

# Math I

## The Real Number System

N-RN

### Extend the properties of exponents to rational exponents.

**N-RN.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  $(5^{1/3})^3 = 5(1/3)^3$  to hold, so  $(5^{1/3})^3$  must equal 5.

**N-RN.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents.

*Note: At this level, focus on fractional exponents with a numerator of 1.*

## Quantities

N-Q

### Reason quantitatively and use units to solve problems.

**N-Q.1** 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.

**N-Q.2** Define appropriate quantities for the purpose of descriptive modeling.

**N-Q.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

## Seeing Structure in Expressions

A-SSE

### Interpret the structure of expressions.

**A-SSE.1** Interpret expressions that represent a quantity in terms of its context.

- Interpret parts of an expression, 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  $P$ .*

*Note: At this level, limit to linear expressions, exponential expressions with integer exponents and quadratic expressions.*

**A-SSE.2** 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  $(x^2 - y^2)(x^2 + y^2)$ .*

### Write expressions in equivalent forms to solve problems.

**A-SSE.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

- Factor a quadratic expression to reveal the zeros of the function it defines.

*Note: At this level, the limit is quadratic expressions of the form  $ax^2 + bx + c$ .*

## Arithmetic with Polynomials & Rational Expressions

A-APR

### Perform arithmetic operations on polynomials.

**A-APR.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.

*Note:* At this level, limit to addition and subtraction of quadratics and multiplication of linear expressions.

## **Creating Equations**

**A-CED**

### **Create equations that describe numbers or relationships.**

**A-CED.1** 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.

*Note:* At this level, focus on linear and exponential functions.

**A-CED.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

*Note:* At this level, focus on linear, exponential and quadratic. Limit to situations that involve evaluating exponential functions for integer inputs.

**A-CED.3** Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

*Note:* At this level, limit to linear equations and inequalities.

**A-CED.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law  $V = IR$  to highlight resistance  $R$ .*

*Note:* At this level, limit to formulas that are linear in the variable of interest, or to formulas involving squared or cubed variables.

## **Reasoning with Equations & Inequalities**

**A-REI**

### **Understand solving equations as a process of reasoning and explain the reasoning.**

**A-REI.1** 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.

### **Solve equations and inequalities in one variable.**

**A-REI.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

### **Solve systems of equations.**

**A-REI.5** Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

**A-REI.6** Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

**Represent and solve equations and inequalities graphically.**

**A-REI.10** 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).

*Note:* At this level, focus on linear and exponential equations.

**A-REI.11** 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.

*Note:* At this level, focus on linear and exponential functions.

**A-REI.12** Graph 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.

**Interpreting Functions****F-IF****Understand the concept of a function and use function notation.**

**F-IF.1** 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. 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  $x$ . The graph of  $f$  is the graph of the equation  $y = f(x)$ .

**F-IF.2** Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

*Note:* At this level, the focus is linear and exponential functions.

**F-IF.3** 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  $n \geq 1$ .

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

**F-IF.4** 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.

*Note:* At this level, focus on linear, exponential and quadratic functions; no end behavior or periodicity.

**F-IF.5** 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.

**Note:** At this level, focus on linear and exponential functions.

**F-IF.6** 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.

**Note:** At this level, focus on linear functions and exponential functions whose domain is a subset of the integers.

### Analyze functions using different representations.

**F-IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

- Graph linear and quadratic functions and show intercepts, maxima, and minima.
- Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

**Note:** At this level, for part e, focus on exponential functions only.

**F-IF.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

- Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

**Note:** At this level, only factoring expressions of the form  $ax^2 + bx + c$ , is expected. Completing the square is not addressed at this level.

- 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.

**F-IF.9** 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.

**Note:** At this level, focus on linear, exponential, and quadratic functions.

## Building Functions

## F-BF

### Build a function that models a relationship between two quantities.

**F-BF.1** Write a function that describes a relationship between two quantities.

- Determine an explicit expression, a recursive process, or steps for calculation from a context.
- 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.

**Note:** At this level, limit to addition or subtraction of constant to linear, exponential or quadratic functions or addition of linear functions to linear or quadratic functions.

**F-BF.2** Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

*Note: At this level, formal recursive notation is not used. Instead, use of informal recursive notation (such as NEXT = NOW + 5 starting at 3) is intended.*

**Build new functions from existing functions.**

**F-BF.3** 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  $k$  (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.

*Note: At this level, limit to vertical and horizontal translations of linear and exponential functions. Even and odd functions are not addressed.*

**Linear, Quadratic, & Exponential Models**

**F-LE**

**Construct and compare linear and exponential models and solve problems.**

**F-LE.1** Distinguish between situations that can be modeled with linear functions and with exponential functions

- Prove 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.

**F-LE.2** 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).

**F-LE.3** Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

*Note: At this level, limit to linear, exponential, and quadratic functions; general polynomial functions are not addressed.*

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

**F-LE.5** Interpret the parameters in a linear or exponential function in terms of a context.

**Congruence**

**G-CO**

**Experiment with transformations in the plane.**

**G-CO.1** Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

*Note: At this level, distance around a circular arc is not addressed.*

**Expressing Geometric Properties with Equations**

**G-GPE**

**Use coordinates to prove simple geometric theorems algebraically.**

**G-GPE.4** Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point  $(1, \sqrt{3})$  lies on the circle centered at the origin and containing the point  $(0, 2)$ .

*Note:* Conics is not the focus at this level, therefore the last example is not appropriate here.

**G-GPE.5** Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

**G-GPE.6** Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

*Note:* At this level, focus on finding the midpoint of a segment.

**G-GPE.7** Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

### **Geometric Measurement & Dimension**

**G-GMD**

**Explain volume formulas and use them to solve problems.**

**G-GMD.1** Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

*Note:* Informal limit arguments are not the intent at this level.

**G-GMD.3** Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.\*

*Note:* At this level, formulas for pyramids, cones and spheres will be given.

### **Interpreting Categorical & Quantitative Data**

**S-ID**

**Summarize, represent, and interpret data on a single count or measurement variable.**

**S-ID.1** Represent data with plots on the real number line (dot plots, histograms, and box plots).

**S-ID.2** 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.

**S-ID.3** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

**Summarize, represent, and interpret data on two categorical and quantitative variables.**

**S-ID.5** 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.

**S-ID.6** 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 and exponential models.
- b. Informally assess the fit of a function by plotting and analyzing residuals.

*Note: At this level, for part b, focus on linear models.*

- c. Fit a linear function for a scatter plot that suggests a linear association.

**Interpret linear models.**

**S-ID.7** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

**S-ID.8** Compute (using technology) and interpret the correlation coefficient of a linear fit.

**S-ID.9** Distinguish between correlation and causation.