Academic Standards for Mathematics

Grades Pre K – High School
March 1, 2014

Pennsylvania Department of Education

PA CORE STANDARDS
Mathematics

INTRODUCTION

The Pennsylvania Core Standards in Mathematics in grades PreK–5 lay a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions, and decimals. Taken together, these elements support a student's ability to learn and apply more demanding math concepts and procedures. The middle school and high school standards call on students to practice applying mathematical ways of thinking to real world issues and challenges; they prepare students to think and reason mathematically. Additionally, they set a rigorous definition of college and career readiness by demanding that students develop a depth of understanding and ability to apply mathematics to novel situations, as college students and employees regularly do. Although the **standards are not a curriculum** or a prescribed series of activities, school entities will use them to develop a local school curriculum that will meet local students' needs.

This document includes PA Core Standards for **Mathematical Content** and **Mathematical Practice**. The mathematics standards define what students should understand and be able to do. Mathematical Practice Standards describes the habits of mind required to reach a level of mathematical proficiency.

PA Core Standards ***Mathematical Content and Mathematical Practice***		
Standards for Mathematical Content		**Standards for Mathematical Practice**
2.1 Numbers and Operations *A) Counting and Cardinality* *B) Numbers and Operations in Base Ten* *C) Numbers and Operations—Fractions* *D) Ratios and Proportional Relationships* *E) The Number System* *F) Number and Quantity*		• *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.* • *Attend to precision.* • *Look for and make use of structure.* • *Look for and make sense of regularity in repeated reasoning.*
2.2 Algebraic Concepts *A) Operations and Algebraic Thinking* *B) Expressions & Equations* *C) Functions* *D) Algebra*		
2.3 Geometry *A) Geometry*		
2.4 Measurement, Data, and Probability *A) Measurement and Data* *B) Statistics and Probability*		

Standards cannot be viewed or addressed in isolation, as each standard depends upon or may lead into multiple standards across grades; thus, it is imperative that educators are familiar with both the standards that come before and those that follow a particular grade level. These revised standards reflect instructional shifts that cannot occur without the integrated emphasis on content and practice.

Standards are overarching statements of what a proficient math student should know and be able to do. The Pennsylvania Assessment Anchors and Eligible Content closely align with the revised standards and are an invaluable source for greater detail.

Key Points in Mathematics

- The standards stress both procedural skills and conceptual understanding to ensure students are learning and applying the critical information they need to succeed at higher levels.

- K–5 standards, which provide students with a *solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions, and decimals*, help young students build the foundation to successfully apply more demanding math concepts and procedures, and move into application. They also provide detailed guidance to teachers on how to navigate their way through topics such as *fractions, negative numbers, and geometry*, and do so by maintaining a continuous progression from grade to grade.

- Having built a strong foundation at K–5, students can do hands-on learning in geometry, algebra, and probability and statistics. Students who have mastered the content and skills through the seventh grade will be *well-prepared for algebra* in grade 8.

- High school standards emphasize *practicing applying mathematical ways of thinking to real world issues and challenges*.

PA CORE STANDARDS
Mathematics

The PA Core Standards for Mathematics detail four standard areas: *Numbers and Operations*, *Algebraic Concepts*, *Geometry*, and *Measurement, Data, and Probability*. These standard areas are reflective of the reporting categories in the PA Core Assessment Anchors and Eligible Content. The intent of this document is to provide a useful tool for designing curriculum, instruction, and assessment. The grade level curriculum and instructional shifts in mathematics cannot occur without the integrated emphasis on content and practice. The chart below illustrates the four standard areas and the development and progression of the strands, with an understanding that all is framed around the Standards for Mathematical Practice.

<table>
<tr><th colspan="13">Mathematical Standards: Development and Progression</th></tr>
<tr><td colspan="13">Standards for Mathematical Practice</td></tr>
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<tr><td></td><td>PreK</td><td>K</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td colspan="2">HS</td></tr>
<tr><td rowspan="3">2.1 Numbers and Operations</td><td colspan="2">(A) Counting & Cardinality</td><td colspan="10"></td></tr>
<tr><td></td><td colspan="5">(B) Numbers and Operations in Base Ten</td><td colspan="3">(D) Ratios and Proportional Relationships</td><td></td><td colspan="2">(F) Number and Quantity</td></tr>
<tr><td colspan="4"></td><td colspan="4">(C) Numbers and Operations — Fractions</td><td colspan="3">(E) The Number System</td><td colspan="2"></td></tr>
<tr><td rowspan="2">2.2 Algebraic Concepts</td><td colspan="7">(A) Operations and Algebraic Thinking</td><td colspan="4">(B) Expressions and Equations</td><td colspan="2">(D) Algebra</td></tr>
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<tr><td>2.3 Geometry</td><td colspan="12">(A) Geometry</td></tr>
<tr><td>2.4 Measurement, Data, and Probability</td><td colspan="7">(A) Measurement and Data</td><td colspan="5">(B) Statistics and Probability</td></tr>
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2.1 Numbers and Operations

The Standards of Mathematical Practices

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	Grade PreK 2.1.PreK	Grade K 2.1.K	Grade 1 2.1.1	Grade 2 2.1.2	Grade 3 2.1.3	Grade 4 2.1.4	Grade 5 2.1.5
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:							
(A) Counting & Cardinality	**CC.2.1.PreK.A.1** Know number names and the count sequence. **CC.2.1.PreK.A.2** Count to tell the number of objects. **CC.2.1.PreK.A.3** Compare numbers.	**CC.2.1.K.A.1** Know number names and write and recite the count sequence. **CC.2.1.K.A.2** Apply one-to-one correspondence to count the number of objects. **CC.2.1.K.A.3** Apply the concept of magnitude to compare numbers and quantities.	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*
(B) Numbers & Operations in Base Ten	*Intentionally Blank*	**CC.2.1.K.B.1** Use place value to compose and decompose numbers within 19.	**CC.2.1.1.B.1** Extend the counting sequence to read and write numerals to represent objects.	**CC.2.1.2.B.1** Use place-value concepts to represent amounts of tens and ones and to compare three digit numbers.	**CC.2.1.3.B.1** Apply place-value understanding and properties of operations to perform multi-digit arithmetic. M03.A-T.1.1.1 M03.A-T.1.1.2 M03.A-T.1.1.3 M03.A-T.1.1.4	**CC.2.1.4.B.1** Apply place-value concepts to show an understanding of multi-digit whole numbers. M04.A-T.1.1.1 M04.A-T.1.1.2 M04.A-T.1.1.3 M04.A-T.1.1.4	**CC.2.1.5.B.1** Apply place-value concepts to show an understanding of operations and rounding as they pertain to whole numbers and decimals. M05.A-T.1.1.1 M05.A-T.1.1.2 M05.A-T.1.1.3 M05.A-T.1.1.4 M05.A-T.1.1.5
		Intentionally Blank	**CC.2.1.1.B.2** Use place-value concepts to represent amounts of tens and ones and to compare two digit numbers.	**CC.2.1.2.B.2** Use place-value concepts to read, write, and skip count to 1000.	*Intentionally Blank*	**CC.2.1.4.B.2** Use place-value understanding and properties of operations to perform multi-digit arithmetic. M04.A-T.2.1.1 M04.A-T.2.1.2 M04.A-T.2.1.3 M04.A-T.2.1.4	**CC.2.1.5.B.2** Extend an understanding of operations with whole numbers to perform operations including decimals. M05.A-T.2.1.1 M05.A-T.2.1.2 M05.A-T.2.1.3
			CC.2.1.1.B.3 Use place-value concepts and properties of operations to add and subtract within 100.	**CC.2.1.2.B.3** Use place-value understanding and properties of operations to add and subtract within 1000.	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*

2.1 Numbers and Operations

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	Grade PreK 2.1.PreK	Grade K 2.1.K	Grade 1 2.1.1	Grade 2 2.1.2	Grade 3 2.1.3	Grade 4 2.1.4	Grade 5 2.1.5
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:							
(C) Numbers & Operations — Fractions	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	**CC.2.1.3.C.1** Explore and develop an understanding of fractions as numbers. M03.A-F.1.1.1 M03.A-F.1.1.2 M03.A-F.1.1.3 M03.A-F.1.1.4 M03.A-F.1.1.5	**CC.2.1.4.C.1** Extend the understanding of fractions to show equivalence and ordering. M04.A-F.1.1.1 M04.A-F.1.1.2	**CC.2.1.5.C.1** Use the understanding of equivalency to add and subtract fractions. M05.A-F.1.1.1
					Intentionally Blank	**CC.2.1.4.C.2** Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers. M04.A-F.2.1.1 M04.A-F.2.1.2 M04.A-F.2.1.3 M04.A-F.2.1.4 M04.A-F.2.1.5 M04.A-F.2.1.6 M04.A-F.2.1.7	**CC.2.1.5.C.2** Apply and extend previous understandings of multiplication and division to multiply and divide fractions. M05.A-F.2.1.1 M05.A-F.2.1.2 M05.A-F.2.1.3 M05.A-F.2.1.4
					Intentionally Blank	**CC.2.1.4.C.3** Connect decimal notation to fractions, and compare decimal fractions (base 10 denominator, e.g., 19/100). M04.A-F.3.1.1 M04.A-F.3.1.2 M04.A-F.3.1.3	*Intentionally Blank*

2.2 Algebraic Concepts

The Standards of Mathematical Practices

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	Grade PreK 2.2.PreK	Grade K 2.2.K	Grade 1 2.2.1	Grade 2 2.2.2	Grade 3 2.2.3	Grade 4 2.2.4	Grade 5 2.2.5
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:							
(A) Operations and Algebraic Thinking	**CC.2.2.PreK.A.1** Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.	**CC.2.2.K.A.1** Extend the concepts of putting together and taking apart to add and subtract within 10.	**CC.2.2.1.A.1** Represent and solve problems involving addition and subtraction within 20.	**CC.2.2.2.A.1** Represent and solve problems involving addition and subtraction within 100.	**CC.2.2.3.A.1** Represent and solve problems involving multiplication and division. M03.B-O.1.1.1 M03.B-O.1.1.2 M03.B-O.1.2.1 M03.B-O.1.2.2	**CC.2.2.4.A.1** Represent and solve problems involving the four operations. M04.B-O.1.1.1 M04.B-O.1.1.2 M04.B-O.1.1.3 M04.B-O.1.1.4	**CC.2.2.5.A.1** Interpret and evaluate numerical expressions using order of operations. M05.B-O.1.1.1 M05.B-O.1.1.2
	Intentionally Blank	*Intentionally Blank*	**CC.2.2.1.A.2** Understand and apply properties of operations and the relationship between addition and subtraction.	**CC.2.2.2.A.2** Use mental strategies to add and subtract within 20.	**CC.2.2.3.A.2** Understand properties of multiplication and the relationship between multiplication and division. M03.B-O.2.1.1 M03.B-O.2.1.2 M03.B-O.2.2.1	**CC.2.2.4.A.2** Develop and/or apply number theory concepts to find factors and multiples. M04.B-O.2.1.1	*Intentionally Blank*
	Intentionally Blank	*Intentionally Blank*	*Intentionally Blank*	**CC.2.2.2.A.3** Work with equal groups of objects to gain foundations for multiplication.	**CC.2.2.3.A.3** Demonstrate multiplication and division fluency.	*Intentionally Blank*	*Intentionally Blank*
	Intentionally Blank	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	**CC.2.2.3.A.4** Solve problems involving the four operations, and identify and explain patterns in arithmetic. M03.B-O.3.1.1 M03.B-O.3.1.2 M03.B-O.3.1.3 M03.B-O.3.1.4 M03.B-O.3.1.5 M03.B-O.3.1.6 M03.B-O.3.1.7	**CC.2.2.4.A.4** Generate and analyze patterns using one rule. M04.B-O.3.1.1 M04.B-O.3.1.2 M04.B-O.3.1.3	**CC.2.2.5.A.4** Analyze patterns and relationships using two rules. M05.B-O.2.1.1 M05.B-O.2.1.2

2.3 Geometry

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	Grade PreK 2.3.PreK	Grade K 2.3.K	Grade 1 2.3.1	Grade 2 2.3.2	Grade 3 2.3.3	Grade 4 2.3.4	Grade 5 2.3.5
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:							
(A) Geometry	**CC.2.3.PreK.A.1** Identify and describe shapes.	**CC.2.3.K.A.1** Identify and describe two- and three-dimensional shapes.	**CC.2.3.1.A.1** Compose and distinguish between two- and three-dimensional shapes based on their attributes.	**CC.2.3.2.A.1** Analyze and draw two- and three-dimensional shapes having specified attributes.	**CC.2.3.3.A.1** Identify, compare, and classify shapes and their attributes. M03.C-G.1.1.1 M03.C-G.1.1.2	**CC.2.3.4.A.1** Draw lines and angles and identify these in two-dimensional figures. M04.C-G.1.1.1	**CC.2.3.5.A.1** Graph points in the first quadrant on the coordinate plane and interpret these points when solving real world and mathematical problems. M05.C-G.1.1.1 M05.C-G.1.1.2
	CC.2.3.PreK.A.2 Analyze, compare, create, and compose shapes.	**CC.2.3.K.A.2** Analyze, compare, create, and compose two- and three-dimensional shapes.	**CC.2.3.1.A.2** Use the understanding of fractions to partition shapes into halves and quarters.	**CC.2.3.2.A.2** Use the understanding of fractions to partition shapes into halves, quarters, and thirds.	**CC.2.3.3.A.2** Use the understanding of fractions to partition shapes into parts with equal areas and express the area of each part as a unit fraction of the whole. M03.C-G.1.1.3	**C.2.3.4.A.2** Classify two-dimensional figures by properties of their lines and angles. M04.C-G.1.1.2	**CC.2.3.5.A.2** Classify two-dimensional figures into categories based on an understanding of their properties. M05.C-G.2.1.1
	Intentionally Blank	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	**CC.2.3.4.A.3** Recognize symmetric shapes and draw lines of symmetry. M04.C-G.1.1.3	*Intentionally Blank*

2.4 Measurement, Data, and Probability

The Standards of Mathematical Practices

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	Grade PreK 2.4.PreK	Grade K 2.4.K	Grade 1 2.4.1	Grade 2 2.4.2	Grade 3 2.4.3	Grade 4 2.4.4	Grade 5 2.4.5
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:							
(A)Measurement and Data	**CC.2.4.PreK.A.1** Describe and compare measurable attributes of length and weight of everyday objects.	**CC.2.4.K.A.1** Describe and compare attributes of length, area, weight, and capacity of everyday objects.	**CC.2.4.1.A.1** Order lengths and measure them both indirectly and by repeating length units.	**CC.2.4.2.A.1** Measure and estimate lengths in standard units using appropriate tools.	**CC.2.4.3.A.1** Solve problems involving measurement and estimation of temperature, liquid volume, mass, and length. M03.D-M.1.2.1 M03.D-M.1.2.2 M03.D-M.1.2.3	**CC.2.4.4.A.1** Solve problems involving measurement and conversions from a larger unit to a smaller unit. M04.D-M.1.1.1 M04.D-M.1.1.2 M04.D-M.1.1.3 M04.D-M.1.1.4	**CC.2.4.5.A.1** Solve problems using conversions within a given measurement system. M05.D-M.1.1.1
	Intentionally Blank	*Intentionally Blank*	**CC.2.4.1.A.2** Tell and write time to the nearest half hour using both analog and digital clocks.	**CC.2.4.2.A.2** Tell and write time to the nearest five minutes using both analog and digital clocks.	**CC.2.4.3.A.2** Tell and write time to the nearest minute and solve problems by calculating time intervals. M03.D-M.1.1.1 M03.D-M.1.1.2	**CC.2.4.4.A.2** Translate information from one type of data display to another. M04.D-M.2.1.3	**CC.2.4.5.A.2** Represent and interpret data using appropriate scale. M05.D-M.2.1.2
	Intentionally Blank	*Intentionally Blank*	*Intentionally Blank*	**CC.2.4.2.A.3** Solve problems and make change using coins and paper currency with appropriate symbols.	**CC.2.4.3.A.3** Solve problems and make change involving money using a combination of coins and bills. M03.D-M.1.3.1 M03.D-M.1.3.2 M03.D-M.1.3.3	*Intentionally Blank*	*Intentionally Blank*

2.4 Measurement, Data, and Probability

The Standards of Mathematical Practices

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Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:							
(A) Measurement and Data	**CC.2.4.PreK.A.4** Classify objects and count the number of objects in each category.	**CC.2.4.K.A.4** Classify objects and count the number of objects in each category.	**CC.2.4.1.A.4** Represent and interpret data using tables/charts.	**CC.2.4.2.A.4** Represent and interpret data using line plots, picture graphs, and bar graphs.	**CC.2.4.3.A.4** Represent and interpret data using tally charts, tables, pictographs, line plots, and bar graphs. M03.D-M.2.1.1 M03.D-M.2.1.2 M03.D-M.2.1.3 M03.D-M.2.1.4	**CC.2.4.4.A.4** Represent and interpret data involving fractions using information provided in a line plot. M04.D-M.2.1.1 M04.D-M.2.1.2	**CC.2.4.5.A.4** Solve problems involving computation of fractions using information provided in a line plot. M05.D-M.2.1.1
	Intentionally Blank	*Intentionally Blank*	*Intentionally Blank*	*Intentionally Blank*	**CC.2.4.3.A.5** Determine the area of a rectangle and apply the concept to multiplication and to addition. M03.D-M.3.1.1 M03.D-M.3.1.2	*Intentionally Blank*	**CC.2.4.5.A.5** Apply concepts of volume to solve problems and relate volume to multiplication and to addition. M05.D-M.3.1.1 M05.D-M.3.1.2
				CC.2.4.2.A.6 Extend the concepts of addition and subtraction to problems involving length.	**CC.2.4.3.A.6** Solve problems involving perimeters of polygons and distinguish between linear and area measures. M03.D-M.4.1.1	**CC.2.4.4.A.6** Measure angles and use properties of adjacent angles to solve problems. M04.D-M.3.1.1 M04.D-M.3.1.2	*Intentionally Blank*

2.1. Numbers and Operations

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	2.1.6 Grade 6	2.1.7 Grade 7	2.1.8 Grade 8		2.1.HS High School
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(D) Ratios & Proportional Relationships	**CC.2.1.6.D.1** Understand ratio concepts and use ratio reasoning to solve problems. M06.A-R.1.1.1 M06.A-R.1.1.2 M06.A-R.1.1.3 M06.A-R.1.1.4 M06.A-R.1.1.5	**CC.2.1.7.D.1** Analyze proportional relationships and use them to model and solve real-world and mathematical problems. M07.A-R.1.1.1 M07.A-R.1.1.2 M07.A-R.1.1.3 M07.A-R.1.1.4 M07.A-R.1.1.5 M07.A-R.1.1.6	*Intentionally Blank*	**(F) Number and Quantity**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. A1.1.1.1.1, A1.1.1.1.2, A1.1.1.3.1, A2.1.2.1.1, A2.1.2.1.2, A2.1.2.1.3, A2.1.2.1.4 **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. A1.1.1.1.1, A1.1.1.1.2, A1.1.1.3.1, A1.1.1.2.1 **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.2.1.2.1, A1.2.1.2.2, A2.2.2.1.1, A2.2.2.1.2, A2.2.3.1.1, A2.2.3.1.2 **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.2.1.2.1, A1.2.1.2.2, A2.2.2.1.1, A2.2.2.1.2 **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A1.1.3.2.1, A1.1.3.2.2, A2.2.3.1.1, A2.2.3.1.2 **CC.2.1.HS.F.6** Extend the knowledge of arithmetic operations and apply to complex numbers. A2.1.1.1.1, A2.1.1.1.2, A2.1.1.2.1, A2.1.1.2.2 **CC.2.1.HS.F.7** Apply concepts of complex numbers in polynomial identities and quadratic equations to solve problems. A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4
(E) The Number System	**CC.2.1.6.E.1** Apply and extend previous understandings of multiplication and division to divide fractions by fractions. M06.A-N.1.1.1	**CC.2.1.7.E.1** Apply and extend previous understandings of operations with fractions to operations with rational numbers. M07.A-N.1.1.1 M07.A-N.1.1.2 M07.A-N.1.1.3	**CC.2.1.8.E.1** Distinguish between rational and irrational numbers using their properties. M08.A-N.1.1.1 M08.A-N.1.1.2 A1.1.1.1.1 A1.1.1.1.2		
	CC.2.1.6.E.2 Identify and choose appropriate processes to compute fluently with multi-digit numbers. M06.A-N.2.1.1				
	CC.2.1.6.E.3 Develop and/or apply number theory concepts to find common factors and multiples. M06.A-N.2.2.1 M06.A-N.2.2.2 A1.1.1.2.1	*Intentionally Blank*	*Intentionally Blank*		

2.1. Numbers and Operations

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Construct viable arguments and critique the reasoning of others.	Model with mathematics.
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	2.1.6 Grade 6	2.1.7 Grade 7	2.1.8 Grade 8		2.1.HS High School
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
	CC.2.1.6.E.4 Apply and extend previous understandings of numbers to the system of rational numbers. M06.A-N.3.1.1 M06.A-N.3.1.2 M06.A-N.3.1.3 M06.A-N.3.2.1 M06.A-N.3.2.2 M06.A-N.3.2.3	*Intentionally Blank*	**CC.2.1.8.E.4** Estimate irrational numbers by comparing them to rational numbers. M08.A-N.1.1.3 M08.A-N.1.1.4 M08.A-N.1.1.5 A1.1.1.1.1		

2.2. Algebraic Concepts

The Standards of Mathematical Practices

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.
Attend to precision.
Look for and make use of structure.
Look for and express regularity in repeated reasoning.

	2.2.6 Grade 6	2.2.7 Grade 7	2.2.8 Grade 8		2.2.HS High School
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(B) Expressions and Equations	**CC.2.2.6.B.1** Apply and extend previous understandings of arithmetic to algebraic expressions. M06.B-E.1.1.1 M06.B-E.1.1.2 M06.B-E.1.1.3 M06.B-E.1.1.4 M06.B-E.1.1.5	**CC.2.2.7.B.1** Apply properties of operations to generate equivalent expressions. M07.B-E.1.1.1	**CC.2.2.8.B.1** Apply concepts of radicals and integer exponents to generate equivalent expressions. M08.B-E.1.1.1 M08.B-E.1.1.2 M08.B-E.1.1.3 M08.B-E.1.1.4 A1.1.1.3.1	**(D) Algebra**	**CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.2.1, A2.1.2.2.2 **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.1.1, A2.1.2.1.2, A2.1.2.1.3, A2.1.2.1.4, A2.1.2.2.1, A2.1.2.2.2 **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.2.1, A2.1.2.2.2 **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. A2.1.2.2.1, A2.1.2.2.2 **CC.2.2.HS.D.5** Use polynomial identities to solve problems. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.2.1, A2.1.2.2.2, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4 **CC.2.2.HS.D.6** Extend the knowledge of rational functions to rewrite in equivalent forms. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4 **CC.2.2.HS.D.7** Create and graph equations or inequalities to describe numbers or relationships. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A1.1.3.2.1, A1.1.3.2.2, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4 **CC.2.2.HS.D.8** Apply inverse operations to solve equations or formulas for a given variable. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2 **CC.2.2.HS.D.9** Use reasoning to solve equations and justify the solution method. A1.1.1.4.1, A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2 **CC.2.2.HS.D.10** Represent, solve, and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A1.1.3.2.1, A1.1.3.2.2, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4
	CC.2.2.6.B.2 Understand the process of solving a one-variable equation or inequality and apply it to real-world and mathematical problems. M06.B-E.2.1.1 M06.B-E.2.1.2 M06.B-E.2.1.3 M06.B-E.2.1.4	*Intentionally Blank*	**CC.2.2.8.B.2** Understand the connections between proportional relationships, lines, and linear equations. M08.B-E.2.1.1 M08.B-E.2.1.2 M08.B-E.2.1.3 A1.2.1.2.2		
	CC.2.2.6.B.3 Represent and analyze quantitative relationships between dependent and independent variables. M06.B-E.3.1.1 M06.B-E.3.1.2	**CC.2.2.7.B.3** Model and solve real-world and mathematical problems by using and connecting numerical, algebraic, and/or graphical representations. M07.B-E.2.1.1 M07.B-E.2.2.1 M07.B-E.2.2.2 M07.B-E.2.3.1 A1.1.1.4.1	**CC.2.2.8.B.3** Analyze and solve linear equations and pairs of simultaneous linear equations. M08.B-E.3.1.1 M08.B-E.3.1.2 M08.B-E.3.1.3 M08.B-E.3.1.4 M08.B-E.3.1.5 A1.1.2.1.1 A1.1.2.2.1 A1.1.2.2.2		

2.2. Algebraic Concepts

The Standards of Mathematical Practices

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Look for and express regularity in repeated reasoning.

	2.2.6 Grade 6	2.2.7 Grade 7	2.2.8 Grade 8		2.2.HS High School
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(C) Functions	*Intentionally Blank*	*Intentionally Blank*	**CC.2.2.8.C.1** Define, evaluate, and compare functions. M08.B-F.1.1.1 M08.B-F.1.1.2 M08.B-F.1.1.3 A1.1.2.1.1 A1.2.1.1.2 A1.2.1.2.1 A1.2.1.2.2 **CC.2.2.8.C.2** Use concepts of functions to model relationships between quantities. M08.B-F.2.1.1 M08.B-F.2.1.2 A1.1.2.1.3 A1.2.1.1.1 A1.2.1.2.2 A1.2.2.1.3 A1.2.2.1.4	**(C) Functions**	**CC.2.2.HS.C.1** Use the concept and notation of functions to interpret and apply them in terms of their context. A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.2.1.1, A1.2.2.1.2, A1.2.2.1.3, A1.2.2.1.4, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, G.2.2.2.1, G.2.2.2.2, G.2.2.2.3, G.2.2.2.4, G.2.2.2.5 **CC.2.2.HS.C.2** Graph and analyze functions and use their properties to make connections between the different representations. A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.1.2.1, A1.2.1.2.2, A1.2.2.1.1, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4 **CC.2.2.HS.C.3** Write functions or sequences that model relationships between two quantities. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.1.2.1, A1.2.1.2.2, A1.2.2.1.3, A1.2.2.1.4, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4 **CC.2.2.HS.C.4** Interpret the effects transformations have on functions and find the inverses of functions. A1.2.1.2.1, A1.2.1.2.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4, A2.2.2.2.1 **CC.2.2.HS.C.5** Construct and compare linear, quadratic, and exponential models to solve problems. A1.2.2.1.1, A1.2.2.1.2, A1.2.2.1.3, A1.2.2.1.4, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4, A2.2.2.2.1 **CC.2.2.HS.C.6** Interpret functions in terms of the situations they model. A1.2.1.2.1, A1.2.2.1.2, A1.2.2.1.3, A1.2.2.2.1, A2.1.3.1.3,A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.2.1.3, A2.2.2.1.4, A2.2.2.2.1 **CC.2.2.HS.C.7** Apply radian measure of an angle and the unit circle to analyze the trigonometric functions. **CC.2.2.HS.C.8** Choose trigonometric functions to model periodic phenomena and describe the properties of the graphs. **CC.2.2.HS.C.9** Prove the Pythagorean identity and use it to calculate trigonometric ratios. G.1.3.2.1, G.2.1.1.1, G.2.1.1.2

2.3. Geometry

The Standards of Mathematical Practices

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	Grade 6 2.3.6	Grade 7 2.3.7	Grade 8 2.3.8		High School 2.3.HS
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(A) Geometry	**CC.2.3.6.A.1** Apply appropriate tools to solve real-world and mathematical problems involving area, surface area, and volume. M06.C-G.1.1.1 M06.C-G.1.1.2 M06.C-G.1.1.3 M06.C-G.1.1.4 M06.C-G.1.1.5 M06.C-G.1.1.6	**CC.2.3.7.A.1** Solve real-world and mathematical problems involving angle measure, area, surface area, circumference, and volume. M07.C-G.2.1.1 M07.C-G.2.1.2 M07.C-G.2.2.1 M07.C-G.2.2.2	**CC.2.3.8.A.1** Apply the concepts of volume of cylinders, cones, and spheres to solve real-world and mathematical problems. M08.C-G.3.1.1 G.2.3.1.2	**(A) Geometry**	**CC.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. G.1.2.1.1, G.1.2.1.2, G.1.2.1.3, G.1.2.1.4, G.1.2.1.5, G.1.3.2.1, G.2.2.1.1, G.2.2.1.2, G.2.2.2.1, G.2.2.2.2, G.2.2.2.3, G.2.2.2.4, G.2.2.2.5 **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. G.1.3.1.1, G.1.3.1.2, G.1.3.2.1 **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. G.2.1.1.1, G.2.1.1.2 **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. G.1.1.1.1, G.1.1.1.2, G.1.1.1.3, G.1.1.1.4, G.1.3.2.1, G.2.2.3.1 **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. G.1.1.1.1, G.1.1.1.2, G.1.1.1.3, G.1.1.1.4, G.2.2.2.1, G.2.2.2.2, G.2.2.2.3, G.2.2.2.4, G.2.2.2.5, G.2.2.3.1 **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. A2.2.1.1.4, A2.2.2.1.1 **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. G.2.1.2.1, G.2.1.2.2, G.2.1.2.3 **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. G.2.3.1.1, G.2.3.1.2, G.2.3.1.3 **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. G.1.1.1.1, G.1.1.1.2, G.1.1.1.3, G.1.1.1.4, G.1.2.1.1, G.1.2.1.2, G.1.2.1.3, G.1.2.1.4, G.1.2.1.5, G.2.3.2.1 **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. G.2.2.4.1, G.2.3.1.1, G.2.3.1.2, G.2.3.1.3
	Intentionally Blank	**CC.2.3.7.A.2** Visualize and represent geometric figures and describe the relationships between them. M07.C-G.1.1.1 M07.C-G.1.1.2 M07.C-G.1.1.3 M07.C-G.1.1.4	**CC.2.3.8.A.2** Understand and apply congruence, similarity, and geometric transformations using various tools. M08.C-G.1.1.1 M08.C-G.1.1.2 M08.C-G.1.1.3 M08.C-G.1.1.4 G.1.2.1.1 G.1.2.1.4 G.2.2.1.1		
	Intentionally Blank	*Intentionally Blank*	**CC.2.3.8.A.3** Understand and apply the Pythagorean Theorem to solve problems. M08.C-G.2.1.1 M08.C-G.2.1.2 M08.C-G.2.1.3 G.2.1.1.1 G.2.1.2.1		

2.4 Measurement, Data, and Probability

The Standards of Mathematical Practices

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.
Attend to precision.
Look for and make use of structure.
Look for and express regularity in repeated reasoning.

	Grade 6 2.4.6	Grade 7 2.4.7	Grade 8 2.4.8		High School 2.4.HS
Pennsylvania's public schools shall teach, challenge, and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(B) Statistics and Probability	**CC.2.4.6.B.1** Demonstrate an understanding of statistical variability by displaying, analyzing, and summarizing distributions. M06.D-S.1.1.1 M06.D-S.1.1.2 M06.D-S.1.1.3 M06.D-S.1.1.4	**CC.2.4.7.B.1** Draw inferences about populations based on random sampling concepts. M07.D-S.1.1.1 M07.D-S.1.1.2	**CC.2.4.8.B.1** Analyze and/or interpret bivariate data displayed in multiple representations. M08.D-S.1.1.1 M08.D-S.1.1.2 M08.D-S.1.1.3 A1.2.2.2.1	**(B) Statistics and Probability**	**CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. A1.2.2.1.2, A1.2.3.1.1, A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3, **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.1.2.1, A1.2.1.2.2, A1.2.2.2.1, A2.2.1.1.1, A2.2.3.1.1, A2.2.3.1.2 **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. A1.2.2.2.1, A1.2.3.1.1, A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3, A2.2.3.1.1, A2.2.3.1.2 **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. A1.2.3.3.1, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3 **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3 **CC.2.4.HS.B.6** Use the concepts of independence and conditional probability to interpret data. A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3 **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model. A1.2.3.3.1, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3
	Intentionally Blank	**CC.2.4.7.B.2** Draw informal comparative inferences about two populations. M07.D-S.2.1.1	**CC.2.4.8.B.2** Understand that patterns of association can be seen in bivariate data utilizing frequencies. M08.D-S.1.2.1		
	Intentionally Blank	**CC.2.4.7.B.3** Investigate chance processes and develop, use, and evaluate probability models. M07.D-S.3.1.1 M07.D-S.3.2.1 M07.D-S.3.2.2 M07.D-S.3.2.3 A1.2.3.3.1	*Intentionally Blank*		

Key Terms for this Document

Standards for Mathematical Content—These standards define what students should know and be able to do in their study of mathematics.

Standards for Mathematical Practice—These standards describe the processes and proficiencies in which all students grades K–12 should engage. Educators must instill these standards of practice in their students so that they become habitual. The standards for mathematical practice should be used as the vehicle to deliver the standards of mathematical content.

Standard Algorithm—A locally agreed upon method of computation which is conventionally taught for solving mathematical problems.

Decimal Fraction—A fraction whose denominator is a power of ten (examples: 2/100, 8/10). These fractions are commonly expressed as decimals.

Unit Fraction—A rational number written as a fraction where the numerator is one and the denominator is a positive integer (example: 1/20).

Bivariate Data—The data involves two variables and is usually represented as a scatter plot.

Rule—A single operation (examples: add 5, multiply by 2).