Unit Title	All Systems Go		**Length of Unit**	5 weeks
Focusing Lens(es)	Modeling Concurrence	**Standards and Grade Level Expectations Addressed in this Unit**	MA10-GR.HS-S.2-GLE.4	
Inquiry Questions (Engaging-Debatable):	• How do you determine when a hybrid car would pay for itself in gas savings compared to a less expensive conventional car? (MA10-GR.HS-S.2-GLE.4-EO.d)			
Unit Strands	Algebra: Reasoning with Equations and Inequalities Algebra: Creating Equations			
Concepts	Systems, constraint, linear, equations, inequalities, solutions, viable, non-viable, intersections, graph, model, approximation, half-plane, substitution, elimination			

Generalizations **My students will Understand that…**	**Guiding Questions** **Factual**	**Conceptual**
When solving systems of linear equations mathematicians can determine the type of solution set (one solution, no solutions, or infinite solutions) both graphically and algebraically. (MA10-GR.HS-S.2-GLE.4-EO.d)	What do the different types of solutions for a system of linear equations look like on a graph? How are solutions to systems of equations visualized or approximated on a graph? Is it possible for a system of equations to have no solution, what would this look like on a graph?	Why does graphing a pair of lines describe the possible solution sets for a system of a pair of linear equations?
The characteristics of the equations in a system determine the most efficient strategy for finding a solution. (MA10-GR.HS-S.2-GLE.4-EO.d)	What are the different types of solution processes for solving systems of linear equations?	Why do different types of systems require different types of solution processes? Why if you use an inefficient method will you still get the correct solution to system of equations? Why is substitution sometimes more efficient than elimination for solving a system of linear equations algebraically and vice versa?
The intersection of two half-planes provides a means to visualize and represent the solution to a system of linear inequalities. (MA10-GR.HS-S.2-GLE.4-EO.e.iii)	What would a graph of a system of linear inequalities with no solution look like?	Why are solutions to linear inequalities better represented graphically than algebraically?

Mathematicians evaluate mathematical solutions for their relevance to a model; not all solutions to a system are viable in context. (MA10-GR.HS-S.2-GLE.4-EO.a.iii)	What are characteristics of non-viable solutions? How do you know when a solution will be viable?	Why is it important to evaluate all solutions within the original context?

Key Knowledge and Skills: My students will…	*What students will know and be able to do are so closely linked in the concept-based discipline of mathematics. Therefore, in the mathematics samples what students should know and do are combined.*

- Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. (MA10-GR.HS-S.2-GLE.4-EO.d.i) (CCSS: A-REI.5) PARCC (Calculator)
  - ✓ Given a system of equations, reason about the number or nature of the solutions
- Solve systems of linear equations exactly and approximately, focusing on pairs of linear equations in two variables. (MA10-GR.HS-S.2-GLE.4-EO.d.ii) (CCSS: A-REI.6)
  - ✓ Solve multi-step contextual problems that require writing and analyzing systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. (CCSS: A-REI.6-1) PARCC (Calculator)
- Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately of polynomials using technology to graph the functions, make tables of values, or find successive approximations; and, include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value. (MA10-GR.HS-S.2-GLE.4-EO.e.ii) (CCSS: A-REI.11)
  - ✓ Find the solutions of where the graphs of the equations y= f(x) and y= g(x) intersect, e.g. using technology to graph the functions, make tables of values or find successive approximations. Limit f(x) and/or g(x) to linear and quadratic functions. (CCSS: A-REI.11-1a) PARCC (Calculator)
    - The "explain" part of standard A-REI.11 is not assessed here. For this aspect of the standard, see Sub-Claim C.
  - ✓ Find the solutions of where the graphs of the equations y= f(x) and y= g(x) intersect, e.g. using technology to graph the functions, make tables of values or find successive approximations. Limit f(x) and/or g(x) to polynomial functions (CCSS: A-REI.11-1b) PARCC (Calculator)
    - The "explain" part of standard A-REI.11 is not assessed here. For this aspect of the standard, see Subclaim C.
    - Polynomials are of degree two and higher.
- Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. (MA10-GR.HS-S.2-GLE.4-EO.e.iii) (CCSS: A-REI.12) PARCC (No calculator)

✓ Solve equations that require seeing structure in expressions. (A.Int.1)
  - Tasks do not have a context.
  - Equations simplify considerably after appropriate algebraic manipulations are performed. For example, $x^4 - 17x^2 + 16 = 0$, $2^{3x} = 7(2^{2x}) + 22x$, $x - \sqrt{x} = 3\sqrt{x}$
  - Tasks should be course level appropriate.

- Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. (MA10-GR.HS-S.2-GLE.4-EO.a.iii) (CCSS: A-CED.3)
  - ✓ Solve multi-step contextual problems that require writing and analyzing systems of linear inequalities in two variables to find viable solutions. (CCSS: A-CED.3-1) PARCC (Calculator)
    - Tasks have hallmarks of modeling as a mathematical practice (less defined tasks, more of the modeling cycle, etc.).
    - Scaffolding in tasks may range from substantial to very little or none.

- Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (MA10-GR.HS-S.2-GLE.4-EO.a.iv) (CCSS: A-CED.4)
  - ✓ Rearrange linear formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. (CCSS: A-CED.4-1) PARCC (Calculator neutral)
    - Tasks have a real-world context.
  - ✓ Rearrange formulas that are quadratic in the quantity of interest to highlight the quantity of interest, using the same reasoning as in solving equations. . (CCSS: A-CED.4-1) PARCC (Calculator neutral)
    - Tasks have a real-world context.

✓ Solve multi-step contextual problems with degree of difficulty appropriate to the course by constructing quadratic function models and/or writing and solving quadratic equations. (HS-Int.1) PARCC (Calculator)
- A scenario might be described and illustrated with graphics (or even with animations in some cases).
- Solutions may be given in the form of decimal approximations. For rational solutions, exact values are required. For irrational solutions, exact or decimal approximations may be required. Simplifying or rewriting radicals is not required; however, students will not be penalized if they simplify the radicals correctly.
- Some examples: - A company sells steel rods that are painted gold. The steel rods are cylindrical in shape and 6 cm long. Gold paint costs $0.15 per square inch. Find the maximum diameter of a steel rod if the cost of painting a single steel rod must be $0.20 or less. You may answer in units of centimeters or inches. Give an answer accurate to the nearest hundredth of a unit. - As an employee at the Gizmo Company, you must decide how much to charge for a gizmo. Assume that if the price of a single gizmo is set at P dollars, then the company will sell 1000 - 0.2P gizmos per year. Write an expression for the amount of money the company will take in each year if the price of a single gizmo is set at P dollars. What price should the company set in order to take in as much money as possible each year? How much money will the company make per year in this case? How many gizmos will the company sell per year? (Students might use graphical and/or algebraic methods to solve the problem.) - At t=0, a car driving on a straight road at a constant speed passes a telephone pole. From then on, the car's distance from the telephone pole is given by C(t) = 30t, where t is in seconds and C is in meters. Also at t=0, a motorcycle pulls out onto the road, driving in the same direction, initially 90 m ahead of the car. From then on, the motorcycle's distance from the telephone pole is given by M(t) = 90 + 2.5 t^2, where t is in seconds and M is in meters. At what time t does the car catch up to the motorcycle? Find the answer by setting C and M equal. How far are the car and the motorcycle from the telephone pole when this happens? (Students might use graphical and/or algebraic methods to solve the problem.)

✓ Solve multi-step mathematical problems with degree of difficulty appropriate to the course that requires analyzing quadratic functions and/or writing and solving quadratic equations. (HS-Int.2) PARCC (Calculator)
- Tasks do not have a context.
- Exact answers may be required or decimal approximations may be given. Students might choose to take advantage of the graphing utility to find approximate answers or clarify the situation at hand. For rational solutions, exact uses are required. For irrational solutions, exact or decimal approximations may be required simplifying or rewriting radicals is not required.
- Some examples: - Given the function f(x) = x^2 + x, find all values of k such that f(3 - k) = f(3). (Exact answers are required.) - Find a value of c so that the equation 2x^2 - cx + 1 = 0 has a double root. Give an answer accurate to the tenths place.

✓ Solve multi-step contextual word problems with degree of difficulty appropriate to the course, requiring application of course-level knowledge and skills articulated in F-LE, A-CED.1, A-SSE.3, F-IF.B, F-IF.7, limited to linear functions and exponential functions with domains in the integers. (HS Int 3-1) PARCC (Calculator)

- F-LE.A, Construct and compare linear, quadratic, and exponential models and solve problems, is the primary content and at least one of the other listed content elements will be involved in tasks as well.

✓ Solve multi-step contextual word problems with degree of difficulty appropriate to the course, requiring application of course-level knowledge and skills articulated in F-LE, A-CED.1, A-SSE.3, F-IF.B, F-IF.7, limited to linear, quadratic, and exponential functions. (HS Int 3-2) PARCC (Calculator)

- F-LE.A, Construct and compare linear, quadratic, and exponential models and solve problems, is the primary content and at least one of the other listed content elements will be involved in tasks as well. For rational solutions, exact values are required. For irrational solutions, exact or decimal approximations may be required. Simplifying or rewriting radicals is not required; however, students will not be penalized if they simplify the radicals correctly.

Critical Language: includes the Academic and Technical vocabulary, semantics, and discourse which are particular to and necessary for accessing a given discipline.
EXAMPLE: A student in Language Arts can demonstrate the ability to apply and comprehend critical language through the following statement: *"Mark Twain exposes the hypocrisy of slavery through the use of satire."*

A student in ______________ can demonstrate the ability to apply and comprehend critical language through the following statement(s):	*The intersection of two linear equations is their solution set; and, if the lines do not intersect, there are no viable solutions.*
Academic Vocabulary:	Intersection, efficiency, characteristics, solutions, one solution, no solutions, infinite solutions, viable, non-viable, approximation, constraints, relevance, context
Technical Vocabulary:	Systems of equations, linear equations, solution set, graphically, algebraically, equations, inequalities, system of inequalities, half-plane, model, elimination, substitution, function, linear