Iowa Mathematics

Algebra 2

Number and Quantity A2.N

N-RN. The Real Number System A2.N-RN

1. Extend the properties of exponents to rational exponents. A2.N-RN.A
   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 (51 3)3 = 5(1 3) 3 to hold, so 5(1 3) 3 must equal 5. A2.N-RN.A.1
   2. Rewrite expressions involving radicals and rational exponents using the properties of exponents. A2.N-RN.A.2

N-Q. Quantities A2.N-Q

1. Reason quantitatively and use units to solve problems. A2.N-Q.A
   1. Use units 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. (A1 and A2) A2.N-Q.A.1
   2. Define appropriate quantities for the purpose of descriptive modeling. A2.N-Q.A.2
   3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A2.N-Q.A.3

N-CN. The Complex Number System A2.N-CN

1. Perform arithmetic operations with complex numbers. A2.N-CN.A
   1. Know there is a complex number ii such that $ii2 = -1$, and every complex number has the form $aa + bbbb$ with aa and bb real. A2.N-CN.A.1
   2. Use the relation ii 2 = −1and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. A2.N-CN.A.2
2. Use complex numbers in polynomial identities and equations. A2.N-CN.C
   1. Solve quadratic equations with real coefficients that have complex solutions. A2.N-CN.C.7

Algebra A2.A

A-SSE. Seeing Structure in Expressions and Equations A2.A-SSE

1. Interpret the structure of expressions. A2.A-SSE.A
   1. Interpret expressions that represent a quantity in terms of its context. For example, interpret $PP(1 + rr)nn$ as the product of PP and aa factor not depending on PP. ★ A2.A-SSE.A.1B
   2. Use the structure of an expression to identify ways to rewrite it. For example, see $xx4 - yy4$ as $(xx2)2 - (yy2)2$, thus recognizing it as a difference of squares that can be factored as $(xx2 - yy2)(xx2 + yy2)$. A2.A-SSE.A.2
2. Write expressions and equations in equivalent forms to solve problems. A2.A-SSE.B
   1. Choose and produce an equivalent form of an expression or equation to reveal and explain properties of the quantity represented by the expression. (A1 and A2) A2.A-SSE.B.3
      a. Factor a quadratic expression to reveal the zeros of the function it defines. A2.A-SSE.B.3.A
      b. Complete the square in a quadratic equation to reveal the maximum or minimum value of the function it defines. A2.A-SSE.B.3.B
      c. Use the properties of exponents to transform expressions for exponential functions. For example, the expression $3xx$ can be rewritten as $(1 + 2)xx$ to reveal the growth rate is 200%. ★ A2.A-SSE.B.3.C
   2. Apply 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. ★ A2.A-SSE.B.4

A-APR. Arithmetic with Polynomials and Rational Expressions A2.A-APR

1. Perform arithmetic operations on polynomials. A2.A-APR.A
    1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. A2.A-APR.A.1
2. Understand the relationship between zeros and factors of polynomials. A2.A-APR.B
    1. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by $xx - aa$ is $pp(aa)$, so $pp(aa) = 0$ if and only if $(xx - aa)$ is a factor of $pp(xx)$. A2.A-APR.B.2
    2. 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. A2.A-APR.B.3
3. Rewrite rational expressions. A2.A-APR.D
    1. Rewrite simple rational expressions in different forms; write $aa(xx)\ bb(xx)$ in the form $qq(xx) + rr(xx)\ bb(xx)$, where $aa(xx)$, $bb(xx)$, $qq(xx)$, and $rr(xx)$ are polynomials with the degree of r(x) less than the degree of b(x). For example, in the same way one may view 11 7 as (7+4) 7 = 1 + 4 7 , one can view $(xx+7)\ (xx+3)$ as $((xx+3)+4)\ (xx+3) = 1 + 4\ xx+3$ A2.A-APR.D.6

A-CED. Creating Equations ★ A2.A-CED

1. Create equations that describe numbers or relationships. A2.A-CED.A
    1. Create equations and inequalities in one variable and use them to solve problems. (A1 and A2) A2.A-CED.A.1
    2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (A1 and A2) A2.A-CED.A.2
    3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods. (A1 and A2) A2.A-CED.A.3
    4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange the formula for the area of a trapezoid, A =(b1 +b2)/2*h for the length of one of the bases. (A1 and A2) A2.A-CED.A.4

A-REI. Reasoning with Equations and Inequalities A2.A-REI

1. Understand solving equations as a process of reasoning and explain the reasoning. A2.A-REI.A
    1. Explain each step in solving an 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. (A1 and A2) A2.A-REI.A.1
    2. Solve rational and radical equations in one variable and give examples showing how extraneous solutions may arise. (A1 and A2) A2.A-REI.A.2
2. Solve equations and inequalities in one variable. A2.A-REI.B
    1. Solve quadratic equations in one variable. (A1 and A2) A2.A-REI.B.4
        a. Use the method of completing the square to transform any quadratic equation in xx into an equation of the form $(xx - pp)2 = qq$ that has the same solutions. A2.A-REI.B.4.A
        b. Solve quadratic equations with real solutions using any method. A2.A-REI.B.4.B
3. Solve systems of equations. A2.A-REI.C
    1. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. (A1 and A2) A2.A-REI.C.7
4. Represent and solve equations and inequalities graphically. A2.A-REI.D
    1. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). (A1 and A2) A2.A-REI.D.10
    2. Explain why the solution(s) of a system of equations are the point(s) of intersection(s) on a coordinate plane. Find the solutions approximately. For example, using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $ff(xx)$ and/or $gg(xx)$ are quadratic, exponential, rational, absolute value functions, polynomial, exponential, and logarithmic functions. ★ (A1 and A2) A2.A-REI.D.11
    3. Graph and interpret (with the use of technology) the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. (A1 and A2) A2.A-REI.D.12

Functions A2.F

F-IF. Interpreting Functions A2.F-IF

1. Interpret functions that arise in applications in terms of the context. A2.F-IF.B
    1. 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 may include intercepts; intervals where the function is increasing, decreasing, positive, or negative; maximum and minimum; and symmetries. ★ (A1 and A2) A2.F-IF.B.4
    2. Relate the domain of a function to its graph and, where applicable, 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. ★ (A1 and A2) A2.F-IF.B.5
    3. Calculate and interpret the average rate of change of a nonlinear function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. ★ (A1 and A2) A2.F-IF.B.6
2. Analyze functions using different representations. A2.F-IF.C
    1. Graph functions expressed symbolically and show key features of the graph by hand in simple cases and using technology for more complicated cases. ★ (A1 and A2) A2.F-IF.C.7
        a. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. A2.F-IF.C.7.A
        b. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. A2.F-IF.C.7.B
        c. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. A2.F-IF.C.7.C

        Note: a exists and can be found in A1.
    2. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. For example, rewrite rational expressions to show the vertical transformation. (A1 and A2) A2.F-IF.C.8
    3. 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. A2.F-IF.C.9

F-BF. Building Functions F-BF

1. Build a function that models a relationship between two quantities. A2.F-BF.A
   1. Write a function that describes a relationship between two quantities. 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. ★ A2.F-BF.A.1B
   2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. ★ (A1 and A2) A2.F-BF.A.2
2. Build new functions from existing functions. A2.F-BF.B
   1. Identify the effect on linear and quadratic graphs of replacing $ff(xx)$ by $ff(xx) + kk$, $kkkk(xx)$, $ff(kkkk)$, and $ff(xx + kk)$ for specific values of kk (both positive and negative); find the value of kk 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. (A1 and A2) A2.F-BF.B.3
   2. Find inverse functions. A2.F-BF.B.4
      a. Solve an equation of the form $ff(xx) = cc$ for a simple function ff that has an inverse and write an expression for the inverse. For example, $ff(xx) = 2xx3$ or, $ff(xx) = (xx+1)\ (xx-1)$ for $xx \neq 1$. A2.F-BF.B.4.A

F-LE. Linear, Quadratic, and Exponential Models ★ F-LE

1. Construct and compare linear, quadratic, and exponential models and solve problems. A2.F-LE.A
   1. 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). (A1 and A2) A2.F-LE.A.2
   2. For exponential models, express as a logarithm the solution to $aa, bbcccc = dd$ where aa, bb, cc, and dd are numbers and the base aa is 2, 10, or ee, evaluate the logarithm using technology. A2.F-LE.A.4
2. Interpret expressions for functions in terms of the situation they model. A2.F-LE.B
   1. Interpret the parameters in a linear or exponential function in terms of a context. (A1 and A2) A2.F-LE.B.5

A2F-TF. Trigonometric Functions A2F-TF

1 Extend the domain of trigonometric functions using the unit circle. A2F-TF.A

1 Understand the radian measure of an angle as the length of the arc on the unit circle subtended by the angle. A2.F-TF.A.1

2 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. A2.F-TF.A.2

3 Use special triangles to determine geometrically the values of sine, cosine for $\pi\pi$ 3 , $\pi\pi$ 4 , and $\pi\pi$ 6 , and use the unit circle to express the values of sine and cosine for $\pi\pi - xx$, $\pi\pi + xx$, and $2\pi\pi - xx$ in terms of their values for xx, where xx is any real number. Note: Does not include tangent. A2.F-TF.A.3

4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. A2.F-TF.A.4

2 Model periodic phenomena with trigonometric functions. A2F-TF.B

1 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. ★ A2.F-TF.B.5

Statistics and Probability ★ A2.S

S-ID. Interpreting Categorical and Quantitative Data ★ A2.S-ID

1 Summarize, represent, and interpret data on a single count or measurement variable. ★ S-ID.A

1 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. ★ A2.S-ID.A.4

S-IC. Making Inferences and Justifying Conclusions ★ A2.S-IC

1. Understand and evaluate random processes underlying statistical experiments.★ A2.S-IC.A
    1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. ★ A2.S-IC.A.1
    2. Decide if a specified model is consistent with results from a given data-generating process. For example, using simulation or 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? ★ A2.S-IC.A.2
2. Make inferences and justify conclusions from sample surveys, experiments, and observational studies.★ S-IC.B
    1. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. ★ A2.S-IC.B.3
    2. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error using simulation models for random sampling. ★ A2.S-IC.B.4
    3. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. ★ A2.S-IC.B.5
    4. Evaluate reports based on data. ★ A2.S-IC.B.6