

STORM THE CASTLE
Build Event
Physics Committee Trial Event

1. **DESCRIPTION:** Prior to the competition, teams will design, construct, and calibrate a single device capable of launching projectiles onto a target and collect data regarding device parameters and performance. **A TEAM OF UP TO:** 2 **EYE PROTECTION:** B **IMPOUND:** Yes **APPROX. TIME:** 10 Minutes
2. **EVENT PARAMETERS:**
 - a. Prior to competition teams must collect and record launch device performance and calibration data.
 - b. Each team may bring tools, supplies, writing utensils, and stand-alone calculators of any type for use (these items need not be impounded). Each team must impound only one launch device and design log. Items must be moveable by the competitors without outside assistance.
 - c. Event Supervisors will provide the projectiles, counterweights, and target.
 - d. Participants must wear eye protection during device setup and operation. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
 - e. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.
3. **CONSTRUCTION PARAMETERS:**
 - a. When ready-to-launch, the launch device, projectiles, stabilizing weights, and all other device components (except for tools / supplies) must fit in a 65.0 cm per side cube, in any orientation chosen by the team.
 - b. The triggering device is not considered part of the device and activating it must not contribute significant energy to the launch. It must extend out of the launch area, allow for competitors to remain at least 75cm away from the launch area, and does not need to return to the launch area after launch. The triggering device must not pose a danger due to flying parts or excessive movement outside of launch area.
 - c. The launch device must be constructed to accommodate the supervisor provided counterweights and projectiles (see Section 6 for details). Teams may not modify the counterweights nor the projectiles.
 - d. The launch force must be entirely supplied by the gravitational potential energy from the supervisor provided falling counterweights. The device, without the counterweight and projectile, must not contribute energy to the launch. This includes any part of the device whose potential energy decreases, with the exception of items of nominal mass, such as strings and thin rods. Devices will be inspected to ensure that there are no other energy sources. At the supervisor's discretion, teams must disassemble devices after competing in order to verify this. Example violations, allowable types, and mechanisms for testing for added energy are available on soinc.org.
 - e. The launch device must be designed and operated in such a way to not damage or alter the floor.
 - f. Electrical components are not allowed as part of the device or triggering device.
4. **DESIGN LOG:**
 - a. Teams must submit a design log showing collected device data, which should contain:
 - i. One or more photos and/or diagrams of the device with labels identifying all the major components and detailing their function, along with a brief summary of how the device was built.
 - ii. Any number of graphs and/or tables showing the relationship between various parameters such as arm position or projectile mass and impact position. Graphs/tables may be computer generated or hand drawn on graph paper. Each data series counts as a separate graph. A template is at www.soinc.org.
 - iii. Example calculations showing how to use the graphs/tables to adjust the device for a target position.
 - b. The team must indicate up to four graphs/tables to be scored, otherwise the first four provided are scored.
 - c. All pages of the design log must be affixed together, such as via three ring binder, staples, or paperclips.
 - d. Design logs will be returned to the team after they are done competing.
5. **THE COMPETITION:**
 - a. Each team will have 8 minutes to setup, adjust, and calibrate its device and to launch a max of 2 shots with each counterweight. Measurement time required by the supervisor is not included in the allotted time. Devices that do not meet the construction specs will not be allowed to launch until brought into spec.
 - b. When instructed by the event supervisor(s), teams must place their device at a location they select in the launch area. Competitors must not be within 75 cm of the launch area or in front of the front edge of the launch area during a launch. They may touch only the part of the triggering device that extends at least 75cm outside of the launch area.
 - c. Teams may move devices within the launch area and/or adjust them in any way between and before shots.

- d. No part of the launching device may extend outside of the launch area before or after a shot. If part of the launching device extends beyond the launch area during the launching action, it must return to and remain in the launch area immediately after the launch without assistance of the competitors.
- e. Before the first launch with each counterweight, the team must notify the supervisor of the desired position of the target (only 0.5 m increments allowed).
- f. Before each launch, teams must notify the event supervisor. Any launch, even if unintended or not announced, will count as one of the four launches allowed to a team.
- g. If the team tries to trigger the device and it does not go through a launch motion, it does not count as one of the team's four launches and the team must be allowed to adjust/rest the device if time allows.
- h. After each launch the event supervisor will indicate to the team when they may approach the target to make measurements to calibrate their device.
- i. If a team hits the target, they may request the target be moved to a new location (in 0.5 m increments).
- j. Supervisors must be responsible for retrieving projectiles and returning them to the team between each launch if less than 2 projectiles of each type are initially provided to the team.
- k. The supervisor will review with the team the data recorded on their scoresheet.
- l. Teams who wish to file an appeal must leave their device and design log with the event supervisor.

6. **COMPETITION AREA:**

- a. The launch area is a rectangular area 1.0m wide by 1.0m long (parallel to the launch direction), designated by tape on the floor. Tape must also be placed 75cm away from the sides and back of the launch area. Supervisors are recommended to use hard surfaces for the floor (e.g., concrete, hardwood, plywood).
- b. The target will be an open-topped container with a minimum dimension of 20 cm x 20 cm x 20 cm.
- c. The supervisor will set the target at a distance selected by the team so that two sides of the target are parallel with a straight line from the center of the Launch Area to the center of the target.
- d. The 2 separate counterweights must consist of a 0.5-1.5 kg (light) or 1.5-2.5 kg (heavy) mass with a standard 1" open hook bolt on top. Each hook and counterweight together must fit inside a 15.0 cm cube.
- e. Projectiles must have a mass of 20.0-40.0 g (for the light counterweight) and 40.0-60.0 g (for the heavy counterweight) and must be approximately spherical with a diameter not exceeding 6.0 cm. Dangerous projectiles must be avoided. If multiple projectiles are used, they must be similar in size, shape, and mass.
- f. Target, counterweight, and projectile dimensions and specifications must be announced only after impound is over and must be the same for all teams.

7. **SCORING:** A scoring spreadsheet is available at www.soinc.org

- a. High score wins. Final Score = Best Light LS + Best Heavy LS + CS.
- b. Launch Score (LS) = $TD - 3 \times AS + B$. Lowest possible LS is 0
- c. Target Distance (TD) = distance, in cm, from the center of the front of the launch area to the target center.
- d. Accuracy Score (AS) = straight line distance, in cm, from the projectile initial impact location to the target
 - i. Eligible impact locations include the floor, wall, support column, target, or other objects. The ceiling and objects affixed to or hanging from it are not eligible impact locations. Shots with projectiles hitting such areas will use the next eligible impact location contacted by the projectile.
 - ii. If the projectile hits the target on initial impact AS = 0.
- e. Bonus (B) = Hitting the target at first impact is worth $0.15 \times TD$ points. Making contact with the inside bottom surface is worth an additional $0.15 \times TD$ points (for a total of $0.30 \times TD$ points).
- f. Chart Score (CS) - One of the submitted graphs and/or tables, selected by the event supervisor, must be scored per items i., ii. and iii. below. Partial credit may be given. Max possible CS is 40.
 - i. 6 points for including data spanning at least one variable range listed in COMPETITION AREA.
 - ii. 6 points for including at least 10 data points in each data series
 - iii. 6 points for proper labeling (e.g., title, team name, units)
 - iv. 3 points for each graph or table turned in (up to 12 points total as long as they are not the same)
 - v. 5 points for including a labeled device picture or diagram
 - vi. 5 points for including at least 2 example calculations
- g. If a team violates any THE COMPETITION rules, their LS scores will be multiplied by 0.9.
- h. If any CONSTRUCTION PARAMETERS violation(s) are corrected during the allotted competition period, or if the team misses impound, their LS scores will be multiplied by 0.7.
- i. Teams disqualified for unsafe operation or that do not having a device that is brought into specs during the allotted competition period will have LS scores of 0.
- j. Participants will be informed before the next launch if they have received a penalty.
- k. Tiebreakers: 1st: best LS; 2nd second best LS; 3rd third best LS