



TRAJECTORY

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, 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 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 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.

TRAJECTORY (CONT.)



See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.



- 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 (or a stand in the case of the near target), 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
 - d. Regionals, 0.50m for States, 10.0cm for Nationals). A distance of at least 2.00m must separate the targets. **If the near target is elevated, on the floor will be an additional marked area (indicated by tape) at least 25 cm larger in diameter/width/length than the target diameter/width/length.**
 - e. The near target must be centered on an imaginary centerline that bisects the launch area and is parallel to the launch direction. The near target may be elevated above the floor up to 2.00 m, in 10.0 cm intervals.
 - f. 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. The far target will be at floor level.
 - g. If requested, a bucket (~1 to ~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.
 - h. 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 Close TS + Best Far TS + CS + BS (if any).
 - b. Target Score (TS) = 2000 (for the close 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.
 - iii. **Projectiles aiming for the near target but having an initial impact location in the surrounding marked area or target support structure will result in half the points that would have been received had the edge of the near target furthest from the center been the location of initial impact.**
 - 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 having 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

GENERAL RULES

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

GENERAL RULES, CODE OF ETHICS, AND SPIRIT OF THE PROBLEM

The goal of competition is to give one's best effort while displaying honesty, integrity, and good sportsmanship. Everyone is expected to display courtesy and respect - see Science Olympiad Pledges. Teams are expected to make an honest effort to follow the rules and the spirit of the problem (not interpret the rules so they have an unfair advantage). Failure by a participant, coach, or guest to abide by these codes, accepted safety procedures, or rules below, may result in an assessment of penalty points or, in rare cases, disqualification by the tournament director from the event, the tournament, or future tournaments.

1. Actions and items (e.g., tools, notes, resources, supplies, electronics, etc.) are permitted, unless they are explicitly excluded in the rules, are unsafe, or violate the spirit of the problem.
2. While competing in an event, participants may not leave without the event supervisor's approval and must not receive any external assistance. All electronic devices capable of external communication as well as calculator applications on multipurpose devices (e.g., laptop, phone, tablet) are not permitted unless expressly permitted in the event rule or by an event supervisor. Cell phones, if not permitted, must be turned off. At the discretion of the event supervisor, participants may be required to place their cell phones in a designated location.
3. Participants, coaches and other adults are responsible for ensuring that any applicable school or Science Olympiad policy, law, or regulation is not broken. All Science Olympiad content such as policies, requirements, clarifications/changes and FAQs on www.soinc.org must be treated as if it were included in the printed rules.
4. All pre-built devices presented for judging must be constructed, impounded, and operated by one or more of the 15 current team members unless stated otherwise in the rules. If a device has been removed from the event area, appeals related to that device will not be considered.
5. Officials are encouraged to apply the least restrictive penalty for rules infractions - see examples in the Scoring Guidelines. Event supervisors must provide prompt notification of any penalty, disqualification or tier ranking.
6. State and regional tournament directors must notify teams of any site-dependent rule or other rule modification with as much notice as possible, ideally at least 30 days prior to the tournament.

COVID-19 PANDEMIC RULES MODIFICATIONS

The COVID-19 pandemic requires that some general modifications be made to the Event Rules listed in this manual in order to permit Science Olympiad competitions to continue in a way that reflects best public health, disease prevention, and personal safety practices. The modifications listed here will be in effect for all Science Olympiad competitions, regardless of level (e.g., Invitational, Regional, State, National), or type (e.g., In-Person, Satellite SO, mini SO). As the pandemic is evolves, these modifications may be amended or rescinded according to local conditions. If changes are made, the Tournament Director for the affected tournament will make an announcement to all participating teams as soon as possible.

1. **If not already allowed, each individual participant can have a personal set of reference materials (e.g., binders, single sheets of paper), calculator, or other academic resource as specified in the specific event rule for use during the competition to facilitate social distancing, isolation, and to prevent resource sharing. Personal sets of resource materials must meet all the criteria established in the specific event rule. This does not apply to Recommended Lab Equipment for Division B or Division C Chemistry Events or tool kits for Build Events.**
2. **Given local conditions, participants may not be able to be in the same location as their partner during competition. Tournaments will allow designated partners to compete from separate locations and competing teams will only need one device for Build or Hybrid with Build Events.**
3. **At the discretion of the Tournament Director, portions of Hybrid Events containing hands-on activities as well as Build and Lab Events may be dropped from the tournament or be conducted as trial events.**
4. **At the discretion of the Tournament Director and Event Supervisors, completion time may be used as a tiebreaker for Core Knowledge and other events where a written or online test is used.**



For Event Supervisors Only - Do Not Post
CHEMISTRY RECOMMENDED LAB EQUIP.

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

Each team may bring any or all of the items listed below for use in Division C Chemistry Events requiring laboratory equipment. Teams not bringing these items will be at a disadvantage as Event Supervisors will not provide Recommended Lab Equipment. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.

Item & Expected Use	Likely to be used in:			
	Chemistry Lab	Forensics	Environmental Chemistry	Materials Science
Box - Containing all of the kit materials	X	X	X	X
10 ml Graduated Cylinder - Measuring volumes	X		X	
25 ml Graduated Cylinder - Measuring volumes	X		X	
100 ml Graduated Cylinder - Measuring volumes	X		X	
50 ml Beakers - Doing reactions, developing chromatograms	X	X	X	X
100 ml Beakers - Doing reactions, developing chromatograms	X	X	X	X
250 ml Beakers - Doing reactions, developing chromatograms	X	X	X	X
400 ml Beakers - Doing reactions, developing chromatograms	X	X	X	X
50 ml Erlenmeyer Flasks - Doing reactions	X		X	
125 ml Erlenmeyer Flasks - Doing reactions	X		X	
250 ml Erlenmeyer Flasks - Doing reactions	X		X	
Test Tubes - Mix Chemicals, heat chemicals	X	X	X	X
Test Tube Brush - Clean Test Tubes	X	X	X	X
Test Tube Holder - Holds test tubes for heating	X	X	X	
Test Tube Rack - Hold Test Tubes	X	X	X	X
Spot Plates - For semi-micro scale reactions, testing solubility, pH	X	X	X	
Petri Dishes - Doing reactions, developing chromatograms	X	X	X	X
Slides - To put hairs, crystals, or fibers on for use with a microscope		X		
Cover Slips - To cover & prevent items from coming off slides		X		
Droppers - Add small amounts of liquids to reactions	X	X	X	X
Spatulas or spoons - Getting small amounts of solids out of containers	X	X	X	X
Metal Tongs, Forceps, or Tweezers - Holding & retrieving objects	X	X	X	X
Stirring Rods - Stirring mixtures	X	X	X	X
Thermometer - Determining the temperature of a solution	X	X	X	
pH or Litmus paper - Test acidity or alkalinity of solution	X	X	X	
Hand Lens - Magnification of small items for identification		X		
Flame Loop - For identification of ions in a compound		X		
Cobalt Blue Glass - To filter out any sodium that might contaminate flame test from hands		X		
Filter Paper - Filter solids from liquids	X		X	
Funnel - Hold Filter Paper	X		X	
9V battery - Electrolysis	X		X	X
Alligator Clip Wires - Connecting meters to metals	X		X	X
Nail - Electrolysis	X		X	X
Piece of Cu metal - Electrolysis	X		X	X
Piece of Zn metal - Electrolysis	X		X	X
Multimeter - Measuring current, voltage, and resistivity	X		X	X
9V or less Battery Conductivity Tester - Determining ionic strength of solution	X	X	X	X
Calipers-mechanical, not digital - Measuring lengths very precisely	X			X
Paper Towels - Cleaning	X	X	X	X
Pencil - Writing, Marking Chromatogram		X		
Ruler - Measuring lengths		X		
Magnets - For extraction and identification of iron filings	X	X	X	X



For Event Supervisors Only - Do Not Post CALCULATOR CLASS DESCRIPTIONS

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

The following document was prepared to offer some guidance to teams as they select calculators for use in different Science Olympiad events. By no means are the calculators listed here inclusive of all possible calculators; instead they are offered as common examples. The decisions of the event supervisors will be final.

Class I - Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators

are the most basic type of calculators and often look like the one shown to the right. These calculators are limited to the four basic mathematics functions and sometimes square roots. These calculators can often be found at dollar stores.



Class II - Stand-alone non-programmable, non-graphing calculators look like the calculator to the right or simpler. There are hundreds of calculators in this category but some common examples include: CASIO FX-260, Sharp EL-501, and TI-30X.



Class III- Stand-alone, programmable, graphing calculators and stand-alone non-graphing, programmable calculators, often look like the calculator shown on the right. Some examples are: Casio 975 0/9850/9860, HP 40/50/PRIME, and TI 83/84/89/NSPIRE/VOYAGE.

To identify a stand-alone non-graphing, programmable calculators are look for the presence of the 'EXE' button, the 'Prog' button, or a 'file' button. Examples include but are not limited to: Casio Super FXs, numerous older Casio models, and HP 35S. A calculator of this type with the buttons labeled is shown to the right.



PROG Button

EXE Button



Class IV - Calculator applications on multipurpose devices (e.g., laptop, phone, tablet, watch) are not allowed unless expressly permitted in the event rule.



EYE PROTECTION GUIDE

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

This resource was created to help teams comply with the Science Olympiad Policy on Eye Protection adopted on July 29, 2015 and posted on the Science Olympiad Website (soinc.org).

Participant/Coach Responsibilities: Participants are responsible for providing their own protective eyewear. Science Olympiad is unable to determine the degree of hazard presented by equipment, materials and devices brought by the teams. Coaches must ensure the eye protection participants bring is adequate for the hazard. All protective eyewear must bear the manufacturer's mark Z87. At a tournament, teams without adequate eye protection will be given a chance to obtain eye protection if their assigned time permits. If required by the event, participants will not be allowed to compete without adequate eye protection. This is **non-negotiable**.

Corresponding Standards: Protective eyewear used in Science Olympiad must be manufactured to meet the American National Standards Institute (ANSI) standard applicable at its time of manufacture. The current standard is ANSI/ISEA Z87.1-2015. Competitors, coaches and event supervisors are not required to acquire a copy of the standard. The information in this document is sufficient to comply with current standards. Water is not a hazardous liquid and its use does not require protective eyewear unless it is under pressure or substances that create a hazard are added.

Compliant Eyewear Categories: If an event requires eye protection, the rules will identify one of these three categories. Compliance is simple as ABC:

CATEGORY A

- Description: Non-impact protection. They provide basic particle protection only
- Corresponding ANSI designation/required marking: Z87
- Examples: Safety glasses; Safety spectacles with side shields; and Particle protection goggles (these seal tightly to the face completely around the eyes and have direct vents around the sides, consisting of several small holes or a screen that can be seen through in a straight line)

CATEGORY B

- Description: Impact protection. They provide protection from a high inertia particle hazard (high mass or velocity)
- Corresponding ANSI designation/required marking: Z87+
- Example: High impact safety goggles

CATEGORY C

- Description: Indirect vent chemical/splash protection goggles. These seal tightly to the face completely around the eyes and have indirect vents constructed so that liquids do not have a direct path into the eye (or no vents at all). If you are able to see through the vent holes from one side to the other, they are NOT indirect vents
- Corresponding ANSI designation/required marking: Z87 (followed by D3 is the most modern designation but, it is not a requirement)
- Example: Indirect vent chemical/splash protection goggles

Examples of Non-Compliant Eyewear:

- Face shields/visors are secondary protective devices and are not approved in lieu of the primary eye protection devices below regardless of the type of vents they have.
- Prescription Glasses containing safety glass should not be confused with safety spectacles. "Safety glass" indicates the glass is made to minimize shattering when it breaks. Unless these glasses bear the Z87 mark they are not approved for use.

Notes:

1. A goggle that bears the Z87+ mark and is an indirect vent chemical/splash protection goggle will qualify for all three Categories A, B & C
2. VisorGogs do not seal completely to the face, but are acceptable as indirect vent chemical/splash protection goggles