**Subject area/course**: Math/Algebra I or Algebra II

**Grade level/band**: 8th -10th

**Task source**: SCALE; author Theresa Morris

**Suspension Bridges**

**TEACHER'S GUIDE**

1. **Task overview**:

Students will apply knowledge of parabolic curves to a real life situation to recommend the height of a main cable that will reduce the cost to build a suspension bridge. There are two options. This can be done as an “on demand” task by using questions 1-6 or can be a more complex task by adding question 7.

1. **Aligned standards:**
2. **Primary Common Core State Standards**

**CCSS.**[**HSA.REI.B.4**](http://www.corestandards.org/Math/Content/HSA/REI/B/4/)**:** Solve quadratic equations in one variable.

**CCSS.**[**HSA.APR.B.3**](http://www.corestandards.org/Math/Content/HSA/APR/B/3/)**:** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

**CCSS.**[**HSA.CED.A.2**](http://www.corestandards.org/Math/Content/HSA/CED/A/2/)**:** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

1. **Secondary Common Core Standards (for Mathematical Practice)**

#### **[CCSS.MATH.PRACTICE.MP1](http://www.corestandards.org/Math/Practice/MP1/)**Make sense of problems and persevere in solving them. [**CCSS.MATH.PRACTICE.MP2**](http://www.corestandards.org/Math/Practice/MP2/)Reason abstractly and quantitatively. [**CCSS.MATH.PRACTICE.MP3**](http://www.corestandards.org/Math/Practice/MP3/) Construct viable arguments and critique the reasoning of others.

**[CCSS.MATH.PRACTICE.MP4](http://www.corestandards.org/Math/Practice/MP4/)** Model with mathematics

**[CCSS.MATH.PRACTICE.MP5](http://www.corestandards.org/Math/Practice/MP5/)** Use appropriate tools strategically.

**[CCSS.MATH.PRACTICE.MP6](http://www.corestandards.org/Math/Practice/MP6/)**Attend to precision.

**[CCSS.MATH.PRACTICE.MP7](http://www.corestandards.org/Math/Practice/MP7/)**Look for and make use of structure.

**[CCSS.MATH.PRACTICE.MP8](http://www.corestandards.org/Math/Practice/MP8/)**Look for and express regularity in repeated reasoning.

1. **Critical abilities**

**Research:** Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience. (Background YouTube videos on suspension bridges)

**Analysis of Information:** Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data. (Students will take information presented, determine and equation to model and solve for other information.)

**Experimentation and Evaluation:** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (Students may use mathematical calculations or graphing calculators to perform a regression to represent the equation.)

**Communication in Many Forms:** Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience. (Student will discuss and also write up analysis.)

**Use of Technology:** Present information, findings, and supporting evidence, making strategic use of digital media and visual displays to enhance understanding. Use technology, including the Internet, to research, produce, publish, and update individual or shared products in response to ongoing feedback, including new arguments or information.(Students will use Internet for research of suspension bridges, graphing calculators to find regression equation. May use PowerPoint to represent solution.)

**Interpersonal interaction and Collaboration:** Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations. (Students will work together in the first part and may also interact if they use a PowerPoint to present solution.)

**Modeling, Design, and Problem Solving**: Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed. (Students are solving a problem, creating a model.)

1. **Time/schedule requirements:**

This task is designed to take about 200-240 minutes (or about 4-5 class periods), based on if question 7 is included (see Instructional Materials).

1. **Materials/resources:**
* Student Instructions/Instructional Materials
1. **Prior knowledge:**

Students should know how to write an equation of a parabola. Students should be able to three points on the parabola to determine the equation.

1. **Connection to curriculum:**

*Suspension Bridges* is designed to provide students an opportunity to apply knowledge and skills related to parabolic curves to make decisions in a real life situation that requires problem solving, communication, reasoning, and analysis of information.

1. **Teacher instructions:**

Daily Breakdown of Activities:

|  |  |  |
| --- | --- | --- |
|  | **Overview** | **Teacher Notes** |
| Day 145-60 minutes | * Class discussion regarding real life examples that use parabolic curves.
* Students become familiar with the main cables, suspender ropes, towers, and roadway associated with a suspension bridge.
* Students work in small groups (2-3 students) to solve the Golden Gate Bridge Activity.
 | * Introduction: student research (notes)

<http://www.design-technology.org/suspensionbridges.htm><https://erkrishneelram.wordpress.com/tag/torsion/><http://goldengate.org/exhibits/exhibitarea4b.php>(Click on image below “Learn More” on this page to see analysis of this relationship.)* View:

<https://www.youtube.com/watch?v=dxoB5dYZg_Y> <https://www.youtube.com/watch?v=j-zczJXSxnw>* Discuss that a parabolic equation can be used to represent the main cable of a suspension bridge.
* The main cable closely resembles a parabola once the weight of the roadway is added to the cable.
* Allow teams to discuss and use various strategies.
* Debrief as a class – this is critical for preparing students for the individual performance assessment.
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| Day 2-4120-180minutes | * Students **individually** complete the Suspension Bridge Performance Assessment.
 | * Allow students to use graphing calculator and notes from previous day.
* This is an opportunity for students to demonstrate their individual knowledge. Provide scaffolds and support as necessary with reading the prompt and understanding the context of the task.
* May need to use computer or word processor to write letter of recommendation at the end. (#7)
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1. **Student support:** Students may be given extended time, read-aloud, chunking, frequent feedback, large poster of bridge with labels/data, separate location, preferential seating and partnering, general equation of a parabola as a note page/resource. .
2. **Extensions or variations:** Work with smaller numbers or building a scale model. Larger graph paper. The extension is question 7, to write a memo to supervisor comparing the original plan submitted and their modifications and recommendation. Students could opt to create a PowerPoint to convey the same information.
3. **Scoring:**

Student work can be scored using the Suspension Bridges - SCALE Math Performance Task rubric.