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Grade Level/Subject: Algebra II - Parabolas

Topic: Parabolas, especially quadratic equations - graphing; writing equations; finding the roots, vertex,, axis of symmetry, directrix, and focus; solving by factoring, completing the square, and the quadratic formulas; systems of quadratics.

Objectives (P.A.S.S.): Algebra II Standard 2:1,3,4,5,6

Introduction: This lesson deals with concept of parabolas, especially dealing with the terminology necessary to learn about and graph parabolas. This lesson gives students a conceptual understanding of the methods but it is not an exploratory or investigative activity.

Instructional process: Students should be familiar with what the graph of a parabola looks like as well as the quadratic equations necessary to create that graph. They should alos become familiar with the terminology necessary for working with quadratic equations and parabolas in particular. Present the project as you work through the section on quadratic equations or conic sections. Give them an overview of their task and them have them complete the tasks as you study that section of quadratics. They will be expected to choose the launch and landing points of the arc, and write an equation that will produce a height within the given range. The purpose for the range of acceptable heights is that most of the students will "play" with a variety of values for a, {y=a(x-x1)(x-x2)} starting with -1, until they get a correct one. (Great to see with a graphing calculator!) This actually helps them better understand the influence of a on the graph rather than if the students simply solved for a. Be sure to pause throughout the project to allow for reflection on each section. The questions on the student handout are listed in ascending order of difficulty. Materials needed are graph paper, calculator, and the student handout.

Closure: If possible, at the end of this project, have the students discuss each of their graphs by sharing it with the class on an overhead graphing calculator or have their graph posted to share with the rest of the class. Be sure to have students continuously check their equations with their graph.

Assessment: The assessment for this project could be the correctly graphed and labeled graph. Be sure there is an understanding of the terms.

Modifications/Accommodations: If you want to make grading easier on this project, have the students put their landing and launch points 10 units apart and give them an established height. This way they will all get the same value for a.

Reflection: Often the students wonder why they are being asked to factor to find the roots when they already know them. The purpose is two fold: one, so they can check their

answers and two, few students initially understand that factoring a trinomial is the inverse operation of multiplying binomials. This factoring process helps them achieve that understanding. Students also need to have lots of guidance on this project unless they fully understand quadratics. Work the project in parts, checking each level as you go.

THE COIN FOUNTAIN PROJECT

You have been hired to design the water arc of a coin fountain. The pool of the fountain is 20 feet wide and the water arc is to be greater than 6 feet tall, but less than 50 feet. You will need to determine the locations of the launch point and landing points and the maximum height of the arc. You will need to write an equation that will describe the water arc in terms of the height of the arc in relation to the horizontal distance along the pool.

1. On graph paper, place the side view of your fountain in a first quadrant graph. Have the surface of the pool correspond the x-axis with the left side at or near the origin. On the graph, show the coordinates of the roots (x-coordinates) and the vertex (highest middle point) of the water arc (parabola).

2. Launch Point: Landing Point:
   Vertex Coordinates:

3. Using the equation $y=a(x-x_1)(x-x_2)$, where $(x_1,0)$ & $(x_2,0)$ are the roots of the parabola, choose a value for "a" that will produce a reasonable arc.

4. Find the equation of the parabola. Use the form $(x-h)^2 = -4p(y-k)$.

5. Convert your standard form equation (from #3) into the form $y = ax^2 + bx + c$

6. Graph the equation in #5 on a calculator to check it with your graph.

7. Using the parabola equation, find the height of your water arc at one foot of horizontal distance.

8. At what horizontal distance will the arc be 5 feet high?

9. Using your launch and landing points, find the equation of a 50 foot water arc.

10. Create (graph) a second arc that intersects the first one. Find the equation of the second arc. Graphically identify their point of intersection. Algebraically prove their point of intersection.

11. Find and graph the coordinates of the focal point and the directrix of the original water arc.