# Air Trajectory

## [Division B/C]

Georgia Tech Event Workshop Series
2024-25


Science Olympiad at Georgia Tech®

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# The Rules Sheet

- Basically have these memorized. Meet these criteria at all costs even if the device doesn't do what you want it to. Getting tiered is extremely detrimental.
- Ping pong balls are usually the most effective projectiles because of their light weight.
- Make sure the device is able to be released using a pencil and fits the dimensions.

3. **<u>CONSTRUCTION PARAMETERS</u>:**
   a. When ready-to-launch, the launch device, projectiles, stabilizing weights, and all other device components (except for tools / supplies) must fit in a 75.0 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 3.500 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 could 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.

# Scoring

- Far Target is significantly more lucrative than Near Target.
- Prioritize making a launcher that is physically capable of shooting a ball that far before tuning and testing.
- Bucket points should not be a priority until the rest of the points are extremely consistent.

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.

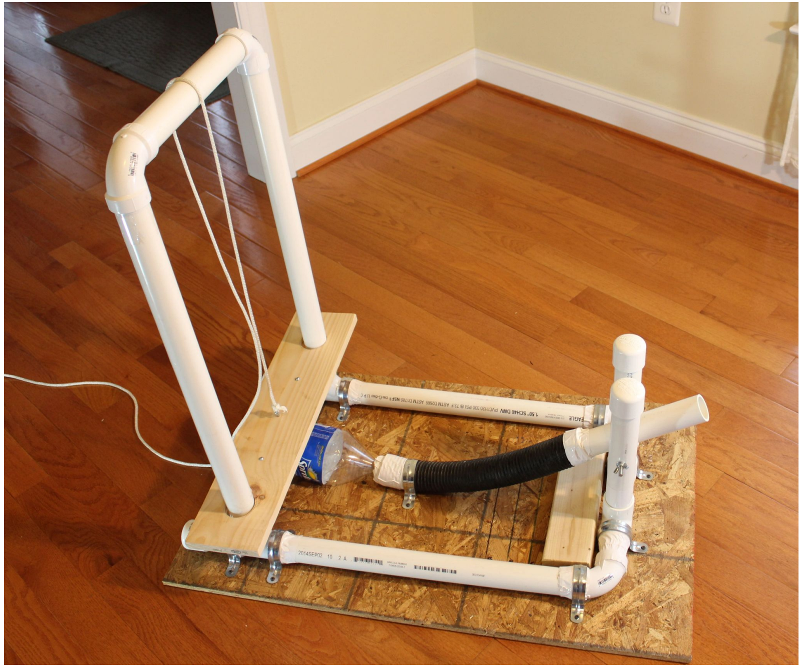
# DIFFICULT TOPICS

# Topic 1: Goals

- Prioritize consistency and basic capability
- Minimize changed variables between trials as much as possible to isolate independent variables

**Design on the right**

- Pros
  - Good starter design
  - Realistic for a first competition
  - Easy materials
- Cons
  - Lots of possible variation



# Topic 2: Consistency

- Have as many measurable things as possible.
  - For example:
    - Angle of launch
    - Angle of platform
    - Height of dropped weight
- Change measurements to reach as many distances as you can
  - I usually start with increments of 0.5m and half the increments each time I go through them all
- Make logs and tweak as many variables as you possibly can, recording everything.
  - Elevation and angles might change because of rules
  - The more data you have, the more you can extrapolate

Only after you have the bare-minimum. Have a device that can go the full distance first before working on achieving all the distances in between.

# Topic 3: Late-Stage

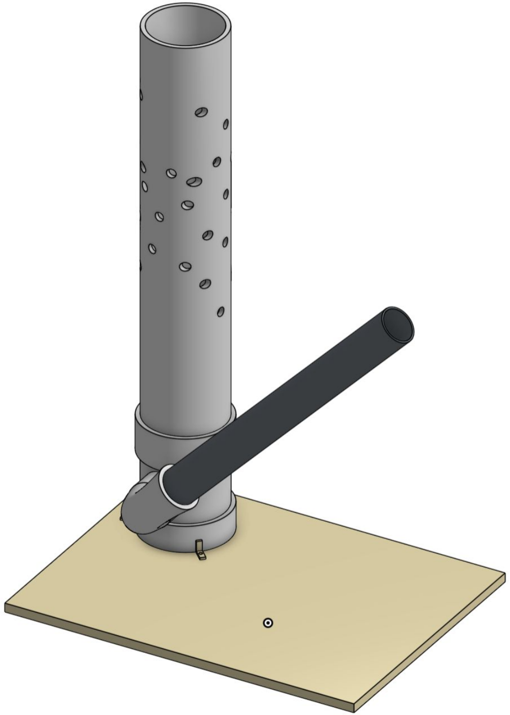
Benefits:

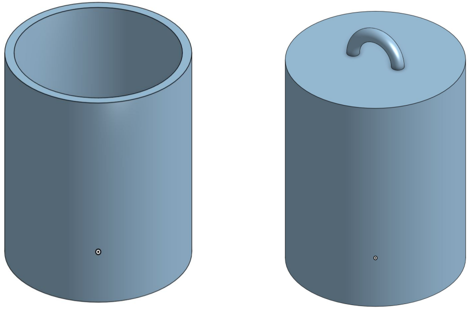
- Consistent placement of holes generating consistent amounts of force
- Accurate and measurable launch angle.

Cons:

- Time consuming to build and acquire all materials for and do all testing.

3D Printed Cylindrical Weight
- filled with small metal balls
- very compact and consistent
- sanded down to be as airtight as possible





# Tips from a Veteran

- Prioritize consistency above everything else
- Collect as much information about your device as possible before competitions
    - Logs
    - Measurements
    - Make sure it meets rules requirements
- **Do NOT get tiered.**
- Make sure you know what is realistic for your timeline
- Get inspired by other designs and whatever you think you can make consistent

# Additional Resources

## Youtube Tutorial

Tutorial for the initial early-stage design I showed in this presentation

## OnShape

Free 3D Modeling software, easy to learn, no download needed.

# THANKS!