

Mathematics

Unit/Timeframe: Polynomials and Polynomial Functions / 18 days	Grade Level: 9, 10, 11, 12
Content Standards	2017 MA Literacy Framework
All.N-CN.C.7 Solve quadratic equations with real coefficients that have complex solutions. All.N-CN.C.8 (+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$ All.N-CN.C.9 (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. All.A-SSE.A.1.a Interpret parts of an expression, such as terms, factors, and coefficients All.A-SSE.A.2 Use the structure of an expression to identify ways to rewrite it. All.A-APR.A.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under certain operations. All.A-APR.B.2 Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$. All.A-APR.B.3 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. All.A-APR.C.4 Prove polynomial identities and use them to describe numerical relationships. All.A-APR.C.5 (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle. All.A-APR.D.6 Rewrite simple rational expressions in different forms; write $\frac{a(x)}{b(x)}$ in the form $q(x) + \frac{r(x)}{b(x)}$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system. All.A-REI.D.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 polynomial, rational, and logarithmic functions. All.F-IF.B.4 For a function that models a relationship between two quantities,	Speaking and Listening Standard: Comprehension and Collaboration 2. Reason abstractly and quantitatively 3. Construct viable arguments and respond to the reasoning of others. Writing Standard: Text, type and purposes 1C. Use words, phrases and clauses with precision.

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. All.F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. All.F-IF.B.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. All.F-IF.C.7 Graph functions expressed symbolically and show key features of the graph; by hand in simple cases and using technology for more complicated cases. All.F-IF.C.7.b Graph square root and cube root functions. All.F-IF.C.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. All.F-IF.C.9 Translate among different representations of functions (algebraically, graphically, numerically in tables, or by verbal descriptions). Compare properties of two functions each represented in a different way. All.F-BF.A.1 Write a function (simple rational, radical, logarithmic, and trigonometric functions) that describes a relationship between two quantities. All.F-BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Include simple rational, radical, logarithmic, and trigonometric functions. Utilize technology to 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.	
Essential Questions	Skills/Knowledge
What does the degree of a polynomial tell you about its related polynomial function? For a polynomial function, how are factors, zeros, and x-intercepts related? For a polynomial equation, how are factors and roots related?	Students will be able to classify polynomials, graph simple polynomial functions, and describe turning points and end behavior. Students will be able to analyze the factored form of a polynomial and will be able to write a polynomial function from its zeros. Students will be able to solve polynomial equations by factoring and by graphing. Students will be able to divide polynomials by long division and by synthetic division. They will be able to use the Remainder Theorem to evaluate a polynomial function. Students will be able to solve equations using the Rational Root Theorem and use the Conjugate Root Theorem.

	Students will prove polynomial identities and use them to describe numerical relationships. Students will be able to use the Fundamental Theorem of Algebra to solve polynomial equations with complex solutions. Students will be able to construct a rough graph of a polynomial functions using zeros, turning points, and end behavior. Students will be able to expand a binomial using Pascal's triangle and/or the Binomial Theorem. Students will be able to apply transformations to polynomial functions.
Common Resources	Common Assessments
Algebra II text and available resources	Quiz 1: Classifying Polynomial Functions, Turning points and end behavior, Linear factors and zeros, graphing simple polynomial functions, solving polynomial equations, Quiz 2: Dividing polynomial functions (long division and synthetic) Remainder Theorem, Rational roots, Fundamental theorem of Algebra, Pascal's Triangle and the Binomial theorem. Unit Test 5
Vocabulary	
Tier II: Degree of a monomial Degree of a polynomial expand a binomial monomial polynomial relative maximum relative minimum Turning point Tier III: Binomial Theorem Conjugate Root Theorem Constant of proportionality Descartes' Rule of Signs difference of cubes end behavior	

Factor Theorem
Fundamental Theorem of Algebra
multiple zero
multiplicity
Pascal's Triangle
polynomial function
power function
Rational Root Theorem
Remainder Theorem
standard form of a polynomial function
sum of cubes
synthetic division

Additional Notes