AIR TRAJECTORY B

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.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** Yes

   CALCULATOR: Class III **APPROXIMATE TIME:** 10 minutes

2. **EVENT PARAMETERS:**
   a. Each team must impound only one launch device, projectiles, **and calibration data (if prepared).** Items must be moveable by the participants without outside assistance. The device must be impounded with the mass(es) detached, which altogether must not exceed the limits in 3.b. **The calibration data are the only papers or notes that the competitors may bring into the competition area and must be impounded.**
   b. Each team may bring tools, supplies, writing utensils, and two stand-alone calculators (Class III) for use (these items need not be impounded).
   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.

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 85.0 cm per side cube, in any orientation chosen by the team.
   b. The launching force must be entirely supplied by the gravitational potential energy from a falling mass less than or equal to 5.000 kg. Any part of the device whose potential energy decreases and provides launch energy is considered part of the mass, with the exception of items of nominal mass, such as strings and thin membranes/plastic container walls. The falling mass may consist of multiple discrete parts, which together count as the total mass.
   c. Devices will be inspected to ensure that there are no other energy sources. At the Event Supervisor's discretion, teams must disassemble devices after competing in order to verify this.
   d. During each launch, the gravitational potential energy must be converted to air pressure or air movement, which is then used to launch the projectile, either directly (e.g., pop gun style, etc.) or indirectly (e.g., using a pneumatic cylinder to swing an arm, etc.).
   e. All device air chambers must start each launch at ambient air pressure and must automatically return to ambient air pressure. Chambers are not required to automatically return to the same shape.
   f. **The competitors must design the device to trigger by using any part of an unsharpened #2 pencil with an unused eraser, provided by the Event Supervisor, to actuate a release mechanism for the falling mass. The pencil may be the release mechanism itself and may extend beyond the dimensions in 3.a. The device must remain in the ready-to-launch configuration without being touched until triggered by the #2 pencil. The trigger must not contribute any significant energy to the launch.**
   g. **Teams must provide a spherical projectile for their device to launch. The projectile must freely fall through a hole with a 3 inch diameter, but not fall freely through a hole with a 1 inch diameter. Also, the projectile must be made out of a material that will not damage floors. Examples of acceptable projectiles include, but are not limited to: ping pong balls, racquet balls, tennis balls, and low density foam balls. Golf balls are not allowed because they are too dense and can damage the floor. Multiple projectiles may be brought for use.**
   h. The launch device must be designed and operated in such a way to not damage or alter the floor.
   i. Electrical components are not allowed as part of the device or triggering device. However, electronic sighting devices, such as laser pointers, that are removed before launch are permitted.

4. **DESIGN LOG: Competitors are not required to submit a design log for scoring, but competitors are encouraged to collect and impound their own calibration data for their device.**

5. **THE COMPETITION:**
   a. Each team will have 8 minutes to set up, adjust and calibrate their device, and launch a max of 2 shots at each target. Measurement time required by the supervisor is not included in the allotted time. **Competitors will be allowed during their setup time to bring their device into compliance if it does not meet all construction parameters.**

b. When instructed by the event supervisor(s), teams must place their device at a location they select in the launch area. Teams may move devices within the launch area and/or adjust them in any way between and before shots. **Teams may change projectiles for each launch.**
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. Before each launch, teams must notify the event supervisor which target they have selected. **When triggering the device, competitors may not touch any part of the device or the triggering mechanism except the #2 pencil.** Any launch, even if unintended or not announced, will count as one of the four launches allowed to a team.
e. 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.
f. 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.
g. If the first shot at a target lands within 500 mm, a bucket shot may be requested in place of the second shot.
h. The supervisor will review with the team the data recorded on their scoresheet.
i. Teams who wish to file an appeal must leave their device with the event supervisor.

6. **COMPETITION AREA:**
   a. The competition area will consist of a near target **that is elevated** and a far target that is at ground level.
   b. The launch area is a rectangular area 1.5 m wide by 1.5 m long (parallel to the launch direction), designated by tape on the floor. Event Supervisors are recommended to use hard surfaces for the floor (e.g., concrete, hardwood, plywood) and not surfaces designed to minimize impact forces (e.g., turf, running tracks).
   c. Two targets, designated by tape on the floor or panels lying on the floor, must be placed in front of the launch area. Supervisors are encouraged to place sand, cat litter, or a similar substance on the ground and target surfaces to help indicate landing spots.
      i. The **near** target surface must be at least a 1.0 m by 1.0 m square and have a marked center point from which measurements will be taken.
      ii. The near target must be centered on an imaginary center line that bisects the launch area and is parallel to the launch direction. **Prior to the start of the competition, the event supervisor will determine the target elevation which will be the same for all teams.**
         (1) **Regional Level: The surface of the near target is either 0.5 m or 1.0 m above the ground.**
         (2) **State Level: The surface of the near target will be between 1.0 m and 1.5 m, inclusive, above the ground**
         (3) **National Level: The surface of the near target will be between 1.0 m and 2.0 m, inclusive, above the ground**
      iii. The far target, designated by tape on the floor, or panels lying on the floor, must be placed in front of the launch area. The target must have a minimum diameter/length/width of 1.00 m and is recommended to be a square shape. It must have a marked center point from which measurements will be taken.
   d. The marked centers of the targets must be between 2.00 m and 8.00 m in front of the launch area in intervals of 1.00 m for Regionals, 0.50 m for States, 10.0 cm for Nationals. A distance of at least 2.00 m (measured parallel to the imaginary center line) must separate the marked centers of the targets.
   e. The marked center of 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 m for Nationals to the right or left of the imaginary centerline.
   f. If requested, a bucket (≈5 gallon size, provided by the Event Supervisor) will be placed with the opening facing up anywhere between 2.00 m and 8.00 m in front of the launch area and anywhere up to 2.00 m 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. The bucket may not be the same location as the far target.
   g. Target locations, bucket location, **and near target elevation** 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. High score wins. Final Score (FS) = Best NTS + Best FTS + BS (if any). A scoring spreadsheet is available at www.soinc.org.
   b. Near Target Score (NTS) = 2000 minus the straight-line distance, in mm, from the center of the initial projectile impact to the center of the target. Lowest possible NTS is 0.
      i. If no target is announced, or the shot is a bucket shot attempt, NTS = 0 for that shot.
      ii. Eligible impact locations for the near target include the floor, wall, support column, other target, or other objects.
      iii. 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.
      iv. **Participants must impact the elevated surface of the near target in order for a measurement to be taken. Failure to strike the target surface will result in an NTS = 0 for that shot.**
   c. Far Target Score (FTS) = 4000 minus the straight-line distance, in mm, from the center of the initial projectile impact to the center of the target. Lowest possible FTS is 0.
      i. If no target is announced, or the shot is a bucket shot attempt, FTS = 0 for that shot.
      ii. Eligible impact locations for the far target include the floor, wall, support column, other target, or other objects.
      iii. 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.
   d. Bucket Score (BS) – Hitting the bucket at first impact is worth 200 points. Making contact with the inside bottom surface is worth an additional 300 points (for a total of 500 points).
   e. If a team violates any of THE COMPETITION rules, their TS scores for that launch will be multiplied by 0.9.
   f. **Devices will be placed in tiers as follows:**
      i. **Tier 1: Device meets all construction parameters at the time of its first launch**
      ii. **Tier 2: Device still has a construction violation(s) at the time of its first launch**
      iii. **Tier 3: A team with its device and/or projectiles not impounded or uses calibration data notes that were not impounded**
   g. Teams that **are prohibited from launching** due to unsafe operation or **have a Final Score (FS) of 0** will **receive Participation Points only**.
   h. Participants will be informed before the next launch if they have received a penalty.
   i. Tiebreakers:
      i. 1st: highest sum of the Best NTS and Best FTS used for the FS;
      ii. 2nd: highest overall NTS or FTS;
      iii. 3rd: highest FTS not used for the FS;
      iv. 4th: highest NTS not used for the FS.

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