Wall Township Public Schools	Board Approval Date:
Course Title: Calculus Honors	
Course Description: Calculus is not only the language for expressing physical laws in precise mathematical terms, but it is also a tool for studying these laws. This course involves a comprehensive study of differential and integral calculus. The concepts of limits and continuity are analyzed as the basis for the study of calculus. A balance is maintained between theory, applications and manipulative techniques. This course prepares students for future study in college level mathematics.	

New Jersey Student Learning Standards - Mathematics

Vision for Mathematics Education in New Jersey

A New Jersey education in Mathematics builds quantitatively and analytically literate citizens prepared to meet the demands of college and career, and to engage productively in an information-driven society. All students will have access to a high-quality mathematics education that fosters a population that:

- leverages data in decision-making and as a lens for discussing, analyzing, and responding to practical questions.
- persists to make sense of and model problems arising in everyday life, society, and the workplace.
- thinks critically and strategically to assess quantitative relationships and to solutions to complex problems.
- employs precise reasoning and constructs viable arguments to deduce conclusions, recognize false statements and assess peers' reasoning.
- interprets, evaluates and critiques the mathematics embedded in social, scientific and commercial systems, as well as the claims made in the private and public sectors.

- communicates precisely when conveying, representing, and justifying both qualitative and quantitative perspectives.

Standards for Mathematical Practice*

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report Adding It Up: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

**See end of document for additional information related to the mathematical practices.*

Inclusion of Climate Change Opportunities

() notes opportunities to integrate specific examples of climate change education provided by additional age-appropriate resources

The goal of inclusion of climate change education implementation is to foster generations of New Jersey students that can analyze, question, interpret, to think independently, and bring critical deduction to fulfill, and to lead in jobs created by burgeoning industries of the future green economy.

Course Sequence & Pacing	
Unit Title	**Estimated Number of Instructional Periods****
Unit 1: Limits	15
Unit 2: Definition of Derivatives	15
Unit 3: Differentiation	15
Unit 4: Applications of Differentiation	15
Unit 5: Implicit Differentiation	15
Unit 6: Definition of Integration	15
Unit 7: Integration	15
Unit 8: 2D Applications of Integrals	15
Unit 9: 3D Applications of Integrals	8

**Instructional periods are scheduled for

Unit 1

Desired Results

Unit 1 Title: Limits

Unit Summary: In this unit, students will evaluate limits numerically, graphically, and analytically as a means of transitions from Pre-Calculus procedures to the Calculus process of differentiation.

Learning Standards

NJSLS Math:
Arithmetic with Polynomials and Rational Expressions
A -APR A. Perform arithmetic operations on polynomials
B. Understand the relationship between zeros and factors of polynomials
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.
Seeing Structure in Expressions
A-SSE B. Write expressions in equivalent forms to solve problems
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
★ a. Factor a quadratic expression to reveal the zeros of the function it defines.
Interpreting Functions
F-IF A. Understand the concept of a function and use function notation
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. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use

function notation in terms of a context.
B. Interpret functions that arise in applications in terms of the context
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.★

Math Practices:
1 Make sense of problems and persevere in solving them.
2 Reason abstractly and quantitatively.
5 Use appropriate tools strategically.
6 Attend to precision.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

With a growth mindset, failure is an important part of success.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze,and use creative skills and ideas. Innovative ideas or innovation can lead to career opportunities.

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities

Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

Computer Science & Design Thinking (*CS & DT***):**

Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information.

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information.

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

Technology innovation and improvement may be influenced by a variety of factors.

8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
What does the slope of a line represent? What is calculus? What is a limit? When does a limit not exist? What role do limits play in calculus? How are limits and continuity related?	The concept of limits is one of the foundations of calculus. The concept of limits can be applied throughout mathematics.
Vocabulary:	

average rate of change ,secant line, instantaneous rate of change, tangent line limits, continutity, Intermediate Value Theorem
Students will be able to: Find the average rate of change of a function over an interval Determine the slope of a secant line through a curve Define the instantaneous rate of change of a function at a given point Write the equation of a tangent line Find the slope of a curve at a point using a table Determine the value of one and two sided limits using a table and a graph Use properties of limits to evaluate limits Evaluate limits algebraically using cancelation, rationalization, and special trigonometric limits Evaluate limits approaching infinity Relate limits to continuity Use the Intermediate Value Theorem to verify function values
Learning Activities: *Suggested or Potential Learning Activities* Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments:

Teacher Observation

Entrance/Exit Pass

Performance: Authentic Task

Summative Assessments: Limits Assessment
Common Benchmark Assessments: Cumulative Assessment
Alternative Assessments: Modified Unit Assessments, Modified Quizzes

Core Instructional & Supplemental Materials
James Stewart Calculus Eighth Edition
Graphing Calculator
Khan Academy
Geogebra
Desmos

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students
Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments - Opportunities for make-up work or reduce number of assignments - Provide access to extra help when possible

Students with 504 Plans

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504 plans are formal plans that schools develop to give kids the support they need and covers any condition that limits daily activities in a major way. Students' accommodations are outlined in their individual 504 plan. -

Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning

-Enrichment/Extension Activities within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Unit 2

Desired Results

Unit 2 Title: Definition of Derivatives

Unit Summary: In this unit, students will differentiate all types of functions in order to find instantaneous rates of change.

Learning Standards

NJSLS Math:
Seeing Structure in Expressions
A-SSE B. Write expressions in equivalent forms to solve problems
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★
c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15^t can be rewritten as (1.151/12)^(12t) ≈1.01212^t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
Interpreting Functions F-IF B. Interpret functions that arise in applications in terms of the context
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.★
The Real Number System N -RN A. Extend the properties of exponents to rational exponents.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Math Practices:
1 Make sense of problems and persevere in solving them.
2 Reason abstractly and quantitatively.
5 Use appropriate tools strategically.
6 Attend to precision.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

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9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities

Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

Computer Science & Design Thinking *(**CS & DT****)*:**

Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

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8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
What is a derivative? What role do derivatives play in calculus? How are limits and derivatives related? How are differentiability and continuity related? What is the relationship between derivatives and tangent lines? What is the difference between average and instantaneous velocity**?**	Calculus can be used to solve real world problems. Algebra is the foundation of all levels of mathematics. The derivative is used to represent the instantaneous rate of change.

Vocabulary:

Continuity, Derivative, Constant Rule, Power Rule, Tangent Line, Normal Line, Limits, Point-Slope

Students will be able to:

Find derivative of a function using limits

Explain what a derivative is

Use different interpretations of the derivative to solve problems involving rates of change, tangent line and normal lines

Determine if a graph is differentiable at a given point

Curve sketching

Evaluate a derivative at a given x value from a table, or with using function notation

Find the derivative of basic functions using basic differentiation rules:

- Constant Rule
- Power Rule
- Sum/Difference Rules

Find higher order derivatives using the Power Rule

L'Hopitals

Learning Activities: *Suggested or Potential Learning Activities*

Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments:

Teacher Observation

Entrance/Exit Passes

Summative Assessments:

Basic Differentiation/Rates of Change Assessment

Common Benchmark Assessments: Cumulative Assessments

Alternative Assessments:
Project: Personal Students will create a poster of a real life situation as to where derivatives apply.
Poster includes the situation and sample calculations and explains how they relate to the real world.

Core Instructional & Supplemental Materials
James Stewart Calculus Eighth Edition
Graphing Calculator
Khan Academy
Geogebra
Desmos

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
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- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments - Opportunities for make-up work or reduce number of assignments - Provide access to extra help when possible

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-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning
-Enrichment/Extension Activities within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Unit 3

Desired Results

Unit 3 Title: Differentiation

Unit Summary: In this unit, students will differentiate all types of functions in order to find instantaneous rates of change.

Learning Standards

NJSLS Math:
Seeing Structure in Expressions
A-SSE B. Write expressions in equivalent forms to solve problems
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★
c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15^t can be rewritten as (1.151/12)^(12t) ≈1.01212^t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
Interpreting Functions
F-IF B. Interpret functions that arise in applications in terms of the context
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.★
Trigonometric Functions
F-TF B. Model periodic phenomena with trigonometric functions
6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

The Real Number System
N -RN A. Extend the properties of exponents to rational exponents.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Math Practices:
1 Make sense of problems and persevere in solving them.
2 Reason abstractly and quantitatively.
5 Use appropriate tools strategically.
6 Attend to precision.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

With a growth mindset, failure is an important part of success.

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9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities

Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

Computer Science & Design Thinking *(**CS & DT****)*:**

Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information.

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

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Technology innovation and improvement may be influenced by a variety of factors.

8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
What is a derivative? What role do derivatives play in calculus? How are limits and derivatives related? How are differentiability and continuity related? What is the relationship between derivatives and tangent lines? What is the difference between average and instantaneous velocity?	Calculus can be used to solve real world problems. Algebra is the foundation of all levels of mathematics. The derivative is used to represent the instantaneous rate of change.

Vocabulary: Derivative, Constant Rule, Power Rule, Sum/Difference Rules, Trig Function Rules, Natural Log,

Exponentials, Exponential Rules, Product Rule, Quotient Rule, Chain Rule, Tangent Line, Normal Line

Students will be able to:

Find the derivative of functions using the following rules:

- Constant Rule
- Power Rule
- Sum/Difference Rules
- Product Rule
- Quotient Rule
- Chain Rule
- Trig Function Rules
- Natural Log
- Exponential Rules

Find the derivative of composite functions using the chain rule

Find higher order derivatives

Write equations of tangent and normal lines

Learning Activities: *Suggested or Potential Learning Activities*

Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments:

Teacher Observation

Entrance/Exit Passes

Task Product/Quotient Rule Assessment Chain Rule Assessment
Summative Assessments: Derivative Assessment
Common Benchmark Assessments: Cumulative Assessments
Alternative Assessments: Modified Assessment, Modified Quizzes

Core Instructional & Supplemental Materials
James Stewart Calculus Eighth Edition
Graphing Calculator
Khan Academy
Geogebra
Desmos

Accommodations and Modifications: Students with Disabilities, English Language Learners,

Students at Risk of Failure, Students with 504s, Gifted & Talented Students

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-Enrichment/Extension Activities within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Unit 4

Desired Results

Unit 4 Title: Application of Differentiation

Unit Summary:

Learning Standards

NJSLS Math:
Seeing Structure in Expressions
A-SSE B. Write expressions in equivalent forms to solve problems
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★
Interpreting Functions
F-IF A. Understand the concept of a function and use function notation
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
B. Interpret functions that arise in applications in terms of the context
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.★

Math Practices:
1 Make sense of problems and persevere in solving them.
2 Reason abstractly and quantitatively.

5 Use appropriate tools strategically.
6 Attend to precision.

Interdisciplinary Connections

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8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
Is there a way to visualize what a derivative is? What does the graph of a function tell about the equation? How do the graphs of the first and second derivatives relate to the graph of a function?	Functions should be analyzed by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior. Simplifying expressions and solving equations allows us to take a complex situation and make it simple. Change is fundamental to understanding functions.

Vocabulary: Extrema, Absolute Extrema, intervals increasing/decreasing, concave up/concave down, first derivative test, points of inflections, second derivative test, horizontal asymptotes, oblique asymptotes

Students will be able to:

Identify and classify all extrema including absolute extrema

Identify intervals where functions are increasing/decreasing.

Apply the first derivative test.

Identify intervals where functions are concave up/concave down.

Locate points of inflections.

Apply the second derivative test.

Find horizontal asymptotes and oblique asymptotes algebraically.

Sketch the graph of a curve.

Learning Activities: *Suggested or Potential Learning Activities*
Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments:
Teacher Observation
Entrance/Exit Passes

Summative Assessments:
Applications of Differentiation Assessment

Common Benchmark Assessments: Cumulative Assessment

Alternative Assessments:
Project: Visual Arts Students will create a poster of a particle motion word problem. On the poster students will include a sketch of the problem, and the calculus used to solve the problem.

Core Instructional & Supplemental Materials

James Stewart Calculus Eighth Edition

Graphing Calculator
Khan Academy
Geogebra
Desmos

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Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups
Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice
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Specific Strategies and Practices that Support Gifted & Talented Students

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Unit 5

Desired Results

Unit 5 Title: Implicit Differentiation

Unit Summary: In this unit, students will enhance their understanding of differentiation by finding the derivative of implicit functions. Additionally, students will apply differentiation to real world problems.

Learning Standards

NJSLS Math:
Seeing Structure in Expressions
A-SSE A. Interpret the structure of expressions
1. Interpret expressions that represent a quantity in terms of its context.★
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)^n as the product of P and a factor not depending on P
B. Write expressions in equivalent forms to solve problems
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★
The Real Number System
N -RN A. Extend the properties of exponents to rational exponents.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Math Practices:
1 Make sense of problems and persevere in solving them.
2 Reason abstractly and quantitatively.

5 Use appropriate tools strategically.
6 Attend to precision.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

With a growth mindset, failure is an important part of success.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze,and use creative skills and ideas. Innovative ideas or innovation can lead to career opportunities.

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities

Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

Computer Science & Design Thinking ***(****CS & DT****)*:

Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information.

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information.

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

Technology innovation and improvement may be influenced by a variety of factors.

8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
Why is implicit differentiation necessary in certain situations? How are related rates and implicit differentiation related? How can related rates be used to show the relationship between area and volume?	Geometry is a building block for Calculus. Calculus is the language of Physics. Calculus is a tool for creating a mathematical model for physical situations

Vocabulary: Implicit, Explicit, Related Rates, Optimization, Area, Volume, Surface Area, Rolle's Theorem, Mean Value Theorem, Power Rule, Chain Rule, Product Rule, Quotient Rule

Students will be able to:

Distinguish between functions written in implicit form and explicit form.

Find derivative of a function expressed implicitly.

When differentiating implicitly, utilize:

- Power Rule
- Chain Rule
- Product Rule
- Quotient Rule

Solve related rates and optimization applications

Learning Activities: *Suggested or Potential Learning Activities*
Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments:
Teacher Observation
Entrance/Exit Passes

Summative Assessments:
Implicit Differentiation/Related Rates Assessment

Common Benchmark Assessments: Cumulative Assessment

Alternative Assessments:
Project: Technology PowerPoint Presentation- Students will create a PowerPoint presentation of a sample related rates questions. Presentation is pictures of the problem itself and calculations as to how to solve the problem.

Core Instructional & Supplemental Materials

James Stewart Calculus Eighth Edition

Graphing Calculator
Khan Academy
Geogebra
Desmos

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

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Unit 6

Desired Results

Unit 6 Title: Definition of Integration

Unit Summary:
In this unit, students will take a graphical and analytic approach to the area under a curve. Students will approximate the area as well as find the exact area via the Fundamental Theorem of Calculus

Learning Standards

NJSLS Math:
Interpreting Functions
F-IF A. Understand the concept of a function and use function notation
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
B. Interpret functions that arise in applications in terms of the context
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.★
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.★

Math Practices:

1 Make sense of problems and persevere in solving them.
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5 Use appropriate tools strategically.
6 Attend to precision.

Interdisciplinary Connections

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Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
What is the relationship between integrals and area under a curve? How is the area under a curve and total distance related? How is the concept of a limit connected to a derivative and to an integral?	Integrals can be used to solve a variety of problems related to area. Differentiation and integration are inverse operations. There can be different strategies to solve a problem, but some are more effective and efficient than others.

Vocabulary: Riemann Sum, Area, Integral, Antiderivative, Particular Solution, Definite Integral, first Fundamental Theorem of Calculus, second Fundamental Theorem of Calculus

Students will be able to:

Estimate the area under a curve from a graph

- Using LRAM
- Using RRAM
- Using MRAM
- Using Trapezoidal Rule

- Using Simpson's Rule

Define an integral in terms of antiderivatives

Use properties of indefinite integrals to evaluate expressions

Determine the original function given the derivative and a particular solution

Calculate a Definite Integral

Learning Activities: *Suggested or Potential Learning Activities*

Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments:

Teacher Observation

Entrance/Exit Passes

Riemann Sum Assessment

Antiderivatives/Particular Solutions Assessment

Area under a Curve/FTC Assessment

Summative Assessments:

Unit Test

Common Benchmark Assessments: Cumulative Assessment

Alternative Assessments:

Project: Visual Arts Students will create a poster of a real life situation as to where antiderivatives apply. Poster includes the situation and sample calculations and explains how they relate to the real world.

Core Instructional & Supplemental Materials
James Stewart Calculus Eighth Edition
Graphing Calculator
Khan Academy
Geogebra
Desmos

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Unit 7

Desired Results

Unit 7 Title: Integration

Unit Summary: In this unit, students will be able to find antiderivatives of functions through the process of indefinite and definite integration.

Learning Standards

NJSLS Math:
Interpreting Functions
F-IF A. Understand the concept of a function and use function notation
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
B. Interpret functions that arise in applications in terms of the context
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.★
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.★

Math Practices:
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2 Reason abstractly and quantitatively.

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8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
What are the numerical methods used to approximate a definite integral and how are they used? How does the Fundamental Theorem relate to evaluating integrals? How are position, velocity and acceleration related?	A definite integral is sum of infinite rectangles. Differentiation and integration are inverse operations. Calculus is a tool for creating a mathematical model for physical situations

Vocabulary: Trigonometric Functions, Logarithm, Exponential, Substitution

Students will be able to:

Evaluate Indefinite and Definite Integrals using

- Trig Rules
- Log and Exponential Rules
- U-Substitution

Apply Integration to particle motion.

Learning Activities: *Suggested or Potential Learning Activities*

Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence
Formative Assessments: Teacher Observation Entrance/Exit Passes
Summative Assessments: Indefinite and Definite U-Sub Integration Assessment
Common Benchmark Assessments: Cumulative Assessments
Alternative Assessments: Modified Assessments

Core Instructional & Supplemental Materials
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Khan Academy
Geogebra
Desmos

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Unit 8

Desired Results

Unit 8 Title: 2D Applications of Integrals

Unit Summary: In this unit, students will find the area between curves and the average value of a function on a given interval through the process of definite integration.

Learning Standards

NJSLS Math:
Interpreting Functions
F-IF A. Understand the concept of a function and use function notation
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. B. Interpret functions that arise in applications in terms of the context
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.★
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.★

Math Practices:
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Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
How does the calculus behind determining area and volume of figure relate to basic principles of geometry? How does a graph/sketch effect that way that area/volume is determined?	Linear measure, area, and volume are fundamentally different but may be related to one another in ways that permit calculation of one given the other. Calculus comprises all areas of mathematics. Mathematics can be used as a language to express thoughts and ideas.

Vocabulary:

Students will be able to:

Determine the average value of a function on a given interval

Determine the input value(s) whose outputs are the average value of a function on a given interval

Calculate the area between two curves

Learning Activities: *Suggested or Potential Learning Activities*

Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments: Teacher Observation Entrance/Exit Passes Quizzes
Summative Assessments: Unit Test
Common Benchmark Assessments: Cumulative Assessment
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Unit 9

Desired Results

Unit 9 Title: Unit 9 3D Applications of Integrals

Unit Summary: In this unit, students will find the area between curves as well as the volume of solids generated when revolving curves about given axes through the process of definite integration.

Learning Standards

NJSLS Math:
Interpreting Functions
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Math Practices:
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6 Attend to precision.

Interdisciplinary Connections
Career Readiness, Life Literacies, & Key Skills *(CLKS)*: **With a growth mindset, failure is an important part of success.** **9.4.12.CI.1:**Demonstrate the ability to reflect, analyze,and use creative skills and ideas. Innovative ideas or innovation can lead to career opportunities. **9.4.12.CI.2:**Identify career pathways that highlight personal talents, skills, and abilities **Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.** **9.4.12.CT.2:** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
Computer Science & Design Thinking ***(****CS & DT****)*: **Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.** **8.1.12.CS.4:**Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. **Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information.** **8.1.12.DA.1:**Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. **Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information.** **8.1.12.DA.5:** Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

Technology innovation and improvement may be influenced by a variety of factors.

8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
How does the calculus behind determining area and volume of figure relate to basic principles of geometry? How does a graph/sketch effect that way that area/volume is determined?	Linear measure, area, and volume are fundamentally different but may be related to one another in ways that permit calculation of one given the other. Calculus comprises all areas of mathematics. Mathematics can be used as a language to express thoughts and ideas.

Vocabulary:

Students will be able to:

Determine the volume of solids of revolution about a zero and non zero axis of rotations using the method of disks/rings

Determine the volume of solids of revolution about a zero and non zero axis of rotations using the method of cylinders/shells

Solve problems involving work

Learning Activities: *Suggested or Potential Learning Activities*

Building Thinking Classroom Tasks, Collaborative Problem Solving, Exit Passes, WarmUps, Flipped Classroom Activity, Graphing Investigations, FRQ Practice, Multiple Choice Practice

Assessment Evidence

Formative Assessments: Teacher Observation Entrance/Exit Passes Quizzes
Summative Assessments: Unit Tests
Common Benchmark Assessments: Cumulative Assessment
Alternative Assessments: Project: Personal Construct a 3 dimensional object and calculate its volume using calculus

Core Instructional & Supplemental Materials
James Stewart Calculus Eighth Edition
Graphing Calculator
Khan Academy
Geogebra
Desmos

Accommodations and Modifications:
Students with Disabilities, English Language Learners,
Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice Alternate or reduced work within Digital Platforms such as Math IXL, Delta Math, and Link It assignments - Opportunities

for make-up work or reduce number of assignments - Provide access to extra help when possible

Students with 504 Plans

Teachers are responsible for implementing designated services and strategies identified on a student's 504 Plan.
504 plans are formal plans that schools develop to give kids the support they need and covers any condition that limits daily activities in a major way. Students' accommodations are outlined in their individual 504 plan. -

Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning

-Enrichment/Extension Activities within Digital Platforms such as Math IXL, Delta Math, and Link It assignments

Standards for Mathematical Practice
1. Make sense of problems and persevere in solving them Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
2. Reason abstractly and quantitatively Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
3. Construct viable arguments and critique the reasoning of others Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of

their conjectures. They are able to analyze situations by breaking them into cases and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

4. Model with mathematics

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. Use appropriate tools strategically

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to

visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6. Attend to precision

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7. Look for and make use of structure

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well-remembered$7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$ older students can see the 14 as $2 \times 7$and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

8. Look for and express regularity in repeated reasoning

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check

whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $\frac{(y-2)}{(x-1)} = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)\left(x^2 + x + 1\right)$ and $(x - 1)\left(x^3 + x^2 + x + 1\right)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.