Calculus: Limits

ESTABLISHED GOALS:

Competencies:

- ***Students will demonstrate the ability to estimate and calculate limits in order to describe continuity, derivatives and integrals.***
- ***Students will demonstrate the ability to analyze and summarize text and integrate knowledge to make meaning of discipline-specific materials.***
- ***Students will demonstrate the ability to produce coherent and supported writing in order to communicate effectively for a range of discipline-specific tasks, purposes, and audiences.***
- ***Students will demonstrate the ability to speak purposefully and effectively by strategically making decisions about content, language use, and discourse style.***

Content Standards:

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

Transfer

Students will be able to independently use their learning to determine the most appropriate and efficient method to solving a problem when multiple approaches are available.

Meaning

ENDURING UNDERSTANDINGS

Students will understand that…

- the concept of a limit is one of the foundations of calculus.
- the previous skills and content learned in math courses are essential tools for success in calculus.

ESSENTIAL QUESTIONS

- When do limits fail to exist?

Acquisition

Students will know…

- *Parametric equations can be used to obtain graphs of relations and functions*
- *Because t often denotes time, an angle, or the distance a particle has traveled along its path from its starting point, parametric graphing can be used to simulate the motion of a particle.*
- *the properties of limits (Sum, Difference, Product, Constant Multiple, Quotient, Power Rules) as* $x \to c$
- *A function has a limit as x approaches c if and*

Students will be skilled at…

- *Performing regression analysis*
- *using parametric mode on a graphing calculator*
- *finding parametrization for a given curve*
- *finding Cartesian equations for a curve that contains a parametrized curve*
- *calculating average and instantaneous speed*
- *applying the properties of limits*
- *calculating the limit as x goes to c of polynomial functions*
- *calculating the limit as x goes to c of rational functions*
- *determining limits using substitution, algebra,*

• 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. • F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. • 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. • 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. • HSF.BF.A.1.C (+) 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*. • MP2 Reason abstractly and quantitatively. • MP4 Model with mathematics. • MP5 Use appropriate tools strategically. • MP7 Look for and make use of structure. • MP8 Look for and express regularity in repeated reasoning.	*only if the right-hand and left-hand limits of c exist and are equal.* • *The Sandwich Theorem* • *the symbol for infinity does not represent a real number, but rather the behavior of a function as it gets farther and farther from zero.* • *the properties of limits (Sum, Difference, Product, Constant Multiple, Quotient, Power Rules) as* $x \to \pm\infty$ • *properties of continuous functions* • *If f is continuous at c and g is continuous at f(c), then the composition g(f(c)) is continuous at c.* • *Intermediate value property* • *The Intermediate Value Theorem for Continuous Functions* • *The average rate of change can always be thought of as the slope of a secant line* <u>vocabulary:</u> *increments, regression analysis, even and odd functions, parametric curve, parametric equation, parameter interval, terminal point of the curve, parameterization of the curve, limit, right-hand limit, left-hand limit, two-sided limit, horizontal asymptote, vertical asymptote, end behavior models, continuous function, discontinuous; jump, infinite, and oscillating discontinuity; average rate of change, slope of the curve, tangent line to curve, difference quotient, normal line to a curve, instantaneous rate of change*	*and/or graphing* • *finding limits as* $x \to \pm\infty$ • *finding vertical and horizontal asymptotes* • *finding end behavior models* • *finding points of continuity and discontinuity* • *calculating average rate of change over a given interval* • *finding the tangent to a curve* • *finding the slope of a line at a given point* • *calculating instantaneous rate of change*

Content Area Literacy Standards	***21st Century Skills***
• RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. • RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate	• *reason effectively* • *use systems thinking*

information expressed visually or mathematically (e.g., in an equation) into words. ● RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. ● WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.	● *solve problems* ● *access and evaluate information* ● *use and manage information* ● *be self-directed learners*

Evaluative Criteria	***Assessment Evidence***
	PERFORMANCE TASK(S):
	OTHER EVIDENCE:

Summary of Key Learning Events and Instruction		
Science Integration	***College, Career, and Civic Life Integration***	***Technology Integration***
District Materials	***Distance Learning/Field Trips***	***Technology Resources***