**ALGEBRA 1 LESSON: PING PONG PARABOLAS**

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| **Math Topic** | **Quadratic Functions** |

**Source of Lesson: Adapted from** [**http://www.nsa.gov/academia/\_files/collected\_learning/high\_school/algebra/catapult\_trajectories.pdf**](http://www.nsa.gov/academia/_files/collected_learning/high_school/algebra/catapult_trajectories.pdf)

**List of appropriate TEKS:**

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| **TEKS #** | **Student Expectation** |
| 1D | (1) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:  (D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate |
| 7A | (7) Quadratic functions and equations. The student applies the mathematical process standards when using graphs of quadratic functions and their related transformations to represent in multiple ways and determine, with and without technology, the solutions to equations. The student is expected to:  (A) graph quadratic functions on the coordinate plane and use the graph to identify key attributes, if possible, including *x*-intercept, *y*-intercept, zeroes, maximum value, minimum values, vertex, and the equation of the axis of symmetry |
| 6A | (6) Quadratic functions and equations. The student applies the mathematical process standards when using properties of quadratic functions to write and represent in multiple ways, with and without technology, quadratic equations. The student is expected to:  (A) determine the domain and range of quadratic functions and represent the domain and range using inequalities |

|  | **Objectives** | **Evaluation Questions** |
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| 1 | I will label the x-intercepts, vertex, and axis of symmetry on the graph of a quadratic function. | C:\Users\cec0233\Desktop\parabola.JPG  On the graph above, label the x-intercepts, vertex, and axis of symmetry. |
| 2 | I will determine the axis of symmetry given the x-intercepts of a parabola. | If the x-intercepts of a parabola are at (0,0) and (10,0). What is the axis of symmetry? |
| 3 | I will determine the domain and range of a quadratic function when given the graph. | C:\Users\cec0233\Desktop\parabola.JPG  What is the domain?  What is the range? |

**Resources, Materials, Handouts, and Equipment List in the form of a table: Example**

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| **ITEM**  **(Specify worksheets)** | **Quantity**  **(How many do you need?)** |
| catapults | 1 for each group of 3-4 students |
| Ping pong balls | 1 for each group of 3-4 students |
| Large chart paper | 1 for each group of 3-4 students |

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| **ITEM**  **(Specify worksheets)** | **Quantity**  **(How many do you need?)** |
| Meter sticks | 1 for each group of 3-4 students |
| markers | 3 for each group of 3-4 students |
| recording device (ipad or cell phone or video camera) | 1 for each group of 3-4 students |

**Safety Rules:**

1) Catapults should be used properly so that they do not break.

2) Ping Pong balls should only be launched from the designated location.

**Advanced Preparations:**

1) Assign students to groups of 3-4.

2) Ensure that all catapults are in working condition.

3) Determine appropriate space for each to work.

**5E Lesson Plan**

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| **Objective Statement: Today we will be exploring trajectory and collecting data. By the end of the lesson, we will be able to communicate the patterns we have discovered and identify the key attributes of quadratic functions.** | | |
| **ENGAGEMENT Time : \_\_5\_Minutes** | | |
| **What the Teacher Will Do** | **Probing/Eliciting Questions and Students Responses** | **What the Students Will Do** |
| “Raise your hand if you think mathematics is fun.”  “Raise your hand if you think mathematics is important.”  “Raise your hand if you think mathematics could be used to help you have fun.”  “We are going to watch a short video entitled, ‘Why Math is Important’. I think you will see some people having fun.  Teacher will play the following video: |  | **Students will raise hands based on their opinions.**  **Students will watch the video.** |
| **Transition Statement** | | |
| We will not be flying across a hillside into a swimming pool, but we will examine what happens when a ping pong ball is launched from a catapult. | | |

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| **EXPLORATION Time: 30 Minutes** | | |
| **What the Teacher Will Do** | **Probing/Eliciting Questions and Student Responses** | **What the Students Will Do** |
| Divide the class into groups of 3 (4 if needed). Assign each group a launcher, videographer, and materials manager. These roles will rotate for each launch so that every student has the opportunity to do each job.  Demonstrate how the catapult works. Discuss safety issues regarding not breaking the catapult nor launching ping pong balls at people. | As students begin to articulate their observations, the teacher may ask these questions to the groups or pose them to the whole class to consider.  “How is this graph the same or different from other graphs we have studied?”  “Can you identify the variables (independent and dependent) in this investigation? | **Students will launch ping pong balls and collect data as described on the labsheet.**  **Students will return materials.**  **Students will a “round robin” structure for listing all of their observations.** |
| **Transition Statement** | | |
| “Let’s share out what we have observed about the trajectory of these ping pong balls.” | | |

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| **EXPLANATION Time: 25 Minutes** | | |
| **What the Teacher Will Do** | **Probing/Eliciting Questions and Student Responses** | **What the Students Will Do** |
| Have each group select a reporter and have the reporter from each group read one observation.  Instruct other groups to check this off their list if they have it or add it if they do not.  Depending on the observations shared- the teacher will add to/clarify to make sure the following are addressed: x-intercepts, maximum, vertex, axis of symmetry, domain, and range | What is one observation you have about your graph?  Where is the origin (0,0) in this investigation?  What is the height when the ping pong ball lands?  What are the possible values for the horizontal distance?  What is the least horizontal distance?  What is the greatest horizontal distance?  What are the possible values for the vertical distance?  What is the least vertical distance?  What is the greatest vertical distance?  What do you notice about the maximum point compared to the x-intercepts? | Students will share their observations and compare them with those of their classmates. |
| **Transition Statement** | | |
| Now that we have some new vocabulary terms and have reviewed some old ones, you will add labels to your graph. | | |

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| **ELABORATION 1 and 2 Time: 20 Minutes** | | |
| **What the Teacher Will Do** | **Probing/Eliciting Questions and Student Responses** | **What the Students Will Do** |
| 1) On your chart paper, please label or write the following: x-intercepts, vertex, maximum, axis of symmetry, domain, and range.  2) Now for the challenge:  I am going to share some data I collected when I shot a skittle with this catapult.  You’re team needs to decide where to place your catapult so that the skittle will land in this bucket. You have five minutes to take measurements and discuss. You will then put a piece of tape down with your team number to indicate where you want to place your catapult. Each team will get 3 shots. | “What pieces of data did you collect to help you determine the placement of your catapult?”  “How did you decide where the catapult should go?” | Students will label their graphs.  Students should measure the height of the bucket and find that height on their parabola. They should then determine the horizontal distance needed for the catapult. |
| **Transition Statement** | | |
| Let’s summarize what we have learned today. | | |
| **Closure Statement** | | |
| Today we have seen how important math is, we have collected data from catapults and used our graphs to learn the key attributes of quadratic functions. | | |

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| **EVALUATION Time: 10 Minutes** | | |
| **What the Teacher Will Do** | **Probing/Eliciting Questions** | **What the Students Will Do** |
| The teacher will instruct students to clear their desk for the evaluation. The teacher will state that the evaluation will be completed individually. |  |  |