

# Precalculus Big Ideas

## Course Description

Prerequisite: Intermediate Algebra

Precalculus students learn to use and understand the following fundamental concepts:

1. Simplify expressions
2. Solve equations/inequalities
3. Use numerical representations
4. Use graphical representations
5. Use algebraic notation
6. Use a variety of functions to model authentic situations.

In preparation for Precalculus, students should have mastered linear and quadratic functions and be able to confidently work with expressions containing rational exponents and radical and rational terms. Areas of study for the course will include exponential, power, polynomial, rational, logarithmic, and piece-wise functions, along with trigonometric functions and their inverses. Students will investigate and explore mathematical ideas using methods that will help them gain a deep understanding of fundamental concepts, develop multiple strategies for analyzing complex situations, and acquire appropriate technological skills. Students will analyze situations verbally, numerically, graphically, and symbolically. Effective communication skills will be developed so that students will be able to discuss, explain, and justify their thoughts and ideas. While mathematical skills will be developed, teaching will focus on building a deep understanding of concepts that will enable students to apply mathematical skills and make meaningful connections to life's experiences. Because of the importance of technology in this course, access to a graphing calculator is required

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The following matrix lists topics covered in Precalculus and is designed to show flow of understanding for students as they progress from other math classes to this course. The two columns following each big idea detail how this topic should be covered. "Solidify" indicates students have seen this concept in a previous course (see Intermediate Algebra outline); it is not intended to be an exhaustive list of all topics previously covered. These concepts may need to be reviewed and should be used throughout the course so that students have mastery by the end of this class. "Develop" indicates new aspects of the big idea presented in this course and it is expected that students successfully completing Precalculus will have facility with these new topics. The USOE Core is linked to big ideas and sub topics, and should be referenced for clarification of concepts. In addition, a blank column is included for textbook alignment. It is suggested that each school match this curriculum with their text book and other instructional resources for alignment.

Indicators have been created in outline form for each "develop" topic and are included as an attachment to this document. These indicators provide clarification for each topic.

<u>Big Idea</u>	<u>Solidify</u>	<u>Develop</u>	<u>State Core Correlation</u>	<u>Textbook Alignment</u>
Functions	<ul style="list-style-type: none"> <li>• Use function notation</li> <li>• Graph and determine domain/range of absolute value, quadratic, radical, sine and cosine, exponential and logarithmic functions (from ordered pairs, table, algebraic representation, or graph)</li> <li>• Find inverse functions</li> <li>• Compose functions and identify the resulting domain and range.</li> </ul>	<ul style="list-style-type: none"> <li>• Families of Functions and their inverses(exponential, power, polynomial, rational, logarithmic, piece-wise, trigonometric) <ul style="list-style-type: none"> <li>• Graph completely and accurately (i.e. intercepts, min/max, asymptotes (vertical, horizontal, slant/oblique), scale, arrows/endpoints, holes, domain/range, etc</li> <li>• Transformations</li> <li>• Approximate instantaneous and average rates of change using graphical and numerical data</li> <li>• Asymptotes (defined as a limit)</li> <li>• Define increasing/decreasing intervals using interval notation</li> <li>• End behavior (defined as a limit)</li> <li>• Symmetry of even/odd functions</li> <li>• Solving equations</li> <li>• Find Inverse Functions and verify numerically, graphically, and algebraically that two functions are inverses</li> <li>• Continuity/Discontinuity</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• 2.3</li> <li>• 2.2.b</li> <li>• 2.2.c</li> <li>• 2.3.b</li> <li>• 2.3.c</li> <li>• 2.3.d</li> <li>• 2.3.c, 2.3.e</li> <li>• 2.3.c</li> <li>2.3.a</li> <li>2.3.c, 2.3.e</li> </ul>	

<p>Quadratic Functions</p>	<ul style="list-style-type: none"> <li>• Factor quadratics (include by grouping) with real coefficients including special cases</li> <li>• Solve quadratic equations (factoring, completing the square, quadratic formula, graphically)</li> <li>• Write the equation of a parabola in form when given a graph and identify max/min values.</li> <li>• Graph quadratic equations by identifying transformations and identify vertex, intercepts, and axis of symmetry.</li> <li>• Connect roots, zeros, solutions, and <math>x</math>-intercepts</li> <li>• Write possible quadratic equations using rational roots</li> </ul>	<ul style="list-style-type: none"> <li>• Attributes of quadratic functions (see the function big idea section)</li> <li>• Factor and Solve other equations in quadratic form:  <math display="block">a [f(x)]^2 + b [f(x)] + c = 0</math> </li> <li>• Model authentic situations using quadratic functions</li> </ul>	<ul style="list-style-type: none"> <li>•</li> <li>•</li> </ul>	
<p>Polynomials</p>	<ul style="list-style-type: none"> <li>• Multiply any polynomials</li> <li>• Use notation (descending order, degree)</li> <li>• Linear Equations**</li> <li>• Quadratic Equations**</li> </ul>	<ul style="list-style-type: none"> <li>• Attributes of polynomial functions (see the function big idea section)</li> <li>• Solve higher degree equations over the complex numbers using various methods (i.e. factoring, polynomial long division, synthetic division, rational root theorem, Descartes' Rule of Signs, etc.)</li> <li>• Model authentic situations using polynomial functions</li> </ul>	<ul style="list-style-type: none"> <li>• 2.1.c</li> <li>• 2.1.c, 2.2.a</li> </ul>	
<p>Radical Expressions and Functions</p>	<ul style="list-style-type: none"> <li>• Solve radical equations algebraically, numerically, and graphically including consideration of extraneous</li> </ul>	<ul style="list-style-type: none"> <li>• Attributes of Radicals functions (see the function big idea section)</li> <li>• Solve radical equations and inequalities with indices greater than 2</li> </ul>	<ul style="list-style-type: none"> <li>• 2.2.a</li> </ul>	

		<ul style="list-style-type: none"> <li>• Model authentic situations using radicals functions</li> </ul>	<ul style="list-style-type: none"> <li>• 2.3.a, 2.3.f</li> </ul>	
Rational Expressions and Functions	<ul style="list-style-type: none"> <li>• Simplify rational expressions with variables in numerator and denominator</li> <li>• Add, subtract, multiply, and divide rational expressions</li> <li>• Solve rational equations algebraically, numerically, and graphically including those with extraneous solutions</li> <li>• Simplify complex rational expressions</li> <li>• Solve rational equations</li> </ul>	<ul style="list-style-type: none"> <li>• Attributes of rational functions (see the function big idea section)</li> <li>• Model authentic situations using rational functions</li> <li>• Graph Rational Functions identifying holes, asymptotes, discontinuities</li> </ul>	<ul style="list-style-type: none"> <li>• 2.2.a</li> <li>• 2.2.b</li> </ul>	
Exponential and Logarithmic Functions	<ul style="list-style-type: none"> <li>• Recognize exponential functions algebraically, numerically, or graphically through application (natural growth/decay, financial situations, etc.)</li> <li>• Recognize logarithms as inverse of exponentials</li> <li>• Compare logarithmic and exponential functions</li> <li>• Properties of logarithm</li> <li>• Solve exponential logarithmic equations</li> </ul>	<ul style="list-style-type: none"> <li>• Attributes of exponential and logarithmic functions (see the function big idea section)</li> <li>• Graph exponential and logarithmic functions</li> <li>• Model authentic situations using exponential and logarithmic functions</li> </ul>	<ul style="list-style-type: none"> <li>• 2.2.b</li> <li>• 2.2.a</li> </ul>	
Matrices	<ul style="list-style-type: none"> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Represent real-world situations with matrices</li> </ul>	<ul style="list-style-type: none"> <li>• 1.1.a</li> </ul>	
		<ul style="list-style-type: none"> <li>• Add, subtract, and multiply (including scalar) matrices by hand and with technology</li> </ul>	<ul style="list-style-type: none"> <li>• 1.1.b</li> </ul>	
		<ul style="list-style-type: none"> <li>• Show that matrix multiplication is associative and distributive but not commutative.</li> </ul>	<ul style="list-style-type: none"> <li>• 1.1.c</li> </ul>	
		<ul style="list-style-type: none"> <li>• Determine additive and multiplicative identities and inverses of a matrix when they exist</li> </ul>	<ul style="list-style-type: none"> <li>• 1.1.d</li> </ul>	
		<ul style="list-style-type: none"> <li>• Solve systems of equations with up to 3 variables using matrices</li> </ul>	<ul style="list-style-type: none"> <li>• 1.1.e</li> </ul>	

Trigonometry	<ul style="list-style-type: none"> <li>• Use radians as measurement of angle (including converting from degrees to radians)</li> <li>• Graph sine and cosine functions including transformations to graphs (amplitude, period, phase shift, vertical shift, and reflections)</li> <li>• Find exact values for sine, cosine, and tangent of familiar angles</li> <li>• Use the sine and cosine graphs to solve real problems</li> <li>• Find the arc length and sector area using radian measure</li> <li>• Use reciprocal relationships of sine, cosine, and tangent to find cotangent, cosecant, and secant.</li> </ul>	<ul style="list-style-type: none"> <li>• Attributes of trigonometry functions (see the function big idea section)</li> <li>• Define the six trig functions using the unit circle</li> <li>• Graph all six trigonometric functions and their inverses including transformations (amplitude, period, phase shift, vertical shift, domain and range, and reflections)</li> <li>• Memorize Fundamental Trigonometric Identities (Reciprocal, Quotient, Sum, Difference, Pythagorean, Power Reducing, Double Angle)</li> <li>• Simplify Trigonometric Expressions and Prove Trigonometric Identities</li> <li>• Use any of the six trigonometric functions to model authentic situations</li> <li>• Law of Sines and Cosines (including the ambiguous case)</li> <li>• Solving trigonometric equations</li> </ul>	<ul style="list-style-type: none"> <li>• 3.1.a</li> <li>• 3.1.e</li> <li>• 3.1.b</li> <li>• 3.1.c, 3.1.b</li> <li>• 2.2.a</li> <li>• 3.1.d</li> <li>• 3.1.c</li> </ul>	
Polar and Parametric	<ul style="list-style-type: none"> <li>• Define imaginary and complex numbers</li> <li>• Add, subtract, multiply, and divide complex numbers</li> </ul>	<ul style="list-style-type: none"> <li>• Graph parametric functions</li> <li>• Write and use Parametric Functions for authentic application of time, etc.</li> <li>• Complex Numbers <ul style="list-style-type: none"> <li>▪ Graph in rectangular and polar form</li> <li>▪ Convert between rectangular and polar form</li> <li>▪ Convert to trig form and apply to authentic examples</li> <li>▪ DeMoivre's Theorem (find <math>n^{\text{th}}</math> roots of complex numbers).</li> <li>▪ Multiply complex numbers in polar form</li> </ul> </li> <li>• Graph polar equations by hand and using technology</li> </ul>	<ul style="list-style-type: none"> <li>• 3.2.e</li> <li>• 2.2.a</li> <li>• 3.2.a, 3.2.b, 3.2.d</li> <li>• 3.2.c</li> </ul>	

Conics	<ul style="list-style-type: none"> <li>• Circles (Geometry)</li> <li>• Parabolas (Intermediate Algebra)</li> </ul>	<ul style="list-style-type: none"> <li>• Write equations in standard and general form (by completing the square)</li> </ul>	• 3.3.a	
		<ul style="list-style-type: none"> <li>• Hyperbola, Ellipse, Parabola               <ul style="list-style-type: none"> <li>▪ Graph Completely and Accurately (including: vertex, foci, lines of symmetry, directrix, major and minor axes, asymptotes)</li> <li>▪ Transformations</li> </ul> </li> </ul>	• 3.3.b	
		<ul style="list-style-type: none"> <li>• Solve real-world applications of conic sections</li> </ul>	• 3.3.c	
Data, Statistics, and Probability	<ul style="list-style-type: none"> <li>• Identify the difference between a permutation and a combination.</li> <li>• Calculate a probability using the Fundamental Counting Principle.</li> <li>• Calculate simple combinations and permutations of n objects taken r at a time.</li> <li>• Determine, analyze, and use the quadratic regression equation to model a given set of bivariate data.</li> </ul>	<ul style="list-style-type: none"> <li>• Sample Spaces</li> <li>• Probability distributions</li> <li>• Binomial Probabilities</li> <li>• Means and variances of a discrete random variable</li> <li>• Calculate probabilities using the normal curve</li> <li>• Parameters of sampling distributions               <ul style="list-style-type: none"> <li>▪ Sample average</li> <li>▪ Sample sum</li> <li>▪ Sample proportion</li> </ul> </li> <li>• Calculate probabilities using sampling distributions</li> </ul>	<ul style="list-style-type: none"> <li>• 4.1.a</li> <li>• 4.1.a</li> <li>• 4.1.b</li> <li>• 4.1.c</li> <li>• 4.1.d</li> <li>• 4.1.e</li> </ul>	
		<ul style="list-style-type: none"> <li>• Calculate probabilities using sampling distributions</li> </ul>	• 4.1.f	

Sequences and Series		<ul style="list-style-type: none"> <li>• Describe a sequence as a function where the domain is the set of natural numbers</li> </ul>	<ul style="list-style-type: none"> <li>• 1.2.a</li> </ul>	
		<ul style="list-style-type: none"> <li>• Represent sequences and series using various notations</li> <li>• Identify arithmetic and geometric sequences and series</li> <li>• Discover and justify formulas for: <ul style="list-style-type: none"> <li>▪ Finite arithmetic series</li> <li>▪ Finite and infinite geometric series</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• 1.2.b</li> <li>• 1.2.c</li> <li>• 1.2.d, 1.2.e</li> </ul>	