine the solutions?

## Exit Skills

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**By the end of Unit 8 Students will be able to:**

- Add and subtract polynomials.
- Multiply a polynomial by a monomial.
- Multiply a polynomial by another polynomial.
- Use FOIL to multiply binomials.
- Write a polynomial in simplest form by combining like terms.
- Factor polynomials by taking out the GCF.
- Factor binomials in the form  $x^2 - c^2$ .
- Factor trinomials in the form  $x^2 + bx + c$ .
- Solve quadratic equations by using the Zero Product Property.

## New Jersey Student Learning Standards (NJSL-S)

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|               |  |
|---------------|--|
| MA.K-12.1     | Make sense of problems and persevere in solving them.  |
| MA.K-12.2     | Reason abstractly and quantitatively.  |
| MA.K-12.4     | Model with mathematics.  |
| MA.K-12.6     | Attend to precision.   |
| MA.K-12.7     | Look for and make use of structure.  |
| MA.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.                   |
| MA.A-APR.B    | Understand the relationship between zeros and factors of polynomials   |
| MA.A-SSE.A.2  | Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$ , thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$ . |
| MA.A-SSE.A.1a | Interpret parts of an expression, such as terms, factors, and coefficients.  |
| MA.A-SSE.B    | Write expressions in equivalent forms to solve problems  |
| MA.A-SSE.B.3  | Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.   |
| MA.A-SSE.B.3a | Factor a quadratic expression to reveal the zeros of the function it defines.  |

## Interdisciplinary Connections

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|----------------|---|
| LA.L.11-12.6   | Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.                 |
| LA.W.11-12.2.D | Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.   |
| LA.RL.11-12.4  | Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (e.g., Shakespeare as well as other authors.) |
| LA.SL.11-12.4  | Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.  |

## Learning Objectives

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### Students will be able to...

- Combine polynomials by using addition and subtraction.
- Rewrite the product of a polynomial and a monomial in simplest form.
- Rewrite the product of two polynomials in simplest form.
- Compare FOIL and the Distributive Property in the process of finding the product of two binomials.
- Break down a polynomial in factored form by taking out the GCF.
- Separate the difference of two squares into two factors, a sum and a difference.

- Determine the factors of a trinomial in the form  $x^2 + bx + c$ .
- Solve quadratic equations by using the Zero Product Property.

| Remember  | Understand    | Apply       | Analyze       | Evaluate  | Create      |
|-----------|---------------|-------------|---------------|-----------|-------------|
| Choose    | Classify      | Choose      | Categorize    | Appraise  | Combine     |
| Describe  | Defend        | Dramatize   | Classify      | Judge     | Compose     |
| Define    | Demonstrate   | Explain     | Compare       | Criticize | Construct   |
| Label     | Distinguish   | Generalize  | Differentiate | Defend    | Design      |
| List      | Explain       | Judge       | Distinguish   | Compare   | Develop     |
| Locate    | Express       | Organize    | Identify      | Assess    | Formulate   |
| Match     | Extend        | Paint       | Infer         | Conclude  | Hypothesize |
| Memorize  | Give Examples | Prepare     | Point out     | Contrast  | Invent      |
| Name      | Illustrate    | Produce     | Select        | Critique  | Make        |
| Omit      | Indicate      | Select      | Subdivide     | Determine | Originate   |
| Recite    | Interrelate   | Show        | Survey        | Grade     | Organize    |
| Select    | Interpret     | Sketch      | Arrange       | Justify   | Plan        |
| State     | Infer         | Solve       | Breakdown     | Measure   | Produce     |
| Count     | Match         | Use         | Combine       | Rank      | Role Play   |
| Draw      | Paraphrase    | Add         | Detect        | Rate      | Drive       |
| Outline   | Represent     | Calculate   | Diagram       | Support   | Devise      |
| Point     | Restate       | Change      | Discriminate  | Test      | Generate    |
| Quote     | Rewrite       | Classify    | Illustrate    |           | Integrate   |
| Recall    | Select        | Complete    | Outline       |           | Prescribe   |
| Recognize | Show          | Compute     | Point out     |           | Propose     |
| Repeat    | Summarize     | Discover    | Separate      |           | Reconstruct |
| Reproduce | Tell          | Divide      |               |           | Revise      |
|           | Translate     | Examine     |               |           | Rewrite     |
|           | Associate     | Graph       |               |           | Transform   |
|           | Compute       | Interpolate |               |           |             |
|           | Convert       | Manipulate  |               |           |             |
|           | Discuss       | Modify      |               |           |             |
|           | Estimate      | Operate     |               |           |             |
|           | Extrapolate   | Subtract    |               |           |             |
|           | Generalize    |             |               |           |             |
|           | Predict       |             |               |           |             |



## Suggested Activities & Best Practices

Supplemental Materials:

- [khanacademy.com](https://www.khanacademy.com)
- [njctl.org](https://www.njctl.org)
- [coolmath.com](https://www.coolmath.com)
- [mathbitsnotebook.com/](https://www.mathbitsnotebook.com/)
- <https://parcc-assessment.org/released-items/>
- <https://accuplacer.collegeboard.org/student/practice>

Assessment and Learning:

- [aleks.com](https://www.aleks.com)
- Google Forms

- [edulastic.com](https://edulastic.com)
- Google Classroom
- <https://kahoot.com/explore/collections/math-kahoot-algebra/> (has all levels of math in the collections)

Strategies:

- <https://mashupmath.com>
- [virtualnerd.com](https://virtualnerd.com)
- [https://ies.ed.gov/ncee/wwc/docs/practiceguide/wwc\\_algebra\\_040715.pdf](https://ies.ed.gov/ncee/wwc/docs/practiceguide/wwc_algebra_040715.pdf)

## **Assessment Evidence - Checking for Understanding (CFU)**

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Edulastic Formative Assessment (Formative)

Kahoots - Various Topics (Formative)

Glencoe McGraw-Hill EAssessment Test Generator (Summative)

Common benchmarks on OnCourse (Benchmark)

"Do Now/Exit Ticket" Activity (Formative)

- Admit Tickets
- Anticipation Guide
- Common Benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Exit Tickets
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities

- Outline
- Question Stems
- Quickwrite
- Quizzes
- Self- assessments
- Socratic Seminar
- Study Guide
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep
- Unit tests
- Web-Based Assessments

## **Primary Resources & Materials**

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- <https://www.nj.gov/education/cccs/2016/math/standards.pdf>
- [aleks.com](https://www.aleks.com)
- [edulastic.com](https://www.edulastic.com)
- [njctl.org](https://www.njctl.org)
- Glencoe McGraw-Hill Algebra 1 2014
- <https://accuplacer.collegeboard.org/student/practice>

## **Ancillary Resources**

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- teacher-prepared worksheets, notes and slides
- [collegeboard.org](https://collegeboard.org)
- [homeschoolmath.net](https://www.homeschoolmath.net)
- <https://www.weareteachers.com/out-of-the-box-ideas-for-teaching-algebra-and-geometry/>
- [mathplanet.com](https://www.mathplanet.com)

## **Technology Infusion**

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Create and assign exit tickets using Google Forms

Create and display slide presentations using Google Slides

Manipulative slider activity showing multiplication of binomials using Geogebra: <https://www.geogebra.org/m/bamcyetS>



- Youtube
- Khan academy
- MS Word
- Google Slides
- Google Classroom
- Google Forms
- Edulastic
- ALEKS
- Desmos.com
- Geogebra.org
- Smart Exchange
- McGraw-Hill Education

# Win 8.1 Apps/Tools Pedagogy Wheel

Podcasts  
 Photostory 3  
 Kid Story Builder  
 Music Maker Jam  
 Paint A Story  
 Office 365  
 MS PowerPoint  
 Stack 'Em Up  
 NqSquared Numbers  
 Physamajig  
 Xylophone 8

Wikipedia  
 Skydrive  
 Lync  
 SkyMap  
 Skype  
 Office 365  
 Puzzle Touch  
 Easy QR  
 Memorylage  
 Life Moments  
 Word Cloud Maker

Where's Waldo?  
 MS Excel  
 Flipboard  
 Office 365  
 Nova Mindmapping

Ted Talks  
 Record Voice Pen



Originally taken from <http://www.coetail.com/vzimmer/files/2013/02/iPadagogy-Wheel.001.jpg>  
 And adapted for Windows 8.1 devices by Charlotte Beckhurst @CharBeckhurst

## Alignment to 21st Century Skills & Technology

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|                 |  |
|-----------------|--|
| CRP.K-12.CRP2   | Apply appropriate academic and technical skills.   |
| CRP.K-12.CRP4   | Communicate clearly and effectively and with reason.   |
| CRP.K-12.CRP8   | Utilize critical thinking to make sense of problems and persevere in solving them.   |
| CRP.K-12.CRP11  | Use technology to enhance productivity.  |
| CAEP.9.2.12.C.2 | Modify Personalized Student Learning Plans to support declared career goals.   |
| TECH.8.1.12.F.1 | Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs. |

## 21st Century Skills/Interdisciplinary Themes

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- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

## 21st Century Skills

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- Financial, Economic, Business and Entrepreneurial Literacy
- Global Awareness

## Differentiation

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GENERAL EXAMPLES INCLUDE:

Use of Glencoe virtual manipulatives: [http://www.glencoe.com/sites/common\\_assets/mathematics/ebook\\_assets/vmf/VMF-Interface.html](http://www.glencoe.com/sites/common_assets/mathematics/ebook_assets/vmf/VMF-Interface.html)  
Study Guides provided prior to tests and quizzes  
Use of ALEKS for differentiated practice or extension of skills

**Differentiations:**

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions

- Use manipulatives
- Center-based instruction
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

#### **Hi-Prep Differentiations:**

- Alternative formative and summative assessments
- Choice boards
- Games and tournaments
- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes
- Tiered activities/assignments
- Tiered products
- Varying organizers for instructions

#### **Lo-Prep Differentiations**

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students
- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share

- Reading buddies
- Varied journal prompts
- Varied supplemental materials

## **Special Education Learning (IEP's & 504's)**

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Flash cards for vocabulary and new concepts

One-on-one questioning during testing to elicit responses

Use of Glencoe personal tutor or The Video Math Tutor for additional instruction

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format
- modified test length
- multiple test sessions
- multi-sensory presentation
- preferential seating
- preview of content, concepts, and vocabulary
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

## **English Language Learning (ELL)**

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Use of multilingual mathematics glossary including definitions in English and its translations to other languages:

[https://my.hrw.com/math06\\_07/nsmedia/tools/glossary/msm/glossary.html](https://my.hrw.com/math06_07/nsmedia/tools/glossary/msm/glossary.html)

Use of Spanish instructional videos of concepts:

<https://www.youtube.com/user/KhanAcademyEspanol/videos>

<https://www.mathtv.com/>

Peer partners for assignments with students that can verbally translate material and meanings of concepts

- teaching key aspects of a topic. Eliminate nonessential information
- using videos, illustrations, pictures, and drawings to explain or clarify
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of work presented or required
- having peers take notes or providing a copy of the teacher's notes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

## **At Risk**

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Printed or video copy of material missed during excessive absences

Retests or test corrections of incorrect work on tests

Working contract to ensure completion of prioritized tasks

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- allowing students to select from given choices
- allowing the use of note cards or open-book during testing
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of work presented or required
- having peers take notes or providing a copy of the teacher's notes
- marking students' correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test

- tutoring by peers
- using authentic assessments with real-life problem-solving
- using true/false, matching, or fill in the blank tests in lieu of essay tests
- using videos, illustrations, pictures, and drawings to explain or clarify

## **Talented and Gifted Learning (T&G)**

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Glencoe Enrichment Activities and Chapter Projects

Complete higher level learning problems in textbook

Complete math league sample contest problems:

<https://www.mathleague.com/index.php/annualcontestinformation/samplecontests>

- Above grade level placement option for qualified students
- Advanced problem-solving
- Allow students to work at a faster pace
- Cluster grouping
- Complete activities aligned with above grade level text using Benchmark results
- Create a plan to solve an issue presented in the class or in a text
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

## **Sample Lesson**

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Unit Name: Applying the Zero Product Property

NJSLS: MA.9-12.A-SSE.B.3a Factor a quadratic expression to reveal the zeros of the function it defines.

Interdisciplinary Connection: Science Connection: In how long will an object reach the ground if its motion can be described by a quadratic function?

Statement of Objective: Statement of Objective: SWDAT Solve a quadratic equation by applying the zero product property.

Anticipatory Set/Do Now: Admit Ticket: Factor Trinomials

Learning Activity: Notes: Zero Product Property; Students practice examples; Selected students place work on

whiteboard; Other students justify their work as a summary.

Student Assessment/CFU's: questioning, observation, exit cards, explaining

Materials: Smart TV, WS: Applying the Zero Product Property - Notes & Practice, use of whiteboard, Google Forms,

Google Slides

21st Century Themes and Skills: critical thinking, communication

Differentiation: note-taking, study guides, team work with peer tutoring

Integration of Technology: use of Smart TV, Google Forms (Admit Ticket), Google Slides