MAFS.912.F-IF.3.8 Also assesses MAFS.912.A-APR.2.3 Also assesses MAFS.912.F-IF.3.7a, b, c, and e.	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. 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. b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y=(1.02)^t$, $y=(0.97)^t$, $y=(1.01)^{12t}$, *and* $y=(1.2)^{t/10}$ *and classify them as representing exponential growth or decay.* 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. Graph functions expressed symbolically and show key features of the graph by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. c. Graph polynomial functions, identifying zeros when suitable factorizations are available and showing end behavior. d. Graph rational functions, identifying zeros and asymptotes 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 and using phase shift.
Item Types	Equation Editor – May require creating a value, an expression, or an equation. GRID – May require plotting points, key features, or an equation on a graph; identifying key features; or selecting key features on a graph. Hot Text – May require selecting key features on a graph. Multiple Choice – May require selecting from a list. Multiselect – May require selecting multiple responses. Open Response – May require explaining and interpreting a function.
Clarifications	Students will identify zeros, extreme values, and symmetry of a quadratic function written symbolically.

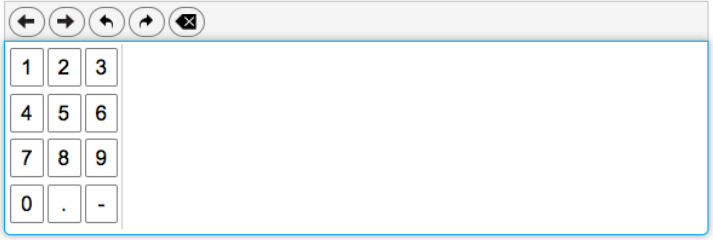
	Students will classify the exponential function as exponential growth or decay by examining the base, and students will give the rate of growth or decay. Students will use the properties of exponents to interpret exponential expressions in a real-world context. Students will write an exponential function defined by an expression in different but equivalent forms to reveal and explain different properties of the function, and students will determine which form of the function is the most appropriate for interpretation for a real-world context. Students will find the zeros of a polynomial function when the polynomial is in factored form. Students will create a rough graph of a polynomial function in factored form by examining the zeros of the function. Students will use the x-intercepts of a polynomial function and end behavior to graph the function. Students will identify the x- and y-intercepts and the slope of the graph of a linear function. Students will identify zeros, extreme values, and symmetry of the graph of a quadratic function. Students will identify intercepts and end behavior for an exponential function. Students will graph a linear function using key features. Students will graph a quadratic function using key features. Students will graph an exponential function using key features. Students will identify and interpret key features of a graph within the real-world context that the function represents.
Assessment Limits	For A-APR.2.3, the leading coefficient should be an integer and the polynomial's degree is restricted to 3 or 4. The polynomial function should not have a zero with multiplicity. The polynomial should be given in factored form. For F-IF.3.8a, items that require the student to transform a quadratic equation to vertex form, the coefficient of the linear term must be an even factor of the coefficient of the quadratic form. For F-IF.3.7e and F-IF.3.8b, exponential functions are limited to simple

	exponential growth and decay functions and to exponential functions with one translation. Base e should not be used. For F-IF.3.8, items may specify a required form using an equation or using common terminology such as standard form. In items that require the student to interpret the vertex or a zero of a quadratic function within a real-world context, the student should interpret both the *x*-value and the *y*-value. For F-IF.3.7a, quadratic functions that are given in the form $y = ax^2 + bx + c$, a, b, and c must be integers. Quadratic functions given in vertex form $y = a(x - h)^2 + k$, a, h, and k must be integers. Quadratic functions given in other forms should be able to be rewritten and adhere to one of the two previous forms.
Stimulus Attributes	Items may require the student to identify a correct graph. Items may be set in a mathematical or real-world context. Items may use function notation. Items should not require the student to complete a sign chart for a polynomial.
Response Attributes	For F-IF.3.7, items may require the student to apply the basic modeling cycle. Items may require the student to choose an appropriate level of accuracy. Items may require the student to choose and interpret the scale in a graph. Items may require the student to choose and interpret units. Responses with square roots should require the student to rewrite the square root so that the radicand has no square factors.
Calculator	Neutral

Sample Item	Item Type
	Item Stimulus with 2 items types associated: Equation Editor and Multiselect.

A bird drops a stick from the top of Miami Tower. The height of the stick after x seconds is given by $f(x) = 625 - 16x^2$.

What is the maximum value of $f(x)$?



Select all the correct interpretations of the coordinates of the point at the maximum of the function $f(x)$.

- ☐ the time it takes the stick to hit the ground
- ☐ the time when the stick is at its highest point
- ☐ the height of the stick when it is dropped from Miami Tower
- ☐ the distance of the stick from Miami Tower when it hits the ground
- ☐ the time when the stick is dropped from the top of the Miami Tower