COURSE INTRODUCTION:

Building on their work with linear, quadratic, and exponential functions, students extend their repertoire of functions to include polynomial, rational, radical and trigonometric functions. Students work closely with the expressions that define the functions, and continue to expand and hone their abilities to model situations and to solve equations, including solving quadratic equations over the set of complex numbers and solving exponential equations using the properties of logarithms. The Mathematical Practice Standards apply throughout each course and together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations. The areas of focus for this course are: (1) polynomial, rational and radical relationships; (2) trigonometric functions; (3) Modeling with functions; (4) Inferences and conclusions from data

(1) This area develops the structural similarities between the system of polynomials and the system of integers. Students draw on analogies between polynomial arithmetic and base-ten computation, focusing on properties of operations, particularly the distributive property. Students connect multiplication or polynomials with multiplication of multi-digit integers, and division of polynomials with long division of integers. Students identify zeros of polynomials, including complex zeros of quadratic polynomials, and make connections between zeros of polynomials and solutions of polynomial equations. The unit culminates with the fundamental theorem of Algebra. A central theme of this unit is that the arithmetic of rational expressions is governed by the same rules as the arithmetic of rational numbers.
(2) Building on their previous work with functions, and on their work with trigonometric rations and circles in Geometry, students now use the coordinate plane to extend trigonometry to model periodic phenomena
(3) In this area, students synthesize and generalize what they have learned about a variety of function families. They extend their work with exponential functions to include solving exponential equations with logarithms. They explore the effects of the transformations on graphs of diverse functions, including functions arising in an application,, in order to abstract the general principle that transformations on a graph always have the same effect regardless of the type of the underlying function. They identify appropriate types of functions to model a situation, they adjust parameters to improve the model, and they compare models by analyzing appropriateness of fit and making judgments about the domain over which a model is a good fit. The description of modeling as *"the process of choosing and using mathematics and statistics to analyze empirical situations, to understand them better, and to make decisions"* is at the heart of this unit. The narrative discussion and diagram of the modeling cycle should be considered when knowledge of functions, statistics, and geometry is applied in a modeling context.
(4) In this area, students see how the visual displays and summary statistics they learned in earlier grades relate to different types of data and to probability distributions. They identify different ways of collecting data—including sample surveys, experiments, and simulations—and the role that randomness and careful design play in the conclusions that can be drawn

CCSM Appendix A, pg. 36

The Mathematics Common Core State Standards (2010) outline eight Standards for Mathematical Practice that describe a variety of

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expertise that mathematics educators at all levels should seek to develop in their students and should be an integral component of mathematics instruction and assessment. These practices, which align to the Show-Me Process Standards (1993), rest on important National Council of Teachers of Mathematics processes including problem solving, reasoning and proof, communication, representation, and connections. The practices also rest on the proficiencies specified by the National Research Council including adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematics concepts, operations, and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently, and appropriately) and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.) They apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations.

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

UNIT DESCRIPTION: Unit 6 Modeling In this unit students will model with mathematics. Students will solve problems using a variety of methods and reason about which methods best solve a mathematical problem or model a given situation. Student will choose and use mathematics to analyze situations to understand them better and make decisions. Throughout this unit, students will be involved in numerous engaging activities where they will use mathematical modeling as a tool. The objectives in this unit are not to be taught in sequence, rather through the activities and lessons outlined within the unit. Most activities and lessons incorporate more than one learning objective as well as multiple CCSS Learning Goals, Content Standards and Standards of Mathematical Practice. The majority of learning in this unit will take place while students complete activities. This unit	**SUGGESTED UNIT TIMELINE:** Approximately 5 weeks **CLASS PERIOD (min.):** 60 min/daily

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places much emphasis on the Standards of Mathematical Practice.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at http://www.dese.mo.gov/divimprove/curriculum/UD-Model-Curriculum-Introduction-Sheet.pdf. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Provide Feedback

ESSENTIAL QUESTIONS:

1. How does mathematical modeling help people make decisions in everyday life and in the workforce?
2. How are functions used to model real-world phenomena?
3. When does a function best model a situation?
4. In what ways can choice of unites, quantities,, and levels of accuracy impact a solution?
5. In what ways can a problem be solved, and why should one method be chosen over another?

ESSENTIAL MEASURABLE LEARNING OBJECTIVES	CCSS LEARNING GOALS (Anchor Standards/Clusters)	CROSSWALK TO STANDARDS				
		GLEs/CLEs	PS	CCSS	MATH	DOK
1. Students will analyze functions using a different representations and communicate properties of functions using precise mathematical language.		**A.1.C.A2** **A.4.A.A2**	**1.6** **1.6**	**F-IF.4** **F-IF.6** **F-IF.7**	**MP1** **MP2** **MP3** **MP5** **MP6** **MP7**	**3**
2. Students will construct and compare linear, quadratic, trigonometric, exponential, and logarithmic models and use		**A.1.D.A2**	**1.6**	**A-CED.1**	**MP1** **MP2**	**3**

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models to solve a variety of real-world and cross curricular problems.		**A.1.E.A2** **A.2.C.A2** **G.1.A.A2**	**1.6** **3.2** **3.2**	**A-CED.2** **A-CED.3** **F-IF.4** **F-LE.1** **F-LE.2** **F-LE.5** **F-TF.5**	**MP3** **MP4** **MP5** **MP6** **MP7** **MP8**	
3. Students will build functions to model relationships between two quantities for increasingly complex and sophisticated situations, given a variety of situations and using a variety of representations.		**A.2.A.A2** **A.3.A.A2**	**3.3** **1.6**	**A-CED.1** **A-CED.2** **G-MG.1** **G-MG.3** **F-IF.4** **F-IF.6** **F-IF.7** **F-BF.1** **F-BF.2**	**MP1** **MP2** **MP3** **MP4** **MP5** **MP6** **MP7** **MP8**	**3**

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4. Students will build functions from existing functions, and use knowledge of a variety of function types (i.e. trigonometric, linear, quadratic) to solve complex problems that require multiple models and/or functions built with multiple function types.		**A.2.B.A2** **G.3.B.A2**	**3.2** **3.3**	**F-BF.1** **F-BF.2** **F-BF.4** **F-BF.5**	**MP1** **MP2** **MP3** **MP4** **MP5** **MP6** **MP7** **MP8**	**3**

ASSESSMENT DESCRIPTIONS*: (Write a brief overview here. Identify Formative/Summative. Actual assessments will be accessed by a link to PDF file or Word doc.)

Throughout this unit, students use data as they move through the statistical process of posing a question, collecting data, creating representations, and interpreting results. However, students do not have to generate the data every time they work on making graphs. After some experiences in generating the data, most work in creating graphs can be done by providing students with data sets. Students should be supported as they learn to construct graphs. Grid paper should be used for assignments as well as assessments. This should help to minimize errors arising from the need to track across a graph visually to identify values. Also, a template can be superimposed on the grid paper, with blanks provided for the student to write in the graph title, labels, and key (when necessary).

This unit builds upon the skills used to measure objects in the linear measurement unit. Students apply their customary and metric linear measurement skills to measure objects and round the lengths to the nearest whole unit (cm or inch). They represent these lengths by making a line plot of the data. In order to make a line plot, students need to be able to label a number line with equally spaced units.

Students draw picture graphs (pictographs) and bar graphs with a single unit scale to represent up to four categories of data. This is an extension from first grade when students organized, represented, and interpreted data with up to three categories. Picture graphs include symbols that represent single units and should include a title, category labels, key, and symbols. When drawing picture graphs, the pictures representing the objects should be drawn in the squares of grid paper. Students draw both horizontal and vertical bar graphs that include a title, scale, scale label, up to four categories, category label, and bars. When drawing bar graphs on grid paper, the tick marks on the count scale should be drawn at intersections of the gridlines. The tops of the bars should reach the respective gridlines of the appropriate tick marks.

Students should be able to interpret a selected graph to note particular aspects of the data collected, including the total number of responses, which category had the most/least responses, and interesting differences/similarities among the data. Students should be able to use bar graphs to solve simple one-step problems, including put together, take-apart, and compare problems. (See CCSS Table 1, pg. 88.)

Formative Assessments

- **Formative Assessment 1_Egg Launch Contest Activity Sheet - http://illuminations.nctm.org/Lessons/9-12/egglaunch/egglaunch-AS-**

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Sheet1.pdf Students use data and quadratic models to predict the path of an egg. Scoring guide included in the lesson.

- **Formative Assessment 2_Growth Rate Activity Sheet** - http://illuminations.nctm.org/Lessons/GrowthRate/GrowthRate-AS-HeightAgeChart.pdf
  Students apply the concept of slope to non-linear graphs. Scoring guide included in the lesson.
- **Formative Assessment 3_ A Model Solar System (F.LE.1, N.Q.2, N.Q.3/MP4) See Activity**
  Students create several scale models of the solar system using everyday items. Scoring guide included.
- **Formative Assessment 4_ Narrow Corridor (A.CED.1, A.CED.2, F.IF.7, F.BF.1, G.SRT.8/MP4, MP5) See Activity**
  Students determine if large bulky items can fit through the corner of a long corridor. Scoring guide included.
- **Formative Assessment 5_ Estimating Temperatures (A.CED.3, F.IF.6/MP4, MP6) See Activity**
  Students use data and a variety of mathematical techniques to accurately estimate temperatures. Scoring guide included.
- **Formative Assessment 6_ Bending Steel (F.IF.4, F.IF.6, G.MG.1, G.MG.3/MP1, MP4, MP6) See Activity**
  Students model the expansion of railroad tracks due to increased ambient temperatures. Scoring guide included.
- **Formative Assessment 7_ A Bit of Information (F.IF.4, F.BF.1, F.BF.5/MP1, MP4, MP5) See Activity**
  In this assessment/activity, students will learn to use a logarithmic function to model information functions. A significant portion of the secondary curriculum revolves around the analysis of functional relationships. In the context of computers, the notion of sending and receiving information gives way to an interesting relationship between the required length of code and how much information it carries. In fact, this represents one of very few real world situations where only a logarithmic function can model the relationship.

For Formative Assessments 3 – 7: **Link to Mathematical Modeling Handbook (Multiple Activities)**

- **Formative Assessment 8_ Modeling Orbital Debris Activity Sheet** - http://illuminations.nctm.org/Lessons/9-12/Orbit/Orbit-AS-Debris.pdf
  In this activity, students create and compare various mathematical models as a way to investigate some of the questions raised by the proliferation of orbital debris. Although the models are greatly simplified to make them understandable to high school students, they offer insight into the process of mathematical modeling and its importance. Scoring guide included in the lesson.
- **Formative Assessment 9_Modeling Collision Activity Sheet** - http://illuminations.nctm.org/Lessons/9-12/Orbit/Orbit-AS-Effects.pdf
  Again, the purpose of the activity is to foster open-ended investigation and discussion of the relative effects of the linear factor (mass) compared with the quadratic component (velocity). We are less concerned with precise answers to particular questions than we are with the larger concept of how these functions behave.

Summative Assessment *Both assessments are performance events which will require multiple class periods to complete. These assessments are to be scored using the holistic scoring guide provided.*

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- **Summative Assessment_Algebra II_Modeling_Part 1.pfd**
- **Summative Assessment_Algebra II_Modeling_Part 2.pdf** **(Note: Both assessments use the PE Holistic Scoring Rubric)**

Obj. #	**INSTRUCTIONAL STRATEGIES (research-based):** **(Teacher Methods)**
1-4	**1. Identifying Similarities and Differences** **Activity 1: A Model Solar System (F.LE.1, N.Q.2, N.Q.3/MP4)** *This activity is described later within Instructional Activities* **Activity 4: Estimating Temperatures (A.CED.3, F.IF.6/MP4, MP6)** *This activity is described later within Instructional Activities* **Building Connections:** *This activity is described later within Instructional Activities* **Egg Launch Contest:** *This activity is described later within Instructional Activities* **How Should I Move? Lesson 1:** *This activity is described later within Instructional Activities* **Determining Functions Using Regression:** *This activity is described later within Instructional Activities*
1-4	**2. Summarizing and Note-Taking –** Throughout the unit as teacher describes each activity, expectations, and the possible skills/concepts students may wish to focus on during the activity.
1-4	**3. Reinforcing Effort and Providing Recognition -** Reinforce effort and provide recognition will occur throughout each and every activity within this unit.
1-4	**4. Homework and Practice –** All activities within this unit may be competed in class or at home. Teachers are encouraged to require students to do research at home to prepare for the activities within the unit.
1-4	**5. Nonlinguistic Representations –** All activities involve a variety of nonlinguistic representations
1-4	**6. Cooperative Learning –** Any and all activities may be completed in cooperative learning groups. Teachers are asked to use their

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	own judgment.
1-4	**7. Setting Objectives and Providing Feedback –** Objectives are set before and are contained within each activity. Feedback should be provided during the activities and after activities are turned in as formative assessments.
1-4	**9. Generating and Testing Hypotheses –** **Activity 1: A Model Solar System (F.LE.1, N.Q.2, N.Q.3/MP4)** *This activity is described later within Instructional Activities* **Activity 4: Estimating Temperatures (A.CED.3, F.IF.6/MP4, MP6)** *This activity is described later within Instructional Activities* **Activity ?: Unstable Table (A.CED.1, F.IF.4, F.BF.4, F.LEW.5/MP1,MP4, MP5)** *This activity is described later within Instructional Activities* **Activity ?: Water Down the Drain (F.LE.1, F.LE.2, F.LE.5/MP4)** **Egg Launch Contest:** *This activity is described later within Instructional Activities* **Modeling Orbital Debris:** *This activity is described later within Instructional Activities*
Obj. #	**INSTRUCTIONAL ACTIVITIES: (What Students Do)** *Many of the activities below are found in the Mathematical Modeling Handbook published by COMAP, The Consortium for Mathematics and It's Applications. A link to this handbook may be found in Resources, and it is available online at www.comap.com* *Note: Each activity allows for quite a bit of differentiation and extension for more advanced students.*
1	**1. Building Connections: http://illuminations.nctm.org/Lessons/BuildingPolys/BuildingPolys-AS-Building.pdf** This activity focuses on having students make connections among different classes of polynomial functions by exploring the graphs of the functions. The questions in the activity sheets allow students to make connections between the x-intercepts of the graph of a polynomial and the polynomial's factors. **Note:** This activity is part of a rich and exciting lesson. Resources for the entire lesson may be found at: **http://illuminations.nctm.org/LessonDetail.aspx?id=L282** **2. Egg Launch Contest: http://illuminations.nctm.org/Lessons/9-12/egglaunch/egglaunch-AS-Sheet1.pdf**

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	Students will determine the path of an egg using data. Students will then create a model from this data and make predictions based on that model. Note: This activity is part of a rich and exciting lesson. Resources for the entire lesson may be found at: **http://illuminations.nctm.org/LessonDetail.aspx?id=L738** **3. Growth Rate: http://illuminations.nctm.org/Lessons/GrowthRate/GrowthRate-AS-HeightAgeChart.pdf** During this activity, students use the formula for slope of a line to approximate the rate of change at a single point on a non-linear graph. To accomplish this, students will use the slope formula to calculate the rate of change between two points very near to the desired point. **Note:** This activity is part of a rich and exciting lesson. Resources for the entire lesson may be found at: **http://illuminations.nctm.org/LessonDetail.aspx?id=L668** **4,5,6. How Should I Move? Lesson 1: Graphs Activity:** **http://illuminations.nctm.org/Lessons/MovementFunctions/HowShouldIMove-AS-Graphs.pdf Questions Activity:** **http://illuminations.nctm.org/Lessons/MovementFunctions/HowShouldIMove-AS-Questions.pdf Comparing Graphs Activity:** **http://illuminations.nctm.org/Lessons/MovementFunctions/HowShouldIMove-AS-Comparison.pdf** This investigation uses a motion detector to help students understand graphs and equations. Students experience constant and variable rates of change and are challenged to consider graphs where no movements are possible to create them. Multiple representations are used throughout the lesson to allow students to build their fluency with in how graphs, tables, equations, and physical modeling are connected. The lesson also allows students to investigate multiple function types, including linear, exponential, quadratic, and piecewise. **Note:** This activity is part of a rich and exciting lesson. Resources for the entire lesson may be found at: **http://illuminations.nctm.org/LessonDetail.aspx?ID=L768**
2	**7. A Model Solar System (F.LE.1, N.Q.2, N.Q.3/MP4)** **Materials -** *Mathematical Modeling Handbook*, by *Teachers College, Columbia University*: Module: *A MODEL SOLAR SYSTEM, by Diane R. Murray, Manhattenville College* Teachers Guide: Pages 1, 7-9 Student Materials on pages 2-6 *Overview – In this two-day lesson, students will create several scale models of the Solar System using everyday items. Open with discussing the size of the universe and aim to steer the conversation towards the size of the astronomical bodies. Pose questions that*

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	make students think about how large one astronomical body is compared to another. How can they create a model that considers the scale of the bodies? **Link to Mathematical Modeling Handbook (Multiple Activities)**
2,3	**8. Narrow Corridor (A.CED.1, A.CED.2, F.IF.7, F.BF.1, G.SRT.8/MP4, MP5)** **Materials -** *Mathematical Modeling Handbook*, by *Teachers College, Columbia University*: Module: *NARROW CORRIDOR, by Lay Chin Tan, Singapore* Teacher's Guide: Pages 37, 44-46 Student Materials: Pages 38 – 43 *Overview – In this two-day lesson, students are asked to determine whether large, long, and bulky objects fit around the corner of a narrow corridor. The objective of this lesson is to apply the concept of turning points (maximum or minimum points) and the Pythagorean Theorem to determine the longest object that can go around the corner of a corridor.* **Link to Mathematical Modeling Handbook (Multiple Activities)**
1,2	**9. Unstable Table (A.CED.1, F.IF.4, F.BF.4, F.LE.5/MP1,MP4, MP5)** **Materials -** *Mathematical Modeling Handbook*, by *Teachers College, Columbia University*: Module: *UNSTABLE TABLE, by Heather Gould, Stone Ridge, NY* Teacher's Guide: Pages 47, 56, 57 Student Materials: Pages 48 – 55 *Overview - In this two-day lesson, students learn to stabilize a table without the use of napkins −they can rotate it up to 90°. The result is counterintuitive but can be verified mathematically.* **Link to Mathematical Modeling Handbook (Multiple Activities)**
2	**10. Estimating Temperatures (A.CED.3, F.IF.6/MP4, MP6)** **Materials -** *Mathematical Modeling Handbook*, by *Teachers College, Columbia University*: Module: *Estimating Temperatures, by Heather Gould, Stone Ridge, NY* Teacher's Guide: Pages 67 ,73,74

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	Student Materials: Pages 68 – 72 *Overview – In this two-day lesson, students will model temperature data. They will use "known temperature stations" in order to estimate temperatures at any given point accurately. Websites that give the temperature at a specific place typically do not give the actual values; they give an estimate based on meteorological data. Explain to students that temperatures are not measured everywhere and educated estimates need to be made. Have the students imagine they are meteorologists interested in making a model to estimate temperature at a given time and at a given location..* **Link to Mathematical Modeling Handbook (Multiple Activities)**
2, 3, 4	**11. Bending Steel (F.IF.4, F.IF.6, G.MG.1, G.MG.3/MP1, MP4, MP6)** **Materials -** *Mathematical Modeling Handbook*, by *Teachers College, Columbia University*: Module: *BENDING STEEL, by Nicholas H. Wasserman, Southern Methodist University* Teachers Guide: Pages 75, 81,82 Student Materials: Pages 76 – 80 *Overview - Metal railroad tracks expand and contract due to weather. In this two-day lesson, using the assumption that a railroad track is secured at both ends, students will use models to estimate how expansion of the track affects the height of the rail off the ground. Sometimes tracks will expand outward along the ground, but this lesson focuses on the case where they expand upward. Interestingly, very small increases in length as a result of expansion have a large effect on height. Students will investigate this phenomenon using both triangular and arc models.* **Link to Mathematical Modeling Handbook (Multiple Activities)**
1,2,3,4	**12. A Bit of Information (F.IF.4, F.BF.1, F.BF.5/MP1, MP4, MP5)** **Materials -** *Mathematical Modeling Handbook*, by *Teachers College, Columbia University*: Module: *A BIT OF INFORMATION, by Nicholas H. Wasserman, Southern Methodist University* Teachers Guide: Pages 83, 89-91

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	Student Materials: Pages 84-88 *Overview- In this two-day lesson, students will learn to use a logarithmic function to model information functions. A significant portion of the secondary curriculum revolves around the analysis of functional relationships. In the context of computers, the notion of sending and receiving information gives way to an interesting relationship between the required length of code and how much information it carries. In fact, this represents one of very few real world situations where only a logarithmic function can model the relationship.* **Link to Mathematical Modeling Handbook (Multiple Activities)**
1, 2, 3, 4	**13. The Whe to Play (F.BF.2, F.LE.2/MP1, MP3,MP4, MP6)** **Materials -** *Mathematical Modeling Handbook, by Teachers College, Columbia University: Module: THE WHE TO PLAY, by Shereen Khan & Fayad Ali, Trinidad and Tobago* Teachers Guide: Pages 109,115,116 Student Materials: Pages 110-114 *Overview - In this two-day lesson, students develop different strategies to play a game in order to win. In particular, they will develop a mathematical formula to calculate potential profits at strategic points in the game and revise strategies based on their predictions. Allow students to imagine that they are living in the twin islands of Trinidad and Tobago where a popular game called Play Whe is played every day. They can think of the game as an investment opportunity and their goal is always to realize a profit. How can they devise a strategy so that their expenditure is always less than their potential winnings?* **Link to Mathematical Modeling Handbook (Multiple Activities)**
2,3	**14. Water Down the Drain (F.LE.1, F.LE.2, F.LE.5/MP4)** **Materials -** *Mathematical Modeling Handbook, by Teachers College, Columbia University: Module: THE WHE TO PLAY, by Dianne R. Murray, Manhattenville College* Teachers Guide: Pages 117, 123-125 Student Materials: Pages 118-122

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	Overview - In this two-day lesson, students will collect data from a water dripping experiment. The data that the students collect will be the basis for estimating how much water is wasted from typical leaky faucets. At the beginning of the lesson, the students are faced with a statistic that states leaky faucets in U.S. homes waste $10,000,000 worth of water each year. At the end of the lesson, students will have the opportunity to determine what specifications (homes, faucets, drips/minute) result in that amount of money. **Link to Mathematical Modeling Handbook (Multiple Activities)**
2,3	**15. Viral Marketing (F.LE.1, F.LE.5/MP4)** **Materials** - *Mathematical Modeling Handbook, by Teachers College, Columbia University: Module: VIRAL MARKETING, by Benjamin Dickman, Brookline, MA* Teachers Guide: Pages 127, 132, 134 Student Materials: Pages 128-131 *Overview - In this two-day lesson, students will model "viral marketing." Viral marketing refers to a marketing strategy in which people pass on a message (such as an advertisement) to others, much like diseases and viruses are spread. To begin, explain that you are interested in starting your own business and you are researching different marketing strategies to "get the word out." Viral marketing is one strategy that should be considered. What is viral marketing and what can be said about it mathematically?* **Link to Mathematical Modeling Handbook (Multiple Activities)**
2,3,4	**16. Sunrise, Sunset (F.TF.5/MP4, MP5))** **Materials -** *Mathematical Modeling Handbook, by Teachers College, Columbia University: Module: SUNRISE, SUNSET, by Edward A. DePeau III, Central Connecticut State University* Teachers Guide: Pages 135, 141, 142 Student Materials: Pages 136-140 *Overview - In this two-day lesson, students will examine changes in the average monthly sunlight over the course of a year. They will use actual sunrise and sunset data found on the internet in order to calculate the "length of an average day" for the chosen city. Students will model the data with a sine curve. The model will be interpreted and used to make connections to the real world.* **Link to Mathematical Modeling Handbook (Multiple Activities)**

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3	**17. Dirt Bike Dilemma** http://illuminations.nctm.org/LessonDetail.aspx?id=L685 Students discover the algorithm for solving linear programming problems and gain conceptual understanding by solving a real-world problem and using graphing calculator applications. . **Note:** This activity is part of a rich and exciting lesson. Resources for the entire lesson may be found at: http://illuminations.nctm.org/LessonDetail.aspx?id=L685

UNIT RESOURCES: (include internet addresses for linking)

Objective 1:
Link to Mathematical Modeling Handbook (Multiple Activities)

- **Building Connections:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L282**
  This lesson focuses on having students make connections among different classes of polynomial functions by exploring the graphs of the functions. The questions in the activity sheets allow students to make connections between the x-intercepts of the graph of a polynomial and the polynomial's factors.
- **Egg Launch Contest:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L738**
  Students will represent quadratic functions as a table, with a graph, and with an equation. They will compare data and move between representations.
- **Growth Rate:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L668**
  Students learn the formula for the slope of a line when they study algebra. However, most students have only used this formula with linear graphs. During this lesson, students use the formula for slope of a line to approximate the rate of change at a single point on a non-linear graph. To accomplish this, students will use the slope formula to calculate the rate of change between two points very near to the desired point.
- **How Should I Move? Lesson 1:** **http://illuminations.nctm.org/LessonDetail.aspx?ID=L768**
  This investigation uses a motion detector to help students understand graphs and equations. Students experience constant and variable rates of change and are challenged to consider graphs where no movements are possible to create them. Multiple representations are used throughout the lesson to allow students to build their fluency with in how graphs, tables, equations, and physical modeling are connected. The lesson also allows students to investigate multiple function types, including linear, exponential, quadratic, and piecewise.
- **Trout Pond Population Lesson 1-4:** **http://illuminations.nctm.org/LessonDetail.aspx?ID=U142**
  This investigation illustrates the use of iteration, recursion and algebra to model and analyze a changing fish population. Graphs, equations, tables, and technological tools are used to investigate the effect of varying parameters on the long-term population.
- **Dirt Bike Dilemma:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L685**

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Students discover the algorithm for solving linear programming problems and gain conceptual understanding by solving a real-world problem and using graphing calculator applications.

Objective 2:
Link to Mathematical Modeling Handbook (Multiple Activities)

- **Determining Functions Using Regression:** **http://illuminations.nctm.org/LessonDetail.aspx?id=U180**
  These lessons guide students though activities that ask students to collect data. Then, they use technology to find functions that best describe a data collected. After analyzing the data, the student should be able to determine a best type of function to describe the trend.
- **Trout Pond Population Lesson 1-4:** **http://illuminations.nctm.org/LessonDetail.aspx?ID=U142** **(Lessons 1 – 4)**
  This investigation illustrates the use of iteration, recursion and algebra to model and analyze a changing fish population. Graphs, equations, tables, and technological tools are used to investigate the effect of varying parameters on the long-term population.

- **Modeling Orbital Debris:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L376**
  In this lesson, students examine the problem of space pollution caused by human-made debris in orbit to develop an understanding of functions and modeling. It allows the students an opportunity to use spreadsheets, graphing calculators, and computer graphing utilities. The problem of space pollution caused by human-made debris in orbit is presented as a context for studying mathematical modeling. This unit should help students realize that not all problems are solvable with precise measurements and exact answers but that mathematical models enable us to look at trends and to make predictions about probable outcomes. The ambiguity of some of these activities may be frustrating to a few students, but it reflects the realities with which mathematicians and scientists must work.
- **Smokey Bear Takes Algebra:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L381**
  This lesson introduces students to the many factors that play a role in creating a forest-fire danger rating index. They will be looking at how we use a scale to quantify the abstract idea of forest fire danger. Using the real-world situation, students examine the meaning of the slope and intercepts of a line. To complete the activities related to these indexes, students should be comfortable with linear, quadratic and exponential functions and their graphs.

Objective 3:
Link to Mathematical Modeling Handbook (Multiple Activities)

- **Modeling Orbital Debris:** **http://illuminations.nctm.org/LessonDetail.aspx?id=L376**
  In this lesson, students examine the problem of space pollution caused by human-made debris in orbit to develop an understanding of functions and modeling. It allows the students an opportunity to use spreadsheets, graphing calculators, and computer graphing utilities.

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The problem of space pollution caused by human-made debris in orbit is presented as a context for studying mathematical modeling. This unit should help students realize that not all problems are solvable with precise measurements and exact answers but that mathematical models enable us to look at trends and to make predictions about probable outcomes. The ambiguity of some of these activities may be frustrating to a few students, but it reflects the realities with which mathematicians and scientists must work.

- **Varying Motion:** http://illuminations.nctm.org/LessonDetail.aspx?id=L801
  This lesson helps students clarify the relationship between the shape of a graph and the movement of an object. Students explore their own movement and plot it onto a displacement vs. time graph. From this original graph, students create a velocity vs. time graph, and from there create an acceleration vs. time graph. The movement present and how to interpret each type of graph is emphasized through the lesson, which serve as an excellent introduction to building blocks of calculus.
- **Smokey Bear Takes Algebra:** http://illuminations.nctm.org/LessonDetail.aspx?id=L381
  This lesson introduces students to the many factors that play a role in creating a forest-fire danger rating index. They will be looking at how we use a scale to quantify the abstract idea of forest fire danger. Using the real-world situation, students examine the meaning of the slope and intercepts of a line. To complete the activities related to these indexes, students should be comfortable with linear, quadratic and exponential functions and their graphs.
- **Dirt Bike Dilemma:** http://illuminations.nctm.org/LessonDetail.aspx?id=L685
  Students discover the algorithm for solving linear programming problems and gain conceptual understanding by solving a real-world problem and using graphing calculator applications.

Objective 4:
Link to Mathematical Modeling Handbook (Multiple Activities)

- **Varying Motion:** http://illuminations.nctm.org/LessonDetail.aspx?id=L801
  This lesson helps students clarify the relationship between the shape of a graph and the movement of an object. Students explore their own movement and plot it onto a displacement vs. time graph. From this original graph, students create a velocity vs. time graph, and from there create an acceleration vs. time graph. The movement present and how to interpret each type of graph is emphasized through the lesson, which serve as an excellent introduction to building blocks of calculus.

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