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| **Lesson 2 : Connecting Tunnels to Functions** | **Unit #: 1** | **Lesson #: 2** | **Activity #: 3** |
| **Activity 1.2.3: Modeling Real World Situations with Functions & Non-Functions** |

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| **Estimated Lesson Duration:** | **6-7 days** |
| **Estimated Activity Duration:** | **2-3 days** |

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| **Setting:** | **classroom** |

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| **Activity Objectives:**   * **Use semi-circles as part of piecewise functions** * **Continue writing piecewise functions to model real world situations** * **Discuss and understand how optimization influences the type of equations used in piecewise functions** * **Find area under the curve and perimeter where needed** |

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| **Activity Guiding Questions:**   * **How do you write the equation of a semi-circle?** * **What ideas about piecewise functions do we need to review?** * **What is optimization and how will we use it in our Challenge?** * **How can we optimize our function models?** * **What is area under the curve?** * **How do we find the length of a piecewise function?** |

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☐ Cause and effect |
| ☐ Planning and carrying out investigations | ☒ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☐ Systems and system models |
| ☒ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☒ Structure and function. |
| ☐ Engaging in argument from evidence | ☐ Stability and change. |
| ☐ Obtaining, evaluating, and communicating information |  |

| **Ohio’s Learning Standards for Science (OLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Ohio’s Learning Standards for Math (OLS) and/or**  **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☒ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☒ Attendto precision |
| ☒ Construct viable arguments and critique the reasoning of others | ☒ Look for and make use of structure |
| ☒ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, OLS and/or CCSS):**   * F-IF.8 Write a function * F-BF.1 Build a function that models a relationship between 2 quantities * G-GPE.1 Derive the equation of a circle or given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. * G-GPE.7 Use coordinates to compute the perimeters of polygons and areas of triangles and rectangles, e.g. using the distance formula. * G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder.) * G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and prove relationships in geometric figures. |

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies)   * Larson, R., *College Algebra: A Graphing Approach, 5th ed.,* * **Worksheet with real world situations that can be mathematically modeled by piecewise functions.** * **Traveling Salesman Problem worksheet/guided notes for speaker day.** |

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| **Teacher Advance Preparation:**   * **Find or write more problems using semi-circles in piecewise functions.** * **Ask guest speaker to come and discuss optimization and how if applies to mathematical modeling.** |

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| **Activity Procedures:**   * **Day 1 – Ask guest speaker to speak about optimization. This might include a discussion of the Traveling Salesman Problem and making decisions.** * **Direct instruction - Write equations of semi-circles.** * **Discover situations in which a semi-circle is a good mathematical model. Each group will have a written real world problem that can be modeled with the equation of a semi-circle. Students will work with their team to write the equation of that semi-circle. They will produce a small poster and display it on the board.** * **Day 2 - Discuss results of quiz and remediate gaps in understanding. This could be done in several ways – small group discussion, peer tutoring by pairs matched by teacher or direct instruction if there is a pervasive misunderstanding.** * **Introduce the equation of a circle. Discuss that it is not a function unless the domain/range are restricted.** * **Day 3 – Bellringer: define & graph piecewise functions similar to those remediated yesterday. Write mathematical models for real world situations that can be defined by piecewise functions, including linear, quadratic and semi-circle functions. Each team will be given a situation to work on together. Teacher will travel to each group, asking questions and giving feedback. Students will be encouraged to find more than one function for their situation.** |

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

* Students will display small posters from Day 1 and receive feedback on their work with semi-circles.
* Students will turn in mathematical models from Day 3.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners. Refer to Activity Template for details.  Teacher will have extension real world situations for teams that quickly solve their first tasks. Remediation of graphing was specific to small groups of students. I re-grouped them for the day so I could address their specific errors. |

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson.  Two professors from University of Cincinnati came to speak to my classes about The Traveling Salesman problem and optimization. The students enjoyed hearing about practical applications of math. The small posters did not happen as I wanted them to. They took too much time and students weren’t clear about the expectations. I need to be more explicit about the instructions. The students did very well with the semi-circle part of this lesson. Their prior knowledge of graphing circles was strong. |