TRAJECTORY

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every 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 **two** stand-alone calculators of any type for use (these items need not be impounded). Each team must impound only one launch device, design log, and any projectiles. Items must be moveable by the competitors without outside assistance.
   c. 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.
   d. 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 60.0 cm per side cube, in any orientation chosen by the team.
   b. The launch force must be supplied by non-metallic elastic solids such as rubber bands/tubing, wood, plastic, or bungee cords. 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.
   c. 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.
   d. Teams must provide unmodified (labeling is permitted) tennis, racquet, Ping-Pong, and/or light weight plastic or foam golf balls to be used as projectiles. Teams may change projectiles for each launch.
   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 available 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.
   e. **If a 3-D printer, laser cutter, CNC machine or similar device was used as a tool to build the team's device, or any component thereof, the following information must also be supplied in the log.**
      i. **Information about the tool hardware, software, materials, and supplies used**
      ii. **Details of the source of any digital files (e.g.; CAD, STL, OBJ) utilized by the tool including but not limited to when and where the file was obtained, including the web address if downloaded from the internet**
      iii. **Descriptions of how the team constructed the final device from the tool created components**
   f. **All submitted logs will be returned to teams.**
5. **THE COMPETITION:**
   a. Each team will have 8 minutes to set up, adjust and calibrate their device, and to launch a max of 2 shots at each target. 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. No part of the launch 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.

d. Teams may move devices within the launch area and/or adjust them in any way between and before shots.
e. Before each launch, teams must notify the event supervisor which target they have selected. Any launch, even if unintended or not announced, will count as one of the four launches allowed to a team.
f. 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/reset the device if time allows.
g. After each launch the event supervisor will indicate to the team when they may approach the target to retrieve their projectile and make measurements to calibrate their device.
h. If the first shot at a target lands within 500mm, a bucket shot may be requested in place of the second shot.
i. The supervisor will review with the team the data recorded on their scoresheet.
j. 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 1.5m 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. Two targets, designated by tape on the floor or panels lying on the floor, must be placed in front of the launch area. Targets must have a minimum diameter / length / width of 1.00m and are recommended to be a square shape. Supervisors are encouraged to place sand, cat litter, or a similar substance in the area around the targets to help indicate landing spots.
   c. The targets must be between 2.00m and 8.00m in front of the launch area (intervals of 1.00m for Regionals, 0.50m for States, 10.0cm for Nationals). A distance of at least 2.00m must separate the targets.
   d. The near target must be centered on an imaginary centerline that bisects the launch area and is parallel to the launch direction.
   e. The far target may be anywhere up to 2.00 m (in intervals of 0.5 m for Regionals, 0.25 m for States, and 0.10 cm for Nationals) to the right or left of the imaginary centerline.
   f. If requested, a bucket (~5 gallon size, provided by the supervisor) will be placed (opening facing up) anywhere between 2.00m and 8.00m in front of the launch area and anywhere up to 2.00m to the right or left of the centerline. The bucket may only be on the course when requested so that it is not an obstacle.
   g. Target and bucket locations and sizes must be announced only after impound is over and must be the same for all teams. Room ceiling height should be considered when setting the distances.

7. **SCORING:** A scoring spreadsheet is available at www.soinc.org
   a. High score wins. Final Score = Best Near TS + Best Far TS + CS + BS (if any).
   b. Target Score (TS) = 2000 (for the near one) or 4000 (for the far one) minus the straight line distance, in mm, from the center of the initial impact of the projectile to the target. Lowest possible TS is 0.
      i. If no target is announced, or the shot is a bucket shot attempt, TS = 0 for that shot.
      ii. Eligible impact locations include the floor, wall, support column, other 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.
   c. 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 400.
      i. 60 points for including data spanning at least one variable range listed in 4.a.ii.
      ii. 60 points for including at least 10 data points in each data series
      iii. 60 points for proper labeling (e.g., title, team name, units)
      iv. 30 points for each graph or table turned in (up to 120 points total as long as they are not the same)
      v. 50 points for including a labeled device picture or diagram
      vi. 50 points for including at least 2 example calculations
   d. Bucket Score (BS) – Hitting the bucket at first impact is worth 100 points. Making contact with the inside bottom surface is worth an additional 200 points (for total of 300 points).
   e. If a team violates any THE COMPETITION rules, their TS scores will be multiplied by 0.9.
   f. If any CONSTRUCTION PARAMETERS violation(s) are corrected during the allotted competition period, or if the team misses impound, their TS scores will be multiplied by 0.7.
   g. Teams disqualified for unsafe operation or that do not have a device that is brought into specs during the allotted competition period will have TS and BS scores of 0.
   h. Participants will be informed before the next launch if they have received a penalty.
   i. Tiebreakers: 1st: highest sum of the two TSs used for the FS; 2nd highest overall TS; 3rd highest Far TS not used for the FS; 4th highest Near TS not used for the FS

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org