VERMONT
AGENCY OF EDUCATION

1 National Life Drive, Davis 5, Montpelier, VT 05620-2501
(p) 802-828-1130 | (f) 802-828-6430 | education.vermont.gov

Mathematics – Sample Proficiency-Based Graduation Requirements and Performance Indicators

Vermont Content Area Graduation Proficiencies and Performance Indicators:

- Are required by Section 2120.8 of the Education Quality Standards
- Reflect existing learning standards required by the Vermont State Board of Education
- Are designed to be used in conjunction with the Vermont Transferable Skill Graduation Proficiencies
- Include three sets of performance indicators differentiated by grade cluster – Elementary, Middle, and High School
- Serve as benchmarks of learning progression for elementary and middle school

This document is designed to:

- Assist Vermont Supervisory Union/School Districts (SU/SDs) and schools in developing learning expectations for their students
- Promote consistency across schools and SU/SDs for transfer students
- Increase personalization and flexibility for instruction and learning
- Help build curriculum and guide assessment development
- Support formative assessment practices, including the use of Performance Assessments
- Simultaneously provide data and insight into achievement when aligned with the transferable skills
- Support student achievement of the expected content standards

Spotlight on Equity: The Spotlight on Equity provides a list of considerations for the purpose of providing an equity literate and socially conscious lens to the teaching and learning of Mathematics, as well as to recognize the historic exclusion and marginalization of groups and communities. The considerations are not a complete list, but rather a starting point from which educators can design historically and socially relevant learning opportunities in Mathematics; more information and supplemental resources can be found in the Mathematics: Spotlight on Equity document on the Mathematics webpage.

Contact Information:

If you have questions about this document or would like additional information, please contact:

Ryan Parkman, Student Pathways Division, at Ryan.Parkman@vermont.gov.

GRADUATION PROFICIENCIES	PERFORMANCE INDICATORS — ELEMENTARY SCHOOL	PERFORMANCE INDICATORS — MIDDLE SCHOOL	PERFORMANCE INDICATORS — HIGH SCHOOL
1. MODELING Use mathematics to help make sense of the real world: identify variables, formulate a model describing the relationship between the variables, interpret results, and validate and report conclusions and the reasoning behind them. **Spotlight on Equity:** Mathematical Modeling and Culturally Relevant Pedagogy *This article provides ideas that mathematics educators and teachers can use to consider contexts that are relevant to students' lives for creating mathematical modeling tasks and focuses on the tenets of Culturally Relevant Pedagogy (CRP).*	a. Use numerical phenomena or quantities to model a situation. b. Use geometric shapes and their properties to model physical objects. c. Use equations to model and interpret situations. d. Use graphing techniques to model situations involving data. e. Compare mathematical models for a situation. f. Interpret the results of applying the model in the context of the situation.	a. Use numerical phenomena or quantities to model a situation. b. Use geometric shapes and their properties to model physical objects. c. Use equations, inequalities and functions to model and interpret situations. d. Use statistics to model situations involving data. e. Compare mathematical models for a situation. f. Interpret the results of applying the model in the context of the situation.	a. Use numerical phenomena or quantities to a model a situation. (HSN.Q) b. Use geometric shapes and their properties to model physical objects. (HSG.SRT.C, GPE.B, GMD.A, MG) c. Use equations, inequalities and functions to model and interpret situations. (HSA.SSE, CED, REI.D; HSF.IF.B,C, BF.A, LE, TF.B) d. Use statistics to model situations involving data. (HSS) e. Compare mathematical models for a situation. f. Interpret the results of applying the model in the context of the situation.

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2. NUMBER AND QUANTITY Reason, describe, and analyze quantitatively, using units and number systems to solve problems. **Spotlight on Equity:** Can I Be a Multicultural Educator in Math - Ethnomathematics *This site presents ways in which an educator can present mathematics from a multi-cultural perspective using Ethnomathematics, which invites us to look into how knowledge was built throughout history in different cultural environments.*	a. Understand the place value system. (5NBT.A) b. Perform operations with multi-digit whole numbers and with decimals to hundredths. (5NBT.B) c. Use equivalent fractions as a strategy to add and subtract fractions. (5NF.A) d. Apply and extend previous understandings of multiplication and division to multiply and divide fractions. (5NF.B)	a. Compute fluently with multi-digit numbers and find common factors and multiples. (6NS.A) b. Apply and extend previous understandings of numbers to the system of rational numbers. (6NS.B) c. Apply and extend previous understandings of operations with fractions. (7NS.A) d. Know that there are numbers that are not rational, and approximate them by rational numbers. (8NS.A)	a. Extend the properties of exponents to rational exponents. (HSN.RN.A) b. Use the properties of rational and irrational numbers. (HSN.RN.B) c. Reason quantitatively and use units to solve problems. (HSN.Q.A) d. Perform arithmetic operations with complex numbers. (HSN.CN.A) e. Use complex numbers in polynomial identities and equations. (HSN.CN.C)

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3. ALGEBRA Create, interpret, use, and analyze expressions, equations and inequalities. **Spotlight on Equity:** Teaching Algebra Using Project-Based Learning *This site provides a rationale for teaching algebra concepts through project-based learning, discusses how to plan for project-based learning, and contains links for further readings.*	a. Write and interpret numerical expressions. (5OA.A)	a. Apply and extend previous understandings of arithmetic to algebraic expressions. (6EE.A) b. Reason about and solve one-variable equations and inequalities. (6EE.B) c. Represent and analyze quantitative relationships between dependent and independent variables. (6EE.C) d. Use properties of operations to generate equivalent expressions. (7EE.A) e. Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7EE.B) f. Work with radicals and integer exponents. (8EE.A) g. Understand the connections between proportional relationships, lines, and linear equations. (8EE.B) h. Analyze and solve linear equations and pairs of simultaneous linear equations. (8EE.C)	a. Interpret the structure of expressions. (HSA.SSE.A) b. Write expressions in equivalent forms to solve problems. (HSA.SSE.B) c. Perform arithmetic operations on polynomials. (HSA.APR.A) d. Understand the relationship between zeros and factors of polynomials. (HSA.APR.B) e. Use polynomial identities to solve problems. (HSA.APR.C) f. Rewrite rational expressions. (HSA.APR.D) g. Create equations that describe numbers or relationships. (HSA.CED.A) h. Understand solving equations as a process of reasoning and explain the reasoning. (HSA.REI.A) i. Solve equations and inequalities in one variable. (HSA.REI.B) j. Solve systems of equations. (HSA.REI.C) k. Represent and solve equations and inequalities graphically. (HSA.REI.D)

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4. FUNCTIONS Use functions, including linear, quadratic, trigonometric and exponential, to interpret and analyze a variety of contexts. **Spotlight on Equity:** Teaching and Learning Functions *This chapter from the National Academies Press details the importance of assessing students' prior knowledge regarding functions, using their own language to describe, and building upon this to gain a deeper understanding of formal mathematical concepts.*	a. Analyze patterns and relationships. (5OA.B)	a. Understand ratio concepts and use ratio reasoning to solve problems. (6RP.A) b. Analyze proportional relationships and use them to solve real-world and mathematical problems. (7RP.A) c. Define, evaluate, and compare functions. (8F.A) d. Use functions to model relationships between quantities. (8F.B)	a. Understand the concept of a function and use function notation. (HSF.IF.A) b. Interpret functions that arise in applications in terms of the context. (HSF.IF.B) c. Analyze functions using different representations. (HSF.IF.C,E) d. Build a function that models a relationship between two quantities. (HSF.BF.A) e. Build new functions from existing functions. (HSF.BF.B) f. Construct and compare linear, quadratic, and exponential models and solve problems. (HSF.LE.A) g. Interpret expressions for functions in terms of the situation they model. (HSF.LE.B) h. Extend the domain of trigonometric functions using the unit circle. (HSF.TF.A) i. Model periodic phenomena with trigonometric functions. (HSF.TF.B) j. Prove and apply trigonometric identities. (HSF.TF.C)

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5. GEOMETRY Understand geometric concepts and constructions, prove theorems, and apply appropriate results to solve problems. **Spotlight on Equity:** Geometry in the Middle Grades: A Multi-Cultural Approach *This links to a study done on using a multi-cultural approach to Geometry instruction to increase student engagement and enjoyment, the link to the full dissertation includes 18 geometry lessons created using a multi-cultural approach.*	a. Graph points on the coordinate plane to solve real-world and mathematical problems. (5G.A) b. Classify two-dimensional figures into categories based on their properties. (5G.B)	a. Solve real-world and mathematical problems involving area, surface area, and volume. (6G.A) b. Draw, construct, and describe geometrical figures and describe the relationships between them. (7G.A) c. Solve real-life and mathematical problems involving angle measure, area, surface area, and volume. (7G.B) d. Understand congruence and similarity using physical models, transparencies, or geometry software. (8G.A) e. Understand and apply the Pythagorean Theorem. (8G.B) f. Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres. (8G.C)	a. Experiment with transformations in the plane. (HSG.CO.A) b. Understand congruence in terms of rigid motions. (HSG.CO.B) c. Prove geometric theorems. (HSG.CO.C) d. Make geometric constructions. (HSG.CO.D) e. Understand similarity in terms of similarity transformations. (HSG.SRT.A) f. Prove theorems involving similarity. (HSG.SRT.B) g. Define trigonometric ratios and solve problems involving right triangles. (HSG.SRT.C) h. Understand and apply theorems about circles. (HSG.C.A) i. Find arc lengths and areas of sectors of circles. (HSG.C.B) j. Translate between the geometric description and the equation for a conic section. (HSG.GPE.A) k. Use coordinates to prove simple geometric theorems algebraically. (HSG.GPE.B)

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5. GEOMETRY (cont.)			l. Explain volume formulas and use them to solve problems. (HSG.GMD.A) m. Visualize relationships between two-dimensional and three-dimensional objects. (HSG.GMD.B) n. Apply geometric concepts in modeling situations. (HSG.MG.A)

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6. STATISTICS AND PROBABILITY Interpret and apply statistics and probability to analyze data, reach and justify conclusions, and make inferences. **Spotlight on Equity:** Culturally Relevant Statistics *This paper describes a project that was based on the principles of culturally relevant pedagogy to create conditions where students themselves would recognize the relevance of statistics in identifying and describing inequities that face their communities.*	a. Convert like measurement units within a given measurement system. (5MD.A) b. Represent and interpret data. (5MD.B) c. Geometric measurement: understand concepts of volume. (5MD.C)	a. Develop understanding of statistical variability. (6SP.A) b. Summarize and describe distributions. (6SP.B) c. Use random sampling to draw inferences about a population. (7SP.A) d. Draw informal comparative inferences about two populations. (7SP.B) e. Investigate chance processes and develop, use, and evaluate probability models. (7SP.C) f. Investigate patterns of association in bivariate data. (8SP.A)	a. Summarize, represent, and interpret data on a single count or measurement variable. (HSS.ID.A) b. Summarize, represent, and interpret data on two categorical and quantitative variables. (HSS.ID.B) c. Interpret linear models. (HSS.ID.C) d. Understand and evaluate random processes underlying statistical experiments. (HSS.IC.A) e. Make inferences and justify conclusions from sample surveys, experiments, and observational studies. (HSS.IC.B) f. Understand independence and conditional probability and use them to interpret data. (HSS.CP.A) g. Use the rules of probability to compute probabilities of compound events in a uniform probability model. (HSS.CP.B)