

1. **DESCRIPTION:** Prior to the tournament, teams will design, construct, and calibrate a device that uses only the energy of a falling counterweight to launch a projectile as far and as accurately as possible at a target.

A TEAM OF UP TO: 2

IMPOUND: Yes

APPROXIMATE TIME: 15 Minutes

2. **CONSTRUCTION:**

- a) The entire device, including the projectiles and counterweight must be no more than **65 cm** high x 75cm wide x 75 cm long when it is in the ready-to-fire position. Length is measured parallel to the direction the device launches. This restriction does not apply during or after launch.
- b) To operate, the device will be placed within a 2 meter by 2 meter square called the Launch Area and may not be anchored to the ground. The device must be triggered from outside the Launch Area by pulling a string, firing pin, etc. Except for the triggering mechanism, no part of the device and counterweight may extend out of the Launch Area before it is triggered or after the launch motion is complete. Any part of the device or counterweight (except for the triggering mechanism) that extends out of the launch area during the launch must return to rest within the Launch Area without assistance.
- c) All teams will use the same projectiles, counterweight, and target provided by the judges. The mass of the counterweight and projectiles will not be announced until all of the devices have been impounded.
 - i) The counterweight will consist of a 1 to 3 kg mass with a hook on top. The hook and counterweight together will have a length (measured from the top of the hook to the bottom of the counterweight) and width of no more than 15 cm. If the hook is used to attach the counterweight, the attaching point on the team's device should be made from material no more than ¼ inch thick with a hole at least 9 mm in diameter. The edge of the hole should be no more than 1 cm from the edge of the material.
 - ii) Projectiles will have a mass of 20 to 60 grams and will be approximately spherical with a diameter not exceeding 6 cm. Dangerous projectiles should be avoided. If multiple projectiles are provided, they will be similar in size, shape, and mass.
 - iii) The device must be constructed to accommodate the counterweight and the projectiles. Neither the counterweight nor the projectiles can be modified.
- d) The device, without the counterweight and projectile, may not contribute energy to the launch. Some violations of this rule are: the center of gravity of the unloaded device drops during a launch motion, the triggering process provides momentum to the launch or any other form of potential energy (compressed or stretched elastic solids, compressed air, etc.) is used. Without a counterweight and projectile, the unloaded device may not move in the direction of a launch motion when released from any position prior to where the projectile is released.

3. **DATA TABLE AND GRAPHS**

- a) Prior to the day of the competition, the team should prepare up to 5 graphs showing the mass of various projectiles (grams) or counterweights (Kg) vs. distance (meters). If they are hand drawn, they must be on graph paper. All graphs should be correctly labeled.
- b) Teams may be required to submit their graphs early as requested by the event supervisor. **If not requested earlier, graphs must be submitted at impound.** They should prepare a duplicate set to use during competition, as those submitted may not be returned.
- c) **All** graphs must be marked to identify the team submitting them.
- d) An Example showing how to use the graphs to position the target for a hypothetical counterweight and projectile should be included.
- e) Students should be prepared to answer questions about how the data was collected and how the graphs are used.

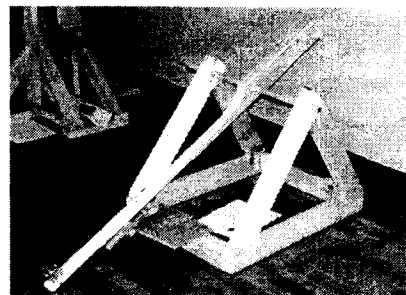
4. **THE COMPETITION:**

- a) The team's device must be impounded before the start of the event and will be released from impound when the team has finished competing. Appeals by teams will not be processed after they remove their device from impound unless it has been released by the appeals committee.
- b) Once teams enter the event area to compete, they may not leave the area or receive outside assistance, materials or communication until they are finished competing.
- c) Students must provide and wear safety spectacles with side shields while setting up and competing. Teams without proper eye protection will not be allowed to complete and will be scored as a no-show. (See: <http://www.soinc.org/general/protection/>)

- d) The team will take their device to the Launch Area along with any other supplies (tools, notes, graphs etc.) they may need when it is time for them to compete. Use of AC powered electrical equipment is not allowed.
- e) The target will be a 3 dimensional object at least 20 cm high, wide and long for Division C and at least 40 cm high, wide and long For Division B.
 - i) Before the first launch, the team will announce the position of the target (Target Distance) in whole meters. The judges will set the target so its center is the desired distance from the front edge of the Launch Area. Once during the competition, after they hit the target, the team may elect to move the target by calling a time out and requesting the new Target Distance (in whole meters).
 - ii) Judges may indicate where previous launches have been marked. They will not provide measurements for accuracy. Participants may not enter the target area to view or measure the results.
 - iii) The device may be moved anywhere within the Launch Area between launches as long as it remains in the Launch Area.
- f) Teams have 5 minutes to make 3 launches. They must give ample warning to the judges and spectators prior to each launch. It will not count as a launch if the participants attempt to initiate a launch and the device does not go through a launch motion.
- g) In the event of a rule violation, the judge will call a time out and explain the reason for the violation. The team may continue to compete after the clock has been restarted. Teams will be immediately disqualified for operating the device in a manner deemed unsafe by the judges.
- h) Devices may be modified in accordance with all rules while the clock is running in order to make successful launches. Only the tools and supplies brought with the contestants before time began can be used during competition.
- i) If the part of the device does not return to within the Launch Area on its own, the device may be repaired/repositioned and subsequent launches scored normally.

5. SCORING:

- a) Each launch will be measured for accuracy. All measurements must be recorded in meters to the nearest centimeter. The Launch Score (LS) for each launch will be: $LS = TD - 3A + B$
- b) The Target Distance (TD) is the distance requested by the competitors and is measured from the center of the front of the launch area to the center of the target.
- c) The Accuracy Score (A) will be the distance from the projectile's point of first impact to the center of the target if the projectile lands in the target area. If the projectile lands behind the front line of the Launch Area or if any part of the device leaves the Launch Area and does not return, the Accuracy Score will be the Target Distance.
- d) A Bonus (B) equal to $0.1 \times TD$ will be awarded if the projectile hits any point on the target before impacting the ground.
- e) GRAPH SCORE: Teams may be awarded up to 2 points per graph (max. 5 graphs) **and up to 2 points for a hypothetical example**, for a maximum Graph Score (G) of 12 points. **To earn points**, each graph must be labeled with school and student's names. Some items supervisors will look for: The graphs are clearly labeled with: Title of Graph; X and Y-axis, including appropriate units, example for hypothetical counterweight and projectile explaining how the graph would be used to determine where to place the target.
 - i) PENALTIES: A three point penalty will be assessed each time any of the following occurs:
 - ii) A participant is warned by the judges for not correctly wearing proper eye-protection.
 - iii) A participant is in the Launch Area when the launch is triggered.
 - iv) The device goes through an unintentional launch motion.
 - v) No warning is given prior to a launch.
 - vi) Outside coaching.
- f) Teams will be ranked according to their Final Score with the highest score winning. The Final Score will be: **the 2 best Launch Scores plus graph score minus penalties.** Teams whose devices violate paragraph 2. a), or 2.d) will be ranked, by their Final Score, behind all teams whose devices comply.



FINAL SCORE = 2 Best Launch Scores + G – Penalties (if applicable)
 Tie Breaker: 1st highest Launch Score; 2nd Second best Launch Score; 3rd Third best Launch Score.