

Pascack Valley Regional High School District

Pascack Hills High School, Montvale, New Jersey 07645

Pascack Valley High School, Hillsdale, New Jersey 07642

Course Name: Calculus

Born On: August, 2017

Previous Revision: August, 2020

Current Revision: August, 2023

Board Approval: 8/28/23

COURSE DESCRIPTION

Calculus is a full year, five credit course in calculus and related topics comparable to courses taught in colleges and universities. A prerequisite is the successful completion of *Precalculus*. The primary objective of this course is to prepare the student for Calculus in college. 11th and 12th grade students enrolled in Calculus have the option of earning college credit by registering with William Paterson University at a reduced price but at student expense. Please note that dual enrollment is not required, and that the course will have the same requirements and expectations whether or not students elect to register for college credit.

Each student who has mastered the concepts and skills in Calculus will exhibit competency with:

1. Polynomial, trigonometric, and exponential and logarithmic functions and function theory
2. The derivative of a function and applications
3. The antiderivatives of a functions and applications
4. Techniques of integration
5. The definite integral and applications

All mathematics courses in the Pascack Valley Regional High School District are designed to address multiple learning styles and needs, and accommodations and modifications are made for students with disabilities, multilingual students, students at risk of failure, gifted and talented students, and students with 504 plans. *Calculus* builds on concepts learned and skills developed in *Precalculus*, while also spiraling in those concepts and skills to reinforce and strengthen students' algebraic foundation. Additionally, *Calculus* anticipates higher-level mathematics that will be learned in college-level math and applied math courses, and enrichment opportunities are provided to challenge students and engage them in rich, interesting mathematics. Students are encouraged to analyze data using tools and models to make valid and reliable claims (9.4.12.IML.3), and various technologies are integrated throughout the curriculum, including scientific calculators, graphing calculators, specialized software, and various Internet programs and subscriptions. These tools enrich the curriculum by giving students' access to additional mathematical representations, and they also help to differentiate by providing students with additional options to engage with mathematical tasks.

The Pascack Valley Regional High School Mathematics Department integrates 21st century life and career skills across its courses, with the dual goal of informing students about careers and fields of study that use mathematics (9.3.ST.5, 9.3.ST-ET.5 and 9.3.ST-SM.2), and helping students improve the quantitative, mathematical, and statistical reasoning skills they will need to be effective producers and consumers of quantitative information in their everyday lives (9.2.12.CAP.2). Mathematics courses address the *New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills*, with a particular emphasis on demonstrating the ability to reflect, analyze and use creative skills and ideas (9.4.12.CI.1), investigating new challenges and opportunities for personal growth, advancement and transition (9.4.12.CI.3), identifying problem-solving strategies used in the development of an innovative product or practice (9.4.12.CT.1), and explaining the potential benefits of collaborating to enhance critical thinking and problem solving (9.4.12.CT.2). Mathematics courses also address the *New Jersey Student Learning Standards for English Language Arts Companion Standards*, with a particular focus on following complex multistep procedures (RST.9-10.3/RST.11-12.3), determining the meaning of symbols, key terms, and other domain-specific words and phrases (RST.9-10.4/RST.11-12.3), and translating quantitative or technical information expressed in words into visual forms and translating information expressed visually or mathematically into words (RST.9-10.7). Similarly, the mathematics department seeks to support students by providing them with opportunities to use quantitative, statistical, and mathematical reasoning in interdisciplinary contexts, in contexts that are meaningful to students, and in contexts that attend to the contributions and perspectives of

historically marginalized groups. Specifically, mathematics courses will look to incorporate, when appropriate, contributions and experiences of people from the LGBTQ+ community and individuals with disabilities, and references to issues of social and cultural relevance, including climate change.

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Content/Topic:	Key Learning Items/Concepts and Pacing Guide	Observable Proficiencies and Skills:	NJSLS	Formative, Summative, Benchmark, and Alternative Assessments	Core Instructional and Supplemental Materials/ Modifications and Accommodations
<p>Unit 1 – Functions</p> <p>Time: 3 weeks (see column 2 for a more detailed breakdown)</p>	<p>Key learning items/concepts:</p> <ul style="list-style-type: none"> - Polynomial/Rational/Algebraic (1 day) - Trigonometric (1 day) - Exponential/Logarithmic (1 day) - General function properties (1 day) - Limits (including one-sided limits) (1 week) - Continuity (1/2 week) - Asymptotes (odd/even); zeros (odd/even); slant asymptotes (1/2 week) <p>Content-specific modifications and accommodations</p> <ul style="list-style-type: none"> - this unit will spiral in concepts and skills that students learned in previous courses - differentiated problem sets can be used to support and challenge 	<p><i>A. Define: polynomial function.</i></p> <p><i>B. Determine the existence, number, and location of zeros of a polynomial function.</i></p> <p><i>C. Define the sine and cosine functions.</i></p> <p><i>D. Utilize proficiently the fundamental and higher level trigonometric identities.</i></p> <p><i>E. Graph sine and cosine functions, including variations of $f(x) = A \sin(Bx + C)$ and $f(x) = A \cos(Bx + C)$.</i></p> <p><i>F. Formulate and interpret examples of exponential and logarithmic functions.</i></p> <p><i>G. Graph exponential and logarithmic functions.</i></p> <p><i>H. Explain and utilize the inverse</i></p>	<p>NJSLS Content Standards</p> <p><i>Calculus</i> builds on many of the concepts and skills learned in the New Jersey Student Learning Standards</p> <p>NJSLS SMP</p> <p>MP1. Make sense of problems and persevere in solving them</p> <p>MP2. Construct viable arguments and critique the reasoning of others</p> <p>MP3. Reason abstractly and quantitatively</p> <p>MP4. Model with mathematics</p> <p>MP5. Attend to precision</p> <p>MP6. Use appropriate tools strategically</p> <p>MP7. Look for and make use of structure</p> <p>MP8. Look for and express regularity in repeated reasoning</p>	<p>Students will be assessed regularly throughout this course, with a focus on both conceptual understanding and procedural fluency.</p> <p>Assessment tools may include the following:</p> <ul style="list-style-type: none"> - quizzes (F) - tests (S) - performance tasks (F/S) - projects (S) - homework (F) - discussions (F) - journals (F) - Form A, B, or C benchmark (B) - alternative assessments 	<p>Selection of primary sources</p> <p><i>Suggestion(s):</i></p> <p>Texts: Larson, Hostetler, Edward, Heath <i>Calculus, 7th</i> edition, 2002 (on grade level); Finney, Ross <i>Calculus Graphical, Numerical, Algebraic</i>, California: Scott Foresman Addison-Wesley Publishing Company, 1999. (advanced); Deltamath (remediation, on grade level, and advanced)</p> <p>Additional Resources:</p> <p>Hughes- Hallett, Gleason, et al. <i>Calculus Single Variable, 2nd Edition</i>. New York: Wiley Publishing Company, Inc., 1998. Hockett, Bock, <i>How to Prepare for the AP Calculus AP Examination 7th ed.</i>, Barron's, 2002.</p> <p>Larson, Roland. <i>Calculus with Analytic Geometry, Third Edition</i>. Massachusetts: D. C. Heath and Company.</p> <p>Stewart, James <i>Calculus, 2nd Edition</i>. New York: GWO Publishing Company, 2001. 1997, 1998, 2003 AP Calculus AB and BC Released exams, The College Board.</p> <p>Exploring Calculus with The Geometer's Sketchpad® Key Curriculum Press, 2002.</p> <p>Software:</p> <p><i>Calculus in Motion</i></p>

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	<p>students</p> <p>Interdisciplinary/additional connections - various graphs may be explored, including those with contexts that draw on the experiences of diverse people and contexts that relate to climate change - problems may include applications in science or engineering</p>	<p><i>relationship between an exponential and a logarithmic function.</i> I. Utilize e as a base, where: - $e = \lim (1 + 1/x)^x$ - $\lim (e^x - 1)/x = 1$ $x \rightarrow 0$ J. Utilize these general function properties: - Odd and even - Sum, difference, product, and quotient - Composite functions - Inverses K. Find the limit of a function. L. Determine whether and where a function is continuous. M. Asymptotes (vertical, horizontal-including multiple, and slant)</p>	<p>NJSLS for ELA Companion Standards RST.9-10.3 RST.9-10.4 RST.9-10.7 RST.11-12.3 RST.11-12.4</p> <p>NJSLS-CLKS - 21st Century Life and Careers 9.4.12.CI.1 9.4.12.CI.3 9.4.12.CT.1 9.4.12.CT.2</p> <p>- Technology 9.4.12.IML.3</p> <p>- Career Education 9.2.12.CAP.2 9.3.ST.5 9.3.ST-ET.5 9.3.ST-SM.2</p> <p>NJSLS – CSDT 8.1.12.DA.1 8.1.12.DA.5 8.1.12.DA.6 8.1.12.AP.1 8.2.12.ETW.2</p>	<p>(A) - Take home exams and investigations (F) - On-line work including AP exam open ended questions (F)</p>	<p><i>Geometric Sketchpad® v. 4.02</i>, Key Curriculum Press, 2001.</p> <p>Calculators: The TI-83, TI-83+, TI-84, TI-89 or TI-92 graphing calculators (Texas Instruments).</p> <p>Modifications and Accommodations: Students with special needs: Teachers and support staff will attend to all modifications and accommodations listed in students' IEPs and 504s. Teachers will incorporate manipulatives, extra time, alternative assessments, scaffolding, spiraling, technology, and flexible grouping to support student learning. Multilingual students: Teachers and support staff will work to support multilingual students in their first language and in English, providing materials and/or resources to support students' understanding. Students will be given additional time, as appropriate, and translation tools will be utilized as needed. Students at risk of school failure: Formative and summative data will be used to monitor student success, and students at risk of failure will receive additional supports and services, which may include parent consultation, extra help, and differentiation strategies, including small group instruction, group work, scaffolding, and spiraling. Gifted and Talented Students: Students who excel in their mastery of course standards will be further challenged with more complex tasks, extensions of concepts and skills, and extended problem solving and critical thinking opportunities.</p>

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<p>Unit 2 – Differential Calculus</p> <p>Time: 14-16 weeks (see column 2 for a more detailed breakdown)</p>	<p>Key learning items/concepts:</p> <p>A. The Derivative (presented graphically, numerically, and analytically) (8-9 weeks)</p> <ol style="list-style-type: none"> 1. Definition (3 days) 2. Applications (3 days) 3. Derivative at a point (2 days) 4. Derivatives of functions (5-7 days) <ol style="list-style-type: none"> a. Polynomial/Rational b. Trigonometric c. Exponential d. Logarithmic 4. Derivatives of sums, products, quotients (5 days) 5. Derivatives of composite functions (3 days) 6. Derivatives of implicitly defined functions (4 days) 7. 2nd derivatives and their properties. (graphical and numerical as well as analytic) (2 days) 8. Exponential Differentiation (2 days) 	<p>A. Define: derivative</p> <p>B. Relate the concept of derivative to:</p> <ol style="list-style-type: none"> 1. Slope of a tangent line 2. Instantaneous velocity 3. Rate of change of a function <p>C. Determine the derivative of these functions:</p> <ol style="list-style-type: none"> 1. Polynomial 2. Trigonometric 3. Exponential 4. Logarithmic <p>D. Take derivatives of sums, products, and quotients.</p> <p>E. Use the Chain Rule to take the derivative of a composite function.</p> <p>F. Take the derivative of an implicitly defined function.</p> <p>G. Complete related rate problems</p> <p>H. Perform</p>	<p>NJSLS Content Standards</p> <p><i>Calculus</i> builds on many of the concepts and skills learned in the New Jersey Student Learning Standards</p> <p>NJSLS SMP</p> <p>MP1. Make sense of problems and persevere in solving them</p> <p>MP2. Construct viable arguments and critique the reasoning of others</p> <p>MP3. Reason abstractly and quantitatively</p> <p>MP4. Model with mathematics</p> <p>MP5. Attend to precision</p> <p>MP6. Use appropriate tools strategically</p> <p>MP7. Look for and make use of structure</p> <p>MP8. Look for and express regularity in repeated reasoning</p> <p>NJSLS for ELA</p>	<p>Students will be assessed regularly throughout this course, with a focus on both conceptual understanding and procedural fluency. Assessment tools may include the following:</p> <ul style="list-style-type: none"> - quizzes (F) - tests (S) - performance tasks (F/S) - projects (S) - homework (F) - discussions (F) - journals (F) - Form A, B, or C benchmark (B) - alternative assessments (A) - Take home exams and investigations (F) - On-line work including AP exam open ended 	<p>Selection of primary sources</p> <p><i>Suggestion(s):</i></p> <p>Texts: Larson, Hostetler, Edward, Heath <i>Calculus, 7th</i> edition, 2002 (on grade level); Finney, Ross <i>Calculus Graphical, Numerical, Algebraic</i>, California: Scott Foresman Addison-Wesley Publishing Company, 1999. (advanced); Deltamath (remediation, on grade level, and advanced)</p> <p>Additional Resources:</p> <p>Hughes- Hallett, Gleason, et al. <i>Calculus Single Variable, 2nd Edition</i>. New York: Wiley Publishing Company, Inc., 1998.</p> <p>Hockett, Bock, <i>How to Prepare for the AP Calculus AP Examination 7th ed.</i>, Barron’s, 2002.</p> <p>Larson, Roland. <i>Calculus with Analytic Geometry, Third Edition</i>. Massachusetts: D. C. Heath and Company.</p> <p>Stewart, James <i>Calculus, 2nd Edition</i>. New York: GWO Publishing Company, 2001. 1997, 1998, 2003 AP Calculus AB and BC Released exams, The College Board.</p> <p>Exploring Calculus with The Geometer’s Sketchpad® Key Curriculum Press, 2002.</p> <p>Software: <i>Calculus in Motion</i></p>

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	<p>9. Logarithmic differentiation (2 days) 10. Derivatives of rational powers of a function (3 days) 11. Rolle’s Theorem (1 day) 12. Mean Value Theorem (1 day) 13. Relation between differentiability and continuity (2 days) 16. Intermediate Value Theorem (2 days) B. Applications of the Derivative (6-7 weeks) 1. Slope of a curve (3 days) 2. Tangent and normal lines (2 days) 3. Curve sketching (6 days) a. Increasing and decreasing functions b. Relative and absolute maximum and minimum points c. Concavity d. Points of inflection e. Given $f'(x)$ and/or $f''(x)$ analyze $f(x)$ from a graphical point of view. 4. Extreme value problems (2 days) 5. Optimization (7 days) 6. Velocity and acceleration of a particle moving along a line (5 days) 7. Average and</p>	<p><i>logarithmic differentiation.</i> <i>I. Take the derivative of a rational power of a function.</i> <i>J. State and explain Rolle’s Theorem.</i> <i>K. Explain the Mean Value Theorem, illustrating graphically and using to obtain approximations.</i> <i>L. Explain the relation between differentiability and continuity.</i> <i>M. Use the concept of derivative to:</i> - Find the slope of a curve - Write equations of tangent lines to a curve - Discuss concavity and find points of inflection <i>N. Sketch curves, being accurate with respect to:</i> - Increasing and decreasing functions - Relative and absolute maximum and minimum points - Concavity</p>	<p>Companion Standards RST.9-10.3 RST.9-10.4 RST.9-10.7 RST.11-12.3 RST.11-12.4 NJSLS-CLKS - 21st Century Life and Careers 9.4.12.CI.1 9.4.12.CI.3 9.4.12.CT.1 9.4.12.CT.2 - Technology 9.4.12.IML.3 - Career Education 9.2.12.CAP.2 9.3.ST.5 9.3.ST-ET.5 9.3.ST-SM.2 NJSLS – CSDT 8.1.12.DA.1 8.1.12.DA.5 8.1.12.DA.6 8.1.12.AP.1 8.2.12.ETW.2</p>	<p>questions (F) - curve sketching task (F) -maximize/ minimize task (F)</p>	<p><i>Geometric Sketchpad® v. 4.02</i>, Key Curriculum Press, 2001. Calculators: The TI-83, TI-83+, TI-84, TI-89 or TI-92 graphing calculators (Texas Instruments). Modifications and Accommodations: Students with special needs: Teachers and support staff will attend to all modifications and accommodations listed in students’ IEPs and 504s. Teachers will incorporate manipulatives, extra time, alternative assessments, scaffolding, spiraling, technology, and flexible grouping to support student learning. Multilingual students: Teachers and support staff will work to support multilingual students in their first language and in English, providing materials and/or resources to support students’ understanding. Students will be given additional time, as appropriate, and translation tools will be utilized as needed. Students at risk of school failure: Formative and summative data will be used to monitor student success, and students at risk of failure will receive additional supports and services, which may include parent consultation, extra help, and differentiation strategies, including small group instruction, group work, scaffolding, and spiraling. Gifted and Talented Students: Students who excel in their mastery of course standards will be further challenged with</p>

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	<p>instantaneous rates of change (2 days) 8. Related rates of change (7 days)</p> <p>Content-specific modifications and accommodations - just in time support will be incorporated to help students reinforce necessary prerequisite skills - differentiated problem sets can be used to support and challenge students</p> <p>Interdisciplinary/additional connections - differential equations may include applications to science or engineering - position, velocity, and acceleration graphs will be explored</p>	<p>- <i>Points of inflection</i> <i>O. Use the derivative to examine extreme values of the function.</i> <i>P. Solve optimization Problems</i> <i>Q. Apply the derivative to motion along a line. (rectilinear motion)</i> <i>R. Solve differential equations</i></p>			<p>more complex tasks, extensions of concepts and skills, and extended problem solving and critical thinking opportunities.</p>

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<p>Unit 3 – Integral Calculus</p> <p>Time: 15-16 weeks (<i>see column 2 for a more detailed breakdown</i>)</p>	<p>Key learning items/concepts:</p> <p>A. Antiderivatives (4 days)</p> <p>B. Applications of antiderivatives (2 weeks)</p> <ol style="list-style-type: none"> Distance and velocity from acceleration and initial conditions (3 days) Polynomial solutions of $y'(n) = 0$ (3 days) Solutions of $y' = ky$ and $y' = c/x$ (applications to growth and decay) (3 days) <p>C. Techniques of integration (3 weeks)</p> <ol style="list-style-type: none"> Integration by substitution (5-7 days) Trigonometric integrals (2 days) Trigonometric substitution (3 days) <p>D. The definite integral (3-4 weeks)</p> <ol style="list-style-type: none"> Concept of area (3 days) Approximation of area (5-6 days) <ol style="list-style-type: none"> Riemann Summations Inscribed and circumscribed rectangles Trapezoids Definition (2 days) 	<p>A. Determine antiderivatives.</p> <p>B. Use antiderivatives to:</p> <ol style="list-style-type: none"> Find distance and velocity from acceleration with initial conditions. Find polynomial solutions of $y'(n) = 0$ Solve differential equations, such as $y'' = -(k^2)y$ Solve equations like $y' = ky$ and $y' = c/x$ <p>C. Integrate by substitution, using identities and change of variable.</p> <p>D. Relate the definite integral to the concept of area.</p> <p>E. Use the definite integral to analyze the concept of</p>	<p>NJSLs Content Standards</p> <p><i>Calculus</i> builds on many of the concepts and skills learned in the New Jersey Student Learning Standards</p> <p>NJSLs SMP</p> <p>MP1. Make sense of problems and persevere in solving them</p> <p>MP2. Construct viable arguments and critique the reasoning of others</p> <p>MP3. Reason abstractly and quantitatively</p> <p>MP4. Model with mathematics</p> <p>MP5. Attend to precision</p> <p>MP6. Use appropriate tools strategically</p> <p>MP7. Look for and make use of structure</p> <p>MP8. Look for and express regularity in repeated reasoning</p> <p>NJSLs for ELA Companion Standards</p> <p>RST.9-10.3</p>	<p>Students will be assessed regularly throughout this course, with a focus on both conceptual understanding and procedural fluency.</p> <p>Assessment tools may include the following:</p> <ul style="list-style-type: none"> - quizzes (F) - tests (S) - performance tasks (F/S) - projects (S) - homework (F) - discussions (F) - journals (F) - Form A, B, or C benchmark (B) - alternative assessments (A) - Take home exams and investigations (F) - On-line work including AP exam open ended 	<p>Selection of primary sources</p> <p><i>Suggestion(s):</i></p> <p>Texts: Larson, Hostetler, Edward, Heath <i>Calculus, 7th</i> edition, 2002 (on grade level); Finney, Ross <i>Calculus Graphical, Numerical, Algebraic</i>, California: Scott Foresman Addison-Wesley Publishing Company, 1999. (advanced); Deltamath (remediation, on grade level, and advanced)</p> <p>Additional Resources:</p> <p>Hughes- Hallett, Gleason, et al. <i>Calculus Single Variable, 2nd Edition</i>. New York: Wiley Publishing Company, Inc., 1998. Hockett, Bock, <i>How to Prepare for the AP Calculus AP Examination 7th ed.</i>, Barron’s, 2002.</p> <p>Larson, Roland. <i>Calculus with Analytic Geometry, Third Edition</i>. Massachusetts: D. C. Heath and Company.</p> <p>Stewart, James <i>Calculus, 2nd Edition</i>. New York: GWO Publishing Company, 2001. 1997, 1998, 2003 AP Calculus AB and BC Released exams, The College Board.</p> <p>Exploring Calculus with The Geometer’s Sketchpad® Key Curriculum Press, 2002.</p> <p>Software:</p> <p><i>Calculus in Motion Geometric Sketchpad® v. 4.02</i>, Key Curriculum Press, 2001.</p>

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	<p>4. Properties (2 days) 5. Fundamental Theorem of Calculus (4 days) E. Application of the integral (4 weeks) 1. Comparison of total distance vs. displacement of velocity functions 2. Average value of a function on an interval (3 days) 3. Areas between curves (5 days) using both dy and dx 4. Volumes of solids of revolution (Discs and Washers) (6 days) 5. Volumes of solids given known cross sections (3 days)</p> <p>Content-specific modifications and accommodations - technology will be utilized to support students' understanding of area under the curve - differentiated problem sets can be used to support and challenge students</p> <p>Interdisciplinary/additional connections - problems may include applications to science or engineering - position, velocity, and acceleration graphs will be explored</p>	<p><i>area.</i> <i>F. State and explain definitions and properties related to the definite integral.</i> <i>G. State and explain the First Fundamental Theorem of Integral Calculus.</i> <i>H. Use the definite integral to:</i> 1. Determine the average value of a function on an interval 2. Find areas between curves 3. Find volumes of solids of revolution <i>Interpret $\ln x$ as the area under the graph of $y = 1/x$</i></p>	<p>RST.9-10.4 RST.9-10.7 RST.11-12.3 RST.11-12.4</p> <p>NJSLS-CLKS - 21st Century Life and Careers 9.4.12.CI.1 9.4.12.CI.3 9.4.12.CT.1 9.4.12.CT.2</p> <p>- Technology 9.4.12.IML.3</p> <p>- Career Education 9.2.12.CAP.2 9.3.ST.5 9.3.ST-ET.5 9.3.ST-SM.2</p> <p>NJSLS – CSDT 8.1.12.DA.1 8.1.12.DA.5 8.1.12.DA.6 8.1.12.AP.1 8.2.12.ETW.2</p>	<p>questions (F) - Reimann sum task (F)</p>	<p>Calculators: The TI-83, TI-83+, TI-84, TI-89 or TI-92 graphing calculators (Texas Instruments).</p> <p>Modifications and Accommodations: Students with special needs: Teachers and support staff will attend to all modifications and accommodations listed in students' IEPs and 504s. Teachers will incorporate manipulatives, extra time, alternative assessments, scaffolding, spiraling, technology, and flexible grouping to support student learning. Multilingual students: Teachers and support staff will work to support multilingual students in their first language and in English, providing materials and/or resources to support students' understanding. Students will be given additional time, as appropriate, and translation tools will be utilized as needed. Students at risk of school failure: Formative and summative data will be used to monitor student success, and students at risk of failure will receive additional supports and services, which may include parent consultation, extra help, and differentiation strategies, including small group instruction, group work, scaffolding, and spiraling. Gifted and Talented Students: Students who excel in their mastery of course standards will be further challenged with more complex tasks, extensions of concepts and skills, and extended problem solving and critical thinking opportunities.</p>
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