

# **Project Catapult Rules**

## **Spring 2008**

### **What is Tau Beta Pi and What Does it Represent?**

Tau Beta Pi is the National Engineering Honor Society. The members of Tau Beta Pi are not only the top students in their graduating class, but they also participate in community service activities.

The Iowa Alpha Chapter at Iowa State University has been recognized nationally for the service projects that it has organized. The catapult competition was designed to reach out to high school students who have an interest in mathematics, physics and engineering. The competition gives students an opportunity to apply theory to a project that is both fun and challenging.

### **1. Quick Glimpse of the Challenge**

The object of the catapult competition is to promote engineering as an exciting field for young people, to provide a service to society, to encourage teamwork, and to assist in education outside of the classroom.

Teams must design catapults to launch raw eggs a specified distance. The catapults will be designed and built by the teams. Each team must provide all materials and use their creativity and imagination in their designs.

The playing field will be a rectangular shape. The teams will set up their catapult in a designated launch area and will launch the eggs at a bull's eye target on the opposite end of the playing field. The catapult range must be adjustable because each team will be shooting from different distances to the target. The exact distance to the target will not be known until the day of the event. A range of distances will be specified in this document. Each team will get three practice shots and five scored shots. This field competition will count for 50 of the total 100 possible points.

In addition to the catapult, a poster must be created. The poster should include calculations of predicted distances, documentation of the design process, and a list of materials used, among other things. The poster will count for 50 of the total 100 points available in the competition. This poster should be of professional quality, visually attractive and demonstrate the groups' understanding of the principles involved.

Upon the completion of this challenge, the members of each team will receive T-shirts. The winning team will also receive an award for display at its school. An extra benefit of the competition is its presence at VEISHEA, the largest and oldest student run celebration in the United States of America! This year, VEISHEA and the catapult competition will be held on **April 12, 2008**.

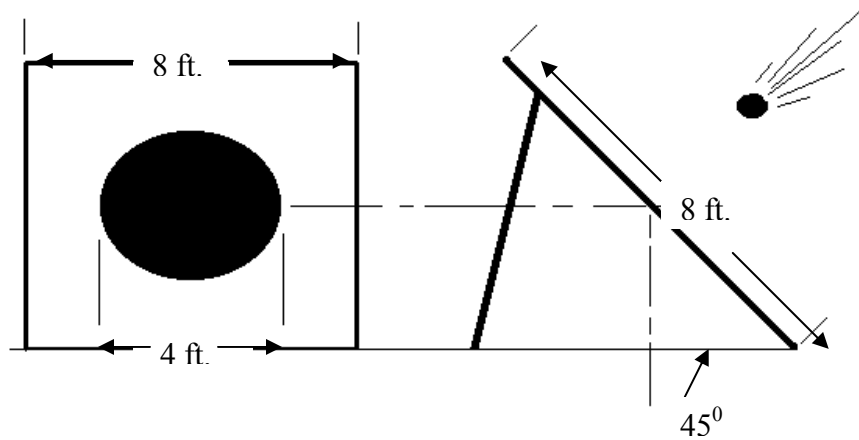
## 2. Rules of the Competition

### 2.1 Teams

Teams will consist of a minimum of four students (recommend no more than eight) and one advisor. A student is someone who has not yet graduated from high school. An advisor may be a teacher, principal, parent, or guardian (anyone who is an adult and willing to take on the challenge and responsibility).

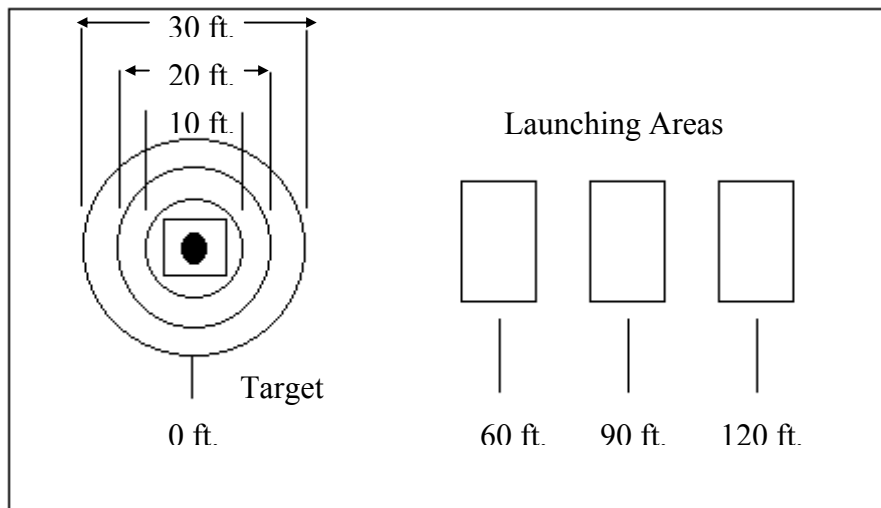
### 2.2 Field and Target Description

The competition field will be a level, rectangular field. The target is an 8' x 8' platform inclined at a 45° angle. The bull's eye will be in the center of the platform and be 4' in diameter (see Figure 1). The launching areas are described in section 2.4.



**Figure 1. Target**

The distance to the center of each launching area will be measured from the center of the bull's eye. There will be three launching areas for the teams to choose from: 60', 90', and 120 feet from the target (see Figure 2).



**Figure 2. Competition Field**

## 2.3 Launching Site

The launching sites will be rectangular areas that measure ten feet long by twenty feet wide. Each team will announce the launching area they wish to attempt at the time of the competition. A team member will then draw a random distance, zero to ten feet, out of a box and that distance will be measured from the front of the launching rectangle. All eggs will then be launched from this distance. The catapult's datum will be the most forward ground brace (see Section 3.8). As an example, a team may choose the 60-foot launching area. The random distance they draw from the hat will then place them anywhere from 55-65 feet from the target's bull's eye.

## 2.4 Eggs

Tau Beta Pi will supply all eggs used in the competition. They will be grade A large eggs.

## 2.5 Practice Shots

Each team will be allowed a total of eight shots, three practice shots and five scored shots from the drawn distance. Teams must announce before each shot whether it will be a practice or scored shot. These practice shots must be carried out within the 30-minute time constraint. (See Section 2.7)

## 2.6 Scoring Shots

Each team will have five scored shots. Points will be awarded for eggs that hit the 4' diameter bull's eye as well as shots that strike the 8' x 8' target platform outside the bull's eye or land within one of the three circles surrounding the target. The landing point of the egg will determine the score (i.e. rolling the egg onto the target does not count). The points awarded will also depend on which launching area the group has chosen (see Table 1).

**Table 1. Scoring Scheme**

	<b>60'</b>	<b>90'</b>	<b>120'</b>
<b>Bull's-eye</b>	6	8	10
<b>Inside 10' Circle (Including Platform)</b>	4	6	8
<b>Inside 20' Circle</b>	2	3	4
<b>Inside 30' Circle</b>	1	2	3
<b>Miss</b>	0	0	0

To obtain the maximum score of 50 points, a group must choose the 120' launching area and strike the bull's eye with every attempt. Each group must therefore consider their catapult's ability and make an engineering decision on

which launching area to attempt. CAUTION: Historically, choosing a longer range has adversely affected accuracy.

## 2.7 Time Constraint

From the time of the drawing, each team will only be allowed thirty minutes to place their catapult, launch all eight shots, and remove the catapult from the field. Catapults may be assembled before the thirty-minute countdown begins.

# 3. Construction Constraints

## 3.1 Initial Size

The size of the catapult must be no greater than 4'x 6'x 3' when disassembled; in other words, it should fit inside a box of these dimensions. This will be tested by judges on competition day! On competition day, a team may bring its catapult disassembled for size testing and then put it together to form a final unit larger than the stated dimensions. While there is no weight constraint, teams should keep in mind that the catapult will need to be transported some distance over grass. The catapult should not be so massive that it requires a truck to move it even short distances. Teams should be able to move their catapult a minimum of ½ mile manually. Some of the roads through campus may be closed due to the VEISHEA parade or other activities, so plan accordingly!

## 3.2 Energy

The only allowed means of providing energy to the catapult will be that of a falling mass. No springs may be used in the construction of the launching mechanism. Tau Beta Pi would like to see creative designs resembling trebuchets rather than slingshots.

## 3.3 Materials

Materials that may be used are any items that may be found at a typical lumberyard or hardware store.

## 3.4 Remote Triggering Device & safety

Each catapult MUST be equipped with a remote triggering device and firing safety. (See Section 4.2)

### 3.5 Cost Constraint

The total cost for the construction of the catapult must be no greater than \$200.00 (see Section 5.6).

### 3.6 Broken Parts

During the competition there might be times when parts will break. These parts may be replaced as long as the replacement materials were included in the initial measurement box. Tools do not have to be placed in the box. All repairs must be done within the thirty-minute time constraint.

### 3.7 Adjustability

Teams will be allowed to make minor modifications and adjustments to their catapults with materials that were included in the initial measurement box. An important aspect of the catapult design is its ability to be adjusted in response to variable launch factors such as wind and distance to target.

### 3.8 Ground Anchors

Each catapult must be fitted with four ground anchors. These should be steel stakes at least 18 in. long (make sure that you remember a means for extracting these stakes after the competition). The stakes should be placed at the corners of a rectangle no less than 4' x 6' with the 6' dimension in the launch direction. The forward-most stake will serve as the datum for the catapult.

### 3.9 Machined Parts

Ingenuity is desirable but excessive use of custom-machined parts, e.g. low friction bearing assemblies, may be penalized. The catapult should be constructed in a typical school or home workshop. Metal parts are acceptable, but metalworking tools should be limited to hand tools. Electric drills may be used. No welding or brazing will be permitted. If there are questions regarding this requirement please feel free to contact us (see Section 8.2).

## 4. Safety

### 4.1 Supervision

Supervision is required when constructing, testing, and transporting the catapult. Tau Beta Pi will not be responsible for injuries incurred during the construction, transportation, or operation of the catapults. BE SAFE!!

## 4.2 Remote Triggering Device & Firing safety

Each catapult must have a remote triggering device. The catapults must be triggered from a minimum distance of ten feet to the side of the launch line. All group members must be outside this minimum distance at the time of firing, and no one should be in the firing line (in front or behind) of the catapult. This minimum distance is required to ensure that no one is hit by the moving parts of the catapult. An example of a satisfactory remote triggering device would be a rope pull ten feet long that activates a launching device.

Catapults should also include a firing safety. The catapult should be unable to fire until the safety is released. The safety may be released within the ten-foot trigger limit.

## 4.3 Safety equipment

All group members that actively participate in the launching of the catapult will wear a hard hat and safety glasses. Tau Beta Pi will have some available on the day of the competition, but groups may also bring their own safety gear. **Be sure to utilize appropriate safety gear when building and testing your designs!!**

## 4.4 Release and Waiver of Liability

**All members participating in the catapult event must sign and complete an Iowa State University Release and Waiver of Liability form and an Iowa State University Medical Information/Release form. Also, any participant under the age of 18 must have the signature of a parent or guardian on the Release and Waiver of Liability form and also the Medical Information/Release form. ANYONE WITHOUT THESE FORMS SIGNED AND COMPLETED ON THE DAY OF COMPETITION WILL NOT BE ALLOWED TO COMPETE IN THE CATAPULT COMPETITION.**

# 5. Poster

## 5.1 General Requirements

Each poster should be made on a 32 x 40 inch tag board. The poster should also be weather proofed either by lamination or covered with a clear garbage sack or plastic sack.

## 5.2 Visual Attraction

The poster will be judged on overall visual attraction and professionalism of the poster. Each poster should contain a picture of the team's catapult. Additional pictures are welcome and encouraged. The poster should also include visual diagrams, including labeled diagrams of catapult designs, with dimensions. These drawings may be hand drawn, but computer generated drawings are encouraged.

### 5.3 Design Process

The poster should include a section on the documentation of the design process. This process could include brainstorming and any research that the team carried out. Assume that the intended audience is not knowledgeable in catapult theory.

### 5.4 Calculations

The poster should also include a section of basic calculations. These calculations should show estimates of how far the egg will shoot with various catapult settings. Clearly show how and why the design of the catapult was selected. Calculations should be organized and easy to follow.

### 5.5 Adjustability

The poster should also include a section on adjustability of the catapult. Specify how the catapult is adjustable and how adjusting it will affect predicted launch distances. Include any results from tests performed.

### 5.6 Prices & Resources

All materials used to create the catapult must be documented. All materials that are purchased must be recorded with the purchased price. Any donated materials, items found in students' garages, and so on must be recorded separately and given an estimated retail value, which will count toward the total cost of the project. The total cost should be no greater than \$200.00!

All resources must also be documented. Any books, movies, websites, or people consulted should be referenced appropriately. A table of resources is encouraged.

### 5.7 Submittal

Posters must be finished and ready to display on the day of the Catapult Competition. Questions about the poster may be submitted by e-mail to [tbp-projects@iastate.edu](mailto:tbp-projects@iastate.edu).

## 5.8 Scoring of the Poster

The poster will be scored out of a possible 50 points. The judges of the posters will be Iowa State University Engineering faculty and/or Tau Beta Pi members. The breakdown of scoring is as follows:

• Overall Visual Attraction and Professionalism	15
• Design Process	10
• Diagrams	10
• Calculations	5
• Price List	5
• <u>Description of Adjustability</u>	5
Total poster point value	50

## 6. Check in and Inspection process

### 6.1 Check in

The competition will occur on **April 12, 2008**. All teams should plan on arriving between **9am and 12pm** to check in with the Tau Beta Pi judges. If you need to arrive earlier, contact us and special arrangements will be made for dropping catapults off before 9am (see Section 8.2). Posters will be displaced when the teams arrive in the morning, and must be finished by 12pm. Iowa State University Release and Waiver of Liability and Medical Information/Release forms will be collected at this time (section 4.4). **ANYONE WITHOUT THESE FORMS SIGNED AND COMPLETED WILL NOT BE ALLOWED TO COMPETE.** Teams will be allowed to leave their catapults at the competition field during the morning, where they will be watched by Tau Beta Pi members while team participants are given time to enjoy some of the other VEISHEA highlights. Teams should be back at the competition site preparing to set up by approximately 12pm. Competition will begin at **12 pm**.

### 6.2 Inspection Process

Tau Beta Pi members will have had time to check the team's poster and will be looking for drastic modifications, expensive catapults, the operation of the remote triggering device, and firing safety before the start of competition. Teams may be asked to demonstrate that their catapult fits in the required volume (3.1).

## 6.3 Penalties and Bonuses

Points will be deducted from any team for the following rule violations:

Exceeds volume constraint (3.1)	-5
Exceeds cost constraint (5.5)	\$0-\$50, -5; \$51-\$100, -10; etc.
Safety violations (4)	-10/violation
Removing protective gear	
Lack of remote trigger	
Lack of ground anchors, etc.	
Time violation	-5

All other infractions will be determined by judges.

Up to five bonus points may be awarded to any team that incorporates a creative theme into their catapult. These may include, but are not limited to: painting schemes, costumes, short skits, or incorporating the VEISHEA theme.

## 7. Selection of the Winners

### 7.1 Winners

The winning team is the team with the most points at the end of the contest. There are a total of 100 points possible, 50 points from the poster and 50 from the field competition. Winners will be announced following the completion of the last team's launch.

In the event of a tie for first place, the teams will be placed randomly in their chosen launching areas and given four additional shots that will be scored as described in Section 2.7. After both teams have completed the four shots, the winner is the team with the highest score. If the teams are still tied, the teams will continue launching volleys of four eggs until a winner is determined.

### 7.2 Awards

Each team member, including one advisor, will receive a T-shirt. (Additional T-shirts may be purchased for parents, etc.) First through third place will receive prizes. The overall winning team will receive an award to display in its school's trophy case.

## 8. Administrative Notes

### 8.1 Entry Form & Fee

To enter the contest, an entry form (included at end) and fee must be submitted. The fee will be \$30.00 per team (four students and one advisor) plus \$6 per

member above the minimum four. This fee helps cover the cost of T-shirts, mailings, field fees, and awards. The entry form and fee should be postmarked by **March 17, 2008**.

Please make checks payable to: ***Iowa Alpha Chapter Tau Beta Pi***

Mail fee and the entry form to:        *Tau Beta Pi*  
    *Catapult Competition*  
    *110 Marston*  
    *Iowa State University*  
    *Ames, IA. 50011*

## 8.2 Contacts

Matt Goodman, Sara Blatz, & Dan Short  
Project Officers  
[tbp-projects@iastate.edu](mailto:tbp-projects@iastate.edu)  
(641)330-8022 (Matt's cell)

## 8.3 Web Page

The following web page will be used to distribute information to all teams participating in the contest. Check it regularly for updates, rules clarifications, and responses to teams' questions. **Directions to the competition site will also be posted here.**

<http://iowaalpha.tbp.org/projects/catapult>

## 8.4 Weather

If the weather turns extremely nasty on the day of the competition, there is the possibility for cancellation. In the morning, check the website for information, or if necessary call Tau Beta Pi Project Officer Matt Goodman at (641) 330-8022. If the weather does force a cancellation, the competition will be rescheduled for the following Saturday, April 19, with details posted to the website.

## 8.5 List of Ames Hotels

*AmericInn Motel & Suites*  
2507 SE 16<sup>th</sup> St.  
Ames, IA. 50010  
(515) 233-1005

*Hampton Inn*  
1400 S. Dayton Ave.  
Ames, IA. 50010  
(515) 239-9999

*Ramada Inn*  
1206 S. Duff Ave.  
Ames, IA. 50010  
(515) 232-3410

*University Inn*  
229 S. Duff Ave.  
Ames, IA 50010  
(515) 232-0280

*Comfort Inn*  
1605 S. Dayton Ave.  
Ames, IA. 50010  
(515) 233-0689

*Heartland Inn*  
I-35 & New Highway 30  
Ames, IA. 50010  
(515) 233-6060

*Super 8 Motel*  
I-35 and US 30  
Ames, IA. 50010  
(515) 232-6510

**NOTE: These rules are subject to change. Please check the catapult website, found under <http://iowaalpha.tbp.org/projects/catapult> for the most current rules.**