The Middletown Public Schools Mathematics Curriculum for grades K-12 was June 2014 by a K-12 team of teachers. The team, identified as the Mathematics Task Force and Mathematics Curriculum Writers referenced extensive resources to design the document that included:

- Common Core State Standards for Mathematics
- Common Core State Standards for Mathematics, Appendix A
- Understanding Common Core State Standards, Kendall
- PARCC Model Content Frameworks
- Numerous state curriculum Common Core frameworks, e.g. Ohio, California, North Carolina and New Jersey
- High School Traditional Plus Model Course Sequence, Achieve, Inc.
- Grade Level and Grade Span Expectations (GLEs/GSEs) for Mathematics
- Third International Mathematics and Science Test (TIMSS)
- Best Practice, New Standards for Teaching and Learning in America's Schools;
- Differentiated Instructional Strategies
- Instructional Strategies That Work, Marzano
- Goals for the district

The Middletown Public Schools Mathematics Curriculum identifies what students should know and be able to do in mathematics. Each grade or course includes Common Core State Standards (CCSS), Grade Level Expectations (GLEs), Grade Span Expectations (GSEs), grade level supportive tasks, teacher notes, best practice instructional strategies, resources, a map (or suggested timeline), rubrics, checklists, and common formative and summative assessments.

**Mission Statement**

Our mission is to provide a sequential and comprehensive K-12 mathematics curriculum in a collaborative student centered learning environment that develops critical thinkers, skillful problem solvers, and effective communicators of mathematics.

**COMMON CORE STATE STANDARDS**

The Common Core State Standards (CCSS):
- Are fewer, higher, deeper, and clearer.
- Are aligned with college and workforce expectations.
- Include rigorous content and applications of knowledge through high-order skills.
- Build upon strengths and lessons of current state standards (GLEs and GSEs).
- Are internationally benchmarked, so that all students are prepared for succeeding in our global economy and society.
- Are research and evidence-based.

Common Core State Standards components include:
- Standards for Mathematical Practice (K-12)
- Standards for Mathematical Content:
  - Categories (high school only): e.g. numbers, algebra, functions, data
  - Domains: larger groups of related standards
  - Clusters: groups of related standards
  - Standards: define what students should understand and are able to do

The Middletown Public Schools Common Core Mathematics Curriculum provides all students with a sequential comprehensive education in mathematics through the study of:
- Standards for Mathematical Practice (K-12)
  - Make sense of problems and persevere in solving them
  - Reason abstractly and quantitatively
  - Construct viable arguments and critique the reasoning of others
  - Model with mathematics*
  - Use appropriate tools strategically
Standards for Mathematical Content:

- K – 5 Grade Level Domains of
  - Counting and Cardinality
  - Operations and Algebraic Thinking
  - Number and Operations in Base Ten
  - Number and Operations – Fractions
  - Measurement and Data
  - Geometry

- 6-8 Grade Level Domains of
  - Ratios and Proportional Relationships
  - The Number System
  - Expressions and Equations
  - Functions
  - Geometry

- 9-12 Grade Level Conceptual Categories of
  - Number and Quantity
  - Algebra
  - Functions
  - Modeling
  - Geometry
  - Statistics and Probability

RESEARCH-BASED INSTRUCTIONAL STRATEGIES

The Middletown Public Schools Common Core Mathematics Curriculum provides a list of research-based best practice instructional strategies that the teacher may model and/or facilitate. It is suggested the teacher:

- Use formative assessment to guide instruction
- Provide opportunities for independent, partner and collaborative group work
- Differentiate instruction by varying the content, process, and product and providing opportunities for:
  - anchoring
  - cubing
  - jig-sawing
  - pre/post assessments
  - tiered assignments
- Address multiple intelligences instructional strategies, e.g. visual, bodily kinesthetic, interpersonal
- Provide opportunities for higher level thinking: Webb’s Depth of Knowledge, 2,3,4, skill/conceptual understanding, strategic reasoning, extended reasoning
- Facilitate the integration of Mathematical Practices in all content areas of mathematics
- Facilitate integration of the Applied Learning Standards (SCANS):
  - communication
  - critical thinking
  - problem solving
  - reflection/evaluation
  - research
Employ strategies of “best practice” (student-centered, experiential, holistic, authentic, expressive, reflective, social, collaborative, democratic, cognitive, developmental, constructivist/heuristic, and challenging)

- Provide rubrics and models
- Address multiple intelligences and brain dominance (spatial, bodily kinesthetic, musical, linguistic, intrapersonal, interpersonal, mathematical/logical, and naturalist)
- Employ mathematics best practice strategies e.g.
  - using manipulatives
  - facilitating cooperative group work
  - discussing mathematics
  - questioning and making conjectures
  - justifying of thinking
  - writing about mathematics
  - facilitating problem solving approach to instruction
  - integrating content
  - using calculators and computers
  - facilitating learning
  - using assessment to modify instruction

The Middletown Public Schools Common Core Mathematics Curriculum includes common assessments. Required (red ink) indicates the assessment is required of all students e.g. common tasks/performance-based tasks, standardized mid-term exam, standardized final exam.

- **Required Assessments**
  - Assessment problems
  - Common units and assessments
  - NWEA Test
  - PARCC Released Test Problems
  - Performance Level Descriptors (PARCC)

- **Common Instructional Assessments (I)** - used by teachers and students during the instruction of CCSS.
- **Common Formative Assessments (F)** - used to measure how well students are mastering the content standards before taking state assessments
  - on-going, dynamic process that involves far more frequent testing
  - serves as a practice for students
  - Common Summative Assessment (S) - used to measure the level of student, school, or program success
  - make some sort of judgment, e.g. what grade
  - program effectiveness
  - e.g. state assessments (AYP), mid-year and final exams

- **Additional assessments include:**
  - Oral presentations
  - Problem/Performance based/common tasks
  - Rubrics/checklists (mathematical practice, modeling)
  - Tests and quizzes
  - Technology
  - Think-alouds
  - Writing genres
    - Argument
    - Informative
  - Anecdotal records
  - Conferencing
  - Exhibits
  - Interviews
  - Graphic organizers
  - Journals
  - Mathematical Practices
  - Modeling
  - Multiple Intelligences assessments, e.g.
Role playing - bodily kinesthetic
Graphic organizing - visual
Collaboration - interpersonal

RESOURCES FOR ALGEBRA I

Textbooks
- Algebra I, McDougal Littel (HS)
- Algebra, Tools for a Challenging World Prentice Hall (grade 8)
- Impact Mathematics Algebra and More for the Middle Grades, Everyday Learning Corporation

Supplementary
- Classroom Instruction That Works, Marzano
- NWEA – MAP Assessments

Technology
- Computer lab
- Computers
- Document camera
- ELMO
- Graphing calculator
- Interactive boards
- LCD projectors
- MIMIO
- Overhead scientific calculator
- Scientific calculator
- Smart board™
- TI Navigator™

Websites
- Live Binder http://www.livebinders.com/play/play/1171650
- explorelearning.com (Gizmo™)
- http://illuminations.nctm.org
- http://www.discoveryeducation.com/
- http://www.parcconline.org/parcc-content-frameworks
- www.commoncore.org/maps
- www.corestandards.org
- www.cosmeo.com
- www.glencoe.com
- www.khanacademy.com
- www.ride ri.gov

Materials
- Algebra tiles
- Colored pencils
- Expo markers
- Graph paper
- Overhead Algebra tiles
- Rulers
- Student white/graph boards

Claims Structure: Mathematics

Master Claim: On-Track for college and career readiness. The degree to which a student is college and career ready (or “on-track” to being ready) in mathematics. The student solves grade-level/course-level problems in mathematics as set forth in the Standards for Mathematical Content with connections to the Standards for Mathematical Practice.

Sub-Claim A: Major Content with Connections to Practices
The student solves problems involving the Major Content for her grade/course with connections to the Standards for Mathematical Practice.

Sub-Claim B: Additional & Supporting Content with Connections to Practices
The student solves problems involving the Additional and Supporting Content for her grade/course with connections to the Standards for Mathematical Practice.

Sub-Claim C: Highlighted Practices MP3,4 with Connections to Content (expressing mathematical reasoning)
The student expresses grade/course-level appropriate mathematical reasoning by constructing viable arguments, critiquing the reasoning of others, and/or attending to precision when making mathematical statements.

Sub-Claim D: Highlighted Practice MP4 with Connections to Content (modeling/application)
The student solves real-world problems with a degree of difficulty appropriate to the grade/course by applying knowledge and skills articulated in the standards for the current grade/course (or for more complex problems, knowledge and skills articulated in the standards for previous grades/courses), engaging particularly in the Modeling practice, and where helpful making sense of problems and persevering to solve them (MP 1), reasoning abstractly and quantitatively (MP 2), using appropriate tools strategically (MP 5), looking for and making use of structure (MP 7), and/or looking for and expressing regularity in repeated reasoning (MP 8).

Sub-Claim E: Fluency in applicable grades (3-4)
The student demonstrates fluency as set forth in the Standards for Mathematical Content in her grade.
<table>
<thead>
<tr>
<th>Task Type</th>
<th>Description of Task Type</th>
</tr>
</thead>
</table>
| I. Tasks assessing concepts, skills and procedures | • Balance of conceptual understanding, fluency, and application  
• Can involve any or all mathematical practice standards  
• Machine scoreable including innovative, computer-based formats  
• Will appear on the End of Year and Performance Based Assessment components  
• Sub-claims A, B and E |
| II. Tasks assessing expressing mathematical reasoning | • Each task calls for written arguments / justifications, critique of reasoning, or precision in mathematical statements (MP.3, 6).  
• Can involve other mathematical practice standards  
• May include a mix of machine scored and hand scored responses  
• Included on the Performance Based Assessment component  
• Sub-claim C |
| III. Tasks assessing modeling / applications | • Each task calls for modeling/application in a real-world context or scenario (MP.4)  
• Can involve other mathematical practice standards  
• May include a mix of machine scored and hand scored responses  
• Included on the Performance Based Assessment component  
• Sub-claim D |
### N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

#### Essential Knowledge and skills
- Rational exponents are exponents that are fractions.
- Properties of integer exponents extend to properties of rational exponents.

#### Examples
- For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3} = 5^1$ to hold, so $(5^{1/3})^3$ must equal 5.

#### PARCC Clarification EOY
- **NONE**

#### Sub Claim ___, Task Type ___

Assessment Problems:
- [http://www.illustrativemathematics.org/bacteria exponential growth context](http://www.illustrativemathematics.org/bacteria exponential growth context)

#### N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

#### Essential Knowledge and skills
- Properties of rational exponents are used to simplify and create equivalent forms of numerical expressions.
- Rational exponents can be written as radicals, and radicals can be written as rational exponents.

#### Examples
\[
\begin{align*}
3\sqrt{5} & = 5^{\frac{1}{3}}, & 5^{\frac{2}{3}} & = 3\sqrt{2}
\end{align*}
\]

Rewrite using fractional exponents:
\[
\begin{align*}
5\sqrt{16} & = 5^{\frac{2}{4}} = 2^{\frac{4}{5}}
\end{align*}
\]
Rewrite \( \frac{\sqrt{x}}{x^2} \) in at least three alternate forms.

Solution
\[
\frac{1}{x} = \frac{1}{x^2} = \frac{1}{x^3} = \frac{1}{x^4}
\]
Rewrite \( \sqrt[4]{2^{-4}} \) Using only rational exponents.

PARCC Clarification
- NONE

Sub Claim __ , Task Type __

Assessment Problems:
- http://www.illustrativemathematics.org/rational versus irrational constructed response
- http://www.illustrativemathematics.org/meaning of rational exponent

### Students use properties of rational and irrational numbers.

**N-RN.3** Explain why
- the sum or product of two rational numbers is rational
- that the sum of a rational number and an irrational number is irrational
- and that the product of a nonzero rational number and an irrational number is irrational.

**Academic vocabulary**
- Irrational numbers
- Rational numbers

**Mathematical Practices**
- 4. Model with mathematics
- 6. Attend to precision

**PARCC Clarification EOY**
Apply properties of rational and irrational numbers to identify rational and irrational numbers
- For rational solutions, exact values are required. For irrational solutions, exact or decimal approximations may be required.
- Simplifying or rewriting radicals is not required

**EOY:** Sub Claim B , Task Type 1

**PBA/MYA notes:** Sub Claim C , Task Type 2, MP3
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td>• integrating content</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <a href="http://www.illustrativemathematics.org/rational">http://www.illustrativemathematics.org/rational</a></td>
<td>• using calculators</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>versus irrational sums</td>
<td>and computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• facilitating learning</td>
<td>• using assessment to</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• using assessment to modify instruction</td>
<td>modify instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUMBER AND QUANTITY</td>
<td>S</td>
<td>Students reason quantitatively and use units to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantities ★ (N-Q)</td>
<td></td>
<td>solve problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N-Q.1 Use units as a way to understand problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and to guide the solution of multi-step problems;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>choose and interpret units consistently in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>formulas; choose and interpret the scale and the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>origin in graphs and data displays.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supporting content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essential Knowledge and skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Units and unit relationships can be used to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>set up and solve multi-step problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Make sure units are compatible when creating,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>simplifying/evaluating, and solving equations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academic vocabulary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mathematical Practices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examples</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A problem might have one object moving 12 feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>per second and another at 5 miles per hour. To</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>compare speeds, students convert 12 feet per</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>second to miles per hour:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 ft = 1 mile, 60 sec = 1 min, 60 min = 1 hr,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>43200 mile = 8.18 miles per hour.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Graphical representations and data displays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>include, but are not limited to: line graphs,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>circle graphs, histograms, multi-line graphs,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>scatter plots, and multi-bar graphs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PARCC Clarification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim __, Task Type __</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parcc -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <a href="http://www.illustrativemathematics.org/unit">http://www.illustrativemathematics.org/unit</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>conversion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.

**Essential Knowledge and skills**
- Appropriate units or quantities need to be used when answering real-world situations.
  - Use labels to put the answers into proper context.
  - Working with expressions, equations, relations and functions can be facilitated by understanding the quantities and their relationships.

**Examples**

**PARCC Clarification**
- NONE

**Assessment Problems:**
- [http://www.illustrativemathematics.org/Weed Killer Concentration](http://www.illustrativemathematics.org/Weed Killer Concentration)

### N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

**Essential Knowledge and skills**
- Graphs should be set up with the appropriate scales and units for the given context.
- Level of accuracy is dependent on the limitations of measurement within the context of the real-world problem.

**Examples**

**PARCC Clarification**
- NONE

**Assessment Problems:**
- [http://www.illustrativemathematics.org/Calories Unit Conversion](http://www.illustrativemathematics.org/Calories Unit Conversion)

---

### A-SSE.1 Interpret expressions that represent a quantity in terms of its context.

- **A-SSE.1a** Interpret parts of an expression, such as terms, factors, and coefficients.
  - **Note:** Interpret the structure of expressions, linear, exponential and quadratic

**TEACHER NOTES**
- See instructional strategies in the introduction
- Employ mathematics best practice

**RESOURCE NOTES**
- See resources in the introduction

**ASSESSMENT NOTES**
- See assessments in the introduction

**REQUIRED**
- Refer to Algebra I @
### Categories and Domains

<table>
<thead>
<tr>
<th>Practices to</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Make sense of problems and persevere in solving them</td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others</td>
</tr>
<tr>
<td>4. Model with mathematics ★</td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
</tr>
<tr>
<td>6. Attend to precision</td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning</td>
</tr>
</tbody>
</table>

### Clusters and Standards

**Middletown Public Schools**

| b. Interpret complicated expressions by viewing one or more of their parts as a single entity. |
| (A-SSE.1b) |

**Essential Knowledge and skills**
- Expressions consist of terms (parts being added or subtracted).
- Terms can either be a constant, a variable with a coefficient, or a coefficient times a variable raised to a power.

**Examples**
- Interpret $P(1+r)^n$ as the product of $P$ and a factor not depending on $P$.
- Suppose the cost of cell phone service for a month is represented by the expression $0.40s + 12.95$. Students can analyze how the coefficient of 0.40 represents the cost of one minute (40¢), while the constant of 12.95 represents a fixed, monthly fee, and $s$ stands for the number of cell phone minutes used in the month. Similar real-world examples, such as tax rates, can also be used to explore the meaning of expressions.
- Factor $3x(x – 5) + 2(x – 5)$.
  - Solution: The “$x – 5$” is common to both expressions being added, so it can be factored out by the distributive property. The factorization is $(3x + 2)(x – 5)$.

**PARCC Clarification EOY**
Interpret quadratic expressions that represent a quantity in terms of its context. ★
- Interpret parts of an expression, such as terms, factors, and coefficients.
- Interpret complicated expressions by viewing one or more of their parts as a single entity.
- See illustrations for A-SSE.1 at [http://illustrativemathematics.org](http://illustrativemathematics.org), e.g., [http://illustrativemathematics.org/illustrations/390](http://illustrativemathematics.org/illustrations/390)

**Sub Claim A, Task Type 1**

**Academic vocabulary**
- Coefficient
- Exponent
- Exponential
- Factor
- Linear
- Power
- Quadratic
- Terms

**Mathematical Practices**
7. Look for and make use of structure

**Calculator - Neutral**

**Assessment Problems:**
- [http://www.illustrativemathematics.org/Animal populations](http://www.illustrativemathematics.org/Animal populations)
- [http://www.illustrativemathematics.org/Analyze Quadratic Formats](http://www.illustrativemathematics.org/Analyze Quadratic Formats)
- [http://www.illustrativemathematics.org/Analyze Exponential Format](http://www.illustrativemathematics.org/Analyze Exponential Format)
- [http://www.illustrativemathematics.org/Using Units to Analyze](http://www.illustrativemathematics.org/Using Units to Analyze)

### Instructional Strategies

- using manipulatives
- facilitating cooperative group work
- discussing mathematics
- questioning and making conjectures
- justifying of thinking
- writing about mathematics
- facilitating problem solving approach to instruction
- integrating content
- using calculators and computers
- facilitating learning
- using assessment to modify instruction

### Resources


### Assessments

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A-SSE.2</td>
<td>Use the structure of an expression to identify ways to rewrite it. <strong>Major content</strong></td>
<td>Academic vocabulary</td>
<td>Calculator - Neutral</td>
<td>PBA/MYA &amp; EOY: Sub Claim A, Task Type 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use factoring techniques such as common factors, grouping, the difference of two squares, the sum or difference of two cubes, or a combination of methods to factor completely.</td>
<td>• Combine like terms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Simplify expressions including combining like terms, using the distributive property and other operations with polynomials</td>
<td>• Difference of squares</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In the traditional pathway, linear, quadratic, and exponential expressions are the focus in Algebra I, and integer exponents are extended to rational exponents (only those with square or cubed roots). In Algebra II, the expectation is to extend to polynomial and rational expressions</td>
<td>• Distributive property</td>
<td>Mathematische Practices</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples</strong></td>
<td>• Factoring</td>
<td>7. Look for and make use of structure (#1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For example, see ( x^2 - y^4 ) as ( (x^2 - y^2)(x^2 + y^2) ), thus recognizing it as a difference of squares that can be factored as ( (x^2 - y^2)(x^2 + y^2) ).</td>
<td>• Expression</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Factor</strong> ( x^3 - 2x^2 - 35x )</td>
<td>• Factoring</td>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PARCC Clarification</strong></td>
<td>• Polynomials</td>
<td>7. Look for and make use of structure (#2. 3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the structure of numerical expressions and polynomial expressions in one variable to identify ways to rewrite it.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Examples: Recognize ( 53^2 = 47^2 ) as a difference of squares and see an opportunity to rewrite it in the easier-to-evaluate form ( (53+47) ). See an opportunity to rewrite ( a^2 + 9a + 14 ) as ( (a +7)(a +2) )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the structure of a numerical expression or polynomial expression in one variable to rewrite it, in a case where two or more rewriting steps are required.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Example: Factor completely ( x^2 -1 + (x-1)^2 ). (A first iteration might give ( (x +1)(x -1)+ (x -1)^2 ) which could be rewritten as ( (x -1)(x + 1+x + 1) ) on the way to factoring completely as ( 2x(x -1) ). Or the student might first expand as ( x^2 -1 + x^2 - 2x +1 ), rewriting as ( 2x^2 -2x ) then factoring as ( 2x(x -1) ).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Tasks do not have a context.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PBA/MYA &amp; EOY:</strong> Sub Claim A, Task Type 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALGEBRA</strong></td>
<td></td>
<td><strong>Students write expressions in equivalent forms to solve problems.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seeing structure in Expressions (A-SSE)</strong></td>
<td>A-SSE.3</td>
<td>Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. <strong>Supporting content</strong></td>
<td><strong>TEACHER NOTES</strong></td>
<td>See instructional strategies in the introduction</td>
<td><strong>ASSESSMENT NOTES</strong></td>
</tr>
<tr>
<td>CATEGORIES and DOMAINS</td>
<td>UNIT</td>
<td>CLUSTERS and STANDARDS Middletown Public Schools</td>
<td>INSTRUCTIONAL STRATEGIES</td>
<td>RESOURCES</td>
<td>ASSESSMENTS</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
<td>------------------------------------------------</td>
<td>-------------------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Use Mathematical Practices to</strong></td>
<td></td>
<td></td>
<td><strong>Employ mathematics best practice strategies e.g.</strong></td>
<td></td>
<td><strong>REQUIRED ASSESSMENTS</strong></td>
</tr>
<tr>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td>• using manipulatives</td>
<td>• Assessment problems</td>
<td></td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td>• facilitating cooperative group work</td>
<td>• Common units and assessments</td>
<td></td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others</td>
<td></td>
<td></td>
<td>• discussing mathematics</td>
<td>• NWEA Test</td>
<td></td>
</tr>
<tr>
<td>4. Model with mathematics</td>
<td></td>
<td></td>
<td>• questioning and making conjectures</td>
<td>• PARCC Released Test Problems</td>
<td></td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td>• justifying of thinking</td>
<td>• Performance Level Descriptors (PARCC)</td>
<td></td>
</tr>
<tr>
<td>6. Attend to precision</td>
<td></td>
<td></td>
<td>• writing about mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
<td>• facilitating problem solving approach to instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning</td>
<td></td>
<td></td>
<td>• integrating content</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Essential Knowledge and skills**
- Given a quadratic function explain the meaning of the zeros of the function. That is if $f(x) = (x - a)(x - c)$ then $f(a) = 0$ and $f(c) = 0$.
- Given a quadratic expression, explain the meaning of the zeros graphically. That is for an expression $(x - a)(x - c)$, $a$ and $c$ correspond to the $x$-intercepts (if $a$ and $c$ are real).

**Examples**
- Express $2(x^2 - 3x^2 + x - 6) - (x - 3)(x + 4)$ in factored form and use your answer to say for what values of $x$ the expression is zero.

**PARCC Clarification**
- NONE

**PBA/MYA & EOY: Sub Claim B, Task Type 1**

<table>
<thead>
<tr>
<th>Essential Knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write expressions in equivalent forms by completing the square to convey the vertex form, to find the maximum or minimum value of a quadratic function, and to explain the meaning of the vertex</td>
</tr>
</tbody>
</table>

**PARCC Clarification**
- NONE

**Sub Claim B, Task Type 1**

**Assessment Problems:**

<table>
<thead>
<tr>
<th>Essential Knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the properties of exponents to transform expressions for exponential functions.</td>
</tr>
</tbody>
</table>

**Academic vocabulary**
- Exponential functions
- Properties of exponents
- Rate of growth or decay

**TEACHER NOTES**
- Quadratic and exponential

**Essential Knowledge and skills**
- Use properties of exponents (such as power of a power, product of powers, power of a product, and rational exponents, etc.) to write an equivalent form of an exponential function to reveal and explain specific information about its approximate rate of growth or decay

**Academic vocabulary**
- Exponential expressions
- Properties of exponents
- Rate of growth or decay

**PARCC Clarification**
- NONE

**Sub Claim B, Task Type 1**

<table>
<thead>
<tr>
<th>Essential Knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.</td>
</tr>
</tbody>
</table>

**Academic vocabulary**
- Equivalent expression
- Factor
- Quadratic function/expression
- X-intercepts
- Zeros of the function

**Mathematical Practices**
- 7. Look for and make use of structure

**PARCC Clarification**
- NONE

**PBA/MYA & EOY: Sub Claim B, Task Type 1**

**Assessment Problems:**

<table>
<thead>
<tr>
<th>Essential Knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the properties of exponents to transform expressions for exponential functions.</td>
</tr>
</tbody>
</table>

**Academic vocabulary**
- Exponential expressions
- Properties of exponents
- Rate of growth or decay

**Mathematical Practices**
- 7. Look for and make use of structure

**PARCC Clarification**
- NONE

**PBA/MYA & EOY: Sub Claim B, Task Type 1**

<table>
<thead>
<tr>
<th>Essential Knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the properties of exponents to transform expressions for exponential functions.</td>
</tr>
</tbody>
</table>

**Academic vocabulary**
- Exponential expressions
- Properties of exponents
- Rate of growth or decay

**Mathematical Practices**
- 7. Look for and make use of structure

**PARCC Clarification**
- NONE

**PBA/MYA & EOY: Sub Claim B, Task Type 1**

**Assessment Problems:**

Refer to Algebra I @ Live Binder http://www.livebinders.com/play/play/1171650 for evidence statements and clarification
### Examples
- For example, the expression $1.15t$ can be rewritten as $(1.15^{1/12})^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
- Write the expression below as a constant multiplied by a power of $x$ and use your answer to decide whether the expression gets larger or smaller as $x$ gets larger.

\[
\frac{(2x^3)(3x^4)}{(x^3)^2}
\]

### PARCC Clarification EOY
Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression, where exponents are limited to integer exponents.
- Use the properties of exponents to transform expressions for exponential functions
- Tasks have a context. As described in the standard, there is an interplay between the mathematical structure of the expression and the structure of the situation such that choosing and producing an equivalent form of the expression reveals something about the situation.

Sub Claim B, Task Type 1

#### Mathematical Practices
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Model with mathematics
4. Use appropriate tools strategically
5. Attend to precision
6. Look for and make use of structure

#### Calculator - Neutral

### ALGEBRA

#### Arithmetic with polynomials and rational expressions (A-APR)

<table>
<thead>
<tr>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQUIRED</td>
</tr>
<tr>
<td>ASSESSMENTS</td>
</tr>
</tbody>
</table>
- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

### TEACHER NOTES
See instructional strategies in the introduction
Employ mathematics best practice strategies e.g.
- using manipulatives
- facilitating cooperative group work
- discussing mathematics
- questioning and making conjectures
- justifying of thinking
- writing about mathematics
- facilitating problem

Refrer to Algebra I @ Live Binder
http://www.livebinders.com/play/play/1171650 for evidence statements and clarification

### RESOURCE NOTES
See resources in the introduction

<table>
<thead>
<tr>
<th>Categories and Domains</th>
<th>Clusters and Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1: Algebra</td>
<td>Students perform arithmetic operations on polynomials.</td>
</tr>
<tr>
<td><strong>A-APR.1</strong></td>
<td>Understand that polynomials, linear and quadratic form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. <strong>Major content</strong></td>
</tr>
</tbody>
</table>

### Essential Knowledge and Skills
- Adding, subtracting and multiplying two polynomials will yield another polynomial, thus making the system of polynomials closed.
- Addition and subtraction of polynomials is combining like terms.
- The distributive property proves why you can combine like terms.
- Multiplication of polynomials is applying the distributive property
- Focus on polynomial expressions that simplify to forms that are linear or quadratic in a positive integer power of $x$.

### Examples
- In the traditional pathway, linear and quadratic polynomial expressions are the expectation in Algebra I

### PARCC Clarification EOY
Add, subtract, and multiply polynomials
- The "understand" part of the standard is not assessed here; it is

### Academic vocabulary
- Polynomials
- Linear
- Quadratic
- Integers

### Mathematical Practices
3. Construct viable arguments and critique the reasoning of others

### Academic vocabulary
- Polynomials
- Linear
- Quadratic
- Integers

### Mathematical Practices
7. Look for and make use of structure

### Calculator - Neutral

### Essential Knowledge and Skills
- Adding, subtracting and multiplying two polynomials will yield another polynomial, thus making the system of polynomials closed.
- Addition and subtraction of polynomials is combining like terms.
- The distributive property proves why you can combine like terms.
- Multiplication of polynomials is applying the distributive property
- Focus on polynomial expressions that simplify to forms that are linear or quadratic in a positive integer power of $x$.

### Examples
- In the traditional pathway, linear and quadratic polynomial expressions are the expectation in Algebra I

### PARCC Clarification EOY
Add, subtract, and multiply polynomials
- The "understand" part of the standard is not assessed here; it is
### Categories and Domains

<table>
<thead>
<tr>
<th>UNIT</th>
<th>Clusters and Standards</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Middletown Public Schools**

**Algebra I Curriculum Grades 8-9**

Curriculum Writers: Gráinne Phelps, Paul Pignatelli, Deanna Smith, Gus Steppen, and Lisa Wood

**Structure**

8. Look for and express regularity in repeated reasoning

Assessed under Sub-claim C on the PBA.

- **PBA/MYA & EOY**: Sub Claim A, Task Type 1
- **PBA/MYA notes**: Sub Claim A, Task Type 2, MP3, calc

**Assessment Problems:**

**ADDED by PARCC**

- **A-APR.3** Identify zeroes of polynomials when suitable factorizations are available, and use the zeroes to construct a rough graph of the function defined by the polynomial (FORMERLY ALGEBRA II)

**Essential Knowledge and skills**

- Find the zeros of a polynomial when the polynomial is factored.
- Use the zeros of a function to sketch a graph of the function

**Examples**

- **PARCC Clarification EOY**
  - For example, find the zeros of \((x - 2)(x^2 - 9)\)

**Sub Claim B, Task Type 1**

**Calculator - NO**

**Essential Knowledge and skills**

- Equations can represent real-world and mathematical problems.
- Include equations and inequalities that arise when comparing the values of two different functions, such as one describing linear growth and one describing exponential growth.

**Academic vocabulary**

- Inequalities

**Mathematical Practices**

- Reason abstractly and quantitatively
- Model with mathematics

**TEACHER NOTES**

Linear and quadratic

**ALGEBRA**

Creating Equations ★ (A-CED)

Use Mathematical Practices to

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics ★
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of

**A-CED.1** Create equations that describe numbers or relationships.

- **Include equations arising from linear and quadratic functions and exponential functions (integers and inputs only)**

**Essential Knowledge and skills**

- Equations can represent real-world and mathematical problems.
- Include equations and inequalities that arise when comparing the values of two different functions, such as one describing linear growth and one describing exponential growth.

**Academic vocabulary**

- Inequalities

**Mathematical Practices**

- Reason abstractly and quantitatively
- Model with mathematics

**TEACHER NOTES**

See instructional strategies in the introduction

Employ mathematics best practice strategies e.g.

- Using manipulatives
- Facilitating cooperative group work
- Discussing mathematics
- Questioning and making conjectures
- Justifying of thinking
- Writing about mathematics

**RESOURCE NOTES**

See resources in the introduction

Refer to Algebra I @ Live Binder

http://www.livebinders.com/play/play/1171650

for evidence statements and clarification

**REQUIRED ASSESSMENTS**

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
### Categories and Domains

<table>
<thead>
<tr>
<th>Unit</th>
<th>Clusters and Standards</th>
<th>Middletown Public Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>Look for and express regularity in repeated reasoning</td>
<td>the volcano is given by ( h(t) = -16t^2 + 64t + 936 ). After how many seconds does the lava reach its maximum height of 1000 feet?</td>
</tr>
</tbody>
</table>

**Examples**
- Given that the following trapezoid has area 54 cm², set up an equation to find the length of the unknown base, and solve the equation
- Lava coming from the eruption of a volcano follows a parabolic path. The height \( h \) in feet of a piece of lava \( t \) seconds after it is ejected from the volcano is given by \( h(t) = -16t^2 + 64t + 936 \). After how many seconds does the lava reach its maximum height of 1000 feet?
- The value of an investment over time is given by the equation \( A(t) = 10,000(1.03)t \). What does each part of the equation represent?
- Solution: The \( 10,000 \) represents the initial value of the investment. The \( 1.03 \) means that the investment will grow exponentially at a rate of 3% per year for \( t \) years.
- You bought a car at a cost of \( $20,000 \). Each year that you own the car the value of the car will decrease at a rate of 25%. Write an equation that can be used to find the value of the car after \( t \) years.
- Solution: \( C(t) = 20,000(0.75)^t \). The base is \( 1 - 0.25 = 0.75 \) and is between 0 and 1, representing exponential decay. The value of \( 20,000 \) represents the initial cost of the car.

**PARCC Clarification**

**NONE**

**EOY:** Sub Claim __ , Task Type __  
**PBA/MYA notes:** Sub Claim D, Task Type 3, MP4&2, calc

**Assessment Problems:**

#### A-CED.2
Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (linear, quadratic and exponential (integer inputs only) Major content

**Essential Knowledge and skills**
- Relationships between two quantities can be represented through the creation of equations in two variables and graphed on coordinate axes with labels and scales.

**Academic vocabulary**
- Coordinate axes
- Scales

**Mathematical Practices**
- Reason abstractly

**Calculator**

**Graphing calculator**

**TEACHER NOTES**
Linear, quadratic, and exponential (integer inputs only) for A.CED.3, linear only
### A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. (linear only)

#### A. Essential Knowledge and skills
- Write and use a system of equations and/or inequalities to solve a real world problem. Recognize that the equations and inequalities represent the constraints of the problem. Use the Objective Equation and the Corner Principle to determine the solution to the problem. (Linear Programming)
- **Examples**
  - For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

#### PARCC Clarification
- Solve multi-step contextual problems that require writing and analyzing systems of linear inequalities in two variables to find viable solutions.
- **Examples**
  - Tasks have hallmarks of modeling as a mathematical practice (less defined tasks, more of the modeling cycle, etc.).
  - Scaffolding in tasks may range from substantial to very little or none.

#### Sub Claim A, Task Type 1
- **PBA/MYA notes:** Sub Claim D, Task Type 3, MP4&2, calc

#### PARCC Clarification
- **NONE**
- **Sub Claim __, Task Type __**
- **PBA/MYA notes:** Sub Claim D, Task Type 3, MP4&2, calc

#### Assessment Problems

### Mathematical Practices
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Model with mathematics

### Academic vocabulary
- Constraints
- Corner principle
- Linear programming
- Maximize
- Minimize
- Nonviable
- Objective equation
- Vertices
- Viable

### Mathematical Practices
- **Calculator – Item specific**
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>A-CED.4</td>
<td>Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (linear, quadratic, and exponential (i integer inputs only)) Major content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Formulas can be rearranged and solved for a given variable using the same reasoning as solving an equation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <em>For example, rearrange Ohm’s law</em> $V = IR$ to highlight resistance $R$.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The Pythagorean theorem expresses the relation between the legs $a$ and $b$ of a right triangle and its hypotenuse $c$ with the equation $a^2 + b^2 = c^2$.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Why might the theorem need to be solved for $c$?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Solve the equation for $c$ and write a problem situation where this form of the equation might be useful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Solve $V = \frac{4}{3} \pi r^3$ for radius $r$.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Motion can be described by the formula below, where $t = \text{time elapsed}$, $u = \text{initial velocity}$, $a = \text{acceleration}$, and $s = \text{distance traveled}$. $s = ut + \frac{1}{2}at^2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Why might the equation need to be rewritten in terms of $a$?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Rewrite the equation in terms of $a$.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PARCC Clarification EOY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rearrange formulas that are quadratic in the quantity of interest to highlight the quantity of interest, using the same reasoning as in solving equations (4.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tasks have a context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rearrange formulas that are quadratic in the quantity of interest to highlight the quantity of interest, using the same reasoning as in solving equations (4.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tasks have a context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PBA/MYA &amp; EOY:</strong> Sub Claim A, Task Type 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PBA/MYA notes:</strong> Sub Claim D, Task Type 3, MP4&amp;2, calc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessment Problems:**

**ALGEBRA**

**Reasoning with**

**A-REI.1** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation

**TEACHER NOTES**
See instructional strategies in the introduction

**RESOURCE NOTES**
See resources in the introduction

**ASSESSMENT NOTES**
See assessments in the introduction
# Algebra I Curriculum

**Grades 8-9**

Curriculum Writers: Gráinne Phelps, Paul Pignatelli, Deanna Smith, Gus Steppen, and Lisa Wood

## Categories and Domains

### Equations and Inequalities (A-REI)

**Use Mathematical Practices to**
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

**Essential Knowledge and Skills**
- Assuming an equation has a solution, construct a convincing argument that justifies each step in the solution process. Justifications may include the associative, commutative, and division properties, combining like terms, multiplication by 1, etc.
- A solution to an equation can be checked, by substituting in that value for the variable and simplifying to see if the equation holds true.

**Examples**
- Explain why the equation \( x/2 + 7/3 = 5 \) has the same solutions as the equation \( 3x + 14 = 30 \). Does this mean that \( x/2 + 7/3 \) is equal to \( 3x + 14 \)?
- Show that \( x = 2 \) and \( x = -3 \) are solutions to the equation \( x^2 + x = 6 \). Write the equation in a form that shows these are the only solutions, explaining each step in your reasoning.
- Transform \( 2x - 5 = 7 \) to \( 2x = 12 \) and tell what property of equality was used.

**PARCC Clarification**
NONE

**Sub Claim __, Task Type __**

**PBA/MYA notes:** Sub Claim C, Task Type 2, MP6, calc

**Calculator -**

**Assessment Problems:**

## CLusters and Standards

### Middletown Public Schools

- has a solution. **Major content**
  - Construct a viable argument to justify a solution method

**Academic vocabulary**
- equality of numbers
- construct a viable argument
- justify
- solution

**Mathematical Practices**
- 1. Make sense of problems and persevere in solving them
- 2. Reason abstractly and quantitatively
- 3. Construct viable arguments and critique the reasoning of others
- 4. Model with mathematics
- 5. Use appropriate tools strategically
- 6. Attend to precision
- 7. Look for and make use of structure
- 8. Look for and express regularity in repeated reasoning

### INSTRUCTIONAL STRATEGIES

- Best practice strategies e.g.
- Using manipulatives
- Facilitating cooperative group work
- Discussing mathematics
- Questioning and making conjectures
- Justifying thinking
- Writing about mathematics
- Facilitating problem solving approach to instruction
- Integrating content
- Using calculators and computers
- Facilitating learning
- Using assessment to modify instruction

### ASSESSMENTS

- [Live Binder](http://www.livebinders.com/play/play/1171650) for evidence statements and clarification

## Resources

- Refer to Algebra I @ Live Binder [http://www.livebinders.com/play/play/1171650](http://www.livebinders.com/play/play/1171650)

## ALGEBRA

### Reasoning with Equations and Inequalities (A-REI)

**Students solve equations and inequalities in one variable.**

**A-REI.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. **Major content**

**Essential Knowledge and Skills**
- Equations and inequalities are solved using properties of operations, equality, and inequality, which can justify each step of the process.

**Examples**

**Academic vocabulary**
- Lateral equations
- Linear equation

**Mathematical Practices**
- 6. Attend to precision

**TEACHER NOTES**
- Master linear, learn as general principle

**REQUIRED ASSESSMENTS**
- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

**TEACHER NOTES**
- See instructional strategies in the introduction
- Employ mathematics best practice strategies e.g.
- Using manipulatives
- Facilitating cooperative group

**RESOURCE NOTES**
- See resources in the introduction

**ASSESSMENT NOTES**
- See assessments in the introduction

- Refer to Algebra I @ Live Binder [http://www.livebinders.com/play/play/1171650](http://www.livebinders.com/play/play/1171650) for evidence statements

8/20/2014 Middletown Public Schools
### Mathematical Practices

1. **Make sense of problems and persevere in solving them**
   - Tasks have a context.
   - Sub Claim A, Task Type 1
   - Assessment Problems:

   A-REI.4-1
   - **Major content**
     - Solve quadratic equations in one variable.
     - Derive the quadratic formula from this form. A-REI.4a

     **Essential Knowledge and skills**
     - Transform a quadratic equation written in standard form to an equation in vertex form - by completing the square. (x - p)^2 = q that has the same solutions.
     - Derive the quadratic formula by completing the square on the standard form of a quadratic equation.

     **Examples**
     - PARCC Clarification EOY
       - The derivation part of the standard is not assessed here; it is assessed under Sub-Claim C on the PBA.

   **Academic vocabulary**
   - completing the square
   - factored form
   - quadratic equations
   - quadratic formula
   - solutions
   - standard form

   **Mathematical Practices**
   - Make sense of problems and persevere in solving them
   - Look for and make use of structure

   **Calculators**
   - Item specific

2. **Reason abstractly and quantitatively**
   - Sub Claim A, Task Type 1
   - Assessment Problems:

3. **Construct viable arguments and critique the reasoning of others**
   - Sub Claim A, Task Type 1
   - Assessment Problems:

4. **Model with mathematics**
   - Sub Claim A, Task Type 1
   - Assessment Problems:

5. **Use appropriate tools strategically**
   - Sub Claim A, Task Type 1
   - Assessment Problems:

6. **Attend to precision**
   - Sub Claim A, Task Type 1
   - Assessment Problems:

7. **Look for and make use of structure**
   - Sub Claim A, Task Type 1
   - Assessment Problems:

   **PARCC Clarification EOY**
   - Tasks have a context.
   - Sub Claim A, Task Type 1
   - Assessment Problems:

   **Essential Knowledge and skills**
   - Transform a quadratic equation written in standard form to an equation in vertex form - by completing the square. (x - p)^2 = q that has the same solutions.
   - Derive the quadratic formula by completing the square on the standard form of a quadratic equation.

   **Examples**
   - PARCC Clarification EOY
     - The derivation part of the standard is not assessed here; it is assessed under Sub-Claim C on the PBA.

   **Academic vocabulary**
   - completing the square
   - factored form
   - quadratic equations
   - quadratic formula
   - solutions
   - standard form

   **Mathematical Practices**
   - Make sense of problems and persevere in solving them
   - Look for and make use of structure

   **Calculators**
   - Item specific

**TEACHER NOTES**

Linear inequalities; literal equations that are linear in the variables being solved for; quadratics with real solutions

**PARCC Clarification EOY**
- Tasks have a context.
- Sub Claim A, Task Type 1
- Assessment Problems:

- **Essential Knowledge and skills**
  - Transform a quadratic equation written in standard form to an equation in vertex form - by completing the square. (x - p)^2 = q that has the same solutions.
  - Derive the quadratic formula by completing the square on the standard form of a quadratic equation.

- **Examples**
  - PARCC Clarification EOY
    - The derivation part of the standard is not assessed here; it is assessed under Sub-Claim C on the PBA.

- **Academic vocabulary**
  - completing the square
  - factored form
  - quadratic equations
  - quadratic formula
  - solutions
  - standard form

- **Mathematical Practices**
  - Make sense of problems and persevere in solving them
  - Look for and make use of structure

- **Calculators**
  - Item specific

**TEACHER NOTES**

Linear inequalities; literal equations that are linear in the variables being solved for; quadratics with real solutions
### Categories and Domains

#### Essential Knowledge and Skills
- Understand why taking the square root of both sides of an equation yields two solutions.
- Explain how complex solutions affect the graph of a quadratic equation.

#### Examples

**PARCC Clarification A-REI 4b-1**

Solve quadratic equations in one variable.
b) Solve quadratic equations with rational number coefficients 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.

- Tasks should exhibit variety in initial forms. Examples of quadratic equations with real solutions:
  
  \[
  t^2 = 49, \quad 3a^2 = 4, \quad 7 = x^2, \quad t^2 = 0, \quad \frac{1}{2} y^2 = \frac{1}{5},
  \]
  
  \[
  y^2 - 8y + 15 = 0, \quad 2x^2 - 16x + 30 = 0, \quad 2p = p^2 + 1.
  \]
  
  \[
  t^2 = 4t, \quad 7x^2 + 5x - 3 = 0, \quad \frac{3}{4} c(c-1) = c.
  \]
  
  \[
  (3x-2)^2 = 6x - 4
  \]

- Methods are not explicitly assessed; strategy is assessed indirectly by presenting students with a variety of initial forms.
- For rational solutions, exact values are required. For irrational solutions, exact or decimal approximations may be required.
- Simplifying or rewriting radicals is not required.
- Prompts integrate mathematical practices by not indicating that the equation is quadratic. (E.g., “Find all real solutions of the equation $t^2 = 4t$...not, “Solve the quadratic equation $t^2 = 4t$.”)

**PARCC Clarification A-REI 4b-2**

Solve quadratic equations in one variable.
b) Recognize when the quadratic formula gives complex solutions.

- Tasks involve recognizing an equation with complex solutions, e.g., “Which of the following equations has no real solutions?” with one of the options being a quadratic equation with non-real solutions.
- Writing solutions in the form $a + bi$ is not assessed here. (N-CN.7 is assessed in Algebra 2)
## Categories and Domains

### Unit

**PBA/MYA & EOY:** Sub Claim A, Task Type 1

**PBA/MYA notes:** Sub Claim C, Task Type 2, MP3, calc

**PBA/MYA notes:** Sub Claim C, Task Type 2, MP6, calc

### Clusters and Standards

**Middletown Public Schools**

### Instructional Strategies

**Calculator** – Item specific

### Resources

### Assessments

**M**

---

### Essential Knowledge and Skills

- Understand why taking the square root of both sides of an equation yields two solutions.
- Explain how complex solutions affect the graph of a quadratic equation.
- Students should solve by factoring, completing the square, and using the quadratic formula. The zero product property is used to explain why the factors are set equal to zero. Students should relate the value of the discriminant to the type of root to expect. A natural extension would be to relate the type of solutions to $ax^2 + bx + c = 0$ to the behavior of the graph of $y = ax^2 + bx + c$.

### Value of Discriminant

<table>
<thead>
<tr>
<th>Value of Discriminant</th>
<th>Nature of Roots</th>
<th>Nature of Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b^2 - 4ac = 0$</td>
<td>1 real root</td>
<td>intersects x-axis once</td>
</tr>
<tr>
<td>$b^2 - 4ac &gt; 0$</td>
<td>2 real roots</td>
<td>intersects x-axis twice</td>
</tr>
<tr>
<td>$b^2 - 4ac &lt; 0$</td>
<td>2 complex roots</td>
<td>does not intersect x-axis</td>
</tr>
</tbody>
</table>

### Examples

- Are the roots of $2x^2 + 5 = 2x$ real or complex? How many roots does it have? Find all solutions of the equation.
- What is the nature of the roots of $x^2 + 6x + 10 = 0$? Solve the equation using the quadratic formula and completing the square. How are the two methods related?
- Projectile motion problems, in which the initial conditions establish one of the solutions as extraneous within the context of the problem.
- An object is launched at 14.7 meters per second (m/s) from a 49-meter tall platform. The equation for the object’s height $s$ at time $t$
seconds after launch is \( s(t) = -4.9t^2 + 14.7t + 49 \), where \( s \) is in meters.

When does the object strike the ground?

**Solution:**

\[
0 = -4.9t^2 + 14.7t + 49 \\
0 = t^2 - 3t - 10 \\
0 = (t+2)(t-5)
\]

**PARCC Clarification**

- Tasks involve recognizing an equation with complex solutions, e.g., "Which of the following equations has no real solutions?" with one of the options being a quadratic equation with non-real solutions.
- Writing solutions in the form \( a \pm bi \) is not assessed here. (N-CN.7 is assessed in Algebra 2)

### Students analyze and solve linear equations and pairs of simultaneous linear equations.

**Essential Knowledge and skills**

- The solution to a system of linear equations in two variables is the point/ordered pair that satisfies both equations simultaneously.
- The solution to a system of linear equations in two variables is the point of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

**8.EE-8a**

- **Major content**
  - Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

**Examples**

- Plant A and Plant B are on different watering schedules. This affects their rate of growth. Compare the growth of the two plants to determine when their heights will be the same.

<table>
<thead>
<tr>
<th>Plant A</th>
<th>Plant B</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>H</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Given each set of coordinates, graph their corresponding lines.

**Academic vocabulary**

- Analyze
- Distributive property
- Expanding
- Like terms
- Linear equation
- Simultaneous
- Solutions

**Mathematical Practices**

1. Reason abstractly and quantitatively
2. Use appropriate tools strategically
3. Attend to precision
4. Look for and make use of structure
5. Look for and express regularity in repeated reasoning

**TEACHER NOTES**

See instructional strategies in the introduction

Employ mathematics best practice strategies e.g.
- using manipulatives
- facilitating cooperative group work
- discussing mathematics
- questioning and making conjectures
- justifying of thinking
- writing about mathematics
- facilitating problem solving approach to instruction

**REQUIRED ASSESSMENTS**

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

**ASSESSMENT NOTES**

See assessments in the introduction

**RESOURCE NOTES**

See resources in the introduction

Refer to Algebra I @ Live Binder

http://www.livebinders.com/play/play/1171650 for evidence statements and clarification

**REQUIRED ASSESSMENTS**

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
### Categories and Domains

**UNIT**

**Clusters and Standards**

**Middletown Public Schools**

**Instructional Strategies**

**Resources**

**Assessments**

---

### Solution:

- Write an equation that represents the growth rate of Plant A and Plant B.
  - Solution: Plant A: \( H = 2W + 4 \)
  - Plant B: \( H = 4W + 2 \)

- At which week will the plants have the same height?
  - Solution: The plants have the same height after one week.
    - Plant A: \( H = 2W + 4 \)
    - Plant B: \( H = 4W + 2 \)
    - Plant A: \( H = 2(1) + 4 \)
    - Plant B: \( H = 4(1) + 2 \)
    - Plant A: \( H = 6 \)
    - Plant B: \( H = 6 \)

  After one week, the height of Plant A and Plant B are both 6 inches.

### PARCC Clarification EOY

- Tasks do not have a context

**Sub Claim A Task Type 1**

**Calculator - NO**

- \( b. \) Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations.
  - Solve simple cases by inspection.
    - For example, \( 3x + 2y = 5 \) and \( 3x + 2y = 6 \) have no solution because \( 3x + 2y \) cannot simultaneously be 5 and 6. 8.EE-8b

### Essential Knowledge and Skills

- System of linear equations can be solved algebraically to find the point of intersection and then checked graphically.

### Examples

- A system of linear equations in two variables can be solved by graphing the two equations and finding the point of intersection. Student may also discover, by graphing, that some systems will never intersect because the lines are parallel. Therefore these systems will not have a solution.

- A system of linear equations can also be solved algebraically using substitution. There are two ways to solve using substitution.
  - Given two equations equal to the same variable.
    - For example: \( C = 2x + 7 \) and \( C = 3x + 5 \)

### Academic Vocabulary

- Algebraically
- Coefficient
- System of linear equations

### Mathematical Practices

8.EE.B.1

1. Make sense of problems and persevere in solving them
Set these two equations equal to each other and solve for the unknown (in this case $x$).

- $2x + 7 = 3x + 5$

  Given two equations in which one equation is solved for a given variable.

  For example: $x = 7 + y$ and $3x + 2y = 6$

  Substitute $7+y$ in for the $x$ in $3x+2y = 6$ that is $3(7+y) + 2y = 6$ and solve for $y$.

- Once you have solved for one variable, substitute that answer into one of the original equations to find the missing coordinate in the ordered pair. Every solution to a system of linear equations should be given as an ordered pair with two variables.

- To check whether a given a point/ordered pair is a solution to a system of linear equations, substitute the values in each equation and simplify to be sure the statements are true.

Example: Check whether $(4, -3)$ is solution to the system $x = 7 + y$ and $3x + 2y = 6$

- That is $4 = 7 + y$ and $3(4) + 2(-3) = 6$

  Therefore $(4, -3)$ is a solution to the system!

PARCC Clarification EOY

- 20% of tasks have a zero coefficient, e.g., as in the system

- 20% of tasks have non-zero whole-number coefficients, and whole-number solutions.

- 20% of tasks have non-zero whole-number coefficients, and at least one fraction among the solutions.

- 20% of tasks have non-zero integer coefficients (with at least one coefficient negative).

- 20% of tasks have non-zero rational coefficients (with at least one coefficient negative and at least one coefficient a non-integer).

- Tasks present students with technology that allows them to (1) graph a point based on coordinates of their choosing; (2) graph a line based on the equation (3) zoom in if the student wishes to do so, rescaling the axes automatically.

- 20% of tasks have a zero coefficient, e.g., as in the system

- 20% of tasks have non-zero whole-number coefficients, and whole-
### CATEGORIES and DOMAINS

**UNIT**

**CLUSTERS and STANDARDS**

Middletown Public Schools

**INSTRUCTIONAL STRATEGIES**

**RESOURCES**

**ASSESSMENTS**

- number solutions.
  - 20% of tasks have non-zero whole-number coefficients, and at least one fraction among the solutions.
  - 20% of tasks have non-zero integer coefficients (with at least one coefficient negative).
  - 20% of tasks have non-zero rational coefficients (with at least one coefficient a non-integer).
  - 8.EE.8b-3
  - Tasks have whole-number or integer coefficients, one coefficient in either or both equations possibly zero.
  - One-third of tasks involve inconsistent systems, where the inconsistency is plausibly visible by inspection as in the italicized example given in the standard 8.EE.8b.

- One-third of tasks involve degenerate systems (infinitely many solutions), where the degeneracy is plausibly visible by inspection, as for example in

\[ 3x + 2y = 1, \quad 6x + 6y = 2. \]

- One-third of tasks involve systems with a unique solution and one coefficient zero, where the solution is plausibly visible by inspection, as for example in

\[ y = 1, \quad 3x + y = 1. \]

- Tasks assess solving by inspection, for example by listing several systems and asking the student for the solution of any freely chosen one of them by inspection

**EOY:** Sub Claim A Task Type 1

**PBA/MYA notes:** Sub Claim C, Task Type 2, MP3&6, calc

**PBA/MYA notes:** Sub Claim D, Task Type 3, MP4+, calc

**Assessment Problems:**

1. **c.** Solve real-world and mathematical problems leading to two linear equations in two variables.
   - For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair. 8.EE.8c

**Essential Knowledge and skills**

- By making connections between algebraic and graphical solutions and the context of the system of linear equations, students are able to make sense of their solutions. Students need opportunities to work with equations and context that include whole number and/or decimals/fractions. Students define variables and create a system of linear equations in two variables

**Examples**

Solve: Victor is half as old as Maria. The sum of their ages is 54. How

**Academic vocabulary**

**Mathematical Practices**

1. Make sense of problems and persevere in solving them

**2. Use appropriate...**
If Maria is 36, then substitute 36 into \( v + m = 54 \) to find Victor’s age of 18.

Note: Students are not expected to change linear equations written in standard form to slope-intercept form or solve systems using elimination.

PARCC Clarification EOY
- Mixture problems are no more than 20% of tasks.
- For an example of an illustrative task, see ITN Appendix F, section A, “Illustrations of innovative task characteristics,” sub-section 6, “Expressing mathematical reasoning,” sub-section “Illustrative tasks that require students to express mathematical reasoning,” the problem of the two shepherds.

EOY: Sub Claim A Task Type 1

PBA/MYA notes: Sub Claim D, Task Type 3, MP4+, calc

Assessment Problems:
- [http://www.illustrativemathematics.org/illustrations/554](http://www.illustrativemathematics.org/illustrations/554)
- [http://www.illustrativemathematics.org/illustrations/472](http://www.illustrativemathematics.org/illustrations/472)
- [http://www.illustrativemathematics.org/illustrations/469](http://www.illustrativemathematics.org/illustrations/469)
- [http://www.illustrativemathematics.org/illustrations/73](http://www.illustrativemathematics.org/illustrations/73)
- [http://www.illustrativemathematics.org/illustrations/1571](http://www.illustrativemathematics.org/illustrations/1571)
- [http://www.illustrativemathematics.org/illustrations/1364](http://www.illustrativemathematics.org/illustrations/1364)

**ALGEBRA**

**Reasoning with Equations and Inequalities (A-REI)**

**Use Mathematical Practices to**
- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of

**A**

**Students solve systems of equations.**

**A-REI.5** Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

**Essential Knowledge and skills**
- Solve systems of equations using the elimination method (sometimes called linear combinations).
- Solve a system of equations by substitution (solving for one variable in the first equation and substitution it into the second equation).
- Systems of linear equations can also have one solution, infinitely many solutions.

**Academic vocabulary**
- elimination
- solutions
- substitution
- systems of equations

**TEACHER NOTES**
- See instructional strategies in the introduction
- Employ mathematics best practice strategies e.g.
  - using manipulatives
  - facilitating cooperative group work
  - discussing mathematics

**RESOURCE NOTES**
- See resources in the introduction
- Refer to Algebra I @ Live Binder [http://www.livebinders.com/play/play/1171650](http://www.livebinders.com/play/play/1171650) for evidence statements and clarification

**REQUIRED ASSESSMENTS**
- Assessment problems
- Common units and assessments
- NWEA Test
### Mathematical Practices

3. Construct viable arguments and critique the reasoning of others

### PARCC Clarification

**NONE**

### Essential Knowledge and Skills

#### Examples

- **José** had 4 times as many trading cards as **Philipe**. After José gave away 50 cards to his little brother and Philipe gave 5 cards to his friend for his birthday, they each had an equal amount of cards. Write a system to describe the situation and solve the system.

#### Additional content

#### Academic vocabulary

- **Mathematical Practices**
  1. Make sense of problems and persevere in solving them
  2. Reason abstractly and quantitatively
  3. Use appropriate tools strategically

### TEACHER NOTES

- **Linear-linear and linear-quadratic**

### PARCC Released Test Problems

- **Performance Level Descriptors (PARCC)**

---

### UNIT: Solving Systems of Linear Equations

- **A-REI.6** Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

- **Examples**
  - Given that the sum of two numbers is 10 and their difference is 4, what are the numbers? Explain how your answer can be deduced from the fact that the two numbers, x and y, satisfy the equations $x + y = 10$ and $x - y = 4$.

- **PARCC Clarification**
  - **NONE**

- **Sub Claim __ , Task Type __**

- **PBA/MYA notes:** Sub Claim C, Task Type 2, MP3, calc

- **Calculators**

---

### INSTRUCTIONAL STRATEGIES

- **questioning and making conjectures**
- **justifying of thinking**
- **writing about mathematics**
- **facilitating of learning**
- **using assessment to modify instruction**

---

### RESOURCES

- **PARCC Released Test Problems**
- **Performance Level Descriptors (PARCC)**
### A-REI.7

Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Additional content

- For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.

#### Essential Knowledge and skills

- Academic vocabulary

#### Examples

- Find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$ algebraically.
- Two friends are driving to the Grand Canyon in separate cars. Suzette has been there before and knows the way but Andrea does not. During the trip Andrea gets ahead of Suzette and pulls over to wait for her. Suzette is traveling at a constant rate of 65 miles per hour. Andrea sees Suzette drive past. To catch up, Andrea accelerates at a constant rate. The distance in miles ($d$) that her car travels as a function of time in hours ($t$) since Suzette’s car passed is given by $d = 3500t^2$. Write and solve a system of equations to determine how long it takes for Andrea to catch up with Suzette.

#### PARCC Clarification

- (EOY)

#### Academic vocabulary

- Mathematical Practices
  - 2. Reason abstractly and quantitatively

#### TEACHER NOTES

See instructional strategies in the introduction

Use mathematics best practices strategies e.g.
- using manipulatives
- facilitating cooperative group work
- discussing

See resources in the introduction

Refer to Algebra I @ Live Binder

http://www.livebinders.com/play/play/1171650 for evidence statements and clarification

### M

**Students represent and solve equations and inequalities graphically.**

#### A-REI.10

Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

**Essential Knowledge and skills**

- Academic vocabulary

**Examples**

- Which of the following points would be on the graph of the equation $3x + 4y = 24$?
  - (a) $(0, 6)$
  - (b) $(-1, 7)$
  - (c) $(4/3, 5)$
  - (d) $(3, 4)$

**Mathematical Practices**

- 7. Look for and make use of structure
and critique the reasoning of others
4. Model with mathematics ★
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

• Graph the equation and determine which of the following points are on the graph of $y = 3x + 1$.
  (a) (2, 7)   (b) (-1, 4/3)   (c) (2, 10)   (d) (0, 1)

PARCC Clarification
• NONE

EOY: Sub Claim A, Task Type 1

Assessment Problems:

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 and exponential.

Essential Knowledge and skills
• Students need to understand that numerical solution methods (data in a table used to approximate an algebraic function) and graphical solution methods may produce approximate solutions, and algebraic solution methods produce precise solutions that can be represented graphically or numerically. Students may use graphing calculators or programs to generate tables of values, graph, or solve a variety of functions.

Examples
• Given the following equations, determine the x value that results in an equal output for both functions.
  $f(x) = 3x - 2$
  $g(x) = (x + 3)^2 - 1$

PARCC Clarification

Find the solutions of where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Limit $f(x)$ and/or $g(x)$ to polynomial functions.

• The “explain” part of standard A-REI.11 is not assessed here. For this aspect of the standard, see Sub-claim C on the PBA.
• Polynomials are of degree two and higher.

PBA/MYA & EOY: Sub Claim A, Task Type 1

Academic vocabulary
• successive approximations
• x-coordinate

Mathematical Practices
1. Make sense of problems and persevere in solving them
5. Use appropriate tools strategically

PARCC Released Test Problems
• Performance Level Descriptors (PARCC)
## Functions

### Interpreting functions (F-IF)

<table>
<thead>
<tr>
<th>Categories and Domains</th>
<th>Unit</th>
<th>Clusters and Standards Middletown Public Schools</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td><strong>M</strong></td>
<td><strong>PBA/MYA notes:</strong> Sub Claim A, Task Type 1, MP4, calc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Essential Knowledge and skills</strong></td>
<td><strong>Examples</strong></td>
<td><strong>Academic vocabulary</strong></td>
<td><strong>MPA/MYA &amp; FOY:</strong> Sub Claim A, Task Type 1</td>
<td><strong>Calculator - NO</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Academic vocabulary</strong></td>
<td><strong>Examples</strong></td>
<td><strong>Mathematical Practices</strong></td>
<td><strong>Resource Notes</strong></td>
<td><strong>ASSESSMENT NOTES</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PARCC Clarification</strong></td>
<td><strong>Examples</strong></td>
<td><strong>Required Assessments</strong></td>
<td><strong>ASSESSMENT NOTES</strong></td>
<td><strong>ASSESSMENT NOTES</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Students define, evaluate, and compare functions. (Grade 8 only)

<table>
<thead>
<tr>
<th>Categories and Domains</th>
<th>Unit</th>
<th>Clusters and Standards Middletown Public Schools</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td><strong>M</strong></td>
<td><strong>PBA/MYA notes:</strong> Sub Claim C, Task Type 2, MP3, calc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Assessment Problems:</strong></td>
<td><strong>Examples:</strong></td>
<td><strong>Academic vocabulary</strong></td>
<td><strong>PBA/MYA &amp; FOY:</strong> Sub Claim C, Task Type 2, MP3, calc</td>
<td><strong>Calculator - NO</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PARCC Clarification</strong></td>
<td><strong>Examples:</strong></td>
<td><strong>Mathematical Practices</strong></td>
<td><strong>Resource Notes</strong></td>
<td><strong>ASSESSMENT NOTES</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Essential Knowledge and skills</strong></td>
<td><strong>Examples:</strong></td>
<td><strong>Required Assessments</strong></td>
<td><strong>ASSESSMENT NOTES</strong></td>
<td><strong>ASSESSMENT NOTES</strong></td>
<td></td>
</tr>
</tbody>
</table>

**8.F.1** Understand that a function is a rule that assigns to each input exactly one output. **Major content**

The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 1

- **Essential Knowledge and skills**
  - A function is a rule that assigns each input exactly one output.
  - A graph of an equation is also the graph of that function consisting of inputs and the corresponding outputs.

- **Examples**

**Academic vocabulary**

- Domain
- Function
- Input
- Output

**TEACHER NOTES**

See instructional strategies in the introduction

Employ mathematics best practice strategies e.g.,

- using manipulatives
- facilitating cooperative group work
- discussing

**RESOURCE NOTES**

See resources in the introduction

Refer to Algebra I @ Live Binder

http://www.livebinders.com/play/play/1171650 for evidence statements and clarification

**REQUIRED ASSESSMENTS**

- Assessment problems
- Common units and assessments

---

8/20/2014

Middletown Public Schools
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Model with mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Attend to precision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Determine which of the following tables represent a function and explain why.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th></th>
<th>B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Solution: A represents a function because for each input there is exactly one output. B does NOT represent a function because the input 1 has two outputs (2 and 3).

Explanation:
- A vertical line test can be performed to determine whether a graph represents a function. By definition a function, each x value (input) of a function can have only one y value (output). If a vertical line is drawn for an x value then that line can only hit the graph at one point (that is one output).

Example:
Determine if the graph represents a function:

Solution

PARCC Clarification EOY
- Tasks do not involve the coordinate plane or the “vertical line test.”
- Tasks do not require knowledge of the concepts or terms domain and range.
- 20% of functions in tasks are non-numerical, e.g., the input could be a person and the output could be his or her month of birth.

EOY: Sub Claim A Task Type 1
PBA/MYA notes: Sub Claim D, Task Type 3, MP4&2, calc

- Range
- Mathematical Practices
  2. Reason abstractly and quantitatively

**INSTRUCTIONAL STRATEGIES**
- Mathematics
- Questioning and making conjectures
- Justifying of thinking
- Writing about mathematics
- Facilitating problem solving approach to instruction
- Integrating content
- Using calculators and computers
- Facilitating learning
- Using assessment to modify instruction

**RESOURCES**
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
## CLUSTERS and STANDARDS

**Middletown Public Schools**

<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.F.2</strong></td>
<td></td>
<td><strong>Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).</strong></td>
</tr>
</tbody>
</table>

### Essential Knowledge and skills

- Functions can be represented algebraically, graphically, numerically in tables or by verbal descriptions.

### Examples

1. Given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
2. Compare the two linear functions listed below and determine which equation represents a greater rate of change.

#### Function 1:

- The function whose input x and output y are related by
- \( y = 3x + 7 \)

#### Function 2:

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>16.50</td>
</tr>
<tr>
<td>2</td>
<td>13.00</td>
</tr>
<tr>
<td>3</td>
<td>9.50</td>
</tr>
<tr>
<td>4</td>
<td>6.00</td>
</tr>
</tbody>
</table>

### Academic vocabulary

- Rate of change
- Slope

### Mathematical Practices

- 2. Reason abstractly and quantitatively
- 5. Use appropriate tools strategically

### Solution:

Function 1 is an example of a function whose graph has negative slope.

Samantha starts with $20 and spends money each week. The amount of money remaining as a function of the number of weeks, x, can be represented by the equation:

\( y = -3x + 20 \)
### PARCC Clarification EOY
- Tasks have “thin context” or no context.
- The testing interface can provide students with a calculation aid of the specified kind for these tasks.

**EOY: Sub Claim A Task Type 1**

**PBA/MYA notes:** Sub Claim D, Task Type 3, MP4&2, calc

**Assessment Problems:**
http://www.illustrativemathematics.org/illustrations/641

---

<table>
<thead>
<tr>
<th>Categories and Domains</th>
<th>Unit</th>
<th>Clusters and Standards Middletown Public Schools</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
</table>
| **8.F.3** | | Interpret the equation \( y = mx + b \) as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. **Major content**
- For example, the function \( A = s^2 \) giving the area of a square as a function of its side length is not linear because its graph contains the points \((1,1),(2,4)\) and \((3,9)\), which are not on a straight line.

**Essential Knowledge and Skills**
- Linear functions are represented by the equation \( y=mx+b \) and a straight line on a graph.

**Example 1**
- Determine if the functions listed below are linear or non-linear. Explain your reasoning:
  1. \( y = -2x^2 + 3 \)
  2. \( y = 0.25 + 0.5(x – 2) \)
  3. \( A = \pi r^2 \)

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

- Solution:
  1. Non-linear
  2. Linear

**Academic vocabulary**
- Linear function
- Non-linear

**Mathematical Practices**
- Reason abstractly and quantitatively
- Look for and make use of structure

- Look for and make use of structure

**Calculator** - YES
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNCTIONS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpreting functions (F-IF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M Students understand the concept of a function and use function notation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>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). Major content.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PARCC Clarification

(B.F.3-1)• Tasks have “thin context” or no context.
• Tasks require students to approach linear equations from a functional perspective, for example by computing outputs from inputs or by identifying equations that do or do not define one variable as a linear function of the other. Equations can be presented in forms other than

\[ y = mx + b. \]

For example, the equation

\[ y = 2x + 2 + x. \]

For example, the equation

\[ 2x + y = 7. \]

Parcc Clarification

(B.F.3-2)• Tasks have “thin context” or no context.
• Tasks require students to demonstrate understanding of function nonlinearity, for example by recognizing or producing equations that do not define linear functions, or by recognizing or producing pairs of points that belong to the graph of the function yet do not lie on a straight line.
• Tasks do not require students to produce a proof; for that aspect of standard 8.F.3, see Grade 8 PBA
• Tasks involving symbolic representations are limited to polynomial functions, e.g. \[ y = 3x + 2. \]

Sub Claim A Task Type 1
Assessment Problems:
http://www.illustrativemathematics.org/illustrations/813

Calculator - NO
A function is a rule that assigns each input exactly one output.

In function notation, \( f(x) \) denotes that \( f \) is a function of \( x \).

The set of all inputs (\( x \)) for a function is called the domain; the set of all outputs (\( f(x) \)) for a function is called the range.

The domain and range of a function can be expressed as a set of numbers using set notation, an inequality, or as a graphed solution.

The graph of a function \( f \) is the graph of the equation \( y = f(x) \).

**Examples**

- For example, the rule that takes \( x \) as input and gives \( x^2 + 5x + 4 \) as output is a function. Using \( y \) to stand for the output we can represent this function with the equation \( y = x^2 + 5x + 4 \), and the graph of the equation is the graph of the function. Students are expected to use function notation such as \( f(x) = x^2 + 5x + 4 \).

Example:

- Determine which of the following tables represent a function and explain why.

<table>
<thead>
<tr>
<th>A</th>
<th></th>
<th>B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( x )</td>
<td>( f(x) )</td>
<td>( x )</td>
<td>( f(x) )</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Solution: A represents a function because for each element in the domain there is exactly one element in the range. B does NOT represent a function because when \( x = 1 \), there are two values for \( f(x) \): 2 and 3.

**PARCC Clarification**

- **NONE**

*PBA/MYA & EOY: Sub Claim A, Task Type 1*  

*Calculator - Neutral*

Assessment Problems:
# Algebra I Curriculum Grades 8-9

**Curriculum Writers:** Gráinne Phelps, Paul Pignatelli, Deanna Smith, Gus Steppen, and Lisa Wood

<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td><strong>F-IF.2</strong></td>
<td>Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. <strong>Major content</strong></td>
<td><strong>Academic vocabulary</strong></td>
<td><strong>Mathematical Practices</strong></td>
<td><strong>Sub Claim A, Task Type 1</strong></td>
</tr>
<tr>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Algebraic equations, written in function notation, can be used to evaluate functions for a given input.</td>
<td></td>
<td></td>
<td>6. Attend to precision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• For a function ( f(x) ), ( f(a) ) represents the value of the function when ( x = a ).</td>
<td></td>
<td></td>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• If ( f(x) = x^2 + 4x - 12 ), find ( f(2) ).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Let ( f(x) = 2(x + 3)^2 ). Find ( f(3) ), ( f\left(-\frac{1}{2}\right) ), ( f(a) ), and ( f(a - h) ).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• If ( P(t) ) is the population of Tucson ( t ) years after 2000, interpret the statements ( P(0) = 487,000 ) and ( P(10) - P(9) = 5,900 ).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PARCC Clarification</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• See illustrations for F-IF.2 at <a href="http://illustrativemathematics.org">http://illustrativemathematics.org</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub Claim A, Task Type 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Assessment Problems:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>M</strong></th>
<th><strong>F-IF.3</strong></th>
<th>Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. <strong>Major content</strong></th>
<th><strong>Academic vocabulary</strong></th>
<th><strong>Mathematical Practices</strong></th>
<th><strong>Sub Claim __, Task Type __</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td><strong>Sub Claim __, Task Type __</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sequences are functions that have a discrete domain, which is a subset of the integers.</td>
<td></td>
<td></td>
<td><strong>Calculator</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A recursive sequence is a sequence in which each term is built upon the previous term.</td>
<td></td>
<td></td>
<td><strong>- Item specific</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For example, the Fibonacci sequence is defined recursively by ( f(0) = f(1) = 1 ) ( f(n+1) = f(n) + f(n-1) ) for ( n \geq 1 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PARCC Clarification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Sub Claim __, Task Type __</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Assessment Problems:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### FUNCTIONS

**Interpreting functions (F-IF)**

- Use Mathematical Practices to
  1. Make sense of problems and persevere in solving them
  2. Reason abstractly and quantitatively
  3. Construct viable arguments and critique the reasoning of others
  4. Model with mathematics ★
  5. Use appropriate tools strategically
  6. Attend to precision
  7. Look for and make use of structure
  8. Look for and express regularity in repeated reasoning

#### 8.F.4

**Construct a function to model a linear relationship between two quantities.**

**Major content**

Determine the rate of change and initial value of the function from a description of a relationship or from two \((x, y)\) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

**Essential Knowledge and skills**

- Linear functions are functions that have a constant rate of change (slope) and an initial value.
- The initial value of a linear function is the place where the line will intersect the vertical axis or the y-intercept.
- Linear functions are represented as verbal descriptions, tables, graphs and equations that are all related by the same rate of change (slope) and initial value.

**Examples**

- The table below shows the cost of renting a car. The company charges $45 a day for the car as well as charging a one-time $25 fee for the car’s navigation system (GPS). Write an expression for the cost in dollars, \(c\), as a function of the number of days, \(d\).

<table>
<thead>
<tr>
<th>Days ((d))</th>
<th>Cost ((c)) in dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>115</td>
</tr>
<tr>
<td>3</td>
<td>160</td>
</tr>
<tr>
<td>4</td>
<td>205</td>
</tr>
</tbody>
</table>

  Students might write the equation \(c = 45d + 25\) using the verbal description or by first making a table.

  Students should recognize that the rate of change is 45 (the cost of renting the car) and that initial cost (the first day charge) also includes paying for the navigation system. Classroom discussion about one time fees vs. recurrent fees will help students model contextual situations.

**PARCC Clarification EOY**

- Pool should contain tasks with and without contexts.
- The testing interface can provide students with a calculation aid of the specified kind for these tasks.

**Sub Claim B Task Type 1**

**Assessment Problems:**

- http://www.illustrativemathematics.org/illustrations/120
- http://www.illustrativemathematics.org/illustrations/247
- http://www.illustrativemathematics.org/illustrations/477

**TEACHER NOTES**

See instructional strategies in the introduction

Employ mathematics best practice strategies e.g.

- using manipulatives
- facilitating cooperative group work
- discussing mathematics
- questioning and making conjectures
- justifying of thinking
- writing about mathematics
- facilitating problem solving approach to instruction
- integrating content
- using calculators and computers
- facilitating learning
- using assessment to modify instruction

**REQUIRED ASSESSMENTS**

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

**ACADEMIC VOCABULARY**

- Function
- Initial value
- Interpret
- Linear function
- Rate of change
- Slope
- Table of values

**MATH PRACTICES**

- 2. Reason abstractly and quantitatively
- 4. Model with mathematics

**ACADEMIC VOCABULARY**

- Calculator - YES

**ASSESSMENT NOTES**

See assessments in the introduction
### Functions

**Interpreting functions (F-IF)**

<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FUNCTIONS</strong></td>
<td><strong>M</strong></td>
<td><strong>Interpreting functions (F-IF)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use Mathematical Practices to</td>
<td></td>
<td>Students interpret linear, exponential and quadratic functions that arise in applications in terms of the context.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>M</strong></td>
<td><strong>F.IF.4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For a function (linear, exponential and quadratic) 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</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sub Claim B Task Type 1**

**Calculator - NO**
## Categories and Domains

**Unit:** CLusters and Standards

**Middletown Public Schools**

| 1. Make sense of problems and persevere in solving them |
| 2. Reason abstractly and quantitatively |
| 3. Construct viable arguments and critique the reasoning of others |
| 4. Model with mathematics ★ |
| 5. Use appropriate tools strategically |
| 6. Attend to precision |
| 7. Look for and make use of structure |
| 8. Look for and express regularity in repeated reasoning |

### Essential Knowledge and Skills

- **Given the key features of a function, sketch the graph**

#### Examples

A rocket is launched from 180 feet above the ground at time \( t = 0 \). The function that models this situation is given by \( h = -16t^2 + 96t + 180 \), where \( t \) is measured in seconds and \( h \) is height above the ground measured in feet.

- What is a reasonable domain restriction for \( t \) in this context?
- Determine the height of the rocket two seconds after it was launched.
- Determine the maximum height obtained by the rocket.
- Determine the time when the rocket is 100 feet above the ground.
- Determine the time at which the rocket hits the ground.
- How would you refine your answer to the first question based on your response to the second and fifth questions?

- Compare the graphs of \( y = 3x^2 \) and \( y = 3^x \).

Let \( f(x) = -x^2 - 5x + 1 \). Graph the function and identify end behavior and any intervals of constancy, increase, and decrease.

### PARCC Clarification

For a linear or quadratic 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 functions is increasing, decreasing, positive, or negative; relative maximums and minimums; end behavior; and symmetries.


### Academic Vocabulary

- Decreasing
- End behavior
- Exponential
- Increasing
- Intervals
- Linear
- Negative
- Positive
- Quadratic
- Relative maximums
- Relative minimums
- Symmetries

### Mathematical Practices

4. Model with mathematics ★

6. Attend to precision

### INSTRUCTIONAL STRATEGIES

- Using manipulatives
- Facilitating cooperative group work
- Discussing mathematics
- Questioning and making conjectures
- Justifying of thinking
- Writing about mathematics
- Facilitating problem solving approach to instruction
- Integrating content
- Using calculators and computers
- Facilitating learning
- Using assessment to modify instruction

### Resources

- [http://www.livebinders.com/play/play/1171650](http://www.livebinders.com/play/play/1171650)

### Assessments

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

### REQUIRED ASSESSMENTS

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

### TEACHER NOTES

Linear, exponential, and quadratic

Sub Claim A, Task Type 1

Assessment Problems:

Calculator – Item specific

Assessment Problems:
### F.IF.5

**Essential Knowledge and skills**
- Determine the practical domain of the function, given the graph.
- The appropriate domain for a function describing a real-life situation may be smaller than the largest possible domain.

**Examples**
- 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.

**PARCC Clarification**
Relate the domain of a function to a graph and, where applicable, to the quantitative relationship it describes, limiting to linear functions, square root functions, piecewise-defined functions (including step functions and absolute-value functions), and exponential functions with domains in the integers. 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 this function. (F-IF-5-1)
- Tasks have a real-world context.

Relate the domain of a function to a graph and, where applicable, to the quantitative relationship it describes, limiting to quadratic functions. 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 this function. (F-IF-5-2)
- Tasks have a real-world context.

**Sub Claim A, Task Type 1 (EOY)**

**Academic vocabulary**
- quantitative relationship

**Mathematical Practices**
2. Reason abstractly and quantitatively

### F.IF.6

**Essential Knowledge and skills**
- The average rate of change of a function \( y = f(x) \) over an interval \([a,b]\) is

**Academic vocabulary**
- rate of change
The average rate of change of a function \( y = f(x) \) over an interval \([a,b]\) is
\[
\frac{\Delta y}{\Delta x} = \frac{f(b) - f(a)}{b - a}
\]

addition to finding average rates of change from functions given symbolically, graphically, or in a table, students may collect data from experiments or simulations (ex. falling ball, velocity of a car, etc.) and find average rates of change for the function modeling the situation.

Example:
- Use the following table to find the average rate of change of \( g \) over the intervals \([-2, -1]\) and \([0, 2]\):

<table>
<thead>
<tr>
<th>( x )</th>
<th>( g(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>2</td>
</tr>
<tr>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>0</td>
<td>-4</td>
</tr>
<tr>
<td>2</td>
<td>-10</td>
</tr>
</tbody>
</table>

The table below shows the elapsed time when two different cars pass a 10, 20, 30, 40 and 50 meter mark on a test track.
- For car 1, what is the average velocity (change in distance divided by change in time) between the 0 and 10 meter mark? Between the 0 and 50 meter mark? Between the 20 and 30 meter mark?
  - Analyze the data to describe the motion of car 1.
- How does the velocity of car 1 compare to that of car 2?

<table>
<thead>
<tr>
<th>Car 1</th>
<th>Car 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( d )</td>
<td>( t )</td>
</tr>
<tr>
<td>10</td>
<td>4.472</td>
</tr>
<tr>
<td>20</td>
<td>6.325</td>
</tr>
<tr>
<td>30</td>
<td>7.746</td>
</tr>
<tr>
<td>40</td>
<td>8.944</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>CATEGORIES and DOMAINS</td>
<td>UNIT</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
</tr>
<tr>
<td>PARCC Clarification EOY</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PBA/MYA &amp; EOY:</strong> Sub Claim A, Task Type 1</td>
<td></td>
</tr>
<tr>
<td>Assessment Problems:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FUNCTIONS</th>
<th>Students analyze functions using different representations.</th>
<th>Supporting Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpreting functions (F-IF)</td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td></td>
<td><strong>Academic vocabulary</strong></td>
</tr>
<tr>
<td><strong>PARCC Clarification EOY</strong></td>
<td></td>
<td><strong>Mathematical Practices</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>1. Make sense of problems and persevere in solving them</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>2. Reason abstractly and quantitatively</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>3. Construct viable arguments and critique the reasoning of others</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>4. Model with mathematics</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>5. Use appropriate tools strategically</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>6. Attend to precision</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>7. Look for and make use of structure</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>8. Look for and express regularity in repeated reasoning</strong></td>
</tr>
</tbody>
</table>

**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.

- Graph linear functions and show intercepts. (F.IF.7a-1)

**Supporting Content**
- Graph linear and quadratic functions and show intercepts, maxima, and minima. (F.IF.7a)

**Academic vocabulary**
- Functions
- Intercepts
- Linear
- Maxima
- Minima
- Quadratic

**Mathematical Practices**
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision

**TEACHER NOTES**
See instructional strategies in the introduction

**REQUIRED ASSESSMENTS**
- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
### Categories and Domains

#### Unit

**PBA/MYA & EOY:** Sub Claim B, Task Type 1

**PBA/MYA notes:** Sub Claim D, Task Type 3, MP4&2, calc

**Essential Knowledge and skills**
- To graph a function you can create a table of values, analyze the equation, or use a graphing calculator.
- Key features of a graph or table may include intercepts, intervals in which the function is increasing, decreasing or constant, intervals in which the function is positive, negative or zero, symmetry, maxima, minima, and end behavior.

**Example**
- Graph the function \( f(x) = |x - 3| + 5 \) and describe key characteristics of the graph.
- Sketch the graph and identify the key characteristics of the function described below.

\[
F(x) = \begin{cases} 
  x + 2 & \text{for } x \geq 0 \\
  -x^2 & \text{for } x < -1 
\end{cases}
\]

**Solution**

![Graph of function](image)

**PARCC Clarification EOY**
Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

**Assessment Problems:**

- **b.** Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. (F.IF.7b)

**Academic vocabulary**
- square root
- cube root
- piecewise-defined
- step functions
- absolute value functions

**Mathematical Practices**
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision

**Resources**

- using calculators and computers
- facilitating learning
- using assessment to modify instruction

**Teacher Notes**
Linear, exponential, quadratic, absolute value, step, piecewise-defined
### CATEGORIES and DOMAINS

#### UNIT

#### CLUSTERS and STANDARDS

**Middletown Public Schools**

- **Essential Knowledge and skills**
  - **Examples**
    - Graph the function $f(x) = 2^x$ by creating a table of values. Identify the key characteristics of the graph.
  - **PARCC Clarification**
    - (EOY)
  - **PBA/MYA & EOY:** Sub Claim B, Task Type 1

- **Academic vocabulary**
  - Amplitude
  - End behavior
  - Exponential functions intercepts
  - Midline
  - Period

- **Mathematical Practices**
  - 1. Make sense of problems and persevere in solving them
  - 5. Use appropriate tools strategically
  - 6. Attend to precision

- **Assessment Problems:**
  - **F.IF.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. **Supporting content**
    - 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. (F.IF.8a)

  - **Essential Knowledge and skills**
    - A linear function can be written in point-slope, slope-intercept or standard form.
    - A quadratic function can be written in vertex or standard form.
    - Factoring a quadratic function will help to determine the zeros.
    - Completing the square will help determine the vertex of the graph.

  - **Examples**
    - Factor the following quadratic to identify its zeros: $x^2 + 2x - 8 = 0$
    - Complete the square for the quadratic and identify its vertex: $x^2 + 6x + 19 = 0$

  - **PARCC Clarification E0Y**
    - Tasks have a context.

- **Academic vocabulary**
  - Completing the square
  - Extreme values
  - Factoring
  - Symmetry
  - Zeros

- **Mathematical Practices**
  - 2. Reason abstractly and quantitatively
  - 3. Construct viable arguments and critique the reasoning of others
### F.IF.8b

**Essential Knowledge and skills**
- For a function of the form \( f(t) = a \cdot b^t \), if \( b>1 \) the function represents exponential growth; if \( b<1 \) the function represents exponential decay.

**Examples**
- For example, identify percent rate of change in functions such as:
  - \( y = (1.02)^t \)
  - \( y = (0.97)^t \)
  - \( y = (1.01)^{12t} \)
  - \( y = (1.2)^{10t} \)

and classify them as representing exponential growth or decay.

### Mathematical Practices

**Essential Knowledge and skills**
- Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

**Examples**
- For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

**Start F-IF.9 by focusing on linear and exponential functions. Include comparisons of two functions presented algebraically. Later in the year focus on expanding the types of functions to include linear, exponential, and quadratic. Extend work with quadratics to include the relationship**

**Mathematical Practices**
1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
between coefficients and roots, and once roots are known, a quadratic equation can be factored.
- Given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.
- Examine the functions below. Which function has the larger maximum? How do you know?
  \[ f(x) = -2x^2 - 8x + 20 \]

PARCC Clarification EOY
Function types should be limited to linear functions, quadratic functions, square root functions, cube root functions, piecewise-defined functions (including step functions and absolute value functions), and exponential functions with domains in the integers. (EOY)
- Tasks may or may not have a context.

Sub Claim B, Task Type 1

Assessment Problems:

### Functions

**Building Functions (F-BF)**

Use Mathematical Practices to
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics ★
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of...
## Categories and Domains

<table>
<thead>
<tr>
<th>Unit</th>
<th>Clusters and Standards</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
</table>
| 8.   | Look for and express regularity in repeated reasoning | decreases by 9% each minute. Write a function describing the temperature of the coffee as a function of time. | - writing about mathematics  
facilitating problem solving approach to instruction  
integrating content  
using calculators and computers  
facilitating learning  
using assessment to modify instruction | Calculator - Level Descriptors (PARCC) |

### PARCC Clarification

**EOY: Sub Claim __, Task Type __**

**PBA/MYA notes: Sub Claim D, Task Type 3, MP4&2, calc**

**Assessment Problems:**

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 function that models the temperature of a heating body.*

**Essential Knowledge and skills**

- The function representing a given situation may be a combination of more than one standard function.
- Standard functions may be combined through arithmetic operations.

**Examples**

**PARCC Clarification**

**Sub Claim __, Task Type __**

**Assessment Problems:**

### Academic Vocabulary

**Mathematical Practices**

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

**Teacher Notes**

Linear, exponential and quadratic

---

**F-BF.2** Write arithmetic and geometric sequences both recursively and with an explicit formula, formula, use them to model situations, and translate between the two forms.

**Essential Knowledge and skills**

- Arithmetic and geometric sequences can be written both recursively and with an explicit formula.
- A recursive formula for a sequence describes how to determine the next term from the previous term(s).
- An explicit formula for a sequence describes how to determine any term in the sequence.

**Academic Vocabulary**

- arithmetic sequences
- explicit
- formula
- geometric
### ALGEBRA I CURRICULUM Grades 8-9
Curriculum Writers: Gráinne Phelps, Paul Pignatelli, Deanna Smith, Gus Steppen, and Lisa Wood

<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Arithmetic sequences can be described by linear functions.</td>
<td></td>
<td></td>
<td>sequences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Geometric sequences can be described by exponential functions.</td>
<td></td>
<td></td>
<td>recursively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sequences model situations in which the domain is a set of integers.</td>
<td></td>
<td></td>
<td>Mathematical Practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples</td>
<td></td>
<td></td>
<td>4. Model with mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Generate the $5^{th}-11^{th}$ terms of a sequence if $A_1=2$ and $A_{n+1} = (A_n)^2 - 1$</td>
<td></td>
<td></td>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Use the formula: $A_n = A_1 + d(n - 1)$ where $d$ is the common difference to generate a sequence whose first three terms are: -7, -4, and -1.</td>
<td></td>
<td></td>
<td>8. Look for and express regularity in repeated reasoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• There are 2,500 fish in a pond. Each year the population decreases by 25 percent, but 1,000 fish are added to the pond at the end of the year. Find the population in five years. Also, find the long-term population.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Given the formula $A_n = 2^n - 1$, find the 17$^{th}$ term of the sequence.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FUNCTIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Building Functions (F-BF)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use Mathematical Practices to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Model with mathematics ★</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Attend to precision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students build new functions from existing functions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of $k$ (both positive and negative); find the value of $k$ given the graphs. (linear, exponential, quadratic, and absolute value function)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essential Knowledge and skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• $f(x) + k$ will translate the graph of the function $f(x)$ up or down by $k$ units.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• $k f(x)$ will expand or contract the graph of the function $f(x)$ vertically by a factor of $k$. If $k&gt;0$ the graph will reflect across the x-axis.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• $f(kx)$ will expand or contract the graph of the function $f(x)$ horizontally by a factor of $k$. If $k&gt;0$ the graph will reflect across the y-axis.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• $f(x + k)$ will translate the graph of the function $f(x)$ left or right by $k$ units.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic vocabulary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Even/odd symmetries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Odd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Symmetries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Translation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Vertical/horizontal translations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parcc Clarification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Claim __ , Task Type __</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculator -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8/20/2014
Middletown Public Schools

<table>
<thead>
<tr>
<th>RESOURCE NOTES</th>
<th>ASSESSMENT NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to Algebra I @ Live Binder</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.livebinders.com/play/play/1171650">http://www.livebinders.com/play/play/1171650</a> for evidence statements and clarification</td>
<td></td>
</tr>
<tr>
<td>REQUIRED ASSESSMENTS</td>
<td></td>
</tr>
<tr>
<td>• Assessment problems</td>
<td></td>
</tr>
<tr>
<td>• Common units and assessments</td>
<td></td>
</tr>
<tr>
<td>• NWEA Test</td>
<td></td>
</tr>
<tr>
<td>• PARCC Released Test Problems</td>
<td></td>
</tr>
<tr>
<td>• Performance Level Descriptors (PARCC)</td>
<td></td>
</tr>
</tbody>
</table>
### CATEGORIES and DOMAINS

**UNIT CLUSTERS and STANDARDS**

**Middletown Public Schools**

<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>reasoning</td>
<td>• If ( f(-x) = f(x) ) then the function is even, therefore its graph is symmetrical across the y-axis. • If ( f(-x) = -f(x) ) then the function is odd, therefore its graph is symmetrical across the origin. <strong>Examples</strong> • Compare the graphs of ( f(x)=3x ) with those of ( g(x)=3x+2 ) and ( h(x)=3x-1 ) to see that parallel lines have the same slope AND to explore the effect of the transformation of the function, ( f(x)=3x ) such that ( g(x)=f(x)+2 ) and ( h(x)=f(x)-1 ). • Explore the relationship between ( f(x)=3x, g(x)=5x, ) and ( h(x) = \frac{1}{2}x ) with a calculator to develop a relationship between the coefficient on ( x ) and the slope. • Describe the effect of varying the parameters ( a, h, ) and ( k ) on the shape and position of the graph ( f(x) = ab^{x+h} + k ), orally or in written format. What effect do values between 0 and 1 have? What effect do negative values have? • Is ( f(x) = x^3 - 3x^2 + 2x + 1 ) even, odd, or neither? Explain your answer orally or in written format. • Compare the shape and position of the graphs of ( f(x) = x^3 ) and ( g(x) = 2x^3 ), and explain the differences in terms of the algebraic expressions for the functions <strong>PARCC Clarification EOY</strong> Identify the effect on the graph of replacing ( f(x) ) by ( f(x)+k ), ( kf(x) ), ( f(kx) ), and ( f(x+k) ) for specific values of ( k ) (both positive and negative); find the value of ( k ) given the graphs limiting the function types to linear and quadratic functions. (EOY) • Tasks do not involve recognizing even and odd functions. • Experimenting with cases and illustrating an explanation are not assessed here. Identify the effect on the graph of a quadratic function of replacing ( f(x) ) by ( f(x)+k ), ( kf(x) ), ( f(kx) ), and ( f(x+k) ) for specific values of ( k ) (both positive and negative); find the value of ( k ) given the graphs. Experiment with cases using technology.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Mathematical Practices**

3. Construct viable arguments and critique the reasoning of others
5. Use appropriate tools strategically
7. Look for and make use of structure

---

**TEACHER NOTES**

Linear, exponential, quadratic, and absolute value; for F,BF, 4a, linear only

---

facilitating problem solving approach to instruction
integrating content
using calculators and computers
facilitating learning
using assessment to modify instruction

---

**8/20/2014 Middletown Public Schools**
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>MIDDLETOWN PUBLIC SCHOOLS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-BF.4</td>
<td></td>
<td>Illustrating an explanation is not assessed here (see Sub-claim C on the PBA)</td>
<td></td>
<td>Calculator – Item specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-LE 1</td>
<td></td>
<td>Students construct and compare linear, quadratic, and exponential models and solve problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F-LE 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distinguish between situations that can be modeled with linear functions and with exponential functions. Supporting content</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. (F-LE.1a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academic vocabulary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Essential Knowledge and skills**

- Linear functions grow by equal differences over equal intervals.
- Exponential functions grow by equal factors over equal intervals.

**Academic vocabulary**

- Exponential functions

**Supporting content**

- Two functions $f$ and $g$ are inverses of one another if for all values of $x$ in the domain of $f$, $f(x)=y$ and $g(y)=x$.
- Not all functions have an inverse.

**Examples**

- Reason abstractly and quantitatively
- Model with mathematics
- Use appropriate tools strategically

**PARCC Clarification EOY**

- Sub Claim __, Task Type ___

**Assessment Problems:**

- Sub Claim C, Task Type 2, MP3, calc
- Sub Claim D, Task Type 3, MP4&2, calc

**TEACHER NOTES**

See instructional strategies in the introduction

Employ mathematics best practice strategies e.g.
- using manipulatives
- facilitating cooperative group

**RESOURCE NOTES**

See resources in the introduction

Refer to Algebra I @ Live Binder

**ASSESSMENT NOTES**

See assessments in the introduction

**REQUIRED ASSESSMENTS**

- Assessment problems
### Categories and Domains

- **Mathematical Practices**
  - 1. Make sense of problems and persevere in solving them
  - 2. Reason abstractly and quantitatively
  - 3. Construct viable arguments and critique the reasoning of others
  - 4. Model with mathematics
  - 5. Use appropriate tools strategically
  - 6. Attend to precision
  - 7. Look for and make use of structure
  - 8. Look for and express regularity in repeated reasoning

### Unit
- **Linear functions**
  - Have an additive recursive pattern; exponential functions have a multiplicative recursive pattern.
  - **Examples**

#### PARCC Clarification
- (EOY)

### Clusters and Standards

#### Middletown Public Schools

- **Mathematical Practices**
  - 2. Reason abstractly and quantitatively
  - 4. Model with mathematics
  - 5. Use appropriate tools strategically
  - 7. Look for and make use of structure
  - 8. Look for and express regularity in repeated reasoning

### Instructional Strategies

- **Work**
  - Discussing mathematics
  - Questioning and making conjectures
  - Justifying of thinking
  - Writing about mathematics
  - Facilitating problem solving approach to instruction
  - Integrating content
  - Using calculators and computers
  - Facilitating learning
  - Using assessment to modify instruction

### Resources

- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)

### Assessments

- **Assessment Problems**
  - [http://www.illustrativemathematics.org/illustrations/385](http://www.illustrativemathematics.org/illustrations/385)
  - **b.** Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. (F.LE.1b)

#### Essential Knowledge and Skills

- **Examples**

#### PARCC Clarification
- (EOY)

- **Calculator - NO**

#### Sub Claim __, Task Type __

**PBA/MYA notes:** Sub Claim C, Task Type 2, MP3, calc

### Assessment Problems:

- **Academic vocabulary**
  - Decays

- **Mathematical Practices**
  - 2. Reason abstractly and quantitatively

- **Calculated - NO**

#### Sub Claim __, Task Type __

**Assessment Problems:**

- **c.** Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. (F.LE.1c)

#### Essential Knowledge and Skills

- **Examples**

#### PARCC Clarification
- (EOY)

- **Calculator - NO**

#### Sub Claim __, Task Type __

**Assessment Problems:**

- **Academic vocabulary**
  - Decays
  - Growth

### Mathematical Practices

- **Examples**
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Middletown Public Schools</td>
<td>Practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calculator - NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1. Mathematical Practices
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Use appropriate tools strategically
4. Model with mathematics
5. Attend to precision
6. Look for and express regularity in repeated reasoning

### 2.  F.LE.2
Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

#### Supporting content
- Linear and exponential functions can be constructed given a graph, a description of a relationship, or a set of input-output pairs (which may be given in a table).

#### Essential Knowledge and skills
- Linear and exponential functions can be constructed given a graph, a description of a relationship, or a set of input-output pairs (which may be given in a table).

#### Examples
- PARCC Clarification
- Tasks are limited to constructing linear and exponential functions with domains in the integers, in simple context (not multi-step). (EOY)
- Solve multi-step contextual problems with degree of difficulty appropriate to the course by constructing linear and/or exponential function models, where exponentials are limited to integer exponents. (EOY)
- Prompts describe a scenario using everyday language. Mathematical language such as “function,” “exponential,” etc. is not used.
- Students autonomously choose and apply appropriate mathematical techniques without prompting. For example, in a situation of doubling, they apply techniques of exponential functions.
- iii) For some illustrations, see tasks at [http://illustrativemathematics.org](http://illustrativemathematics.org) under F-LE.

#### Assessment Problems:
- Sub Claim __, Task Type __
- Assessment Problems:
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>F.LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. Supporting content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essential Knowledge and skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• An exponential growth model will eventually exceed in quantity any linear or quadratic growth model.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examples</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PARCC Clarification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim __, Task Type __</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUNCTIONS</td>
<td>F-LE.5 Students interpret expressions for functions in terms of the situation they model.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear, Quadratic, and Exponential Models★ (F-LE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interpret the parameters in a linear or exponential function in terms of a context. Supporting content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essential Knowledge and skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A given situation will set parameters for any linear or exponential function that models the situation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examples</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PARCC Clarification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim __, Task Type __</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEACHER NOTES See instructional strategies in the introduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Employ mathematics best practice strategies e.g.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• using manipulatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• facilitating cooperative group work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• discussing mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• questioning and making conjectures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• justifying of thinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• writing about mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• facilitating problem solving approach to instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• integrating content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• using calculators and computers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• facilitating learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• using assessment to modify instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RESOURCE NOTES See resources in the introduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refer to Algebra I @ Live Binder <a href="http://www.livebinders.com/play/play/1171650">http://www.livebinders.com/play/play/1171650</a> for evidence statements and clarification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASSESSMENT NOTES See assessments in the introduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>REQUIRED ASSESSMENTS • Assessment problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Common units and assessments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NWEA Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PARCC Released Test Problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Performance Level Descriptors (PARCC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATEGORIES and DOMAINS</td>
<td>UNIT</td>
<td>CLUSTERS and STANDARDS</td>
<td>INSTRUCTIONAL STRATEGIES</td>
<td>RESOURCES</td>
<td>ASSESSMENTS</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
<td>------------------------</td>
<td>--------------------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>GEOMETRY</strong></td>
<td>M</td>
<td>Students understand and apply the Pythagorean theorem. (Grade 8 only)</td>
<td>TEACHER NOTES Linear and exponential of form f(x) = b^x + K</td>
<td>RESOURCES</td>
<td>ASSESSMENTS</td>
</tr>
<tr>
<td>Geometric Measurement and Dimension (8.G)</td>
<td></td>
<td></td>
<td></td>
<td>RESOURCE NOTES</td>
<td></td>
</tr>
<tr>
<td>Use Mathematical Practices to</td>
<td></td>
<td></td>
<td></td>
<td>ASSESSMENT NOTES</td>
<td></td>
</tr>
<tr>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td></td>
<td>REQUIRED ASSESSMENTS</td>
<td></td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
<td>• Assessment problems</td>
<td></td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others</td>
<td></td>
<td></td>
<td></td>
<td>• Common units and assessments</td>
<td></td>
</tr>
<tr>
<td>4. Model with mathematics ★</td>
<td></td>
<td></td>
<td></td>
<td>• NWEA Test</td>
<td></td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
<td>• PARCC Released Test Problems</td>
<td></td>
</tr>
<tr>
<td>6. Attend to precision</td>
<td></td>
<td></td>
<td></td>
<td>• Performance Level Descriptors (PARCC)</td>
<td></td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Essential Knowledge and skills**
- Pythagorean theorem states that for a right triangle the sum of the square of the two legs is equal to the square of the hypotenuse. \((a^2 + b^2 = c^2)\)
- The converse of the Pythagorean theorem states that if the sum of the squares of the smaller sides in a triangle equals the square of the third side, then the triangle must be a right triangle.

**Example 1**
- Pythagorean Theorem: Students should verify, using a model, that the sum of the squares of the legs is equal to the square of the hypotenuse in a right triangle.

**Academic vocabulary**
- Converse
- Legs
- Hypotenuse
- Pythagorean theorem

**Mathematical Practices**
- Explanation of the Pythagorean Theorem and its converse.

**Major content**

**8.G.6** Explain a proof of the Pythagorean Theorem and its converse.

**Essential Knowledge and skills**
- Converse of Pythagorean Theorem: Students should also understand that if the sum of the squares of the 2 smaller legs of a triangle is equal to the square of the third leg, then the triangle is a right triangle.

**Example 2**
- The distance from Jonestown to Maryville is 180 miles, the distance from Maryville to Elm City is 300 miles, and the distance from Elm City to Jonestown is 240 miles. Do the three towns form a right triangle? Why or why not?
- Solution: If these three towns form a right triangle, then 300 would be the hypotenuse since it is the greatest distance.

\[
\begin{align*}
180^2 + 240^2 &= 300^2 \\
32400 + 57600 &= 90000 \\
90000 &= 90000 \checkmark
\end{align*}
\]
These three towns form a right triangle.

**PARCC Clarification**
- Sub Claim ___ Task ___
- Calculator - YES
- Assessment Problems: [http://www.illustrativemathematics.org/illustrations/724](http://www.illustrativemathematics.org/illustrations/724)

**TEACHER NOTES**
- Connect to radicals, rational exponents, and irrational numbers

**ASSESSMENT NOTES**
- See assessments in the introduction

**RESOURCE NOTES**
- See resources in the introduction

**ASSESSMENT NOTES**
- Refer to Algebra I @ Live Binder [http://www.livebinders.com/play/play/1171650](http://www.livebinders.com/play/play/1171650) for evidence statements and clarification
### M 8.G.7

**Essential Knowledge and skills**
- If a triangle is a right triangle, Pythagorean Theorem can be used to find a missing side length or hypotenuse.
- Real world problems in both two and three dimensions that involve right triangles can be solved using Pythagorean theorem.

**Example 1**
Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

- The Irrational Club wants to build a tree house. They have a 9-foot ladder that must be propped diagonally against the tree. If the base of the ladder is 5 feet from the bottom of the tree, how high will the tree house be off the ground?

**Solution:**

\[
\begin{align*}
9^2 &= 5^2 + c^2 \\
81 &= 25 + c^2 \\
56 &= c^2 \\
\sqrt{56} &= c
\end{align*}
\]

- Solution:

**Example 2**
Find the length of \(d\) in the figure to the right if \(a = 8\) in., \(b = 3\) in. and \(c = 4\) in.

**Solution:** First find the distance of the hypotenuse of the triangle formed with legs \(a\) and \(b\)

\[
\sqrt{73} = \text{length of base of a triangle with \(c\) as the other leg and \(d\) is the hypotenuse. To find the length of } d:\n\]

\[
\begin{align*}
\sqrt{73} &= d \\
73 &= d^2 \\
89 &= d^2 \\
\sqrt{89} &= d
\end{align*}
\]

**PARCC Clarification**

**Simple planar case**
- Tasks have “thin context” or no context.
- Tasks require students to find one side of a right triangle in the plane, given the other two sides.
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>8.G.8</td>
<td>Apply the Pythagorean Theorem to find the distance between two points in a coordinate system. <strong>Major content</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Essential Knowledge and skills**
- The distance between two points on a coordinate plane can be found by drawing the vertical and horizontal lines from the points to create a right triangle and then applying the Pythagorean theorem.

**Example 1**
- One application of the Pythagorean Theorem is finding the distance between two points on the coordinate plane. Students build on work from 6th grade (finding vertical and horizontal distances on the coordinate plane) to determine the lengths of the legs of the right triangle drawn connecting the points. Students understand that the line segment between the two points is the length of the hypotenuse.

**Academic vocabulary**
- Coordinate system
- Horizontal line
- Points
- Pythagorean Theorem
- Vertical line

**Mathematical Practices**

Sub Claim ___ Task ___
Assessment Problems:
- http://www.illustrativemathematics.org/illustrations/112
- http://www.illustrativemathematics.org/illustrations/1699
- http://www.illustrativemathematics.org/illustrations/655
- http://www.illustrativemathematics.org/illustrations/900
- http://www.illustrativemathematics.org/illustrations/902
- http://www.illustrativemathematics.org/illustrations/1130
- http://www.illustrativemathematics.org/illustrations/903

- In 50% of tasks, the answer is a whole number and is to be given as a whole number.
- In 50% of tasks, the answer is irrational and is to be given approximately to three decimal places.
- The testing interface can provide students with a calculation aid of the specified kind for these tasks.

- Simple three-dimensional
  - Tasks have “thin context” or no context.
  - Tasks require students to find one side of a right triangle in three dimensions, given information on a diagram that straightforwardly determines the other two sides.
  - In 50% of tasks, the answer is a whole number and is to be given as a whole number.
  - In 50% of tasks, the answer is irrational and is to be given approximately to three decimal places.
  - The testing interface can provide students with a calculation aid of the specified kind for these tasks.

- Calculator - **YES**
### Categories and Domains

**Unit:** Middletown Public Schools

**Clusters and Standards**

- **Middletown Public Schools**

<table>
<thead>
<tr>
<th>Categories and Domains</th>
<th>Unit</th>
<th>Clusters and Standards</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Algebra I Curriculum Grades 8-9</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Curriculum Writers:</strong> Gráinne Phelps, Paul Pignatelli, Deanna Smith, Gus Steppen, and Lisa Wood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8/20/2014</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Middletown Public Schools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Note: The use of the distance formula is not an expectation. Example 1:

1. Form a right triangle so that the given line segment is the hypotenuse.
2. Use Pythagorean Theorem to find the distance (length) between the two points.

#### Example 1

Find the length of $AB$.

**Solution:**

\[
\begin{align*}
  e^2 + f^2 &= c^2 \\
  35 + 39 &= c^2 \\
  74 &= c^2
\end{align*}
\]

#### Example 2

Find the distance between (-2, 4) and (-5, -6).

**Solution:**

The distance between -2 and -5 is the horizontal length; the distance between 4 and -6 is the vertical distance. Horizontal length: 3

Vertical length: 10

Students find area and perimeter of two-dimensional figures on the coordinate plane, finding the distance between each segment of the figure. (Limit one diagonal line, such as a right trapezoid or parallelogram)

**PARCC Clarification**

- The testing interface can provide students with a calculation aid of the specified kind for these tasks.

**Sub Claim A Task Type 1**

Assessment Problems:

[http://www.illustrativemathematics.org/illustrations/1556](http://www.illustrativemathematics.org/illustrations/1556)

**Calculator** - YES

### Statistics and Probability

**Interpreting Categorical and Quantitative Data (S-ID)**

<table>
<thead>
<tr>
<th>A</th>
<th>Students summarize, represent, and interpret data on a single count or measurement variable.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S-ID.1</strong></td>
<td>Represent data with plots on the real number line (dot plots, histograms, and box plots).</td>
</tr>
<tr>
<td><strong>Additional Content</strong></td>
<td>Essential Knowledge and Skills</td>
</tr>
<tr>
<td></td>
<td>Academic Vocabulary</td>
</tr>
</tbody>
</table>

**Teacher Notes**

- See instructional strategies in the introduction

**Resource Notes**

- See resources in the introduction

**Assessment Notes**

- Refer to Algebra I
### Categories and Domains

**Use Mathematical Practices to**
- 1. Make sense of problems and persevere in solving them
- 2. Reason abstractly and quantitatively
- 3. Construct viable arguments and critique the reasoning of others
- 4. Model with mathematics
- 5. Use appropriate tools strategically
- 6. Attend to precision
- 7. Look for and make use of structure
- 8. Look for and express regularity in repeated reasoning

**Examples**

**PARCC Clarification**

1. Use mathematical practices: Mathematical Practices
   1. Make sense of problems and persevere in solving them
   2. Reason abstractly and quantitatively
   3. Model with mathematics
   4. Use appropriate tools strategically
   5. Attend to precision

**Assessment Problems:**

**S-ID.2** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

**Essential Knowledge and Skills**
- The measure of center or variability that best interprets a data set will depend upon the shape of the data distribution and context of data collection.

**Examples**
- What measure of center or variability would best represent the data distribution for the height of basketball players on this team? Why?

**Basketball Team – Height of Players in inches for 2010-2011 Season**

75, 73, 76, 78, 79, 78, 79, 81, 80, 82, 81, 84, 82, 84, 80, 84

**Academic Vocabulary**
- Center median
- Data distribution
- Interquartile range
- Mean
- Skewed
- Spread
- Standard deviation
- Statistics

**Mathematical Practices**
- 1. Make sense of problems and persevere in solving
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>S-ID.3</strong> Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).** Additional content**</td>
<td>them 2. Reason abstractly and quantitatively 4. Model with mathematics 5. Use appropriate tools strategically 6. Attend to precision</td>
<td>Calculator - <strong>YES</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td><strong>PARCC Clarification</strong></td>
<td><strong>Sub Claim B, Task Type 1 (EOY)</strong></td>
<td><strong>Assessment Problems:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
<td>Extreme data points (outliers) can affect the shape, measures of center, and spread of a given data set.</td>
<td><strong>Academic vocabulary</strong></td>
<td>Extreme data point Outliers</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples</strong></td>
<td></td>
<td><strong>Mathematical Practices</strong></td>
<td>1. Make sense of problems and persevere in solving them 2. Reason abstractly and quantitatively 4. Model with mathematics 5. Use appropriate tools strategically 6. Attend to precision</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PARCC Clarification</strong></td>
<td><strong>NONE</strong></td>
<td><strong>Calculator - YES</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Statistics and Probability

#### Interpreting Categorical and Quantitative Data (8.SP)

- **Essential Knowledge and Skills**
  - Data that is collected using two variables is called bivariate data.
  - Scatterplots and two-way frequency tables are used to show patterns of association and relationships between bivariate categorical data.
  - Students recognize that not all data will have a linear association.

#### Examples

- Students recognize that not all data will have a linear association. Some associations will be non-linear as in the example below:

#### Data for 10 students’ Math and Science scores are provided in the chart. Describe the association between the Math and Science scores.

<table>
<thead>
<tr>
<th>Student</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Data for 10 students’ Math scores and the distance they live from school are provided in the table below. Describe the association between the Math scores and the distance they live from school.

<table>
<thead>
<tr>
<th>Student</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dist from school (miles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Data from a local fast food restaurant is provided showing the number of staff members and the average time for filling an order are provided in the table below. Describe the association between the number of staff and the average time for filling an order.

<table>
<thead>
<tr>
<th>Number of staff</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average time to fill orders (seconds)</td>
<td>180</td>
<td>138</td>
<td>120</td>
<td>108</td>
<td>96</td>
<td>84</td>
</tr>
</tbody>
</table>

#### The chart below lists the life expectancy in years for people in the United States every five years from 1970 to 2005. What would you expect the life expectancy of a person in the United States to be in 2020?
## CATEGORIES and DOMAINS

### UNIT

<table>
<thead>
<tr>
<th>Categories and Domains</th>
<th>Clusters and Standards</th>
<th>Middletown Public Schools</th>
<th>Instructional Strategies</th>
<th>Resources</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.SP.2</td>
<td>Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Supporting content

**Essential Knowledge and skills**

- Scatterplots can suggest a linear association/relationships.
- If a scatterplot suggests a linear relationship, then a line of best fit can be drawn and a linear equation can be created to model the relationship between the bivariate data.

**Examples:**

- The capacity of the fuel tank in a car is 13.5 gallons. The table below shows the number of miles traveled and how many gallons of gas are left in the tank. Describe the relationship between the variables. If the data is linear, determine a line of best fit. Do you think the line represents a good fit for the data set? Why or why not? What is the average fuel efficiency of the car in miles per gallon?

<table>
<thead>
<tr>
<th>Miles traveled</th>
<th>0</th>
<th>75</th>
<th>120</th>
<th>160</th>
<th>250</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallons used</td>
<td>0</td>
<td>2.3</td>
<td>4.5</td>
<td>5.7</td>
<td>9.7</td>
<td>10.7</td>
</tr>
</tbody>
</table>

**PARCC Clarification EOY**

- Tasks might have spreadsheet-like technology features such as the ability to adjust the position of a line and rotate it.
- Tasks do not require students to write or identify an equation.

### Sub Claim B Task Type 1

**Assessment Problems:**

- [http://www.illustrativemathematics.org/illustrations/41](http://www.illustrativemathematics.org/illustrations/41)
- [http://www.illustrativemathematics.org/illustrations/975](http://www.illustrativemathematics.org/illustrations/975)
- [http://www.illustrativemathematics.org/illustrations/1097](http://www.illustrativemathematics.org/illustrations/1097)
- [http://www.illustrativemathematics.org/illustrations/1520](http://www.illustrativemathematics.org/illustrations/1520)

**Academic vocabulary**

- Informally assess the model
- Informally fit a straight line
- Linear association
- Quantitative variables
- Scatter plots

**Mathematical Practices**

2. Reason abstractly and quantitatively
5. Use appropriate tools strategically
7. Look for and make use of structure
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
</table>
| 8 SP.3                  | Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. **Supporting content** | **Essential Knowledge and skills** | • An equation of a line of best fit can be used to interpret and solve problems in the context of bivariate measurement data. | **Academic vocabulary** | • Bivariate  
• Interpreting  
• Linear model  
• Measurement data | **Mathematical Practices**  
2. Reason abstractly and quantitatively  
4. Model with mathematics  
6. Attend to precision  
7. Look for and make use of structure |
|                        | **Examples** | | • For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.  
• In a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.  
• Given data from students’ math scores and absences, make a scatterplot. | **Academic vocabulary** | • Bivariate  
• Interpreting  
• Linear model  
• Measurement data | **Mathematical Practices**  
2. Reason abstractly and quantitatively  
4. Model with mathematics  
6. Attend to precision  
7. Look for and make use of structure |
|                        | **Essential Knowledge and skills** | | • Draw a line of best fit, paying attention to the closeness of the data points on either side of the line | | | |
|                        | **Examples** | | • From the line of best fit, determine an approximate linear equation that models the given data (about $y = \frac{25}{3}x + 95$)  
• Students should recognize that 95 represents the y intercept and $\frac{25}{3}$ represents the slope of the line.  
• Students can use this linear model to solve problems. For example, through substitution, they can use the equation to | | | |
| Assessment Problems:   | http://www.illustrativemathematics.org/illustrations/41  
http://www.illustrativemathematics.org/illustrations/1520  
http://www.illustrativemathematics.org/illustrations/1558 | | | | | |
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>determine that a student with 4 absences should expect to receive a math score of about 62. They can then compare this value to their line.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PARCC Clarification EOY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tasks are word problems based on bivariate measurement data that require students to use the equation of a linear model.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The testing interface can provide students with a calculation aid of the specified kind for these tasks.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim B Task Type 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td>Calculator - YES</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="http://www.illustrativemathematics.org/illustrations/1370">http://www.illustrativemathematics.org/illustrations/1370</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.SP.A</td>
<td>Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. <strong>Supporting content</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Understand that a two-way table provides a way to organize data between two categorical variables. Data for both categories needs to be collected from each subject. Students calculate the relative frequencies to describe associations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The table illustrates the results when 100 students were asked the survey questions: Do you have a curfew? and Do you have assigned chores? Is there evidence that those who have a curfew also tend to have chores?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Solution:</strong> Of the students who answered that they had a curfew, 40 had</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Academic vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bivariate categorical data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequencies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patterns of association</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relative frequencies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two categorical variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two-way table</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mathematical Practices</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Model with mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Look for and make</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
chores and 10 did not. Of the students who answered they did not have a curfew, 10 had chores and 40 did not. From this sample, there appears to be a positive correlation between having a curfew and having chores.

PARCC Clarification

- One-third of tasks involve basic comprehension questions about a two-way table, such as “How many students who don’t have chores have a curfew?”
- One-third of tasks involve computing marginal sums or marginal percentages.
- One third of tasks involve interpretation or patterns of association.
- Tasks that require finding missing values within the categories are excluded.
- Tasks are limited to two-by-two tables.
- The testing interface can provide students with a calculation aid of the specified kind for these tasks.

Sub Claim B Task Type 1

Assessment Problems:
- http://www.illustrativemathematics.org/illustrations/973
- http://www.illustrativemathematics.org/illustrations/1098

Students summarize, represent, and interpret data on two categorical and quantitative variables.

S-ID.5 Summarize categorical data for two categories in two-way frequency tables.

Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies).

Recognize possible associations and trends in the data.

Supporting content

Essential Knowledge and skills

- Two-way frequency tables can be used to interpret joint, marginal and conditional relative frequencies of categorical data.

Examples

PARCC Clarification

NONE

TEACHER NOTES

See instructional strategies in the introduction

Employ mathematics best practice strategies e.g.

- using manipulatives
- facilitating cooperative group work
- discussing mathematics
- questioning and making conjectures
- justifying of thinking
- writing about mathematics
- facilitating problem solving approach to

RESOURCE NOTES

See resources in the introduction

Refer to Algebra I @ Live Binder

http://www.livebinders.com/play/play/1171650

for evidence statements and clarification

ASSESSMENT NOTES

REQUIRED ASSESSMENTS

- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S-ID.6</td>
<td>Relative marginal frequencies, Two-way frequency tables</td>
<td>instruction, integrating content, using calculators and computers, facilitating learning, using assessment to modify instruction</td>
<td>Calculator - YES</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mathematical Practices 1. Make sense of problems and persevere in solving them 5. Use appropriate tools strategically 7. Look for and make use of structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Claim B, Task Type 1 (EOY) Assessment Problems:</td>
<td></td>
<td>Mathematically fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. (S-ID.6a) (linear focus)</td>
<td>TEACHER NOTES Linear focus; discuss general principle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-ID.6</td>
<td>Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Supporting content a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. (S-ID.6a) (linear focus)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essential Knowledge and skills</td>
<td></td>
<td>Scatter plots of data sets can be used to identify the type of function that best represents the shape of the data (linear, quadratic or exponential).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARCC Clarification</td>
<td>NONE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic vocabulary</td>
<td></td>
<td>Line of best fit, Quantitative data, Scatter plot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculator - YES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATEGORIES and DOMAINS</td>
<td>UNIT</td>
<td>CLUSTERS and STANDARDS</td>
<td>Middletown Public Schools</td>
<td>INSTRUCTIONAL STRATEGIES</td>
<td>RESOURCES</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
<td>------------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Informally assess the fit of a function by plotting and analyzing residuals. (S-ID.6b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Residuals (lines of regressions) are drawn on scatter plots in order to informally assess the fit of a function to a data set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PARCC Clarification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Academic vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Residuals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mathematical Practices</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Model with mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Attend to precision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim __ , Task Type __ (EOY)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Fit a linear function for a scatter plot that suggests a linear association. (S-ID.6c)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Essential Knowledge and skills</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If a scatter plot has a linear association, then a line of best fit can be drawn to interpret the data set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Measure the wrist and neck size of each person in your class and make a scatter plot. Find the least squares regression line. Calculate and interpret the correlation coefficient for this linear regression model. Graph the residuals and evaluate the fit of the linear equation. Use the line of best fit to predict the wrist size for a person not in your class.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PARCC Clarification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Academic vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Linear association</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Linear function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mathematical Practices</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Model with mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Attend to precision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATEGORIES and DOMAINS</td>
<td>UNIT</td>
<td>CLUSTERS and STANDARDS Middletown Public Schools</td>
<td>INSTRUCTIONAL STRATEGIES</td>
<td>RESOURCES</td>
<td>ASSESSMENTS</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
<td>--------------------------------------------------</td>
<td>--------------------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>STATISTICS AND PROBABILITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpreting Categorical and Quantitative Data (S-ID)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use Mathematical Practices to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Model with mathematics ★</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Attend to precision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sub Claim __ , Task Type __ (EOY)**

**Assessment Problems:**

**S-ID.7** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. **Major content**

**Essential Knowledge and skills**
- If a scatter plot has a linear association, then a linear model can be drawn and used to identify and interpret the meaning of the slope (constant rate of change) and the intercept (constant term) between the data sets.

**Examples**
- Lisa lights a candle and records its height in inches every hour. The results recorded as (time, height) are (0, 20), (1, 18.3), (2, 16.6), (3, 14.9), (4, 13.2), (5, 11.5), (7, 8.1), (9, 4.7), and (10, 3). Express the candle's height (h) as a function of time (t) and state the meaning of the slope and the intercept in terms of the burning candle.

**Solution:**
- $h = -1.7t + 20$
- Slope: The candle's height decreases by 1.7 inches for each hour it is burning.
- Intercept: Before the candle begins to burn, its height is 20 inches.

**PARCC Clarification**
- NONE

**Assessment Problems:**

**S-ID.8** Compute (using technology) and interpret the correlation coefficient of a linear fit. **Major content**

**Essential Knowledge and skills**
- Technology is used to compute and interpret the correlation coefficient (the slope) of a linear model.

**Academic vocabulary**
- Correlation coefficient

**Mathematical Practices**
- Statistical evidence
- Calculating
- Interpreting
- Using technology

**TEACHER NOTES**
- See instructional strategies in the introduction
- Refer to Algebra I @ Live Binder

**REQUIRED ASSESSMENTS**
- Assessment problems
- Common units and assessments
- NWEA Test
- PARCC Released Test Problems
- Performance Level Descriptors (PARCC)
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS Middletown Public Schools</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Examples</td>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Collect height, shoe-size, and wrist circumference data for each student. Determine the best way to display the data. Answer the following questions: Is there a correlation between any two of the three indicators? Is there a correlation between all three indicators? What patterns and trends are apparent in the data? What inferences can be made from the data?</td>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PARCC Clarification</td>
<td>4. Model with mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NONE</td>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim __, Task Type __ (EOY)</td>
<td>6. Attend to precision</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>S-ID.9 Distinguish between correlation and causation. Major content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essential Knowledge and skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A correlation does not necessarily mean there is causation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examples</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Diane did a study for a health class about the effects of a student’s end-of-year math test scores on height. Based on a graph of her data, she found that there was a direct relationship between students’ math scores and height. She concluded “doing well on your end-of-year math tests makes you tall.” Is this conclusion justified? Explain any flaws in Diane’s reasoning.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PARCC Clarification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Claim __, Task Type __ (EOY)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Problems:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assessment Problems:

S-ID.9 Distinguish between correlation and causation. Major content

Essential Knowledge and skills

• A correlation does not necessarily mean there is causation.

Examples

• Diane did a study for a health class about the effects of a student’s end-of-year math test scores on height. Based on a graph of her data, she found that there was a direct relationship between students’ math scores and height. She concluded “doing well on your end-of-year math tests makes you tall.” Is this conclusion justified? Explain any flaws in Diane’s reasoning.

PARCC Clarification

• NONE

Sub Claim __, Task Type __ (EOY)

Assessment Problems:

Academic vocabulary

• Causation

• Correlation

Mathematical Practices

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision

Calculator -
<table>
<thead>
<tr>
<th>CATEGORIES and DOMAINS</th>
<th>UNIT</th>
<th>CLUSTERS and STANDARDS</th>
<th>INSTRUCTIONAL STRATEGIES</th>
<th>RESOURCES</th>
<th>ASSESSMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MODELING ★</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choosing and using appropriate mathematics and statistics to analyze empirical situations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use Mathematical Practices to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Make sense of problems and persevere in solving them</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Model with mathematics ★</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Use appropriate tools strategically</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Attend to precision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Look for and make use of structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Students**

Understand and use **descriptive modeling** which simply describes the phenomena or summarizes them in a compact form. Graphs of observations are a familiar descriptive model - for example, graphs of global temperature and atmospheric CO$_2$ over time.

- Explain multiple approaches that lead to equivalent results when solving problems. (6.3.2)

Understand that **analytical modeling** seeks to explain data on the basis of deeper theoretical ideas, albeit with parameters that are empirically based; for example, exponential growth of bacterial colonies (until cut-off mechanics such as pollution or starvation intervene) follows a constant reproduction rate. Functions are an important tool for analyzing such problems.

Use graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry software as powerful tools that can be used to model purely mathematical phenomena (e.g. the behavior of polynomials) as well as physical phenomena.

- Use technology whenever appropriate to solve real-world problems (e.g., personal finance, wages, banking and credit, home improvement problems, measurement, taxes, business situations, purchasing, and transportation) (5.1.2)

Understands and use the basic **modeling cycle ★**:  
- **Problem**: Identifying variables in the situation and selecting those that represent essential features
- **Formulate**: formulating a model by creating and selecting geometric, graphical, tabular, algebraic or statistical representations that describe relationships between the variables
- **Compute**: analyzing and performing operations on these relationships to draw conclusions
- **Interpret**: interpreting the results of the mathematics in terms of the original situation
- **Validate**: validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable
- **Report**: reporting on the conclusions and the reasoning behind them.

![Modeling Cycle Diagram](image)