Catapult Project Planet Holloway Physics

Objective.
Design and build a catapult capable of launching a small round projectile (a light weight golf ball) more than 12 ft and up to 40 feet away in order to accurately hit a target. Using your catapult, calculate the exit velocity that occurs during the launch by the projectile. Use your model catapult to explain key physics concepts.

Requirements.
The catapult is to be made of low cost material and be very portable. The size of the base should not exceed 22 inches square and the arm should not exceed 24 inches. Try to leave half the base free to stand on when launching. This will keep the catapult stable. The catapult is to use some sort of a spring or elastic bands (think rubber bands) to provide the force that creates the torque to accelerate the arm. The catapult must have a rotating arm that "throws" the projectile. We are not building trebuchets, balistas, or sling-shots; catapults only please. For ideas check out these sites:

- http://www.stormthecastle.com/catapult/how-to-build-a-catapult.htm
- http://www.knightforhire.com/catapult.htm
- http://www.redstoneprojects.com/trebuchetstore/build_a_catapult.html

Remember, these are just ideas. Your catapult should be able to launch to different ranges, therefore, the tension and the launch angle should be adjustable. Try to consider how does one shoot the projectile close, as well as how does one shoot the projectile 40 feet away, or anywhere in-between.

Teams should be able to adjust the catapult to launch the projectile to different locations ranging from approximately 12 to 40 feet. Hitting a target will earn your group extra credit. Plan accordingly.

Even though we will be wearing safety glasses, the catapult must not have any sharp edges that could injure yourself or others.

Grading.
There are three grades for this project, one for the oral presentation of four concepts, one for performance and one for the calculations. Each section is worth 50 points for a total of 150 points.

Extra credit is available for groups who hit targets on first shot. You will have four shots, so you will be able to get extra credit four times. Each different target hit is 5 points extra, except the furthest target is worth 10 points. This means you can earn up to 25 extra credit points.

Research.
Included in this project is a oral presentation on topics related to catapults. Research these three sections. Consider the physics behind the parts of the catapult. How does the projectile end up going forward at the correct angle. Think in terms of physics. This next section is not required, but is really useful for a successful launch and explanation.

- **Key Components**
  - Identify four different components of a catapult and describe what a catapult does in terms of physics. Think about forces, inertia, acceleration, changes in energy, etc. and explain in as much detail as you can what the catapult does to the ball.
- **Manipulating Distance**
  - Briefly describe how you will be able to change the height and range that your catapult will be able to launch the projectile.
- **Physics involved**
  - Include a sketch or photo of your catapult and a description of key parts.
  - Explain the strengths and weaknesses of your design and estimate how far and how high you expect your catapult to launch.
  - Label torque, spring or elastic force, friction (both static and kinetic), potential energy and kinetic energy.
  - Briefly define each label above and relate how they are part of the catapult launch.

Oral Presentation.
Your group will explain four of the following concepts, selected at random by your teacher. You must be able to define the concept generally, explain where it happens or belongs on the catapult and what it contributes to the catapult system. I am looking for understanding of the physics concepts and proper use of vocabulary. Please include the following in your explanation:

- Definition
- General concept
- Units of measure
- Scalar or Vector
- Location on the catapult
- How it contributes to the catapult

The concepts you will be presenting on will be chosen at random from the following list:

- Force
- Normal force
- Friction
- Tension
- Spring force
- Torque
- Weight
- Air Resistance
- Acceleration
- Angular Acceleration

- Potential energy
- Kinetic energy
- Centripetal Force

Calculations.
By making measurements before, during and after the launch you must calculate the following:

- t - the total time in the air.
- v_0 – the initial speed with which the projectile left the catapult.

In order to make these calculations, you will need to make the following measurements:

- h_0 – the initial height of the projectile relative to the ground before it is launched. This is the exit height of the projectile.
- h_f – peak height during the flight of the projectile. Helps to film this.
- d – the horizontal distance the projectile travels, from launch to first impact.
- θ_0 – the starting angle of the projectile as it leaves the catapult. Helps to film this.

It is helpful to video the launch of your projectile from a profile view and measure from the video.

Assume that g is 9.8 m/s.
Show all work neatly and keep your work well organized!

Calculations are due four days after testing concludes.

Bring these two pages with you on testing day. Record your results here and submit with the write up.

Data

h_0 – the initial height	
h_f – peak height	
d – the horizontal distance of the flight	
θ_0 – the starting angle of the projectile	

Notes and Illustrations from test day. (Record anything interesting that happens while testing).

Performance.
You will be scored on being able to adjust your catapult to match given conditions. You may pivot your catapult, but you may not move its original position.

Teams may bring in their catapult early to test it and make marks (gradations) on the catapult for different heights and distances. You may also make measurements for the calculation section ahead of time on these practice days.

Scoring for performance:

Accomplished task (4 attempts max)	**Score**	**Points Earned**
Projectile clears 30ft in the air	50 points	
Projectile clears 21ft in the air	45 points	
Projectile clears 12ft,	35 points	
Projectile clears 6ft	30 points	
Built catapult and it launches projectile forward	25 points	
Built catapult	20 points	
Only the best score above will count. Check all that apply, but only record the best score.		
Extra Credit		
Hits first target in the air (without bouncing or rolling)	+ 5 points	
Hits second target in the air	+ 5 points	
Hits third target in the air	+ 5 points	
Hits farthest target in the air	+10 points	
Total Score		

Good luck and have fun!