

# Unpacked South Dakota State Mathematics Standards

**Purpose:** *In order for students to have the best chance of success, standards, assessment, curriculum resources, and instruction must be aligned in focus, coherence, and rigor. Unpacked standards documents are intended to help align instruction to the focus, coherence, and rigor of the South Dakota State Mathematics Standards. The standards have been organized in clusters as they are not so much built from topics, but rather woven out of progressions. Not all content in a given grade is emphasized equally in the mathematics standards. Some clusters require greater emphasis than others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. To say that some things have greater emphasis is not to say that anything in the standards can safely be neglected in instruction. Neglecting standards will leave gaps in student skill and understanding and may leave students unprepared for the challenges of a later grade.*

<b>Domain: Number and Quantity</b>		<b>Grade Level: 4th Year</b>
<p><b>HS4.N.CN.B Cluster: Represent complex numbers and their operations on the complex plane.</b> Students are extending their understanding of the real number system to the complex number system. Students connect their knowledge of polar coordinates, vectors, and complex solutions.</p>		
<p><b>This is a SUPPORTING cluster.</b> <i>Students should spend the large majority of their time (65-85%) on the major work of the grade. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade.</i></p>		
<p><b>N.CN.4</b> 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.</p> <p><b>N.CN.5</b> Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation.</p> <p><b>N.CN.6</b> 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.</p> <p><b>N.CN.8</b> Extend polynomial identities to the complex numbers. For example, rewrite <math>x^2+4</math> as <math>(x+2i)(x-2i)</math>.</p> <p><b>N.CN.9</b> Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.</p>		
<p><b>Aspects of Rigor of Student Learning:</b> (Conceptual, Procedural, and/or Application)</p>		
<p><b>N.CN.4</b> 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.</p>		
<b>Conceptual Understanding</b>	<b>Procedural Fluency</b>	<b>Application</b>
Students should be able to draw a vector representing a complex number on the complex plane where the x- axis represents the real number and the y-axis represents the imaginary number.		
<p><b>N.CN.5</b> Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation.</p>		
<b>Conceptual Understanding</b>	<b>Procedural Fluency</b>	<b>Application</b>
Students use vector operations as a basis for the geometric representation of operations of complex numbers.	Students can add, subtract, multiply and divide complex numbers.	
<p><b>N.CN.6</b> 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..</p>		

<b><i>Conceptual Understanding</i></b>	<b><i>Procedural Fluency</i></b>	<b><i>Application</i></b>
Students relate finding the distance and midpoint of complex numbers with the distance and midpoint formulas of real numbers.	Students can find the midpoint and distance between complex numbers.	
<b>N.CN.8</b> Extend polynomial identities to the complex numbers. For example, rewrite $x^2+4$ as $(x+2i)(x-2i)$ .		
<b><i>Conceptual Understanding</i></b>	<b><i>Procedural Fluency</i></b>	<b><i>Application</i></b>
Students see the relationship between factoring with real components and complex components.		
<b>N.CN.9</b> Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.		
<b><i>Conceptual Understanding</i></b>	<b><i>Procedural Fluency</i></b>	<b><i>Application</i></b>
Students understand that an $n$ th degree polynomial will have $n$ roots.	Students can find the roots for a polynomial.	
<b>Enacting the Mathematical Practices - Evidence of Students Engaging in the Practices</b>		
<ol style="list-style-type: none"> <li>1. <b>Make sense of problems and persevere in solving them.</b></li> <li>2. <b>Reason abstractly and quantitatively.</b></li> <li>3. <b>Construct viable arguments and critique the reasoning of others.</b></li> <li>4. <b>Model with mathematics.</b></li> <li>5. <b>Use appropriate tools strategically.</b></li> <li>6. <b>Attend to precision.</b></li> <li>7. <b>Look for and make use of structure.</b> <ul style="list-style-type: none"> <li>• Students should relate the structure of equations, specifically the roots of equations, to real and non-real zeros.</li> </ul> </li> <li>8. <b>Look for and express regularity in repeated reasoning.</b> <ul style="list-style-type: none"> <li>• Students should connect factorizations of polynomials to their real and complex representations.</li> </ul> </li> </ol>		
<b>Vertical and Horizontal Coherence and Learning Progressions</b>		
<b><u><i>Previous Learning Connections</i></u></b>	<b><u><i>Current Learning Connections</i></u></b>	<b><u><i>Future Learning Connections</i></u></b>
<p>In prior Algebra courses, students have solved quadratic equations by factoring and using the quadratic formula. In these problems, they have encountered imaginary roots.</p> <p>In Geometry, students have developed and used the distance and midpoint formulas.</p> <p>In Precalculus, students have explored vectors and vector operations.</p>	Students are extending their understanding of the real number system to the complex number system. Students connect their knowledge of polar coordinates, vectors, and complex solutions.	Students will encounter complex numbers in a College Algebra class. Complex numbers can be a stand-alone course in a college curriculum.
<b>Vocabulary (key terms and definitions)</b>		

- Fundamental Theorem of Algebra

***Relevance, Explanations, and Examples:***