Names: _____ Date: _____

Calculating with Catapults: Discovering Parabolic Properties

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Grade Level: high school

Purpose: Discover properties of a parabola and make connections between hands-on work and mathematical vocabulary.

Materials:

- Approximately 13 popsicle sticks
- 3 rubber bands
- Ruler/Tape Measure
- Dime (or other projectile)
- Graphing calculator
- Paper and pencil

Directions: Break up into groups of 3-4. Assign a group member to each role:

The Recorder(s) makes and records measurements: _____

The Foundation holds the catapult: _____

The Launcher shoots the projectile: _____

Construct the catapult according to the following steps:

- Stack eleven popsicle sticks and rubber band each end tightly
- Carve two notches at one end of each of the remaining two popsicle sticks
- Insert one notched popsicle stick above the bottom popsicle stick in the stack
- Place the other notched popsicle stick on top of the stack
- Loosely rubber band the notched popsicle sticks to make the arm

Practice with your catapult, perform your trials ***in inches***, and record your data:

Launch Height*	**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	**Average Distance****
¼						
½						
$\frac{7}{8}$						
1						
1 ¼						
1 ½						
$1\frac{7}{8}$						

* *Launch height* refers to the distance above the ground the launch arm is pushed and will be the **x-axis** of your graph.

** *Average distance* will be the **y-axis** of your graph.

Now create a quadratic equation and graph from your data using your graphing calculator:

1.) STAT → `Edit`
2.) Input *launch heights* for `L1` and *average distance* for `L2`.
3.) STAT → `Calc` → select "`5:QuadReg`" → ENTER
4.) VARS → `Y-Vars` → select "`1:Function`" → ENTER
5.) Select "`1:Y1`" → ENTER
6.) ENTER to get quadratic equation
7.) Y=
8.) Use "up" arrow to highlight "`Plot1`" → ENTER
9.) GRAPH → WINDOW to adjust screen so that all seven points are in view.

Quadratic Equation:

_____

Analysis Questions:

1.) What does the point (1.875 , 0) represent?

2.) What is the highest point on the graph, and what does it represent?

3.) Describe the behavior of the graph in terms of how launch height affects projectile distance.

4.) What does the "a" term of the quadratic equation tell us, and why does this make sense?

Extension Activities:

- List sports/occupations in which an understanding of projectile motion is useful.
- Predict the launch height needed to land the projectile in a basket at a known distance.