Curriculum Sample: HS Math: Number and Quantity
Max. 8 Pages

Grade Level	High School (11th)	**Content Area**	Math
Course Title (grades 9-12 Only)	Honors Pre-Calculus		
Length of Unit	Five 55-minute periods	**Time of Year**	Second Quarter
Expected Prior Knowledge *The knowledge/skills mastered earlier in the year foundational to the mastery of the required Standard in the current sample.*	Students will have an understanding of imaginary numbers and how to work with them. They will also have knowledge of complex numbers in the form a + bi and how to graph the point on a complex coordinate plane. Students will understand how to manipulate fractions and how to multiply two binomials.		
Alignment to Program of Instruction *Briefly outline methods of instruction found in this sequence of lessons that align to the Program of Instruction described in A.3.*	The school's program of instruction stresses alignment with research-supported instructional techniques of Hunter's Essential Elements of Instruction. Instruction during this unit will include direct instruction of key points and examples, guided practice including worksheets and partner activities, independent practice, and daily formative assessments conducted at the end of each class period.		
Standard Number and Description *List the Number* and full description for the required Standard.*	N-CN.3 Conceptual Category: Number and Quantity Domain: The Complex Number System (N-CN) Standard: #3 – Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers		
Summative Assessment *Describe a cumulative and comprehensive activity, clearly separate from instruction and guided or independent practice, which allows each student to individually demonstrate mastery of the required Standard. A copy of the summative assessment must be attached to the curriculum sample.*	Students will complete a 10 question open-response summative to assess their ability at determining the conjugate of a complex number. Students will also be tested on their knowledge of how to find moduli and quotients of complex numbers using complex conjugates.		
Scoring Scale and Mastery Level *Explain how the assessment is scored, to include points per question, how points are awarded, total points possible, criteria necessary to demonstrate mastery, and grading scale. A copy of the answer key and*	The 10 open-response questions will be scored on an absolute scale with an answer key provided for both correct answers and appropriate justification. Credit will only be awarded for answers that completely match the answer key, and no partial credit will be awarded. Students must get at least 8 of the 10 questions completely correct to master the standard.		

scoring rubric (whichever applicable) must be attached to the curriculum sample.	
Materials/Resources Needed	Poster board, construction paper, white boards, markers

* ***Standard Number****: For English Language Arts (Reading and Writing), use Grade, Strand, Standard (e.g., 3.RI.2). For K-8 Math, use Grade, Domain, Standard (e.g., 6.EE.7). For HS Math, use Conceptual Category-Domain, Standard (e.g., A-REI.6). For Science, use Grade, Strand, Concept, PO (e.g., 4.1.3.1).*

Lesson (add as needed	**Instruction**	**Student Activities**
1	SWBAT find the conjugate of a complex number Key Points: • When referring to *a + bi*, the *a* is the real part and the *bi* is the imaginary part • To find the conjugate of a complex number, change the sign of the imaginary part *bi* (ie: 3 + 4i becomes 3 – 4i) • The real part *a* stays the same • When you multiply *a + bi* by it's conjugate *a – bi* the result is a real number (e.g.: (3 + 4i)(3 – 4i) = 25)	Do Now: Students will review basic concepts of imaginary numbers and complex numbers. Guided Practice: Students will be given note cards. Each note card with have a value for *a* or a value for *bi*. Students will sort the values and label them as "real" or "imaginary." Then students will create their own expressions in the form *a + bi*, find the complex conjugate and multiply them by the original complex number. Each answer should result in a real number. Independent Practice: Students will create a poster that explains how to find the complex conjugate and provide multiple examples. Exit Ticket: Students will participate in a gallery walk and comment on other students' posters.
2	SWBAT find the modulus of a complex number Key Points: • On a complex coordinate plane, the modulus is the distance from the origin to the complex number • The modulus of a complex number Z is often denoted *mod Z* • The modulus may be referred to as the absolute value • The modulus of a complex number Z where *Z = x +iy* is given by $\sqrt{x^2+y^2}$ When multiplying a complex number by it's conjugate, take the square root of the resulting real number to find the modulus	Do Now: Students will review basic concepts of complex numbers and conjugates of complex numbers. Guided Practice: Students will participate in a discovery activity. Students will review graphing complex numbers on a coordinate plane. Teacher with then introduce the concept of a modulus and ask students to problem solve and try to discover the process for finding the modulus. Teacher will explain the relationship between multiplying complex numbers and their conjugates and how students can use this to find the modulus. Independent Practice: Students will be given a worksheet and asked to work independently on the review problems. When finished, students will partner with another student and check their answers. Exit Ticket: Students will answer the following questions: *How do you find the conjugate to a complex number?* *How do you find the modulus of a complex number?*

		What is the relationship between the conjugate and the modulus?
3	SWBAT find the quotient of two complex numbers Key Points: • When multiplying a complex number by it's conjugate, the result is a real number • When dividing two complex numbers follow these steps: 1. Find the complex conjugate of the denominator 2. Multiply the numerator and denominator by the complex conjugate of the denominator (this will result in the denominator becoming a real number) 3. Simplify	Do Now: Students will review basic concepts of complex numbers, conjugates, and moduli. Guided Practice: Students will be given a worksheet with multiple review problems. They will work with a partner to solve the problems and check answers with guidance from the teacher. Independent Practice: Students will receive white boards and markers. Students will participate in a game and work in groups to solve problems. The group that gets the problem right first will receive a point. All students in the group must have the correct answer in order to receive a point. Exit Ticket: Students will be given a review sheet with 3 problems. They will be required to answer these problems correctly before leaving the class.
4	SWBAT find the conjugate and modulus of a complex number and the quotient of two complex numbers Key Points: • This lesson is a continuation of the previous three lessons and reviews important key concepts: ○ To find the conjugate, change the sign of the imaginary part of the complex number ○ To find the modulus, multiply the complex number by it's conjugate and take the square root of the resulting real number ○ To find the quotient of two complex numbers, multiply the numerator and denominator by the conjugate of the denominator and then simplify	Do Now: Students will review basic concepts of complex numbers, conjugates, and moduli. Guided Practice: Students will review all of the information learned up to this point. They will create a book to teach other students about complex numbers, conjugates, moduli, and quotients. Students will be required to write definitions, provide example problems, and create unique problems. Independent Practice: When finished, students will give their books to another student. Together, they will solve the problems and check each other's answers. Exit Ticket: No exit ticket today.
5	SWBAT find the conjugate and modulus of a complex number and the quotient of two complex numbers Key Points: • This is a continuation of yesterday's lesson and reviews the key concepts learned so far in the unit	Do Now: Students will complete a brief review worksheet that summarizes everything learned thus far. Guided Practice: Students will share their answers from their books and ask any remaining questions.

		Independent Practice: Student assessment. Exit Ticket: Summative assessment.

Paste Summative Assessment Here:

1. What is the term for the distance between the origin and a complex number on a complex coordinate plane?
   a. Conjugate b. Modulus c. Quotient d. Midpoint

2. What is the complex conjugate of the following complex numbers?
   a. 4 + 5i
   b. 6 – 3i
   c. -2 – 4i

3. When you multiply a complex number by it's conjugate, is your answer a real number or an imaginary number?

4. Multiply the following complex number by it's conjugate: 2 + 3i

5. Using a complex conjugate, find the modulus: 3 – 4i

6. Using $\sqrt{x^2+y^2}$ find the modulus: 3 – 4i

7. Find the modulus: -2 + 6i

8. Simplify: $\frac{-10-5i}{-6+6i}$

9. Simplify: $\frac{-5-9i}{9+8i}$

10. Simplify: $\frac{-4+10i}{3+4i}$

Paste Answer Key/Scoring Rubric Here:

1. b. Modulus
2. a. 4 – 5i b. 6 + 3i c. -2 + 4i
3. Real number
4. 13
5. 5
6. 5
7. $\sqrt{40} = 2\sqrt{10}$
8. $\frac{5+15i}{12}$
9. $\frac{-117-41i}{145}$
10. $\frac{28+46i}{25}$