



THE UNIVERSITY of MISSISSIPPI

Thirteenth Annual Catapult Competition at Ole Miss *Thursday April 2, 2020*

The School of Engineering, the Center for Mathematics and Science Education, and the Division of Outreach at the University of Mississippi cordially invite Mississippi high school and middle school students and teachers to participate in an exciting science and engineering event! On **April 2, 2020**, the Thirteenth Annual Catapult Competition will be held at the University of Mississippi. The day will begin at 8:00 a.m. and conclude with an award ceremony at 3:00 p.m.

The morning begins with registration, followed by a demonstration of the student designs. At this time, catapults will go through a **rigorous safety check** to ensure they were constructed within the rules and specifications of the competition. Each team of students designing and constructing a surgical tube catapult that meets the specified criteria will be given the opportunity to launch tennis balls. Faculty members, staff and students from University of Mississippi School of Engineering, the Center for Mathematics and Science Education and Division of Outreach will manage the competition.

- *Teams will compete in Design, Pop-A-Shot, Humpty Dumpty, Siege the Castle, and Art & Aesthetic*
- *Awards will be given in each category*
- *An Overall Winner will be determined from the total of the individual event scores*

Registration forms with a list of students participating and t-shirt sizes must be submitted by March 19, 2020. There is a \$75 per team registration fee. You may register online [HERE](#)

For additional information on Specifications or for Registration and Day of Event information contact Tiffany Gray, umcmse@olemiss.edu.

Design Specifications - 2020

1. Each team will consist of 2 - 4 students, with a teacher sponsor and/or an engineer mentor. (Teachers and mentors may sponsor more than one team.)
 2. Teams shall prepare a consolidated Data Table (Bill of Material). The columns of that table can be Part Number, Part Description (function), Quantity/Size, and Estimated cost per unit, Total Cost. A small picture image of each component can be included in the description.
 3. Teams shall prepare individual part drawings, in addition to an assembly drawing.
 4. The catapult will not exceed **3 feet in launch height**, measured from the ground with the throwing arm at rest in its vertical position. It may be no more than **3 feet wide** and may not weigh more than **50 pounds** (total weight of structure). Dead weight applied to the base is allowed. The dead weight must not impede the action of your catapult and will be included in the structure's total weight. There is no restriction in the "length" of the catapult, the weight will dictate maximum length. You may need to add "length" to your catapult with footholds for your team to stand on to hold the catapult down; students must still be 36" away from the catapult. Student weight is free weight. YOU must be a safe distance from the catapult. No student can stand within the swing arc of the catapult. If you bring anything to put under your catapult or you build your catapult in such a way that you can raise it up, keep in mind your catapult must be STABLE. If you chose to raise up your catapult for different launching angles, your catapult still CANNOT exceed 3 feet in launch height.
 5. The catapult will solely utilize **up to 6 linear feet of latex surgical tubing** to provide the required torque for the throwing arm.
 - a. Catapult launch mechanism should be a rotating arm design. Any other siege weapons designs must be approved prior to the competition.
 - b. **Tubing must be stretched in a linear fashion.** Torsional spring designs are not allowed.
 - c. Teams must be able to **fully unload** their surgical tubing for inspection, measurement and movement purposes.
 - i. While moving the catapult, the tubing must be in a fully relaxed position
- Please note: This specification is intentionally left vague to promote as many potential design configurations. If you have any questions or concerns, send a quick question, picture, napkin drawing, etc. to umcmse@olemiss.edu. You can also choose to submit your question through our website at <http://umcmse.com/outreach/catapult-competition/>.*
6. Lubricants of any kind are not allowed.
 7. **The catapult must have a safe, secure mechanism to hold the throwing arm in the cocked position.**

a. If you think it could be unsafe, it is probably unsafe. Please pay critical attention to this mechanism. Before you can compete, you will be required to pass a safety inspection and perform a test launch to verify the safe release.

8. The release mechanism for the throwing arm must be triggered with one motion, such as pulling a pin with a wire or rope. Students may not pull the throwing arm to accelerate the projectile.
 - a. All launches must be done remotely with 36" separation between the plane of action for the throwing arm. Meaning students cannot stand behind during the launch process. They must be to the side.
 - i. You will need to be able to adjust between launches, but once the pin is set all teammates must be behind the 36" line.
 - ii. If you have built in footholds, these footholds must have you standing behind the 36" line.
9. Wheels are not allowed. The bottom surface of the base of the catapult must be smooth so as not to damage the floor. Given the multiple stations of this year's game be sure to have a moveable catapult with a base that will protect any floor from damage during operation.
 - a. Catapult base should include a soft layer on the bottom (carpet remnants, rubber pads, etc.) to protect the wood floors.
10. The base of the catapult must allow for easy positioning but must be substantial enough to make the catapult stable. It must stand up by itself.
11. Figures 5 and 6 have been provided in this document to aid in the design process. Of note is the different projectile behavior when accounting for the drag. Plots were produced using a Python code based program to determine the projectile motion of the tennis ball. Code and usage instructions are available at the CMSE website.

This project has limited specifications to give the students opportunities to BE ENGINEERS! Students must research and experiment with their designs to learn the relationships and interactions of all the parts of the catapult. Part of the engineering experience is adjusting the catapult to achieve maximum performance. Students will decide on:

- A creative design
- The materials to be used for the construction
- The base for the catapult
- The length of the throwing arm
- The pivot mechanism
- The location of the pivot on the structure
- The location of the pivot on the throwing arm
- The material, size, and stiffness of the surgical tubing
- How the surgical tubing is attached to the arm
- The safe, secure mechanism to hold the throwing arm in the cocked position
- The release mechanism for the throwing arm
- The material and length of the sling
- The attachment and release mechanism of the sling to the throwing arm
- How the sling will release the tennis ball at the proper angle for distance, height, and accuracy
- A dedicated place on the front to post a placard with the team number

- And everything else that is not specified in this document
- Math and science should be a part of every design. This is Sir Isaac Newton at his finest.

You **MUST** consider **SAFETY FIRST!** Take proper safety precautions and wear safety glasses when constructing the catapult. Although it will launch whatever you want, we are launching tennis balls for this competition. You may have the ability to throw objects farther than you expect, so please make sure you have adequate space to test.

The **ENGINEERING PROCESS** (included in packet) will guide you through the design, construction, and testing.

Applying the Engineering Design Process

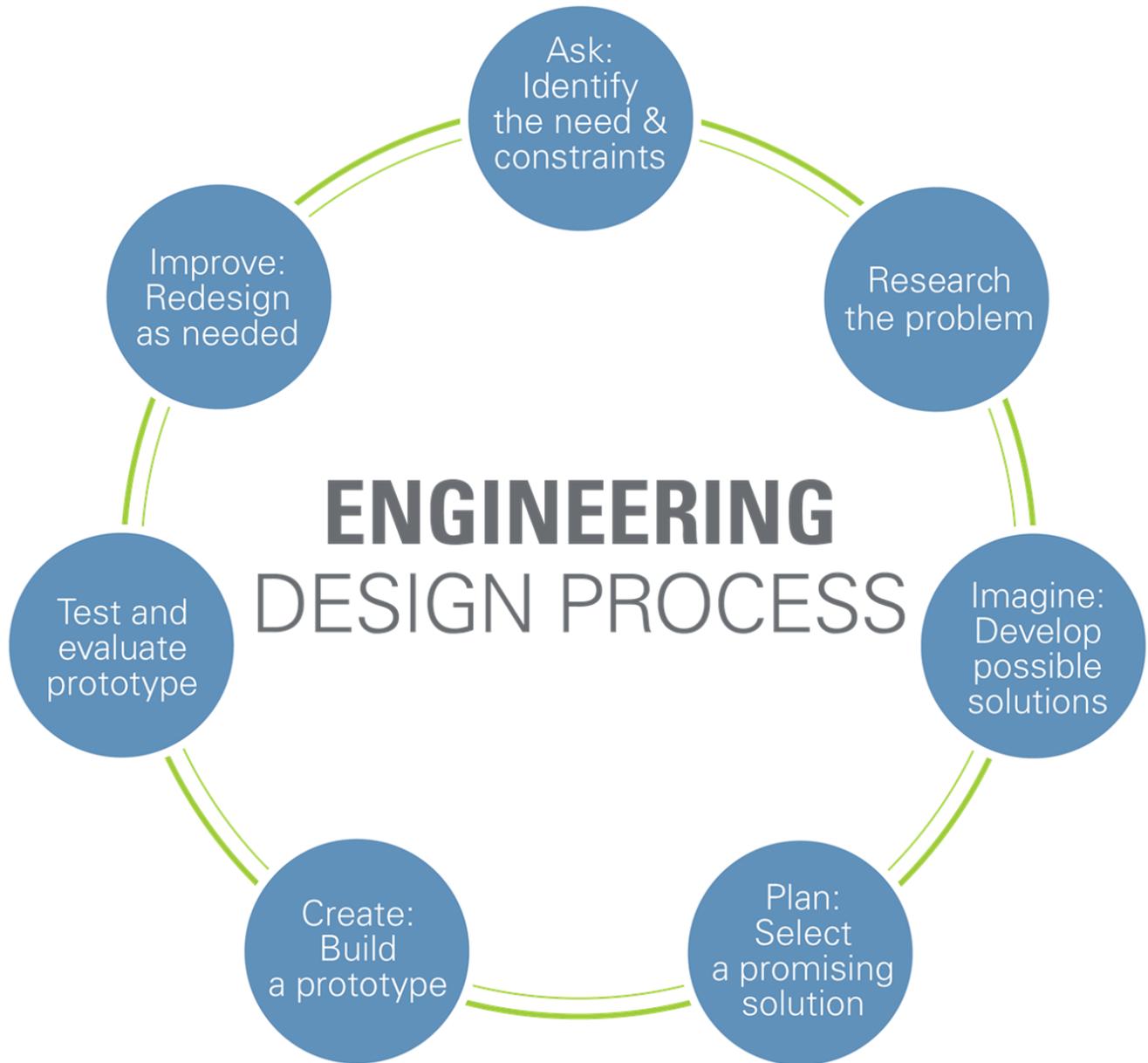


Figure 1: Engineering Design Process

Design Scoring Details - 2019

Catapult must meet all required specifications to participate in the Competitions.

The Design portion of the competition is broken down as follows:

Due to surface restrictions, wheels will not be allowed.

Design Process: 25 points

Poster Board - Fill each bubble in the figure on page 4 with how your team approached each step in the design process

List of Materials - Each team must submit a **Value Assessment**

(**List of materials, including cost** (if donated, approximate cost) required to construct their catapult).

Bonus (10 points): to scale drawing [Hand or computer] – Check out Google Sketch-Up!!!! Free CAD software

Bonus (10 points): Approval of catapult design prior to competition day. Send us your design and pictures and/or video of your build for approval up to the week before for bonus points.

Total Cost \$

Safety Features: 15 points

Is the throwing arm secure in the cocked position?

Is the frame designed for stability?

Do students know where not to stand when firing?

Construction: 20 points

Is the catapult structurally sound?

Is the catapult easily and safely moveable?

Creativity and Originality of the Design: 20 points

Interview with Team: 20 points

Each team is required to begin interview portion with a short 3-5 minute presentation about their design process, and experiences. After presentations, judges will ask follow up questions. Please consider the question examples of what the judges may ask after your presentation.

Use and knowledge of the Engineering Design Process

Understanding of the engineering principals pertaining to the catapult and the launching process research.

- *Questions will be asked about the engineering design process (see the figure on the prior page) performed by your team as well as how you used your knowledge of math and science to make decisions along the way. Documenting your decisions is highly recommended. Written, video, pictures are all valid forms of documentation to share with judges. Please be ready to highlight your unique team strengths, your team failures and how you persisted.*

Pop-A-Shot 3 Point Challenge - 2019

The catapult will line up with the leading edge of the structure on the indicated point along the 3 point line. Team members should stay within their 9-foot radius area during the competition, each team's catapult will need to stay in the designated box. Teams will launch 4 shots from 3 different locations (12 shots total) on the basketball court to try and score in a regulation basketball hoop. The locations will be as indicated on Figure 2 below.

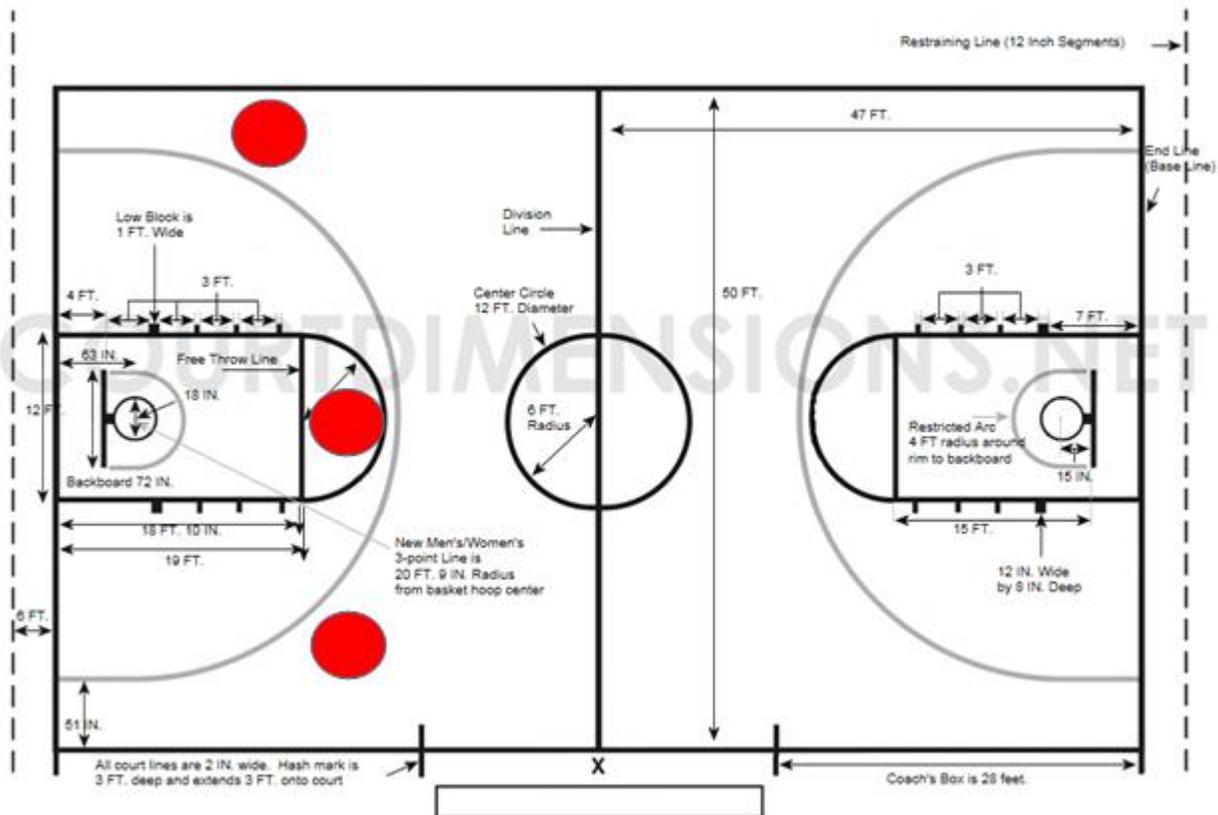


Figure 2: Pop-A-Shot Challenge Shot Locations

Teams will rotate through the stations and shoot when told to do so by the challenge coordinator. Teams will also be given 4 practice shots at their first location, when they get to the other two locations they will be given one practice shot each.

Scoring will be as follows:

- **1 point** for shooting the ball past the basketball hoop before hitting the ground.
- **4 points** for hitting the backboard.
- **8 points** for each shot made through the hoop.
- **2 additional points** if you can call “glass” (before you shoot) and bank it in the hoop off of the backboard for a total of 10 points.
- **Minus 4 points** if you call “glass” and make it through the hoop without hitting the glass for a total of 4 points.
- **0 points** if you call glass and miss the backboard and the hoop.

Siege the Castle - 2019

The third challenge will be about the combined power and accuracy of your machine. The teams will have unlimited number of tennis balls to knock down as many bricks as possible. Each team will fire from the free mid-court line towards the baseline. The bricks will be 12" wide by 6" in height made from cardboard. **The walls will be 6' wide by 5' tall (6 boxes by 8 boxes).** The distance will be 15' to the brick wall. Figure 3 provides a general idea of the location. Each team will get 5 minutes to launch as many balls as possible. The winner will be determined by the number of bricks removed from the wall. The brick has to be completely removed from the wall. Bricks **will not** be moved during a team's firing time. To count a box must have moved over half of its thickness either forward or back of the back/front edge of the original wall as designated by the lines on the floor. Please note that teams will **NOT** be allowed to pick up their catapult during this round, teams **must** remain 36" to the side of their catapult. Figure 4 shows a general configuration for dimensions. Actual locations on court may vary.

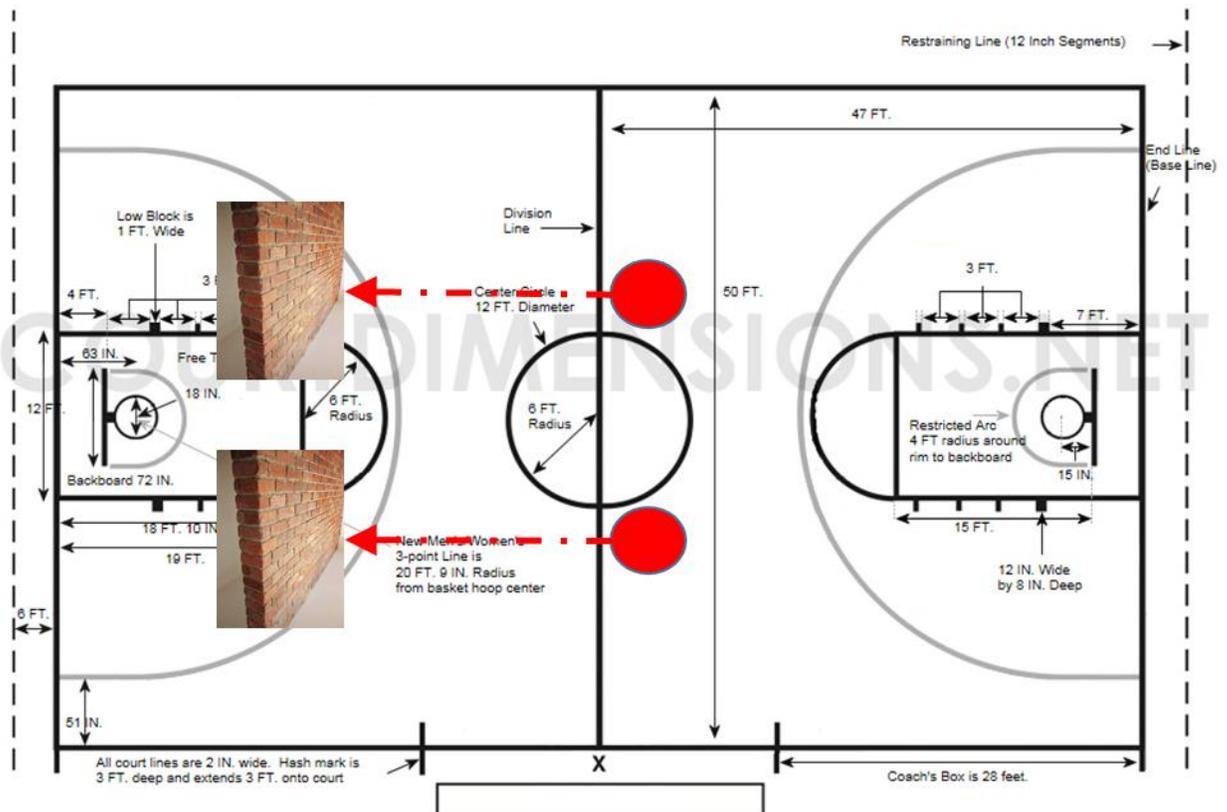


Figure 4: Siege the Castle Challenge Schematic

Scoring will be as follows:

- **1 point** for each box that has moved more than half its thickness. So a box must move **6** inches forward or backward from its original position. No box will be counted until the end of 5 minutes. At that time score keepers will count boxes and determine box positions.

Tie Breaker will be time.

Art and Aesthetic - 2017

This challenge is about the decorating your catapult. It will have nothing to do with engineering, instead it will allow you to show your artistic side. We would like you to decorate your catapult anyway you choose (i.e. painting, drawing on it, adding decorative items, etc.) to make it look aesthetically pleasing. Keep in mind that the paint and decorations cannot interfere with the safety of your catapult, SAFETY is still FIRST. We will be bringing in college art students and/or professors to judge this aspect of the competition.

Overall Competition Winners - 2019

In each category teams will be ranked based on the number of points they received. Ranks will only go to 12th place, meaning the 12th place and on will all be ranked at 12th place. We will then sum all of the ranks together and rank the sum for the Overall score.

Possible Awards:

- Design
- Pop-A-Shot
- Humpty Dumpty
- Siege the Castle
- Overall
- Top Middle School Team
- Art and Aesthetic Award

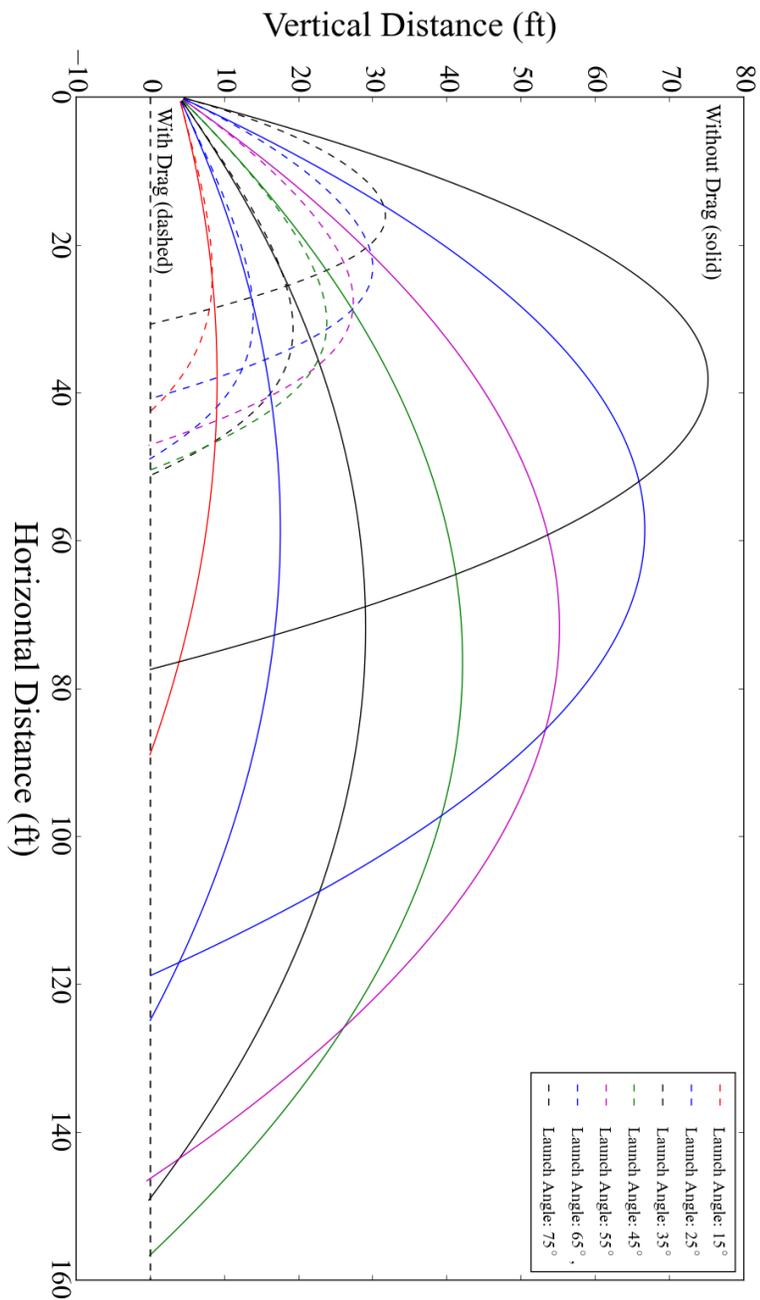


Figure 5: Tennis ball trajectory comparison for with and without drag

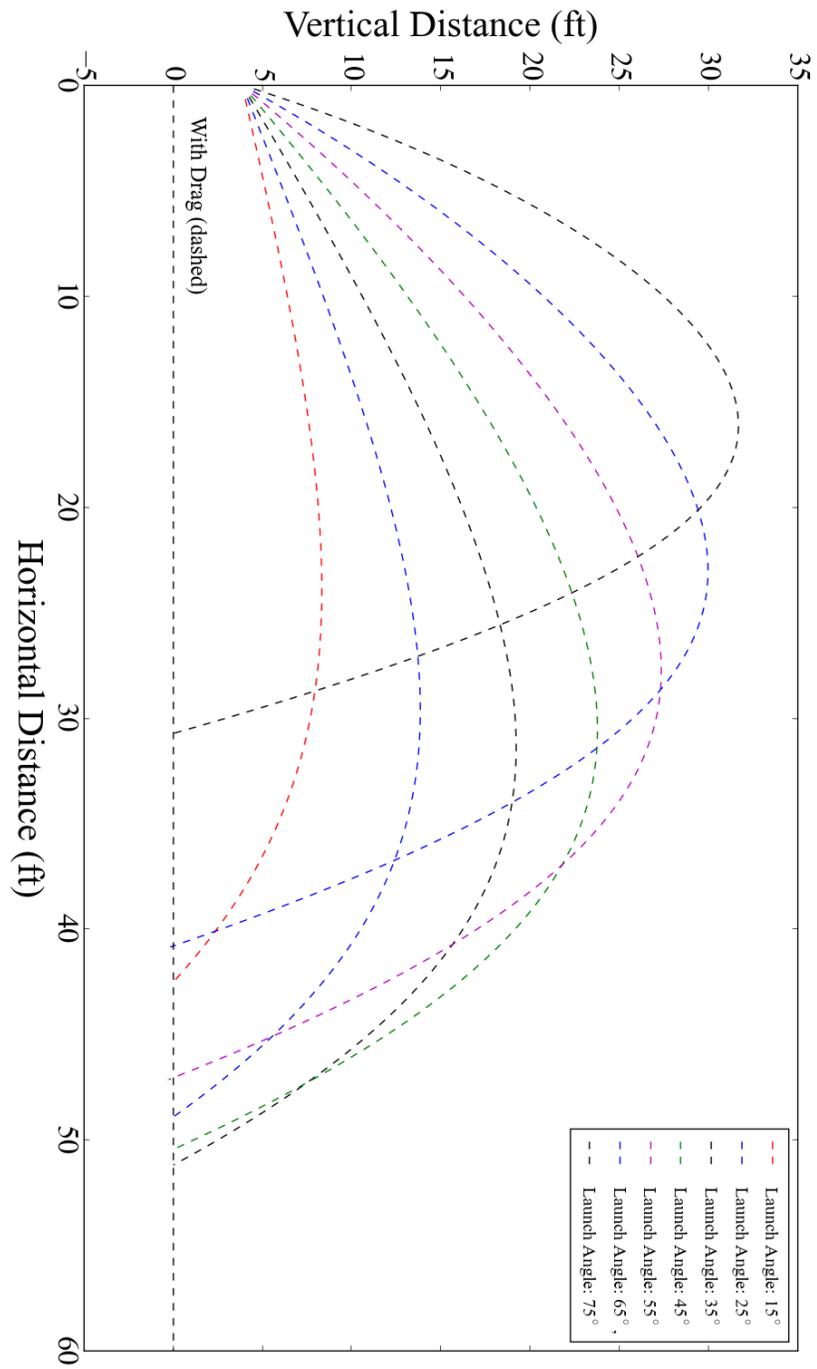


Figure 6: Tennis ball trajectory with drag

14th Annual Catapult Competition at Ole Miss

April 2, 2020

****Please note that for safety reasons NO COACH OR SPECTATOR will be allowed on the floor****

Schedule of Events:

8:00 – 9:30	Registration and Safety Check– Tad Smith Coliseum <i>*Please bring consent forms and any fees to be paid</i> <i>*All teams must arrive no later than 9:30AM</i>
8:00-9:30	Team Photos with catapult (As soon as you have successfully made it through Safety Check)
8:00-11:00	Pop-A-Shot – Competition 1 (As soon as you are done with team photos you may begin)
8:00-2:45	Judging Begins *****
11:00-12:30	Lunch – Each team is on its own for lunch. Some lunch suggestions are available – email umcmse@olemiss.edu or pick up a list at registration table.
12:30-1:00	Each team needs to be back at their catapult and ready to begin.
1:00 – 2:45	Launching Competitions 2 (Humpty Dumpty) and 3 (Siege the Castle)
3:00 – 3:30	Award Ceremony (participation required)

*******Please note that there will be 2 sets of Judges. This year they will be walking around during the competition to talk to you. They will also watch your catapult in action. *******

- At the end of the competition 3 (Siege the Castle), students may begin dismantling and loading catapults.
- **Students are responsible for the cleanliness of the competition area.**