

Core Content

Cluster Title: Represent complex numbers and their operations on the complex plane.
Standard (+) N.CN.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.
Concepts and Skills to Master
<ul style="list-style-type: none"> • Convert between the rectangular form, $z = x + yi$, and polar form, $z = r(\cos \theta + i \sin \theta)$, of a complex number. • Graph complex numbers on a complex plane in both rectangular and polar form. • Justify rectangular and polar forms of a complex number as representing the same number.

Supports for Teachers

Critical Background Knowledge	
<ul style="list-style-type: none"> • Complex numbers • Graphing polar coordinates • Trigonometric identities on the unit circle • Modulus 	
Academic Vocabulary	
complex plane, rectangular form, polar form, modulus, argument	
Suggested Instructional Strategies	Resources
<ul style="list-style-type: none"> • Plot a complex number represented in rectangular form on the complex plane. • Lead students to see the relationship between (x, y) and (r, θ). 	
Sample Formative Assessment Tasks	
<p>Skill-Based Task: Express the complex number $z = \sqrt{3} - i$ in polar form. Plot this number on the complex plane.</p>	<p>Problem Task: Given the complex number in polar form $z = r(\cos \theta + i \sin \theta)$, what is the polar form of $-z$? Justify your answer with both verbal and algebraic arguments.</p>

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Standard (+) N.CN.5: Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. <i>For example, $(-1 + \sqrt{3}i)^3 = 8$ because $(-1 + \sqrt{3}i)$ has modulus 2 and argument 120°.</i>
Concepts and Skills to Master
<ul style="list-style-type: none"> • Represent geometrically the sum, difference, product, and conjugation of complex numbers on the complex plane. • Show that the conjugate of a complex number in the complex plane is the reflection across the x-axis. • Evaluate the power of a complex number, in rectangular form, using the polar form of the complex number.

Supports for Teachers

Critical Background Knowledge	
<ul style="list-style-type: none"> • Complex numbers • Complex plane 	
Academic Vocabulary	
complex plane	
Suggested Instructional Strategies	Resources
<ul style="list-style-type: none"> • Use properties of parallelograms for addition and subtraction of complex numbers, and use properties of similar triangles for multiplication of complex numbers. • Approach addition, subtraction, and multiplication of complex numbers as vectors by showing that when multiplying two vectors, you add the arguments to find the resulting argument, and multiply the moduli to find the resulting modulus. 	
Sample Formative Assessment Tasks	
Skill-Based Task: Find the sum and product of $2 + 3i$ and $4 + 2i$ graphically and algebraically.	Problem Task: Find two sets of complex numbers whose differences are equal. Justify graphically.

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Standard (+) N.CN.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.
Concepts and Skills to Master
<ul style="list-style-type: none"> • Show that the distance between two complex numbers is equivalent to the modulus of the difference by applying the distance formula. • Find the midpoint of a segment between two complex numbers by taking the average of the numbers at its endpoints using the midpoint formula.

Supports for Teachers

Critical Background Knowledge	
<ul style="list-style-type: none"> • Distance formula • Midpoint formula • Modulus • Complex plane 	
Academic Vocabulary	
complex plane, modulus	
Suggested Instructional Strategies	Resources
<ul style="list-style-type: none"> • Use graphical representations to show relationships between distance formula and the modulus of the difference, and the relationship between a segments midpoint and the average of its endpoints. 	
Sample Formative Assessment Tasks	
Skill-Based Task: Find the distance and the midpoint between $-2 + 3i$ and $1 - 5i$.	Problem Task: A treasure is hidden in the complex plane. Follow the sequence of events: From the origin, travel to $1 + 3i$, then travel to Point A located at $2 + 5i$, noting the distance and direction traveled. Now return to the origin. Travel the same distance and direction to find Point B. The treasure will be halfway between point A and point B. Give the coordinate location of the treasure.