Standards	Precalculus Lesson(s)
Arithmetic with Polynomials and Rational Expressions	
A-APR.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 $p(x)$.	1.2
A-APR.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.	10.2
A-APR.6 Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, 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.	2.3
A-APR.7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.	1.4
Reasoning with Equations and Inequalities	
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.	1.4, 2.2
A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.	2.2
A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 +y^2 = 3$.*	1.4
A-REI.8 Represent a system of linear equations as a single matrix equation in a vector variable.	9.4
A-REI.9 Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater).	9.4
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.	1.4
Seeing Structure in Expressions	
A-SSE.1a Interpret parts of an expression, such as terms, factors, and coefficients.	1.1
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 $(x^2 - y^2)(x^2 + y^2)$.*	1.1, 1.2, 2.3
A-SSE.3a Factor a quadratic expression to reveal the zeros of the function it defines.	1.2
Building Functions	
F-BF.1c Compose functions. *For example, if $T(y)$ is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.*	3.1, 7.5
F-BF.4a Solve an equation of the form $f(x)$ = c for a simple function f that has an inverse and write an expression for the inverse. *For example, f(x) =$2x^3$ or f(x) = (x+1)/(x–1) for x ≠ 1.*	3.2
F-BF.4b Verify by composition that one function is the inverse of another.	3.2
F-BF.4c Read values of an inverse function from a graph or a table, given that the function has an inverse.	3.3
F-BF.4d Produce an invertible function from a non-invertible function by restricting the domain.	3.3, 3.4
F-BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.	3.4

Interpreting Functions

Standard	Lessons
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 $y = f(x)$.	2.1, 3.1
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.	2.1
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.*	2.4, 2.6
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.	2.1
F-IF.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.	2.2, 2.6, 2.7
F-IF.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.	1.2
F-IF.7d Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.	2.4, 2.5
F-IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.	4.3, 4.5
F-IF.8a Use the process of factoring and completing the square in quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.	1.1
F-IF.8b 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.*	3.5

Linear, Quadratic, and Exponential Models

Standard	Lessons
F-LE.4 For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.	3.5

Trigonometric Functions

Standard	Lessons
F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.	4.1
F-TF.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.	4.2
F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi–x$, $\pi+x$, and $2\pi–x$ in terms of their values for x, where x is any real number.	4.2
F-TF.4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.	4.4
F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.	4.4
F-TF.6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows it's inverse to be constructed.	4.6
F-TF.7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.	4.6, 5.3
F-TF.8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.	5.1
F-TF.9 Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.	5.1, 5.2

Circles

Standard	Lessons
G-C.4 Construct a tangent line from a point outside a given circle to the circle.	4.2

Congruence	
G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).	6.4
G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.	6.4
Geometric Measurement and Dimension	
G-GMD.2 Give an informal argument using Cavalier's principle for the formulas for the volume of a sphere and other solid figures.	4.1
Expressing Geometric Properties with Equations	
G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.	7.3
G-GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.	7.3, 7.4
Similarity, Right Triangles, and Trigonometry	
G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.	4.1
G-SRT.9 Derive the formula $A = 1/2\ ab$ sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.	4.1
G-SRT.10 Prove the Laws of Sines and Cosines and use them to solve problems.	5.4
G-SRT.11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).	5.4
The Complex Number System	
N-CN.3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.	6.1, 6.2
N-CN.4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.	7.1, 7.2
N-CN.5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation.	6.4, 7.1, 7.2
N-CN.6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.	6.3
N-CN.8 Extend polynomial identities to the complex numbers. *For example, rewrite x^2 + 4 as $(x + 2i)$ $(x - 2i)$.*	1.3
N-CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.	1.3
Vector Quantities and Matrices	
N-VM.1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes. (e.g., *v*, |*v*|, ||*v*||, *and v*).	8.1, 8.4
N-VM.2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.	8.1
N-VM.3 Solve problems involving velocity and other quantities that can be represented by vectors.	8.4
N-VM.4a Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.	8.2, 8.4
N-VM.4b Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.	8.2
N-VM.4c Understand vector subtraction *v* − *w* as *v* + (−*w*), where −*w* is the additive inverse of *w*, with the same magnitude as *w* and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.	8.2, 8.4

N-VM.5 Multiply a vector by a scalar.	8.3, 8.4
N-VM.5a Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.	8.3
N-VM.5b Compute the magnitude of a scalar multiple $c\boldsymbol{v}$ using $||c\boldsymbol{v}|| = |c|v$. Compute the direction of $c\boldsymbol{v}$ knowing that when $|c|v \neq 0$, the direction of $c\boldsymbol{v}$ is either along $\boldsymbol{v}$ (for $c > 0$) or against $\boldsymbol{v}$ (for $c < 0$).	8.3
N-VM.6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.	9.1
N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.	9.2
N-VM.8 Add, subtract, and multiply matrices of appropriate dimensions.	9.2
N-VM.9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.	9.3
N-VM.10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.	9.3
N-VM.11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.	8.5, 9.5
N-VM.12 Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.	9.5
Conditional Probability and the Rules of Probability	
S-CP.8 Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.	10.1
S-CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.	10.1
Using Probability to Make Decisions	
S-MD.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.	10.3, 10.5
S-MD.2 Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.	10.3, 10.4, 10.5
S-MD.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. *For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*	10.4, 10.5
S-MD.4 Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. *For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*	10.4
S-MD.5a Find the expected payoff for a game of chance. *For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.*	10.6
S-MD.5b Evaluate and compare strategies on the basis of expected values. *For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*	10.6
S-MD.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).	10.7
S-MD.7 Analyze decisions and strategies using probability concepts (e.g. Product testing, medical testing, pulling a hockey goalie at the end of a game).	10.8