Cluster Title: Perform arithmetic operations with complex numbers.

**Standard (Honors) N.CN.3:** Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

#### **Concepts and Skills to Master**

- Given a complex number, determine the conjugate.
- Define the modulus of a complex number as the positive square root of the sum of the squares of the real and imaginary parts of a complex number.
- Use conjugates to express quotients of complex numbers in standard form.

Critical Background Knowledge					
Complex numbers					
Complex plane					
Rationalizing denominators					
• $l^2 = -1$					
Academic Vocabulary					
conjugate, modulus, magnitude, complex plane					
Suggested Instructional Strategies		Resources			
<ul> <li>Use properties of difference of two squares to find the modulus.</li> </ul>		Modulus Visual Representation			
Relate the modulus visually using vectors.		http://demonstrations.wolfram.com/ComplexNumber/			
Sample Formative Assessment Tasks					
Skill-Based Task:	Problem Task:				
Write the following quotient in standard form:	Determine if the following statement is true or false using complex				
2 + 3i	conjugates: The modulus of z and the modulus of $\overline{z}$ are equal.				
$\overline{3-5i}$	Justify your answer with both verbal and algebraic arguments.				

Cluster Title: Represent complex numbers and their operations on the complex plane.

**Standard (Honors) 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**

- 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.

Critical Background Knowledge					
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			
Plot a complex number represented in rectangular form on the					
complex plane.					
• Lead students to see the relationship between $(x, y)$ and $(r, \theta)$ .					
Sample Formative Assessment Tasks					
Skill-Based Task:	Problem Task:				
Express the complex number $z = \sqrt{3} - i$ in polar form. Plot	Given the complex number in polar form $z = r(\cos \theta + i \sin \theta)$ ,				
this number on the complex plane.	what is the polar form of $-z$ ? Justify your answer with both				
	verbal and alg	ebraic arguments.			

Cluster Title: Represent complex numbers and their operations on the complex plane.

**Standard (Honors) N.CN.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°.

#### **Concepts and Skills to Master**

- 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.

Critical Background Knowledge					
Complex numbers					
Complex plane					
Academic Vocabulary					
complex plane					
Suggested Instructional Strategies	Resources				
<ul> <li>Use properties of parallelograms for addition and subtract complex numbers, and use properties of similar triangles multiplication of complex numbers.</li> <li>Approach addition, subtraction, and multiplication of com as vectors by showing that when multiplying two vectors arguments to find the resulting argument, and multiply the find the resulting modulus.</li> </ul>	ction of s for aplex numbers , you add the e moduli to				
Sample Formative Assessment Tasks					
Skill-Based Task:	Problem Task:				
Find the sum and product of $2 + 3i$ and $4 + 2i$ graphically	Find two sets of complex numbers whose differences are				
and algebraically.	equal. Justify graphically.				

Cluster Title: Represent complex numbers and their operations on the complex plane.

**Standard (Honors) 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**

- 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.

Critical Background Knowledge				
Distance formula				
Midpoint formula				
Modulus				
Complex plane				
Academic Vocabulary				
complex plane, modulus				
Suggested Instructional Strategies		Resources		
• Use graphical representations to show relationships between distance				
formula and the modulus of the difference, and the relati	onship			
between a segments midpoint and the average of its end				
Sample Formative Assessment Tasks				
Skill-Based Task:	Problem Task	<:		
Find the distance and the midpoint between -2 + 3 <i>i</i> and 1-	A treasure is hidden in the complex plane. Follow the			
5 <i>i</i> .	sequence of events: From the origin, travel to 1 + 3 <i>i</i> , 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.			