

Quadratic Catapult Lab

Team Members: _____



Overview:

You will use what you know about the principles of design and quadratic functions to complete all stages of the Product Development Cycle. Your team will create and produce a catapult to consistently launch M&Ms at a target. Your goal will be to find an equation to model the flight of the M&M, and you will use this equation to determine the best position to place your catapult in order to hit a target.



Important Deadlines:

Research & Development	May 6 th
Testing & Analysis	May 6 th
Product Debut	May 8 th
Lab write up due	May 14 th

Rubric:

4	3	2	1
<ul style="list-style-type: none"> Team remained on task 100% of the time. All deadlines are met. All questions are answered and calculations are accurate. The final equation accurately models the flight path of the M&M. Target is hit on 1st or 2nd try. 	<ul style="list-style-type: none"> Team remained on task 85% of the time. Most deadlines are met. All questions are answered and calculations are mostly accurate. The final equation almost models the flight path of the M&M. Target is hit on 1st or 2nd try. 	<ul style="list-style-type: none"> Team remained on task 75% of the time. Some deadlines are met. All questions are answered but calculations may contain errors. The final equation mostly models the flight path of the M&M but may have some errors. Target is hit within 3 tries. 	<ul style="list-style-type: none"> Team remained on task less than 70% of the time. Deadlines are unmet or project isn't finished. Questions are unanswered or there are serious calculations errors. The final equation does not model the flight path of the M&M. Target is not hit.

New Product Development



CATAPULT RESEARCH & DEVELOPMENT

Plan / Create

In teams of 3 or 4, students will design and build a catapult. You may build the BASIC catapult, or you may research and design a small catapult that will consistently launch an M&M.

Some websites to research are:

<http://sweenymath.blogspot.com/2009/08/m-catapult-project-pt-1-catapult-plans.html>

<http://www.stormthecastle.com/catapult/free-catapult-plan.htm>

<http://www.stormthecastle.com/catapult/how-to-build-a-catapult.htm>

<http://www.instructables.com/id/5-minute-M--M-catapult-game/>

Google: "easy catapult designs"

Guidelines for ALL catapults:

- The more securely the pieces are glued, the better our launcher will be. Excessive glue will actually cause your launcher to be lesser quality and more difficult to assemble.
- Although the 5 steps to assemble the launcher can be completed in one class period, allow about 5 minutes between each set for the glue to start to dry. Moving on to another step with the glue really wet can cause the previous step's work to fall apart.
- Because the popsicle sticks are not originally designed to be assembled into Skittles Launchers, you may need to press pieces together and hold them for several minutes in order for there to be a stronger bond with the glue and avoid gaps between the pieces due to warped wood. Your project will be significantly delayed if the launcher falls apart!

Instructions for the BASIC catapult:

- Step 1: Take two THIN popsicle sticks, cut them in half and glue all four pieces together to form the ***base***.
- Step 2: Glue the clothespin to the top of the base.
- Step 4: Glue the ***base*** (w/clothespin) onto the center of a square of cardboard. Write your team name on it.
- Step 3: Glue one WIDE popsicle stick to the top half of the clothespin to form the launch platform. Be sure the popsicle stick is right at the end of the closed side of the clothespin.
- Step 4 (optional): Cut a popsicle stick in half and glue one half vertically alongside the catapult, and the other half to form a support angle. Do NOT glue this guide to the launch platform it will get stuck!
- Step 5: Glue the bottle cap to the top of the launch platform towards the higher end. Leave about ¼ inch between the bottle cap and the end of the launch pad. This will be the M&M holder.
- The diagram below shows you the final product.



CATAPULT TESTING

Evaluate

Place the catapult on the ground. Be careful that it does not change position during tests. Fire a few practice rounds, making sure to pull the catapult back the same distance each time. It is very important to make sure that your shots are as consistent as possible!

Test your catapult for *launch distance* and *launch time*. If either of these vary greatly with each launch, your catapult is not consistent and you need to INVESTIGATE the problem, and come up with a PLAN to fix it.

Detail any issues and what your team did to resolve them below:

CATAPULT ANALYSIS

STEP 1: Your team needs a designated LAUNCHER, SPOTTER, TIMER, and RECORDER

- Try a few practice runs to make sure that you can hit close to the same spot with each shot.
- The timer is the official launch coordinator. They give the launch countdown, and are responsible for accurately timing a launch from the moment the M&M is released until it hits the ground.
- The launcher will be in charge of firing M&Ms from the group's catapult for the official tries. THE LAUNCHER MUST MAKE SURE TO LAUNCH THE M&Ms THE EXACT SAME WAY EVERY TIME.
- The spotter will put a piece of tape on the exact mark where each M&M lands and measure the distance (in meters).
- The recorder will record the distance (in meters) and the time (in seconds).

STEP 2: Once you get a fairly consistent launch time and launch distance, record 3 official times and their corresponding 3 official distances. Record these values in the table below. Average your three times and distances for the final boxes.

Distance 1:			Time 1:	
Distance 2:			Time 2:	
Distance 3:			Time 3:	
Average Horizontal Distance:			Average Time in the Air:	

1) To find the maximum height of your M&M, use the formula:

$$h = \frac{gt^2}{2}$$

where **h** is the vertical distance traveled (*meters*), **g** is the acceleration due to gravity (9.81 *meters/sec sq.*) and **t** is the time in seconds of *free fall*. **Keep in mind, the M&M was rising for half of its flight, then fell for the other half. Therefore, to find the time it was free falling you must divide your average time by 2.**

Average time in free fall (t):		
Maximum height of M&M (h):		

2) Find the vertex of the parabola using **x** as the horizontal distance traveled and **y** as the vertical distance traveled.

3) Using the vertex you calculated and a start point of (0,0) , calculate you're **a**-value.

4) Write the final equation for the flight of your M&M:

Equation:	
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