Michigan Mathematics

High School — Number and Quantity

Adopted 2010

Standards for Mathematical Practice

1. **Make sense of problems and persevere in solving them.** CCSS.MATH.PRACTICE.MP1
2. **Reason abstractly and quantitatively.** CCSS.MATH.PRACTICE.MP2
3. **Construct viable arguments and critique the reasoning of others.** CCSS.MATH.PRACTICE.MP3
4. **Model with mathematics.** CCSS.MATH.PRACTICE.MP4
5. **Use appropriate tools strategically.** CCSS.MATH.PRACTICE.MP5
6. **Attend to precision.** CCSS.MATH.PRACTICE.MP6
7. **Look for and make use of structure.** CCSS.MATH.PRACTICE.MP7
8. **Look for and express regularity in repeated reasoning.** CCSS.MATH.PRACTICE.MP8

The Real Number System

A. Extend the properties of exponents to rational exponents. CCSS.MATH.CONTENT.HSN-RN.A

1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. CCSS.MATH.CONTENT.HSN-RN.A.1
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents. CCSS.MATH.CONTENT.HSN-RN.A.2

B. Use properties of rational and irrational numbers. CCSS.MATH.CONTENT.HSN-RN.B

3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational. CCSS.MATH.CONTENT.HSN-RN.B.3

Quantities

A. Reason quantitatively and use units to solve problems. CCSS.MATH.CONTENT.HSN-Q.A

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1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. CCSS.MATH.CONTENT.HSN-Q.A.1
2. Define appropriate quantities for the purpose of descriptive modeling. CCSS.MATH.CONTENT.HSN-Q.A.2
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. CCSS.MATH.CONTENT.HSN-Q.A.3

The Complex Number System

A. Perform arithmetic operations with complex numbers. CCSS.MATH.CONTENT.HSN-CN.A

1. Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + bi with a and b real. CCSS.MATH.CONTENT.HSN-CN.A.1
2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. CCSS.MATH.CONTENT.HSN-CN.A.2
3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. CCSS.MATH.CONTENT.HSN-CN.A.3

B. Represent complex numbers and their operations on the complex plane. CCSS.MATH.CONTENT.HSN-CN.B

4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. CCSS.MATH.CONTENT.HSN-CN.B.4
5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. CCSS.MATH.CONTENT.HSN-CN.B.5
6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints. CCSS.MATH.CONTENT.HSN-CN.B.6

C. Use complex numbers in polynomial identities and equations. CCSS.MATH.CONTENT.HSN-CN.C

7. Solve quadratic equations with real coefficients that have complex solutions. CCSS.MATH.CONTENT.HSN-CN.C.7
8. (+) Extend polynomial identities to the complex numbers. CCSS.MATH.CONTENT.HSN-CN.C.8
9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. CCSS.MATH.CONTENT.HSN-CN.C.9

Ve Qu **Represent and model with vector quantities.** CCSS.MATH.CONTENT.HSN-VM.A

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1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). CCSS.MATH.CONTENT.HSN-VM.A.1
2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. CCSS.MATH.CONTENT.HSN-VM.A.2
3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. CCSS.MATH.CONTENT.HSN-VM.A.3

B. Perform operations on vectors. CCSS.MATH.CONTENT.HSN-VM.B

4. (+) Add and subtract vectors. CCSS.MATH.CONTENT.HSN-VM.B.4
   a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. CCSS.MATH.CONTENT.HSN-VM.B.4A
   b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. CCSS.MATH.CONTENT.HSN-VM.B.4B
   c. Understand vector subtraction v - w as v + (-w), where -w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. CCSS.MATH.CONTENT.HSN-VM.B.4C
5. (+) Multiply a vector by a scalar. CCSS.MATH.CONTENT.HSN-VM.B.5
   a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(v_x, v_y) = (cv_x, cv_y). CCSS.MATH.CONTENT.HSN-VM.B.5A
   b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v ? 0, the direction of cv is either along v (for c > 0) or against v (for c < 0). CCSS.MATH.CONTENT.HSN-VM.B.5B

C. Perform operations on matrices and use matrices in applications. CCSS.MATH.CONTENT.HSN-VM.C

6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. CCSS.MATH.CONTENT.HSN-VM.C.6
7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. CCSS.MATH.CONTENT.HSN-VM.C.7
8. (+) Add, subtract, and multiply matrices of appropriate dimensions. CCSS.MATH.CONTENT.HSN-VM.C.8
9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. CCSS.MATH.CONTENT.HSN-VM.C.9

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10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. CCSS.MATH.CONTENT.HSN-VM.C.10
11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors. CCSS.MATH.CONTENT.HSN-VM.C.11
12. (+) Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area. CCSS.MATH.CONTENT.HSN-VM.C.12