# Orange Public Schools

Office of Curriculum & Instruction
2020-2021 Mathematics Curriculum Guide

# Algebra 2

## Unit1: Polynomial Equations

***September 9, 2020 – November 27, 2020***

Board Approved: 1.14.2020

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# Contents

# Curriculum Map

| A STORY OF UNITS (Yearlong Pacing Guide) | | | | |
|---|---|---|---|---|
| Marking Period | Unit 1 (9/8/20 – 11/27/20) | Unit 2 (11/28/20- 1/30/21) | Unit 3 (1/31/21-3/30/21) | Unit 4 (4/1/21-6/22/21) |
| Unit Topic | Polynomial Equations | Transformation, Radical equation, and Rational Function/equation | Exponential and Logarithmic function | Trigonometric function and Probability and statistics |
| Description | Solve quadratic functions with non-real solutions, and operations with complex numbers; simplify imaginary numbers; identify key features of the cubic/quartic polynomial and sketch the cubic/quartic polynomial; solve problems involving rate of change; solve cubic equations; solve problems using long division and Remainder Theorem; find the sums and differences of cubes | Solve problems involving: transformation, even and odd functions, radical equations, rational functions/equations, systems of equation | Solve problems involving: arithmetic sequences, geometric sequences and series; simplify rational exponents; create exponential functions; sketch exponential functions; rewrite exponential function as logarithmic functions; evaluate logarithmic functions; solve logarithmic functions; sketch logarithmic functions | Understand radians and convert radians to degrees and vice versa. find sine, cosine, and tangent of special triangles; use trig ratios to solve problems; find key features of a period function; sketch sine and cosine; solve problems involving sampling; conduct observational and experimental studies; apply sampling techniques; recognize the key components of observational studies. |

## Unit Overview

### **Unit 2:** Polynomial Function and Equations

*Essential Questions*

- What is polynomial function?
- How do you perform arithmetic operation on polynomials?
- How do you interpret key features of graphs and tables in terms of the quantities?
- How do you describe concavity of a graph?
- How do you identify odd and even function based on the symmetry?
- What is a rational expression?
- How do you simplify rational expressions?
- How do you re-write rational expressions?
- How are the degrees of polynomials related to its' zeroes?
- How can you analyze functions using different representation?
- How do you sketch graphs showing key features given a verbal description of the relationship?
- What is the difference between absolute values and relative values?
- What is a short-term behavior?
- What is a long-term behavior?
- How can you analyze functions using different representation?
- What is polynomial equation?
- What is a complex number?
- How do you solve polynomial equation?
- How does discriminant help you make prediction about roots of quadratic equations?
- What is synthetic division?
- What is the fundamental theorem of Algebra?
- What is remainder theorem?

*Enduring Understandings*

- Polynomial functions take the form $f(x) = a_nx^n + a_{n-1}x^{n-1}+...+a_1x+a_0$, where n is a nonnegative integer and $a_n \neq 0$.
- 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.
- Understand the Key features of graphs such as; intercepts, intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries and point of inflections.
- Understand the concavity of graphs. Concave up is when graph decreases first then increases (left to right). Concave down is when graph increases first then decreases(left to right)
- Understand that a function that has line symmetry with respect to y axis is called even function
- Understand that function that has point symmetry with respect to the origin is called odd function
- A rational expression is the quotient of two polynomial expressions, expressed as a ratio.
- Rational expression can be simplified through factoring
- Understand how to use long division to Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x).
- Identify zeros of polynomials when suitable factorizations are available.

- Use the zeros of a function, critical points (relative max, min) and intervals for increasing and decreasing function, end behavior, and symmetries to construct a rough graph of the function defined by the polynomial.
- Understand that for any absolute values graph reaches the highest or lowest point then decreases or increases over an interval
- Understand that for any local values graph reaches a high point then a low point and then it keep increasing or decreasing and there is not absolute values
- The behavior of a function over small intervals is called the short-term behavior**,** or local behavior**,** of a function
- Long-term behavior is the same as end behavior, of the polynomial. End behavior of the function is defined as the behavior of the values of f(x) as x approaches negative infinity and as x approaches positive infinity.
- Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- A polynomial equation is any equation that can be written in the form $(a_nx^n + a_{n-1}x^{n-1}+...+a_1x+a_0= 0$.
- Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + bi with a and b real.
- When you know one of the roots you can find other factor by dividing the polynomial by linear expression.
- You can solve polynomial through factoring. If it is quadratic equation then you can also solve by completing the square or by using the quadratic equation
- If the discriminant is positive, there are two distinct real roots. If the discriminant is zero, there is one distinct real root. If the discriminant is negative, there are two distinct non-real complex roots.
- Synthetic division is a short hand for long division
- According to the Fundamental Theorem of Algebra, any polynomial with real coefficients of degree n has at least one complex root.
- For a polynomial p(x) and a number a, the remainder on division by x –a is p(a)

*New Jersey Student Learning Standards (NJSLS)*

1) A.SSE.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 $(x^2 - y^2)(x^2 + y^2)$

2) A.SSE.3: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
   a. Factor a quadratic expression to reveal the zeros of the function it defines.

3) A-APR.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.

4) A-APR.2: Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

5) A-APR.3: Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

6) A-APR.4: Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

7) A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

8) A-REI.4: Solve quadratic equations in one variable.
   b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real Numbers a and b
   d. Represent and solve equations and inequalities graphically

9) A-REI.11: Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

10) A.CED.1: Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

11) A-CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

12) F-IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

13) F-IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; ~~end behavior; and periodicity.~~

14) F-IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function

15) F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
   c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

16) F-IF.8: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
    a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, ~~and interpret these in terms of a context~~

17) F-IF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum

18) F-BF.1: Write a function that describes a relationship between two quantities.
    b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

19) N-CN.1: Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + bi with a and b real

20) N-CN-2: Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

21) N-CN.7: Solve quadratic equations with real coefficients that have complex solutions

22) N-CN.8: +) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.

23) N-CN.9: (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Major Content
Supporting Content
Additional Content
~~Parts of standard not contained in this unit~~
Algebra I Content

## Student Learning Material

This course uses Agile Mind as its primary resource, which can be accessed at the following URL:

- www.orange.agilemind.com

Each unit consists of 1-3 topics. Within each topic, there are “Exploring” lessons with accompanying activity sheets, practice, and assessments. The curriculum guide provides an analysis of each topic - detailing the standards, objectives, skills, and concepts to be covered. In addition, it provides suggestions for pacing, sequence, and emphasis of the content.

Along with Agile Mind, the district additional guide where all the lesson materials have been organized.
See the link below:

https://www.dropbox.com/sh/5oik0b0ermds8z4/AAC5eL5Rmh7YwuQ950qF_9zha?dl=0

## Modifications

| **Special Education/ 504:** | **English Language Learners:** |
|---|---|
| -Adhere to all modifications and health concerns stated in each IEP.<br>-Give students a MENU options, allowing students to pick assignments from different levels based on difficulty.<br>-Accommodate Instructional Strategies: reading aloud text, graphic organizers, one-on-one instruction, class website (Google Classroom), handouts, definition list with visuals, extended time<br>-Allow students to demonstrate understanding of a problem by drawing the picture of the answer and then explaining the reasoning orally and/or writing , such as Read-Draw-Write<br>-Provide breaks between tasks, use positive reinforcement, use proximity<br>-Assure students have experiences that are on the Concrete- Pictorial- Abstract spectrum by using manipulatives<br>-Common Core Approach to Differentiate Instruction: Students with Disabilities (pg 17-18)<br>-Strategies for Students with 504 Plans | - Use manipulatives to promote conceptual understanding and enhance vocabulary usage<br>- Provide graphic representations, gestures, drawings, equations, realia, and pictures during all segments of instruction<br>- During ALEKS lessons, click on “Español” to hear specific words in Spanish<br>- Utilize graphic organizers which are concrete, pictorial ways of constructing knowledge and organizing information<br>- Use sentence frames and questioning strategies so that students will explain their thinking/ process of how to solve word problems<br>- Utilize program translations (if available) for L1/ L2 students<br>- Reword questions in simpler language<br>- Make use of the ELL Mathematical Language Routines (click here for additional information)<br>-Scaffolding instruction for ELL Learners<br>-Common Core Approach to Differentiate Instruction: Students with Disabilities (pg 16-17) |
| **Gifted and Talented:** | **Students at Risk for Failure:** |
| - Elevated contextual complexity<br>- Inquiry based or open ended assignments and projects<br>- More time to study concepts with greater depth<br>- Promote the synthesis of concepts and making real world connections<br>- Provide students with enrichment practice that are | - Assure students have experiences that are on the Concrete- Pictorial- Abstract spectrum<br>- Modify Instructional Strategies, reading aloud text, graphic organizers, one-on-one instruction, class website (Google Classroom), inclusion of more visuals and manipulatives, Field Trips, Google Expeditions, Peer Support, one on one instruction<br>- Assure constant parental/ guardian contact throughout |

| | |
|---|---|
| imbedded in the curriculum such as:<br>● Application / Conceptual Development<br>● Are you ready for more?<br>- Common Core Approach to Differentiate Instruction: Students with Disabilities (pg. 20)<br>- Provide opportunities for math competitions<br>- Alternative instruction pathways available | the year with successes/ challenges<br>- Provide academic contracts to students and guardians<br>- Create an interactive notebook with samples, key vocabulary words, student goals/ objectives.<br>- Always plan to address students at risk in your learning tasks, instructions, and directions. Try to anticipate where the needs will be and then address them prior to lessons.<br>-Common Core Approach to Differentiate Instruction: Students with Disabilities (pg 19) |

## 21st Century Life and Career Skills:

Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.

https://www.state.nj.us/education/cccs/2014/career/9.pdf

- **CRP1**. Act as a responsible and contributing citizen and employee.
- **CRP2**. Apply appropriate academic and technical skills.
- **CRP3**. Attend to personal health and financial well-being.
- **CRP4**. Communicate clearly and effectively and with reason.
- **CRP5**. Consider the environmental, social and economic impacts of decisions.
- **CRP6**. Demonstrate creativity and innovation.
- **CRP7**. Employ valid and reliable research strategies.
- **CRP8**. Utilize critical thinking to make sense of problems and persevere in solving them.
- **CRP9**. Model integrity, ethical leadership and effective management.
- **CRP10**. Plan education and career paths aligned to personal goals.
- **CRP11**. Use technology to enhance productivity.
- **CRP12**. Work productively in teams while using cultural global competence.

**Students are given an opportunity to communicate with peers effectively, clearly, and with the use of technical language. They are encouraged to reason through experiences that promote critical thinking and emphasize the importance of perseverance. Students are exposed to various mediums of technology, such as digital learning, calculators, and educational websites.**

## Technology Standards:

All students will be prepared to meet the challenge of a dynamic global society in which they participate, contribute, achieve, and flourish through universal access to people, information, and ideas.

https://www.state.nj.us/education/cccs/2014/tech/

### 8.1 Educational Technology:

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

A. **Technology Operations and Concepts:** Students demonstrate a sound understanding of technology concepts, systems and operations.
B. **Creativity and Innovation:** Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
C. **Communication and Collaboration:** Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
D. **Digital Citizenship:** Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
E. **Research and Information Fluency:** Students apply digital tools to gather, evaluate, and use of information.
F. **Critical thinking, problem solving, and decision making:** Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

### 8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming:

All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

A. **The Nature of Technology: Creativity and Innovation-** Technology systems impact every aspect of the world in which we live.
B. **Technology and Society:** Knowledge and understanding of human, cultural, and societal values are fundamental when designing technological systems and products in the global society.
C. **Design:** The design process is a systematic approach to solving problems.
D. **Abilities in a Technological World:** The designed world in a product of a design process that provides the means to convert resources into products and systems.
E. **Computational Thinking: Programming-** Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

## Interdisciplinary Connections:

**English Language Arts:**

| | |
|---|---|
| ELA.Literacy.RI-9-10.4 | Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language of a court opinion differs from that of a newspaper). |
| ELA-LITERACY.SL.9-10.4 | Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task. |
| ELA-LITERACY.W.9-10.2.A | Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. |

| Overview | | |
|---|---|---|
| Topic | Name | Suggested Pacing |
| **0** | Transition Lesson | 7 blocks<br>(Based on Diagnostic Assessment results) |
| **4** | Building New Functions | 3 blocks |
| **5** | Polynomial Functions | 3 blocks |
| **6** | Polynomial Equations | 8-9 blocks |

## Scope and Sequence

| | |
|---|---|
| Diagnostic Assessment | ½ block |
| NEW LESSONS | 22 Bocks |
| Teacher created test | 1 block |
| MP1 Benchmark Assessment | 1 block |
| ECRs | 20-30 minutes per ECR |
| Fall NWEA | 1 – 2 Days |
| Performance Task 1 | ½ block |
| Performance Task 2 | ½ block |
| Review | 2 blocks |
| Flex days (Revisit, Intervention, etc.) | 3 days |
| Total | ≈31 ½ blocks |

NWEA Map test (1-2 days):

Test Window: September 21 – October 2, 2020

Benchmark Assessment Window: Oct. 28 -- Nov. 13, 2020

## Calendar

Please complete the calendar based on suggested pacing.

| September 2020 | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| September 2020 | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| | | | | | | |

| October 2020 | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| October 2020 | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| | | | | | | |
| | | | | | | |

| November 2020 | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| | | | | | | |
| | | | | | | |

| November 2020 | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Assessment Framework

| Assessment | Assignment Type | Grading | Source | Estimated in-class time | When? |
|---|---|---|---|---|---|
| Diagnostic Assessment<br>*Unit 1 Diagnostic* | Test | Traditional<br>(zero weight) | Curriculum Dept. created – see Dropbox | < ½ block | Beginning of unit |
| Mid-Unit Assessment | Test | Traditional | Teacher created using "Assessments" in Agile Mind | ½ to 1 block | Mid unit<br>(optional, must have 3 tests per MP) |
| End of Unit Assessment<br>*Unit 1 Assessment* | Test | Traditional | Curriculum Dept. created – distributed at end of unit | 1 block | End of unit |
| Performance Task<br>*Unit 2 Performance Task1* | Authentic Assessment | Rubric | Topic constructed response (also see Dropbox) | ½ block | In topic 1 |
| Performance Task<br>*Unit 2 Performance Task2* | Authentic Assessment | Rubric | Topic constructed response (also see Dropbox) | ½ block | In topic 3 |
| Quizzes | Quiz | Rubric or Traditional | Teacher created or "Practice" in Agile Minds | < ½ block | Varies (must have 3 quizzes per MP) |
| Exit Ticket | Formative | | Teacher created | 5-7 minutes | Daily (or based on lessons) |

NWEA Map test (1-2 days):

Test Window: September 9 – September 20

Benchmark Assessment Window: Oct. 29 -- Nov. 12

# Topic 0: Transition Lessons

Topic Objectives (Note: these are not in 3-part or SMART objective format)

Students will

1. Identify zeroes of the quadratic equations in standard form graphs; justify solution(s) algebraically and identify the key features
2. Identify key features of quadratic functions in factored form and standard form and sketch showing key features
3. Using a graphing calculator, re-write the standard form into factored form
4. Re-write standard form in to factored form using area model
5. Solve quadratic equations in standard form by factoring or graphing and sketch the graph to show key features.
6. Given a vertex form of the quadratic function students will Solve simple quadratic equations
    a. (e.g. $x^2 = 49$, $(x+2)^2 = 49$, $x^2 – 2 = 2$) and sketch the graph to show key features.
7. Solve quadratic equations in vertex form by taking square roots
8. By completing squares students will
    - Derive the quadratic formula
    - Apply the quadratic formula to find real solution
    - identify the nature of the roots and number of real roots from graphs And the discriminate

Focused Mathematical Practices

- MP 2: Reason abstractly and quantitatively
- MP3: Model with mathematics
- MP 5: Use appropriate tools strategically
- MP 6: Attend to precision
- MP7: Look for and make sense of structure

Vocabulary

Polynomial expression, polynomial function, rational expression, rational function, leading coefficient, increasing function, decreasing function, concavity, inflection point, interval notation, odd function, and even function

Pre-Requisites

- Multiply Binomials using distributive property
- Graphing calculator to find zeros and concept of x intercepts from any function

| **Day** | **Objective(s) covered** | **MP** | **Additional Notes** |
|---|---|---|---|
| 1 | 1 | 2,3, 5, 8 | Those transition lessons were reviewed for Algebra I Quadratic function. Teachers need to make decision about which lessons will be used based on the data. |
| 2 | 2 | 2,7, 5, 8 | |
| 3 | 3 | 4, 6 | |
| 4 | 4 | 4,6 | |
| 5 | 5 | 5,6,8 | |
| 6 | 6 and 7 | 6,4,5 | |
| 7 | *8* | | |

| NJSLS | **Concepts**<br>What students will know | **Skills**<br>What students will be able to do | Material/Resource |
|---|---|---|---|
| F-IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries;<br>1)F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.<br>a. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.<br>2)F-IF.8: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.<br>a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph<br>1) A-REI.4: Solve quadratic equations in one variable.<br>b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the | ***Day 1: Review***<br>• Review definition of x intercepts and y intercept | ***Day 1: Review***<br>Using the graphing calculator | https://www.dropbox.com/s/ng0t1xu12b2t83w/Lesson%201.docx?dl=0 |
| | ***Day 2 : Review***<br>• Understand when factored form is best used and when standard form is best used | ***Day 2 : Review***<br>• Use the graphing calculator to rewrite the standard form in to factored form<br>• Use graphing calculator to find max and min | https://www.dropbox.com/s/yamqp122od540na/Lesson%202.docx?dl=0 |
| | ***Day 3 : Review***<br>• Use area model and understand that length and width are the factors of the area (area is in standard form)<br>• Factors are the length and width of the area | ***Day 3 : Review***<br>• Multiplying binomial<br>• Factoring standard form of the polynomials | https://www.dropbox.com/s/i6ii8nbi3itolta/Lesson%203.docx?dl=0 |
| | ***Day 4 : Review***<br>• Definition of equation<br>• Point of intersection is the solution to an equation | ***Day 4 : Review***<br>• Solve quadratic equations by factoring and graphing | https://www.dropbox.com/s/h2feg2lsf1vq76w/Lesson%204.docx?dl=0 |
| | ***Day 5: Review***<br>• Understand the structure of vertex form and when it is best used<br>• Understand that standard form and vertex form are the same | ***Day 5: Review***<br>• Identify key features of vertex form<br>• Use the graphing calculator to convert the standard form to vertex form | https://www.dropbox.com/s/fplhs4my7ay7sux/Lesson%205.docx?dl=0 |

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| square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real Numbers a and b<br>b. Represent and solve equations and inequalities graphically<br>2) A-REI.11: Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. | ***Day 6 Review***<br>• Definition of square root<br>• Principal square root | ***Day6: Review***<br>• Solve the simple quadratic equation and perfect square equation by taking square roots | https://www.dropbox.com/s/lwp9ra7fvg9hvth/Lesson%206.docx?dl=0 |
| | ***Day 7 Review***<br>• Understand the quadratic formula and where it came from<br>• When to use the quadratic formula<br>• Definition of discriminant | ***Day7: Review***<br>• Solve quadratic equations using the quadratic formula | https://www.dropbox.com/s/gr42lzos5khkbjr/Lesson%207.docx?dl=0 |

## Topic: Building New Functions

### Building New functions

Topic Objectives (Note: these are not in 3-part or SMART objective format)

1. Identify polynomial functions
2. Add, subtract, and multiply polynomial expressions
3. Identify the interval for increasing and decreasing functions from a graph
4. Define rational expression
5. Simplify rational expressions

Focused Mathematical Practices

- MP 2: Reason abstractly and quantitatively
- MP3: Model with mathematics
- MP 5: Use appropriate tools strategically
- MP 6: Attend to precision
- MP7: Look for and make sense of structure

Vocabulary

Polynomial expression, polynomial function, rational expression, rational function, leading coefficient, increasing function, decreasing function, concavity, inflection point, interval notation, odd function, and even function

Fluency

- Compare and contrast the parent functions
- Simplify Algebraic expressions
- Multiply binomial and trinomial
- Factor trinomials in standard form

### Suggested Topic Structure and Pacing

| **Day** | **Objective(s) covered** | **Agile Mind "Blocks"** (see Professional Support for further lesson details) | **MP** | **Additional Notes** |
|---|---|---|---|---|
| 1 | 1 and 2 | *Block 1*<br>*Block 2*<br>*Block 3* | 2,3, 5, 8 | Overview is optional<br>Explore (Building Polynomial) Pages 1 - 11 |
| 2 | 3 | *Block 4* | 2, 4, 5, 8 | Explore "Quadratic and Cubic" Pages 1, 2, 3, 6, and 7; Skip pages 4, 5, 8, and 9. However introduce interval notation on slide 3 |
| n/a | | | | Skip even and odd functions. It will be covered in Unit 2 |
| 3 | 5,6 | *Block 5* | 2,8 | Explore "Quadratic and Cubic" Pages 1 and 2 Students will only have to simplify<br>Department will provide supplements for the standard A-APR.6 |

| NJSLS | **Concepts**<br>What students will know | **Skills**<br>What students will be able to do | Material/Resource |
|---|---|---|---|
| A.SSE.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 $(x^2 – y^2)(x^2 + y^2)$<br>A-APR.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.<br>A-APR.6. Rewrite simple rational expressions in different forms; write | ***Day 1: Review***<br>• Algebraic expressions, binomials, parent function<br>***Day 1: New***<br>• Polynomials | ***Day1 Review***<br>• Simplify algebraic expressions using the distributive property and by combing like terms<br>• Multiply binomials<br>• Compare and contrast the parent functions learned in previous unit<br>***Day 1: New***<br>• Adding, subtracting, and multiplying polynomials will result in new polynomials | Agile Mind<br>Topic 4<br>*** Overview**<br>*** Exploring**<br>“Building polynomials ”<br>**P 1 – 11**<br>Suggested assignment:<br>SAS 1 Q4a – d<br>SAS 2 Q9a – c and Q10a – d<br>More practice<br>1 – 6<br>* Overview is optional<br>*Students will need Chromebooks; 1 per two students. |

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| a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.<br>A-CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.<br>F-IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).<br>F-IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: | ***Day 2 : Review***<br>Domain of a function, linear equation, linear inequality<br>***Day 2: New***<br>• Linear inches<br>• Cubic expressions and cubic functions<br>• Increasing and decreasing functions | ***Day 2 : Review***<br>• Multiplying three binomials<br>• Graphing Linear equation<br>• Solving linear inequalities with negative coefficient<br>• Graphing inequality on a number line<br>***Day 2: New***<br>• Graphing cubic function<br>• Rate of change makes a difference in the increasing or decreasing function<br>• Use the interval notation to describe for what values of x the graph is concave up or down | Agile Mind<br>Topic 4<br>*** Exploring**<br>"Quadratic and Cubics"<br>**P 1, 2, 3, 6, and 7**<br>Suggested assignment:<br>SAS 3 Q14a – c<br>GP P1 – 5<br>More Practice<br>Pg. 7 only<br>* Skip pages 4, 5, 8, and 9. However introduce interval notation on slide 3 |
| | ***Day 3 : Review***<br>• Rotation, Reflection<br>***Day 3 : New***<br>• Sketching graphs given characteristics<br>• Line symmetry<br>• Point symmetry<br>• Odd function<br>• Even function | ***Day 3 : Review***<br>• Rotating shapes on a coordinate plane<br>• Reflecting lines over line<br>***Day3 : New***<br>• Sketching graphs given intervals where the function is concave up or down and given the point of inflection<br>• Determining whether a function is even using line symmetry<br>• Determining whether a function is odd using point symmetry<br>• Determine whether a function is even or odd algebraically | Agile Mind<br>Topic 4<br>*** Exploring**<br>"Quadratic and Cubic"<br>**P10 - 11**<br>SAS 3 Q15a – c<br>GP 7 – 10<br>MP pg. 11 only<br>*Department will provide supplements for identifying even and odd functions algebraically |

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| a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.<br>A-CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.<br>F-IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).<br>F-IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, | ***Day 4 : Review***<br>Factoring, long division, Operations with fractions<br>***Day 4 : New***<br>Rational Functions, Simplifying rational functions | ***Day 4 : Review***<br>Factor trinomial<br>Factor perfect squares<br>Long division<br>Add, subtract and multiply fractions<br>***Day4 : New***<br>Define rational functions;<br>Write rational function from the polynomials;<br>Factor to simplify rational functions | Agile Mind<br>Topic 4<br>*** Exploring**<br>"Building rational from polynomials"<br>**P 1 and 2 only**<br>MP 12, 13, 14,<br>*When simplifying rational expressions, the degree in the numerator and denominator is limited to 2 |

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| positive, or negative; relative maximums and minimums; symmetries; ~~end behavior; and periodicity.~~<br>F.BF.1: Write a function that describes a relationship between two quantities.<br>b. Combine standard function types using Arithmetic operation. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential and relate these function to the model | | | |

**Topic: Polynomial Function**

## Topic 6: Polynomial Equation

Topic Objectives (Note: these are not in 3-part or SMART objective format)

After completing the topic polynomial equations, students will be able to

1. Define and use imaginary and complex numbers in the solution of quadratic equations
2. Use the discriminant of a quadratic equation to determine the number and type of roots of the equation;
3. Use polynomial long division and synthetic division to solve problems;
4. Factor the sum and difference of two cubes;
5. Factor polynomial expressions by grouping;
6. Solve polynomial equations with real coefficients by applying a variety of techniques in mathematical and real-world problems;
7. Understand the implications of the Fundamental Theorem of Algebra and the Remainder Theorem.

Focused Mathematical Practices

- MP 2: Reason abstractly and quantitatively
- MP 4: Model with mathematics
- MP 5: Use appropriate tools strategically
- MP 6: Attend to precision
- MP 7: Look for and make use of structure

Vocabulary

Quadratic formula, Imaginary numbers, complex numbers, discriminant, real roots and complex roots

Fluency

- Factoring Trinomials
- Using the quadratic formula to solve quadratic equations
- Solving simple quadratic equations
- Graphing quadratic function

### Suggested Topic Structure and Pacing

| **Block** | **Objective(s) covered** | **Agile Mind "Blocks"** (see Professional Support for further lesson details) | **MP** | **Additional Notes** |
|---|---|---|---|---|
| 1 | 1 | *Block 1*<br>*Block 2* | 2,4,5 | Review and explore quadratic equation page 1-5 |
| 2/3 | 2 and 3 | *Block 3*<br>*Block 4* | 2, 4, 5,7 | Agile Mind Topic 6 * **Exploring** "Quadratic Equation " P 6 – 12 * **Exploring** "Complex number " SAS 2 and 3 |
| 4/5 | 3,4 | *Block 5* | 4, 5<br>7 | Agile Mind<br>Topic 6* **Exploring** "Other Polynomial equation " P 1-10<br>Suggested assignment: SAS 4 Q10 *More practice*p9-13 |
| 6/7 | 5-6 | *Block 6* | 4, 7 | Agile Mind<br>Topic 6 * **Exploring** "Other Polynomial equation "<br>P 10-18 Suggested assignment: SAS 4<br>Q15 and 16 More practice p14-16 Guided practice |
| 8/9 | 7 | *Block 7* | 4,7,8 | Agile Mind<br>Topic 6 * **Exploring** "Theorems of Algebra " SAS 5 Q8 More practice p17-20 |

## Topic : Polynomial Equations

| NJSLS | **Concepts**<br>What students will know | **Skills**<br>What students will be able to do | Material/Resource |
|---|---|---|---|
| 3) N-CN.1: Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + bi with a and b real<br>4) N-CN-2: Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.<br>5) N-CN.7: Solve quadratic equations with real coefficients that have complex solutions<br>6) N-CN.8: +) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.<br>7) A.SSE.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 $(x^2 - y^2)(x^2 + y^2)$<br>8) A.SSE.3: Choose and produce an equivalent | ***Block 1 Review:***<br>• Quadratic and cubic functions,<br>• Using quadratic functions to model problem situation<br>• Factoring trinomials<br>• Transformations<br>• Discriminant<br>• x intercepts<br>***Block 1 New***<br>• Connection between the x intercept of the graph and quadratic equations<br>• Real zeros and real roots<br>• Using transformation to show zeroes of the quadratic function | ***Block 1 Review***<br>• Graphing quadratic and cubic functions,<br>• Using quadratic functions to model problem situation<br>• Factoring trinomial to solve quadratic equations<br>• Using transformation to find the zeroes of the quadratic equation<br>***Block 1 New***<br>• Number of real zeroes and number of real roots | Agile Mind<br>Topic 6<br>*** Overview**<br>*** Exploring**<br>"Quadratic Equations"<br>P 1-5<br>SAS 1 and 2<br>Suggested assignment:<br>SAS 2<br>Q6 a – d and Q8, 9a-e, 10, and 11 a - b<br>Guided Practice<br>Pg. 1 - 4 |
| | ***Block 2/3 Review:***<br>• Quadratic formula and graph<br>• Whole numbers, integers, real numbers, rational numbers, complex numbers<br>• Multiplying binomials<br>• Simplifying algebraic expressions<br>***Block 2/3 New:***<br>• Non-real complex roots of quadratic equations<br>• Connect non-real root complex solutions to the graph of the associated quadratic function<br>• Arithmetic of complex number | ***Block 2/3 Review***<br>• Using quadratic formula to solve quadratic equation<br>• Solving simple quadratic equation<br>• Identifying the number system<br>***Block 2 /3New***<br>• Using Discriminant to recognize when the quadratic equation gives complex solution<br>• Use the quadratic formula to determine such roots and connect non-real complex solutions to the graph of the associated quadratic function | Agile Mind<br>Topic 6<br>*** Exploring**<br>"Quadratic Equations"<br>P 6 – 12<br>*** Exploring**<br>"Complex numbers"<br>SAS 2 and 3<br>Suggested assignment:<br>SAS 2<br>Q20a-c<br>*More practice*<br>p1-5<br>SAS 3<br>SAS 3<br>Q7a-b, 8a-b, and 9<br>*More practice*<br>p6-8 |

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| form of an expression to reveal and explain ties of the quantity represented by the expression.<br>a. Factor a quadratic expression to reveal the zeros of the function it defines.<br>9) A-APR.2: Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).<br>10) A-APR.3: Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.<br>11) A-APR.4: Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.<br>12) A-REI.4: Solve quadratic equations in one variable.<br>b. Solve quadratic equations by inspection | ***Block 4/5 Review:***<br>• Long division (with whole numbers)<br>• Factoring<br>• Sum and difference of the squares<br>• Square of the sum and difference<br>• x intercepts from graphs<br>***Block 4/5 New:***<br>• Long division of the polynomials<br>• Solving cubic polynomials<br>• Sum and difference of the cubic polynomials | ***Block 4/5 Review:***<br>• Perform long division with whole numbers<br>• Factor trinomials with a = 1 and a>1<br>• Expanding sum and difference of the squares<br>• Expanding square of the sum and difference<br>• Determining x intercepts from graphs<br>***Block 4/5 New:***<br>• Using long division to factor cubic polynomial<br>• Solving cubic polynomials<br>• Expanding sum and difference of the cubic polynomials | Agile Mind<br>Topic 6<br>*** Exploring**<br>“Other Polynomial equation ”<br>P 1-10<br>Suggested assignment:<br>SAS 4<br>Q10<br>*More practice*<br>p9-13 |
| | ***Block 6/7 Review:***<br>• Long division (with whole numbers)<br>• Factoring<br>• GCF<br>***Block 6/7 New:***<br>• Factoring Cubic polynomial by grouping and using GCF | ***Block 6/7 Review:***<br>• Factoring simple quadratic expressions by factoring Greatest common factor.<br>• Factoring Trinomials using greatest common factor<br>***Block 6/7 New:***<br>• Factoring Cubic polynomial by grouping and using GCF | Agile Mind<br>Topic 6<br>*** Exploring**<br>“Other Polynomial equation ”<br>P 10-18<br>Suggested assignment:<br>SAS 4<br>Q15 and 16<br>More practice<br>p14-16<br>Guided practice |
| | ***Block 8/9 Review:***<br>• Long division with a remainder<br>• Quotient, divisor, remainder<br>***Block 8/9 New:***<br>• Fundamental Theorem of Algebra<br>• Implication for the number of complex roots of a polynomial equation<br>• Remainder Theorem | ***Block 8/9Review:***<br>• Rewrite the solution to long division as the quotient, divisor and remainder<br>• Long division of the polynomial<br>***Block 8/9New:***<br>• Understand the implications of the Fundamental Theorem of | Agile Mind<br>Topic 6<br>*** Exploring**<br>“Theorems of Algebra ”<br>SAS 5<br>Q8<br>More practice<br>p17-20 |

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| (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real Numbers a and b<br>d. Represent and solve equations and inequalities graphically<br>13) A-REI.11: Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.<br>14) A.CED.1: Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and | | Algebra and the Remainder Theorem | |

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| quadratic functions, and simple rational and exponential functions. | | | |

| **5 Practices for Orchestrating Productive Mathematics Discussions** | |
|---|---|
| Practice | Description/ Questions |
| 1. Anticipating | What strategies are students likely to use to approach or solve a challenging high-level mathematical task?<br>How do you respond to the work that students are likely to produce?<br>Which strategies from student work will be most useful in addressing the mathematical goals? |
| 2. Monitoring | Paying attention to what and how students are thinking during the lesson.<br>Students working in pairs or groups<br>Listening to and making note of what students are discussing and the strategies they are using<br>Asking students questions that will help them stay on track or help them think more deeply about the task. (Promote productive struggle) |
| 3. Selecting | This is the process of deciding the *what* and the *who* to focus on during the discussion. |
| 4. Sequencing | What order will the solutions be shared with the class? |
| 5. Connecting | Asking the questions that will make the mathematics explicit and understandable.<br>Focus must be on mathematical meaning and relationships; making links between mathematical ideas and representations. |

## Ideal Math Block

*The following outline is the department approved ideal math block for grades 9-12.*

1) Do Now (7-10 min)

   a. Serves as review from last class' or of prerequisite material
   b. Provides multiple entry points so that it is accessible by all students and quickly scaffolds up

2) Starter/Launch (5 min)
   a. Designed to introduce the lesson
   b. Uses concrete or pictorial examples
   c. Attempts to bridge the gap between grade level deficits and rigorous, on grade level content
   d. Provides multiple entry points so that it is accessible by all students and quickly scaffolds up

3) Mini-Lesson/TASK (15-20 min)
   a. Design varies based on content
   b. May include an investigative approach, direct instruction approach, whole class discussion led approach, etc.
   c. Includes CFU's
   d. Anticipates misconceptions and addresses common mistakes

4) Guided Practice (25-30 min)
   a. Design varies based on content
   b. May include partner work, group work/project, experiments, investigations, game based activities, etc.

5) Independent Practice (7-10 min)
   a. Provides students an opportunity to work/think independently

6) Closure (5-10 min)
   a. Connects lesson/activities to big ideas
   b. Allows students to reflect and summarize what they have learned
   c. May occur after the activity or independent practice depending on the content and objective

7) DOL (5 min)
   a. Exit slip

# Ideal math block with Intervention station

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|---|---|---|---|---|
| Whole Group Instruction | 50 min | INSTRUCTION (Grades 9 – 12)<br>Daily Routine:<br>Mathematical Content or Language Routine<br>Anchor Task: Anticipate, Monitor, Select, Sequence, Connect<br>Collaborative Work*<br>Guided Practice<br>Independent Work (Demonstration of Student Thinking) | TOOLS<br>Manipulatives<br>RESOURCES<br>Agile Mind | |
| Rotation Stations (Student Notebooks & Chromebooks Needed) | 1-2X 35 min | STATION 1:<br>Focus on current Grade Level Content<br>STUDENT EXPLORATION*<br>Independent or groups of 2-3<br>Emphasis on MP's 3, 6 (Reasoning and Precision)<br>And MP's 1 & 4 (Problem Solving and Application)<br>TOOLS/RESOURCES<br>Agile Mind<br>Math Journals | STATION 2:<br>Focus on Student Needs<br>TECH STATION<br>Independent<br>TOOLS/ RESOURCES<br>Khan Academy<br>Approved Digital Provider<br>Fluency Practice | TEACHER STATION:<br>Focus on Grade Level Content; heavily scaffolded to connect deficiencies<br>TARGETED INSTRUCTION<br>4 – 5 Students<br>TOOLS/ RESOURCES<br>Agile<br>Homework<br>Manipulatives |
| | 5 min | INSTRUCTION<br>Exit Ticket (Demonstration of Student Thinking)<br>TOOLS/RESOURCES<br>Notebooks or Exit Ticket Slips | | |

## Sample Lesson Plan (Agile Mind)

| | | | |
|---|---|---|---|
| **Lesson** | Topic 4 Building polynomials Exploring “Quadratic and cubic” | **Days** | 1 |
| **Objective** | By using the concept of breathing and the definition of increasing, and decreasing functions SWBAT<br>• Visualize and identify cubic polynomial<br>• Identify the interval where the cubic function is increasing and decreasing<br>• Sketch a graph using the given interval<br>And show their mastery completing at least 4-4 independent practice problem and 1/1 problems on the DOL correctly | **NJSLS** | A.APR.1 |
| **Learning activities/strategies** | **Materials needed:** Computer with projection device, transparency to insert the activity sheets, and activity sheet<br><br>**Fluency Practice:** (5 minutes) Graphing inequality on the number line. Quickly go over the concepts and notations used to include a point on the line or not include a point on the line.<br><br>**Do Now (5 minutes):**<br>• Provide the breathing cycle graph to students from yesterday’s lesson and ask “How is the volume of the air in the lung changes shown by the graph.<br>• During the summary ask guided questions such as “as you breathe in does the volume of air increases or decreases?” “As you breathe out does the volume of air increases or decreases? Discuss the rate of the volume also by asking “when is the rate of air increasing faster” students should see from the graph that it’s increasing aster at the beginning as you breath in the air. And it slows down as your lung is filled with air.<br>**Starter/Launch (2 minutes):**<br>• Ask students if they think of any other situation where they might see quadratic or cubic polynomials. Introduce the objective of the day and the importance of polynomial in real life<br>**Mini lesson and practice (20 minutes):**<br>• Display page 2 from “explore” to introduce the definition of increasing and decreasing function. Have students write the definition down in question 1 SAS 3.<br>• Ask students to show using arrows on the graph where the function is increasing and where the function is decreasing then ask them to hold up their transparency sheet with the activity sheet in it check their answer.<br>• Ask students to use inequality to write the interval where the function is increasing and where the function is decreasing<br>• Display page 3 and play animation slide 1 and 2 for students to see the rate of change for a simple linear and cubic function . Students will complete question 3 SAS3<br>➢ Guided question: what is happening to rate of change before zero and after zero?<br>➢ Play animation slide 3 and 4 for students check their answer | | |

- Use page 6 to illustrate interval notation for students. Point out that often context is the only thing that distinguishes interval notation from ordered pair notation. (Misconception: Students might see the interval notation as ordered pair, which is not the same)

**Group work/ Partner work (15 minutes)**

Students will complete the puzzle on page 7 and 8 with a partner or in their respective group (SAS 3 questions 5 and 6)

Summarize by asking students to come to the smart board and complete the puzzle on Agile mind.

**Independent Practice (10 minutes):**

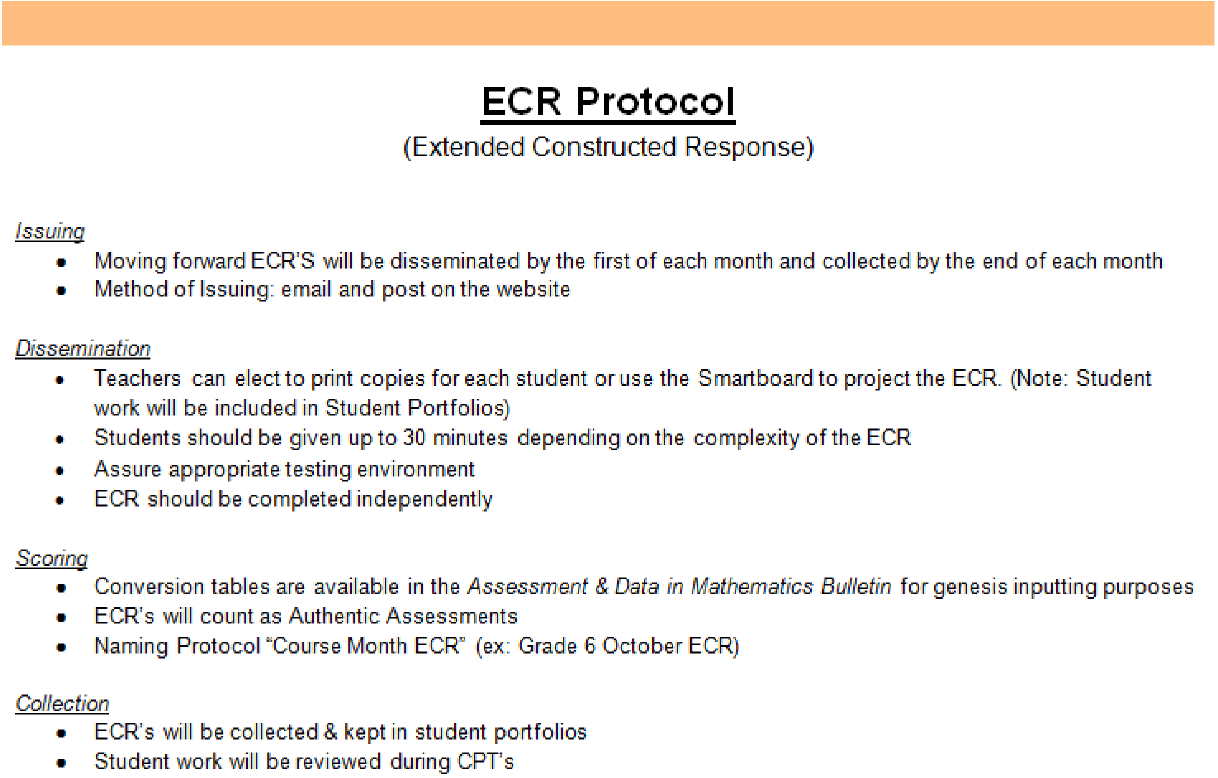
- Re-inforce SAS 3: question 14 More practice page 7-10
- Summarize as a class

**Closure (2 minutes):**

- Ask what is an increasing function, decreasing function, concave up, concave down and point of inflection.

**DOL (5 minutes):**

# Extended constructed Response Protocol



## ECR Protocol

(Extended Constructed Response)

*Issuing*

- Moving forward ECR'S will be disseminated by the first of each month and collected by the end of each month
- Method of Issuing: email and post on the website

*Dissemination*

- Teachers can elect to print copies for each student or use the Smartboard to project the ECR. (Note: Student work will be included in Student Portfolios)
- Students should be given up to 30 minutes depending on the complexity of the ECR
- Assure appropriate testing environment
- ECR should be completed independently

*Scoring*

- Conversion tables are available in the *Assessment & Data in Mathematics Bulletin* for genesis inputting purposes
- ECR's will count as Authentic Assessments
- Naming Protocol "Course Month ECR" (ex: Grade 6 October ECR)

*Collection*

- ECR's will be collected & kept in student portfolios
- Student work will be reviewed during CPT's

**OCTOBER ECR (NJSLS N.CN.1/2)**

https://www.dropbox.com/s/0byu2oyr2chhi1o/Algebra%202%20ECR%20Tier1.docx?dl=0

**October ECR (NJSLS A.APR.B.3)**

**https://www.dropbox.com/s/1ffzvwjjs5jriwq/Algebra%202%20ECR%20%28Tier%202%29.docx?dl=0**

**November ECR ( NJSLS A.APR.B.2.)**

https://www.dropbox.com/s/xm2htyuel26k2nn/Algebra%202%20ECR%20November%20%28Tier%201%29.docx?dl=0

# ECR Conversion Chart

| Points | Genesis Conversion | Points | Genesis Conversion | Points | Genesis Conversion |
|---|---|---|---|---|---|
| 0 | 55 | 0 | 55 | 0 | 55 |
| 1 | 59 | 1 | 69 | 1 | 69 |
| 2 | 69 | 2 | 79 | 2 | 89 |
| 3 | 79 | 3 | 89 | 3 | 100 |
| 4 | 89 | 4 | 100 | | |
| 5 | 100 | | | | |

## Performance Based Tasks

### Volume of a box

**https://www.dropbox.com/s/pr0eupwhimwlxx0/Algebra%202%20Unit%201%20Performance%20task%203%20Box%20Volume.docx?dl=0**

**Rubric**

https://www.dropbox.com/s/ej7ddqlwojnfker/Rubric%20of%20Unit%201%20Performance%20task%203%20Box%20Volume.docx?dl=0

https://www.dropbox.com/s/smlnlih7vemckvy/Scoring%20guide%20for%20unit%201%20performance%20task%203%20Box%20volume.docx?dl=0

### Graphing from the roots

https://www.dropbox.com/s/umjh0953771h9y5/Reasoning%20Task%20%28Graphing%20from%20roots%29.docx?dl=0

# NJSLA Sample Items

Unit 1 Preparation Material

PART I

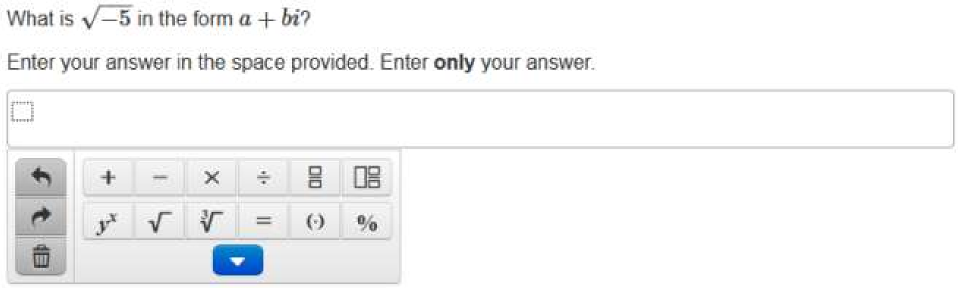
NJSLS: N.CN.A

CN.1: **Know there is a complex number** i **such that** i2=−1**, and every complex number has the form** a+bi **with** a**and** b **real**

CN.2: **Use the relation** i2=−1 **and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.**

NJSLS Practice

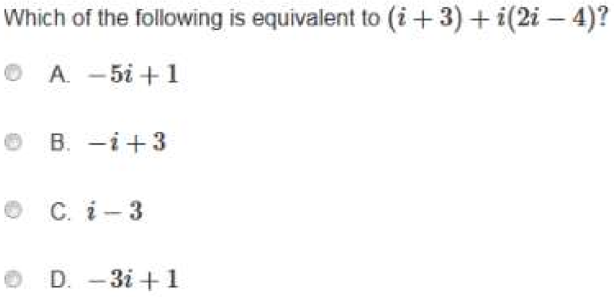
Task 1



What is $\sqrt{-5}$ in the form $a + bi$?

Enter your answer in the space provided. Enter **only** your answer.

Task 2



Which of the following is equivalent to $(i + 3) + i(2i - 4)$?

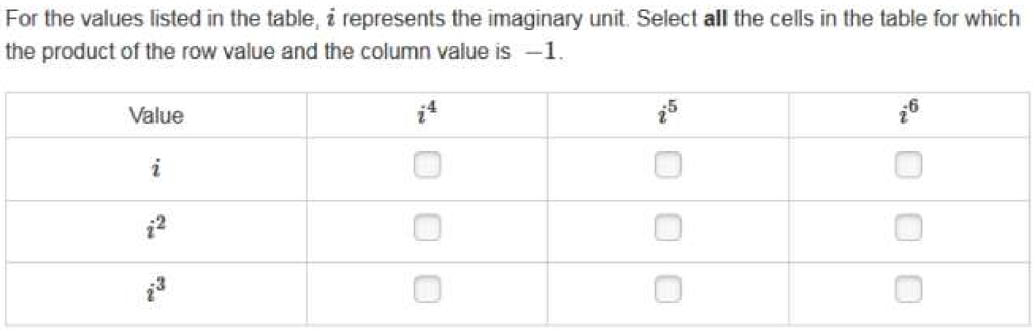
○ A. $-5i + 1$

○ B. $-i + 3$

○ C. $i - 3$

○ D. $-3i + 1$

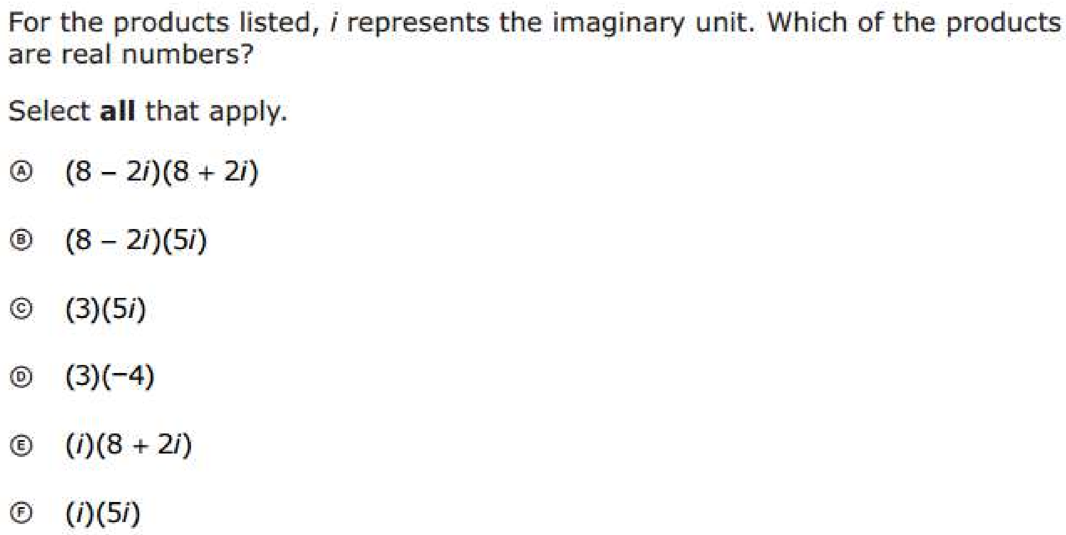
Task 3



For the values listed in the table, $i$ represents the imaginary unit. Select **all** the cells in the table for which the product of the row value and the column value is $-1$.

| Value | $i^4$ | $i^5$ | $i^6$ |
|---|---|---|---|
| $i$ | ☐ | ☐ | ☐ |
| $i^2$ | ☐ | ☐ | ☐ |
| $i^3$ | ☐ | ☐ | ☐ |

Task 4



For the products listed, $i$ represents the imaginary unit. Which of the products are real numbers?

Select **all** that apply.

Ⓐ $(8 - 2i)(8 + 2i)$

Ⓑ $(8 - 2i)(5i)$

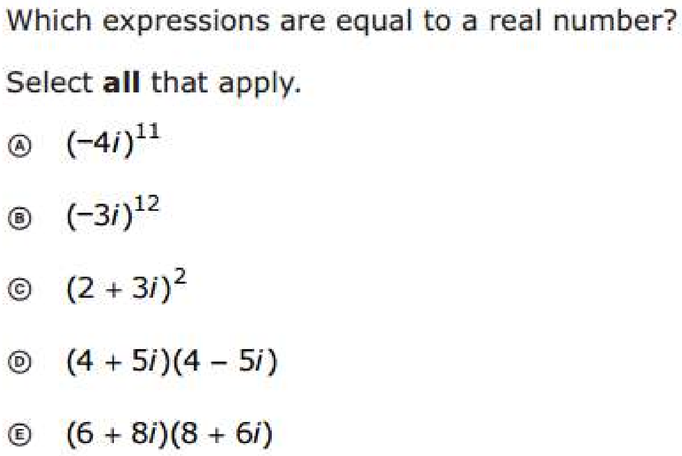
Ⓒ $(3)(5i)$

Ⓓ $(3)(-4)$

Ⓔ $(i)(8 + 2i)$

Ⓕ $(i)(5i)$

Task 5



Which expressions are equal to a real number?

Select **all** that apply.

Ⓐ $(-4i)^{11}$

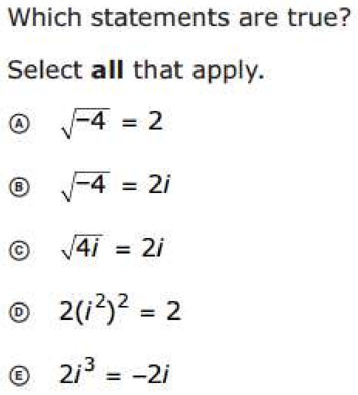
Ⓑ $(-3i)^{12}$

Ⓒ $(2 + 3i)^2$

Ⓓ $(4 + 5i)(4 - 5i)$

Ⓔ $(6 + 8i)(8 + 6i)$

Task 6



Which statements are true?

Select **all** that apply.

Ⓐ $\sqrt{-4} = 2$

Ⓑ $\sqrt{-4} = 2i$

Ⓒ $\sqrt{4i} = 2i$

Ⓓ $2(i^2)^2 = 2$

Ⓔ $2i^3 = -2i$

Task 7

Which of the following is equivalent to $i^{49}$ ?

a. $i$
b. $-1$
c. $-i$
d. $1$

Task 8

What is the sum $(2+3i)+(-4-2i)$ ?

What is the difference $(5-8i)-(-6-11i)$ ?

What is the product $(1-6i)(-5+8i)$ ?

PART II

NJSLS:N.CN.7

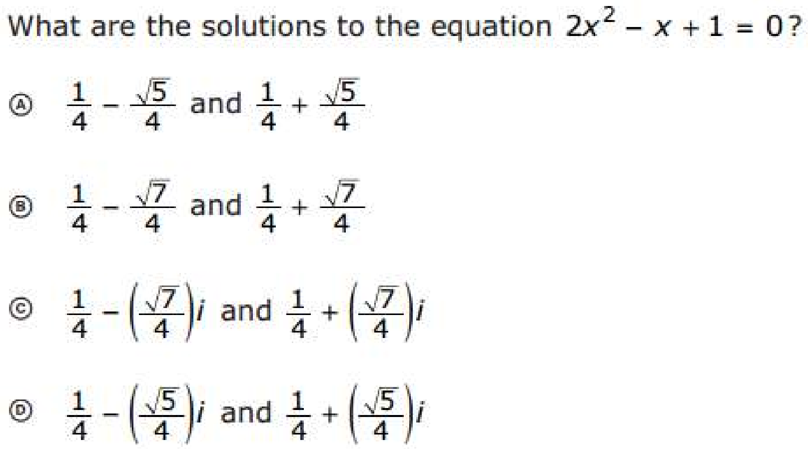
**Solve quadratic equations with real coefficients that have complex solutions.**

NJSLS Practice

Task 1

One zero for $x^2 - 10x + 169 = 0$ is $x = 5 + 12i$. Find the second zero for $x^2 - 10x + 169 = 0$.

Task 2



What are the solutions to the equation $2x^2 - x + 1 = 0$?

- Ⓐ $\frac{1}{4} - \frac{\sqrt{5}}{4}$ and $\frac{1}{4} + \frac{\sqrt{5}}{4}$
- Ⓑ $\frac{1}{4} - \frac{\sqrt{7}}{4}$ and $\frac{1}{4} + \frac{\sqrt{7}}{4}$
- Ⓒ $\frac{1}{4} - \left(\frac{\sqrt{7}}{4}\right)i$ and $\frac{1}{4} + \left(\frac{\sqrt{7}}{4}\right)i$
- Ⓓ $\frac{1}{4} - \left(\frac{\sqrt{5}}{4}\right)i$ and $\frac{1}{4} + \left(\frac{\sqrt{5}}{4}\right)i$

Task 3

The function $f$ is defined by $f(x) = x^2 - 6x + 21$. What are the solutions of $f(x) = 0$ ? Show your work.

Task 4

Which of the following are the solutions for the equation $0 = x^2 - x + 1$ ?

a. $x = \frac{-1 + i\sqrt{3}}{2}$ and $x = \frac{-1 - i\sqrt{3}}{2}$

b. $x = \frac{-1 + i\sqrt{5}}{2}$ and $x = \frac{-1 - i\sqrt{5}}{2}$

c. $x = \frac{1 + i\sqrt{5}}{2}$ and $x = \frac{1 - i\sqrt{5}}{2}$

d. $x = \frac{1 + i\sqrt{3}}{2}$ and $x = \frac{1 - i\sqrt{3}}{2}$

Task 5

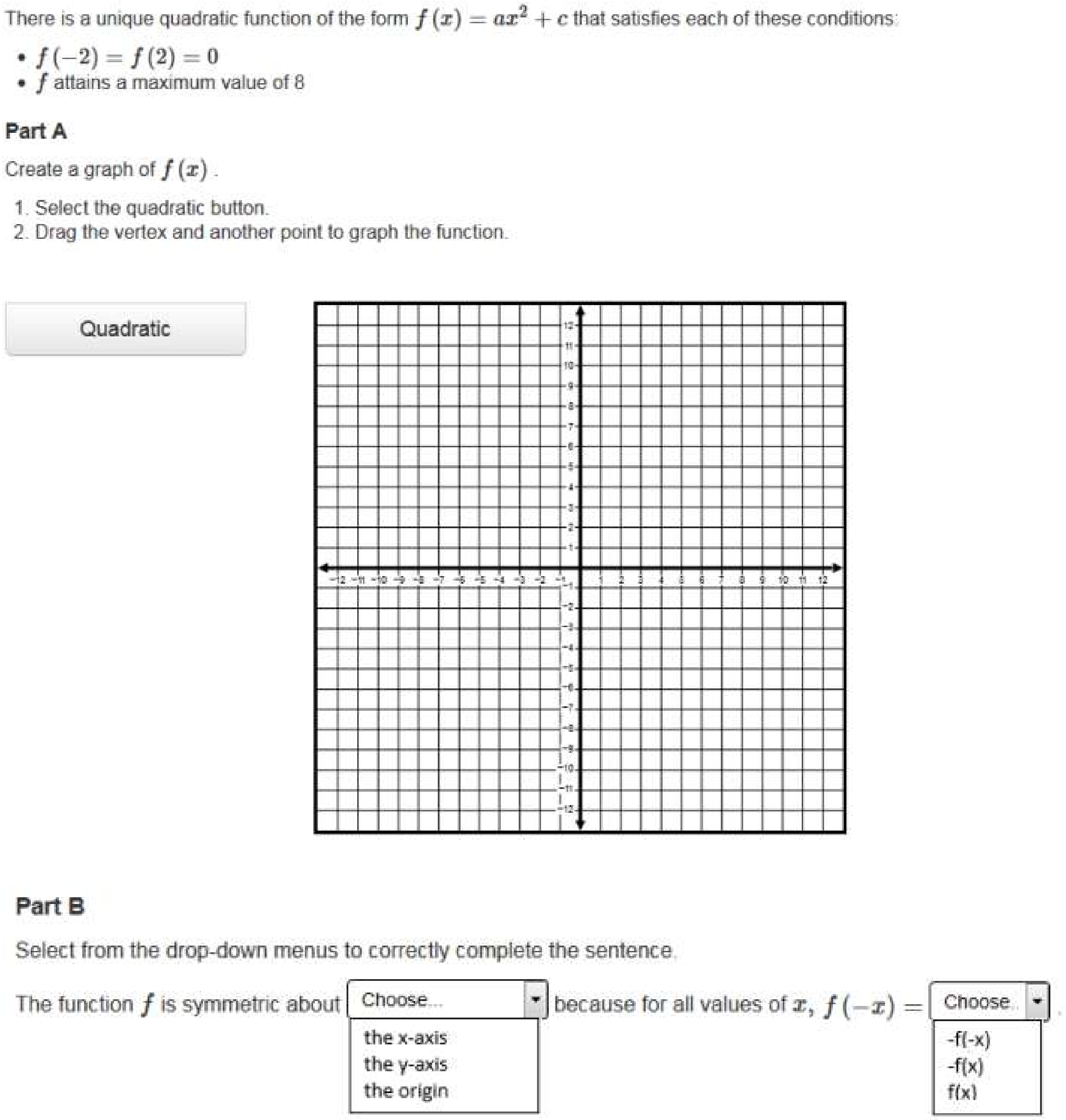
What are the solutions to the equation $x^2 + 9 = 0$ ?

NJSLS: F.IF.4-2

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

NJSLA Practice

Task 1



There is a unique quadratic function of the form $f(x) = ax^2 + c$ that satisfies each of these conditions:

- $f(-2) = f(2) = 0$
- $f$ attains a maximum value of 8

**Part A**

Create a graph of $f(x)$.

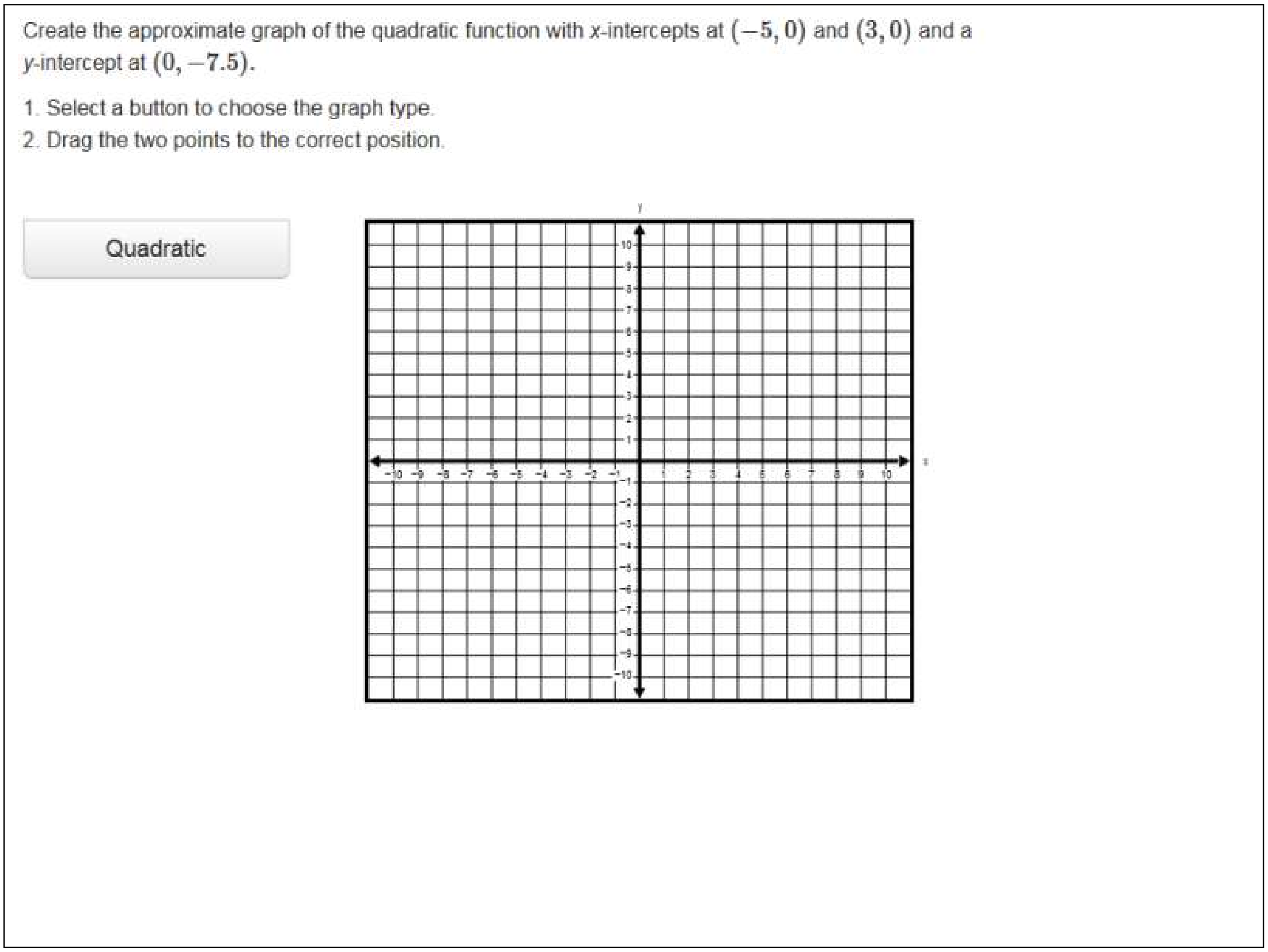
1. Select the quadratic button.
2. Drag the vertex and another point to graph the function.

**Part B**

Select from the drop-down menus to correctly complete the sentence.

The function $f$ is symmetric about [Choose...] because for all values of $x$, $f(-x) =$ [Choose...].

Task 2



Create the approximate graph of the quadratic function with $x$-intercepts at $(-5, 0)$ and $(3, 0)$ and a $y$-intercept at $(0, -7.5)$.

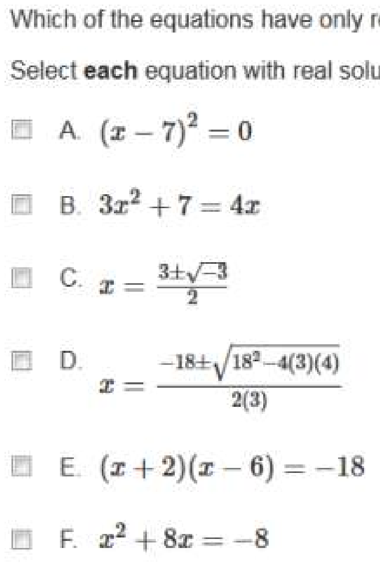
1. Select a button to choose the graph type.
2. Drag the two points to the correct position.

PART IV

NJSLS: A.REI.4

Solve quadratic equations by inspection (e.g., for $x^2=49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a±bi for real numbers a and b.

| Task |
|---|



Which of the equations have only real solutions?

Select **each** equation with real solutions.

☐ A. $(x-7)^2=0$

☐ B. $3x^2+7=4x$

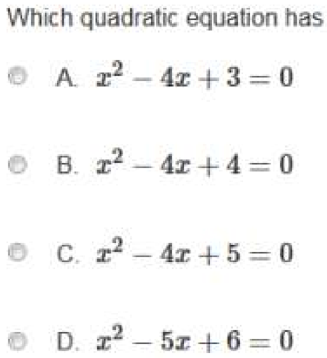
☐ C. $x=\frac{3\pm\sqrt{-3}}{2}$

☐ D. $x=\frac{-18\pm\sqrt{18^2-4(3)(4)}}{2(3)}$

☐ E. $(x+2)(x-6)=-18$

☐ F. $x^2+8x=-8$

Task



Which quadratic equation has nonreal roots?

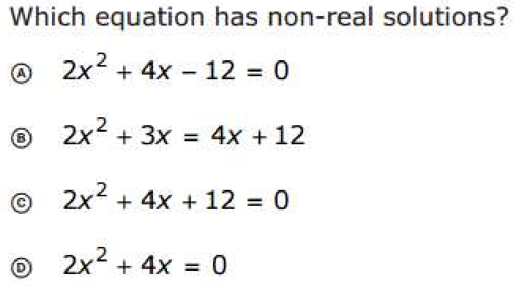
○ A. $x^2-4x+3=0$

○ B. $x^2-4x+4=0$

○ C. $x^2-4x+5=0$

○ D. $x^2-5x+6=0$

Task



Which equation has non-real solutions?

Ⓐ $2x^2+4x-12=0$

Ⓑ $2x^2+3x=4x+12$

Ⓒ $2x^2+4x+12=0$

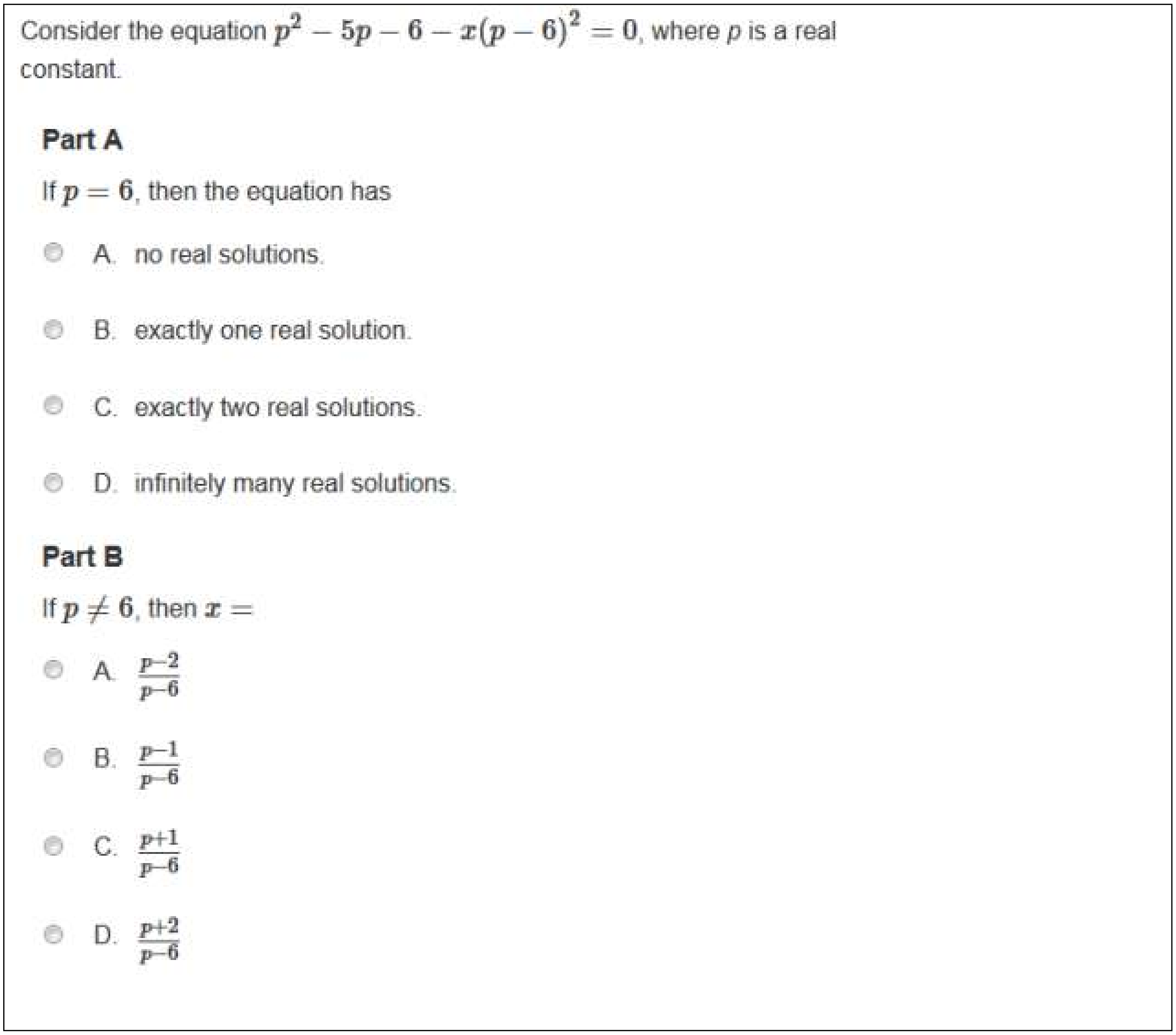
Ⓓ $2x^2+4x=0$

PART IV

NJSLS: A.Int.1

**Solve equations that require seeing structure in expressions**

Task 1:



Consider the equation $p^2 - 5p - 6 - x(p-6)^2 = 0$, where $p$ is a real constant.

**Part A**

If $p = 6$, then the equation has

○ A. no real solutions.

○ B. exactly one real solution.

○ C. exactly two real solutions.

○ D. infinitely many real solutions.

**Part B**

If $p \neq 6$, then $x =$

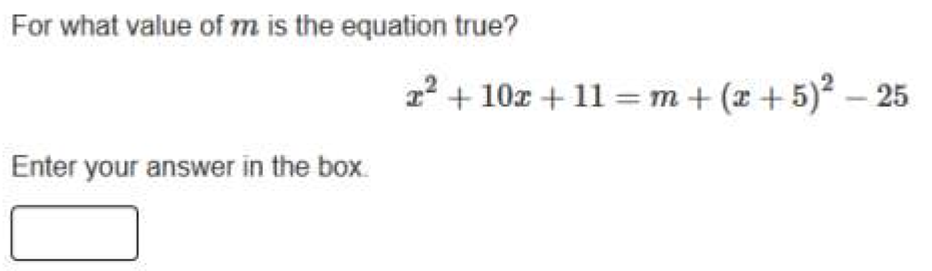
○ A. $\frac{p-2}{p-6}$

○ B. $\frac{p-1}{p-6}$

○ C. $\frac{p+1}{p-6}$

○ D. $\frac{p+2}{p-6}$

Task 2



For what value of $m$ is the equation true?

$$x^2 + 10x + 11 = m + (x+5)^2 - 25$$

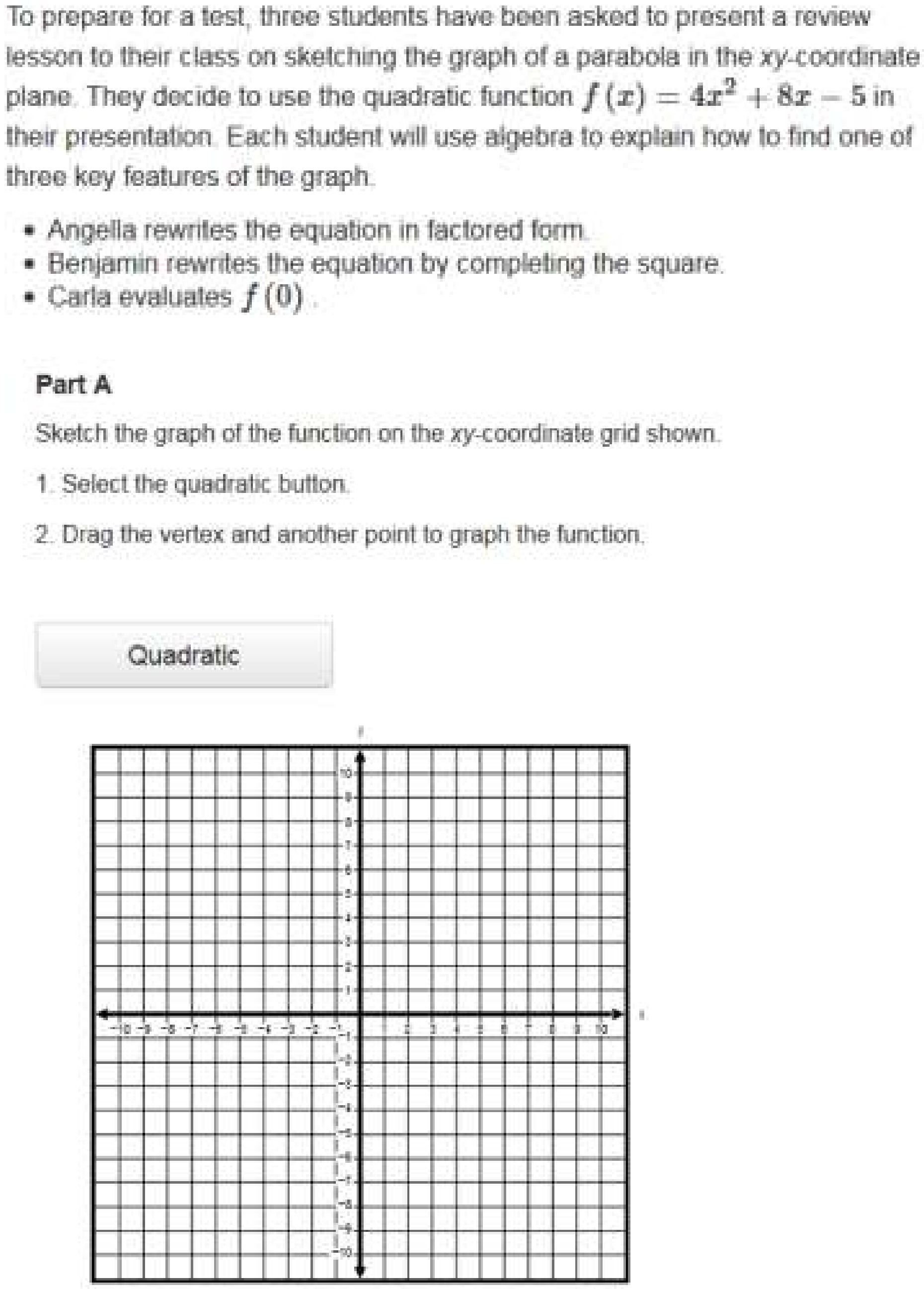
Enter your answer in the box.

PART V

NJSLS: HS. C.CCR

**Solve multi-step mathematical problems requiring extended chains of reasoning and drawing on a syntheses of the knowledge and skills articulated across.**

Task 1



To prepare for a test, three students have been asked to present a review lesson to their class on sketching the graph of a parabola in the *xy*-coordinate plane. They decide to use the quadratic function $f(x) = 4x^2 + 8x - 5$ in their presentation. Each student will use algebra to explain how to find one of three key features of the graph.

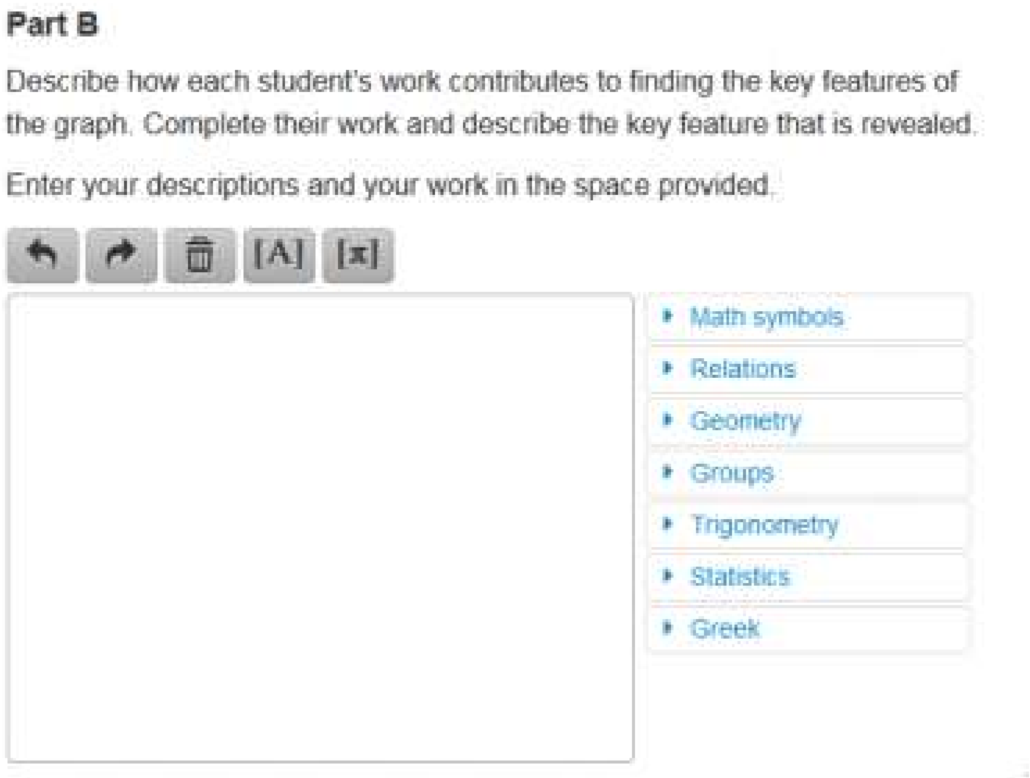
- Angella rewrites the equation in factored form.
- Benjamin rewrites the equation by completing the square.
- Carla evaluates $f(0)$.

**Part A**

Sketch the graph of the function on the *xy*-coordinate grid shown.

1. Select the quadratic button.

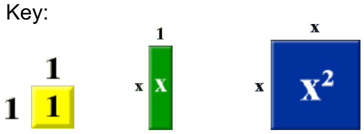
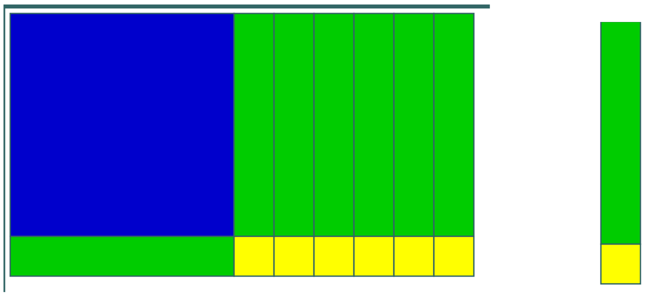
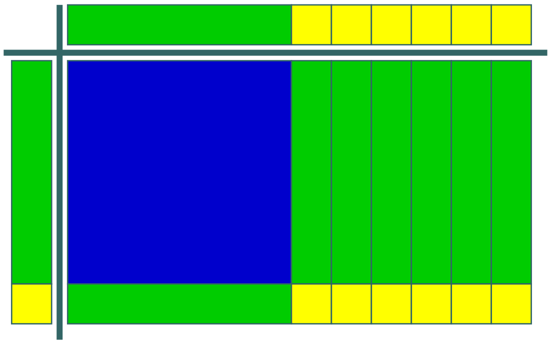
2. Drag the vertex and another point to graph the function.



**Part B**

Describe how each student's work contributes to finding the key features of the graph. Complete their work and describe the key feature that is revealed.

Enter your descriptions and your work in the space provided.

| Multiple Representation (Dividing Polynomial) | |
|---|---|
| **Concreted Model** | Key:  <br><br>**$( x^2 + 7x + 6 )$ ÷ $(x + 1)$**<br>**Quotient Q(x)=(x + 6)**<br><br>**Divisor D(x)=(x + 1)**<br>**Divident P(x)= $( x^2 + 7x + 6 )$** |
| **Symbolic (Polynomial Long Division)** | $\begin{array}{r} x + 6 \\ x + 1 \overline{\smash{)}\, x^2 + 7x + 6} \\ x^2 + x \\ \hline 6x + 6 \\ 6x + 6 \\ \hline 0 \end{array}$<br>**Remainder R(x) = 0**<br>**Divident = (Divisor)(quotient) + Remainder** |

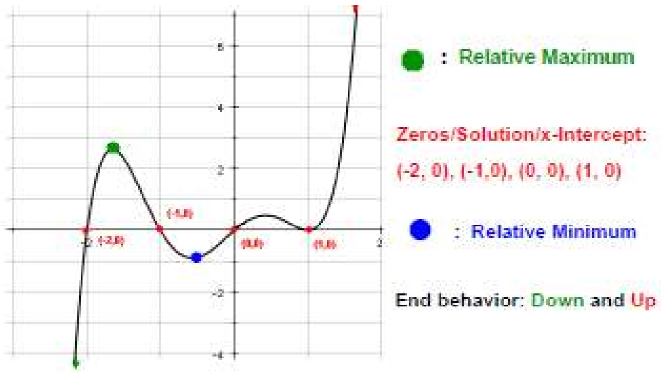
## Multiple Representations

**P(x) = D(x)Q(x) + R(x)**

## Polynomial Graph

**Using graph to show vocabulary**

Key features of polynomial function graph



## End Behavior of a Polynomial Function With Leading Term $ax^n$

**Using Graphing Organizer**

Leading Coefficient Test

(Predicting End Behavior)

$$ax^n + bx^{n-1} + c\,x^{n-2}\ldots$$