SCIENCE OLYMPIAD

Since 1984 40 YEARS ™

Exploring the World of Science

Division C Rules Manual

Division C (Gr. 9-12)

WELCOME TO THE 2024 SCIENCE OLYMPIAD!

This Rules Manual will help you prepare to compete in Invitational, Regional, State and National Tournaments held across the United States annually. Each Science Olympiad event has a corresponding page on the Science Olympiad national website complete with free resources, training handouts and useful links. All users of this manual are subject to the Terms of Use Agreement. To compete, users must first join the Science Olympiad program in their home state and become registered members.

See our website for info on Membership, Policies and Terms of Use at www.soinc.org

Division C (Grades 9-12) Membership Rules

A team may have up to fifteen (15) members. A maximum of seven (7) 12th grade students is permitted on a Division C team.

Division B (Grades 6-9) Membership Rules

A team may have up to fifteen (15) members. A maximum of five (5) 9th grade students is permitted on a Division B team. Because middle schools that do not have grades 7, 8 or 9 are at a slight disadvantage, they may invite any combination of up to five (5) of their last year's 6th, 7th or 8th grade students to be part of the team. Possible examples can be found on the Science Olympiad website.

Students Below Grade Level Designations

Science Olympiad encourages students to participate in the Division that matches current Science Olympiad grade level designations. However, to support the inclusion of students who wish to participate in Science Olympiad, schools with grade levels lower than those stated in a Division are permitted to invite members below the grade level designations. Participation is limited to age-appropriate events (as determined by a coach, principal or tournament director) and prohibited where safety is a concern (such as the use of chemicals). See Team Qualifications for more information.

Science Olympiad Team Membership

Science Olympiad requires that all teams (up to 15 members) competing in any Science Olympiad Tournament (Invitational, Regional, State or National) must be a member of Science Olympiad and pay the national fee (currently $75, paid as part of the state membership). There is no exception to this requirement, regardless of what teams from the same school are called (Varsity, JV, Alternate Team, Extra Team, Team Two, Team B). No school, region or state Science Olympiad organization is allowed to alter or amend these national membership requirements. Please see the Science Olympiad Copyrights and Use Statement outlining use of Science Olympiad Rules and procedures at sanctioned tournaments.

Find more Science Olympiad team information under the Policies section of the national website: Code of Ethics & Rules, Scoring Guidelines, Home & Virtual Schools, Small Schools, All Stars, Copyrights and Use, Lasers, Building Policy, Eye Protection, Significant Figures and Wristband Procedures.

SCIENCE OLYMPIAD
DIVISION C RULES MANUAL

Table of Contents

Tournament Formats 1
Event Type Descriptions 2
General Rules 3
Air Trajectory **4**
Anatomy & Physiology 7
Astronomy 9
Chemistry Lab 10
Codebusters 12
Detector Building 14
Disease Detectives 17
Dynamic Planet 19
Ecology 21
Experimental Design 23
Experimental Design Checklist 24
Fermi Questions 26
Flight 27
Forensics 30
Forestry 32
2024 National Tree List 33
Fossils 35
2024 Fossils List 37
Geologic Mapping **40**
Microbe Mission **42**
Optics **44**
Robot Tour 47
Scrambler 52
Tower 56
Wind Power 61
Write It Do It 64
Trial Event Rules Explanation 65
Aerial Scramble 66
Agricultural Science 68
Botany 70
Cybersecurity 71
Digital Structures 73
Engineering CAD 75
Home Horticulture 76
Mission Possible 77
Solar Power 81
Division C Chemistry Lab Equipment 83
Calculator Class Descriptions 84
Calculator & Events Matrix 85
Eye Protection Guide 86
Div. C National Tournament Schedule 87

- Please read the General Rules on the next page as they apply to all events. Note: all changes are in **bold**.
- Please visit the official Science Olympiad web site: www.soinc.org for Membership Information, Team Size Requirements, Clarifications/Rules Changes, FAQs, New Store Items, news, tips, resources, and other valuable information.

TOURNAMENT FORMATS

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

While the COVID-19 situation still changes daily, Science Olympiad has developed a series of models for tournaments which will allow State Chapters to start the season with enough options and flexibility to provide registered Science Olympiad teams with a safe and positive experience, no matter how students are learning or how local situations evolve. These models are the result of thoughtful conversations that spanned the entire Science Olympiad community. We would like to thank everyone for their candor, thoughtfulness, and creativity. In the end, we feel we were able to create options that acknowledge that circumstances vary across the US while maintaining the spirit and goals of the organization.

In-Person, Single-Location Tournaments - The Gold Standard

The expectation for the 2023 season is that if health conditions in your region/state allow for traditional in-person, single-location tournaments, your State Chapter will provide that experience for teams, qualifying them all the way through to our 2023 Science Olympiad National Tournament held at Wichita State University May 19-20, 2023. In order to achieve this expectation, our State Chapters are ready to provide accommodations due to local public health regulations. Additionally, participants will be asked to sign a COVID-19 release.

Satellite SO

This is a new model that accounts for situations where students are physically attending school, but large public gatherings in a single location are prohibited. A Satellite SO Tournament will take place over the course of a few days after school with each team competing from their own school. This format requires that Tournaments use tech tools that schools and teachers have been using these last few months like Zoom, Google Classroom, Google Meet, Microsoft Teams and Facebook Live that have opened up new ways to communicate, learn and gather for events. This model presents shortfalls when compared to a traditional tournament, especially with regard to the scope of hands-on activity, but it capitalizes on the amount of time Science Olympiad teams are encouraged to spend in months-long preparation for competition – building, breaking, studying, making binders, taking quizzes, and prepping log books. Teams will need to accept these limitations willingly, understand the academic honor code will be in full force, and that they will need to abide by a safety agreement provided by Science Olympiad, Inc.

Mini SO

This model accounts for situations where students are unable to physically attend school and are distance learning from their homes by allowing some events to be run at home. Since students will be at home without faculty supervision, no hands-on events will be allowed to run. A chart showing acceptable events can be found online at soinc.org. As with Satellite SO, this model presents shortfalls when compared to a traditional tournament, especially with regard to the scope of hands-on activity. Teams will need to accept these limitations willingly and understand the academic honor code will be in full force. This model can be delivered through a variety of tech platforms, via email, or even postal mail if needed.

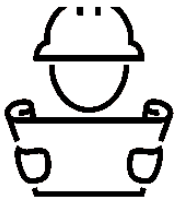
EVENT TYPE DESCRIPTIONS

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

While a Science Olympiad tournament typically consists of 23 different events, those 23 events can be classified into one of four event types. This information is being provided so that Science Olympiad participants more easily can identify events that they may enjoy competing in regardless of the event content, coaches can approach coaching from the perspective of event type as opposed to event content, and teams can be aware of how the format of the tournament they are intending to compete may affect available events. The symbol to the left of each description has been added to the upper right-hand corner of each Event Rule to identify the event by event type.

Core Knowledge Event: An event where participants are given a set of topics that they are expected to research and master the factual content. Mastery is demonstrated at a tournament by taking a paper-pencil, station, or computer test.

Core Knowledge Events can be run regardless of the tournament format that has been chosen by the State Chapter and the Tournament Director.

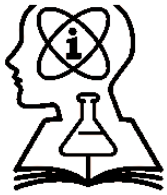


Build Event: An event where participants are given some specifications about a device or object they are expected to design, create, and test in advance of the tournament. The devices or objects are often modified on site to account for an unknown parameter prior to testing or evaluation.

In some cases, Build Events may or may not be run depending upon the format of Science Olympiad tournament being conducted. The Tournament Director will make these decisions to ensure safety and fairness for all teams. If a Build Event is not to be run at a tournament, the Tournament Director will notify all teams in advance of the given tournament.

Laboratory/Hands-On Event: An event where participants are given a general topic in which they will be expected to deepen their content knowledge of the topic and associated research techniques prior to the tournament. At the tournament they will be assessed by the completion of a hands-on task, which may or may not require a written report, within a defined timeframe.

Depending upon the format of Science Olympiad Tournament being held, there may be some alterations to or cancelation of Lab Events. To the greatest extent possible, Tournament Directors will work to ensure Lab Events are conducted; though, that may mean in some cases participants will be working with previously collected data and hands-on activities will be omitted. The Tournament Director will make these decisions to ensure safety and fairness for all teams. If a Lab Event is altered or not to be run at a tournament, the Tournament Director will notify all teams in advance of the given tournament.



Hybrid Event: An event which contains elements from two, or more, of the above event types in combination. The most common combination mixes elements of a Core Knowledge event with elements of a Building or Lab event.

As with the previous events, Hybrid Events may be altered to fit the format of the Science Olympiad Tournament being held. This may mean that Lab or Build elements of the event are modified or not conducted. The Tournament Director will make these decisions to ensure safety and fairness for all teams. If a Build Event is not to be run at a tournament, the Tournament Director will notify all teams in advance of the given tournament.

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.

AIR 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 must impound only one launch device, design log, and any projectiles. 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.
   c. Each team may bring tools, supplies, writing utensils, and two stand-alone calculators of any type for use (these items need not be impounded).
   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.
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 75.0 cm (Division C); 85.0 cm (Division B) 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 (Division C); 5.000 kg (Division B). 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 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 75 cm 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.
   g. Teams must provide unmodified (labeling is permitted), standard (i.e., can be used in regulation competitions) tennis, racquet, and/or Ping Pong balls to be used as projectiles. Teams may change projectiles for each launch.
   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 a laser pointer, that are removed before launch are permitted.
4. **DESIGN LOG:**
   a. Teams must submit a Design Log along with their device. The log must include the following:
      i. Materials used to construct the device
      ii. A labeled diagram or picture that identifies and describes the parts of the device
      iii. Any number of graphs and/or data tables showing the relationship between multiple parameters, such as launch angle, projectile mass, or impact position may be submitted. The team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
      iv. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph. A template is available at www.soinc.org.
      v. Example calculations showing how to use the graphs/tables to adjust the device for a target position.
      vi. A front cover labeled with the Team Name and the Team Number for the current tournament.
   b. If a 3-D printer, laser cutter, CNC machine or similar device was used by the team as a tool to build the team's device, or any component thereof, the following information must also be supplied in the log. Any such parts purchased as an end item or as part of a kit do NOT require this information.

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

c. All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured. SI units should be the default standard.
d. Teams are encouraged to have a duplicate of their Design Log, as the submitted copy may not be returned.
e. **Event Supervisors may decide that Design Logs must be submitted by a deadline up to 4 days in advance of the competition.**

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. 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 75 cm 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 500 mm, 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 competition area will consist of a near target and a far target, both 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. Tape must also be placed 75 cm 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) 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 must be centered on an imaginary center line that bisects the launch area and is parallel to the launch direction.
ii. The target surface must be at least a 1.0 meter by 1.0 meter square and have a marked center point from which measurements will be taken.
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 1.0 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 and bucket location 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 + LS + 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.
   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 loactions. Shots with projectiles hitting such areas will use the next eligible impact loaction contacted by the projectile.
   d. Log Score (LS) - One of the submitted graphs and/or tables, selected by the event supervisor, must be scored per items items ii., iii., and iv below. Partial credit may be given. Max possible CS is 400.
      i. 30 points for submitting a properly formatted Design Log containing all the required elements described in Section 4
      ii. 60 points for including data spanning at least one variable range listed in 4.a.iii.
      iii. 55 points for including at least 10 data points in each data series
      iv. 40 points for proper labeling (e.g., title, units)
      v. 30 points for each graph or table turned in (up to 120 points total as long as they are not the same)
      vi. 45 points for including a labeled device picture or diagram
      vii. 50 points for including at least 2 example calculations
   e. 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 total of 500 points).
   f. If a team violates any of THE COMPETITION rules, their TS scores for that launch will be multiplied by 0.9.
   g. If the team misses impound, their Best NTS and Best FTS scores will be multiplied by 0.7.
   h. If a team is unable to fix the construction violation(s), the event supervisor may still permit them to compete but be ranked behind every team that did not have a construction violation(s) or were able to fix their construction violation(s) during the allotted competition period.
   i. Teams disqualified for unsafe operation or that do not have a device will have Best NTS, Best FTS and BS scores of 0.
   j. Participants will be informed before the next launch if they have received a penalty.
   k. 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 Far TS not used for the FS;
      iv. 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

ANATOMY & PHYSIOLOGY

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

1. **DESCRIPTION:** Participants will be assessed on their understanding of the anatomy and physiology for the human Cardiovascular, Lymphatic, and Excretory systems.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 Minutes

2. **EVENT PARAMETERS:** Each team may bring one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source along with two stand-alone non-programmable, non-graphing calculators (Class II).

3. **THE COMPETITION:** This Event may be administered as a written test or as series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Content topics will include:
   a. CARDIOVASCULAR SYSTEM:
      i. Anatomy and physiology of the cardiovascular system
      ii. The Heart – chambers and valves of the heart, electrical stimulation of myocardial tissue, pacemaker tissue, interpreting ECG/EKG readings on strips, effect of electrolyte abnormalities on heart rhythm
         (1) Lethal & non-lethal cardiac strip ECG/EKG pattern interpretation:
            (a) Division B Only: Atrial Fibrillation (A Fib), Pulseless Electrical Activity (PEA), Ventricular Tachycardia (V Tach)
            (b) Division C Only: All Division B patterns in addition to Torsades de pointes, Premature Ventricular Contractions, Supraventricular Tachycardia (SVT)
         (2) Division C States/Nationals Only: understanding the effects of sympathetic nervous system receptors (α_1, α_2, β_1, β_2) on the heart and vasculature, understanding the effects of antiarrhythmic drugs on cardiac physiology (i.e. Class Ia, Ib, Ic, II, III, IV)
      iii. Blood Vessels – structure and function of arteries, arterioles, veins, venules, capillaries, including the functionality of Starling's forces in the capillaries
      iv. Blood – plasma, hematocrit, red blood cells, oxygen transport, hemoglobin and cooperative binding of oxygen, platelets and blood clotting, regulation of blood plasma volume and acidity, blood typing & basic genetics of ABO and Rh blood types
         (1) Division B Nationals Only & Division C Only: Blood coagulation pathways and feedback/regulation
      v. Measurement of the pulse rate and blood pressure with appropriate instrumentation (e.g. utilization of sphygmomanometer and stethoscope in measuring blood pressure, palpation of the radial artery in assessing pulse rate)
      vi. Relevant calculations include systolic and diastolic pressure, mean arterial pressure, stroke volume and cardiac output, systemic vascular resistance
      vii. Effects of exercise, smoking, alcohol, caffeine, and drugs on the cardiovascular system
      viii. Disorders: Congestive Heart Failure, Atrial Fibrillation, Myocardial Infarction, Atherosclerosis, Bradycardia, Tachycardia, anemias (i.e. microcytic, normocytic, macrocytic) and associated blood smears, hypotension, hypertension, non-cranial aneurysms affecting peripheral vasculature (i.e., abdominal aortic aneurysms, thoracic aortic aneurysms), aortic dissection
         (1) Division B States/Nationals Only: disseminated intravascular coagulation, capillary leak syndrome, peripheral artery disease, deep vein thrombosis
         (2) Division C States/Nationals Only: All Division B disorders in addition to heart conduction disorders and valvular heart disease
      ix. Nationals Only: Treatments, prevention, and complications for all conditions listed above (i.e., drugs, surgery)
   b. LYMPHATIC SYSTEM:
      i. Anatomy and physiology of the lymphatic system
      ii. Role and function of Primary, Secondary, and Tertiary lymphoid tissues
      iii. Structure and function of general lymphatic structures, including lymph nodes (including tonsils), lymph ducts, lymphatic capillaries, bone marrow, interstitial fluid and lymph
      iv. Structure and function of the thymus (including its role in leukocyte development and immune function)
      v. Structure and function of the spleen (including its role in leukocyte development and immune function, as well as causes and complications of removal)
      vi. Function and role of the lymphatic system in the absorption and transport of fats/lipids

(1) Division C State/Nationals Only: function and role of the lymphatic system in the gastrointestinal immune system

vii. Disorders: Tonsillitis, Lymphedema, Hodgkin lymphoma, non-Hodgkin lymphoma, Lymphadenopathy, Splenomegaly
   (1) Division C States/Nationals Only: Burkitt lymphoma, acute lymphoblastic leukemia, acute myelogenous leukemia, chronic lymphocytic leukemia, chronic myelogenous leukemia

viii. Nationals Only: Treatments, prevention, and complications for all conditions listed above (i.e., drugs, surgery)

c. EXCRETORY SYSTEM:
   i. Anatomy and physiology of the excretory system
   ii. Basic anatomy of the urinary system including kidneys, ureters, bladder, and urethra
   iii. Structure and function of the nephron
      (1) Division C Only: Effects of drug classes on the nephron (i.e. osmotic diuretics, carbonic-anhydrase inhibitors, loop diuretics, thiazide diuretics, potassium-sparing diuretics) and the changes they can exert on specific electrolytes
   iv. Formation of urine, Glomerular Filtration Rate (GFR) calculation, and concepts of tubular secretion, tubular reabsorption, and fluid homeostasis
   v. Understand the renin-tension-aldosterone system (RAAS) and the effects of drugs that target this system (e.g. ACE inhibitors, angiotensin receptor blockers, direct renin blockers), especially in blood pressure control
   vi. Understand disorders: Kidney stones, Urinary Tract Infections (UTI's) (e.g., urethritis, cystitis, pyelonephritis), Renal failure, Urinary Incontinence
      (1) Division C State/Nationals Only: Compare and contrast Nephrotic vs. Nephritic Syndromes, Prostatitis, and BPH (Benign Prostatic Hyperplasia)
   vii. Nationals Only: Treatments and/or prevention for all conditions listed above (i.e., drugs, surgery)

4. **SCORING:**
   a. High score wins.
   b. Selected questions will be used to break ties.

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

ASTRONOMY

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

1. **DESCRIPTION:** Teams will demonstrate an understanding of **Stellar Evolution: Star Formation & Exoplanets.**

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one of the following options containing information in any form and from any source: a computer/tablet and a three-ring binder, two computers/tablets, of any kind, or two three-ring binders.
   b. If three ring binders are used they may be of any size and the information contained should be attached using the available rings. The information or pages may be removed during the event. Sheet protectors and laminated sheets are allowed.
   c. Each team may bring two stand-alone calculators of any type. If the participants are using a computer/tablet they may use the calculator app or other program on their device in place of a stand-alone calculator.
   d. Participants using computers/tablets as a resource should have all information stored so that it is available to them offline. However, teams may be asked to access a dedicated NASA image analysis website to answer some JS9 questions. If so, supervisors will provide an alternative (e.g., proctor-supplied computer) for teams that did not bring a laptop/tablet.
3. **THE COMPETITION:** Using information which may include Hertzsprung-Russell diagrams, spectra, light curves, motions, cosmological distance equations and relationships, stellar magnitudes and classification, multi-wavelength images (gamma-ray, X-ray, UV, optical, IR, radio), charts, graphs and JS9 imaging analysis software, teams will complete activities and answer questions related to:
   a. Stellar evolution including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, **H I/II regions, molecular clouds, protostars, Herbig-Haro Objects, T Tauri variables, Herbig Ae/Be stars, planet formation, brown dwarfs, protoplanetary disks, debris disks, and exoplanets including but not limited to gas giants and terrestrial planets.**
   b. Use orbital mechanics, Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of **planetary systems**; use parallax, spectroscopic parallax, and the distance modulus to calculate distances **to stars and planetary systems**; **use the radial velocity, transit, and direct imaging methods to determine properties of exoplanets,** use the **radiation laws** to answer questions relating to **planetary surface temperatures and habitability.**
   c. Identify and answer questions relating to the content areas outlined above for the following objects and systems:
      i. **Carina Nebula,**
      ii. **NGC 1333,**
      iii. **TW Hya,**
      iv. **HH 7-11,**
      v. **AB Aurigae,**
      vi. **HD 169142,**
      vii. **Luhman 16,**
      viii. **V830 Tau b,**
      ix. **V 1298 Tau b,**
      x. **WASP-18b,**
      xi. **WASP-39b,**
      xii. **WASP-43b,**
      xiii. **HR 8799,**
      xiv. **Beta Pictoris,**
      xv. **2M 1207,**
      xvi. **TRAPPIST-1.**
4. **SCORING:** All questions will have been assigned a predetermined number of points. The highest score wins. Selected questions will be used to break ties.

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

This event is supported by NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network

CHEMISTRY LAB

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

1. **DESCRIPTION:** Teams will complete one or more tasks and answer a series of questions involving the scientific processes of chemistry focused in the areas of Periodicity and **Equilibrium.**

   A TEAM OF UP TO: 2 **EYE PROTECTION:** C **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each participant must bring safety equipment (e.g., goggles, lab coat, apron), a writing implement, and may bring a stand-alone calculator of any type.
   b. Each participant may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, with information on both sides in any form and from any source.
   c. Teams should bring any or all of the items listed on the Division C Chemistry Events Lab Equipment List, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
   d. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
   e. Supervisors will provide any required reagents, additional glassware, and/or references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).

3. **THE COMPETITION:**
   a. The competition will consist of a series of tasks **focused in the areas of Periodicity and Equilibrium**. These tasks could include hands-on activities, questions on listed topics, interpretation of data (e.g., graphs, diagrams, tables), or observation of an established and running experiment.
   b. Teams may be asked to collect data using a probeware set-up demonstrated by the Supervisor(s). Following a demonstration of the sensors/probes, participants may be given data sets to interpret.
   c. Nomenclature, formula writing, & stoichiometry (mole conversions & percentage yield) are essential tools of chemistry & may be included in the event. Participants are expected to know the symbols & charges for: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate, & hydroxide. Participants should know how to use the "ite" form of anion (one less oxygen than the "ate" form). With a periodic table, participants should be able to obtain charges for monatomic ions (e.g., Na^{+}, S^{2-}).
   d. **Equilibrium: Students must be able to write equilibrium reactions, predict the direction of a reaction using Le Châtelier's Principle, calculate an equilibrium constant, & use equilibrium constants to determine concentrations. Tasks will be chosen from the following:**
      i. **Use a titration or data of a weak acid/base with a strong acid/base to calculate an equilibrium constant.**
      ii. **Investigate an equilibrium reaction and determine what happens when it is stressed.**
      iii. **Stoichiometry of equilibrium reactions.**
      iv. **Construct/use a standard absorption curve to determine an equilibrium constant.**
      v. **Use a calorimeter to predict a curve.**
      vi. **State & Nationals: knowledge/application of equilibrium to separate chemicals may be included.**
   e. Participants should understand the following about Periodicity
      i. Physical Properties (e.g., atomic & ionic radii, ionization energy, melting point, electro-negativity, etc.)
      ii. Electronic structure and bonding formation (e.g., ionic vs. covalent, charges on ions)
      iii. Chemical properties (e.g., precipitate formation – K_{sp} calculations, solubilities, reactions with acids)

4. **SAMPLE TASKS:**
   a. Use freezing point depression to determine the molar mass of a solute.
   b. Identify and explain factors that affect solution formation.
   c. Determine whether a solution is saturated, unsaturated, or supersaturated.
   d. Given the concentration of the reactants and products at equilibrium, calculate the equilibrium constant
   e. Construct and ICE chart given the original concentration of the reagents.

5. **SCORING:**
   a. High score wins. Points will be divided evenly between Periodicity and **Equilibrium**.
   b. Time may be limited at each task but will not be used as a tiebreaker or for scoring.
   c. Ties will be broken by pre-selected questions.
   d. A penalty of up to 10% may be given if the area is not cleaned up as instructed.
   e. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.

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

CODEBUSTERS

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

1. **DESCRIPTION:** Teams will cryptanalyze and decode encrypted messages using cryptanalysis techniques for historical and modern advanced ciphers.

   A TEAM OF UP TO: 3 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Teams must bring writing utensils and may bring up to three (3) stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators (Class I).
   b. No resource materials, except those provided by the Event Supervisor, may be used.
   c. The Event Supervisor will provide scratch paper for each team to use.
   d. The exam packet will include a resource sheet with the Morse Code Table, English/Spanish letter frequencies, Porta Table, and Baconian mappings as needed for the questions on the exam.
3. **THE COMPETITION:**
   a. This event consists of participants using cryptanalysis techniques and advanced ciphers to decrypt messages on a written or computer based exam.
   b. Teams will begin the event simultaneously at the indication of the Event Supervisor.
   c. Teams must not open the exam packet nor write anything prior to the "start" signal, nor may they write anything after the "stop" signal.
   d. Participants are allowed to separate the pages of the test to be free to answer the questions in any order, working individually or in groups, attempting whichever of the questions seem right for them.
   e. The code types that may be used at Division C Regional Tournaments are as follows:
      i. Monoalphabetic substitution using K1, K2, K3, or random alphabets as defined by the American Cryptogram Association (ACA) with or without a hint
         (1) Aristocrats - messages with spaces included but no spelling or grammar errors
         (2) Aristocrats - messages with spaces including spelling/grammar errors
         (3) Patristocrats - messages with spaces removed with letters grouped in sets of 5
      ii. For aristocrats, patristocrats and xenocrypts encoded using a K1, K2 or K3 alphabet, the answer requested can be the keyword or key phrase used to construct the alphabet instead of the deciphered text.
      iii. The Baconian Cipher - decrypting ciphertext encoded with the a and b values represented as one or more letters, glyphs, symbols, or character rendering variations (e.g., bold, underline, italic)
      iv. Xenocrypt - no more than one cryptogram can be in Spanish
      v. Cryptanalysis of the Fractionated Morse Cipher - decrypting Morse code ciphertext encoded as letters and spaces with a "crib" of at least 4 plaintext characters.
      vi. Cryptarithms - determining mapping values to letters in base 10 (decimal) mathematical equations and decoding a word or phrase using that mapping
      vii. The Porta Cipher - Decrypting ciphertext given a key
      viii. Cryptanalysis of the Complete Columnar Transposition Cipher - Decrypting ciphertext encoded in 9 columns or less given a crib which is no shorter than one less than the number of columns used.
      ix. The Nihilist Cipher - Decrypting ciphertext given the keys
      x. The Hill Cipher - Decrypting ciphertext given the 2x2 encryption matrix
   f. The code types that may be used on the exam at State and National competitions are as follows:
      i. All Invitational and Regional code types
      ii. Xenocrypt - at the state and national levels, at least two cryptograms will be in Spanish
      iii. Cryptanalysis of the Porta Cipher with a "crib" of at least 3 plaintext characters.
      iv. The Hill Cipher - Decrypting ciphertext with a 3x3 decryption matrix provided.
      v. Cryptanalysis of the Nihilist Cipher with a "crib" that is no shorter than two less than the length of the keyword used.
      vi. Cryptanalysis of the Complete Columnar Transposition Cipher - Decrypting ciphertext encoded in 11 columns or less given a crib which is no shorter than three less than the number of columns used.
   g. For aristocrats, patristocrats, and xenocrypts, no letter can ever decrypt to itself.
   h. The first question of the exam will be timed.
      i. The first question will be the decoding of an Aristocrat as defined by 3.e.i.(1)
      ii. A team member should signal when his or her team has broken the cryptogram.
      iii. Before the exam begins, the Event Supervisor will announce the nature of the signal that must be used (e.g., shouting "bingo", or quietly raising hand).

iv. The time in seconds, to the precision of the device used, to solve the cryptogram will be recorded by the Event Supervisor or designee.
v. If a team gets the timed question wrong, they may attempt to answer the question repeatedly without penalty. The timing bonus will be calculated from the start of the event until the question is successfully answered by the team with two or fewer errors, or until 10 minutes has elapsed. After 10 minutes, the timed question can still be answered but the timing bonus is zero.

i. Up to three questions which are not aristocrats, patristocrats or xenocrypts will be marked on the exam as special bonus questions.

4. **SCORING:**

a. The high score wins. Final Score = Exam Score + Timing Bonus + Special Bonus.
b. The scores for each question will be added together to determine the exam score.
c. For questions such as cryptograms, with answers composed of letters, the final points will be determined based on the number of errors found in the decoded plaintext as is appropriate to the question.
   i. Two or fewer errors will be scored as correct and result in full credit.
   ii. Each additional error results in a penalty of 100 points but the penalty will not exceed the value of the question. For example, a 400-point question with 5 errors earns 100 points [400 - 3(100)] whereas the same 400-point question with 7 errors would earn 0 points, not -100 points.
d. For answers involving the keyword or key phrase for a K1, K2 or K3 alphabet, the final points will be determined based on the number of errors found in the keyword or key phrase
   i. Zero errors are required for full credit.
   ii. Each error results in a penalty of 100 points but the penalty will not exceed the value of the question. For example, a 500-point question with eight (8) errors would earn 0 points, not -300 points.
e. A Timing Bonus can be earned based on the number of seconds it takes a team to correctly decode the first question. The timing bonus is equal to 2 x (600 - number of seconds). For example, 6 minutes = 2 x (600-360) = 480 points.
f. A special Bonus can be earned by solving any of the questions marked as special bonus questions with no penalty points. The bonus will be awarded as follows: One solved = 150 points, Two solved = 400 points, All three solved = 750 points.
g. Scoring example: Team A earns 3600 points on the exam and solved the timed question in 435 seconds and solved one Special Bonus question

Exam Score	=	3600 points
+ Timing Bonus 2(600-435)	=	330 points
+ Special Bonus (One=150)	=	150 points
Final Score		4080 points

h. Tiebreakers: For teams that are tied, select questions predetermined by the Event Supervisor, will be used to break the tie using the following criteria in this order: score, degree of correctness and number attempted.

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.

DETECTOR BUILDING

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

1. **DESCRIPTION:** Teams will build a durable **ORP or Redox Probe** that will accurately measure and display both voltage and the concentrations of NaCl in parts per million from 0 to 5000 ppm of different water samples and complete a written test on the principles and theories behind the event.

A TEAM OF UP TO: 2 **EYE PROTECTION: C**

IMPOUND: No **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one participant-constructed, **ORP or Redox probe** with a laptop or a calculator for programming/display, two calculators of any type, and one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted.
   b. **Event Supervisors should supply distilled or ROI water for participants to rinse the probes between tests, and will provide two (2) standardized saltwater samples from 0 to 5000 ppm in 4 oz souffle cups with approximately 7 cm mouth with approximate depth of 5 cm with a removable lid.**
   c. **Regional competition will test 3 unknown concentrations. State and National Competition will test 4 different concentrations**
   d. Teams must be able to answer questions regarding the design, construction, programming, and operation of the Device per the Building Policy found at www.soinc.org.
3. **CONSTRUCTION PARAMETERS:**
   a. Devices must be built using a microcontroller or microcontroller board (e.g., TI Innovator, Raspberry Pi, Arduino, Micro:bit), a display, LED lights, and a participant-built sensor/probe. The sensor must produce a voltage which varies according to the concentration of the salt solution. The Device may be connected to a laptop and/or calculator. Wi-Fi/Internet connection is not allowed at any time during competition.
   b. **The sensor must be student constructed with a salt bridge from fundamental electronic components such as resistors, capacitors, DIP package integrated circuits, op-amps, transistors, relays, surface mount adaptor boards, wire, glass or plastic, and an internal standard solution. All supporting circuits must be assembled on a breadboard. This includes solderable breadboards and perfboards. SOIC that do not conatin additional electronic components are allowed.**
   c. **The following are construction violations:**
      i. **preassembled devices,**
      ii. **printed circuit boards (except digital display boards),**
      iii. **integrated circuit daughterboards.**
   d. **The sensor and wires/cables together; must be a minimum of 30.0 cm in length and narrow enough to fit through an opening of 7 cm. The end must be immersible up to 5.0 cm** in water.
   e. **Suggestions for building an ORP Sensor can be found on the event page at soinc.org.**
   f. The Device may use any code libraries for calibration of the device.
   g. The Device must have a digital display that clearly shows voltage, **and salt concentrations in ppm to the nearest unit value.** This can be displayed on a laptop or calculator. If the team chooses to use a laptop for display purposes, it CANNOT be used for the Written Test portion of the event.
   h. The Device must also be able to indicate the specific **concentration** range zone using three separate LEDs: one red, one green, and one blue. RGB LEDs may be used but must be wired for only one color. The exact **concentration** range of each zone will not be revealed until teams enter to compete and may be different for different rotations. At States/Nationals, zones may require more than one color to be displayed at the same time.
   i. Teams must not use electrical outlets at any time during the competition. If the Device is not powered by a connected laptop or calculator, then the Device must be powered by commercially available batteries. Multiple batteries may be connected in series or parallel as long as the total input voltage does not exceed 12 volts as calculated using each battery's voltage (as labeled by the manufacturer). Teams with devices using a total input voltage exceeding 12 volts or devices that the Event Supervisor deems unsafe will not participate in Device Testing.
4. **DESIGN LOG:**
   a. Teams must submit a Design Log with their Device.
   b. This Design Log should contain the following eight (8) Sections:

i. A top-down photograph, diagram, or picture of the Device with the school name labeled on the device, labels identifying all the components and detailing their functions. This section should also include a brief summary explaining how the Device was constructed.
ii. A data table with at least 10 trials showing the raw sensor reading (voltage, time, etc.) versus the corresponding **ppm**. If multiple fixed resistors are tried, include the data and graphs of all potential resistors.
iii. Scatter-plot graph of this data with **concentration in ppm** on the Y-axis and voltage on the X-axis.
iv. Function graph of the mathematical model supported by the data overlaid on a scatter-plot of the data.
v. Equation of the above the mathematical model used to convert measured voltage to the corresponding **concentration in ppm** highlighted for easy identification.
vi. Printout of the program with its code highlighted showing this exact mathematical equation or its code implementation converting the raw sensor reading (voltage, time, etc.) to **ppm**.
vii. On the same program printout, highlight the code that will illuminate the appropriate LED(s) according to their assigned **concentration** range(s).
viii. A front cover labeled with the Team Name and the Team Number for the current tournament.

c. 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. Any such parts purchased as an end item or as part of a kit do NOT require this information.
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
d. All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured. SI units should be the default standard.
e. All logs will be returned to teams after inspection.

5. **THE COMPETITION:**

Part I: Device Testing

a. Only participants and Event Supervisors are allowed in the competition areas. Once participants enter the event area, they must not leave or receive outside assistance, materials, or communication.
b. Event Supervisors will provide the labeled samples of unknown **concentration** (three (3) at Regional/ Invitational Tournaments, and four (4) at State/National Tournaments) that teams will need to measure.
c. Teams may modify their code (e.g., alter the LED code to match the posted **concentration** ranges during the setup time.
d. At all Tournaments, teams will have 5 minutes to set up their Device, verify their Device with **known samples** provided by the Event Supervisor and modify their code. After this time no other changes to the device are allowed.
e. After the setup/calibration time, the teams will measure the unknown **concentration** samples. Teams will have 1 minute to measure each sample. The Event Supervisor will note if a voltage is being displayed, and then record the **concentration in ppm** to the nearest 1 **ppm** as displayed by the Device, along with the LED color displayed for each **concentration**.
f. The Event Supervisor will review with teams the data recorded on their scoresheet.
g. Teams who wish to file an appeal regarding Part I must leave their Design Log and Device in the competition area.

Part II: Written Test

a. Teams will be given a written test to assess their knowledge of the theories behind the event. Teams may use the entire time block to take the written test. The written test will be limited to the following topics:
i. Voltage dividers and the effect of different fixed resistors and the output voltage recorded.
ii. **ORPs and their operation**.
iii. **The environmental significance of chloride concentrations**.
iv. **The half reactions**
v. **The effect of temperature on concentration**
vi. **Standard Cell Potentials**

vii. Converting between concentration units.
viii. The conversion from analog reading to voltage.
ix. Theory of LEDs, working principles, and applications.
x. The process of calibration - working with raw data and determining real world relationships.
xi. Operational knowledge of basic Device components.
xii. Topics for State and National Tournaments only:
(1) **Nernst Equations**

b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
c. While working on the written test teams are not allowed to use any laptops they may have brought with them.

6. **SCORING:**

a. The team with the highest Total Score wins.
b. Total Score = Build Score + Written Test Score + Design Log Score
c. Build Score: There will be three unknown **concentrations** at Regionals (Maximum 57 points) and four unknown **concentrations** at States/Nationals (Maximum 76 points)
i. Accuracy Score for each **concentration** = 15 pts - (relative error of the **concentration** measurement x multiplier) but will not go below 0 pts.
(1) Regional Multiplier = 20
(2) State Multiplier = 30
(3) National Multiplier = 40
(4) Teams not able to produce a reading will receive an accuracy score of 0 for that **concentration**.
ii. LED Score for each **Concentration** = 4 pts awarded for the correct LED color (as determined by the **concentration** displayed by the Device).
iii. Teams that violate rules 3.a-b. will have the Build Score multiplied by 0.6 for each violation.
iv. Teams that violate rules 3.c-e. will have the Build Score multiplied by 0.8 for each violation.
v. Teams that did not participate in Device Testing will receive a Build Score of 0.
d. Written Test Score = (raw score / highest score achieved by teams) x 50 pts (Maximum 50 points)
e. Design Log Score (Maximum **32** points): Points for the Design Log will be awarded or deducted as follows:
i. Four (4) points are awarded for each completed section of the Design Log specified in 4.b.i-viii. as well as being able to answer questions about each section.
ii. Points are deducted from the Design Log Score as follows:
(1) If any digital manufacturing techniques were used as part of the build by the team as described in 4.c. four (4) points will be deducted for each section of 4.c. that was not addressed or is incomplete (Maximum 12 point penalty).
(2) One (1) point may be deducted for each section specified in 4.b.ii.-vii. where appropriate units were not provided with numerical values (Maximum 4 point penalty).
f. Teams that violate any rule under "THE COMPETITION" will have the Total Score multiplied by 0.9.
g. Tiebreakers:
i. Highest Build Score
ii. Highest Written Test Score
iii. Selected questions on the Written Test.

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

This event is supported by Texas Instruments

DISEASE DETECTIVES

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

1. **DESCRIPTION:** Participants will use their investigative skills in the scientific study of disease, injury, health, and disability in populations or groups of people.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**

   Each team may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed, along with two stand-alone non-programmable, non-graphing calculators (Class II).

3. **THE COMPETITION:**
   a. This event addresses three topics related to disease, injury, health, and disability in populations or groups of people. Each part should count approximately equally towards a team's final score. Questions should be process-oriented and involve skills in evaluation and interpretation. Matching pathogens with specific diseases (i.e. – What causes X disease?) or knowledge of signs, symptoms or epidemiologic characteristics such as incubation or latency periods or infectious dose is not part of this event. However, it is appropriate to provide this information as background information and expect competitors to be able to use it.
   b. The topics for this event are as follows:
      i. Background & Surveillance
         (1) Understand the Clinical Approach (health of individuals) vs Public Health Approach (health of populations)
         (2) Understand the history and development of epidemiology
         (3) Understand the roles of epidemiology in public health and the steps in solving health problems
         (4) Understand the Natural History and Spectrum of Disease. Understand in broad terms the impact of infectious (bacterial, viral, fungal, protest and prion diseases) and noninfectious causes of disease (such as accidents, exposures, and toxicities)
         (5) Understand the basic epidemiological and public health terms found in the glossary of CDCs Principles of Epidemiology in Public Health Practice (e.g., outbreak, epidemic, pandemic, surveillance, risk, vector, etc.)
         (6) Understand the role of Surveillance in identifying health problems, the 5-Step Process for Surveillance. the types of surveillance and the attributes of a surveillance system
      ii. Outbreak Investigation
         (1) Analyze actual or hypothetical outbreaks given in case scenarios
         (2) Understand Experimental and Observational studies and the Types of Epidemiological Studies – (e.g., case control, cohort, ecological, cross-sectional. Know the advantages and disadvantages of each. Recognize various fundamental study designs and identify which is appropriate to use in analysis of presented outbreak scenarios
         (3) Identify the Steps in an Outbreak Investigation and how they guide hypothesis generation
         (4) Identify the problem using person, place, and time triad to formulate case definitions
         (5) Interpret epi curves, line listings, cluster maps, subdivided tables, PFGE gels, SNP mapping and the PulseNet concept
         (6) Understand the agent, host, environment triad and chain of transmission
         (7) Evaluate data by calculating and comparing simple rates and proportions such as attack rate, relative risk, odds-ratio, and explain their meaning. Determine whether presented data support hypotheses of disease within scenarios, and revise hypotheses as appropriate.
         (8) Apply the Bradford Hill Criteria for Verifying the Cause of presented outbreaks. Compare the accuracy of Bradford Hill criteria, Koch's and Evan's postulates, and newer causality models such as Directed Acyclic graphs, Sufficient/component cause models, and GRADE methods

(9) Division C Only: Recognize factors such as study design/biases, errors, and confounding that influence results. Be able to propose appropriate control or comparison groups and data collection methods, and recognize limitations. Be able to interpret and use confidence intervals for measures of association. Competitors need not be able to calculate these confidence intervals since this is most often done through computer programs. Understand and use methods such as stratification and adjusted rates. Know the experimental and observational methods used to calculate vaccine effectiveness and efficacy and be able to use them. Understand the concept of herd immunity. Be able to calculate and interpret herd immunity threshold, basic and effective reproductive numbers

(10) Division C - Nationals Only: Suggest types of control & prevention measures for outbreaks and other public health problems.

iii. Patterns, Control, and Prevention

(1) Identify patterns and trends of epidemiologic data in charts, tables and graphs.

(2) Using given data, calculate disease risk and frequency ratio, proportion, incidence proportion (attack rate), incidence rate, prevalence death rate and mortality rate

(3) Understand the Strategies of Disease Control as they apply to given disease scenarios

(4) Understand Strategies for Prevention, including the Scope and Levels of Prevention,

(5) Division C Only: Propose a reasonable set of prevention strategies for public health problems within the scenarios provided, once the cause has been determined by your analyses

(6) Division C - Nationals Only: Identify the strengths and weaknesses of a set of proposed prevention strategies and analyze pre-and post-intervention data, to determine effectiveness of presented strategies.

4. **SCORING:**

a. High score wins. Selected questions may be used as tiebreakers.

b. Points will be assigned to the various questions and problems. Both the nature of the questions and scoring will emphasize an understanding that is broad and basic rather than detailed and advanced.

c. Depending on the problem, scoring may be based on a combination of answers, including graphs/charts, explanations, analysis, calculations, and closed-ended responses to specific questions. Critical reasoning skills and data interpretation with hypothesis generation will be evaluated.

d. Points will be awarded for both quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods.

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

In partnership with the Centers for Disease Control (CDC) Foundation

DYNAMIC PLANET

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

1. **DESCRIPTION:** Participants will demonstrate an understanding of the large-scale processes affecting the structure of Earth's crust.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring a binder of any size containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder throughout the event.
   b. Each team may bring two stand-alone non-programmable, non-graphing calculators.
3. **THE COMPETITION:** Participants will be given one or more tasks presented as an exam and/or timed stations. An emphasis will be placed on the interconnectivity of Earth's processes **in relation to global and environmental changes in the past, present, and future**. Topics will include the following:
   a. Structures of Earth's interior: crust, lithosphere, mantle, asthenosphere, inner core, outer core.
   b. Magma composition - chemistry and properties in different geological settings, including but not limited to: subduction zones, mid-ocean ridges, hot spots, explosive vs. effusive volcanic eruptions
   c. Geologic history of North America, limited to: Evolution of the North American craton, Rocky Mountains, Appalachian Mountains, Yellowstone Hot Spot, Long Valley Caldera.
   d. Plate tectonics
      i. History of the theory of plate tectonics
         (1) Major contributions of key scientists
         (2) Evidence, including but not limited to: matching shapes of continents, matching fossils, earthquake and volcano patterns, paleomagnetic patterns
      ii. Driving forces of plate tectonics, types of plates, plate boundaries and margins.
      iii. Types of tectonic basins, processes that form them, and the nature of the sedimentary record for each.
      iv. Plate movement and impacts of plate movement, including but not limited to: Wilson Cycle, terranes, orogenic belts, past supercontinents, convergence, divergence, transform motion, and associated faults.
      v. Role of plate tectonics in the opening and closure of ocean gateways and land-bridges, with specific reference to ocean circulation changes, climate changes, and biotic migrations.
      vi. Isostatic adjustments - plate thickness and the impact of mass wasting and glaciation, hypsometry and the elevation/depth of continental and oceanic crust.
      vii. Natural hazards due to plate tectonics (e.g. tsunamis, earthquakes, volcanoes) and their mitigation strategies.
      viii. Geological settings of ores, hydrothermals, hydrocarbons in relation to tectonic processes and features.
      ix. **Division C only**: Interpretation of geophysical data to understand plate tectonics including brittle and ductile deformation in rocks, magnetic anomalies, gravity anomalies, stress, and seismicity.
   e. Earthquakes
      i. Types of earthquakes, including but not limited to: spreading center, subduction zone, transform fault, intraplate
      ii. Faults, limited to: normal and reverse (dip-slip), strike-slip, transform
      iii. Seismic waves, limited to: body (primary/P and secondary/S), surface
         (1) Usage in determining origin time, magnitude, and epicenter
         (2) **Division C Only**: Usage of seismic waves and shadow zones to determine phases and properties of Earth's interior.
      iv. Measurement, limited to: magnitude, intensity, focal depth
         (1) **Division C Only**: seismic moment
      v. Earthquake monitoring: history, identification of faultlines, remote seismograph positioning, changes in groundwater levels
   f. Volcanoes
      i. Types of volcanoes, including but not limited to: shield, stratovolcanoes (composite), cinder cones: active, dormant, extinct
      ii. Volcanism at plate boundaries, over hot spots; hydrothermal vents
      iii. Climactic effects of volcanic ejecta, both solid particles and gasses, related to the atmosphere
      iv. Volcanic monitoring: history, associated earthquake activity, magma movement, satellite data, hazard maps

4. **SAMPLE QUESTIONS/TASKS:**
   a. Using maps and available datasets, plot the horizontal movement of lithospheric features and respond to interpretative questions.
   b. Using a paleogeographic reconstruction of the late Cretaceous, identify the location of major plate boundaries represented (https://deeptimemaps.com/).
   c. Interpret expression of Earth's surface features from topographic/bathymetric maps and satellite data.
   d. Given a rate of loading or unloading of ice sheets, estimate vertical lithospheric movement due to isostatic adjustments.
   e. **Division C only:** Interpretation of magnetic and gravity data to infer subsurface geological features.
5. **SCORING:**
   a. High score wins.
   b. Points will be awarded for the quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods of responses.
   c. Ties will be broken by the accuracy and quality of answers to pre-selected questions and/or sections.

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

This event is supported by National Oceanic and Atmospheric Administration (NOAA) and the North American Association for Environmental Education (NAAEE)

ECOLOGY

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

1. **DESCRIPTION:** Students will answer questions involving content knowledge and process skills in the area of ecology and adaptations in featured North American biomes.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 Minutes

2. **EVENT PARAMETERS:** Each team may bring only one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form from any source without annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators (Class II).

3. **THE COMPETITION:**

   This event will be composed of three parts of approximately equal point value.
   The event will emphasize these process skills as they apply to ecology: defining variables; analyzing data from graphs and tables; presenting data in graphs and tables; forming hypotheses; making calculations and predictions. If stations are used, students must spend the same amount of time at each station.
   a. Part 1: Review of the General Principles of Ecology
      i. General Principles of Ecology - food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics (including density dependent/independent limiting factors, carrying capacity, doubling time, exponential/logistical growth and how to calculate population growth), extinction, selection and migration. At the regional and state level, the general ecological principles should focus on local and regional ecology.
      ii. **Division C State and Nationals only:** life history strategies (e.g., age structure, survival curves, life tables, succession, R and K strategies)
   b. Part 2: Terrestrial Ecosystems
      i. **Ecology of the Tundra, Taiga and Deciduous Forests**
      ii. Understand basic concepts of biodiversity (e.g., importance, different types)
      iii. **Div. C State and Nationals only:** Be able to apply knowledge of biodiversity (plot maps, simulations of selection effects on populations)
      iv. **Div. C Nationals only:** Understand terminology and be able to calculate biodiversity of sample data (species richness, Simpson index, Shannon-Wiener index)
   c. Part 3: Human Impact on Ecosystems
      i. Topics such as climate change, invasive species, acid deposition (including acid rain), erosion, and chemical contamination (pollution)
      ii. The pros and cons of using alternative energy and its effect on the environment
      iii. Understand the goals of conservation biology and how they can be obtained
      iv. Reclamation of disturbed areas versus reintroduction of species
      v. **Division C State and Nationals only:** Be able to answer questions as they pertain to case studies
      vi. **Division C only: adding indigenous knowledge or traditional ecological knowledge (TEK) to our "toolkit"**

4. **SAMPLE QUESTIONS:**

   a. **Division B:**
      i. From the description of community interactions, create a food web. Then predict what would happen to the food web if the primary producers were greatly reduced in number by a disease.
      ii. Given a description of the interaction between two species, identify the type of community interaction.
      iii. List three ways a tundra is different than a taiga.
      iv. Compare a tundra with a taiga. What kinds of adaptations may be common in both environments? How are the organisms in each environment adapted for the rates of nutrient recycling that you would expect to find?
   b. **Division C:**
      i. Given a complex food web, create a trophic pyramid and determine the amount of energy in each level when given a quantity of energy entering the producer level.
      ii. Students are given a graph depicting the changes in two interacting populations of different species in a habitat. Predict which population is the predator and which is the prey. Give reasons for your choices.

iii. Determine the population growth rate for an area given r (rate of increase) and N (number of individuals).
iv. Students are given three age structures and asked to determine which population has the highest birth rate, death rate, doubling time, and mean age.

5. **SCORING:** Questions will be assigned point values. Students will be ranked from highest to lowest score. Ties will be broken by pre-determined tiebreaker questions.

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

This event is supported by Corteva Agriscience

EXPERIMENTAL DESIGN

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

1. **DESCRIPTION:** This event will determine the participant's ability to design, conduct, and report the findings of an experiment entirely on-site.

   A TEAM OF UP TO: 3 **EYE PROTECTION:** C **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Participants must bring goggles and writing utensils. Experiments will not require any other safety equipment.
   b. Teams may bring one timepiece, one linear measuring device, and one stand-alone calculator of any type. Teams CANNOT use any of these as part of the experiment - they must only be used for their intended function.
   c. The Event Supervisor will provide each team with identical sets of materials either at a distribution center or in an individual container.
   d. The Event Supervisor must provide the 2 part reporting packet posted on the event page at soinc.org, for teams to record their experimental information and data.
3. **THE COMPETITION:**
   a. The teams must design, conduct, and report the findings of an experiment conducted on site that addresses the assigned question/topic area provided by the Event Supervisor. The assigned question/topic area should be the same for all teams and allow the participants to conduct experiments involving relationships between independent and dependent variables (i.e., height vs. distance).
   b. During the first 20 minutes of the event, participants will receive the assigned question/topic area, materials, and Part I of the report packet. Participants will focus on designing and conducting their experiment.
   c. After the first 20 minutes, participants will receive Part II of the report packet and will focus on analyzing their experiment and reporting findings. Participants may continue experimenting throughout the entire event.
   d. Each team must use at least two of the provided materials to design and conduct an experiment. Teams failing to use at least two items will have their final score multiplied by 0.95. The materials will be listed on the board or placed on a card for each team. If provided, both the card and the container will be considered part of the materials. The identity of the materials will be unknown until the start of the event.
   e. When a team finishes, all materials must be returned to the Event Supervisor including both parts of the report packet.
4. **SCORING:**
   a. High score wins. Scoring will be done using the Experimental Design Checklist found on the Science Olympiad website (soinc.org).
   b. Points will be awarded depending upon the completeness of the response. Zero points will be given for no responses as well as illegible or inappropriate responses.
   c. Ties will be broken by comparing the point totals in the scoring areas of the checklist in the following order:
      i. Analysis of Claim/Evidence/Reasoning
      ii. Procedure and Set-Up Diagrams
      iii. Variables
      iv. Data Table
      v. Graph
   d. Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
   e. Any team not using at least 2 of the provided materials will have their final score multiplied by 0.95.
   f. Any team not following clean-up procedures will have their final score multiplied by 0.95.
   g. Any team not addressing the assigned question/topic area will have their final score multiplied by up to 0.75 based on the extent to which the report deviates from the assigned topic.
   h. Any team not collecting data by conducting an experiment on-site will have their final score multiplied by 0.25.

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

EXPERIMENTAL DESIGN CHECKLIST

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

2024 Experimental Design Division C Checklist

(Note: The maximum points available for each task are shown.)

Part I – Design and Construction of the Experiment (70 pts)

A. Statement of the Problem (2 pts)
- ② ① ⓪ Statement addresses the experiment including variables (Not a yes/no question)

B. Hypothesis (6 pts)
- ② ① ⓪ Statement predicts a relationship between the independent and dependent variables
- ② ① ⓪ Statement gives specific direction to the prediction(s) (i.e., a stand is taken)
- ② ① ⓪ A rationale is given for the hypothesis.

C. Variables (20 pts)

a. Independent (IV) & Dependent (DV) Variable (12 pts)
- ④ ③ ② ① ⓪ IV Correctly identified and **operationally** defined
- ④ ③ ② ① ⓪ Levels of IV given
- ④ ③ ② ① ⓪ DV Correctly identified and **operationally** defined

b. Controlled Variables (CV) (**6** pts)
- ② ① ⓪ First CV correctly identified **and relevant**
- ② ① ⓪ Second CV correctly identified **and relevant**
- **② ① ⓪ Third CV correctly identified and relevant**

c. Constant (2 pts)
- ② ① ⓪ First Constant correctly identified **and relevant**

D. Experimental Control (Standard of Comparison) (4 pts)
- ② ① ⓪ SOC logically identified for the experiment
- ② ① ⓪ Reason given for selection of SOC

E. Materials (4 pts)
- ② ① ⓪ All materials used are listed and quantified
- ② ① ⓪ No unused or extra materials are listed

F. Procedure and Set-up Diagrams (14 pts)
- ② ① ⓪ Procedure is presented in list form
- ② ① ⓪ Procedure is in a logical sequence
- ② ① ⓪ Steps for repeated trials are included
- ② ① ⓪ Multiple diagrams of setup are provided
- ② ① ⓪ All diagrams are appropriately labeled
- ④ ③ ② ① ⓪ Procedure detailed enough to repeat experiment accurately

G. Qualitative Observations (12 pts)
- ④ ③ ② ① ⓪ Observations about procedure provided
- ④ ③ ② ① ⓪ Observations about the results provided
- ④ ③ ② ① ⓪ Observations given throughout the course of the experiment

H. Quantitative Data - Data Table (8 pts)
- ② ① ⓪ All raw data is provided
- ② ① ⓪ Condensed data table with only the data to be graphed is provided
- ② ① ⓪ Tables and columns labeled properly
- ② ① ⓪ All data has units

Part II – Data, Analysis and Conclusions (97 pts)

I. Graph (12 pts)
- ④ ③ ② ① ⓪ Appropriate Graph is provided
- ④ ③ ② ① ⓪ Graph properly titled and labeled
- ④ ③ ② ① ⓪ Appropriate scale and units included

J. Statistics (14 pts)
- ④ ③ ② ① ⓪ Statistics of Central Tendency used (i.e., best fit, median, mode, mean)
- ④ ③ ② ① ⓪ One example calculation is given for each statistic with units
- ④ ③ ② ① ⓪ Statistics of Variation are included (i.e., minimum, maximum, range, standard deviation)
- ② ① ⓪ Calculations are accurate

K. Significant Figures (12 pts)
- ④ ③ ② ① ⓪ Data is reported using correct significant figures
- ④ ③ ② ① ⓪ Graph completed using correct significant figures
- ④ ③ ② ① ⓪ Statistics are reported using correct significant figures

L. Analysis of Claim/Evidence/Reason (CER) (18 pts)
- ② ① ⓪ Variation Claim completed logically
- ② ① ⓪ Variation Evidence completed logically
- ② ① ⓪ Variation Reasoning completed logically
- ② ① ⓪ Outliers Claim completed logically
- ② ① ⓪ Outliers Evidence completed logically
- ② ① ⓪ Outliers Reasoning completed logically
- ② ① ⓪ Data Trend Claim completed logically
- ② ① ⓪ Data Trend Evidence completed logically
- ② ① ⓪ Data Trend Reasoning completed logically

M. Possible Experimental Errors (8 pts)
- ④ ③ ② ① ⓪ One specific error is identified and effect on results discussed.
- ④ ③ ② ① ⓪ Second specific error is identified and effect on results discussed.

N. Conclusion (8 pts)
- ② ① ⓪ Hypothesis is re-stated
- ② ① ⓪ Hypothesis Claim completed logically
- ② ① ⓪ Hypothesis Evidence completed logically
- ② ① ⓪ Hypothesis Reasoning completed logically

O. Applications & Recommendations for Further Use (9 pts)
- ③ ② ① ⓪ Suggestions to improve the experiment with rationale are provided
- ③ ② ① ⓪ Suggestions for practical applications of experiment are provided
- ③ ② ① ⓪ Suggestions for future experiments are provided

***Continued on back ***

EXPERIMENTAL DESIGN CHECKLIST (CONT.)

P. Abstract (16 pts)

④ ③ ② ① ⓪ Brief and well-organized

④ ③ ② ① ⓪ Contains the Statement of the Problem and Hypothesis

④ ③ ② ① ⓪ Describes the research procedure

④ ③ ② ① ⓪ Includes major findings and conclusion

School:_____ Team#_____

Point Total: _____/167

Deduction multiplier(s): _____
Materials Used (0.95),
Non-clean up (0.95),
Off topic (0.75),
or Non-lab (0.25)

Final Score: _____

FERMI QUESTIONS

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

1. **DESCRIPTION:** Teams provide answers to a series of "Fermi Questions"; science related questions that seek fast, rough estimates of a quantity, which is either difficult or impossible to measure directly.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. The participants must bring writing utensils. No other materials or resources are allowed.
   b. The event supervisor will provide the questions, scrap paper, and answer sheets with identifying units.
3. **THE COMPETITION:**
   a. Each team will have the same amount of time to answer as many questions as possible.
   b. All teams competing in a given time block will be quizzed together and will be given no feedback during the contest.
   c. All answers are to be written to the correct power of ten (exponent) as follows:
      i. For a number in the form $Cx10^E$, the guide for rounding of the coefficient (C) is: if C is 5 or greater (to 9.99...), round C up to 10. For example, if the number is 5.001×10^3, the correct power of ten is 4. Responses recorded as 5.001×10^3 on the answer sheet will be marked as incorrect.
      ii. If C is below 5 (and greater than 1), round C down to 1. For example, if the number is 4.99×10^6, you record 6 as your answer.
      iii. All answers must be written to only the correct power of ten (exponent). The answer will include only the exponent and NOT the coefficient. For example, if the calculated value is 3.67×10^7, the correct answer would be 7.
      iv. **All answers must be written as an integer.**
   d. Positive exponents are the default. For negative exponents, the minus (-) sign must be included in the answer. If the number is $1.5x10^{-3}$, the correct power of ten is -3.
   e. Teams are allowed to finish before the allotted time: they should hand in their answer sheet, have the time recorded by the event supervisor, and exit the room quietly.
4. **SAMPLE QUESTION/TASK:**
   a. "How many drops of water are there in Lake Erie?" requires an estimate of the volume of a drop, the volume of Lake Erie from its approximate dimensions and conversion of units to yield an answer.
   b. "What is the mass of helium gas is required to fill the Goodyear Blimp?" requires an estimate of the volume of the Goodyear Blimp, the number of helium molecules, and the mass of those molecules to yield an answer.
   c. "How many birds are in the Amazon Rain Forest?" requires an estimate of the number of birds on the planet and the surface of the planet covered by the Amazon Rain Forest to yield an answer.
5. **SCORING:**
   a. High score wins.
   b. Ties are broken by counting the highest number of answers that receive five (5) points. If the number of 5-point answers is the same, the number of 3-point answers will be used. Time is used as the third tiebreaker, if needed.

If the response is:	**It earns:**
Equal to the accepted value	5 points
±1 of the accepted value	3 points
±2 of the accepted value	1 point

Scoring Example: If the accepted value is seven and the response given is 7; then five (5) points are awarded. A response of 6 or 8 receives three (3) points and a response of 5 or 9 receives one (1) point.

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

FLIGHT

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

1. **DESCRIPTION:** Prior to the tournament, teams will **construct, collect data on test flights, analyze and optimize a** free flight rubber-powered aircraft to achieve maximum time aloft.

   A TEAM OF UP TO: 2 **IMPOUND:** No

   APPROXIMATE TIME: 15 minutes

2. **EVENT PARAMETERS:**
   a. **Teams may bring up to 2 aircraft, Flight Log, transportation boxes, tools, and equipment.**
   b. **Teams must bring one or more Measurement Boxes; transportation and measurement boxes may be the same box.**
   c. Event Supervisors will provide all **other** measurement tools and timing devices for scoring purposes.
3. **CONSTRUCTION PARAMETERS:**
   a. Aircraft may be constructed from published plans, commercial kits, competitor's designs, and/or other sources of design. Kits, if used, must not contain any pre-glued joints or pre-covered surfaces.
   b. Aircraft includes any heavier-than-air device capable of flight. This includes but is not limited to: airplanes, monoplanes, biplanes, triplanes, tandem-wings, canards, flying wing, helicopters, gliders, ornithopters, and gyrocopters. However, some aircraft have unique requirements as follows:
      i. Helicopters must have a flat balsa wood disc, large enough to cover a dime, as the upper most part of the helicopter, the part that would touch a flat ceiling first during the flight.
      ii. Gliders must have a hand-held launcher in its ready to use configuration that fits in the box with the glider when it is presented for inspection.
   c. Any materials except Boron filaments may be used in construction of the aircraft and boxes.
   d. The aircraft, in its flight configuration, must fit **fully** into a team-provided **Measurement** Box.
      i. For Division B, the external dimensions of the Measurement Box must fit within a **right, rectangular prism** of **41.0** cm x 28.5 cm x **65.0** cm, including any external protuberances.
      ii. For Division C, the external dimensions of the Measurement Box must fit within a **right, rectangular prism** of **32.0 cm x 23.0 cm x 47.0 cm,** including any external protuberances.
   e. Measurement Boxes (with or without a lid) may be constructed by the participants or purchased:
      i. **For Division B, typically available long bankers or file boxes should fit within the dimensions. The team is responsible for verifying their own boxes prior to the competition.**
      ii. **For Division C, typically available 8-ream copy paper boxes should fit within the dimensions. The team is responsible for verifying their own boxes prior to the competition.**
   f. "Flight configuration" means the aircraft is fully assembled and ready to fly. For example, no change in chord, span, length, or total lifting area can occur after removing the aircraft from its box and throughout the flight itself. Components that rotate during flight may be rotated such as propellers or rotors to allow the aircraft to fit into the box. **The rubber motor(s) does not have to be on the aircraft or wound.**
   g. All aircraft-lifting forces must be generated by wing(s) or rotor style flying surfaces.
   h. Total mass of the aircraft, excluding the rubber motor(s), must be 8.00 g or more.
   i. The propeller/rotor assembly/assemblies may be built by the participants or purchased pre-assembled. This may include a propeller, a shaft, a hanger, and/or a thrust bearing. Variable-pitch propellers that include mechanisms to actively change the propeller/rotor diameter or blade angle must not be used.
   j. The sole power for the aircraft must come from rubber motor(s).
      i. The total mass of the rubber motor or rubber motor set, including any attachments such as o-rings, must not exceed **1.5 g**.
      ii. For multi-motor aircraft, rubber motors must be massed together as a set and individual rubber motors may not be interchanged between sets.
      iii. Motors will be massed separately from the aircraft. Motors may be lubricated before and/or after check-in.
      iv. Up to 6 motors, or sets of motors for multi-motor aircraft, may be checked in.
   k. Participants may use any type of winder, but electricity may not be available.
   l. 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.
   m. Aircraft must be labeled so that the Event Supervisor can easily identify to which team it belongs.

4. **FLIGHT LOGS:**
   a. Teams must present a Flight Log of recorded data. This data must include 6 or more parameters (3 required and at least 3 additional) with units for 10 or more test flights prior to the competition.
      i. The required parameters are:
         (1) Motor size before windup
         (2) Number of turns on the motor or torque at launch
         (3) Flight time
      ii. The team must choose 3 additional data parameters beyond those required (e.g., turns remaining at landing, estimated/recorded peak flight altitude, the motor torque at landing, propeller pitch, etc.).
   b. All logs will be returned to teams after inspection.
5. **THE COMPETITION:**
   a. The event will be held indoors. Tournament officials will announce the room dimensions (approximate length, width, and ceiling height) in advance of the competition. Tournament officials and the Event Supervisor are urged to minimize the effects of environmental factors such as air currents.
   b. Once participants enter the cordoned off competition area to trim, practice, or compete they must not receive outside materials **(except as permitted by the Event Supervisor)**, assistance, or communication. Only participants may handle aircraft until the event ends. Teams violating this rule will be ranked below all other teams. Spectators will be in a separate area.
   c. At the Event Supervisor's discretion:
      i. Multiple official flights may occur simultaneously.
      ii. Test flights may occur throughout the contest but must yield to any official flight.
      iii. No test flights will occur in the final half-hour of the event's last period, except for teams that declare a trim flight during their 10-minute Flight Period.
   d. Check-in:
      i. Prior to check-in with the Event Supervisor, a self-check inspection station may be made available to participants for checking their **Measurement Box(es)**, aircraft, and motor(s).
      ii. At check-in, participants will present their aircraft in **Measurement Box(es)**, motor(s), and Flight Logs for inspection immediately prior to their Flight Period.
      iii. The Event Supervisor will verify the external dimensions of the **Measurement Box(es)** and that the aircraft fits fully inside the Measurement Box while in its flight configuration. The aircraft's overall dimensions must not change after being removed from the box. This may be verified by showing that the aircraft slides into and out of the box without changing shape at the discretion of the Event Supervisor.
      iv. The participants will remove the aircraft from the box to allow for the mass to be measured.
      v. All motor(s) will be collected, massed, and returned to the team at the start of their 10-minute Flight Period.
      vi. Only Participants **should** handle the aircraft or **Measurement Box(es)**.
   e. Flight Period:
      i. The 10-minute flight period begins when the Event Supervisor returns the motor(s) to the team.
      ii. Any flight beginning within the 10-minute Flight Period will be permitted to fly to completion.
      iii. Participants may make adjustments/repairs/trim flights during their official Flight Period.
      iv. Before each launch, participants must indicate to the Timers whether a flight is an official flight or a trim flight. A flight is considered official if a team fails to notify the Timer(s) of the flight's status.
      v. Teams must not be given extra time to recover or repair their aircraft.
      vi. Teams may make up to a total of 2 official flights using 1 or 2 aircraft.
      vii. Time aloft for each flight starts when the aircraft leaves the participant's hand and stops when any part of the aircraft touches the floor, the lifting surfaces no longer support the weight of the aircraft (such as the aircraft landing on a girder or basketball hoop) or the Event Supervisors otherwise determine the flight to be over.
      viii. Event Supervisors are strongly encouraged to utilize three (3) timers on all flights. The median flight time in seconds to the precision of the device used is the official time aloft.
      ix. Participants must not steer the aircraft during flight.
      x. **Students must be on the floor to launch and must not use artificial aids to increase launch height.**

xi. In the unlikely event of a collision with another aircraft, a team may elect a re-flight. The decision to re-fly may be made after the aircraft lands. Timers are allowed to delay a launch to avoid a possible collision. The 10-minute Flight Period does not apply to such a flight.

f. **If requested by the Event Supervisor, the participants must demonstrate that each aircraft still fits fully inside the Measurement Box(es) in the flight configuration. Teams may not manipulate the configuration of the aircraft in order to fit into the box except to rotate components that rotated during flight such as propellers or rotors. The aircraft's overall dimensions must not change after being removed from the box. Motor(s) may be removed from the aircraft or left in place during the demonstration.**

g. The Event Supervisor will verify with the team the data being recorded on their scoresheet.

h. Teams filing an appeal must leave their aircraft, Measurement Box(es), motor(s), and Flight Log in the event area.

6. **SCORING:**

a. Highest Final Score wins. A team's Final Score is the larger of the team's Flight Scores.

b. Flight Score for each official flight = Flight Time x Bonus (5.c.)

c. Flight Log Bonus:

i. Teams with a complete Flight Log with receive a 20% bonus multiplier (x 1.2)

ii. Teams with a partial Flight Log will receive a 10% bonus multiplier (x 1.1)

iii. Teams without a Flight Log will receive no bonus multiplier (x 1.0)

iv. Teams that violate rule(s) under "CONSTRUCTION PARAMETERS" or "THE COMPETITION" that do not have a specific penalty will be ranked after all teams that do not violate those rules.

d. Ties will be broken by the longest non-scored official Flight Score.

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

This event is supported by National Free Flight Society (NFFS)

FORENSICS

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

1. **DESCRIPTION:** Given a scenario and some possible suspects, students will perform a series of tests. These tests, along with other evidence or test results, will be used to solve a crime.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** C **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each participant may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed.
   b. Each team may bring any or all of the items listed on the Division C Chemistry Events Lab Equipment List, posted on soinc.org, to use during this event and two stand-alone calculators of any type. Teams not bringing these items may be at a disadvantage. The Supervisor will not provide them.
   c. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
   d. The Supervisor will provide:
      i. iodine reagent (I_2 dissolved in KI solution)
      ii. 1M HCl
      iii. 1M NaOH
      iv. Benedict's solution
      v. a hot water bath
      vi. a Bunsen burner or equivalent BTU heat source to perform flame tests
      vii. a waste container
      viii. chromatography materials (e.g., beakers, Petri dishes, etc.)
      ix. a wash bottle with distilled water
   e. The Supervisor may provide:
      i. other equipment (e.g., a microscope, probes, etc.)
      ii. candle & matches if fibers given
      iii. differential density solutions or other method of determining density of polymers if plastics given
      iv. reagents to perform other tests

3. **THE COMPETITION:**
   a. The competition will consist of evidence from Parts 3.b. - e. and analysis of the evidence in Part 3.f. Analysis or questions can only be on the evidence topics included in the competition. The collected evidence and other data given may be used in a mock crime scene. The amount of evidence included will be according to the following table:

Level	Part b. # of samples	Part c. # of samples	Part d. # of chromatograms	Part e. # of topics	Part f.
Regional	3-8	5-9	1 type + Mass Spectra	1-2	Required
State	6-10	6-12	1-2 types + Mass Spectra	1-3	Required
National	10-14	10-18	1-3 types + Mass Spectra	3-5	Required

   b. Qualitative Analysis: Participants may be asked to identify the following substances: sodium acetate, sodium chloride, sodium hydrogen carbonate, sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid, and ammonium chloride (there will be no mixtures). All teams will have the same set of solids to identify.
   c. Polymers: Participants may be asked to identify:
      i. Plastics: PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA, PC – Participants will not perform any burn tests on these plastics, but the Supervisor may provide burn test results on them.
      ii. Fibers: cotton, wool, silk, linen, nylon, spandex, polyester - burn tests will be permitted on the fibers.
      iii. Hair: human, bat, cow, squirrel, and horse - participants will need to know hair structure including medulla, cortex, cuticle, root and hair scale classification.

d. Chromatography/Spectroscopy: Participants will be expected to separate components using paper chromatography, TLC, and/or analyze mass spectra. Participants may be expected to measure Rfs.
e. Crime Scene Physical Evidence:
   i. Fingerprint Analysis: Participants will be expected to know the 8 specific fingerprint patterns (plain arch, tented arch, radial loop, ulnar loop, plain whorl, central pocket whorl, accidental whorl, and double loop whorl). Participants should also be familiar with the common fingerprint development techniques of dusting, iodine fuming, ninhydrin, and cyanoacrylate fuming. Participants should understand terminology such as bifurcation, ridges, island, enclosure, loop, whorl, and arch. Participants should be able to answer questions about skin layers and how fingerprints are formed. Participants may be asked questions on the different methods of detecting fingerprints and the chemistry behind each of these methods.
   ii. DNA: Participants may be asked to compare DNA chromatograms/electropherograms from materials found at the scene to those of the suspects. Participants will be expected to know how DNA is copied. See http://educationalgames.nobelprize.org/educational/chemistry/pcr/
   iii. Glass analysis: Participants may be asked to use index of refraction to determine the type of a glass found broken at a crime scene. They may be asked to analyze which hole or fractures occurred before others based on a piece of glass available for examination or a picture of a piece of glass.
   iv. Entomology: Participants may be asked to identify how long an animal has been dead based on the type of insects found on the body at the scene.
   v. Spatters: Participants may be asked to analyze actual spatters or photographs of spatters to determine the angle and velocity with which the liquid approached the solid object bearing the spatter & the spatter origin direction.
   vi. Seeds and Pollen: Participants may be asked to compare pictures of seeds/pollen found at the scene with either seeds/pollen found on the suspects or seeds/pollen from different country regions.
   vii. Tracks and Soil: Participants may be asked to match tire tracks or footprints found at the scene to tires or shoes of the suspects. Participants may be given the composition of soil found at the scene or on the suspects and asked to determine if this implicates any of the suspects.
   viii. Blood: Participants may be asked to identify the ABO blood type using artificial blood (Event
   ix. Supervisor required to provide instructions on how the typing system works) or participants may be asked to identify if a blood sample, either prepared microscope slide or pictures of microscope slide, is human, avian, mammalian, or reptilian/amphibian.
   x. Bullet striations: Participants may be asked to match the striations on bullets or casings found at the crime scene and fired from a given gun.
f. Analysis of the Crime: Participants will be asked to write an analysis of the crime scene explaining not only which pieces of evidence implicate which suspect(s) and why the suspect(s) was (were) chosen as the culprit(s), but also why the other suspects were not chosen. They will also answer any other crime scene analysis questions posed by the Event Supervisor.
g. Teams will dispose of waste as directed by the Event Supervisor.

4. **SCORING:**

a. High score wins. Time will not be used for scoring.
b. The score will be composed of the following elements (percentages given are approximate): Part 3.b. ≈ 20%, Part 3.c. ≈ 20%, Part 3.d. ≈ 15%, Part 3.e. ≈ 15%, and 3.f. ≈ 30%.
c. Ties will be broken by the highest score on the analysis of the crime scene, which includes the reasons why certain suspects have been eliminated or others remain in the pool of possible criminals.
d. A 10% penalty may be given if the area is not cleaned up as designated by the Event Supervisor.
e. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.

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

FORESTRY

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

1. **DESCRIPTION:** Participants will be assessed on their **general forestry** knowledge **and the trees found in the United States** that are on the **2024 Official Science Olympiad National Tree List**.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs, and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays, no material may be removed from the binder throughout the event.
   b. Each team may also have one commercially produced field guide which may be tabbed or annotated.
   c. In addition to their resource binder and field guide, each team may bring one (1) copy of either the **2024 Official Science Olympiad National Tree List** or a state or regional tree list if issued.
3. **THE COMPETITION:**
   a. All questions will be restricted to specimens on the **Official Science Olympiad National Tree List** and no more than 50% of the competition will require giving a **scientific and/or common name**.
   b. This event may be held either indoors, in a wooded lot, or both. Specimens (or pictures/slides if necessary) will be lettered or numbered at stations.
   c. Each team will be given an answer sheet on which they will record answers to each question.
   d. Participants should be able to do basic identification to the level indicated on the **2024 Official Science Olympiad National Tree List which is posted on the Science Olympiad National website**.
   e. **Tree** specimens may be live or preserved depending on availability and may **include leaves,** twigs, cones, **flowers, fruits, entire trees, or other structures**. Identification will be based on an examination of the specimens **and their structural characteristics.** Structural characteristics may include leaf and flower types, shapes, margins, venation, and arrangement on the stem, as well as buds, bud scars, bark, fruit types, and tree shapes.
   f. For each specimen, students will be asked correlated question**s** that pertains to the tree's ecology, economic characteristics, **or management**. Ecological characteristics may include habitats, adaptations to the environment, biomes, succession, and relationships (e.g., symbiosis and competition) with animals or other plants. Economic characteristics may include beneficial or detrimental aspects of trees such as sources of food, medicine, building materials, chemicals, fuel, fiber, and trees as nuisance species. **Management questions may pertain to regeneration, thinning, and harvesting methods as well as pest/disease/invasive species concerns, ecosystem services, urban forestry, and forest measurement.**
   g. States may have a modified **State or Regional Tree List** which are limited to or focus on local trees. This list if created will be **posted on the state website no later than November 1st**.
   h. The National competition will be based on the **2024 Official Science Olympiad National Tree List** which is **based on the taxonomy of the National Audubon Society Trees of North America, 2021 Edition. While not titled as such for our competitions, this book is considered a field guide.**
4. **SAMPLE ACTIVITIES:**
   a. Identify **scientific name** and/or common name of the provided sample.
   b. What conclusion can be drawn about the habitat(s) of the given specimens?
   c. Which of these specimens does not fit within this **family of trees**?
   d. What unique feature distinguishes the specimen shown in the picture?
   e. Consider the potential impact of human activities on this particular tree.
5. **SCORING:**
   a. High score wins.
   b. Selected questions may be used as tiebreakers.

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

This event is supported by USDA Forest Service - Conservation Education

2024 NATIONAL TREE LIST

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

Family: Family Name
Genus species (Common Name)

Ginkgoaceae: Ginkgo Family
Ginkgo biloba (Ginkgo)

Taxaceae: Yew Family
Taxus brevifolia (Pacific Yew)

Pinaceae: Pine Family
Abies balsamea (Balsam Fir)
Abies concolor (White Fir)
Abies grandis (Grand Fir)
Abies lasiocarpa (Subalpine Fir)
Larix laricina (Tamarack)
Larix occidentalis (Western Larch)
Picea engelmannii (Engelmann Spruce)
Picea glauca (White Spruce)
Picea mariana (Black Spruce)
Picea pungens (Blue Spruce)
Picea rubens (Red Spruce)
Picea sitchensis (Sitka Spruce)
Pinus attenuata (Knobcone Pine)
Pinus banksiana (Jack Pine)
Pinus contorta (Lodgepole Pine)
Pinus echinata (Shortleaf Pine)
Pinus edulis (Colorado Pinyon Pine)
Pinus lambertiana (Sugar Pine)
Pinus palustris (Longleaf Pine)
Pinus ponderosa (Ponderosa Pine)
Pinus resinosa (Red Pine)
Pinus rigida (Pitch Pine)
Pinus strobus (Eastern White Pine)
Pinus taeda (Loblolly Pine)
Pseudotsuga menziesii (Douglas-fir)
Tsuga canadensis (Eastern Hemlock)
Tsuga heterophylla (Western Hemlock)
Tsuga mertensiana (Mountain Hemlock)

Cupressaceae: Cypress Family
Chamaecyparis lawsoniana (Port-Orford Cedar)
Cupressus macrocarpa (Monterey Cypress)
Juniperus osteosperma (Utah Juniper)
Juniperus scopulorum (Rocky Mountain Juniper)
Juniperus virginiana (Eastern Redcedar)
***Sequoia* sempervirens** (Redwood)
Sequoiadendron giganteum (Giant Sequoia)
Taxodium distichum (Baldcypress)
Thuja occidentalis (Northern White-cedar)
Thuja plicata (Western Redcedar)

Arecaceae: Palm Family
Sabal palmetto (Cabbage Palmetto)
Washingtonia filifera **(**California Fan Palm)

Salicaceae: Willow Family
Populus alba (White Poplar)
Populus angustifolia (Narrowleaf Cottonwood)
Populus balsamifera (Balsam Poplar)
Populus deltoides (Eastern Cottonwood)
Populus grandidentata (Bigtooth Aspen)
Populus tremuloides (Quaking Aspen)
Salix bebbiana (Bebb Willow)
Salix nigra (Black Willow)
Salix scouleriana (Scouler Willow)

Juglandaceae: Walnut Family
Carya cordiformis (Bitternut Hickory)
Carya glabra (Pignut Hickory)
Carya illinoinensis (Pecan)
Carya ovata (Shagbark Hickory)
Juglans cinerea (Butternut)
Juglans nigra (Black Walnut)

Betulaceae: Birch Family
Alnus rubra (Red Alder)
Betula alleghaniensis (Yellow Birch)
Betula lenta (Sweet Birch)
Betula nigra (River Birch)
Betula occidentalis (Water Birch)
Betula papyrifera (Paper Birch)
Betula populifolia (Gray Birch)
Carpinus caroliniana (American Hornbeam)
Ostrya virginiana (Eastern Hophornbeam)

Fagaceae: Beech Family
Castanea dentata (American Chestnut)
Fagus grandifolia (American Beech)
Notholithocarpus densiflorus (Tanoak)**
Quercus agrifolia (Coast Live Oak)
Quercus alba (White Oak)
Quercus chrysolepis (Canyon Live Oak)
Quercus douglasii (Blue Oak)
Quercus falcata (Southern Red Oak)
Quercus garryana (Oregon White Oak)
Quercus kelloggii (California Black Oak)
Quercus macrocarpa (Bur Oak)
Quercus palustris (Pin Oak)
Quercus phellos (Willow Oak)
Quercus montana (Chestnut Oak)**
Quercus rubra (Northern Red Oak)
Quercus velutina (Black Oak)
Quercus virginiana (Live Oak)

Cannabaceae: Hemp Family
Celtis occidentalis **(Northern** Hackberry)

Ulmaceae: Elm Family
Ulmus americana (American Elm)
Ulmus rubra (Slippery Elm)

Moraceae: Mulberry Family
Maclura pomifera **(**Osage-orange)
Morus alba (White Mulberry)
Morus rubra (Red Mulberry)

Magnoliaceae: Magnolia Family
Liriodendron tulipifera (Yellow-poplar)
Magnolia grandiflora (Southern Magnolia)
Magnolia macrophylla (Bigleaf Magnolia)

2024 NATIONAL TREE LIST (CONT.)

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

Annonaceae: Custard Apple Family
Asimina triloba (Common Pawpaw)

Lauraceae: Laurel Family
Sassafras albidum (Sassafras)
Umbellularia californica (California-laurel)

Hamamelidaceae: Witch-Hazel Family
Hamamelis virginiana (Witch-hazel)

Altingiaceae: Sweetgum Family
Liquidambar styraciflua (Sweetgum)

Platanaceae (Sycamore Family)
Platanus occidentalis (American Sycamore)
Platanus racemosa (California Sycamore)

Rosaceae: Rose Family
Amelanchier alnifolia (Western Serviceberry)
Cercocarpus ledifolius (Curl-leaf Mountain Mahogany)
Heteromeles arbutifolia (Toyon)
Prunus americana (American Plum)
Prunus emarginata (Bitter Cherry)
Prunus pensylvanica (Pin Cherry)
Prunus serotina (Black Cherry)
Prunus virginiana (Common Chokecherry)
Pyrus calleryana (Bradford Pear)
Sorbus americana (American Mountain-ash)

Fabaceae: Legume Family
Albizia julibrissin (Silktree)
Cercis canadensis (Eastern Redbud)
Gleditsia triacanthos (Common Honeylocust)
Gymnocladus dioicus (Kentucky Coffeetree)
Parkinsonia florida (Blue Paloverde)
Prosopis glandulosa (Honey Mesquite)
Robinia pseudoacacia (Black Locust)
Vachellia farnesiana (Sweet Acacia)

Rutaceae: Rue Family
Zanthoxylum clava-herculis (Hercules'-club)

Simaroubaceae: Quassia Family
Ailanthus altissima (Ailanthus)

Anacardiaceae: Cashew/Sumac Family
Rhus glabra (Smooth Sumac)
Rhus typhina (Staghorn Sumac)

Aquifoliaceae: Holly Family
Ilex opaca (American Holly)
Ilex vomitoria (Holly/Yaupon)

Sapindaceae: Maple Family
Acer macrophyllum (Bigleaf Maple)
Acer negundo (Box Elder)
Acer platanoides (Norway Maple)
Acer rubrum (Red Maple)
Acer saccharinum (Silver Maple)
Acer saccharum (Sugar Maple)

Hippocastanaceae (Buckeye Family)
Aesculus californica (California Buckeye)
Aesculus glabra (Ohio Buckeye)

Malvaceae: Mallow Family
Tilia americana (American Basswood)

Cactaceae: Cactus Family *
Carnegiea gigantea (Saguaro) ***

Agavaceae: Yucca Family *
Yucca brevifolia **(**Joshua Tree) ***

Myrtaceae: Myrtle Family
Eucalyptus globulus (Bluegum Eucalyptus)

Cornaceae: Dogwood Family
Cornus florida (Flowering Dogwood)
Cornus nuttallii (Pacific Dogwood)

Nyssaceae: Tupelo Family
Nyssa sylvatica (Black Tupelo)

Ericaceae: Heath Family
Arbutus menziesii (Pacific Madrone)

Ebenaceae: Ebony Family
Diospyros virginiana (Common Persimmon)

Oleaceae: Olive Family
Fraxinus americana (White Ash)
Fraxinus latifolia (Oregon Ash)
Fraxinus pennsylvanica (Green Ash)
Fraxinus velutina (Velvet Ash)

Bignoniaceae: Bignonia Family
Catalpa bignonioides (Southern Catalpa)
Catalpa speciosa (Northern Catalpa)
Chilopsis linearis (Desert-willow)

Paulowniaceae: Paulownia Family
Paulownia tomentosa (Princess-tree)

Adoxaceae: Muskroot Family
Sambucus nigra (American Elderberry)

Euphorbiaceae: Spurge Family*
Aleurites moluccanus (Candlenut) ***
Triadica sebifera (Chinese Tallow) ***

Note: The 2024 Official Science Olympiad National Tree List taxonomy is based on the National Audubon Society Trees of North America, 2021 Edition.

*** - indicates not in the National Audubon Society Trees of North America, 2021 Edition.**

**** - indicates that the scientific name has been changed since the publication of the National Audubon Society Trees of North America, 2021 Edition; the name listed matches that book.**

FOSSILS

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

1. **DESCRIPTION:** Teams identify and classify fossils and demonstrate their knowledge of ancient life. Tasks **will be** related to interpretation of past environments and ecosystems, adaptations, evolutionary relationships, and **the** use of fossils in dating and correlating rock units.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one **(1)** magnifying glass and one **(1) three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted**.
   b. **Each team may also have one commercially produced field guide which may be tabbed and annotated.**
   c. **In addition to the resource binder and field guide, each team may bring one (1) copy of the 2024 Science Olympiad Fossil List, which does not have to be secured in the binder and two stand-alone non-programmable, non- graphing calculators (Class II).**
   d. **Teams are not permitted to bring samples or specimens to the event.**
   e. If the event features a rotation through a series of laboratory stations where the participants interact with
   f. samples, specimens, or displays; no material may be removed from the binder, **except for the 2024 Science Olympiad Fossil List.**

3. **THE COMPETITION:**
   a. Where possible, participants will move from station to station, with the length of time at each station predetermined and announced by the Event Supervisor.
   b. Participants may not return to stations but may continue to work on their responses throughout.
   c. Stations will feature task-oriented activities emphasizing application of paleontological concepts.
   d. Identification will be limited to specimens on the **2024** Science Olympiad Fossil List, but other samples may be used to illustrate key concepts.
   e. Questions will be chosen from the following topics:
      i. Identification of fossil specimens on the **2024** Science Olympiad Fossil List
      ii. Taxonomic classification restricted to the hierarchy on the Science Olympiad Fossil List
      iii. Conditions **that favor preservation of fossils (e.g., rapid burial, hard parts, low oxygen environment, escape destruction)**
      iv. Common modes of preservation: petrification/petrifaction (e.g., permineralization & mineral replacement including silicification, pyritization, **and phosphatization),** cast, external vs. internal molds (steinkerns), imprints, carbonization, unaltered remains **(e.g., shells, teeth)**
      v. Uncommon modes of preservation: **limited to** encasement in amber, mummification, freezing, tar
      vi. **Bias in the Fossil Record: e.g., animals with mineralized hard parts (skeletons or shells) more likely preserved than soft bodied animals; aquatic organisms more likely to be preserved than terrestrial (land) organisms**
      vii. **Determining the age of fossils and the rocks they are in through relative or absolute dating techniques.**
         (1) Relative dating **techniques: limited to** law of superposition, original horizontality, cross-cutting relationships, unconformities, **faunal succession, correlation of rock layers and/or fossils**
         (2) Absolute dating **techniques: limited to** radiometric dating, including half-life, radioactive isotopes used **(e.g., Carbon 14, Potassium/Argon, Uranium/Lead)**
         (3) **Limitations of relative and absolute dating in determining the age of fossils**
         (4) **Use of radiometric dating of igneous rocks and volcanic ash along with relative dating techniques to determine the age of fossils.**
      viii. The Geologic Time Scale, its organization, major events, the 5 major mass extinctions, and the Pleistocene-Holocene extinction of megafauna. An official Science Olympiad Geologic Time Scale is posted at soinc.org & should be used for all competitions
      ix. Index Fossils: characteristics and use in determining the age of rocks & geologic formations
      x. Fossil-bearing sedimentary rocks **and their significance in interpreting ancient environments and habitats**
      xi. Modes of life **and mobility: benthonic**/benthic (**infaunal vs epifaunal; sessile vs vagrant); planktonic/planktic; nektonic/nektic (swimmers); terrestrial**

xii. **Ecologic role and trophic level (role in food web): producers, filter/suspension feeder, predator, scavenger, deposit feeder (detritovore), herbivore**
xiii. **Differences in plant reproduction through seeds or spores.**
xiv. Environments: marine (**e.g., shallow marine/shelf**, reef, lagoon, deep marine); terrestrial (**e.g., tropical, temperate forest, grassland, wetlands, desert, taiga, tundra),** fresh water **(e.g., lakes, rivers, swamps)**
xv. Mineral and organic components of exoskeletons, shells, and bones/teeth (e.g., calcite, aragonite, silica, chitin, biological apatite/**calcium phosphate**)
xvi. Adaptations and morphologic features **and their implications (e.g., serrated sharp teeth in vertebrates indicate predatory behavior)**
xvii. **Significance of** important paleontological discoveries (**e.g.,** non-avian dinosaurs with feathers; transitional species such as *Tiktaalik* and *Archaeopteryx*)
xviii. **Paleontological significance of** *Lagerstätten* (conservation and concentration) limited to: Burgess Shale, Beecher's Trilobite Bed, Mazon Creek, Ghost Ranch, Solnhofen Limestone, Yixian Formation (Liaoning), Green River Formation, and La Brea Tar Pits
xix. Major evolutionary events, **trends,** and transitions: (e.g., Cambrian Explosion, Ordovician Radiation, Mesozoic Marine Revolution, **Mesozoic-Cenozoic Radiation; suture patterns in cephalopods,** fish to tetrapods transition, **evolution of** birds **from dinosaurs**, **evolution of** whales, **evolution of** horses)
xx. **Convergent evolution: (e.g., fins in fish, marine reptiles, and mammals; wings in insects, pterosaurs, birds, and bats)**
xxi. **Interpretation of cladograms to show evolutionary relationships**
xxii. Stromatolites, how they form, their role in the history of life and **the** development of Earth's atmosphere, **including the Great Oxygenation Event**
xxiii. Trace fossils (ichnofossils) **as evidence of fossil behavior**. **Limited** to trails, **tracks &** trackways, **footprints, resting traces,** borings, burrows, tubes, predation marks, and coprolites
(1) Use of dinosaur footprints to calculate hip height of animal
(2) Use of dinosaur trackway to determine running or walking speed

4. **SAMPLE QUESTIONS/TASKS:**
a. Identify each fossil, and record its mode of preservation.
b. List samples in order from oldest to most recent.
c. Based on the fossil and **the type of rock it is**, determine the environment in which the organism lived. **(e.g., Seed fern in black shale indicates terrestrial swamp)**
d. The fossils illustrated **(ichthyosaur, pterosaur, and *Archeopteryx*)** were discovered in the Solnhofen Limestone, a unique Lagerstätten in Germany. What geological period is indicated based on the specimens in this limestone?
e. Describe the evolutionary relationships between the organisms illustrated on the family tree (cladogram/ phylogenetic tree).
f. **A volcanic ash layer is discovered within a continuous sequence of fossiliferous limestones. Through the use of radiometric isotopes, the ash layer is determined to be 370 million years old. What is the most likely time period of the fossils in the limestone?**
g. Construct a range chart and determine the age of the fossil assemblage **by using the data provided for each fossil. Based on the range of the fossils present, what is the age of the assemblage? Which specimen would be the best Index Fossil?**
h. **The image and diagram show a dinosaur footprint. Using the measurements provided, determine the hip height of the dinosaur.**

5. **SCORING:**
a. High score wins.
b. Points will be awarded for the quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods of responses.
c. Ties will be broken by the accuracy and quality of answers to pre-selected questions and/or sections.

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

FOSSIL LIST

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

KINGDOM PROTOZOA

Phylum Foraminifera (Forams) *

Order Fusulinida (Fusulinids)*

Genus *Triticites**

Order Rotaliida*

Genus *Nummulites**

KINGDOM ANIMALIA

SPONGES (Phylum Porifera)*

Genus *Astraeospongia* (calcareous sponge)*

Genus *Hydnoceras* (glass sponge)*

BRYOZOANS (Phylum Bryozoa)

Growth forms: branching, massive, fenestrate)

Genus *Archimedes*

Genus *Rhombopora*

GRAPTOLITES (Phylum Hemichordata)*

Order Dendroidea (benthic graptolites)

Order Graptoloidea (planktic graptolites)

CORALS (Phylum Cnidaria)

Order Tabulata (tabulate corals)

Genus *Favosites*

Genus *Halysites**

Order Rugosa (rugose corals)

Genus *Heliophyllum* (horn coral)

Genus *Hexagonaria*

Order Scleractinia (stony corals)

Genus *Septastrea*

ARTHROPODS (Phylum Arthropoda)

Subphylum Crustacea (shrimp, lobsters, crabs, barnacles, ostracods)*

Subphylum Chelicerata

Order Eurypterida (Eurypterids)

Genus *Eurypterus*

Class Insecta (Insects)

Class Trilobita (Trilobites)

Polymerids

Genus *Cryptolithus*

Genus *Calymene*

Genus *Elrathia*

Genus *Isotelus**

Genus *Eldredgeops* (formerly *Phacops*)

Agnostids

Genus *Peronopsis*

BRACHIOPODS (Phylum Brachiopoda)

Class Inarticulata

Genus *Lingula*

Class Articulata

Genus *Atrypa*

Genus *Composita*

Genus *Juresania**

Genus *Leptaena**

Genus *Mucrospirifer*

Genus *Platystrophia*

Genus *Rafinesquina*

MOLLUSKS (Phylum Mollusca)

Class Bivalvia (clams, oysters, mussels)

Genus *Exogyra*

Genus *Gryphaea*

Genus *Pecten*

Genus *Glycymeris*

Genus *Astarte*

Genus *Nucula*

Class Cephalopoda

Order Goniatitida (goniatites)*

Order Ceratitida (ceratites)*

Order Ammonitida (ammonites)

Genus *Baculites*

Genus *Dactylioceras*

Order Belemnitida (Belemnites)

Genus *Belemnitella*

Order Nautilida (Chambered Nautilus)

Order Orthocerida ("Orthoceras")

Class Gastropoda (Snails) Genus *Conus*

Genus *Cypraea*

Genus *Platyceras*

Genus *Turritella*

Genus *Worthenia*

ECHINODERMS (Phylum Echinodermata)

Class Asteroidea (Starfish)*

Class Blastoidea

Genus *Pentremites*

Class Crinoidea (stems, columns, calyxes)

Class Echinoidea

(regular or irregular echinoids: sea urchins, sand dollars and heart urchins)

Class Ophiuroidea (brittle stars)*

Note: Taxa marked by an asterisk (*) are for State and National Tournaments only

FOSSIL LIST (CONT.)

VERTEBRATES (Phylum Chordata)

- Superclass Agnatha (Jawless Fish) (Ostracoderms)*
  - Class Placodermi (Armored Jawed Fish)
    - Genus *Bothriolepis*
    - Genus *Dunkleosteus*
  - Class Chondrichthyes (Cartilaginous Fish)
    - Superorder Selachimorpha (Sharks)
      - Genus *Otodus*
      - Genus *Carcharocles* (formerly *Carcharodon)*
        - Species *C. megalodon*
    - Superorder Batoidea (Rays)*
  - Superclass Osteichthyes (Bony Fish)
- Class Actinopterygii (ray-finned)
  - Genus *Knightia*
  - Genus *Xiphactinus**
- Class Sarcopterygii (lobe-finned)
  - Genus *Eusthenopteron*
  - Genus *Latimeria* (Coelacanth)
  - Genus *Tiktaalik*
- Class Amphibia (Amphibians)
  - Genus *Acanthostega*
  - Genus *Eryops*
  - Genus *Diplocaulus*
- Class Reptilia (Reptiles)
  - Order Crocodilia (crocodiles)*
  - Order Testudines (turtles)*
  - Order Ichthyosauria (Ichthyosaurs)
  - Order Squamata
    - Family Mosasauridae (Mosasaurs)
  - Order Plesiosauria (Plesiosaurs & Pliosaurs)
  - Order Pterosauria (Pterosaurs)
- Clade Dinosauria (Dinosaurs)
  - Order Saurischia (lizard-hipped)
    - Suborder Theropoda
      - Genus *Allosaurus*
      - Genus *Coelophysis*
      - Genus *Dilophosaurus*
      - **Genus *Deinonychus****
      - Genus *Spinosaurus**
      - Genus *Tyrannosaurus*
      - Genus *Velociraptor*
    - Suborder Sauropodomorpha
      - **Genus *Apatosaurus****
      - Genus *Brachiosaurus*
      - Genus *Diplodocus*
      - Genus *Patagotitan**
      - Genus *Plateosaurus*
  - Order Ornithischia (bird-hipped)
    - Infraorder Ankylosauria
      - Genus *Ankylosaurus*
    - Infraorder Ceratopsia
      - Genus *Triceratops*
      - Genus *Protoceratops**
    - Infraorder Ornithopoda
      - Genus *Iguanodon*
      - Genus *Parasaurolophus*
      - Genus *Maiasaura*
    - Infraorder Pachycephalosauria
      - Genus ***Pachycephalosaurus****
    - Infraorder Stegosauria
      - Genus *Stegosaurus*
  - Class Aves (Birds)
    - Genus *Archaeopteryx*
    - Genus *Titanis* (Terror Bird)
    - **Genus *Hesperornis****
- Clade Synapsida
- **Stem Mammals/Proto-Mammals**
  - Genus *Dimetrodon* (pelycosaurs)
  - Genus *Lystrosaurus* (therapsids)
  - **Genus *Gorgonops* (therapsid)***
  - Class Mammalia (Mammals)
    - Genus *Basilosaurus* (prehistoric whale)
    - Genus *Equus* (modern horse)
    - Genus *Mesohippus* (three-toed horse)
    - Genus *Australopithecus* (hominin)*
    - Genus *Homo* (hominin)
      - Species *H. neanderthalensis*
      - Species *H. erectus**
      - Species *H. sapiens*
    - Genus *Mammut* (Mastodon)
    - Genus *Mammuthus* (Mammoth)
      - Species *M. primigenius*
    - Genus *Megacerops* (brontothere)
  - **Genus *Megalonyx* (Giant Ground Sloth)***
  - Genus *Smilodon* (saber-toothed cat)
  - **Genus *Merycoidodon* (oreodont)***

Note: Taxa marked by an asterisk (*) are for State and National Tournaments only

KINGDOM PLANTAE

FLOWERING PLANTS (Division Anthophyta)
- Genus *Acer* (Maple)
- Genus *Populus* (Aspen & Poplar)
- Genus *Platanus* (Sycamore)

GINKGOS (Division Ginkgophyta)
- Genus *Ginkgo*

CLUB MOSSES (Division Lycophyta)
- Genus *Lepidodendron* (scale tree)

CONIFERS (Division Pinophyta)
- Genus *Metasequoia*

HORSETAILS (Division Sphenophyta)
- Genus *Calamites* (form leaf genus: *Annularia)*

SEED FERNS (Division Pteridospermatophyta)
- Genus *Glossopteris*

TRUE FERNS (Division Polypodiophyta)
- Genus *Psaronius* (form leaf genus: *Pecopteris)*

ADDITIONAL EARTH MATERIALS

Trace Fossils **limited to:**
- Trails, Tracks, Trackways, Borings, Burrows, Tubes, Predation marks, Coprolites

Stromatolites

Amber/copal

Petrified wood

Sedimentary Rocks **limited to:**
- Coquina
- **Chalk**
- **Fossil limestone**
- Sandstone
- Shale
- Chert

Note: Taxa marked by an asterisk (*) are for State and National Tournaments only

GEOLOGIC MAPPING

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

1. **DESCRIPTION:** Teams will demonstrate understanding in the construction and use of topographic maps, geologic maps, and cross sections, and their use in forming interpretations regarding subsurface structures and past depositional environments on Earth and other planetary bodies.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring a three-ring binder of any size containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder throughout the event.
   b. Each team may bring two protractors, two rulers, and two stand-alone non-programmable, non-graphing calculators (Class II).

3. **THE COMPETITION:**

   Participants will be given one or more tasks presented as an exam and/or timed stations. The participants will be expected to use process skills (e.g., communicating, classifying, inferring, measuring, observing, predicting, and using number relationships) to answer questions on the following topics:
   a. Elements and processes of structural geology
      i. Surface and subsurface structural elements of macroscopic and regional-scale geology
      ii. Deformation forces and associated structures (e.g., folding, faulting)
      iii. Depositional sequences and erosion patterns of different lithologies and structural elements
      iv. Measurements of structural elements (e.g., strike and dip)
   b. Rock formation and lithologies - igneous, sedimentary, metamorphic
      i. Methods and environments of formation (e.g., crystallization from magma, chemical precipitation, alteration under heat & pressure)
      ii. Relationships between texture (e.g., intrusive/extrusive), composition (e.g., mafic/felsic), and environments of formation
      iii. Relationship between temperature, pressure, and depth to types of metamorphism and metamorphic facies
      iv. Connections between physical and chemical properties on smaller scales of rock formation and how they inform properties on macroscopic/regional scales
   c. Interpretation and synthesis of geologic data (real and/or simulated)
      i. Application of stratigraphic principles
      ii. Topographic and geologic maps, cross-sections, and related data
      iii. Projections of mapped features, bed thicknesses, and orientations of planes from points
      iv. Geologic data collection (limited to drill cores and ground-penetrating radar)
   d. Sedimentary structures and their implications about depositional processes and environments (e.g., plane bedding, cross-bedding, sequence stratigraphy, ripple marks, mud cracks)
   e. Changes in depositional environments over time and space (e.g., transgressions, regressions, uplift)
   f. Applications of geologic mapping, including but not limited to assessment of:
      i. Groundwater quality and contamination
      ii. Earthquake, volcano, and landslide hazards
      iii. Responsible economic land management

4. **SAMPLE QUESTIONS/TASKS:**
   a. Use a topographic map to construct a topographic profile.
   b. Determine the order of events based on stratigraphic principles.
   c. Determine the attitude of a rock bed from three outcroppings (three point problem).
   d. Use a geologic map and its corresponding strike and dip data to construct a cross-section of sub-surface structures.
   e. Reconstruct the depositional systems across a geographic region, based on lithologies, fossil assemblage, and sedimentary structures in a mapped area.

5. **SCORING:**
   a. The high score wins. Points will be awarded for the quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods of responses. Ties will be broken by the accuracy and quality of answers to pre-selected questions and/or sections.

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

MICROBE MISSION

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

1. **DESCRIPTION:** Teams will answer questions, solve problems, and analyze data pertaining to microbes.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C **APPROXIMATE TIME:** 50 Minutes

2. **EVENT PARAMETERS**: For events with a lab practical portion, each student must bring goggles. Each team may bring one 8.5" X 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators (Class II). Any measurements must be made to the precision of the device.

3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Some questions/stations may involve the use of a microscope. Questions should emphasize age/division appropriate process skills such as: data interpretation from graphs and tables, drawing conclusions, calculations, inferences, and making observations. Students may be asked to perform simple laboratory procedures as measurements or using probes (sufficient information will be provided at the station). Possible live specimens may only include baker's yeast, ciliates, amoebae, lichens, and algae. Pictures & prepared slides are appropriate for all microbial types. The content areas include:
   a. **Regional topics:** The competition should cover all of the topics and not emphasize just one area such as microbial disease.
      i. Understanding parts, functions, images and sample preparation in bright field, phase contrast, reflected light/inverted microscopes, confocal microscopes and electron microscopes. Estimation/calculation of size based on scales in pictures or microscopic information and field of view determination.
      ii. Structure (e.g., size, organelles, membrane and cell wall composition, as applicable) & function of prions, viruses, viroids, bacteria, archaea, and eukaryotic microbes (e.g., fungi, algae, heterotrophic protists, parasitic worms)
      iii. Structure and function of nuclei, mitochondria and chloroplasts & theory of symbiogenesis
      iv. Identification of bacterial cell shapes (i.e., rods, cocci, spirochetes); Gram stain procedure and difference between $gram^+$, $gram^-$, and acid fast bacteria
      v. Methods to culture bacteria (i.e., liquid vs. agar), interpreting bacterial growth curves, plate counts to quantify bacteria; defined vs. complex media, differential vs. selective media, the "Great Plate Count Anomaly", differences between batch culture and chemostat growth
      vi. Using growth curves to identify limiting nutrients and optimal growth conditions
      vii. Techniques to determine antibiotic susceptibility, mechanisms of antibiotic resistance and resistance transfer, Distinguish between bacteriostatic and bactericidal antibiotics
      viii. Bacterial transcription, translation, and genome replication
      ix. Bacterial gene regulation as demonstrated in the lac operon and trp operons
      x. Culture-independent methods to study microbial communities: 16/18s rRNA amplicon sequencing and metagenomics, basic sample preparation and data analysis procedures for these techniques
      xi. Contrasting photoautotrophic vs. heterotrophic metabolic strategies, describe metabolic strategies of green sulfur bacteria, iron oxidizing, heterotrophic, and cyanobacteria based on energy and carbon source.
      xii. List and describe the steps of lytic and lysogenic virus replication
      xiii. Mechanisms of horizontal gene transfer (i.e., transduction, transformation, conjugation)
      xiv. Industrial applications of microbes – identify which microbes are commonly involved and their uses in: fermentation in bread and kombucha production, algal biofuels, bioremediation, & phage therapy
      xv. Describe types of microbial interactions, ie competition, cooperation, and parasitism
      xvi. Causes and effects of microbial population explosions in the context of algal blooms, thrush, and enterocolitis.
      xvii. Describe the structure and function of spores and cysts
      xviii. Extremophiles (i.e., thermophiles, halophiles, psychrophiles) and their characteristics

xix. Desrcibe the function and life cycle of the following organisms and agents:
   (1) Viruses: SARS-CoV-2 virus, HIV-1, Influenza A virus, Hepatitis B virus, T4 phage, Canine parvovirus 2, Mimivirus, Poliovirus, Banana bunchy top virus
   (2) Bacteria: Vibrio cholerae, Rickettsia rickettsii, Streptococcus pneumoniae, Corynebacterium diphtheriae, Methicillin-resistant Staphylococcus aureus, Mycobacterium tuberculosis, Cutibacterium acnes, Haemophilus influenzae, Wolbachia species, Agrobacterium tumefaciens
   (3) Fungi: Candida aureus, Alternaria solani
   (4) Protists: Plasmodium falciparum, Giardia duodenalis, Toxoplasma gondii, Alexandrium catenella
   (5) Prions and Prion-Like Proteins: PrP, amyloid beta, tau proteins, α-Synuclein
   (6) Worms: Taenia solium, Ancylostoma duodenale
   (7) Viroids: Potato spindle tuber viroid

b. **State & National Topics:** All regional-level material and
   i. Culture-independent methods to study microbial activity (i.e., metatranscriptomics, proteomics, metabolomics)
   ii. Phage lambda cro repressor system
   iii. Control of lac and trp operons for research applications
   iv. Functions of microbes in lakes and oceans, soil, and the gut microbiome
   v. Describe metabolic strategies of sulfate reducing, purple sulfur, and purple non-sulfur based on energy and carbon source
   vi. Phylogenetic methods to detect horizontal gene transfer (i.e., comparing gene and species phylogenies)
   vii. Describe treatments and vaccines for diseases caused by organisms and agents listed in Section 3.a.xix.

4. **SCORING:**
   a. High score wins. Selected questions may be used as tiebreakers
   b. Points will be awarded for quality and accuracy of answers, quality of supporting reasoning, and the use of proper scientific methods

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

OPTICS

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

1. **DESCRIPTION:** Teams will participate in an activity involving positioning mirrors to direct a laser beam towards a target and complete a written test on the principles of geometric and physical optics.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** None Required **APPROX. TIME:** 50 Minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
   b. Each team may also bring tools, premade templates, supplies, writing utensils, and two stand-alone calculators of any type.
   c. Teams must not bring lasers or mirrors.

3. **THE COMPETITION:**

   Part I: Written Test
   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The test will consist of at least 5 questions from each of the following areas:
      i. **Topics for Division B Regional Tournaments:**
         (1) **Reflection, specular & diffuse**
         (2) **Refraction, index of refraction, and prisms (deviation & dispersion)**
         (3) **Mirrors & lenses: convex, concave, plain; ray tracing; focal length; real, virtual, erect, and inverted objects and images; magnification**
         (4) **Color theory: additive & subtractive; primary & secondary colors; absorption & reflection**
         (5) **Structure and function of the human eye**
      ii. **Topics for Division B State & National Tournaments:**
         (1) **Structure and function of microscopes, telescopes, cameras, glasses, retro reflectors, and periscopes**
         (2) **Absorption spectra in films, chemicals, & dyes**
      iii. **Topics for Division C Regional Tournaments:**
         (1) **All Division B Regional Topics**
         (2) **Snell's law & critical angle**
         (3) **Lens maker's equation & thin lens approximation**
         (4) **Polarization: films & scattering, Brewster's angle**
      iv. **Topics for Division C State & National Tournaments:**
         (1) **All Division B State & National Topics**
         (2) **Lasers: structure and function, coherent light**
   d. Questions on the test will use the following mathematical content:
      i. **Math expectations for Division B Regional Tournaments:**
         (1) **Primarily qualitative (non-computational) questions and ray tracing**
         (2) **Standard arithmetic operations (including ratios)**
         (3) **Basic 2D geometry required for ray tracing: parallel & perpendicular lines, rays, triangles (similar & congruent), and circles, for example**
         (4) **No trigonometric functions or angles in radians**
      ii. **Math expectations for Division B State & National Tournaments:**
         (1) **Exam should still emphasize qualitative questions, but students can expect more computational work**
         (2) **Simple algebra manipulations, including solving one equation for one variable**
         (3) **Simple trigonometric relations to enable use of trigonometric functions on a calculator**
         (4) **No angles in radians**
      iii. **Math expectations for Division C Regional Tournaments:**
         (1) **Same as Division B State & National Tournaments**
      iv. **Math expectations for Division C Sate & National Tournaments:**
         (1) **Same as Division B State & National Tournaments**
         (2) **More sophisticated algebra, such as solving systems of equations for multiple variables**

Part II: Laser Shoot

a. The objective is to reflect a laser beam with mirrors around barriers towards the Target Point located on the wall opposite the laser.
b. The event supervisor must select a Target Point location that is the same for all teams. Teams must not be informed of the location until it is their turn to compete in Part II of the event.
c. The Event Supervisor must test the beam's alignment before each team is permitted to see the LSS.
d. All mirrors must be placed in a home position designated by the event supervisor before each team is permitted to see the LSS.
e. When a team is ready to begin, the event supervisor must give a countdown of "3, 2, 1 start" and start a timer. Event Supervisors must give teams a warning when 3 minutes have elapsed.
f. Competitors must make all measurements, calculations, and mirror placement/alignment within a 4-minute time period. Competitors may choose to use between 1 and 5 moveable mirrors.
g. Timing must stop when 4 minutes have elapsed or the competitors remove the material covering the face of one mirror. Competitors must not make any additional adjustments to the mirrors at that point other than to remove the mirror coverings. The Event Supervisor must not remove the coverings.
h. Competitors must not mark on or modify the LSS.
i. Competitors must not touch the laser or change its orientation and/or position.
j. The laser must not be turned on until timing stops. Once turned on, the Event Supervisor must mark on the paper mounted above the metric scale where the laser strikes it to record the results. Participant tools/ templates may remain on the LSS during this process.
k. The Event Supervisor will review with the team the Part II data recorded on their scoresheet.

4. **<u>THE COMPETITION AREA</u>:**

a. Example setups are provided on the event page at www.soinc.org.
b. The Event Supervisor will provide the Laser Shoot Setup (LSS), including timers, laser, mirrors and barriers. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.
c. The LSS has a horizontal flat surface 56 ± 1.0 cm by 35 ± 1.0 cm enclosed by a 2 ± 0.5 cm thick wall. The bottom surface may be a table top. The height of the wall above the surface is 9 ± 1.5 cm.
d. Five (5) moveable flat mirrors with a width of 5.0 – 8.0 cm must be placed in the LSS and must be back-surface mirrors. Each mirror must be mounted so that it stands vertically (~90 degree angle to the bottom surface), does not have excess mounting material on its sides, has its approximate center at the level of the laser beam and can be easily relocated anywhere in the LSS by the competitors. The mirror faces must initially be covered with a cardboard sleeve or other easily removable non-reflecting, opaque material.
e. A laser is mounted through the approximate center of one of the 35 cm walls at a height of 1.5 - 6.0 cm above the bottom surface. The laser must be securely mounted such that it cannot be moved and the beam is perpendicular to the wall through which it is mounted. The Laser Policy on www.soinc.org must be followed. The laser must remain fixed throughout the entire event.
f. A midline is drawn on the LSS from a point directly below the emitting tip of the laser to a point directly below the center of the laser beam where it strikes the opposite wall.
g. A metric scale with a resolution of at least 1 mm must be attached horizontally to the other 35 cm wall opposite the laser at the level at which the laser strikes. One of the marks on the scale is the Target Point. A sheet of paper must be also fastened to the wall, with a mark on the paper indicating the Target Point location.
h. A barrier must be placed somewhere along the midline to block the laser beam (non-perpendicular angles permitted). In Division C only, 2 additional barriers must be placed elsewhere in the LSS at a distance from the laser and taregt walls sufficient to allow a team to redirect the laser.
i. Barrier(s) must have a width of 2.0 to 8.0 cm and be tall enough to block the laser beam. They must be fixed in the same position and orientation in the LSS for all teams. One barrier must have a mirror similar to the others attached to one side and covered similarly. Competitors must not adjust the mirror's position. In Division C, any of the three barriers may have the mirror.

5. **SCORING:**
   a. Final Score (FS) = ES + MS + AS + BS. The maximum possible FS is 100 points. High score wins. A scoring spreadsheet is available on the event page on www.soinc.org
   b. Exam Score (ES) = (Part I score / Highest Part I score of all teams) x 50 points
   c. Mirrors Score (MS) = # moveable mirrors the laser reflects off of x 4 points. The max possible MS is 20.
   d. Accuracy Score (AS) = (25 – (accuracy (in mm)/10)) points. The smallest possible AS is 0.
      i. The accuracy is the horizontal distance from the Target Point to the center of where the laser strikes a wall. If the laser strikes another wall instead of the wall the Target Point is on, the accuracy is the sum of the straight-line measurements from the Target Point to the corner along one wall and along the other wall from the corner to the laser dot.
      ii. If the laser does not strike a wall, AS is 0, but the MS and BS should still be calculated.
   e. Barrier Score (BS) = 5 points if the laser reflects off the barrier mirror
   f. Teams that are disqualified for unsafe operation receive an AS, MS and BS of 0, but must still be allowed to compete in Part I.
   g. The AS, MS, and BS must be multiplied by 0.9 when calculating the Final Score if the team violates any of the rules in Section 3: THE COMPETITION.
   h. Ties are broken using designated question(s) on the written test. The Event Supervisor must identify tiebreakers to the Participants at the beginning of the competition period.

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

ROBOT TOUR

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

1. **DESCRIPTION:** Teams design, build, program and test one Robotic Vehicle to navigate a track to reach a target in a set amount of time as accurately and efficiently as possible.

   A TEAM OF UP TO: 2 **IMPOUND:** Yes **EVENT TIME:** 18 minutes

2. **EVENT PARAMETERS:**
   a. Each team must bring and impound one Robotic Vehicle (Robot), a Practice Log (if prepared), programming unit (except laptops), and any additional/spare parts.
      i. If the programming unit is a laptop, then a USB Flash Drive must be impounded instead of the laptop. The USB drive, or similar storage device, must contain only one robot program that is the starting program for the Robot.
   b. The Practice Log are the only papers or notes that the competitors may bring into the event area and must be impounded.
   c. Teams may bring tools, which includes a stand-alone non-programmable, non-graphing calculator (Class II), which do not need to be impounded..

3. **CONSTRUCTION PARAMETERS:**
   a. The Robot must be designed and programmed to navigate a track, make decisions, travel to gate zones, and stop at a designated target point on the track without external interactions.
   b. Electrical energy used by the Robot for any purpose, including propulsion, must be stored in a maximum of **6 (six)** AA or AAA 1.2 to 1.5-volt common, commercially available batteries, individually labeled by the manufacturer. Rechargeable batteries are allowed.
   c. Any battery containing lithium or lead acid is not permitted. Teams using these batteries will not be permitted to run and will receive only participation points.
   d. Batteries and Robot are to remain separate from the moment they are impounded until after the start of the team's time slot. At Impound, the batteries to be used must be stored in a method that will prevent a short circuit. The robot should be submitted at the same time but physically separate from the batteries. Teams violating any of these conditions will have the opportunity to remedy the situation to the satisfaction of the Event Supervisor should time allow. The Event Supervisor will instruct the teams when to install the batteries and prepare their Robot for its run.
   e. An approximately ¼" to ⅜" wooden dowel must be attached to the front of the Robot. The dowel must be approximately perpendicular to the floor, extend to within 1.0 cm of the track surface, and extend at least 10.0 cm above the floor. The dowel must be easily accessible by the Event Supervisor. No part of the Vehicle can extend beyond the front of the dowel, other than the dowel attachment device. The dowel's front bottom edge will be the Robot's Measurement Point for distance measurements.
   f. The entire Robot in the ready-to-run configuration must fit in any orientation in a 30.0 cm by 30.0 cm space of any height.
   g. Teams may use sensors to provide information about the environment or the Robot's movements. The Robot must remain autonomous and not be remotely controlled
   h. All parts of the Robot must move as a whole; no tethers or other separate pieces are allowed. The only parts allowed to contact the floor during the run are parts already in contact with the floor in the ready-to-run configuration. Pieces falling off during the run constitutes a construction violation.
   i. 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.

4. **PRACTICE LOG: A Practice Log is recommended but not required. The Practice Log must be impounded in order for the team to use it during Setup Time.**

5. **THE TRACK:**
   a. The track area will be a 2 meter by 2-meter square area on a smooth, level, and hard surface. A PDF diagram of the track is available on the Event Page at sonic.org.
   b. The square track area will be marked by 2.5 cm tape lines on the outside. The 2.0 meter dimension is measured inside to inside of the tape lines.
   c. The outside tape lines will be marked every 0.5 m or 50 cm for the imaginary lines within the track area. There are three (3) imaginary lines in both vertical and horizontal directions for a total of six (6) lines. All imaginary lines are perpendicular to the outside tape lines. The imaginary lines will form sixteen (16) square zones (approximately 50 cm x 50 cm) within the track area. It is recommended to use ¼" wide tape to mark all imaginary lines, but not required.

d. The Start Point will be marked on the outer boundary tape line and on the inside edge. The mark will be centered between any imaginary line and/or a perpendicular outer boundary tape line.
e. The Target Point will be in the center of one of the sixteen (16) zones defined by the imaginary lines and outer tape lines. The Target Point will be marked on approximately 2.5 cm x 2.5 cm tape with the Target Point marked at the center of the tape.
f. Eight (8) wooden 2x4 Obstacles are placed on the track lines. The 2x4 can be placed on any imaginary line or outside tape lines. The 2x4s are placed centered between adjacent perpendicular track lines (outside or imaginary). The dimensions of the 2x4 obstacles are 1.5 inches by 3.5 inches by 16 inches long. The location of the 2x4s needs to be marked by the Event Supervisor in case a 2x4 needs to be relocated after a robot makes contact or is temporarily removed for measurements.
g. Bonus Gate Zones will be marked by 2.5cm tape lines. Each Gate Zone is approximately 50 cm by 50 cm square. The tape will be placed on the inside edge of the imaginary lines and/or the outer tape line to form the Gate Zone. The Event Supervisor will select the locations of the Gate Zones after impound. Each Gate Zone will be marked with a letter (Ex: “A”, “B”, “R”, ”X”, …).
h. At the Event Supervisor’s discretion, more than one track may be used. If so, the team may choose which track they use. All of a team’s runs must be on the same track.

6. **THE COMPETITION:**
   a. The Start Point, Target Point, Target Time, and number of Gate Zones along with their locations are chosen by the Event Supervisor (ES) and must not be announced until the impound period is over. The number of Gate Zones will be up to 3 for regionals, up to 4 for states and up to 6 for nationals. The Target Time will be chosen between 50 and 75 seconds.
   b. Only participants and the Event Supervisors will be allowed in the event area. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication.
   c. Teams are allowed to make programming changes to achieve the maximum points during their Event Time. If a laptop is the programming unit:
      i. Participants must open the single program file from the impounded USB drive in front of the Event Supervisor.
      ii. Teams must only modify the impounded program file during the competition.
      iii. Opening other files or referencing the Internet will result in their Final Score receiving the Not Impounded penalty.
   d. A team’s Event Time is a combination of their Setup Time and Track Time. The Event Supervisor will record the total Track Time used which may be used as a tiebreaker.
      i. Teams are given Setup Time to determine the robot’s path and make any configuration or programming changes. Teams have a maximum of 10 minutes for setup. All work must take place away from the track. The teams are not permitted to test their Robot’s movements on any surface during the Setup Time. Using a software simulation of the robot to verify motions and / or run times is not permitted. Time starts after the completion of the inspections and the competitors are ready to begin the setup process. Competitors will notify the Event Supervisor when ready to move to the track.
      ii. Teams are given a maximum of 8 minutes for their Track Time. All actions described below must take place during their Track Time. The Track Time will not include time used by the Event Supervisor for measuring. If a run has started before the 8-minute period has elapsed, it will be allowed to run to completion. The recorded Track Time will stop at the end of the team’s last run.
   e. At the Event Supervisor’s discretion Participants may use AC outlet power during their time slot but this may depend on event location.
   f. Teams may have up to 2 successful runs or 3 Failed Runs (whichever comes first). Teams may ask to have the run recorded as a Failed Run and stop the run. Removing a Robot before the end of a run will be recorded as a Failed Run.
   g. In the ready-to-run configuration, the Robot’s Measurement Point must be over the Start Point with the Robot in any orientation. If the robot is starting from outside of the Track then the robot’s first movement must be to enter the Track area. The Robot must remain at the starting position without being touched.
   h. Teams may adjust their Robot (ex: programming changes, physical modifications, ...) during their event time. The Event Supervisor may re-verify that the Robot meets specifications prior to each run.
   i. Teams must run their Robot on the track provided by the Event Supervisor. Running the Robot on any surface other than the event track will result in the team’s next run being recorded as a failed run for each occurrence.

j. Participants may clean the track during their event time, but the track must remain undamaged and dry at all times. No wet and/or tacky substances may be applied to the track, wheels, or treads.
k. Teams must start the Robot using any part of an unsharpened #2 pencil with an unused eraser, supplied by the Event Supervisor, in any motion to actuate a trigger. They may not touch the Robot to start it, hold it while actuating the trigger, or "push" the Robot to get it started. Once they start a run, the participants must not touch their Robot and must wait until notified by the Event Supervisor to retrieve their Robot.
l. Run Time starts when the robot begins to move and ends when the Robot comes to a complete stop; recoils are considered part of the Run Time. If the robot does not move within 3 seconds after coming to a stop, the run is considered to have ended; the 3 seconds are not included in the Run Time. Any action occurring after that time does not count as part of the run. Movement is defined by the Robot's measurement point changing location on the track. The Event Supervisor is encouraged to use three timers. The middle time of the 3 timers must be the official Run Time. The Run Time must be recorded in seconds to the precision of the timing devices.
m. A Gate Zone Bonus is awarded for each Gate Zone entered in any order. Each Gate Zone may only be counted once. The front side of the Robot with the dowel rod must be the first side of the robot to travel into the Gate Zone. Traveling backwards or sideways will not count as entering the Gate Zone.
n. A Contact Penalty is awarded for making contact with any of the 2x4 Obstacles during a team's run. This penalty can only occur once. Teams may choose before moving to the track area to compete without the 2x4 Obstacles for a penalty less than the Contact Penalty. All runs must be attempted with or without the 2x4 Obstacles. Teams cannot change their decision once their Track Time begins.
o. A Stalling Penalty will be awarded for delaying movement actions at the end of a run with the intent to improve only the Time Score. Possible delaying actions can include but not limited to: repeating a single or multiple movements, moving in small circles, or other motions designed to improve the Time Score only. The end of the run is defined as occurring in the 50cm by 50cm Target Point square or an adjacent 50cm by 50cm square. An Event Supervisor may request the last run to be repeated to verify the presence of delaying movements. This repeat run will not count toward the team's Track Time or used for scoring.
p. A Failed Run occurs for any run that:
    i. Does not finish within twice the target time
    ii. The Robot exits the track area as determined by all Robot floor contact points being completely outside of the track's outer perimeter lines.
    iii. If the time and/or distance cannot be measured for a Robot (e.g., it starts before the Event Supervisor is ready, the participants pick it up before it is measured).
q. If the Robot does not move upon actuation of the trigger, it does not count as a run and the team may set up for another run.
r. A team filing an appeal must leave their Robot and programming unit/USB in the competition area.

7. **SCORING:**

a. Each team's Final Score is their lowest Run Score plus any Final Score Penalties. Low score wins.
b. The Run Score for each run
    i. Non-Failed Run = Time Score + Distance Score + Gate Bonus + Run Penalties.
    ii. Failed Run = 750 points + Run Penalties
c. The Time Score is determined by:
    i. Run Time less than Target Time: Time Score = 100 + (Target Time - Run Time) x 2
    ii. Run Time greater or equal to Target Time: Time Score = 100 + (Run Time - Target Time)
d. The Distance Score = Robot Distance x 1 point/cm. The Robot Distance is the point-to-point distance from the Measurement Point to the Target Point in centimeters measured to the nearest 0.1 cm.
e. Gate Bonus for each run = -15 points for each Gate Zone entered in any order.

f. Run Penalties:
   i. Contact Penalty: 50 points added to each Run Score that has 1 or more contacts with the 2x4 Obstacles.
   ii. No 2x4 Obstacle Penalty: 35 points added to all Run Scores when a team chooses to run without the 2x4 Obstacles.
   iii. Stalling Penalty: 20 points added to each Run Score with delaying movement actions.
   iv. Competition Violation: 150 points added to each Run Score that has 1 or more Competition Violations.
   v. Construction Violation: 300 points added to each Run Score that has 1 or more Construction Violations.

g. Final Score Penalties:
   i. Robot's movements tested during Setup Time: 200 points added to the team's Final Score.
   ii. Robot Not Impounded: 5000 points added to the team's Final Score.

h. Ties must be broken by this sequence:
   i. Lower Time Score on scored run;
   ii. Lower Robot Distance on scored run.
   iii. Higher number of Gate Zones entered on scored run.
   iv. Lower Track Time used.
   v. Next better non-scored run score.

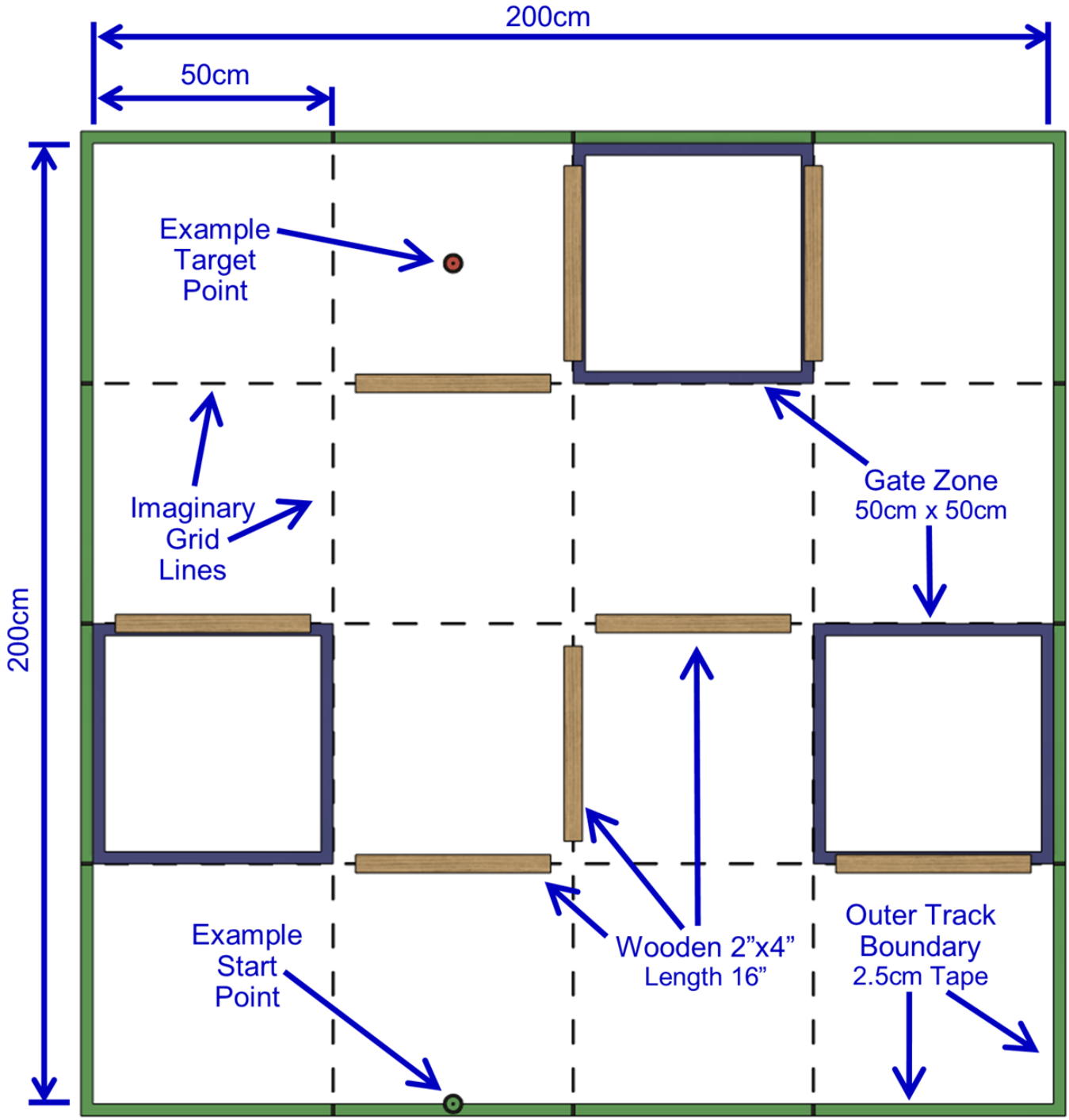
8. **SCORING EXAMPLE:** At a competition, the track has 3 Gates (A, B & C). Target Time is 53s. A team's Robot stopped 21.7 cm from the Target Point with a Run Time of 68.53 sec. Gate Zones "C" and "A" were entered. The team had a recorded Track Time of 7 minutes and 35 seconds.

Time Score	= 100 + (68.53 – 53)	=	115.53
Distance Score	= 21.7cm x 1.0 pts/cm	=	21.7
Gate Bonus	= 2 Gates x -15 pts/Gate	=	-30.00
Run Score		=	107.23

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

ROBOT TOUR TRACK

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



SCRAMBLER

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

1. **DESCRIPTION:** Teams design, build, and test a mechanical device, which uses the energy from a falling mass to transport an egg along a track as quickly as possible and stop as close to the center of a Terminal Barrier (TB) without breaking the egg.

   A TEAM OF UP TO: 2 **IMPOUND:** Yes **EYE PROTECTION:** B **APPROX. TIME:** 12 minutes

2. **EVENT PARAMETERS:**
   a. Each team must bring and impound one Scrambler (with falling mass detached), alignment devices (if used), and additional/spare parts.
   b. **Teams may share energy propulsion system between teams from the same school.**
   c. Teams may bring data and a stand-alone calculator of any type along with non-electronic tools which do not need to be impounded.
   d. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not be allowed to compete and will receive participation points.
   e. Teams 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. The Scrambler must consist of an egg transport (Vehicle) and an energy propulsion system. These may be separate or combined into a single unit.
   b. The entire Scrambler including the egg, falling mass, **and cushion to protect the floor**, in the ready-to-run configuration, must completely fit within an imaginary rectangular box with **100.0 cm x 50.0 cm base and a 100.0 cm height**.
   c. All energy used to propel the Vehicle must come from a falling mass not to exceed 1.50 kg**. The gravitational potential energy of the falling mass may be converted to other forms of energy**. The mass must be part of the energy propulsion system and need not travel with the Vehicle. Any additional sources of kinetic energy must be in their lowest energy state in the ready-to-run configuration**.** Any part of the Scrambler whose gravitational potential energy decreases and provides energy to propel the Vehicle after the Scrambler is actuated is considered to be part of the falling mass. The falling mass must not directly contact the venue floor by using a pad or similar protective cushion. To facilitate mass measurements, the Scrambler must be impounded with the mass detached.
   d. The stopping mechanism must be contained completely within the Vehicle and work automatically. The Vehicle must not be remotely controlled or tethered. Pre-loaded energy storage devices may be used to operate other Scrambler functions (e.g., braking system) as long as they do not provide kinetic energy to propel the Vehicle.
   e. The egg must rest on two (2) **1/4" to 3/8"** wooden dowels which extend out between 3.0 and 4.0 cm from a rigid, unpadded and flat (no unfilled holes) backstop for the egg. The bottom of the wooden dowels must be between 5.0 and 10.0 cm above the track and within 1.0 cm from the bottom of the backstop. The egg backstop must be built of any rigid material, and it must have a flat surface of 5.0 ± 0.5 cm wide by 5.0 ± 0.5 cm high by 1.27 cm (0.50") thick. Nominal blemishes which do not affect the point of contact of the egg with the backstop are allowed. A diagram of the backstop will be available on www.soinc.org. One or more violations of this paragraph counts as a single Construction Violation.
   f. For timing, **a 1/4" to 3/8"** wooden dowel must be attached vertically and directly to the top of the rigid backstop. The dowel must extend at least 20.0 cm above the Track's surface. **A paper flag for the timing system must be attached to the trailing side of the dowel with the paper's center height at 17.0cm ± 1.0 cm. The paper size must be 5.0 cm by 5.0 cm ± 1.0 cm. The paper may be any color and decorated.** One or more violations of this paragraph counts as a single Construction Violation.
   g. The Event Supervisor (ES) must provide uncooked grade A large chicken eggs, one of which is selected by the team immediately prior to their 8-minute Event Time. Tape will be provided by the ES to secure the egg to the Vehicle, with no tape placed on the front or rear 1.0 cm of the egg. The egg's rounded end must be touching the backstop and visible to the ES when attached. The egg must be the foremost point of the Vehicle. At the ES's discretion, the egg may be placed inside a thin transparent plastic bag.
   h. Competitors must design the Scrambler to start by using any part of an unsharpened #2 pencil with an unused eraser, provided by the ES, to actuate a release mechanism. The pencil may be the release mechanism itself and may extend beyond the dimensions in 3.b. Actuating the release mechanism must not impart additional energy to the Vehicle.

i. All parts of the Vehicle must move as a whole; no anchors, tethers, tie downs, or other separate pieces are allowed. The only parts allowed to contact the floor during the run are those already in contact with the floor in the ready-to-run **configuration.** All wheels must be in contact with the floor at launch. Pieces falling off during the run constitutes a Construction Violation.
j. No electrical or electronic devices may be used (with the exception of any type of calculator).

4. **PRACTICE LOG: A Practice Log is recommended but not required.**

5. **THE TRACK:**
   a. The Track must be on a smooth, level, and hard surface with a Terminal Barrier (TB) extending across its end. Space is recommended on each side of the Track and beyond the TB to allow for error in the Vehicle's path. Refer to soinc.org for a diagram of the Track.
   b. The Start **Point** will be **marked on a piece of tape approximately 2.5 cm wide and 5.0 cm long.**
   c. **The End Point is the point defined by the intersection of the imaginary Center Line and the front edge of the TB. Like the Start Point (rule 5.b.), the End Point will also be marked on a piece of tape attached to the floor.**
   d. **The imaginary Center Line is a line that connects the Start Point to the End Point. This line does NOT need to be marked by the ES.**
   e. **A 5-gallon bucket with a bottom diameter of 25.0-27.0 cm must be placed on the imaginary Center Line, at the midpoint between the Start Point and the End Point. The center of the bucket must be directly on the imaginary Center Line. The bucket should have a small hole drilled in the center of its bottom by the ES to aid in placing it in the correct position. It is suggested that the bucket be weighed down so that it does not move if hit by a team's Vehicle.**
   f. The TB must be a hard, flat, vertical wall at least 25.0 cm tall, placed perpendicular to the imaginary Center Line that connects the Start Point and the End Point. It must be a minimum of 1.00 m long. The exact Target Distance from the Start Point to the End Point will be between 8.00 m and **12.00** m. At Regionals/Invitationals the interval will be 0.50 m, for States 0.20 m, and for Nationals 0.05 m. The Target Distance will be chosen by the ES and will be announced after the impound period is over.
   g. Two Timing Lines are marked with pieces of tape approximately 2.5 cm wide and at least 1.00 m long, at distances of **0.50 m** and **7.00 m** from the **Start Point**, centered on and perpendicular to the imaginary Center Line. The edges of the tape closest to the **Start Point** define those lines.
   h. A photogate timing system is highly recommended. See www.soinc.org for information. If used, the system will be installed at the Timing Lines with the beams at a height of 17.0 ± 2.0 cm **and a minimum gap of 2.0 m across the Track**. At least one manual timer should be used as a backup. If photogates are not being used, three timekeepers should be utilized with the middle time used as the official Run Time; lasers are recommended to be placed at the Timing Lines so the timekeepers only have to watch for the flash of light as the dowel cuts through the laser beam.
   i. At the ES's discretion, more than one Track may be used. If so, the team may choose which Track they use, but must use the same Track for both runs.

6. **THE COMPETITION:**
   a. Only participants and the Event Supervisors will be allowed in the Impound and Track areas. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing and have left the event area.
   b. Teams have 8 minutes of Event Time to set up and start up to 2 runs. During this time, they must not increase the falling mass once it has been measured. Scramblers in the ready-to-run configuration before the end of the Event Time will be allowed to complete a run.
   c. Electric/electronic tools must not be used except for the calculator (2.c.).
   d. **In the ready-to-run configuration, the pointed tip of the egg must be placed directly above the Start Point.** The Scrambler must remain in the ready-to-run **configuration** without being touched until triggered by the #2 pencil.
   e. Teams may adjust their Scrambler (e.g., directional control) within their Event Time. The ES may re-verify that the Scrambler meets specifications prior to each run. Timing is paused during any measurements made by the ES. Timing resumes once the participants pick up their device or begin making their own measurements.
   f. Teams may use their own non-electronic measuring devices to verify the Track dimensions during their Event Time.

g. Only non-electronic sighting/aiming devices are permitted. If placed on the Track, they must be removed before each run. If placed on the Vehicle, they may be removed at the team's discretion.
h. Teams must not roll the Vehicle on the floor of the Track on the day of the event without tournament permission. If permitted, only participants may be present.
i. Substances applied to the device must be approved by the ES prior to use and must not damage or leave residue on the floor, Track and/or event area. Teams may clean the Track during their Event Time, but it must remain dry.
j. If the Vehicle does not move upon actuation of the release mechanism, it does not count as a run and the team may request to set up for another run, but must not be given additional time.
k. Once they start a run, teams must not follow their Vehicle and must wait until called by the ES to retrieve their Vehicle. The 8 min time resumes once competitors pick up their Vehicle or begin to make their own measurements.
l. If the Vehicle passes the **0.50 m** Timing Line but stops before the **7.00** m Timing Line, it is considered a Competition Violation. The ES records the run measurement.
m. If the egg is broken **during a run** (as defined by cracking the egg enough to leave a wet spot on a paper towel) it is considered a Competition Violation. If the egg breaks on the first run, a second run must not be permitted and **is** scored as a Failed Run. **There is no penalty if an egg breaks prior to the device being actuated before the first launch. A second egg will be provided. The second egg may be a used egg; this will be the ES's choice.**
n. If any part of the Vehicle (besides the egg) touches the TB, it is considered a Competition Violation. **If the tip of the egg goes past the front face of the TB anytime during the run, it is also considered a Competition Violation.**
o. **If the Vehicle collides with the 5-gallon bucket causing the bucket to move off of its correct location it is considered a Competition Violation. If the bucket does not move, no penalty will be assessed.**
p. A Failed Run can occur if the Vehicle starts before the ES is ready, if its distance or time cannot be measured (e.g., it starts before the ES is ready, if it moves but does not go at least **0.50 m**, the participants pick it up before it is measured), or if the team pushes the Vehicle down the Track. Construction and/or Competition Violations must still be recorded for Failed Runs. A team having only one successful run during the 8-minute Event Time will be assessed a Failed Run for a 2nd Run Score. If the Vehicle does not move during the Event Time, the team will be assessed 2 Failed Runs.
q. The ES will review with teams the data recorded on their scoresheet.
r. Teams filing an appeal must leave their Scrambler in the event area.

7. **SCORING:**

a. Each team's Final Score is the better of the 2 Run Scores + Final Score Penalties. Low score wins.
b. Run Score = Distance Score + Time Score + Run Penalties
c. Time Score = Run Time x 2
d. Distance Score = 1 pt./cm x Vehicle Distance. The Distance Score for a Failed Run is **2000** points.
e. The Vehicle Distance is a point-to-point measurement from the End Point to the pointed end of the egg (or the point of impact for broken eggs) measured to the nearest 0.1 cm.
f. The Run Time begins when the Vehicle's dowel reaches the **0.50 m** Timing Line and ends when it passes the **7.00 m** Timing Line. The Run Time is recorded in seconds to the precision of the timing device used. The Run Time will be recorded as 0.00 seconds for Failed Runs or if the Vehicle passes the **0.50 m** Timing Line but stops before the **7.00 m** Timing Line.
g. Run Penalties:
    i. Competition Violation: 150 points added to the Run Score per violation
    ii. Construction Violation: 300 points added to the Run Score per violation
    iii. Failed Runs can be assessed violations.
h. Final Score Penalties: Scrambler not Impounded: 5000 points added to the team's Final Score.
i. Two or more teams tied with 2 Failed Run scores, without Competition or Construction Violations, will remain scored as ties. Other ties are possible.
j. Tiebreakers in order: 1. Better Vehicle Distance of the scored run; 2. Lower Time Score of the scored run; 3. Better Vehicle Distance of the non-scored run; **4. Better Time Score of the non-scored run**.

8. **SCORING EXAMPLES:**

A Scrambler has 2 runs in the allotted time.

- In the 1st run, the Vehicle stopped 67.6 cm from the TB center with a Run Time of 7.27 s
- In the 2nd run, the Vehicle stopped 27.6 cm from the TB center with a Run Time of 8.67 s

Distance Score	= 67.6 cm x 1.0 pts/cm	=	67.60
Time Score	= 7.27 x 2	=	14.54
1st Run Score		**=**	**82.14**
Distance Score	= 27.6 cm x 1.0 pts/cm	=	27.60
Time Score	= 8.67 x 2	=	17.34
2nd Run Score		**=**	**44.94**

Final Score = 2nd Run Score (Better Score) = 44.94 pts

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

TOWER

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

1. **DESCRIPTION:** Teams will design and build a Tower (Structure) meeting requirements specified in these rules to achieve the highest structural efficiency.

   A TEAM OF UP TO: 2 **IMPOUND:** NO **EYE PROTECTION:** B **EVENT TIME:** 6 minutes

2. **EVENT PARAMETERS:**
   a. Each team is allowed to enter only one Structure, built prior to the competition.
   b. All participants must properly wear eye protection at all times. Teams without proper eye protection will be immediately informed and given a chance to obtain eye protection if time allows. Participants not wearing proper eye protection will not be allowed to compete and be placed in Tier 3.
   c. Participants may NOT bring any equipment such as levels or squares.
   d. The Event Supervisor will provide all Test Apparatus (see Section 6) and tools/materials for measurement. For virtual tournaments, the teams must supply all Test Apparatus that fully meets the requirements of Section 6, any deviations from Section 6 will be scored as a construction violation for the team.
   e. Carefully review the event specific FAQs for any further rule's clarification and guidance

3. **CONSTRUCTION PARAMETERS:**
   a. The Structure must be a single assembly with no separate, loose, sliding, or detachable pieces, constructed of wood, and bonded by adhesive. No other materials are permitted.
      i. Wood is defined as the hard, fibrous substance making up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include bark, particleboard, wood composites, bamboo or grasses, paper, commercially laminated wood (i.e., plywood), or members formed of sawdust, wood shavings, and adhesive. Wood may never be painted, soaked, or coated in glue, color enhanced, or have tape/preprinted/paper labels affixed. Ink barcodes or markings from the construction process may be left on the wood.
      ii. There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated by the team without restriction.
      iii. Adhesive is a substance used to join two or more materials together and may be used only for this purpose. Any commercially available adhesive may be used (e.g., glue, cement, cyanoacrylate, epoxy, hot melt, polyurethane, and super glues). Adhesive tapes are not allowed.
   b. The Structure must span a 20 cm x 20 cm opening on a Test Base (6.a.) and may be placed on the Test Base surface in any orientation such that the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base. Bonus Points (7.c.) can be obtained by designing the Tower to span a 29-cm diameter circle, centered on the 20 cm x 20 cm opening of the Test Base and holding 15.0 kg.
   c. The Structure must support the Loading Block (6.b.i.) a minimum of 50.0 cm (Division B) or 60.0 cm (Division C) above the Test Base. There is no maximum Tower height.
   d. The loading point on the Structure must be constructed to permit placement of the Loading Block (6.b.i.) on the tower and constructed such that only the Loading Block (6.b.i.) supports the chain and bucket.
   e. Participants must be able to answer questions regarding the design, construction, and operation of the structure per the Building Policy found on www.soinc.org.

4. **DESIGN LOG:**
   a. **Division B - Design logs are optional and will not be scored.**
   b. **Division C - Teams may submit a Deisgn Log of structures tested prior ti competition and may earn a Log Book Multiplier if the log is complete.**
      i. **A Design Log template is inlcuded in these rules and must be used for any submitted log.**
      ii. **A minimum number of unique structures should be tested and documented in the log prior to each tournament. The minimum number expected for each tournament is as follows:**
         (1) **Invitational: 1**
         (2) **Regional: 2**
         (3) **State: 3**
         (4) **National: 4**

5. **THE COMPETITION:**

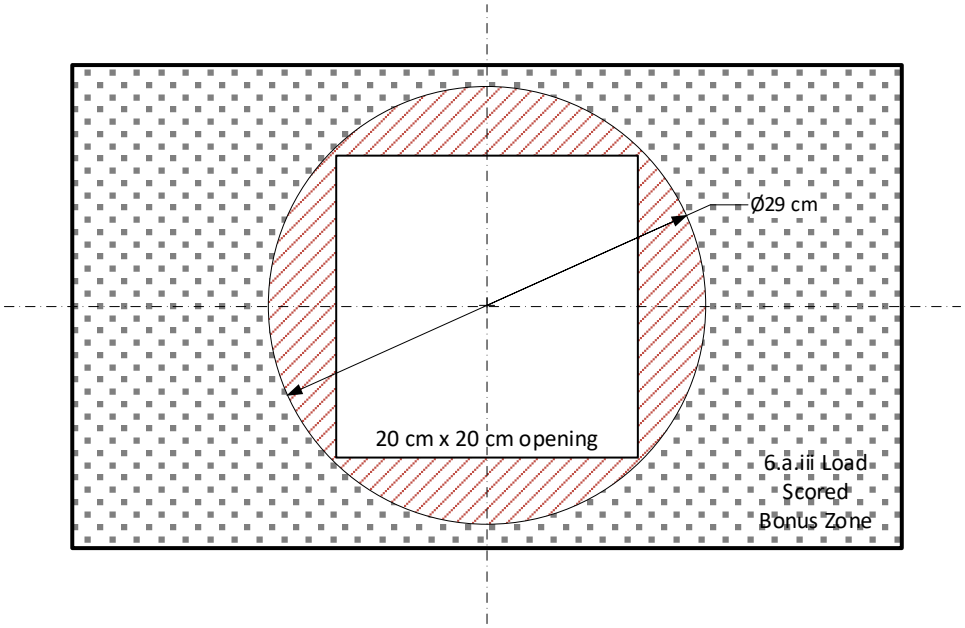
   Part I: Check-In
   a. The team must present their Structure for inspection & measurement. The team must also submit their design log if they have one.

b. The team must place their Structure on the Structure Scale (6.e) so the Event Supervisor or Assistant can determine the mass, in grams to the nearest 0.01 g or best precision available.
c. The team will measure the Structure height using provided materials so the Event Supervisor or Assistant can determine if it meets or exceeds the minimum height (3.c.) in cm to the nearest 0.1 cm.
d. The team must submit their Estimated Load Supported (7.f.i) to be used as a tiebreaker.
e. No alterations, substitutions, or repairs may be made to the Structure after the check-in process has started.
f. Prior to b. Part II: Testing, the Event Supervisor will verify that the combined mass of the Loading Assembly and sand is at least 15,100 g, but no more than 15,200 g.

Part II: Testing

a. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
b. Participants will have 6 minutes to set up and test their Structure to maximum load or failure.
c. The participants must place the Structure on the Test Base and assemble the Loading Block Assembly and bucket as required to load the Structure. If necessary, participants may disassemble the Loading Block Assembly but must re-assemble in the same order as presented by the Event Supervisor. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Structure to deflect.
d. The participants will be allowed to adjust the Structure until they start loading sand. Once loading of sand has begun, the Structure must not be further adjusted.
e. The Event Supervisor will check the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base before loading begins.
f. The Event Supervisor before testing will verify that no part of the Tower's span touches or is supported within the 29.0 cm diameter circle for the Tower to qualify for the "Load Scored Bonus".
g. Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. The bucket may only be stabilized by using the tips of the provided Bucket Stabilizing Sticks (6.d.).
h. Loading stops immediately when the Structure failure occurs, or time expires. Structure Failure is defined as the inability of the Structure to carry any additional load, if any part of the load is supported by anything other than the Structure or the Structure touches the Test Base. Incidental contact of the chain/eyebolt with the structure is not a failure.
i. Once loading stops, any parts of the Structure in the bucket will be removed. The Load Supported (mass of the Loading Assembly and the sand in the bucket) will be recorded to the nearest gram or best precision available. The minimum Load Supported is the mass of the Loading Assembly. The maximum Load Supported is 15,000 g.
j. At the Event Supervisor's discretion, more than one Test Apparatus may be used.
k. The Event Supervisor will review with the team the data recorded on their scoresheet.
l. Teams who wish to file an appeal must leave their structure with the Event Supervisor.

6. **TEST APPARATUS:**
   a. The Test Base shall be a solid, level surface as follows:
      i. At least 55.0 cm long x 32.0 cm wide, stiff enough that it does not bend noticeably when loaded. Shall have a smooth, hard surface (e.g., metal, high-pressure plastic laminate)
      ii. Shall have an opening at its center approximately 20.0 cm x 20.0 cm
      iii. Shall have a 29-cm circle drawn on the surface, centered on the 20 cm x 20 cm square opening. The surface outside the 29 cm circle shall be the **Load Scored Bonus Zone.**



   b. The Loading Assembly will consist of:
      i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt
      ii. A ¼ inch threaded eyebolt (1-inch nominal eye outside diameter), minimum 2 ¼ inch length to a maximum 4 ½ inch length, and a ¼ inch wing nut. The loading block must be mounted on the eye bolt and be trapped between the "eye" of the eye bolt and the wing nut. The loading block cannot sit on top of the wing nut or be loose.
      iii. A chain and S-hook that are suspended from the eyebolt on the Loading Block
      iv. An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain
      v. The total combined mass of the Loading Assembly may not exceed 1.5 kg
   c. Sand: sand or other clean, dry free-flowing material.
   d. Two (2) Bucket Stabilizing Sticks each made from a piece of ½" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org.
   e. Structure scale: Must be a digital scale. Scale shall have a minimum resolution of 0.1 grams; recommended resolution is of 0.01 gram.
   f. Sand scale and load verification: Must be a digital scale. Scale shall have minimum resolution of 10 grams; recommended resolution is of 1 gram

7. **SCORING:**
   a. High score wins. Score = [Load Score (g)/Mass of Structure (g)] * Log Multiplier.
   b. The Load Score= Load Supported (5.b.ix) + Load Scored Bonus (7.c).
   c. Load Scored Bonus: Structures that ONLY contact the Test Base outside the 29 cm circle and holding 15.0 kg will earn a Bonus of 5,000 g.
   d. **Log Multiplier:**
      i. **Division B: Log is not scored, Multipler is 1.0**
      ii. **Division C: The Multiplier is 1.25 for a Compliant Log (4.b.i.-ii.), a Multiplier of 1.0 is applied to Incomplete, Non-Compliant, or Not Submitted Logs**

e. Structures will be placed in three tiers as follows:
   i. Tier 1: Holding any load and meeting all construction parameters and competition requirements
   ii. **Tier 2: Holding any load with any violations of the construction parameters and/or competition requirements. For virtual meets, Test Apparatus not meeting requirements.**
   iii. Tier 3: Unable to be loaded for any reason (e.g., cannot accommodate or hold Loading Assembly, failure to wear eye protection) and will be ranked by lowest mass
f. Ties are broken as follows:
   i. Estimated Load Supported closest to, without exceeding, the actual Load Supported
   ii. Lowest Structure mass
g. Example score calculations:
   i. **Structure 1: mass= 10.12 g, Load Supported= 12,134 g; No Load Scored Bonus, NO Log: Score (1.0x) = 1,199**
   ii. **Structure 2: mass= 10.12 g, Load Supported= 12,134 g; No Load Scored Bonus, Log Compliant: Score (1.25x) = 1,499**
   iii. **Structure 3: mass= 10.12 g, Load Supported= 12,134 g + 5000 g Load Scored Bonus, Log Compliant: Score (1.25x) = 2,116**

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

This event is supported by Cleveland-Cliffs Foundation & SkyCiv

Design Log

School:	Team:	Students:
Design Name/Number:		

Requirement	Team Notes	Event Supervisor Comment
Sketch of design ● Add hand or CAD drawing to the back of this form or attach a separate sheet. ● Include key dimensions, angles, size of structure members, name of student(s) and date.		
Materials used List materials used and why you chose these materials		
Predictions load held, weak points		
Date of Test		
Weight before testing in grams		
Test results load held, breaking points		
Observations **W**hat did you learn from the construction and testing of the Structure?		
Design Improvements What will you do differently on the next structure?		

WIND POWER

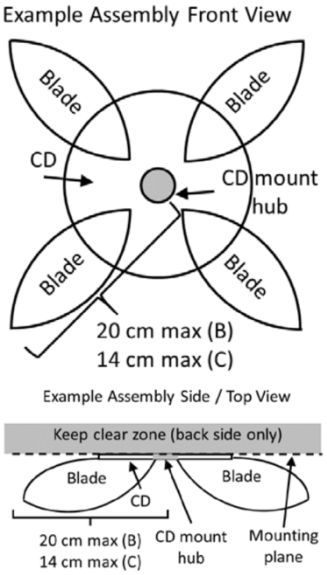
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams construct a blade assembly device prior to the tournament that is designed to capture wind power and complete a written test on the principles of alternative energy.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** No **APPROX. TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
   b. Each team may also bring tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event. Each team must bring their device and a Design Log for scoring.
   c. The event supervisor will provide the testing materials listed in the COMPETITION AREA section.
   d. Competitors must wear eye protection during Part II. Teams without proper eye protection must be immediately informed and given an opportunity 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.

3. **CONSTRUCTION PARAMETERS:**
   a. The blade assembly device consists of any kind and number of propeller/pinwheel/rotor blade(s) attached to a central disc (i.e., a compact disc (CD), digital video disc (DVD), or Blu-Ray disc).
   b. Each team may bring one pre-constructed blade assembly device attached to a 12.0 cm diameter CD, DVD, or Blu-Ray (teams must not bring the testing materials listed in 6.d.). Note: adjacent diagrams do not show CD to scale.
   c. The CD must fit on the mount found in a standard CD player. Modification of the CD is not allowed (except to affix the blades via tape, glue, etc.).
   d. When mounted, no part of the blade assembly may have a radial distance from the center of the axis of rotation of more than 20 cm (Div B) / 14 cm (Div C).
   e. The blade assembly must be made of only nonmetallic substance(s).
   f. Commercial kits or third-party designs may be used, but must have at least one functional modification, defined as a modification such that the lack of it will result in the assembly working differently or not working.
   g. When initially mounted, no part of the blade assembly may extend behind the mounting plane of the disc. This is to ensure clearance with the motor/generator and support stand. There is no limit on how far forward the blade assembly may extend.



4. **DESIGN LOG:**
   a. Teams must submit a Design Log along with their device. The log must include the following:
      i. Materials used to construct the device.
      ii. A labeled diagram or picture that identifies and describes the parts of the device.
      iii. Any number of graphs and/or data tables showing the relationship between voltage and position for various device or testing setup configurations may be submitted, but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
      iv. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph. A template is available at www.soinc.org.
      v. A front cover labeled with the Team Name and the Team Number for the current tournament.
   b. If a 3-D printer, laser cutter, CNC machine or similar device was used by the team as a tool to build the team's device, or any component thereof, the following information must also be supplied in the log. Any such parts purchased as an end item or as part of a kit do NOT require this information.
      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.

c. All numerical values should be labeled with standard units (e.g. SI or English) appropriate to the dimension being measured. SI units should be the default standard.
d. Teams are encouraged to have a duplicate of their Design Log, as the submitted copy may not be returned.

5. **THE COMPETITION:**

Part I: Written Test

a. Teams will be given a minimum of 20 minutes to complete a written test consisting of a variety of different types (i.e., multiple choice, true-false, completion, or calculation) questions/problems.
b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
c. The test will consist of at least 5 questions from each of the following areas:
   i. Wind power rotor/fan blade design (e.g., types of designs, pros/cons of designs, ways to improve designs, sources of loss)
   ii. Power generator general questions (e.g., generator design for wind, nuclear, coal, gas, solar, or hydroelectric power plants)
   iii. Power storage questions (e.g., how is the power stored during charging and how is it used during discharge, concepts relating to methods of power storage)
   iv. Power transmission questions (e.g., ways electricity is transmitted, how power is lost in transmission, ways to reduce power loss)
   v. Historical applications, environmental impacts, and ecological impacts of wind power (e.g., commercial vs. individual use, how wind power has evolved from windmills, how it is used today for agricultural and industrial use, power generation using wind power, impacts on land use, effects on wild life)

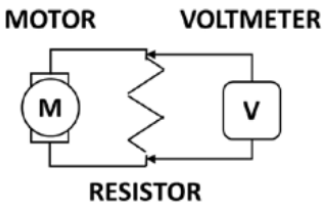
Part II: Device Testing

a. The blade assembly must be tested once with the fan at a high wind speed and once at a low wind speed.
b. Event Supervisors must check the blade assembly specifications right before a team's blade testing period begins. Teams must be notified as soon as possible if a blade assembly does not meet specifications. Event Supervisors may prohibit blade assemblies from being tested if they will damage the testing setup (e.g., due to excessive weight/torque, residue on the disc mount, etc.)
c. Teams may modify the blade assembly during their Part II testing period, if time is available. This may be to bring the blade assembly into compliance with event specifications. Blades not meeting construction specifications at the beginning of the 30 second measurement period must receive a Max Voltage Score of zero (0) for that wind speed. Modifications are not allowed during the 30 second measurement periods.
d. Teams must complete set-up and device testing in no more than 3 minutes per wind speed. At 2 minutes, the event supervisor must give the team a warning. Teams that do not complete testing in this time must receive a Max Voltage score of 0 for that wind speed.
e. Once the 3-minute testing period begins, teams must attach their blade assembly to the motor/generator mount and position it. At the request of the students, the event supervisor must turn on or off the fan during the set-up to allow the students to better position the blade assembly relative to the fan. No voltage measurements are allowed to be made by or seen by the competitors during the testing period. Teams are allowed to adjust, modify, start and stop the blade assembly rotation and reposition the support stand during the testing period.
f. No later than 2 minutes 15 seconds into the testing period, with the fan already on and the blade assembly already rotating for at least 10 seconds, the students must tell the event supervisor to begin a 30 second measurement period. The team must not touch or reposition the blade assembly or support stand during the measurement period.
g. The Event Supervisor must record the Maximum Voltage the occurs during the 30 second measurement period and inform the team of the result.
h. The Event Supervisor will review with the team the Part II data recorded on their scoresheet.
i. Teams filing an appeal regarding Part II must leave their blade assembly device in the competition area.

6. **THE COMPETITION AREA:**

a. Example setups are provided on the event page on www.soinc.org

b. The Event Supervisor will provide the testing materials listed below which will be the same for all teams.
   i. One or two 20" multispeed box fan(s) to be used as the wind source (recommended fans listed on www.soinc.org)
   ii. Support stand(s) that allow for vertical and horizontal adjustments of the blade assembly
   iii. Motor/generator(s) mounted to the support stand(s), with axis of rotation approximately parallel to that of the fan.
   iv. Load resistor(s) between 5 and 25 ohms (1/4 Watt or greater) wired in parallel with the motor/generator that must have the same value for all teams



   v. Device(s) to measure voltage across the load resistor. Voltage measurement devices that have 'peak hold' or 'max hold' functions are recommended.

c. The fan(s) must be mounted in a fixed position with the bottom of the grill at least 15 cm above the table.
d. There may be one or two test stations. If there are two, one must be used for all high wind speed tests and the other for all low wind speed tests. The load resistors at each station are allowed to be different, but must be consistent for all teams.
e. The motor/generator must be equipped with an adapter to accommodate a standard 12.0 cm disc or if the motor/generator is from a disc player, it must be removed from the disc player and mounted on the support stand.

7. **SCORING:**
   a. Final Score (FS) = ES + CS + HSS + LSS + SB. The maximum possible FS is 100 points. High score wins. A scoring spreadsheet is available at www.soinc.org.
   b. Exam Score (ES) = (Part I score / highest Part I score for all teams) x 45 points
   c. Chart Score (CS) - One of the submitted graphs/tables, selected by the Event Supervisor, is scored using i., ii., and iii., described below for a maximum of 6 points. Four (4) additional CS points are available via items iv. and v. Partial credit may be given.
      i. 2 points for including data spanning at least two fan speed settings
      ii. 2 points for including at least 10 data points in each data series
      iii. 2 points for proper labeling (e.g. title, team name, units)
      iv. 0.5 points for each distinct graph or table turned in (up to 2 points total). Different test runs with the same variables measured are considered distinct graphs or tables.
      v. 1 point for including a labeled device diagram
      vi. 1 point for including a labeled front cover
   d. High Speed Score (HSS) = (high speed test Max Voltage / Highest high speed test Max Voltage of all teams) x 21 points
   e. Low Speed Score (LSS) = (low speed test Max Voltage / Highest low speed test Max Voltage of all teams) x 21 points
   f. Submission Bonus (SB) = 3 points if device is brought in a box labeled with team name & number
   g. If the blade assembly stops turning for a period of 10 or more seconds during the measurement period, has any pieces that detach from the assembly, or the team violates any of THE COMPETITION rules, the Max Voltage at that wind speed must be multiplied by 0.9 when calculating the Speed Score.
   h. Both Max Voltages must be multiplied by 0.7 when calculating the Speed Score if any CONSTRUCTION violation(s) are corrected during the competition block.
   i. The Speed Scores must be zero (0) if a team is disqualified for unsafe operation, modifying a CD, or fails to bring a blade assembly device. Such teams will be allowed to compete in Part I.
   j. Tiebreakers
      i. 1st – Best HSS
      ii. 2nd – Best LSS
      iii. 3rd – Specific Test Questions

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

WRITE IT DO IT

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

1. **DESCRIPTION:** One participant will write a description of an object and how to build it. The other participant will attempt to construct the object from this description.

   A TEAM OF: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. The participant who will be doing the writing must bring a writing utensil.
   b. No other materials or resources are allowed.
3. **THE COMPETITION:**
   a. One participant from each team is shown an object, which may be abstract but is the same for all teams, built from, but not limited to, such items as science materials, inexpensive materials (e.g., straws, push pins, Styrofoam balls, paper cups, Popsicle sticks, etc.) or commercial sets (e.g., K'nex, Tinker Toys, Lego, Lincoln Logs, etc.). This participant is not allowed to touch the object unless the Event Supervisor permits it.
   b. The participant viewing the object has twenty-five (25) minutes to write a description of the object and how to build it. There will be no advantage to finishing early.
   c. Drawings and diagrams of the model or subsections of the model are not allowed. Numerals, words and single letters that fit within the context of the written description are allowed. The participant may use abbreviations and do not have to define the abbreviation. Editing, punctuation, or scientific symbols that fit within the context of the written description are allowed.
   d. The Event Supervisor will pass the description to the second team member who will take the description and attempt to recreate (build) the original object in twenty (20) minutes.
   e. Supervisors will attempt to use different materials than the materials that were used last year.
4. **SCORING:**
   a. The team that builds the object nearest to the original and has a written description with no drawings or diagrams will be declared the winner.
   b. Each individual piece will receive points as applicable for: proper size, color, location, orientation, and/or connection.
   c. Pieces that are connected correctly beyond an incorrect connection will be counted in the score. No penalty will be assessed for parts that were not used.
   d. Students drawing a subsection of the model will be ranked in Tier 2. Drawing a picture of the model will result in disqualification.
   e. Time for the construction phase will be used as a tiebreaker.

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

TRIAL EVENT RULES

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

Science Olympiad is continually in the process of researching, developing and evaluating new events. We are looking for events, activities and projects that engage students in all aspects of the scientific endeavor while presenting them with exciting and challenging problems to solve and content to master. In an effort to ensure our events meet those standards, we have established a process that moves an event from a creative concept through a series of pilots and trials, with the ultimate goal of making it into rotation as a current event.

For the 2023-2024 season, we are publishing a selection of Trial Events in the 2024 Rules Manual. The events presented here are not a comprehensive list of all the events under development. For a full list please visit: https://www.soinc.org/learn/trial-events. These particular events are being showcased here because of the topics they address, their approach to challenging Science Olympiad participants and their potential to become part of the competition in the next few seasons. Right now, they still need additional testing and trial. Besides being incorporated into this manual the rules for these events and additional resources are posted at https://www.soinc.org/learn/trial-events.

We have incorporated the rules for these Trial Events into the 2024 Rules Manual so that all teams, event supervisors, and tournaments have easy access to them. If conditions allow, we encourage State Chapters and Tournament hosts to run some of these Trial Events as they offer participants looking for an extra challenge the ability to compete against like-minded peers while contributing important information to prepare these events to become part of the competition in 2025 and beyond.

If a Tournament does choose to run one of the Trial Events published here, a Trial Event from the Trial Event page, or one of their own creation we would ask that you have both event participants and Event Supervisors complete the appropriate post-event evaluation. These evaluations can be found online at soinc.org on the Trial Event page. These brief surveys provide important information to help us fine tune events as well as make decisions about which events are worthy of being part of the Science Olympiad National Competition.

AERIAL SCRAMBLE

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

1. **DESCRIPTION:** At the Tournament, teams will assemble, test, and fly up to two aircraft built on-site without using adhesives from unopened standardized model airplane kits.

   A TEAM OF UP TO: 2 **IMPOUND:** No **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. For Invitational and Regional competitions, teams must bring two unopened kits for inspection and their use. Only kits that, by design, are assembled without adhesives (i.e., Guillows Skystreak, AMA Alpha) and can be disassembled and reassembled to fly again will be accepted.
   b. At the State and National competitions, event supervisors will provide all airplane kits used in the event. Organizers will stipulate the airplane kit to be used in competition at least 2 weeks prior to the competition. Teams will choose two kits for the event from a selection of unopened standardized kits provided by the Event Supervisor. All teams must use the tournament provided standardized kit.
   c. Teams may bring up to 4 rubber motors, each not exceeding 2.0 grams.
   d. Teams may bring winders, assembly tools, fixtures (freestanding from airplanes), sandpaper, adhesive systems, thread, pins, tape, rubber O-rings for motors, clay and their logbook. All items must fit inside a single clear sided container with an approximate footprint of no more than 12” x 12”.
   e. Teams must bring a first aid kit that should contain at least 3 adhesive band-aids and any other first aid equipment the team feels is necessary.
   f. Additionally, teams must bring cutting boards and wax paper to cover any and all work surfaces.
   g. The items in 2.e. and 2.f. do not need to be included in the above referenced (2.d.) tool box.
   h. Any team not using a cutting board will receive a 20% deduction on their final score.
   i. Each team is responsible for their work site. Any debris must be disposed of, and the site cleaned and inspected before official flights are attempted.
   j. Teams will be allowed to attempt two (2) official flights for scoring.

3. **CONSTRUCTION PARAMETERS:**
   a. Only those materials found as part of the two kits will be allowed in model assembly. Glue, tape, pins or clay ballast may be added by teams and are considered as parts of each model.
   b. Boron, carbon fiber, extra wood or foam plastic materials are not allowed in the construction of the aircraft.
   c. The stock rubber motor may be replaced by other rubber elastic loops.
   d. Total mass without motor must be more than 10.0 grams and cannot exceed 25.0 grams.
   e. The wingspan cannot exceed 50.0 cm.
   f. Airplanes must use the propeller provided in the kit, which may not exceed 14.0 cm in diameter.
   g. Motors may have rubber O-rings and be lubricated after check-in.
   h. Airplanes will be labeled in such a way that can be identified by the participants in reference for their logbooks.

4. **THE COMPETITION:**
   a. The event will be held indoors. Tournament officials will announce the room dimensions (approx. length, width and ceiling height) in advance of the competition. Tournament Officials and Event Supervisors are urged to minimize the effects of environmental factors such as air currents. Rooms with minimal ceiling obstructions are preferred over very high ceilings.
   b. The event will be scheduled in hour time slots with no more than 10 teams competing in a time slot. The first 30 minutes will be devoted to complete primary check-in, model assembly and trim flights. The final 20 minutes will be to accomplish the team’s two official flights. These flights will occur in 2-3 team mass launches within a 4-minute scheduled window.
   c. At their scheduled time a team will enter a cordoned off competition area to begin Primary Check-In, where they:
      i. Sign-in and are scheduled, in sequence of their arrival, for an official flight time-slot, as well as receive from or have their model kits inspected by from the Event Supervisors depending upon the type of competition being held.

ii. Teams will then submit their tools and materials kit (2.d.) as well as their first aid kit (2.e.) for inspection. Teams must show officials that they have at least a minimum of 3 adhesive band-aids as part of this kit or a 10% deduction will be applied to their final score.
iii. The team members remain in the competition area until their official flights are completed. No outside assistance is allowed.
iv. Teams will assemble up to two airplanes from the two kits and proceed to test/trim fly their models.
v. The first thirty minutes of the hour include check-in, model construction and flight trimming.
vi. At the Event Supervisor's Discretion:
(1) Test Flights may occur throughout the contest but will yield to official flights.
(2) Teams ready early can proceed to make their official flights in sequence.
(3) No Test Flights may occur in the last half hour of the event.
vii. A self-check inspection station may be made available to competitors for checking their airplanes prior to the Secondary Check-In for their Official Flights.
viii. Competitors may use any kind of winder, but electricity may not be available.

d. For Secondary Check-in and their Official Flight Time-Slot, teams must present up to two airplanes, their logbook, and up to 4 motors for inspection immediately prior to their Official Flight Time-Slot. Logbooks must describe at least 4 tasks that were used in either model construction or test flying their models prior to the competition. The logbooks may contain numerical data.
e. During Secondary Check-in, Timers will collect the motors presented for inspection. Allowable motors will be returned to the team just prior to their Official Flight Time-Slot.
f. After Secondary Check-in, teams will be taken in groups of 2 or 3 to make official flights:
i. Teams may make up to two (2) official flights using 1 or 2 airplanes.
ii. Teams will be instructed to put their airplanes on the floor then asked to pick them up.
iii. All motors that meet specifications and were collected during Secondary Check-in will be returned to the teams for their official flights.
iv. When picked-up, teams will have one minute to wind airplanes.
v. Timers will follow and observe teams as they are winding their motors.
vi. In the last 10 seconds of that minute, a timer will audibly announce the countdown. At "3-2-1 Launch!" all models in the group will be launched and timed independently.
vii. When the last model lands, teams will again be instructed to pick-up their models starting a one minute countdown for the second official flight. These flights will be timed to conclusion.
viii. Time aloft for each flight starts when the model leaves the competitor's hands and stops when any part of the model touches the floor, the lifting surfaces no longer support the weight of the model (such as the airplane landing on a girder or basketball hoop) or the Event Supervisors otherwise determine the flight is over.
ix. In an unlikely event of a collision, the two teams involved will re-fly the round.
x. Event Supervisors are strongly encouraged to utilize three (3) timers on all flights. The median flight time in seconds to the precision of the device used is the official time aloft.

5. **SCORING:**

a. The final score is made by adding the two flight times together.
b. Ties will be broken by the longest single official flight time per team.
c. Teams with incomplete flight logs will have each flight time multiplied by 0.90.
d. Teams that worked without a cutting board will have each flight time multiplied by 0.80 after other penalties have been applied.
e. Teams without flight logs will have each flight time multiplied by 0.70.

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

AGRICULTURAL SCIENCE

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

1. **DESCRIPTION:** Participants will solve problems and answer questions about agricultural sciences using their knowledge of ecology, animal and plant biology, and environmental chemistry.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source.
   b. Each team may bring two stand-alone, non-programmable, non-graphing calculators.
3. **THE COMPETITION:**
   a. This event may be run as stations and include observations, inferences, data analysis, and calculations. This event will be composed of four parts of approximately equal point value.
   b. The four parts of the event are as follows:
      i. **Part A -** Students will be tested on their knowledge of agricultural science. Year one of the rotation will focus on plants and year two of the rotation will focus on animals. This section will use multiple choice, matching, fill-in-the-blank and/or short answers in areas such as:
         (1) YEAR 1 crop rotation, nitrogen and phosphate fertilization, pest and plant pathogen management, methods of measuring plant and soil health, measuring crop yield, non-responsive fields, plant-associated microbes, ecological function of soil invertebrates, nutrient cycling in soils, agricultural runoff, water usage, effect of tilling on soil chemistry, angiosperm development and reproduction, and classical plant breeding.
         (2) YEAR 2: herd management, hormone use in animals, pest and animal pathogen management, measuring animal yield (meat and milk production), animal development and reproduction, classical animal breeding, animal welfare.
      ii. **Part B -** Prior to the tournament, teams must perform an agricultural experiment on one or more plants. Students will impound one notebook prior to the start of the tournament for grading. The notebook must contain at least three clear pictures of both team members working together with their plants. Notebooks which do not have these pictures included will not be graded.
      iii. **Part C -** Students will be required to answer exam questions on site that demonstrate their understanding of their personal experiment.
      iv. **Part D -** Students will be tested on their knowledge of experimental design. This section will use multiple choice, matching, fill-in-the-blank and/or short answers.
4. **SAMPLE QUESTIONS:**
   a. PART A: What nutrients are supplied by mycorrhizal fungi to their plant hosts? What nutrients are supplied by plants to mycorrhizae?
   b. PART A: The two specimens at this station were raised in fields with or without nitrogen fertilizer. Based on these specimens, is it likely that nitrogen fertilization improved crop yield? Why?
   c. PART C: Define experimental replicate and explain how many replicates were done in your experiment.
   d. PART D: Two sets of tomato plants are growing in a greenhouse. One set is given fertilizer. The height of the plants is measured after 1 week. What is the experimental variable?
5. **SCORING:**
   a. High score wins. Final Score = Exam score (part A, C, and D) + Notebook score (part B)
   b. If students do not impound a notebook the score for parts B and C will be zero. If students impound a notebook with an experiment that is not related to agriculture or the required pictures are missing the score for part B will be zero. All other sections will be scored as normal.
   c. Selected questions on the exam may be used as tiebreakers.
   d. Notebook score: Score will reflect the accuracy of the material provided, not whether or not the hypothesis was supported. See sample scoresheet.
      i. Hypothesis- 15% of score
      ii. Variables- 25% of score
      iii. Experimental Control- 10% of score
      iv. Methods and Materials- 10% of score
      v. Results- 15% of score
      vi. Conclusions- 25% of score

AGRICULTURAL SCIENCE NOTEBOOK
SAMPLE SCORESHEET
Total Score 50 points

1) Notebook documents an experiment related to agriculture
Yes- continue to grade
No- notebook score is zero

2) Three clear pictures of both team members working together with their plants
Yes- continue to grade
No- notebook score is zero

3) Hypothesis- 15% of score (7.5 points)			
Statement predicts a relationship or trend.	3pts	2pts	0pts
Statement gives a specific direction.	3pts	2pts	0pts
A rationale is given.	1.5 pts	1pts	0pts
4) Variables- 25% of score (12.5 points)			
Independent variable correctly identified	4pts	2pts	0pts
Dependent variable correctly identified	4pts	2pts	0pts
Controlled variables corrected identified	4.5pts	2pts	0pts
5) Experimental Control- 10% of score (5 points)			
Experimental control correctly identified	3pts	2pts	0pts
Reason given for experimental control	2pts	1pts	0pts
6) Methods and Materials- 10% of score (5 points)			
Methods listed	3pts	2pts	0pts
Materials listed separately from methods	2pts	1pts	0pts
7) Results- 15% of score (7.5 points)			
Qualitative observations are included	2pts	1pts	0pts
Quantitative data is given in a table	2pts	1pts	0pts
Quantitative data is given in a graph	2pts	1pts	0pts
Relevant statistics are given	1.5pts	1pts	0pts
8) Conclusions- 25% of score (12.5 points)			
Hypothesis evaluated according to data	4pts	2pts	0pts
Reasons to accept/reject given	4pts	2pts	0pts
Statements supported by data	4.5pts	2pts	0pts

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

This event is sponsored by Corteva Agriscience

BOTANY

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

1. **DESCRIPTION**: Participants will demonstrate their knowledge of plant life and general botany principles.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** A **EVENT TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each participant may bring one 8.5" x 11" sheet of paper, which may be in sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed as well as a stand-alone, non-programmable, non-graphing calculator.
   b. Each participant must wear a lab coat and googles when dealing with specimens.
   c. Event Supervisors will provide live/preserved specimens, pictures, tables, graphs of data, microscopes, slides, and any other required equipment for the event. If used, toxic/irritating plants or specimens in liquid (e.g., Algae, protists) must be in closed, non-breakable containers.
3. **THE COMPETITION:**
   a. This event may be run as either a sit-down exam or a series of laboratory stations with questions.
   b. Participants will be expected to master the structure of plant cells, roots, stems, leaves, spore forming bodies and flowers, aspects of plant growth and differentiation, and the transport and storage of gases, water, and nutrition throughout the plant body.
   c. Participants should also have a broad knowledge of the major divisions between groups of plants (i.e., algae vs. multicellular plants, monocot vs. dicot, embryophytes vs. cryptogams, woody vs. herbaceous plants).
   d. In addition to the above listed topics, participants should know:
      i. The history of botany
      ii. Basic plant genetics and reproduction
      iii. Photosynthesis
      iv. Differences between the major taxonomic groups of plants
      v. Paleo-botany and plant evolution
      vi. The role of plants in global energy and nutrient cycles
      vii. Use of plant materials by animals and humans
      viii. Competition in the plant community
      ix. Genetically Modified Organisms (GMOs)
      x. Production of foodstuffs and plant products
      xi. Plant diseases; including nutrient deficiencies and infections
   e. For Division C Only, participants are expected to know:
      i. Principles of horticulture and aquaculture
      ii. Plant biochemistry
      iii. The roles of plants in medicine and environmental management
      iv. Importance of plant diversity
4. **SAMPLE QUESTIONS/TASKS:**
   a. What leaf structure is being shown on this microscope slide?
   b. Using the graph, identify the peak wavelength for chlorophyll absorbance.
   c. Identify three key differences between flowering plants and ferns.
   d. Which plants would be in the next wave of plant succession for the region shown?
   e. Describe the role plants play in the nitrogen cycle.
5. **SCORING:**
   a. High Score wins.
   b. Selected questions will be used to break ties.

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

This event is sponsored by Corteva Agriscience

CYBERSECURITY

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

1. **DESCRIPTION:** Competitors will be assessed on their knowledge of cybersecurity through hands-on tasks as well as theoretical questions focused in the areas of cryptography and web architecture.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring up to two 8.5" x 11" sheets of paper, which may be in a sheet protector sealed by tape or laminated that may contain information on both sides in any form and from any source without any annotations or labels affixed.
   b. Each team may also bring tools, supplies, and writing utensils. Teams may use the internet during the competition only to access an online IDE, reference the official documentation for their programming language of choice, and visit any other website required for the event by the Event Supervisor. Teams may also provide their own mouse.
   c. Supervisors will provide a computer capable of accessing the internet. Tournament Directors are encouraged to provide computer specifications to the teams at least one month in advance.

3. **THE COMPETITION:**

   Both Part I and Part II of the event will be provided to the participants at the beginning of the event. Participants may work on both parts simultaneously during the entire event.

   Part I: Written Test (65%)
   a. Participants will complete a written test consisting of the topics Cryptography and Web Architecture, as well as general cybersecurity principles and concepts.
      i. Cryptography
         (1) The cryptographic protocols are limited to:
            (a) Hashing algorithms
            (b) The XOR operation
            (c) Classical Cryptography: Substitution Ciphers, Transposition Ciphers
            (d) Modern Cryptography: RSA, Diffie Hellman Key Exchange, Block Ciphers, Stream Ciphers, Elliptic Curve Cryptography
         (2) Identifying vulnerabilities in implementations of cryptosystems
         (3) Common applications of the topics in the Cryptography section (3.a.i)
         (4) Post-quantum cryptography
      ii. Web Architecture
         (1) History of the internet
         (2) Web page construction: HTML, CSS, JavaScript, APIs
         (3) HTTP: requests, responses, headers, query parameters, status codes, verbs
         (4) URL syntax and structure
         (5) Storage, session management, and cookies
         (6) Types of networks and connections including TCP/IP, WiFi, and SOHO and how information travels through these networks
         (7) Common web exploitation techniques
      iii. Principles of Cybersecurity
         (1) Authentication and security best practices
         (2) Cybersecurity ethics
         (3) Online safety

   Part II: Hands-On Tasks (35%)
   a. The programming portion of the hands-on tasks will consist of multiple programming problems. Competitors must use an online IDE to write code, and it is suggested that HackerRank is used to host the problems. Each problem must be solved using any of the following supported languages: C, C++, C++11, Java, Python 2, or Python 3. Only the standard library for these languages may be used.
      i. Competitors will write code to implement various common algorithms to a variety of problems and test cases. Topics may include, but are not limited to:
         (1) String manipulation
         (2) Boolean expressions
         (3) Control structures
         (4) Implementation of math operators and integer evaluation, such as primality tests and prime sieves

(5) Recursion

ii. Test cases for programming challenges will be provided to teams to test their program. The problem statement may include time and memory constraints, and these constraints may vary by language; any given test case will fail if these constraints are not met.

iii. Each problem will be checked against the answer and the code submitted. Point values may vary between questions based on difficulty and points given may be determined by the number of test cases passed.

iv. Teams will be required to submit their code to the event supervisor at the end of the event.

4. **SCORING:**

a. High score wins.

b. The written portion will account for 65% and the hands-on portion will account for 35% of the total number of available points.

c. In the written portion, points will be awarded based on accuracy of the responses. In the hands-on portion, points will be awarded based on accuracy of outputs.

d. Ties will be broken by 1) Part II score, 2) Selected questions from the written test.

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

Topic Rotation

Year	Topic 1	Topic 2
Year 1	Web Architecture	Cryptography
Year 2	Cryptography	Data Forensics
Year 3	Data Forensics	Web Architecture

DIGITAL STRUCTURES

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

1. **DESCRIPTION:** Teams will design and test a Tower using SkyCiv structural analysis software that meets requirements specified in these rules to achieve the highest structural efficiency while withstanding multiple vertical and lateral loads.

   A TEAM OF UP TO: 2 **EVENT TIME:** 45 minutes

2. **EVENT PARAMETERS:**
   a. Each participant may bring one stand-alone non-programmable, non-graphing calculator, a writing utensil and unmarked scratch paper.
   b. This event will take place on an internet-connected computer with browser access to SkyCiv. Each team will need a SkyCiv license.

3. **CONSTRUCTION PARAMETERS:**
   a. The Tower must be a single structure constructed by connecting members made of the material available when using the SkyCiv Science Olympiad add-on. The cross-section of individual members must be rectangular with minimum cross-sectional dimensions as specified in SkyCiv of 1.5 mm by 1.5 mm.
   b. The xz-plane ($y = 0$) will be defined as the Testing Base. All nodes of the Tower must be on the non-negative-y side of the xz-plane prior to load testing. The Tower must be supported using exactly four supports placed in the plane of the Test Base ($y = 0$); two must be "Horizontal Rollers in X" with x-coordinates ≥ 22.5 cm and two must be "3D Pin Supports" with x-coordinates ≤ -22.5 cm, without restrictions on z-coordinates.
   c. The Tower must be designed to support multiple Area Loads, each in the negative y-direction over a 5.0 cm by 5.0 cm rectangular area.
      i. The number of Area Loads the Tower must support is two for Regionals, three for State, and four for Nationals.
      ii. One Area Load must have nodes at ($x = \pm 2.5$ cm, $y = 50.0$ cm, $z = \pm 2.5$ cm) for Division B and ($x =$
      iii. ± 2.5 cm, $y = 60.0$ cm, $z = \pm 2.5$ cm) for Division C.
      iv. The other Area Load(s) will have nodes at coordinates specified by the Event Supervisor in the range (-22.5 cm $\leq x \leq 22.5$ cm, $0 \leq y \leq 10.0$ cm, $z = \pm 2.5$ cm) for Division B and (-22.5 cm $\leq x \leq 22.5$ cm, $0 \leq y \leq 15.0$ cm, $z = \pm 2.5$ cm) for Division C. The y-coordinates for all nodes in an Area Load must be the same.
   d. To simulate lateral loading, each of the four nodes of the Area Load in 3.c.ii. must have a Point Load in the positive-z direction with magnitude 5–25 N, the same magnitude for all Point Loads.

4. **THE COMPETITION:**
   a. The Event Supervisor will determine the coordinates, to the closest 0.1 cm, of nodes for the additional Area Load(s) (3.c.iii.) and the magnitude, to the closest 1 N, used for the Point Loads (3.d.). At the beginning of each session, the Event Supervisor will tell teams these parameters. The same parameters will be used for all teams at the tournament.
   b. Before receiving the event parameters from the Event Supervisor, students must turn on Competition Mode in the SkyCiv Science Olympiad add-on.
   c. After being told the parameters in 4.a. and prior to building, participants must submit their Estimated Load Supported to be used as a tiebreaker.
   d. Participants will have 45 minutes to build, test, and submit their Tower in SkyCiv. Participants may test their Tower any number of times.
      i. With Competition Mode enabled, the SkyCiv Science Olympiad add-on will not display scores. Participants are encouraged to use the "Solve" function to evaluate and improve their Tower before submission.
   e. SkyCiv will load all Area Loads evenly and stop loading when failure occurs. Failure is defined as any member of the Tower buckling or experiencing stress exceeding the parameters of that member.
   f. The maximum Load Supported across all Area Loads is 15,000 g.

5. **SCORING:**
   a. High score wins. Score = Load Score (g)/Mass of Tower (g).
   b. The Load Score = Load Supported (4.e.) + Bonus.
   c. Towers that have a Load Supported of 15,000 g will earn a Bonus of 5,000 g.
   d. Towers will be placed in three tiers as follows:
      i. Tier 1: Holding any load and meeting all construction parameters and competition requirements
      ii. Tier 2: Holding any load with any violations of the construction parameters and/or competition requirements
      iii. Tier 3: Unable to hold any load and will be ranked by lowest mass
   e. Ties are broken as follows:
      i. Estimated Load Supported closest to, without exceeding, the actual Load Supported
      ii. Ranked by lowest Tower mass
   f. Example score calculations:
      i. Device 1: Mass = 10.12 g, Load Supported = 12,134 g; Score = 1,199
      ii. Device 2: Mass = 12.32 g, Load Supported = 15,000 g + Bonus (5,000 g) = 20,000 g;
      iii. Score = 1,623

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

This event is sponsored by SkyCiv

ENGINEERING CAD

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

1. **DESCRIPTION:** Teams will read a set of engineering drawings and collaboratively create CAD parts and assemblies that match the drawings while incorporating provided components and be able to answer questions about the drawing and generated model.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME**: 50 minutes

2. EVENT PARAMETERS:
   a. Teams will use PTC Onshape on two computers with mice to create the model. Tournament directors will either provide devices or allow teams to bring their own devices depending on the tournament logistics.
   b. Teams must bring writing utensils
   c. No resource materials, except those provided by the Event Supervisor, may be used.
   d. Teams will be provided with a set of engineering drawings (either printed or online) and may receive a starting model that has some parts needed for building the finished model.
3. **THE COMPETITION:**
   a. Teams will CAD parts and an assembly based on the engineering drawings which specify the geometry, materials, and units for each part.
      i. For Regionals, teams will be required to model 2 to 3 components for 1 assembly.
      ii. For State and Nationals, teams will be required to model 4 to 6 components for 1 assembly.
   b. Teams will be required to answer questions about the drawing as well as mass, moment of inertia, and dimensions for individual parts and the completed assembly. Answers will need to be at a specified precision and units.
   c. Students on the team will work collaboratively on the model.
4. **SCORING:**
   a. The high score wins. Final Score = Test Score + Modeling Score.
   b. The test and modeling scores should be weight evenly such that: Max Test Score = Max Modeling Score
   c. Test scores will be based on the precision and/or accuracy of the answer to questions about the modeled parts and drawings.
   d. The scores for each test question will be added together to generate the Test Score.
   e. Modeling score for parts is determined by comparing the **mass** of named parts as specified in the engineering drawing to the correct values. A perfect match for the mass is 20 points and the minimum score is 0 for each part. Points for each part will be calculated as:
      i.
      $$Individual\ Part\ Score = 20 - 100\ abs\left(\frac{Student_{mass} - Correct_{mass}}{Correct_{mass}}\right)$$
   f. Modeling score for assemblies is determined by comparing each component of the **center of mass** of the named assembly as specified in the engineering drawing to the correct values. A perfect match for the center of mass is 20 points and the minimum score is 0. Points for each assembly will be calculated as:
      i.
      $$Individual\ Assembly\ Score = 20 - 100\left(\frac{1}{3}abs\left(\frac{Student_{center_x} - Correct_{center_x}}{Correct_{center_x}}\right) + \frac{1}{3}abs\left(\frac{Student_{center_y} - Correct_{center_y}}{Correct_{center_y}}\right) + \frac{1}{3}abs\left(\frac{Student_{center_z} - Correct_{center_z}}{Correct_{center_z}}\right)\right)$$
   g. The individual score for each part and assembly will be added together to generate the Modeling Score.
   h. Tiebreakers: The first tiebreaker is the model score; the team with the highest model score wins the tiebreaker. The second tiebreaker is modeling time; the team with lowest modeling time as measured from the creation of their document to the submission version wins the tiebreaker.

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.

This event is sponsored by OnShape

HOME HORTICULTURE

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

1. **DESCRIPTION:** Participants will use their investigative skills in the scientific study of home horticulture.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C **EVENT TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
   b. Each team may bring two stand-alone calculators of any type to use during the event.
   c. Each team must bring a soil test kit complete with chemicals to test soil samples for pH, N, P, and K.
3. **THE COMPETITION:**
   a. The competition will consist of a series of task that could include hands-on activities, questions on listed topics, interpretation of data (e.g., graphs, diagrams, and tables), or observation of an established and running experiment.
   b. Teams may be asked to analyze soil samples for pH, nitrogen, phosphorus, and/or potassium.
   c. Participants are expected to have knowledge of the following topics:
      i. basic botany
      ii. plant propagation
      iii. soil health, fertilizer management, and composting
      iv. entomology of pests & pest management
      v. plant diseases,
      vi. vegetables, tree fruit, & small fruit (e.g., blueberries. brambles, currants, gooseberries, grapes, & strawberries)
      vii. lawn care & pruning ornamentals,
      viii. woody ornamentals, herbaceous plants, and native plants
      ix. weeds and invasive plants
      x. garden wildlife (e.g., butterflies, hummingbirds, bumble bees)
      xi. nuisance animals (e.g., chipmunks, cottontail rabbits, voles, raccoons, skunks, squirrels, deer, & woodchucks)
   d. English units will be used for all calculations as current horticulture literature uses English units exclusively.
4. **SAMPLE QUESTIONS/ACTIVITIES:**
   a. Use soil test kit to determine the soil pH.
   b. Calculate the amount of 10-10-10 fertilizer to use in a 100 ft^2 garden.
   c. Identify an herbaceous plant from a picture.
   d. Determine the spacing for woody plants in a garden bed given the mature size.
   e. Recall the difference between a warm season turfgrass and a cool season turfgrass.
   f. Identify an insect pest from a picture.
5. **SCORING:**
   a. Scoring will be split approximately 75% exam and 25% hands-on activities. High score wins.
   b. Time may be limited at each task but will not be used as a tiebreaker for scoring.
   c. Ties will be broken by pre-selected questions.
   d. A penalty of up to 10% may be given if the area is not cleaned up as instructed.
   e. A penalty of up to 10% may be given if a team brings prohibited equipment to the event.

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

This event is sponsored by Corteva Agriscience

MISSION POSSIBLE

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

1. **DESCRIPTION:** Prior to the competition, participants design, build, test, and document a Rube Goldberg®-like Device that completes required Start and Final Actions through a series of specific actions.

   A TEAM OF UP TO: 2 **IMPOUND:** State & National only **EYE PROTECTION:** C

   SET-UP TIME: 30 minutes for points **MAXIMUM RUN TIME:** approximately 3 minutes

2. **EVENT PARAMETERS:**
   a. At State and National Tournaments, teams must impound their Device along with any tools or parts that they will use during their set-up time or run. Electric outlet access will not be available.
   b. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not compete.
   c. Each Device must pass a safety inspection before operation. Devices with potential hazards or safety concerns must not be permitted to run unless safety concerns are resolved to the satisfaction of the Event Supervisor, otherwise they must receive only participation points.
   d. Event Supervisors will need their own eye protection (e.g.; safety glasses), meter sticks, stopwatches, and measuring tape.
   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. During operation, the Device's outer dimensions should be no greater than 60.0 cm x 60.0 cm x 100.0 cm., in any orientation.
   b. All actions used for scoring must be visible and/or verifiable. The top and at least two vertical walls must be open or transparent for viewing all actions. Actions must be consecutive. Parallel and/or dead-end actions will not count for points. Any action in the Device not designed to contribute to the completion of the Final Action will not count for points.
   c. Each movable/adjustable physical object in the Device must be utilized by at most one assigned action. An object at the end of one action may initiate the next action but must not go beyond the initiation of the second action.
   d. Sensitive components (e.g., springs/mousetraps, dominoes) may be set/placed just before starting the Device.
   e. Use of electricity is prohibited anywhere in the device.
   f. Candles, flames, matches, hazardous liquids, lead objects (even if encased), gases, and hazardous materials (e.g., rat traps, combustible fuses, dry ice, liquid nitrogen) and unsafe handling of chemicals will not be permitted.

4. **DESIGN LOG:**
   a. Teams must submit a Design Log along with their device. The log must include the following:
      i. Materials used to construct the device
      ii. A labeled diagram or picture that identifies and describes the parts of the device
      iii. A front cover labeled with the Team Name and the Team Number for the current tournament
      iv. All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured. SI units should be the default standard.
   b. 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 Design 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
   c. All submitted logs will be returned to teams after inspection.

5. **DEVICE OPERATION:**
   a. Start Action: (100 points) - Participants must drop a US Quarter into the Device from a point completely above the Device. The quarter must fall into the Device and initiate the next action.

b. Scorable Actions: (50 points each) – Participants may have up to the first 6 scorable unique actions (i. through vi.) to count for points at a Regional Tournament. Actions vii., viii. and ix. may be added at the State level and x., xi. and xii. may be added at the National Tournament.
c. Just before setting up, a team will be given the scorable sequence of actions for the day. They must re-arrange their actions to match the given sequence as close as possible. Once the first action on the given list is successfully completed, the team will receive 50 points. If the first action is not successful or attempted, then the next action on the list is eligible for points if successful. Then, 50 points will be awarded for each of the listed actions that are successfully completed in the proper sequence after the first successful listed action. Other actions may be inserted between those that could count, but the inserted actions will not be scoreable.
d. Each of the actions below may be attempted only once in the device. For example, if all six actions at a Regional are completed in the given sequence, then 300 points will be awarded.
   i. Use an object to operate a wheel & axle to raise another object 10 cm. that then initiates the next action.
   ii. Use a wedge to separate two touching marbles so that one moves 20 cm. from its spot and then initiates the next action.
   iii. Remove a wedge that is keeping a golf ball from rolling, so that the golf ball rolls at least 20 cm. horizontally to initiate the next action.
   iv. Push or pull an object up an inclined plane with an IMA of at least 2 so that the object is vertically raised at least 10 cm. before it initiates the next action.
   v. Use a 3rd class lever to raise an object 10 cm. before the object initiates the next action.
   vi. Operate a pulley system with IMA of 3 to raise an object at least 10 cm. before the object initiates the next action.

   (Added for State Level for an additional 150 points)

   vii. Use a marble to knock over a series of 3 dominoes so the last domino moves another marble to initiate the next action.
   viii. Use a 2nd class lever to raise an object 10 cm. before the object initiates the next action.
   ix. Use a single marble to hit a chain of 5 touching marbles so that the last marble moves at least 10 cm. and then initiates the next action.

   (Added for National Tournament for an additional 150 points)

   x. Use water to raise a golf ball at least 5 cm. that then rolls out of the container to initiate the next action.
   xi. Use falling marbles to turn a paddlewheel. The wheel must make at least one full revolution before triggering the next action.
   xii. Use an Archimedes screw to raise a marble 20 cm vertically before the marble triggers the next action.
e. Final Action:
   i. After all other planned scorable actions have been attempted, the device may release a golf ball attached to the end of a string that forms a pendulum. To count, the pendulum must swing from the release point, swing, and strike a button or release mechanism that raises a Stop Sign completely above the device. The Stop Sign must be cardboard or poster board, oriented vertically, red and square or octagonal. It must be at least 15 cm. high and 15 cm. wide.
   ii. If the entire Stop Sign is vertical and completely higher than the entire device, 250 points will be awarded. If the Stop Sign is vertical and only partially above the device, only 125 points will be awarded. If the Stop Sign is not vertical, zero points will be awarded.
   iii. The distance the golf ball pendulum swings to the release button will add 5 points per cm. that it swings, only if it touches the release button for the sign at the end of its swing.
f. Two printed copies of an Action Sequence List must be given to the Event Supervisor at the time of check-in (regionals)/impound (state and national). The list must indicate the Start and the action initiated by the Quarter, the Sand Timer (if one is included), the action that releases the golf ball pendulum, the distance between the golf ball and the Stop Sign release button (in cm.), and the Stop Sign release button. The format should be the same as the one posted on the Science Olympiad website. Everything required in the ASL should also be labeled at the proper places within the device.
g. Once the team is at set-up and has received the preferred sequence of scoreable actions, they must insert (write) the names of the actions they plan to attempt at the proper place in their ASL and the copy for the supervisor.

6. **THE COMPETITION:**
   a. The Target Operation Time is 60 seconds at Regionals/Invitationals, 61 to 90 seconds at State, and 91 to 120 seconds at Nationals. For State and National tournaments, teams will be told the target time at the start of their setup. The target time will be the same for all teams at State and Nationals.
   b. Timing and scoring begin when a participant drops the Quarter into the Device. Timing stops when the golf ball pendulum strikes the STOP Sign release button, or after 2 x the Target Time in seconds have elapsed, whichever comes first.
   c. Teams that have a time of twice the Target Time will receive no (zero) points for running time.
   d. Participants may designate one sand timer, an action taking over 10 seconds, to be eligible for bonus points. This timer must not be one of the scorable actions.
      i. A 1-point bonus will be awarded for every full second the sand timer runs before the Target Operation Time. The timer may run past the Target Operation Time but will not receive points for the duration after the Target Operation Time.
      ii. The timer must successfully initiate the next action for any bonus points to count.
      iii. For State/National tournaments, the team must demonstrate how this timer is adjusted to account for the increased length of Target Operation Time for the bonus points to count.
   e. If the Device stops, jams, or fails, the participants will be allowed to adjust it to continue operation up to three times. An adjustment may consist of multiple physical touches and is only completed once the Device runs again on its own. Obvious adjusting only to stall or impact operation time will result in disqualification.
   f. If a participant completes a scorable action or makes an adjustment that leads directly to the completion of that action, then that action will not count for points, even if it is part of the Final Action.
   g. Participants will not be allowed to touch the device to release the golf ball pendulum or anything after that point.
   h. The Supervisor will review with teams the data recorded on the scoresheet.
   i. Teams filing an appeal must leave their Device and ASL in the event area.

7. **SCORING:**
   a. High score wins.
   b. Award 50 points if participants use no more than 30 minutes to set up their Device.
   c. Award 25 points if 2 printed copies of the ASL are presented at the proper time.
   d. Award 25 points if ASLs are in proper format, include all scorable actions and are accurate.
   e. Award 25 points if the original actions in the ASL are properly labeled in the device.
   f. Award 25 points if the planned preferred actions have been inserted in the ASL at set-up.
   g. Award 50 points the first time each unique action in part 3. is successfully completed as described AND in the sequence given by the Event Supervisor.
   h. Award 100 points for completing the Start Action
   i. Award 250 points for completing the Final Action as described in 3.M or 125 points if partially completed.
   j. Award 5 points for each cm. that the golf ball pendulum swings on its way to striking the STOP sign release button. (If nothing else is touched by the pendulum and it strikes the button.)
   k. Award 2 points for each full second (rounded down) of operation up to the Target Operation Time. Devices running twice the Target Time will receive zero points for the run.
   l. Award 1 point per full second that a sand timer runs before the Target Operation Time if all conditions are met, and the next action is initiated by the timer
   m. Award 0.1 point for each 0.1 cm that the Device dimensions are under 60.0 cm for 2 dimensions and 100 cm. for the third. dimension. The maximum score awarded for each dimension is 30 points, for a total of 90 points (Only at in-person tournaments.)
   n. Award 75 points for a Device that has no adjustments during operation.
   o. Teams failing to impound their device on-time will be ranked after all teams that impounded on-time.
   p. Teams receive only participation points for impounding a Device but not competing, unsafe Devices, Devices with a dimension greater than 1 meter, or Devices that are remotely timed/controlled

8. **PENALTIES:**
   a. Deduct 2 points for each full second (rounded down) that the Device operates past the Target Operation Time up to 2 x the Target Time seconds.
   b. Deduct 10 points for incomplete Design Log
   c. Deduct 25 points for missing Design Log
   d. Deduct 25 points:
      i. For each dimension of the Device that exceeds its limit of 60 or 100 cm.
      ii. If the top and 2 vertical walls are not open or transparent
      iii. For each time the Device is adjusted during operation, up to 3 times. If the Device stops or fails after the third adjustment, scoring stops and the operation time will be 2 x the Target Time in seconds.
   e. Deduct 50 points if any solid or liquid leaves the measured dimensions of the Device.
   f. Devices that use electricity within the device will not be allowed to run.
9. **TIEBREAKERS:**

   Ties are broken as follows: a) Fewest penalty points; b) Smallest overall dimensions (L+D+H) of the Device.

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

SOLAR POWER

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

1. **DESCRIPTION:** Teams must construct a collecting device prior to the tournament that is designed to collect heat and complete a written test on alternative energy concepts.

   A TEAM OF UP TO: 2 **IMPOUND:** No **APPROX. TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
   b. Each team may bring their heat collection device, an unaltered, glass or plastic, standard (height ~1.4 times the diameter) 250 mL beaker, copies of graphs and/or tables for scoring, tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event.
   c. Event supervisors will supply the water, and thermometers or probes (recommended). Non-contact thermometers are allowed.
   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. Devices may be constructed of and contain any materials (e.g., cardboard, aluminum foil, reflective fabric or material, glue, tape, mirrors, tiles and lenses).
   b. The device, including beaker, must fit within a 35.0 cm x 35.0 cm x 35.0 cm cube when set up for testing.
   c. Within the device, participants must be able to insert and remove a beaker that they supply (see 2.b).
   d. The device must also easily accommodate the insertion and removal of a thermometer/probe into the beaker. Parts of the device may be inside the beaker, but the device must not contact the water.
   e. Devices will be inspected to ensure that there are no energy sources (e.g., no electrical components, small battery powered heaters, chemical reactions, etc.) to help warm the water. At the event supervisor's discretion, teams must disassemble their devices at the end of the testing period in order to verify the materials used in construction.
   f. All parts of the device must not be significantly different from room temperature at the start of the event.
   g. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between elapsed time and water temperature. A labeled device diagram should be included.
      i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
      ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph . A template is available at www.soinc.org.
      iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned.
4. **THE COMPETITION:**

   Part I: Written Test
   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The competition must consist of at least five questions from each of the following areas:
      i. Basic information and definitions about energy, work, heat and heat transfer, temperature, temperature scales, thermal energy and insulation.
      ii. General information about renewable energy including but not limited to solar, wind, hydroelectric, tidal, ocean thermal energy conversion (OTEC), and geothermal.
      iii. General information about energy conservation practices including but not limited to recycling, reusing, and using materials with greater efficiency.
      iv. Mathematical relationships and equations used in determining heat loss and gain, specific heat, and heat transfer.

   Part II: Device Testing
   a. At the start of the competition block, teams will be given 5 minutes to set up or modify their devices and use their graphs and/or tables to calibrate them. Devices that do not meet the construction specs will not be allowed to be tested until brought into specification.

b. At each station, the event supervisor will provide an incandescent lamp with a bell-shaped reflector. The lamp will be mounted, facing down, above the testing surface (on which teams will set up their device) such that the bottom of the bulb is at least 40.0 cm from the testing surface. Multiple identical stations may be used.
c. At the start of a team's device testing period the supervisor, using their own measuring device, will dispense 100 mL of water into the team's beaker. A team may elect to install the beaker in a device prior to this, but must leave sufficient access to the beaker. Otherwise the team may then place the beaker into their device.
d. Teams will use their graphs and/or tables to predict the temperature of the water in their beaker at the end of the 10-minute heating time. After receiving water, teams will be given at least 3, but no more than 5 minutes to make their final predictions. During this time, teams may use their own thermometers to measure the starting water temperature in their beaker, but after this time must remove them.
e. The supervisor will insert a probe/digital thermometer into the water to measure and record the initial temperature to the nearest tenth of a degree. Supervisors may leave thermometers/probes in the devices for the entire heating period, but will announce if they will do so before impound. Otherwise they will insert a thermometer/probe into the beaker in the device, wait at least 20 seconds, and record the resulting temperature. Multiple thermometers/probes may be used at the supervisor's discretion
f. The light source must be turned on and a stopwatch started. At the end of 10 minutes the light will be turned off and the thermometer/probe will be read and recorded to the nearest tenth of a degree to determine the gain in temperature.
g. The supervisor will review with the team the Part II data recorded on their scoresheet.
h. Teams filing an appeal regarding Part II must leave their device in the competition area.

5. **SCORING:**
   a. High score wins.
   b. All scoring calculations are to be done in degrees Celsius.
   c. Final Score (FS) = TS + CS + HS + PS; The maximum possible FS is 100 points. A scoring spreadsheet is available at www.soinc.org.
   d. Test Score (TS) = (Part I score / Highest Part I score for all teams) x 50 points
   e. Chart Score (CS): One of the submitted graphs/tables, selected by the Event Supervisor, is scored using i., ii., and iii., described below for a maximum of 6 points. Four (4) additional CS points are available via items iv. and v. Partial credit may be given. A device must be present to receive a CS.
      i. 2 points for including data spanning at least one variable range
      ii. 2 points for including at least 10 data points
      iii. 2 points for proper labeling (e.g., title, team name, units)
      iv. 0.5 points for each distinct graph or table turned in (up to 2 points total)
      v. 2 points for including a labeled device diagram
   f. Heat Score (HS) = (HRF / Highest HRF of all teams) x 15 points; HRF (Heat Retention Factor) = (final beaker water temp / starting beaker water temp)
   g. Prediction Score (PS) = (PE / Highest PE of all teams) x 25 points; PE (Prediction Estimate) = (1-(abs (final beaker water temp - predicted final beaker water temp) / final beaker water temp)). The minimum PS possible is 0 points.
   h. If a team violates any COMPETITION rules, their HRF and PE values will be multiplied by 0.9 when calculating the scores.
   i. If any CONSTRUCTION violation(s) are corrected during the Part II testing period the HRF and PE values will be multiplied by 0.7 when calculating the scores.
   j. Teams that are disqualified for unsafe operation or do not bring a collecting device receive zero points for their HRF and PE scores. Teams will be allowed to compete in Part I.
   k. Tie Breakers: 1st — Best TS; 2nd — Best HS; 3rd — Best PS

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

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 the listed 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
Graduated Cylinders (10 - 100 mL) - Measuring volumes	X		X	
Beakers (50 - 500 mL) - Doing reactions, developing chromatograms	X	X	X	X
Erlenmeyer Flasks (10 - 250 mL) - 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 paper/meter - 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		
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
Cobalt Blue Glass – To filter out any sodium that might contaminate flame test from hands		X		

CALCULATOR CLASS DESCRIPTIONS

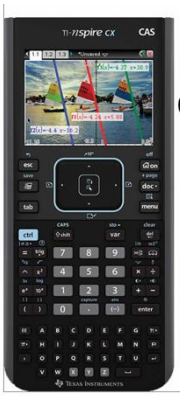
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

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.

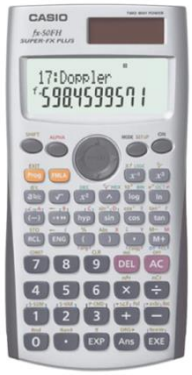
Class I - Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators
are the most basic type of calculators and often look like the one shown to the right. These calculators are limited to the four basic mathematics functions and sometimes square roots. These calculators 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.



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

CALCULATOR AND EVENTS MATRIX

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

Events	Type of Calculator Allowed				
	None	Class I	Class II	Class III	Class IV
Air Trajectory		**X**	**X**	**X**	
Anatomy & Physiology		X	X		
Astronomy		X	X	X	X
Chemistry Lab		X	X	X	
Codebusters		X			
Detector Building		X	X	X	
Disease Detectives		X	X		
Dynamic Planet		X	X	X	
Ecology		**X**	**X**		
Experimental Design		X	X	X	
Fermi Questions	X				
Flight	X				
Forensics		X	X	X	
Forestry	X				
Fossils		**X**	**X**		
Geologic Mapping		**X**	**X**		
Microbe Mission		**X**	**X**		
Optics		**X**	**X**	**X**	
Robot Tour		**X**	**X**		
Scrambler		X	X	X	
Tower	**X**				
Wind Power		**X**	**X**	**X**	
Write It Do It	X				
Trial Events					
Aerial Scramble	X				
Agriscience		X	X		
Botany		X	X		
Cybersecurity	X				
Digital Structures		X	X		
Engineering CAD	**X**				
Home Horticulture		X	X	X	
Mission Possible	X				
Solar Power		X	X	X	

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

NATIONAL TOURNAMENT SCHEDULE

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

2024 National Tournament Schedule
Michigan State University; East Lansing, Michigan
Saturday, May 25 2024

Event	7:00 – 8:00 AM	8:00 - 9:00 AM	9:20 – 10:20 AM	10:40 – 11:40 AM	12:10 – 1:10 PM	1:30 – 2:30 PM	2:50 – 3:50 PM	7:30– 9:30 PM
Air Trajectory	Impound	Self-Schedule						
Anatomy & Physiology		51-60	1-10	11-20	21-30	31-40	41-50	Closing Ceremony
Astronomy		51-60	1-10	11-20	21-30	31-40	41-50	
Chem Lab		31-40	41-50	51-60	1-10	11-20	21-30	
Codebusters		31-40	41-50	51-60	1-10	11-20	21-30	
Detector Building		11-20	21-30	31-40	41-50	51-60	1-10	
Disease Detectives		1-10	11-20	21-30	31-40	41-50	51-60	
Dynamic Planet		41-50	51-60	1-10	11-20	21-30	31-40	
Ecology		31-40	41-50	51-60	1-10	11-20	21-30	
Experimental Design		21-30	31-40	41-50	51-60	1-10	11-20	
Fermi Questions		1-10	11-20	21-30	31-40	41-50	51-60	
Flight		Self-Schedule						
Forensics		1-10	11-20	21-30	31-40	41-50	51-60	
Forestry		41-50	51-60	1-10	11-20	21-30	31-40	
Fossils		11-20	21-30	31-40	41-50	51-60	1-10	
Geologic Mapping		21-30	31-40	41-50	51-60	1-10	11-20	
Microbe Mission		21-30	31-40	41-50	51-60	1-10	11-20	
Optics		51-60	1-10	11-20	21-30	31-40	41-50	
Robot Tour	Impound	Self-Schedule						
Scrambler	Impound	Self-Schedule						
Tower		Self-Schedule						
Wind Power		41-50	51-60	1-10	11-20	21-30	31-40	
Write It, Do It		11-20	21-30	31-40	41-50	51-60	1-10	

SCIENCE OLYMPIAD™

Exploring the World of Science

Science Olympiad wishes to acknowledge the following business, government and education leaders for partnering with our organization. Working together, we can increase global competitiveness, improve science and technology literacy and prepare the STEM workforce of the future. Thanks to: Michigan State University (2024 National Tournament Host), Wichita State University (2023 National Tournament Host), NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network, Avantor Foundation, Cleveland-Cliffs Foundation, Corteva Agriscience, Combined Federal Campaign, Double Good Foundation, Google, NBC Universal Foundation, Ward's Science, Amcor Cares Foundation, Centers for Disease Control and Prevention (CDC) Foundation, Discovery Education 3M Young Scientist Challenge, North American Association for Environmental Education (NAAEE), National Oceanic and Atmospheric Administration (NOAA), National Eye Institute, Texas Instruments, ThermoFisher Scientific, University of Delaware, Catalent, Investing in Communities, National Free Flight Society (NFFS), Onshape, SkyCiv and Yale Young Global Scholars. Strategic Partners: Code.org, Japan Science and Technology Agency, mHUB, Midnight Science Club, Million Women Mentors (MWM), MxD (The Digital Manufacturing Institute), STEMConnector and USDA Forest Service – Conservation Education.

See the Science Olympiad website: www.soinc.org for current information regarding Policies, Standards, Summer Workshops, Official Kits from Ward's Science and print plus digital items in the Science Olympiad Store

Science Olympiad

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