

High School - Number & Quantity

The Real Number System N.RN

A Extend the properties of exponents to rational exponents N.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. For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3=5^{(1/3)^3}$ to hold, so $(5^{1/3})^3$ must equal 5. N.RN.A.1
 - 2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. N.RN.A.2
 - 3 Simplify radicals, including algebraic radicals (e.g. $\sqrt[3]{54}=3\sqrt[3]{2}$, simplify $\sqrt{(32x^2)}$). N.RN.A.3
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Quantities N.Q

A Reason quantitatively and use units to solve problems N.Q.A

- 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. N.Q.A.1
 - 2 Define appropriate quantities for the purpose of descriptive modeling. N.Q.A.2
 - 3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. N.Q.A.3
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The Complex Number System N.CN

A Perform arithmetic operations with complex numbers N.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. N.CN.A.1
- 2 Use the relation $i^2=-1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. N.CN.A.2
- 3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. N.CN.A.3

B Represent complex numbers and their operations on the complex plane N.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. N.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. For example, $(-1+\sqrt{3}i)^3=8$ because $-1+\sqrt{3}i$ has modulus 2 and argument 120° . N.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. N.CN.B.6

C Use complex numbers in polynomial identities and equations N.CN.C

- 7 Solve quadratic equations with real coefficients that have complex solutions. N.CN.C.7
- 8 Extend polynomial identities to the complex numbers. For example, rewrite x^2+4 as $(x+2i)(x-2i)$. N.CN.C.8
- 9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. N.CN.C.9

Vector and Matrix Quantities N.VM**A Represent and model with vector quantities** N.VM.A

- 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., $v, |v|, \|v\|, v$). N.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. N.VM.A.2
- 3 Solve problems involving velocity and other quantities that can be represented by vectors. N.VM.A.3

B Perform operations on vectors N.VM.B

- 4 Add and subtract vectors. N.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. N.VM.B.4.A
 - b Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. N.VM.B.4.B
 - 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. N.VM.B.4.C
- 5 Multiply a vector by a scalar. N.VM.B.5
 - a Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$. N.VM.B.5.A
 - b Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$). N.VM.B.5.B

C Perform operations on matrices and use matrices in applications N.VM.C

- 6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. N.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. N.VM.C.7
- 8 Add, subtract, and multiply matrices of appropriate dimensions. N.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. N.VM.C.9
- 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. N.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. N.VM.C.11
- 12 Work with 2×2 matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area. N.VM.C.12