Algebra II

Curriculum Framework

2013

Compiled using the Common Core State Standards for Mathematics and the PARCC Model Content Frameworks for Mathematics Version 3.0 (November 2012 revision)

Course Title:	Algebra II
Course/Unit Credit:	1
Course Number:	432000
Teacher Licensure:	Please refer to the Course Code Management System (https://adedata.arkansas.gov/ccms/) for the most current licensure codes.
Grades:	9-12
Prerequisite:	Algebra I or Algebra A/B

Course Description: "Building on their work with linear, quadratic, and exponential functions, students extend their repertoire of functions to include polynomial, rational, and radical functions. Students work closely with the expressions that define the functions, and continue to expand and hone their abilities to model situations and to solve equations, including solving quadratic equations over the set of complex numbers and solving exponential equations using the properties of logarithms. The Mathematical Practice Standards apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations." - http://www.corestandards.org/

This document was created to delineate the standards for this course in a format familiar to the educators of Arkansas. For the state-provided Algebra A/B, Algebra I, Geometry A/B, Geometry, and Algebra II documents, the language and structure of the Common Core State Standards for Mathematics (CCSS-M) have been maintained. The following information is helpful to correctly read and understand this document.

> "**Standards** define what students should understand and be able to do.
> **Clusters** are groups of related standards. Note that standards from different clusters may sometimes be closely related, because mathematics is a connected subject.
> **Domains** are larger groups of related standards. Standards from different domains may sometimes be closely related." - http://www.corestandards.org/

"Standards do not dictate curriculum or teaching methods. For example, just because topic A appears before topic B in the standards for a given grade, it does not necessarily mean that topic A must be taught before topic B. A teacher might prefer to teach topic B before topic A, or might choose to highlight connections by teaching topic A and topic B at the same time. Or, a teacher might prefer to teach a topic of his or her own choosing that leads, as a byproduct, to students reaching the standards for topics A and B. . . . These Standards are not intended to be new names for old ways of doing business. They are a call to take the next step. It is time for states to work together to build on lessons learned from two decades of standards based reforms. It is time to recognize that standards are not just promises to our children, but promises we intend to keep." - http://www.corestandards.org/

This document includes only the standards designated as assessable by the PARCC Model Content Frameworks. The standards in this document appear exactly as written in the CCSS-M. Italicized portions of the standards offer clarification. The Plus Standards (+) from the Common Core State Standards for Mathematics may be incorporated into the curriculum to adequately prepare students for more rigorous courses (e.g., Advanced Placement, International Baccalaureate, or concurrent credit courses).

If a standard is assessed on more than one end-of-course test, the assessment limitations and clarifications (ALC) for that standard are included below the standard.

Algebra II

Domain	Cluster	Course Emphases
The Real Number System		
	1. Extend the properties of exponents to rational exponents	Major
Quantities*		
	2. Reason quantitatively and use units to solve problems	Supporting
The Complex Number System		
	3. Perform arithmetic operations with complex numbers	Additional
	4. Use complex numbers in polynomial identities and equations	Additional
Seeing Structure in Expressions		
	5. Interpret the structure of expressions	Major
	6. Write expressions in equivalent forms to solve problems	Major
Arithmetic with Polynomials and Rational Expressions		
	7. Understand the relationship between zeros and factors of polynomials	Major
	8. Use polynomial identities to solve problems	Additional
	9. Rewrite rational expressions	Supporting
Creating Equations*		
	10. Create equations that describe numbers or relationships	Supporting
Reasoning with Equations and Inequalities		
	11. Understand solving equations as a process of reasoning and explain the reasoning	Major
	12. Solve equations and inequalities in one variable	Supporting
	13. Solve systems of equations	Additional
	14. Represent and solve equations and inequalities graphically	Major
Interpreting Functions		
	15. Understand the concept of a function and use function notation	Supporting
	16. Interpret functions that arise in applications in terms of the context	Major
	17. Analyze functions using different representations	Supporting
Building Functions		
	18. Build a function that models a relationship between two quantities	Major
	19. Build new functions from existing functions	Additional
Linear, Quadratic, and Exponential Models*		
	20. Construct and compare linear, quadratic, and exponential models and solve problems	Supporting
	21. Interpret expressions for functions in terms of the situation they model	Additional
Trigonometric Functions		
	22. Extend the domain of trigonometric functions using the unit circle	Additional
	23. Model periodic phenomena with trigonometric functions	Additional
	24. Prove and apply trigonometric identities	Additional

Algebra II

Domain	Cluster	Course Emphases
Expressing Geometric Properties with Equations		
	25. Translate between the geometric description and the equation for a conic section	Additional
Interpreting Categorical and Quantitative Data		
	26. Understand and evaluate random processes underlying statistical experiments	Additional
	27. Make inferences and justify conclusions from sample surveys, experiments and observational studies	Supporting
Making Inferences and Justifying Conclusions		
	28. Understand and evaluate random processes underlying statistical experiments	Supporting
	29. Make inferences and justify conclusions from sample surveys, experiments and observational studies	Major
Conditional Probability and the Rules of Probability		
	30. Understand independence and conditional probability and use them to interpret data	Additional
	31. Use the rules of probability to compute probabilities of compound events in a uniform probability model	Additional

* *Asterisks identify potential opportunities to integrate content with the modeling practice*

Domain: The Real Number System
Cluster(s): 1. Extend the properties of exponents to rational exponents

N.RN.1	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. *For example, we define* $5^{1/3}$ *to be the cube root of* 5 *because we want* $\left(5^{1/3}\right)^3 = 5^{(1/3)^3}$ *to hold, so* $\left(5^{1/3}\right)^3$ *must equal* 5.	Major (CS)
N.RN.2	1	Rewrite expressions involving radicals and rational exponents using the properties of exponents.	Major (CS)

Domain: Quantities*
Cluster(s): 2. Reason quantitatively and use units to solve problems

N.Q.2	2	Define appropriate quantities for the purpose of descriptive modeling. ALC for N.Q.2: This standard will be assessed in Algebra II by ensuring that some modeling tasks (involving Algebra II content or securely held content from previous grades and courses) require the student to create a quantity of interest in the situation being described (i.e., this is not provided in the task). For example, in a situation involving periodic phenomena, the student might autonomously decide that amplitude is a key variable in a situation, and then choose to work with peak amplitude.	Supporting (CM)

Domain: The Complex Number System
Cluster(s): 3. Perform arithmetic operations with complex numbers
4. Use complex numbers in polynomial identities and equations

N.CN.1	3	Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.	Additional (CA)
N.CN.2	3	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.	Additional (CS)
N.CN.7	4	Solve quadratic equations with real coefficients that have complex solutions.	Additional (CS)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Seeing Structure in Expressions
Cluster(s): 5. Interpret the structure of expressions
6. Write expressions in equivalent forms to solve problems

A.SSE.2	5	Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$*.* ALC for A.SSE.2: i) Tasks are limited to polynomial, rational, or exponential expressions. ii) Examples: *see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$. In the equation $x^2 + 2x + 1 + y^2 = 9$, see an opportunity to rewrite the first three terms as $(x + 1)^2$, thus recognizing the equation of a circle with radius 3 and center (⍰1, 0). See $(x^2 + 4)/(x^2 + 3)$ as $((x^2 + 3) + 1)/(x^2 + 3)$, thus recognizing an opportunity to write it as $1 + 1/(x^2 + 3)$.	Major (CA)
A.SSE.3	6	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* c. Use the properties of exponents to transform expressions for exponential functions. *For example the expression* 1.15^t *can be rewritten as* $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ *to reveal the approximate equivalent monthly interest rate if the annual rate is 15%* ALC for A.SSE.3c: i) Tasks have a real-world 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. ii) Tasks are limited to exponential expressions with rational or real exponents.	Major (CM, CA)
A.SSE.4	6	Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. *For example, calculate mortgage payments.**	Major (CM)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Arithmetic with Polynomials and Rational Expressions

Cluster(s): 7. Understand the relationship between zeros and factors of polynomials
8. Use polynomial identities to solve problems
9. Rewrite rational expressions

A.APR.2	7	Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.	Major (CS)
A.APR.3	7	Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. ALC for A.APR.3: i) Tasks include quadratic, cubic, and quartic polynomials and polynomials for which factors are not provided. For example, find the zeros of $(x^2 - 1)(x^2 + 1)$	Major (CA)
A.APR.4	8	Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity* $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.*	Additional (CA)
A.APR.6	9	Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.	Supporting (CA)

Domain: Creating Equations*

Cluster(s): 10. Create equations that describe numbers or relationships

A.CED.1	10	Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* ALC for A.CED.1: i) Tasks are limited to exponential equations with rational or real exponents and rational functions. ii) Tasks have a real-world context.	Supporting (CM)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Reasoning with Equations and Inequalities

Cluster(s): 11. Understand solving equations as a process of reasoning and explain the reasoning
12. Solve equations and inequalities in one variable
13. Solve systems of equations
14. Represent and solve equations and inequalities graphically

A.REI.1	11	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 has a solution. Construct a viable argument to justify a solution method. ALC for A.REI.1: i) Tasks are limited to simple rational or radical equations.	Major (CS)
A.REI.2	11	Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.	Major (CS)
A.REI.4	12	Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b. ALC for A.REI.4b: i) In the case of equations that have roots with nonzero imaginary parts, students write the solutions as $a \pm bi$ for real numbers a and b.	Supporting (CS)
A.REI.6	13	Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. ALC for A.REI.6: i) Tasks are limited to 3x3 systems.	Additional (CS)
A.REI.7	13	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line* $y = -3x$ *and the circle* $x^2 + y^2 = 3$.	Additional (CS)
A.REI.11	14	Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.* ALC for A.REI.11 i) Tasks may involve any of the function types mentioned in the standard.	Major (CA)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Interpreting Functions

Cluster(s): 15. Understand the concept of a function and use function notation

16. Interpret functions that arise in applications in terms of the context

17. Analyze functions using different representations

F.IF.3	15	Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by* $f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1)$ *for* $n \geq 1$. ALC for F.IF.3: i) This standard is Supporting work in Algebra II. This standard should support the Major work in F-BF.2 for coherence.	Supporting (CA)
F.IF.4	16	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.** ALC for F.IF.4: i) Tasks have a real-world context ii) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions. Compare note (ii) with standard F-IF.7. The function types listed here are the same as those listed in the Algebra II column for standards F-IF.6 and F-IF.9.	Major (CA)
F.IF.6	16	Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* ALC for F.IF.6: i) Tasks have a real-world context. ii) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions. The function types listed here are the same as those listed in the Algebra II column for standards F-IF.4 and F-IF.9.	Major (CA)
F.IF.7	17	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.	Supporting (CM)
F.IF.8	17	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay*	Supporting (CA)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

F.IF.9	17	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.* ALC for F.IF.9: i) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions. The function types listed here are the same as those listed in the Algebra II column for standards F-IF.4 and F-IF.6.	Supporting (CA)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Building Functions
Cluster(s): 18. Build a function that models a relationship between two quantities
19. Build new functions from existing functions

F.BF.1	18	Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.* ALC for F.BF.1a: i) Tasks have a real-world context ii) Tasks may involve linear functions, quadratic functions, and exponential functions.	Major (CM)
F.BF.2	18	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*	Major (CA, CM)
F.BF.3	19	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. 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.* ALC for F.BF.3: i) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions ii) Tasks may involve recognizing even and odd functions. The function types listed in note (i) are the same as those listed in the Algebra II column for standards F-IF.4, F-IF.6, and F-IF.9.	Additional (CA)
F.BF.4a	19	Find inverse functions. a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2\,x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.	Additional (CS)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Linear, Quadratic, and Exponential Models*

Cluster(s): 20. Construct and compare linear, quadratic, and exponential models and solve problems
21. Interpret expressions for functions in terms of the situation they model

F.LE.2	20	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). ALC for F.LE.2: i) Tasks will include solving multi-step problems by constructing linear and exponential functions.	Supporting (CM)
F.LE.4	20	For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.	Supporting (CS)
F.LE.5	21	Interpret the parameters in a linear or exponential function in terms of a context. ALC for F.LE.5: i) Tasks have a real-world context. ii) Tasks are limited to exponential functions with domains not in the integers.	Additional (CA)

Domain: Trigonometric Functions

Cluster(s): 22. Extend the domain of trigonometric functions using the unit circle
23. Model periodic phenomena with trigonometric functions
24. Prove and apply trigonometric identities

F.TF.1	22	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.	Additional (CA)
F.TF.2	22	Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.	Additional (CA)
F.TF.5	23	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*	Additional (CM)
F.TF.8	24	Prove the Pythagorean identity $sin^2(\theta) + cos^2(\theta) = 1$ and use it to find $sin(\theta)$, $cos(\theta)$, or $tan(\theta)$ given $sin(\theta)$, $cos(\theta)$, or $tan(\theta)$ and the quadrant of the angle.	Additional (CA, CS)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Expressing Geometric Properties with Equations

Cluster(s): 25. Translate between the geometric description and the equation for a conic section

G.GPE.2	25	Derive the equation of a parabola given a focus and directrix.	Additional (CM)

Domain: Interpreting Categorical and Quantitative Data

Cluster(s): 26. Understand and evaluate random processes underlying statistical experiments
27. Make inferences and justify conclusions from sample surveys, experiments and observational studies

S.ID.4	26	Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.	Additional (S)
S.ID.6	27	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. 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. ALC for S.ID.6a: i) Tasks have a real-world context. ii) Tasks are limited to exponential functions with domains not in the integers and trigonometric functions.	Supporting (S)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Making Inferences and Justifying Conclusions

Cluster(s): 28. Understand and evaluate random processes underlying statistical experiments

29. Make inferences and justify conclusions from sample surveys, experiments and observational studies

S.IC.1	28	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.	Supporting (S)
S.IC.2	28	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. *For example, a model says a spinning coin falls heads up with probability* 0.5. *Would a result of* 5 *tails in a row cause you to question the model?*	Supporting (S)
S.IC.3	29	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	Major (S)
S.IC.4	29	Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.	Major (S)
S.IC.5	29	Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.	Major (S)
S.IC.6	29	Evaluate reports based on data.	Major (S)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Domain: Conditional Probability and the Rules of Probability
Cluster(s): 30. Understand independence and conditional probability and use them to interpret data
31. Use the rules of probability to compute probabilities of compound events in a uniform probability model

S.CP.1	30	Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").	Additional (S)
S.CP.2	30	Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.	Additional (S)
S.CP.3	30	Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.	Additional (S)
S.CP.4	30	Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*	Additional (S)
S.CP.5	30	Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*	Additional (S)
S.CP.6	31	Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.	Additional (S)
S.CP.7	31	Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.	Additional (S)

Key:

CCSS-M Domain and Standard #	CCSS-M Cluster	CCSS-M Standard	PARCC Course Emphases (Category)

Make sense of problems and persevere in solving them Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
Reason abstractly and quantitatively Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
Construct viable arguments and critique the reasoning of others Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.
Model with mathematics Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

Use appropriate tools strategically Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.
Attend to precision Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.
Look for and make use of structure Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well-remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see 5 – 3(x – y) 2 as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.
Look for and express regularity in repeated reasoning Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through $(1, 2)$ with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

The information contained in this document provides one way to frame discussions about scope and sequence of the standards leading to the development of local curriculum maps. This document incorporates the priorities assigned to each standard in the PARCC Model Content Frameworks (Major, Supporting, and Additional), which will help guide discussions related to priority, focus, and time allocated for each topic. In the spring of 2013, a committee composed of Arkansas educators categorized each standard based on its cognitive demand or complexity. These categories are defined below. Districts are encouraged to approach the development of a curriculum in a manner that best serves the needs of their students.

Frameworks Committee Categorization of Algebra II Standards (indicated in the column to the far right of each standard):

- Statistics (S)
- Compare and Analyze (CA)
- Create and Model (CM)
- Compute and Solve (CS)