Algebra I
Part A
Content Standards
2016

Compiled using the Arkansas Mathematics Standards

Course Title: Algebra I Part A
Course/Unit Credit: 1
Course Number: 430100
Teacher Licensure: Please refer to the Course Code Management System (https://adedata.arkansas.gov/ccms/) for the most current licensure codes.
Grades: 9-12

Course Description: "The fundamental purpose of this course is to formalize and extend the mathematics that students learned in the middle grades. Because it is built on the middle grades standards, this is a more ambitious version of Algebra I than has generally been offered. The critical areas, called units, deepen and extend understanding of linear and exponential relationships by contrasting them with each other and by applying linear models to data that exhibit a linear trend, and students engage in methods for analyzing, solving, and using quadratic functions.

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 Arkansas Mathematics Standards (AMS) 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.

Notes:

1. Teacher notes offer clarification of the standards.
2. The Plus Standards (+) from the Arkansas Mathematics Standards may be incorporated into the curriculum to adequately prepare students for more rigorous courses (e.g., Advanced Placement, International Baccalaureate, or concurrent credit courses).
3. Italicized words are defined in the glossary.
4. All items in a bulleted list must be taught.
5. Asterisks (*) identify potential opportunities to integrate content with the modeling practice.

Algebra I

Domain	Cluster
The Real Number System	
	1. Use properties of rational and irrational numbers
Quantities*	
	2. Reason quantitatively and use units to solve problems
Seeing Structure in Expressions	
	3. Interpret the structure of expressions
	4. Write expressions in equivalent forms to solve problems
Arithmetic with Polynomials and Rational Expressions	
	5. Perform arithmetic operations on polynomials
	6. Understand the relationship between zeros and factors of polynomials
	7. Use polynomial identities to solve problems
	8. Rewrite rational expressions
Creating Equations*	
	9. Create equations that describe numbers or relationships
Reasoning with Equations and Inequalities	
	10. Understand solving equations as a process of reasoning and explain the reasoning
	11. Solve equations and inequalities in one variable
	12. Solve systems of equations and inequalities graphically
	13. Solve systems of equations
Interpreting Functions	
	14. Understand the concept of a function and use function notation
	15. Interpret functions that arise in applications in terms of the context
	16. Analyze functions using different representations
Building Functions	
	17. Build a function that models a relationship between two quantities
	18. Build new functions from existing functions
Linear, Quadratic, and Exponential Models*	
	19. Construct and compare linear, quadratic, and exponential models and solve problems
	20. Interpret expressions for functions in terms of the situation they model
Interpreting categorical and quantitative data	
	21. Summarize, represent, and interpret data on a single count or measurement variable
	22. Summarize, represent, and interpret data on two categorical and quantitative variables
	23. Interpret linear models

The following abbreviations are for the conceptual categories and domains for the Arkansas Mathematics Standards. For example, the standard HSN.RN.B.3 is in the High School Number and Quantity conceptual category and in The Real Number System domain.

High School Number and Quantity – HSN
- The Real Number System – RN
- Quantities – Q
- The Complex Number System – CN
- Vectors and Matrix Quantities – VM

High School Algebra – HSA
- Seeing Structure in Expressions – SSE
- Arithmetic with Polynomials and Rational Expressions – APR
- Creating Equations – CED
- Reasoning with Equations and Inequalities – REI

High School Functions – HSF
- Interpreting Functions – IF
- Building Functions – BF
- Linear, Quadratic and Exponential Models – LE
- Trigonometric Functions – TF

High School Geometry – HSG
- Congruence – CO
- Similarity, Right Triangles, and Trigonometry – SRT
- Circles – C
- Expressing Geometric Properties with Equations – GPE
- Geometric Measurement and Dimension – GMD
- Modeling with Geometry – MG

High School Statistics and Probability – HSS
- Interpreting Categorical and Quantitative Data – ID
- Making Inferences and Justifying Conclusions – IC
- Conditional Probability and the Rules of Probability – CP
- Using Probability to Make Decisions – MD

Domain: The Real Number System
Cluster(s): 1. Use properties of rational and irrational numbers

HSN.RN.B.3	1	Explain why: • The sum/difference or product/quotient (where defined) of two *rational numbers* is *rational* • The sum/difference of a *rational number* and an *irrational number* is *irrational* • The product/quotient of a nonzero *rational number* and an *irrational number* is *irrational* • The product/quotient of two nonzero *rational numbers* is a nonzero *rational*

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

HSN.Q.A.1	2	• Use units as a way to understand problems and to guide the solution of multi-step problems • Choose and interpret units consistently in formulas • Choose and interpret the scale and the origin in graphs and data displays
HSN.Q.A.2	2	Define appropriate quantities for the purpose of descriptive modeling (i.e., use units appropriate to the problem being solved) Limitation: This standard will be assessed in Algebra I by ensuring that some modeling tasks (involving Algebra I content or securely held content from grades 6-8) require the student to create a quantity of interest in the situation being described (i.e., a quantity of interest is not selected for the student by the task). For example, in a situation involving data, the student might autonomously decide that a measure of center is a key variable in a situation, and then choose to work with the mean.
HSN.Q.A.3	2	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

Domain: Seeing Structure in Expressions
Cluster(s): 3. Interpret the structure of expressions
4. Write expressions in equivalent forms to solve problems

HSA.SSE.A.1	3	Interpret *expressions* that represent a quantity in terms of its context* • Interpret parts of an *expression* using appropriate vocabulary, such as *terms*, *factors*, and *coefficients* • Interpret complicated *expressions* by viewing one or more of their parts as a single entity For example: Interpret $P(1 + r)^n$ as the product of P and a factor not depending on P.

Domain: Creating Equations*

Cluster(s): 9. Create equations that describe numbers or relationships

HSA.CED.A.1	9	Create *equations* and *inequalities* in one variable and use them to solve problems Note: Including but not limited to *equations* arising from: • *Linear functions* • *Quadratic functions* • *Exponential functions* • *Absolute value functions*
HSA.CED.A.2	9	• Create *equations* in two or more *variables* to represent relationships between quantities • Graph *equations*, in two *variables*, on a *coordinate plane*
HSA.CED.A.3	9	• Represent and interpret constraints by *equations* or *inequalities*, and by *systems of equations* and/or *inequalities* • Interpret solutions as viable or nonviable options in a modeling and/or real-world context
HSA.CED.A.4	9	Rearrange *literal equations* using the properties of equality

Domain: Reasoning with Equations and Inequalities

Cluster(s): 10. Understand solving equations as a process of reasoning and explain the reasoning
11. Solve equations and inequalities in one variable
12. Solve systems of equations and inequalities graphically
13. Solve systems of equations

HSA.REI.A.1	10	Assuming that *equations* have a solution, construct a solution and justify the reasoning used Note: Students are not required to use only one procedure to solve problems nor are they required to show each step of the process. Students should be able to justify their solution in their own words. (limited to quadratics)
HSA.REI.B.3	11	Solve linear equations, inequalities and *absolute value equations* in one *variable*, including equations with *coefficients* represented by letters
HSA.REI.B.4	11	Solve quadratic equations in one *variable* • Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions Note: This would be a good opportunity to demonstrate/explore how the quadratic formula is derived. This standard also connects to the transformations of *functions* and identifying key features of a graph (F-BF3). Note: Introduce this with a leading coefficient of 1 in Algebra I. Finish mastery in Algebra II. • Solve quadratic equations (as appropriate to the initial form of the equation) by: o Inspection of a graph o Taking square roots o Completing the square o Using the quadratic formula o Factoring Recognize complex solutions and write them as $a \pm bi$ for real numbers a and b. (Algebra 2 only) Limitation: i) Tasks do not require students to write solutions for quadratic equations that have roots with nonzero imaginary parts. However, tasks can require the student to recognize cases in which a quadratic equation has no real solutions. Note: Solving a quadratic equation by factoring relies on the connection between zeros and factors of polynomials (cluster A-APR.B). Cluster A-APR.B is formally assessed in Algebra II.

Domain: Reasoning with Equations and Inequalities

Cluster(s): 10. Understand solving equations as a process of reasoning and explain the reasoning
11. Solve equations and inequalities in one variable
12. Solve systems of equations and inequalities graphically
13. Solve systems of equations

HSA.REI.C.5	12	• Solve *systems of equations* in two variables using substitution and elimination • Understand that the solution to a system of equations will be the same when using substitution and elimination
HSA.REI.C.6	12	Solve *systems of equations* algebraically and graphically Limitation: i) Tasks have a real-world context. ii) Tasks have hallmarks of modeling as a mathematical practice (less defined tasks, more of the modeling cycle, etc.).
HSA.REI.D.10	13	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
HSA.REI.D.11	13	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 by: • Using technology to graph the *functions* • Making tables of values • Finding successive approximations Include cases (but not limited to) where $f(x)$ and/or $g(x)$ are: • Linear • Polynomial • Absolute value • Exponential (Introduction in Algebra 1, Mastery in Algebra 2) Teacher notes: Modeling should be applied throughout this standard.
HSA.REI.D.12	13	Solve linear inequalities and systems of linear inequalities in two variables by graphing

Domain: Interpreting Functions

Cluster(s): 14. Understand the concept of a function and use function notation
15. Interpret functions that arise in applications in terms of the context
16. Analyze functions using different representations

HSF.IF.A.1	14	• 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* • Understand that 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*. • Understand that the graph of *f* is the graph of the equation *y* = *f(x)*.
HSF.IF.A.2	14	In terms of a real-world context: • Use *function notation* • Evaluate functions for inputs in their *domains* • Interpret statements that use *function notation*
HSF.IF.A.3	14	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* $f(0) = f(1) = 1$, $f(n + 1) = f(n) + (n - 1)$ *for* $n \geq 1$.
HSF.IF.B.4	15	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 Note: Key features may include but not limited to: *intercepts*; intervals where the *function* is increasing, decreasing, positive, or negative; relative *maximums* and *minimums*; symmetries; *end behavior*; and periodicity.* Limitation: i) Tasks have a real-world context. ii) Tasks are 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. Compare note (ii) with standard F-IF.7. The function types listed here are the same as those listed in the Algebra I column for standards F-IF.6 and F-IF.9.
HSF.IF.B.5	15	• Relate the *domain* of a *function* to its graph • Relate the *domain* of a *function* to the quantitative relationship it describes For example: If the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

Domain: Interpreting Functions
Cluster(s): 14. Understand the concept of a function and use function notation
15. Interpret functions that arise in applications in terms of the context
16. Analyze functions using different representations

HSF.IF.B.6	15	• Calculate and interpret the *average rate of change* of a *function* (presented algebraically or as a table) over a specified interval* • Estimate the rate of change from a graph* Limitation: i) Tasks have a real-world context. ii) Tasks are 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. The function types listed here are the same as those listed in the Algebra I column for standards F-IF.4 and F-IF.9.
HSF.IF.C.7	16	Graph *functions* expressed algebraically and show key features of the graph, with and without technology • Graph *linear* and *quadratic functions* and, when applicable, show *intercepts*, maxima, and minima • Graph square root, cube root, and *piecewise-defined functions*, including *step functions* and *absolute value functions* • Graph *exponential functions*, showing *intercepts* and *end behavior*
HSF.IF.C.9	16	Compare properties of two *functions* each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions) Limitation: i) Tasks are 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. The function types listed here are the same as those listed in the Algebra I column for standards F-IF.4 and F-IF.6.

Domain: Building Functions
Cluster(s): 17. Build a function that models a relationship between two quantities
18. Build new functions from existing functions

HSF.BF.A.1	17	Write a *function* that describes a relationship between two quantities • From a context, determine an explicit expression, a recursive process, or steps for calculation Limitation: i) Tasks have a real-world context. ii) Tasks are limited to linear functions, quadratic functions, and exponential functions with domains in the integers.
HSF.BF.B.3	18	• 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* (*k*, a constant both positive and negative) • Find the value of k given the graphs of the transformed functions • Experiment with multiple transformations and illustrate an explanation of the effects on the graph with or without technology. Note: Include recognizing *even* and *odd functions* from their graphs and algebraic expressions for them Limitation: i) Identifying 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) is limited to linear and quadratic functions. ii) Experimenting with cases and illustrating an explanation of the effects on the graph using technology is 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. iii) Tasks do not involve recognizing even and odd functions. The function types listed in note (ii) are the same as those listed in the Algebra I column for standards F-IF.4, F-IF.6, and F-IF.9.

Domain: Linear, Quadratic, and Exponential Models*

Cluster(s): 19. Construct and compare linear, quadratic, and exponential models and solve problems

20. Interpret expressions for functions in terms of the situation they model

HSF.LE.A.1	19	Distinguish between situations that can be modeled with *linear functions* and with *exponential functions* • Show that *linear functions* grow by equal differences over equal intervals, and that *exponential functions* grow by equal factors over equal intervals • Recognize situations in which one quantity changes at a constant rate per unit interval relative to another • Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another
HSF.LE.A.2	19	Construct linear and exponential equations, including arithmetic and geometric sequences,: • given a graph • a description of a relationship • two input-output pairs (include reading these from a table) Limitation: i) Tasks are limited to constructing *linear* and *exponential functions* in simple context (not multi-step).
HSF.LE.B.5	20	In terms of a context, interpret the parameters (rates of growth or decay, *domain* and *range* restrictions where applicable, etc.) in a function Limitation: i) Tasks have a real-world context. ii) Exponential functions are limited to those with domains in the integers.

Domain: Interpreting categorical and quantitative data

Cluster(s): 21. Summarize, represent, and interpret data on a single count or measurement variable
22. Summarize, represent, and interpret data on two categorical and quantitative variables
23. Interpret linear models

HSS.ID.A.1	21	Represent data with plots on the real number line (dot plots, histograms, and box plots)
HSS.ID.A.2	21	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
HSS.ID.A.3	21	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers) For example: Be able to explain the effects of extremes or outliers on the measures of center and spread.
HSS.ID.B.5	22	• 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
HSS.ID.B.6	22	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related • Fit a *function* to the data; use functions fitted to data to solve problems in the context of the data Note: Use given *functions* or choose a *function* suggested by the context. Emphasize linear, quadratic, and exponential models. The focus of Algebra I should be on linear and exponential models while the focus of Algebra II is more on quadratic and exponential models.
HSS.ID.C.7	23	Interpret the *slope* (*rate of change*) and the intercept (constant term) of a linear model in the context of the data
HSS.ID.C.8	23	Compute (using technology) and interpret the *correlation coefficient* of a linear fit
HSS.ID.C.9	2	Distinguish between *correlation* and *causation*

Glossary

Absolute value equation	Any equation with absolute value symbols; $\|2x - 7\| = 21$
Absolute value function	Any function in the family with parent function $f(x) = \|x\|$
Absolute value inequality	Any inequality with absolute value symbols; $\|x + 2\| < 5$
Algebraic expression	A symbolic representation of mathematical operations that can involve both numbers and variables
Average rate of change	The difference between two output values divided by the difference between corresponding input values
Binomial	A polynomial with exactly two terms
Causation	A relationship in which changes in one variable cause changes in another variable
Coefficient	A number by which a variable is multiplied
Constant	A value that does not change
Coordinate plane	A plane spanned by the x- and y-axis
Correlation	An association between two variables that may or may not imply causation
Correlation Coefficient	A measure of how nearly a scatter plot falls on a straight line; the correlation coefficient is always between -1 and $+1$
Cube root function	Any function in the family with parent function $f(x) = \sqrt[3]{x}$
Domain	The set of input values for a function
End behavior	The behavior of a graph of $f(x)$ as x approaches positive or negative infinity
Equation	A statement that has one value or algebraic expressions equal to another number or algebraic expression
Even function	A function symmetric with respect to the y-axis; $f(-x) = f(x)$ for all x in the domain of f
Exponential function	A function in which a variable appears in the exponent; $f(x) = 2^x$
Expression	A mathematical phrase consisting of numbers, variables, and operations
Extraneous solutions	A solution that emerges from the process of solving an equation but is not a valid solution to the original problem
Factor	One of the numbers, variables or expressions multiplied to obtain a product
Function	A rule or relationship in which there is exactly one output value for each input value
Function notation	The f(x) notation can be thought of as another way of representing the y-value in a function; for example $f(x) = 3x$
Inequality	A statement that has one quantity less than or greater than another; $<$, $>$, $\leq$, $\leq$
Intercept	Where the graph crosses the x-axis (x-intercept) or the y-axis (y-intercept)
Irrational number	A number that cannot be expressed as a fraction p/q for any integers p and q; have decimal expansions that neither terminate nor become periodic
Linear function	A function characterized by a constant rate of change
Literal equation	An equation where variables represent known values; $V=lwh$, $C=2\pi r$, $d=rt$
Maximum	The greatest value of a function
Minimum	The least value of a function
Monomial	A polynomial with only one term
Odd function	A function symmetric with respect to the origin; $f(-x) = -f(x)$
Piece-wise function	A function that consists of two or more functions defined on different intervals
Polynomial	A sum of terms that have positive integer exponents
Quadratic function	Any function in the family with parent function $f(x) = x^2$
Radical	The symbol used to represent a root; $\sqrt{}$

Radical expression	An expression containing a root symbol; $\sqrt{\ }$
Radicand	The quantity under a radical sign
Range	The set of output values for a function
Rational expression	A ratio of two polynomial expressions with a non-zero denominator; $\frac{3x+1}{x+2}$
Rational number	A number that can be written as a ratio of two integers
Scatter plot	A two-variable data display in which values on a horizontal axis represent value of one variable and values on a vertical axis represent values of the other variable
Slope	The ratio of the vertical change to the horizontal change between two points on a line
Square root function	Any function in the family with parent function $f(x)=\sqrt{x}$
Step function	A function whose graph consists of a series of horizontal line segments
Systems of equations	A set of two or more equations with the same variables
Term	An algebraic expression that represents only multiplication and division between variables and constants
Trinomial	A polynomial with exactly three terms
Variable	A symbol used to represent an unknown or undetermined value in an expression or equation
Zeros	The values of the independent variable (*x*-value) that make the corresponding values of the function equal to zero

Table 1: Properties of Operations

Associative property of addition	(a + b) + c = a + (b + c)
Commutative property of addition	a + b = b + a
Additive identity property of 0	a + 0 = 0 + a = a
Existence of additive inverses	For every a there exists –a so that *a + (-a) = (-a) + a = 0*
Associative property of multiplication	(a x b) x c = a x (b x c) *
Commutative property of multiplication	a x b = b x a *
Multiplicative identity property 1	a x 1 = 1a = a *
Existence of multiplication inverses	For every a ≠ 0 there exists 1/*a* so that a x 1/a = 1/a x a = 1 *
Distributive property of multiplication over addition	a x (b + c) = a x b + a x c *

*The x represents multiplication not a variable.

Table 2: Properties of Equality

Reflexive property of equality	a = a
Symmetric property of equality	If a = b, then b = a.
Transitive property of equality	If a = b and b = c, then a = c.
Addition property of equality	If a = b, then a + c = b + c.
Subtraction property of equality	If a = b, then a – c = b – c.
Multiplication property of equality	If a = b, then a x c = b x c. *
Division property of equality	If a = b and c ≠ 0, then a ÷ c = b ÷ c.
Substitution property of equality	If a = b, then b may be substituted for a in any expression containing a.

*The x represents multiplication not a variable.

Table 3: Properties of Inequality

Exactly one of the following is true: a < b, a = b, a > b.
If a > b and b > c, then a > c.
If a > b, b < a.
If a > b, then a $\pm$ c > b $\pm$ c.
If a > b and c > 0, then a x c > b x c. *
If a > b and c < 0, then a x c < b x c. *
If a > b and c > 0, then a ÷ c > b ÷ c.
If a > b and c < 0, then a ÷ c < b ÷ c.

*The x represents multiplication not a variable.