Algebra I Aligned to 6-8 Grade Level Content Expectations

Sixth Grade	Seventh Grade	Eighth Grade	Algebra 1
Represent rational numbers as fractions or decimals **N.ME.06.05** Order rational numbers and place them on the number line. **N.ME.06.06** Represent rational numbers as fractions or terminating decimals when possible, and translate between these representations. **N.ME.06.07** Understand that a fraction or a negative fraction is a quotient of two integers, e.g., - 8/3 is -8 divided by 3. **Use exponents** **N.ME.06.16** Understand and use integer exponents, excluding powers of negative bases; express numbers in scientific notation. **Understand rational numbers and their location on the number line** **N.ME.06.17** Locate **negative rational numbers** (including integers) on the number line; know that numbers and their negatives add to 0, and are on opposite sides and at equal distance from 0 on a number line. **N.ME.06.18** Understand that rational numbers are quotients of integers (non zero denominators), e.g., a rational number is either a fraction or a negative fraction. **N.ME.06.19** Understand that 0 is an integer that is neither negative nor positive. **N.ME.06.20** Know that the absolute value of a number is the value of the number ignoring the sign; or is the distance of the number from 0.	**Apply basic properties of real numbers in algebraic contexts** **A.PA.07.11** Understand and use basic properties of real numbers: additive and multiplicative identities, additive and multiplicative inverses, commutativity, associativity, and the distributive property of multiplication over addition. **Recognize irrational numbers** **N.MR.07.06** Understand the concept of square root and cube root, and estimate using calculators.	**Understand real number concepts** **N.ME.08.01** Understand the meaning of a square root of a number and its connection to the square whose area is the number; understand the meaning of a cube root and its connection to the volume of a cube. **N.ME.08.02** Understand meanings for zero and negative integer exponents. **N.ME.08.03** Understand that in decimal form, rational numbers either terminate or eventually repeat, and that calculators truncate or round repeating decimals; locate rational numbers on the number line; know fraction forms of common repeating decimals, e.g., 0.1= 1/9 ; 0.3= 1/3. **N.ME.08.04** Understand that irrational numbers are those that cannot be expressed as the quotient of two integers, and cannot be represented by terminating or repeating decimals; approximate the position of familiar irrational numbers, e.g., $\sqrt{2}$, $\sqrt{3}$, π, on the number line. **N.FL.08.05** Estimate and solve problems with square roots and cube roots using calculators. **N.FL.08.06** Find square roots of perfect squares and approximate the square roots of non-perfect squares by locating between consecutive integers, e.g., $\sqrt{130}$ is between 11 and 12.	**L1.1 Number Systems and Number Sense** **L1.1.1** Know the different properties that hold in different number systems, and recognize that the applicable properties change in the transition from the positive integers, to all integers, to the rational numbers, and to the real numbers. **L1.1.2** Explain why the multiplicative inverse of a number has the same sign as the number, while the additive inverse of a number has the opposite sign. **L1.1.3** Explain how the properties of associativity, commutativity, and distributivity, as well as identity and inverse elements, are used in arithmetic and algebraic calculations. **L1.1.4** Describe the reasons for the different effects of multiplication by, or exponentiation of, a positive number by a number less than 0, a number between 0 and 1, and a number greater than 1. **L1.1.5** Justify numerical relationships (e.g., show that the sum of even integers is even; that every integer can be written as $3m+k$, where k is 0, 1, or 2, and m is an integer; or that the sum of the first n positive integers is $n(n+1)/2$). **L1.2 Representations and Relationships** **L1.2.2** Interpret representations that reflect absolute value relationships (e.g. $\lvert x - a \rvert \leq b$, *or* $a \pm b$) in such contexts as error tolerance. **L1.2.4** Organize and summarize a data set in a table, plot, chart, or spreadsheet; find patterns in a display of data; understand and critique data displays in the media.

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Find equivalent ratios **N.ME.06.11** Find equivalent ratios by scaling up or scaling down. **Calculate rates** **A.PA.06.01** Solve applied problems involving rates, including speed, e.g., if a car is going 50 mph, how far will it go in 3 1/2 hours? **Add and subtract integers and rational numbers** **N.MR.06.08** Understand integer subtraction as the inverse of integer addition. Understand integer division as the inverse of integer multiplication. **N.FL.06.09** Add and multiply integers between -10 and 10; subtract and divide integers using the related facts. Use the number line and chip models for addition and subtraction. **N.FL.06.10** Add, subtract, multiply and divide positive rational numbers fluently. **Multiply and divide fractions** **N.MR.06.01** Understand division of fractions as the inverse of multiplication, e.g., if 4/5 ÷ 2/3 = ☐, then 2/3 • ☐ = 4/5 , so ☐ = 4/5 • 3/2 = 12/10 . **N.FL.06.02** Given an applied situation involving dividing fractions, write a mathematical statement to represent the situation. **N.MR.06.03** Solve for the unknown in equations such as 1/4 ÷ ☐= 1, 3/4 ÷ ☐= 1/4 , and 1/2 = 1 • ☐. **N.FL.06.04** Multiply and divide any two fractions, including mixed numbers, fluently.	**Understand derived quantities** **N.MR.07.02** Solve problems involving derived quantities such as density, velocity, and weighted averages. **Understand and solve problems involving rates, ratios, and proportions** **N.FL.07.03** Calculate rates of change including speed. **N.MR.07.04** Convert ratio quantities between different systems of units, such as feet per second to miles per hour. **N.FL.07.05** Solve proportion problems using such methods as unit rate, scaling, finding equivalent fractions, and solving the proportion equation a/b = c/d; know how to see patterns about proportional situations in tables.	**Solve problems** **N.MR.08.10** Calculate weighted averages such as course grades, consumer price indices, and sports ratings. **MR.08.07** Understand percent increase and percent decrease in both sum and product form, e.g., 3% increase of a quantity x is x + .03x = 1.03x. **N.MR.08.08** Solve problems involving percent increases and decreases. **N.FL.08.09** Solve problems involving compounded interest or multiple discounts. **N.FL.08.11** Solve problems involving ratio units, such as miles per hour, dollars per pound, or persons per square mile.	**L2.1 Calculation Using Real and Complex Numbers** **L2.1.1** Explain the meaning and uses of weighted averages (e.g., GNP, consumer price index, grade point average). **L2.1.2** Calculate fluently with numerical expressions involving exponents; use the rules of exponents; evaluate numerical expressions involving rational and negative exponents; transition easily between roots and exponents. **L2.1.3** Explain the exponential relationship between a number and its base 10 logarithm, and use it to relate rules of logarithms to those of exponents in expressions involving numbers. **L2.1.4** Know that the complex number *i* is one of two solutions to $x^2 = -1$. **L2.1.5** Add, subtract, and multiply complex numbers; use conjugates to simplify quotients of complex numbers. **L2.1.6** Recognize when exact answers aren't always possible or practical; use appropriate algorithms to approximate solutions to equations (e.g., to approximate square roots). **L3.1 Measurement Units, Calculations, and Scales** **L3.1.2** Describe and interpret logarithmic relationships in such contexts as the Richter scale, the pH scale, or decibel measurements (e.g., explain why a small change in the scale can represent a large change in intensity); solve applied problems.

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Use variables, write expressions and equations, and combine like terms **A.FO.06.03** Use letters, with units, to represent quantities in a variety of contexts, e.g., y lbs., k minutes, x cookies. **A.FO.06.04** Distinguish between an algebraic expression and an equation. **A.FO.06.05** Use standard conventions for writing algebraic expressions, e.g., 2x + 1 means "two times x, plus 1" and 2(x + 1) means "two times the quantity (x + 1)." **A.FO.06.06** Represent information given in words using algebraic expressions and equations. **A.FO.06.07** Simplify expressions of the first degree by combining like terms, and evaluate using specific values.	**Combine algebraic expressions and solve equations** **A.FO.07.12** Add, subtract, and multiply simple algebraic expressions of the first degree, e.g., (92x + 8y) – 5x + y, or x(x+2) and justify using properties of real numbers. **A.FO.07.13** From applied situations, generate and solve linear equations of the form ax + b = c and ax + b = cx + d, and interpret solutions.	**Recognize, represent, and apply common formulas** **A.FO.08.07** Recognize and apply the common formulas: (a + b)2 = a2 + 2 ab + b2 (a – b)2 = a2 – 2 ab + b2 (a + b) (a – b) = a2 – b2 ; represent geometrically. **A.FO.08.08** Factor simple quadratic expressions with integer coefficients, e.g., $x^2 + 6x + 9$, $x^2 + 2x – 3$, and $x^2 – 4$; solve simple quadratic equations, e.g., $x^2 = 16$ or $x^2 = 5$ (by taking square roots); $x^2 – x – 6 = 0$, $x^2 – 2x = 15$ (by factoring); verify solutions by evaluation. **A.FO.08.09** Solve applied problems involving simple quadratic equations.	**A1.1 Construction, Interpretation, and Manipulation of Expressions** **A1.1.1** Give a verbal description of an expression that is presented in symbolic form, write an algebraic expression from a verbal description, and evaluate expressions given values of the variables. **A1.1.2** Know the definitions and properties of exponents and roots, and apply them in algebraic expressions. **A1.1.3** Factor algebraic expressions using, for example, greatest common factor, grouping, and the special product identities (e.g., differences of squares and cubes). **A1.1.6** Transform exponential and logarithmic expressions into equivalent forms using the properties of exponents and logarithms including the inverse relationship between exponents and logarithms.
Solve equations **A.FO.06.11** Relate simple linear equations with integer coefficients, e.g., 3x = 8 or x + 5 = 10, to particular contexts and solve. **A.FO.06.12** Understand that adding or subtracting the same number to both sides of an equation creates a new equation that has the same solution. **A.FO.06.13** Understand that multiplying or dividing both sides of an equation by the same non-zero number creates a new equation that has the same solutions. **A.FO.06.14** Solve equations of the form ax + b = c, e.g., 3x + 8 = 15 by hand for positive integer coefficients less than 20, use calculators otherwise, and interpret the results.		**Understand solutions and solve equations, simultaneous equations, and linear inequalities** **A.FO.08.10** Understand that to solve the equation f(x) = g(x) means to find all values of x for which the equation is true, e.g., determine whether a given value, or values from a given set, is a solution of an equation (0 is a solution of $3x^2 + 2 = 4x + 2$, but 1 is not a solution). **A.FO.08.11** Solve simultaneous linear equations in two variables by graphing, by substitution, and by linear combination; estimate solutions using graphs; include examples with no solutions and infinitely many solutions. **A.FO.08.12** Solve linear inequalities in one and two variables, and graph the solution sets. **A.FO.08.13** Set up and solve applied problems involving simultaneous linear equations and linear inequalities.	**A1.2 Solutions of Equations and Inequalities** **A1.2.1** Write equations and inequalities with one or two variables to represent mathematical or applied situations, and solve. **A1.2.2** Associate a given equation with a function whose zeros are the solutions of the equation. **A1.2.3** Solve (and justify steps in the solutions) linear and quadratic equations and inequalities, including systems of up to three linear equations with three unknowns; apply the quadratic formula appropriately. **A1.2.4** Solve absolute value equations and inequalities, $\|X-3\| < 6$, and justify steps in the solution. **A1.2.6** Solve power equations (e.g., solve $(x + 1)^3 = 8$) and equations including radical expressions (e.g., solve $\sqrt{(3x - 7)} = 7$), justify steps in the solution, and explain how extraneous solutions may arise. **A1.2.8** Solve an equation involving several variables (with numerical or letter coefficients) for a designated variable, and justify steps in the solution.

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Represent linear functions using tables, equations, and graphs **A.RP.06.08** Understand that relationships between quantities can be suggested by graphs and tables. **A.PA.06.09** Solve problems involving linear functions whose input values are integers; write the equation; graph the resulting ordered pairs of integers, e.g., given c chairs, the "leg function" is 4c; if you have 5 chairs, how many legs?; if you have 12 legs, how many chairs? **A.RP.06.10** Represent simple relationships between quantities using verbal descriptions, formulas or equations, tables, and graphs, e.g., perimeter-side relationship for a square, distance-time graphs, and conversions such as feet to inches. **Understand the coordinate plane** **A.RP.06.02** Plot ordered pairs of integers and use ordered pairs of integers to identify points in all four quadrants of the coordinate plane.	**Understand and apply directly proportional relationships and relate to linear relationships** **A.PA.07.01** Recognize when information given in a table, graph, or formula suggests a directly proportional or linear relationship. **A.RP.07.02** Represent directly proportional and linear relationships using verbal descriptions, tables, graphs, and formulas, and translate among these representations. **A.PA.07.03** Given a directly proportional or other linear situation, graph and interpret the slope and intercept(s) in terms of the original situation; evaluate $y = mx + b$ for specific x values, e.g., weight vs. volume of water, base cost plus cost per unit. **A.PA.07.04** For directly proportional or linear situations, solve applied problems using graphs and equations, e.g., the heights and volume of a container with uniform cross-section; height of water in a tank being filled at a constant rate; degrees Celsius and degrees Fahrenheit; distance and time under constant speed. **A.PA.07.05** Recognize and use directly proportional relationships of the form $y = mx$, and distinguish from linear relationships of the form $y = mx + b$, b non-zero; understand that in a directly proportional relationship between two quantities one quantity is a constant multiple of the other quantity.	**Understand the concept of non-linear functions using basic examples** **A.RP.08.01** Identify and represent linear functions, quadratic functions, and other simple functions including inversely proportional relationships ($y = k/x$); cubics ($y = ax^3$); roots ($y = \sqrt{x}$); and exponentials ($y = ax$, $a > 0$); using tables, graphs, and equations. **A.PA.08.02** For basic functions, e.g., simple quadratics, direct and indirect variation, and population growth, describe how changes in one variable affect the others. **A.PA.08.03** Recognize basic functions in problem context, e.g., area of a circle is πr^2, volume of a sphere is $4/3\ \pi r^3$, and represent them using tables, graphs, and formulas. **A.RP.08.04** Use the vertical line test to determine if a graph represents a function in one variable.	**A2.1 Definitions, Representations, and Attributes of Functions** **A2.1.1** Recognize whether a relationship (given in contextual, symbolic, tabular, or graphical form) is a function; and identify its domain and range. **A2.1.2** Read, interpret, and use function notation, and evaluate a function at a value in its domain. **A2.1.3** Represent functions in symbols, graphs, tables, diagrams, or words, and translate among representations. **A2.1.4** Recognize that functions may be defined by different expressions over different intervals of their domains; such functions are piecewise-defined (e.g., absolute value and greatest integer functions). **A2.1.5** Recognize that functions may be defined recursively, and compute values of and graph simple recursively defined functions (e.g., $f(0) = 5$, and $f(n) = f(n-1) + 2$). **A2.1.6** Identify the zeros of a function and the intervals where the values of a function are positive or negative, and describe the behavior of a function, as x approaches postive or negative infinity, given the symbolic and graphical representations. **A2.1.7** Identify and interpret the key features of a function from its graph or its formula(e), (e.g. slope, intercept(s), asymptote(s), maximum and minimum value(s), symmetry, average rate of change over an interval, and periodicity). **A2.3 Families of Functions** **A2.3.1** Identify a function as a member of a family of functions based on its symbolic or graphical representation; recognize that different families of functions have different asymptotic behavior at infinity, and describe these behaviors. **A2.3.2** Describe the tabular pattern associated with functions having constant rate of change (linear); or variable rates of change.

	Understand and represent linear functions **A.PA.07.06** Calculate the slope from the graph of a linear function as the ratio of "rise/run" for a pair of points on the graph, and express the answer as a fraction and a decimal; understand that linear functions have slope that is a constant rate of change. **A.PA.07.07** Represent linear functions in the form y = x + b, y = mx, and y = mx + b, and graph, interpreting slope and y-intercept. **A.FO.07.08** Find and interpret the x and/or y intercepts of a linear equation or function. Know that the solution to a linear equation of the form ax+b=0 corresponds to the point at which the graph of y=ax+b crosses the x axis. **Understand and solve problems about inversely proportional relationships** **A.PA.07.09** Recognize inversely proportional relationships in contextual situations; know that quantities are inversely proportional if their product is constant, e.g., the length and width of a rectangle with fixed area, and that an inversely proportional relationship is of the form y = k/x where k is some non-zero number. **A.RP.07.10** Know that the graph of y = k/x is not a line, know its shape, and know that it crosses neither the x nor the y-axis.	*(You might consider leaving the concepts in A.RP.08.05 and 06 for Algebra 1 in high school. There is probably enough about quadratic functions in A.RP.08.01 and A.PA.08.02 for a typical 8th grade course, given how this topic is addressed in the HSCEs for Alg 1.)* **Understand and represent quadratic functions** **A.RP.08.05** Relate quadratic functions in factored form and vertex form to their graphs, and vice versa; in particular, note that solutions of a quadratic equation are the x-intercepts of the corresponding quadratic function. **A.RP.08.06** Graph factorable quadratic functions, finding where the graph intersects the x-axis and the coordinates of the vertex; use words "parabola" and "roots"; include functions in vertex form and those with leading coefficient –1, e.g., $y = x^2 - 36$, $y = (x - 2)^2 - 9$; $y = -x^2$; $y = -(x - 3)^2$.	**A2.4 Lines and Linear Functions** **A2.4.1** Write the symbolic forms of linear functions (standard [i.e., Ax + By = C, where B ≠ 0], point-slope, and slope-intercept) given appropriate information, and convert between forms. **A2.4.2** Graph lines (including those of the form x = h and y = k) given appropriate information. **A2.4.3** Relate the coefficients in a linear function to the slope and x- and y-intercepts of its graph. **A2.4.4** Find an equation of the line parallel or perpendicular to given line, through a given point; understand and use the facts that non-vertical parallel lines have equal slopes, and that non-vertical perpendicular lines have slopes that multiply to give -1. **A2.6 Quadratic Functions** **A2.6.1** Write the symbolic form and sketch the graph of a quadratic function given appropriate information (e.g., vertex, intercepts, etc.). **A2.6.2** Identify the elements of a parabola (vertex, axis of symmetry, direction of opening) given its symbolic form or its graph, and relate these elements to the coefficient(s) of the symbolic form of the function. **A2.6.3** Convert quadratic functions from standard to vertex form by completing the square. **A2.6.4** Relate the number of real solutions of a quadratic equation to the graph of the associated quadratic function. **A2.6.5** Express quadratic functions in vertex form to identify their maxima or minima, and in factored form to identify their zeros.

	Represent data and interpret **D.AN.07.02** Create and interpret scatter plots and use an estimated line of best fit to answer questions about the data.		**S2.1 Scatterplots and Correlation** **S2.1.1** Construct a scatterplot for a bivariate data set with appropriate labels and scales. **S2.1.2** Given a scatterplot, identify patterns, clusters, and outliers; recognize no correlation, weak correlation, and strong correlation. **S2.1.3** Estimate and interpret Pearson's correlation coefficient for a scatterplot of a bivariate data set; recognize that correlation measures the strength of linear association. **S2.1.4** Differentiate between correlation and causation; know that a strong correlation does not imply a cause-and-effect relationship; recognize the role of lurking variables in correlation. **S2.2 Linear Regression** **S2.2.1** For bivariate data which appear to form a linear pattern, find the least squares regression line by estimating visually and by calculating the equation of the regression line; interpret the slope of the equation for a regression line. **S2.2.2** Use the equation of the least squares regression line to make appropriate predictions.

The following expectations appear in Algebra 1 but have no direct link to the middle school expectations.

A2.5 Exponential and Logarithmic Functions

A2.5.1 Write the symbolic form and sketch the graph of an exponential function given appropriate information. (e.g., given an initial value of 4 and a rate of growth of 1.5, write $f(x) = 4(1.5)^x$).

A2.5.4 Understand and use the fact that the base of an exponential function determines whether the function increases or decreases and how base affects the rate of growth or decay.

A2.5.5 Relate exponential and logarithmic functions to real phenomena, including half-life and doubling time.

A2.7 Power Functions (including roots, cubics, quartics, etc.)

A2.7.1 Write the symbolic form and sketch the graph of power functions.

A2.7.2 Express direct and inverse relationships as functions (e.g., $y = kxn$ and $y = kx\text{-}n$, $n > 0$) and recognize their characteristics (e.g., in $y = x^3$, note that doubling x results in multiplying y by a factor of 8).

A2.7.3 Analyze the graphs of power functions, noting reflectional or rotational symmetry.

A2.8 Polynomial Functions

A2.8.1 Write the symbolic form and sketch the graph of simple polynomial functions.

A2.8.2 Understand the effects of degree, leading coefficient, and number of real zeros on the graphs of polynomial functions of degree.

A2.8.3 Determine the maximum possible number of zeroes of a polynomial function, and understand the relationship between the x-intercepts of the graph and the factored form of the function.

A2.2 Operations and Transformations

A2.2.1 Combine functions by addition, subtraction, multiplication, and division.

A2.2.2 Apply given transformations (e.g., vertical or horizontal shifts, stretching or shrinking, or reflections about the x- and y-axes) to basic functions, and represent symbolically.

A2.2.3 Recognize whether a function (given in tabular or graphical form) has an inverse and recognize simple inverse pairs (e.g., $f(x) = x^3$ and $g(x) = x^{1/3}$).

A3.1 Models of Real-world Situations Using Families of Functions

Example: An initial population of 300 people grows at 2% per year. What will the population be in 10 years?

A3.1.1 Identify the family of function best suited for modeling a given real-world situation (e.g., quadratic functions for motion of an object under the force of gravity; exponential functions for compound interest. In the example above, recognize that the appropriate general function is exponential ($P = P0a^t$)

A3.1.2 Adapt the general symbolic form of a function to one that fits the specifications of a given situation by using the information to replace arbitrary constants with numbers. In the example above, substitute the given values $P0 = 300$ and $a = 1.02$ to obtain $P = 300(1.02)t$.

A3.1.3 Using the adapted general symbolic form, draw reasonable conclusions about the situation being modeled. In the example above, the exact solution is 365.698, but for this problem an appropriate approximation is 365.