SCIENCE OLYMPIAD™

Exploring the World of Science

Division C Rules Manual

Division C (Gr. 9-12)

WELCOME TO THE 2023 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 $60, 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
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- 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.

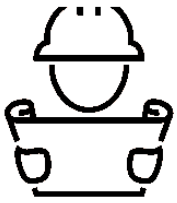
EVENT TYPE DESCRIPTIONS

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.

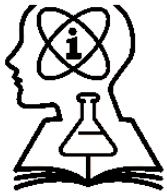


Build Event: An event where participants are given some specifications about a device or object they are expected to design, create, and test in advance of the tournament. The devices or objects are often modified on site to account for an unknown parameter prior to testing or evaluation.

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.

COVID-19 PANDEMIC RULES MODIFICATIONS

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

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

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 **Respiratory, Digestive, and Immune** 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, 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.

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. **RESPIRATORY SYSTEM:**
      i. Anatomy and functions of the respiratory system
      ii. Mechanisms and measures of pulmonary ventilation
      iii. Patterns of breathing
      iv. Ability to read a spirogram as related to pulmonary ventilation
      v. Gas exchange and O2 transport including oxygen dissociation curves
      vi. Effects of exercise and high altitude on the respiratory system
      vii. Understand disorders: COPD, asthma, emphysema, pneumonia, sleep apnea and cystic fibrosis
      viii. National Tournament Only:
         (1) Additional diseases/disorders: tuberculosis, pulmonary edema, pleurisy, small cell and non-small cell lung cancer, pulmonary fibrosis, pneumoconiosis (e.g., silicosis, coal worker lung, asbestosis)
         (2) Blood chemistry and respiratory rhythm, regulation and control of the respiratory system
         (3) Treatments and/or preventions (e.g., drugs, surgery) for ALL conditions listed above

   b. **DIGESTIVE SYSTEM:**
      i. Anatomy and functions of the digestive system
      ii. Basic anatomy of the component parts of the alimentary canal and accessory organs of digestion
      iii. Anatomy of the four layers of the wall of the alimentary canal
      iv. Comparison of the lining of the esophagus, stomach, small intestine and large intestine
      v. Compare and contrast mechanical and chemical digestion
      vi. Physiology of chemical digestion of proteins, fats and carbohydrates
      vii. Effects of exercise and obesity on the digestive system
      viii. The diseases on each level from the cell to the whole person as listed: stomach & duodenal ulcers, cancers of the digestive system, diarrhea, lactose intolerance, hepatitis, appendicitis
      ix. National Tournament Only:
         (1) Additional diseases: diverticular disease, GERD, peptic ulcer disease, ulcerative colitis, Crohn's Disease and celiac disease
         (2) The function of the liver, including Kupffer cell function, as well as the pancreas in the digestive system. The exocrine role of the pancreas may be assessed at the Regional and State levels.
         (3) Treatments and/or prevention (e.g., drugs, surgery) for ALL conditions listed above

   c. **IMMUNE SYSTEM:**
      i. Anatomy and functions of the immune system (bone marrow, thymus, spleen, lymph nodes, skin)
      ii. Anatomy and physiology of innate immune system (e.g., anatomical barriers, complement system, Toll-like receptors, inflammation, and innate immune cells)
      iii. Anatomy and physiology of adaptive immune system
      iv. Physiology of the immune response and allergic reactions
      v. Disorders: acquired and genetic immunodeficiencies (e.g., HIV/AIDS, common variable immunodeficiency, severe combined immunodeficiency), autoimmune diseases (e.g., multiple sclerosis, rheumatoid arthritis, Hashimoto thyroiditis, Graves' Disease), and type 1-4 hypersensitivities (e.g., anaphylaxis, urticaria, myasthenia gravis, Arthus reaction, serum sickness, contact dermatitis)

vi. National Tournament Only:
   (1) Types of Organ Transplants and Prevention of Rejection (allograft and autograft)
   (2) Cancer Immunotherapies (Antibody therapies, CAR-T cell therapy)
   (3) Additional disorders: systemic lupus erythematosus, dermatomyositis, scleroderma, psoriasis and psoriatic arthritis
   (4) Treatments and/or prevention (e.g., drugs, surgery) for ALL conditions listed above

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** & **Variability**.
   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:
      i. a computer/tablet and a three-ring binder; or,
      ii. two computers/tablets, of any kind; or,
      iii. 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 or screen shots) 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, white dwarfs, planetary nebulas, **neutron stars, pulsars,** red giants, Mira variables, **semiregular variables,** RR Lyrae variables, **globular clusters, Population I & II stars, Wolf-Rayet stars, Classical & Type II Cepheid variables, luminous blue variables,** dwarf novas, **symbiotic variables, X-ray binaries,** Type II &Type Ia, **Ib & Ic supernovas, kilonovas, gravitational waves**.
   b. Use orbital mechanics, Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of binary and multiple star systems; use parallax, spectroscopic parallax, period-luminosity relations, the distance modulus to calculate distances; **and the radiation laws to answer questions relating to stellar structure and evolution.**
   c. Identify and answer questions relating to the content areas outlined above for the following objects:

      i. AG Carinae
      ii. GW170817
      iii. PSR J2030+4415
      iv. R Hydrae
      v. R Aquarii
      vi. NGC 7027
      vii. RS Puppis
      viii. NaSt1
      ix. HD 184738 (Campbell's Hydrogen Star)
      x. W Virginis
      xi. G344.7-0.1
      xii. SS Cygni
      xiii. E0102-72.3
      xiv. 47 Tucanae
      xv. X9
      xvi. SN 2008D

4. **SCORING:**
   a. All questions will have been assigned a predetermined number of points.
   b. The highest score wins.
   c. 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 NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network

BRIDGE

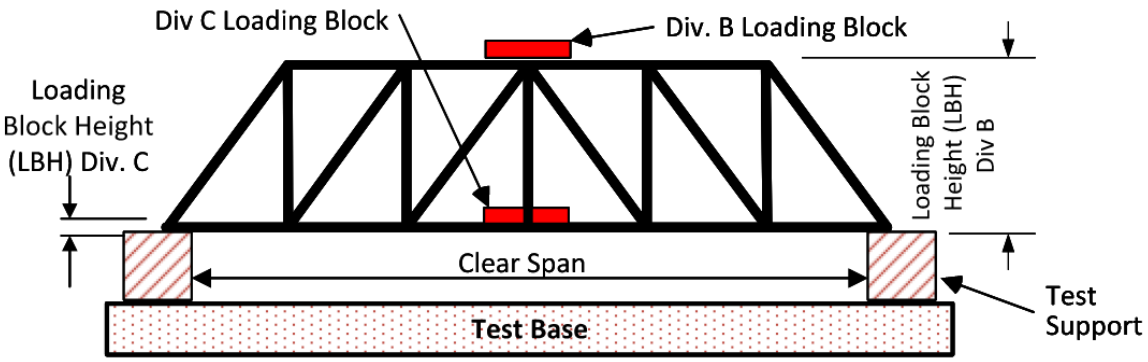
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

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

   TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** No **APPROXIMATE 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 the Test Apparatus (see Section 6) and tools/materials for measurement. **For remote tournaments, the teams must supply all Test Apparatus that fully meet the requirements of Section 6 - any deviations from Section 6 will be a violation of construction parameters and place the team in Tier 2.**
   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.**

3. **CONSTRUCTION PARAMETERS:**
   a. The Structure must be a single structure 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 be designed to sit on top of the Test Supports and support the Loading Assembly at the center of the spanned opening. **The Structure cannot touch the vertical sides of the Test Supports or the Test Base before or during the test.**
   c. **The Structure must be designed and built to the following dimensions and specifications for each Division:**
      i. **Division B Dimensions and Specifications:**
         (1) **The Structure must be designed to hold the bottom of the Loading Block at least 15 cm above the plane made by the tops of the Test Supports (6.b).**
         (2) **The Structure must be designed to only touch the Test Supports (6.b) within the Division B Contact Zone (6.b.iv.1).**
         (3) **Before loading, the Structure may NOT be below the plane made by the tops of the Test Supports. During the test, the Structure can deflect below the plane made by the tops of the Test Supports, but cannot touch the Test Base.**
         (4) The Clear Span will be 35 cm.
      ii. **Division C Dimensions and Specifications:**
         (1) **The Structure must be designed to hold the bottom of the Loading Block no more than 1 cm above the plane made by the top of the Test Supports, but above the plane made by the top of the Test Base.**
         (2) **The Structure must be designed to only touch the Test Supports (6.b) within the Division C Contact Zones (6.b.iv.2).**
         (3) **Before loading, no part of the Structure may go below the plane made by the top of the Test Base (6.a). During the test, the Structure can deflect below the top of the Test Base, but cannot touch it.**
         (4) The Clear Span will be 45 cm.



4. **DESIGN LOG:**
   a. Teams must submit a Design Log with documentation of a number of Structures tested prior to competition.
      i. Regional/Invitational: 1 or more
      ii. State: 3 or more
      iii. National: 4 or more
   b. Documentation for each Structure in the Design Log must include:
      i. Materials used
      ii. Sketch of the design
      iii. Weight and other dimensions of the Structure
      iv. Predictions: Load held & weak points
      v. Test results: Load held & breaking point(s)
      vi. Observations & recommended design improvements
   c. **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**
   d. **The Log must have a front cover labeled with the Team Name and the Team Number for the current tournament or be considered incomplete.**
   e. **All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured or be considered incomplete. SI units should be the default standard.**
   f. All logs will be returned to teams after inspection.

5. **THE COMPETITION:**

Part I: Check-In

   a. The team must present their Structure for inspection & measurement.
   b. The team must place their Structure on the Structure Scale (6.g) so the Event Supervisor can determine the mass, in grams to the nearest 0.01 g or best precision available.
   c. The team must submit their estimated Load Supported (5. Part II.g.) to be used as a tiebreaker.
   d. No alterations, substitutions, or repairs may be made to the Structure after the check-in process has started.
   e. Prior to 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.

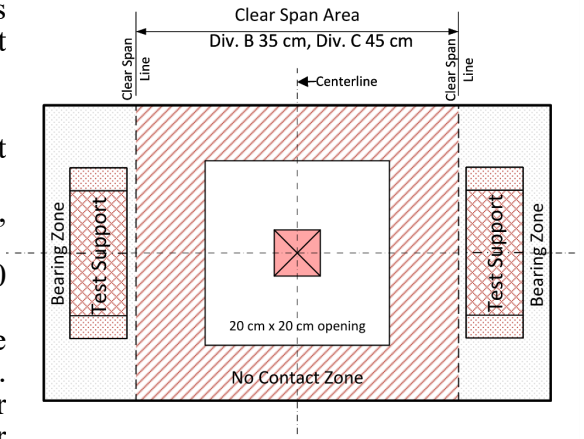
Part II: Testing

   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 Test Supports within the Bearing Zones (6.a.iv) of the Test Apparatus. Participants will then place their Structure within the proper Contact Zones on the Test Supports. They will then place the Loading Assembly as required to load the Structure. If necessary, participants may disassemble & reassemble the Loading Assembly. If the Loading Assembly is disassembled & re-

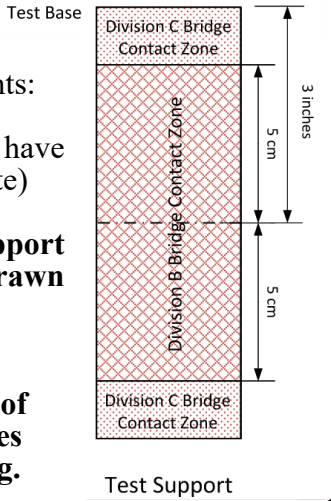
assembled, it must retain the original sequence with no loose pieces and the opposing force must always be on the bottom of the Loading Block. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the structure to deflect.

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. Prior to loading, the Event Supervisor will verify that:
   i. The Test Supports are properly placed on the Test Base
   ii. The Structure is placed properly on the Test Supports and the loading point must be within 2 cm of the center of the span.
      (1) **Division B: No portion of the Structure is below the tops of the Test Supports.**
      (2) **Division C: No portion of the Structure is below the top of the Test Base.**
f. 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.f.).
g. Loading stops immediately when 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 if the Structure touches the Test Base. Incidental contact of the chain/eyebolt with the Structure is not a failure.
h. 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.
i. At the Event Supervisor's discretion, more than one Test Apparatus may be used. Teams must be given a choice of which apparatus they will use.
j. The Event Supervisor will review with the team the data recorded on their scoresheet.
k. Teams who wish to file an appeal must leave their Structure **and Design Log** with the Event Supervisor.

6. **<u>TEST APPARATUS</u>**: A list of possible questions, tasks, stations and/or examples that will help to demonstrate how the event may be run.



   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
      ii. Shall have a smooth, hard surface (e.g., hard wood, metal, high-pressure plastic laminate)
      iii. Shall have an opening at its center approximately 20.0 cm x 20.0 cm
      iv. A Centerline and parallel Clear Span Lines shall be marked across the width of the surface of the Test Base. The Centerline shall divide the Test Base in half; Clear Span Lines to each side of the Centerline at 17.5 cm for Division B (35 cm span), or 22.5 cm for Division C (45 cm span) indicate the Bearing Zones.



   b. Two identical Test Supports shall be provided meeting the following requirements:
      i. Must be 1-1/2 inches by 1-1/2 inches by 6 inches.
      ii. Made of a material such that it does not noticeably compress when loaded and have smooth, hard surfaces (e.g., hard wood, metal, high-pressure plastic laminate)
      iii. Must be able to rest flat and unfixed on the Test Base.
      iv. **Must have a centerline drawn on the top surface of each Test Support perpendicular to the 6-inch sides. Additionally, boundary lines will be drawn 5 cm on both sides of the centerline.**
         (1) **Division B: The area between the two boundary lines will define the Division B Contact Zone.**
         (2) **Division C: The areas outside of the two boundary lines to the ends of the Test Support will define the Contact Zones. Division C Structures may not touch the Division B Contact Zone before or during loading.**

c. 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. 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
d. Sand: sand or other clean, dry free-flowing material.
e. 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.
f. Structure scale: Must be a digital scale. Scale shall have a minimum resolution of 0.1 grams; recommended resolution is 0.01 gram.
g. Sand scale and load verification: **Must be a digital scale.** Scale shall have minimum resolution of 10 grams; recommended resolution is 1 gram

7. **SCORING:**
   a. High score wins. Score = [Load Score (g)/Mass of Structure (g)] * Design Log Penalty Multiplier.
   b. The Load Score = Load Supported (5.Part II.h) + Bonus (7.c).
   c. Structures that have a Load Supported of 15,000 g will earn a Bonus of 5,000 g.
   d. Design Log Penalty Multipliers:
      i. Complete Design Log: 1.0
      ii. Incomplete or non-compliant log: 0.9
      iii. No Log: 0.5
   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 and/or Test Apparatus requirements for virtual meets.
      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; Log is complete; Score= 1,199
      ii. Structure 2: mass= 12.32 g, Load Supported= 15,000 g + 5,000 g (Bonus) = 20,000 g; **Log is complete**; Score= 1,623
      iii. **Structure 3: mass= 12.32 g, Load Supported= 15,000 g + 5,000 g (Bonus) = 20,000 g; No Log (0.5 multiplier); Score= 812**

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 the Cleveland-Cliffs Foundation & SkyCiv

CELL BIOLOGY

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

1. **DESCRIPTION:** This event integrates content knowledge and process skills in the areas of cell biology and cellular biochemistry.

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

2. **EVENT PARAMETERS:**
   a. 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.
   b. **Participants must wear eye protection if the event is run as a series of lab-practical stations.**
3. **THE COMPETITION:**
   a. The competition may be administered as **a written test** or as a series of lab-practical stations.
   b. Participants are expected to be able to know general science process skills such as writing hypotheses, determining independent and dependent variables, controlling variables, graphing, analyzing data, interpreting results as well as using and applying technologies.
   c. Participants should be able to interpret, analyze, and identify appropriate controls for biological assays and techniques listed in the topics.
   d. Content topics will include:
      i. Biological monomers and polymers **(i.e., carbohydrates, lipids, proteins, and nucleic acids)**
      ii. **Understanding secondary and tertiary protein structure, post-translational modifications (i.e., phosphorylation, glycosylation, ubiquitylation, cleavage)**
      iii. Bioenergetics, **catabolic and anabolic networks (i.e., glycolysis, gluconeogenesis, Krebs cycle, oxidative phosphorylation, Calvin cycle, and light-dependent photosynthetic reactions)**, fermentation products **(ethanol and lactic acid)** and uses
      iv. Questions pertaining to the exact amount of ATP produced during cellular respiration must not be used, as the amount of ATP produced may vary within a cell.
      v. **Differences in** C3, C4, and CAM **metabolisms and their respective uses** by plants
      vi. **Membrane structure, composition, and function as well as transport across membranes**
      vii. Apoptosis (**intrinsic and extrinsic pathways**)
      viii. Cancer **and its hallmarks**
      ix. Cellular homeostasis (pH, osmolarity, etc.)
      x. Cell organelles/structures and their functions in eukaryotes and prokaryotes
      xi. **Cell cytoskeleton,** vesicle formation, fusion, **and intracellular trafficking**
      xii. Cell wall structure **(plant, fungal, and bacterial)**
      xiii. Enzymes and **enzyme inhibitors (competitive vs. non-competitive), quantitative descriptions of reversible inhibition, Michaelis-Menten kinetics**
      xiv. Cell cycle and mitosis, **qualitative understanding of the** role of cyclins and kinases
      xv. Membrane receptors and signal transduction **(with emphasis on GPCRs, tyrosine kinases, and second messengers)**
      xvi. **Assays & Techniques: Gel electrophoresis, Western blots, ELISA, immunoprecipitation (including co-IP)**
      xvii. State Tournament Only:
         (1) **Understanding protein structure as it relates to hydrophilicity plots and Ramachandran plots**
         (2) **Catabolic and anabolic** networks **(e.g., pentose phosphate pathway, fatty acid metabolism, urea cycle)**
         (3) **Allosteric modulation (cooperativity) of enzymes and other proteins, Hill Equation**
         (4) **Cellular differentiation (i.e., differences between totipotency,** pluripotency**, and unipotent cells)**
         (5) Signal transduction **(i.e., cytokines, integrins, Toll-like receptors, ligand-gated ion channels)**
         (6) Cellular basis of antibiotics **limited to penicillins, cephalosporins, and glycopeptides**

xviii. National Tournament Only:
   (1) Assays & Techniques: Fluorescent microscopy, Flow cytometry (FACS), FRET assays, Immunohistochemistry
   (2) **Catabolic and anabolic networks (e.g., glyoxylate cycle, shikimic acid pathway)**
   (3) **Mechanisms of cellular differentiation, dedifferentiation, and** induced pluripotent stem cells
   (4) Cellular basis of chemotherapies
   (5) **Mutagens**, carcinogens, **and the Ames test**
   (6) **Human**/Virus interactions **(e.g., influenza, HIV, HPV, AAV)**
   (7) **Diseases and disorders related to** improper protein folding
   (8) Bioethics relating to the above topics

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

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 science processes of chemistry focused in the areas of Oxidation/Reduction and **Periodicity**.

   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 as Recommended Lab Equipment for Division C Chemistry Events, 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. Teams may bring only specified items. Other items not listed are prohibited. The Event Supervisors will check each team's equipment, confiscate non-allowed items, and have the right to penalize the team up to 10% if additional equipment is brought to the event.
   f. 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 similar to those in first year high school courses. 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. Given the data/watching a running Redox titration, students should be able to determine the endpoint of the titration and the number of moles of target ion in the titration.
   d. Participants should understand the following Oxidation/Reduction Chemistry concepts:
      i. Writing and balancing half reactions
      ii. Oxidation numbers
      iii. Balancing Redox reactions in neutral, acidic, and basic solutions
      iv. Calculating standard cell potentials using a table of standard reduction potentials
      v. State and Nationals Only - knowledge of fuel cells, knowledge & application of the Nernst equation & common storage batteries
   e. Participants should understand the following about **Periodicity**:
      i. **The periodic nature of the elements by predicting or explaining trends**
      ii. **Physical properties (e.g., atomic & ionic radii, ionization energy, melting point, electronegativity, crystal structure)**
      iii. **Electronic structure and bonding formation (e.g., ionic vs. covalent, charges on ions)**
      iv. **Chemical properties (e.g., precipitate formation - no K_{sp} calculations, solubilities, reactions with acids)**
      v. **Knowledge about Periodicity may be demonstrated experimentally by collecting and/or analyzing data**
      vi. State and Nationals Only:
         (1) **Approximate bond strength**
         (2) **Bond angle**
         (3) **Formal charges**
         (4) **Effective nuclear charge**
         (5) **Properties of coordination complexes (hybridization)**

4. **SAMPLE QUESTIONS/ACTIVITIES:**
   a. Titrations to determine percent composition, molarity, and/or molecular mass.
   b. Given an unbalanced Redox equation, students should be able to determine the 2 half reactions and balance the equation.
   c. Given the data/watching a running Redox titration, students should be able to determine the endpoint of the titration and the number of moles of target ion in the titration.
   d. **Use a conductivity meter to determine the trends in bonding of a series of solutions.**
   e. **Use a pH meter to determine the trends in reactions**.
5. **SCORING:**
   a. High score wins. Points will be divided evenly between Oxidation/Reduction and Periodicity.
   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 are on the Event Pages at soinc.org

This event is sponsored by Ward's Science

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.
   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, Baconian mapping and modulus inverse tables 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 and encrypt 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 B & C Regional Tournaments are as follows:
      i. Monoalphabetic substitution using K1, K2, 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. 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)
      iii. Xenocrypt - no more than one cryptogram can be in Spanish
      iv. the Pollux and Morbit Ciphers - decrypting Morse code ciphertext encoded as digits and spaces given the mapping of at least **5** of the digits
      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 mathematical equations and extracting the word or words used for mapping**
      vii. **The Porta Cipher - Encrypting plaintext or decrypting ciphertext given a key**
   f. Division B Only - The following code types may also be used at Regional Tournaments:
      i. The Caesar Cipher, also called a shift cipher
      ii. The Atbash Cipher (In English, not Hebrew)
      iii. The Affine Cipher - encrypting plaintext or decrypting ciphertext given the a and b values
      iv. **The Rail Fence Cipher – decrypting transposed text given a range for the rails and offset of 0**
   g. Division C Only - The following code types may also be used at Regional Tournaments:
      i. For Monoalphabetic substitution ciphers, a K3 alphabet as defined by the ACA may also be used.
      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 Rail Fence cipher - Decrypting transposed text given the number of rails and an unknown offset
      iv. The Hill Cipher – Encrypting plaintext or decrypting ciphertext given the corresponding 2x2 matrix
   h. 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. Cryptanalysis of The Pollux and Morbit Ciphers with a "crib" of at least **3** plaintext characters
      iii. Cryptanalysis of the Porta Cipher with a "crib" of at least **3** plaintext characters
      iv. Cryptanalysis of The Rail Fence Cipher with a "crib" of at least 4 plaintext characters given a range for the rails and offset of 0
      v. **The Pollux and Morbit Ciphers – decrypting Morse code ciphertext encoded as digits and spaces given the mapping of only 4 of the digits**

i. **Division B Only – The following code type may also be used at the State and National Tournaments**:
   i. **Cryptanalysis of the Affine Cipher with a "crib" of at least 2 plaintext characters**

j. Division C Only - The following code types may also be used at State and National Tournaments.
   i. Xenocrypt - at the State and National levels, at least two cryptograms will be in Spanish
   ii. Cryptanalysis of the Rail Fence Cipher with a "crib" of at least **4** plaintext characters and a range for the rails and offset
   iii. The Hill Cipher – Decrypting ciphertext with a 3x3 decryption matrix provided

k. For aristocrats, patristocrats, and xenocrypts, no letter can ever decrypt to itself.

l. No more than 2 cipher questions will be an encryption on the exam.

m. 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

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

4. **<u>SCORING:</u>**

a. 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 or encoded ciphertext 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 should never exceed the value of the question. For example, a 400-point question with five (5) errors would earn a total of 100 points [400 – 3(100)] whereas the same 400-point question with seven (7) errors would earn 0 points, not -100 points.**

d. **For answers involving the keyword or key phrases 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 (0) errors are required for full credit**
   ii. **Each error results in a penalty of 100 points but the penalty should never exceed the value of the question. For example, a 500-point question with eight (8) errors would earn 0 points, not -300.**

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
+	<u>Special Bonus (One=150)</u>	=	<u>150 points</u>
	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.

<u>Recommended Resources</u>: 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 **Mass/Force-sensing Device** that will accurately measure and display both voltage and actual masses of different solid samples ranging from 30 to 1,000 grams.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** None

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one participant-constructed, **Mass/Force**-sensing device 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. 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 mass of the object. 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 from fundamental electronic components such as force sensitive resistors (FSR), strain gauges, capacitors, resistors, wires, DIP package integrated circuits, and surface mount adapter boards. All supporting circuits must be assembled on a breadboard. The following are construction violations: preassembled devices, load cells, printed circuit boards (except digital display boards), integrated circuit daughterboards.
   c. The construction of the device must allow the placement of an unknown mass ranging from 30 to 1,000 grams of at most 8 cm in diameter and no height obstructions for mass determination. The Device may not use any code libraries for calibration of the device.
   d. The Device must have a digital display that clearly shows voltage, and mass in grams to the nearest 0.1 grams. 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.
   e. The Device must also be able to indicate the specific mass 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 mass 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.
   f. 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 masses in grams. If multiple fixed resistors are tried, include the data and graphs of all potential resistors.
      iii. Scatter-plot graph of this data with mass in grams 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 mass in grams 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 grams.

vii. On the same program printout, highlight the code that will illuminate the appropriate LED(s) according to their assigned mass 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. **<u>THE COMPETITION</u>:**

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 mass (three (3) at Regional/Invitational Tournaments, and four (4) at State/National Tournaments) that teams will need to measure. Multiple sets of the mass samples may be used as long as the masses are the same for each set to the precision of the ES' scale.
c. The Event Supervisor's scale will be made available for teams to use during their setup period - however, teams will need to bring their own calibration samples. The same scale must be used for all teams to verify their devices and for the measurement of the official masses.
d. Teams may modify their code (e.g., alter the LED code to match the posted mass ranges during the setup time.
e. At all Tournaments, teams will have 5 minutes to set up their Device, verify their Device with the scale provided by the Event Supervisor, and modify their code.
f. After the setup/calibration time, the teams will measure the unknown mass 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 mass in grams to the nearest 0.1 gram as displayed by the Device, along with the LED color displayed for each mass.
g. The Event Supervisor will review with teams the data recorded on their scoresheet.
h. 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. Types of force sensors and their working principles.
   iii. The relationship between force, stress, strain, and resistance.
   iv. The relationship between force (weight), mass, pressure.
   v. The conversion from analog reading to voltage.
   vi. Theory of LEDs, working principles, and applications.
   vii. The process of calibration - working with raw data and determining real world relationships.
   viii. Operational knowledge of basic Device components.
   ix. **Topics for State and National Tournaments only:**
      (1) Capacitance
      (2) Piezoelectricity
      (3) Wheatstone Bridges
      (4) Unless otherwise requested, answers must be in metric units with appropriate significant figures.
      (5) 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 masses at Regionals (Maximum 57 points) and four unknown masses at States/Nationals (Maximum 76 points)
      i. Accuracy Score for each mass = 15 pts - (relative error of the mass 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 mass.
      ii. LED Score for each mass = 4 pts awarded for the correct LED color (as determined by the mass 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 sponsored by Texas Instruments

DISEASE DETECTIVES

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.

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.
   b. **The topics for this event are as follows:**
      i. Background & Surveillance
         (1) Understand the Clinical Approach (health of individuals) and Public Health Approach (health of populations)
         (2) Understand the roles of epidemiology in public health and the steps in solving health problems
         (3) Understand the Natural History and Spectrum of Disease and the Chain of Infection
         (4) Understand basic epidemiological and public health terms (e.g., outbreak, epidemic, pandemic, surveillance, risk, vector, etc.)
         (5) Understand the role of Surveillance in identifying health problems, the 5-Step Process for Surveillance and the types of surveillance
      ii. Outbreak Investigation
         (1) Analyze an actual or hypothetical outbreak
         (2) Understand the Types of Epidemiological Studies – Experimental and Observational
         (3) Identify the Steps in an Outbreak Investigation
         (4) Identify the problem using person, place, and time triad – formulate case definition
         (5) Interpret epi curves, line listings, cluster maps, and subdivided tables
         (6) Generate hypotheses using agent, host, environment triad
         (7) Recognize various fundamental study designs and which is appropriate for this outbreak
         (8) Evaluate the data by calculating and comparing simple rates and proportions as attack rate, relative risk, odds-ratio and explaining their meaning
         (9) Apply the Bradford Hill Criteria for Verifying the Cause of this outbreak
         (10) Division C Only: Recognize factors such as study design/biases, errors, confounding that influence results
         (11) Division C - Nationals Only: Suggest types of control & prevention measures for this outbreak
      iii. Patterns, Control, and Prevention
         (1) Identify patterns, 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 and mortality rate
         (3) Understand the Strategies of Disease Control
         (4) Understand Strategies for Prevention-the Scope and Levels of Prevention
         (5) Division C Only: Propose a reasonable set of prevention strategies for a public health problem once the cause has been determined
         (6) Division C - Nationals Only: Identify the strengths and weaknesses of a set of proposed prevention 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.
   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

This event is offered through a partnership with the Centers for Disease Control (CDC) Foundation

DYNAMIC PLANET

1. **DESCRIPTION:** Students will use process skills to complete tasks related to Earth's fresh waters.
   A TEAM OF UP TO: 2 **APPROXIMATE 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. 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 calculators of any type.
3. **THE COMPETITION:**
   a. Participants will be presented with questions which may include one or more tasks at a workstation or a timed station-to-station format.
   b. The participants will be expected to use process skills (e.g., communicating, classifying, inferring, measuring, observing, predicting, & using number relationships) to answer questions on the following topics:
      i. Interpretation of fresh water features shown on USGS topographic maps
      ii. Stream drainage systems: stream order, drainage patterns, main channel, tributaries and watersheds
      iii. Channel types: braided, meandering, straight and calculations of sinuosity
      iv. Sediment: weathering, erosion, clast forms & sizes, transportation, capacity & competence, deposition
      v. River valley forms and processes: geology, gradient, base level, floodplain features, dynamic equilibrium, nick points, waterfalls, stream capture, deltas and fans
      vi. Perennial and intermittent stream flow, stream gauging and monitoring, stream flow calculations, discharge, load, floods, recurrence intervals
      vii. Groundwater: zone of aeration, zone of saturation, water table, porosity, permeability, aquifers, confining beds, hydraulic gradient, water table contour lines, flow lines, capillarity, recharge and discharge, saltwater intrusion, and interactions between surface and groundwater
      viii. Karst features: sinkholes, solution valleys, springs, disappearing streams, caves
      ix. Lake formation & types: faulting, rifting, volcanic action, glaciation, damming of rivers, changes over time
      x. Lake features: inflow & outflow, physical & chemical properties, stratification, shorelines, waves
      xi. Wetlands: interactions between surface and groundwater in the evolution of bogs and marshes
      xii. Destruction/Effects of land use changes, dams and levees: sedimentation, down-cutting, diversion of water, flooding, ecological changes
      xiii. Hydrologic cycle and water budgets: precipitation, runoff, evaporation
      xiv. Pollution: types, sources, transport
      xv. Critical zone hydrology: infiltration, evapotranspiration, soil moisture, permafrost, pingos
      xvi. Division C Only:
         (1) Chezy and Manning equations
         (2) Darcy's Law
4. **REPRESENTATIVE ACTIVITIES:**
   a. Analyze and interpret features and actions of a stream or river appearing on a topographic map including watershed boundaries, elevation, gradient, direction of flow, drainage pattern, valley shapes, erosional landscapes, and depositional features.
   b. Construct a water table contour map and indicate the direction of groundwater movement.
   c. Analyze data on the thermal structure of a lake and determine how the stratification changes seasonally.
   d. Given a geologic map, cross section, or lithologic sequence, determine pattern of water flow and storage, optimal reservoir sitting.
5. **SCORING:**
   a. All questions will have been assigned a predetermined number of points.
   b. The highest score wins.
   c. 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 the National Oceanic and Atmospheric Administration (NOAA) and the North American Association for Environmental Education (NAAEE)

ENVIRONMENTAL CHEMISTRY

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

1. **DESCRIPTION:** This event will focus on fresh water (e.g., residential, industrial or natural), the identified pages of The Clean Water Act (1972 & 1977), wastewater operator's certification manual (Indiana March 2018 revision) and its applications, various testing of particular analytes using standardized curves (either interpreted or created), **stabilization ponds, and introduction to the National Pretreatment Program.**

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

2. **EVENT PARAMETERS:**
   a. Teams should bring pencils for graphing and answering questions, a ruler (12-15 in.) for best fit line approximation, two stand-alone non-programmable, non-graphing calculators, and one three-ring binder of any size containing information in any form and from any source attached using the available rings. Sheet protectors are permitted. Participants may not remove information or pages during the event.
   b. Event Supervisors will provide samples to be tested and any other reagents, glassware, information (e.g., periodic table, charts, instrumentation) are appropriate for the task(s) participants are asked to perform.
   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. Teams should bring any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
   e. **Teams may bring only specified items. Other items not listed are prohibited. The Event Supervisors will check each team's equipment, confiscate non-allowed items, and have the right to penalize the team up to 10% if additional equipment is brought to the event.**

3. **THE COMPETITION:**
   a. The competition will consist of a series of tasks that may include hands-on activities, questions about a topic, interpretation of experimental data (e.g., graphs, diagrams), generating a standardized curve using data provided, using a given standardized curve to determine unknowns, or observation of an experiment set up & running. Supervisors are encouraged to use computers or calculators with sensors/probes. Participants may be asked to collect data using probe-ware that has been set up & demonstrated by the Supervisor. The Supervisor may provide Participants with data sets collected by such sensors/probes following demonstration of the data collection. Data will be presented in tabular and/or graphic format & students will be expected to interpret the data. Participants should be aware that nomenclature, formula writing & stoichiometry, concentration conversions are essential tools of chemistry & may always be part of an event.
   b. Participants will generate one standardized curve by serial dilution at the Regional level, two to three curves at the State level, and three or more at the National level. Standardized curves will be generated either from data given about standards already read, reading standards provided, or making and reading standards (State & National level only).
   c. No hazardous analytes will be used in this event. Analytes identified as hazardous will be measured in a safe and non-invasive manner (typically colorimetric or by probe such as a millivolt reading). Analytes which are to be determined may come from the following list. Analytes of interest with respect to all water types are as follows:

      i. Ammonia
      ii. Phosphorous
      iii. COD – High Range
      iv. COD – Low Range
      v. Residual Chlorine (colorimetric)
      vi. Low Level Chlorine (amperometry)
      vii. Conductivity
      viii. pH
      ix. Salinity
      x. Total Dissolved Solids
      xi. GC-MS of regulated PCBs

4. **SAMPLE QUESTIONS/TASKS:**
   a. Teams may answer questions concerning the standardized curves in general. Standard Curve: Participants may be given a standard of known concentration and asked to make a series of dilutions. The dilutions

will then be read and recorded. Values will be entered and teams with the better R^2 value (i.e. - value closest to $R^2 = 1.000$) may be awarded additional points or used as a tie breaker at the discretion of the event supervisor.

b. Teams may answer questions about how to choose the appropriate wavelength for a particular analyte.
c. Teams may answer questions about the relationship between absorbance and transmission.
d. When given data, teams may have to recreate the standardized curve and use it to determine unknown values. These values will then be used to answer questions about permit limits, violations, etc. Any question where a comparison must be made, with respect to limits, will have those limits provided by the event supervisor.
e. Teams will be required to generate by hand a standardized curve (graph paper required – 10 sq/in.).
f. All teams must include on their graph the best fit line and its equation.
g. Teams may be asked questions about the best fit lines.
h. **Teams will be asked questions from:**
    i. **Pages 1-59 of the 1972 Clean Water Act Introduction**
    ii. **Pages 1-74 of the 1977 Clean Water Act**
    iii. **Pages 1-86 the Wastewater Operator Certification Manual**
    iv. **Operations Manual: Stabilization Ponds**
    v. **The Introduction to the National Pretreatment Program**

5. **<u>SCORING</u>:**
    a. The score will be comprised of approximately 60% of the points for wet chemistry tasks/making & interpreting standardized curves, 20% of the points for equations and interpreting data, and approximately 20% of the points for questions on the reference material.
    b. The team with the highest score wins.
    c. Time will not be used for scoring but could be part of the event.
    d. Ties may be broken by the accuracy of the standardized curves, or selected questions chosen by the event supervisor. In other words, the closer the R^2 value is to 1.000 for standardized curves, the greater the points awarded.
    e. A penalty of up to 10% will be applied if the team's area is not cleaned up as instructed by the event supervisor.
    f. **A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.**

<u>Recommended Resources</u>: 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

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. Division B teams may bring one timepiece, one linear measuring device, and one stand-alone non-programmable non-graphing calculator. **Teams CANNOT use any of these as part of the experiment - they must only be used for their intended function**.
   c. Division C 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**.
   d. The Event Supervisor will provide each team with identical sets of materials either at a distribution center or in an individual container.
   e. The Event Supervisor will supply a report packet, based on the Experimental Design Checklist, posted on the event page at soinc.org, for recording 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 0.75.
   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.

2023 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 defined

④ ③ ② ① ⓪ Levels of IV given

④ ③ ② ① ⓪ DV Correctly identified and defined

b. Controlled Variables (CV) (**4** pts)

② ① ⓪ First CV correctly identified

② ① ⓪ Second CV correctly identified

c. Constant (4 pts)

② ① ⓪ First Constant correctly identified

② ① ⓪ Second Constant correctly identified

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 ***

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: _____

(revised 06/07/2022)

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.**
   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 design, construct and test 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, each in its own team-provided box, any tools, and their Flight-Design Log. Teams may bring two different types of aircraft.
   b. Event Supervisors will provide all 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, including but not limited to: Airplanes of any wing configuration (e.g., monoplane, biplane, triplane, tandem wing, canard), 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 and during the flight must fit into a team-provided rectangular box.
      i. For Division B, the external dimensions of the box, with or without a lid, must be no larger than 39.0 cm x 28.5 cm x 63.0 cm.
      ii. For Division C, the external dimensions of the box, with or without a lid, must be no larger than 33.0 cm x 27.0 cm x 43.0 cm.
   e. Boxes may be purchased or constructed by the participants.
   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 (as verified by returning aircraft to box after flying) can occur after removing the aircraft from its box and throughout the flight itself. Rotating components such as propellers or rotors may be rotated to allow the aircraft to fit into the box.
   g. Trimming is allowed as long as the constraints of 3.d.-e. are followed.
   h. For the aircraft to "fit" into the box, 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.
   i. All aircraft-lifting forces must be generated by wing(s) or rotor style flying surfaces.
   j. Total mass of the aircraft, excluding the rubber motor(s), must be 8.00 g or more.
   k. 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.
   l. The sole power for the aircraft must come from rubber motor(s).
      i. Each motor used for single-motor aircraft, including any attachments such as O-rings, must mass no more than 2.00 g.
      ii. Each set of motors for multi-motor aircraft must not exceed a combined mass of 2.00 g and must be checked in as a set. If different sets of motors are checked in, individual motors must not be interchanged between sets.
      iii. Motor(s) will be massed separately from aircraft. Motor(s) 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.
   m. Participants may use any type of winder, but electricity may not be available.
   n. 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.
   o. Aircraft must be labeled so that the Event Supervisor can easily identify to which team it belongs.
4. **FLIGHT-DESIGN 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 after landing, estimated/recorded peak flight altitude, the motor torque at landing, propeller pitch, etc.).

b. Teams must also present a Design Log. The log must include the following:
   i. A list of materials used to construct the aircraft
   ii. A labeled diagram or picture that identifies the parts of the aircraft
   iii. 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. Any such parts purchased as an end item or as part of a kit do not require this information.
      (1) Information about the tool hardware, software, materials, and supplies used
      (2) 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
      (3) Descriptions of how the team constructed the final device from the tool-created components
c. Each log must have a front cover with the Team Name and the Team Number for the current tournament or be considered incomplete.
d. All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured or be considered incomplete. SI units should be the default standard.
e. All logs will be returned to teams after inspection.

5. **<u>THE COMPETITION</u>:**
   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 assistance, materials, 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 box(es), aircraft, and motor(s).
      ii. At check-in, participants will present their Flight-Design Log, motor(s), and aircraft in box(es) for inspection immediately prior to their Flight Period.
      iii. The Event Supervisor will verify the external dimensions of the box(es). Only participants are allowed to handle the box(es).
      iv. After verifying the box(es') dimensions, at the direction of the Event Supervisor, only participants will remove the aircraft from the box(es) and mass the aircraft.
      v. All motor(s) will be collected, massed and returned to the team at the start of their 10-minute Flight Period.
   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. Participants may make adjustments/repairs/trim flights during their official 10-minute Flight Period. Before their launches, participants must indicate to the Timers whether a flight is official or a trim flight. A flight is considered official if a team fails to notify the Timer(s) of the flight's status. Teams must not be given extra time to recover or repair their aircraft.
      iii. Teams may make up to a total of 2 official flights using 1 or 2 aircraft.

iv. 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.
v. 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.
vi. Participants must not steer the aircraft during flight.
vii. 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. After all flights are completed, the participants must (if requested by the Event Supervisor) demonstrate that each aircraft still meets the dimension requirements by placing the aircraft inside the team's box(es) in the as-flown configuration. Teams may not manipulate the configuration of the aircraft in order to fit into the box except to rotate components (such as propellers/rotors) that were spinning about an axis of rotation on the aircraft during the flight. 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, box(es), motor(s) and Flight-Design 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. Flight Score for each official flight = Flight Time + Bonus (6.b.) - Penalties (6.c.-6.d.).
b. A bonus of 10% of the Flight Time will be added to the Flight Score of an aircraft that has the entire surface of the wing between at least 2 ribs or at least one of the wingtip fences or a vertical stabilizer completely marked with black marker or black tissue. If no ribs are present, the whole surface must be black. Aircraft with no wings or vertical stabilizer must have at least one black-colored lifting surface.
c. Teams with incomplete or missing Logs will have the following deduction from their Flight Time from each Flight Score.
   i. An incomplete Flight Log is a 10% deduction while a missing Flight Log is a 20% deduction.
   ii. An incomplete Design Log is a 5% deduction while a missing Design Log is a 10% deduction.
d. 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.
e. 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 sponsored by the 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 as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org, to use during this event and two stand-alone calculators of any type. Teams not bringing these items will be at a disadvantage. The Supervisor will not provide them.
   c. Teams may bring only specified items. Other items not listed are prohibited. The Event Supervisors will check each team's equipment, confiscate non-allowed items, and have the right to penalize the team up to 10% if additional equipment is brought to the event.
   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. The Supervisor will provide:
      i. iodine reagent (I_2 dissolved in KI solution)
      ii. 2M HCl
      iii. 2M 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
   f. 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.c. - f. and analysis of the evidence in Part 3.g. Analysis or questions can only be on the evidence topics included in the competition. The amount of evidence included will be according to the following table:

Level	Part c. # of samples	Part d. # of samples	Part e. # of chromatograms	Part f. # of topics	Part g.
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. The collected evidence and other data given may be used in a mock crime scene.
   c. 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.
   d. 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, and root

e. 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.
f. 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 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.
   ix. 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.
g. 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 and why the suspect(s) was (were) chosen as the culprit(s), but also why the other suspect(s) were not chosen. They will also answer any other crime scene analysis questions posed by the Event Supervisor.
h. 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):
      i. Part 3.c. ≈ 20%,
      ii. Part 3.d. ≈ 20%,
      iii. Part 3.e. ≈ 15%,
      iv. Part 3.f. ≈ 15%,
      v. Part 3.g. ≈ 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 penalty of up to 10% may be given if the area is not cleaned up as instructed 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 knowledge of **trees found in the United States** that are on the **2023 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 2023 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 **2023 Official Science Olympiad National Tree List**.
   e. Leaf specimens may be live or preserved depending on availability and may be accompanied by twigs, cones, seeds, or other parts of the tree. Identification will be based on an examination of the leaf specimens (compound leaves should be intact). For each specimen, students will be asked a correlated question that pertains to the tree's structure, ecology, or economic characteristics. Structural characteristics may include leaf types, leaf shapes, leaf margins, leaf venation, leaf arrangement on the stem, twigs, bark, flowers, cones, fruits, seeds, and tree shapes.
   f. 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.
   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 **2023 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 sponsored by the USDA Forest Service - Conservation Education

2023 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 albicaulis (Whitebark Pine)
Pinus aristata (Bristlecone Pine)
Pinus attenuate (Knobcone Pine)
Pinus banksiana (Jack Pine)
Pinus contorta (Lodgepole Pine)
Pinus echinate (Shortleaf Pine)
Pinus edulis (Colorado Pinyon Pine)
Pinus flexilis (Limber Pine)
Pinus lambertiana (Sugar Pine)
Pinus monophyla (Singleleaf Pinyon)
Pinus monticola (Western White 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)
Pinus virginiana (Virginia 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 (Oregon 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 (Baldcyprus)
Thuja occidentalis (Northern White-cedar)
Thuja plicata (Western Redcedar)

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

Salicaceae: Willow Family
Populus angustifolia (Narrowleaf Cottonwood)
Populus balsamifera (Balsam Poplar)
Populus deltoides (Eastern Cottonwood)
Populus fremontii (Fremont Cottonwood)
Populus grandidentata (Bigtooth/Largetooth Aspen)
Populus tremuloides (Quaking Aspen)
Populus trichocarpa (Black Cottonwood)
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 occidentalis (Water Birch)
Betula papyrifera (Paper Birch)
Betula populifolia (Gray Birch)
Carpinus caroliniana (American Hornbeam)
Ostrya virginiana (American/Eastern Hophornbeam)

Fagaceae: Beech Family
Castanea dentata (American Chestnut)
Fagus grandifolia (American Beech)
Lithocarpus densiflorus (Tanoak)
Quercus agrifolia (Coast Live Oak)
Quercus alba (White Oak)
Quercus bicolor (Swamp White Oak)
Quercus chrysolepis (CanyonLive Oak)
Quercus douglasii (Blue Oak)
Quercus falcata (Southern Red Oak)
Quercus garryana (Oregon White Oak)
Quercus imbricaria (Shingle Oak)
Quercus kelloggii (California Black Oak)
Quercus macrocarpa (Bur Oak)
Quercus muehlenbergii (Chinkapin Oak)
Quercus palustris (Pin Oak)
Quercus prinus (Chestnut Oak)
Quercus rubra (Northern Red Oak)
Quercus velutina (Black Oak)
Quercus virginiana (Live Oak)

Ulmaceae: Elm Family
Celtis occidentialis (Northern Hackberry)
Ulmus americana (American Elm)
Ulmus rubra (Slippery Elm)

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

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

Annonaceae: Custard Apple Family
Asimina triloba (Pawpaw)

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

Hamamelidaceae: Witch-Hazel Family
Hamamelis virginiana (Witch-hazel)
Liquidambar styraciflua (Sweetgum)

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

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

Leguminosae: Legume Family
Acacia farnesiana (Huisache/Sweet Acacia)
Cercis canadensis (Eastern Redbud)
Cercidium floridum (Blue Paloverde)
Gleditsia triacanthos (Honeylocust)
Gymnocladus dioicus (Kentucky Coffeetree)
Prosopis glandulosa (Honey Mesquite)
Robinia pseudoacacia (Black Locust)

Rutaceae: Rue/Citrus Family
Zanthoxylum clava-herculis (Hercules-club/ Toothache-Tree)

Simaroubaceae: Quassia Family
Ailanthus altissima (Ailanthus/Tree of Heaven)

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

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

Aceraceae: Maple Family
Acer negundo (Boxelder)
Acer rubrum (Red Maple)
Acer saccharinum (Silver Maple)
Acer saccharum (Sugar Maple)

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

Tiliaceae: Basswood Family
Tilia americana (American Basswood)

Cactaceae: Cactus Family
Cereus giganteus (Saguaro)[1]

Myrtaceae: Myrtle Family
Eucalyptus globulus (Bluegum Eucalyptus)

Cornaceae: Dogwood Family
Cornus florida (Flowering Dogwood)
Cornus nuttallii (Pacific Dogwood)
Nyssa sylvatica (Black Tupelo/Blackgum)

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 velutina (Velvet Ash)

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

Caprifoliaceae: Honeysuckle Family
Sambucus canadensis (American Elder/Elderberry)

Euphorbiaceae: Spurge Family
Aleurites moluccana (Candlenut/Kukui)[2]

Note: The 2023 Official Science Olympiad National Tree List taxonomy is based the National Audubon Society Trees of North America, 2021 Edition.
1: This organism is not listed in the National Audubon Society Trees of North America, 2021 Edition as it is a cactus but for our purposes is considered a tree.
2: This organism is not listed in the National Audubon Society Trees of North America, 2021 Edition as it is found in the Hawaiian Islands which are not addressed in the book.

GREEN GENERATION

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

1. **DESCRIPTION:** Students will demonstrate an understanding of general ecological principles, the history and consequences of human impact on our environment, solutions to reversing trends and sustainability concepts.

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

2. **EVENT PARAMETERS**: Each team may bring one 8.5"x11" 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 any annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators.

3. **THE COMPETITION:**
   a. This event will be composed of three sections of approximately equal point value.
   b. **Questions** may include analysis, interpretation or use of charts, graphs and sample data.
   c. Green Generation is designed **to rotate the content over a two-year period with** the first year **addressing** aquatic issues, air quality, and climate change while the **second year addresses** terrestrial issues, population growth issues, and **climate change**. **The content for this year's events is as follows:**
      i. Review of the General Principles of Ecology
         (1) General Principles of Ecology – food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics, species diversity, indicator species, and invasive species
         (2) Overview of **Terrestrial** Environments – **forests, grasslands, deserts, tundra**
      ii. Problems resulting from human impacts on the quality of our environment
         (1) **Terrestrial** Environmental Issues –**Desertification, Deforestation, Soil Pollution, Waste Disposal, Mining**
         (2) **Population Growth** Issues –**Habitat Destruction, Farming Practices, Fertilizers, and Pesticides**
         (3) **Climate Change – Effects on Plants, Animals, and Ecosystems**
      iii. Solutions to reversing/reducing human impacts that harm our environment
         (1) Sustainability Strategies –Environmental Stewardship of **Terrestrial** Ecosystems
         (2) Bioremediation Strategies
         (3) **Nonrenewable, Renewable, and Alternative Energy Sources**
         (4) **Waste Management**
         (5) Division C Only: Legislation and Economic Opportunity for Solving Problems

4. **SCORING:**
   a. Questions will be assigned point values.
   b. High score wins.
   c. 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

IT'S ABOUT TIME

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

1. **DESCRIPTION:** Teams will answer questions related to time and construct one non-electrical device **that triggers a single signal to occur three times at equally spaced time intervals**.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** None **IMPOUND:** Yes **APPROX. TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team must impound only one device and all components that are integral to its operation (e.g., water, sand, etc.) as well as a **Design Log** for scoring.
   b. 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.
   c. Each team may also bring tools, supplies, writing utensils, components needed to set up, calibrate, and clean up (e.g., tools, clean-up supplies, reference materials, other time keeping devices), and two stand-alone calculators of any type for use during any part of the event. These items need not be impounded.
   d. **To aid the Event Supervisor in a construction check during impound or before setup, students are encouraged to show a brief video of the device emitting the signal, plus a few seconds of operating time preceding it. This is particularly useful in cases where the device requires significant setup and therefore does not resemble its operating form while in its impounded form.**
   e. **Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy. Per the Digital Fabrication section of that policy, teams may use 3D printers, laser cutters, CNC mills, and other similar machines as a tool to construct all or part of their device. Teams are encouraged to design customized tool files/models (e.g., CAD, STL, OBJ) from scratch and should review the complete policy on www.soinc.org for more details and examples.**

3. **CONSTRUCTION PARAMETERS:**
   a. **Devices may not contain electrical or electronic components. Electrical or electronic tools (such as a scale) may be used for setup, calibration, and preparation before and between the time trials, as long as they are removed prior to the start of a time trial.**
   b. Commercial counters, tally devices, timepieces or their parts are not allowed. Commercial balances, scales, test tubes, beakers, graduated cylinders, and burettes are not considered counters and are allowed, **as long as they are not electrical or electronic**.
   c. **The device must be designed, constructed, and operated so that it does not damage or alter the competition area, contains spillage, and minimizes possible impacts on other teams (e.g., as quiet as possible, occupies a reasonable amount of space when set up, etc.)**.
   d. **The device must be designed and constructed so that it does not require manual intervention during a time trial.**
   e. **The device must be constructed to provide a SINGLE distinct audible and/or visual signal that will occur three times at equally spaced time intervals set by the event supervisor. Each occurrence of the signal must be the same event produced by the same mechanism. The device itself must produce the signal and it is not permissible for a participant to call out when the signal has been reached. The signal must also be distinct in that it only occurs at the end of each of the equally spaced time intervals.**
      i. **A broad range of events qualify as permissible signals, including (but not limited to): a flag popping up, a bell being rung, the movement of a lever arm, a moving indicator passing the same mark, or a container being filled or emptied.**
      ii. **A lever arm or water level passing different marks is NOT a single signal.**
   f. **The device does not need to stop itself at the end of a time trial.**
   g. The impounded device and any storage boxes must be clearly marked with the team's school name and team number. At impound, the device and all impounded components must be able to fit into an 80.0 cm x 80.0 cm x 80.0 cm cube and be movable by the competing team members without outside assistance. The device may be larger after setting up for Part II.

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 elapsed times and device configuration parameters 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. **<u>THE COMPETITION</u>:**

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 must consist of at least four questions from each of the following areas:
i. Time standards (e.g., UTC, sidereal time, leap years/seconds, time zones, daylight savings time, text-based time formats, **solar vs. lunar calendars,** and the Gregorian, **Chinese and Mayan** calendars)
ii. Physics of modern timekeeping devices (e.g., atomic clocks, quartz clocks, electronic oscillations)
iii. Historical time keeping devices (e.g., pendulum clocks, water clocks, sundials, **equation clocks,** early clocks and watches)
iv. **Half-life, dating of ancient artifacts, error bounds on dating methods**
v. Waves and frequencies (e.g., electromagnetic waves, frequency analysis, harmonics, normal modes, resonance, **analog-to-digital conversion, sampling frequency)**
vi. State and National Only
(1) **Orbital dynamics (e.g., Kepler's laws, gravitational force, the two-body problem, and planetary motion) and special relativity**
(2) Computer representations of time, methods of time synchronization, and situations in which accurate time keeping has significant impact (e.g., navigation, electronic financial transactions, the Internet of Things, security protocols, and signal multiplexing)

Part II: Device Testing

a. Teams must be allowed to interact with their device **at any time**, except while the device is actively timing a time trial.
b. The event supervisor must pre-select a different **time** interval for each of **2** time trials. The same **time** intervals must be used for all teams. Teams must be informed of the selected intervals at the start of their competition block. **The intervals selected for the two time trials must be different from each other.**
c. The two time trial repeated intervals will be chosen from the following ranges:
i. **Regionals: 10.0 – 30.0 seconds; in 1.0 second intervals**
ii. **States: 10.0 – 45.0 seconds; in 0.5 second intervals**
iii. **Nationals: 10.0 – 60.0 seconds; in 0.1 second intervals**
d. At the start of the competition block, teams will be given 5 minutes to setup or modify their devices and use their graphs and/or tables to calibrate them. **During the 5 minutes, competitors may attempt to resolve any construction violations in their device.** Devices that do not meet construction specs **may still be tested if time allows and at the discretion of the Event Supervisor, but will score a zero for the TT score**.
e. While all teams are working on Part I, the Event Supervisor will individually call each team to a station. Multiple identical stations may be used.

f. Prior to the start of a team's time trials, the team must demonstrate the audible and/or visual signal that the device makes.
g. Event Supervisors are strongly encouraged to utilize 3 Timers on all time trials. **The Event Supervisor will make sure 3 timers are ready and then signal a team member to make a loud announcement of, "3, 2, 1, START!" Then a team member will proceed to start the device. Timers will record the lap times for the first three occurrences of the device signal. The median time in seconds to the precision of the device used, recorded by the 3 Timers, is the official recorded lap time**.
h. **If the Device stops, jams, or fails, the participants will be allowed to adjust it once per time trial to continue operation. 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 a score of zero for the time trial.**
i. **Once the device has emitted the signal for a third time in the time trial, participants may manually stop the device. No penalties will be assessed for the device continuing to run or signals being emitted after the third signal in the trial.**
j. Teams must then have 90 seconds at Regionals, **75** seconds at States, **60** seconds at Nationals to configure and prepare their device for the next time trial.
k. Teams must completely clean up before leaving the competition area.
l. The Supervisor will review with the team the Part II data recorded on their scoresheet.
m. Teams filing an appeal regarding Part II must leave their device in the competition area.

6. **<u>SCORING</u>:**
   a. High score wins; Final Score (FS) = ES + **TT** + CS. The maximum possible FS is 100 points. A scoring spreadsheet is available at www.soinc.org.
   b. **Time Trial Score (TT) = 45 points x (TT1+TT2) / (Highest TT1 +TT2 for all teams)**
   c. **To score each time trial, first use the recorded lap times to compute the three signal times:**
      i. **ST1 = Time from start of the time trial to the device's first signal**
      ii. **ST2 = Time from start of the time trial to the device's second signal**
      iii. **ST3 = Time from start of the time trial to the device's third signal**
   d. **Next convert the actual times ST1, ST2, and ST3 into scores S1, S2, and S3. Each score is 5 points minus the difference between actual and expected times, with a minimum of zero:**
      i. **S1 = max(0, 5 – abs(ST1 – expected time to first signal))**
      ii. **S2 = max(0, 5 – abs(ST2 – expected time to second signal))**
      iii. **S3 = max(0, 5 – abs(ST3 – expected time to third signal))**
      iv. **The "expected time to the N^{th} signal" is the time trial interval multiplied by the signal number (1, 2, or 3)**
      v. **TT1 = S1 (first trial) + S2 (first trial) + S3 (first trial)**
      vi. **TT2 = S1 (second trial) + S2 (second trial) + S3 (second trial)**
      vii. **A Scoring Example is as follows:**
      First Time Trial: A target time interval of 20.1 seconds is given. The expected times for the device to signal are 20.1 seconds, 40.2 seconds, and 60.3 seconds. The device emits the signal at 19.5 seconds (ST1), 39.0 seconds (ST2), and 66.3 seconds (ST3).
      S1 = max(0,5 – abs(19.5 – 20.1)) = 4.4
      S2 = max(0,5 – abs(39.0 – 40.2)) = 3.8
      S3 = max(0,5 – abs(66.3 – 60.3)) = 0.0
      TT1 = S1 + S2 + S3 = 4.4 + 3.8 + 0.0 = 8.2
      viii. **A second scoring example is as follows:**
      Second Time Trial: A target time interval of 10.3 seconds is given. The expected times for the device to signal are 10.3 seconds, 20.6 seconds, and 30.9 seconds. The device emits the signal at 9.1 seconds (ST1) and 30.9 seconds (ST2), but never emits a third signal. The students touch the device once during its operation after it jams after the first signal.
      S1 = max(0, 5 – abs(10.3 – 9.1)) = 3.8
      S2 = max(0, 5 – abs(20.6 – 30.9)) = 0.0
      S3 = 0.0
      TT2 = Penalty x (S1 + S2 + S3) = .5 x (3.8 + 0.0 + 0.0) = 1.9
   e. Exam Score (ES) = (Part I score / Highest Part I score for all teams) x 45 points.

f. 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 the possible time range
   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 series of tests measuring the same variables are considered distinct graphs or tables
   v. 2 points for including **a proper materials list and diagram and digital fabrication information (if applicable)**
g. **If a Device is adjusted during the time trial, the time trial score (TT1, TT2, or both) during which the touch occurred will be multiplied by 0.5.**
h. **If a team violates any COMPETITION rule other than the Device Touch, the time trial score (TT1, TT2, or both) during which the violation occurred will be multiplied by 0.9.**
i. If any CONSTRUCTION violation(s) are corrected during the competition block, or if the team misses impound, their **TT1 and TT2 results** will be multiplied by 0.7.
j. Teams with no device or that do not make an honest attempt **to test a device** receive TT1 and TT2 scores of 0. Such teams will be allowed to compete in Part I (the written test).
k. Tiebreakers:
   i. 1st - best score from **Time Trial 2 (TT2),**
   ii. 2nd - designated questions from the 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

REMOTE SENSING

1. **DESCRIPTION:** Participants will use remote sensing imagery, data, and computational process skills to complete tasks related to climate change processes in the Earth system.

   A TEAM OF UP TO: 2 **APPROXIMATE 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. 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 participant may bring a metric ruler, a protractor, and a non-programmable, non-graphing calculator dedicated to computation.
3. **THE COMPETITION:**
   a. The event will consist of questions and activities testing concepts related to the collection and use of remote sensing data to observe and study climate change processes in the Earth system.
   b. The test should be divided **so that approximately 25 % focuses on topics under 3.c.i.**, **35 % focuses on topics under 3.c.ii.**, **25 % focuses on topics under 3.c.iii.**, **and 15 % focuses on topics under 3.c.iv.**
   c. **The questions will address the following topics:**
      i. Remote sensing instrumentation and physics: active vs. passive sensors; optical and infrared imagers; radiometers; LiDAR; radar altimetry; precipitation radar; Planck function; Stefan-Boltzmann Law; beam attenuation; absorption and scattering by aerosols; refraction and refractive indices; scattering, gravity.
      ii. Interpretation of remote sensing images and data sets from the following satellites: Atmospheric and sea-surface temperature (GOES-16, ATMS and CrIS on NPP); global mean temperature; energy flux (CERES on NPP); optical, infrared and Doppler radar imagery of clouds and precipitation (MODIS, CALIPSO, CloudSat, **GOES, Suomi NPP**); CO_2 cycle (OCO-2); aerosol scattering, absorption and optical depth (MODIS, **GOES, Suomi NPP**); detection of trace gas concentrations by satellites (OCO-2, AURA, **GOES**); sea level rise and surface waves (radar altimeters, especially TOPEX-Poseidon, JASON-1 and JASON-3**,** GRACE).
      iii. Climate processes and climate change: greenhouse gasses (concentrations and distribution) and trace gas concentrations; clouds and radiation; aerosol forcing; carbon cycle; surface albedo; comparison of remote sensing data with climate model data
      iv. Using, applying, and interpreting the output of small-scale models of planetary energy balance (e.g., Wien's Law, blackbody radiation).
4. **SAMPLE QUESTIONS/TASKS:**
   a. Use a comparison of visible and IR satellite images of clouds to interpret relationships between clouds and outgoing radiation, and to explain how clouds influence the Earth's radiative balance.
   b. Given information characterizing the extinction coefficient of a layer of dust in the atmosphere and the observed reduction in outgoing radiation, calculate the thickness of the dust layer.
   c. Modify a simple energy balance model to include an idealized greenhouse gas response to these CO2 concentrations and show how this affects global atmospheric temperature.
   d. Interpret a pair of radar altimeter returns to look at differences in significant wave height.
   e. Interpret signals of changes in groundwater storage from GRACE gravity data.
5. **SCORING:**
   a. High score wins.
   b. Points will be awarded for the quality and accuracy of responses.
   c. 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

ROCKS AND MINERALS

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 rocks and minerals.
   A TEAM OF UP TO: 2 **APPROXIMATE 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. 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. If the event features a rotation through a series of stations where the participants interact with samples, specimens or displays; no material may be removed from the binder throughout the event.
   c. In addition to a binder and a field guide, each team may bring one copy of the 2023 Rocks & Minerals List and one magnifying glass which does not have to be secured in the binder. Teams are not permitted to bring samples or specimens to the event.
3. **THE COMPETITION:**
   a. Emphasis will be placed upon task-oriented activities such as identification of rocks and minerals based on observations of properties and characteristics, interpretation of graphs and charts, and analyzing data.
   b. Where possible, participants will move from station to station, with the length of time at each station predetermined and announced by the event supervisor. Participants may not return to stations, but may change or add information to their original responses while at other stations.
   c. Identification will be limited to specimens appearing on the Official Science Olympiad **2023** Rocks and Minerals List but other rocks or minerals may be used to illustrate key concepts. Tournament Directors may include up to five additional specimens important to their own state. If additional specimens are to be included, all teams must be notified no later than three weeks prior to the competition.
   d. If identification of a specimen is not possible through observation, key characteristics/properties of the specimen will be provided.
   e. Written descriptions as to how a specimen might react were it to be tested with HCl may be provided. HCl will not be used or provided nor will participants be allowed to do a taste test.
   f. Participants are expected to be able to answer questions about the following Mineral topics:
      i. Identification - specimens or images used should show observable properties. Where observable properties are insufficient to identify a specimen, other diagnostic characteristics will be provided
      ii. Physical Properties - color, hardness, luster, streak, cleavage/fracture, density/specific gravity/ heft, diaphaneity, tenacity
      iii. Other properties - reaction with acid, fluorescence, magnetism, smell, taste, double refraction, piezoelectricity, radioactivity, etc.
      iv. Mineral habit - limited to acicular (needlelike), bladed, botryoidal, cubic, dendritic, dodecahedral, doubly terminated, druzy, geodic, hexagonal, hopper, massive, micaceous, octahedral, pisolitic, prismatic, radiating, rosette, stalactitic, twinning, and tabular
      v. Chemical composition – **chemical formulas, relationships between chemistry and properties (e.g., effect of trace elements on mineral color)**
         (1) **Division C Only - Solid solution series (e.g., feldspar ternary diagrams)**
         (2) **Division C Only – Phase diagram interpretation: temperature/pressure, temperature/ composition (limited to two component systems)**
      vi. Polymorphs (e.g., diamond/graphite and orthoclase/microcline)
      vii. Classification - mineral families based on composition. (see Rock and Mineral List)
         (1) Mineral groups (e.g., feldspars, garnet, tourmaline) - similarities of chemical composition and shared properties
         (2) Division C Only – Silicate **tetrahedra** and their structures: isolated tetrahedra (nesosilicates), **island (sorosilicates),** chain (inosilicates), **ring (cyclosilicates),** sheet (phyllosilicates), and framework (tectosilicates)
         (3) **Division C - State/Nationals Only - Crystal Systems – cubic, tetragonal, orthorhombic, monoclinic, triclinic, trigonal, and hexagonal; emphasis on how crystalline structures result in certain physical properties (e.g., cleavage planes, crystal shape)**
      viii. Methods of formation **and environments** (e.g., hydrothermal, **chemical weathering,** crystallization from magma, evaporites, **chemical precipitation,** alteration under heat & pressure)

ix. Minerals associated with rock-forming environments (e.g., evaporite minerals in sedimentary settings; mafic minerals in oceanic crust; minerals that form under metamorphic conditions)
x. Bowen's Reaction Series – relationship between mineral crystallization and temperature in magma
xi. Uses of minerals (e.g., ores, **industry**, jewelry, **geochronology**)
(1) **Precious and semiprecious gemstones including minerals on the Rocks & Minerals List as well as the following varieties, limited to: emerald, aquamarine, morganite, peridot, ruby, sapphire, pearl and amber.**

g. **Participants are expected to be able to answer questions about the following Rock topics:**
i. Identification - specimens or images used should show observable characteristics. Where observable characteristics are insufficient to identify a specimen, other diagnostic characteristics will be provided (e.g., mineral composition of fine-grained igneous rocks)
ii. Classification - igneous, sedimentary, and metamorphic including observable diagnostic characteristics that facilitate classification (e.g., glassy or vesicular texture in igneous; rounded grains, fossils, or layers in sedimentary; and foliation or banding in metamorphic)
iii. Igneous Rocks:
(1) Textures - including but not limited to aphanitic (fine-grained), glassy, vesicular, porphyritic, pyroclastic, phaneritic (coarse-grained), pegmatitic
(2) Composition and essential minerals - felsic, intermediate, mafic, ultramafic
(3) Intrusive and extrusive environments - including but not limited to batholith, dike, sill, volcanic neck, lava flow, pyroclastic flow, laccolith
(4) Relationship between textures and environments of formation (e.g., intrusive/plutonic, extrusive/volcanic and relative rates of solidification.)
iv. Sedimentary Rocks:
(1) Textures - limited to clastic (detrital), chemical, and biochemical/organic
(2) Composition and essential minerals
(3) Grain sizes (e.g., clay, silt, sand, pebble, cobble, boulder), sorting, and shape
(4) Relationship between textures and composition to environments of deposition
(5) Environments of deposition - including, but not limited to alluvial fan, delta, river/stream **(fluvial), lake (lacustrine)**, swamp, **wind (aeolian**), floodplain, beach, shallow marine/**shelf,** deep marine
(6) Primary sedimentary structures and **their implications about depositional processes and environments** (e.g., plane bedding, cross-bedding, ripple marks, mud cracks, graded bedding, fossil tracks & trails)
v. Metamorphic Rocks:
(1) Textures - foliated and non-foliated
(2) Mineral composition
(3) Protoliths (parent rocks)
(4) Regional and contact metamorphism
(5) Grade of metamorphism and metamorphic index minerals (e.g., chlorite, epidote, garnet, staurolite, kyanite, sillimanite)
(6) Division C Only - Relationship of temperature, pressure, depth to types of metamorphism and metamorphic facies (e.g., hornfels, zeolite, greenschist, amphibolite, granulite, eclogite) based on interpretation of graphs and charts
(7) Division C Only - Environments of metamorphism in the context of plate tectonics - regional metamorphism and mountain building at convergent continental-continental boundary; blueschist and eclogite formation in subduction zones; greenstone/greenschist formation from basalt or gabbro at ocean crust divergent boundaries
vi. Rock Cycle – emphasis on the geologic processes that form rocks (e.g., melting and solidification; uplift, erosion & deposition; burial, compaction & cementation; heat & pressure resulting in recrystallization & deformation)
vii. Economic importance and uses of rocks **(e.g., building stone, ores, ornamental, agriculture, fossil fuels)**

viii. **Division C, States and National Only - Thin Sections of Rocks; using photographs taken through a microscope (photomicrographs)**
   (1) **Identify minerals using their optical properties and features in polarized light (twinning, extinction, cleavage planes, birefringence); limited to microcline, plagioclase, calcite, augite, and garnet.**
   (2) **Distinguish rock types and characteristics of igneous, sedimentary, metamorphic rocks by their microscopic textures limited to:**
      a. **Igneous - fine grained crystalline (holocrystalline), vesicular, glassy, porphyritic (e.g., basalt vs. pumice)**
      b. **Sedimentary – rounded, angular, well sorted vs. poorly sorted, skeletal fragments (e.g., oolites, sandstone vs. arkose)**
      c. **Metamorphic – foliated (e.g., schistose)**

4. **SAMPLE ACTIVITIES:**
   a. **Using the materials provided, determine the relative hardness of the mineral specimens.**
   b. **Identify the minerals and describe each specimen's luster.**
   c. **Determine the breakage pattern (cleavage or fracture) of the minerals.**
   d. **The color of the specimen is caused by which element?**
   e. Based on the texture of the metamorphic rocks, list the specimens in order from lowest to highest grade of metamorphism.
   f. Based on the provided diagram of igneous environments**, which specimen cooled at the slowest rate in a batholith?**
   g. Based on the grain size of the shale, sandstone, and conglomerate, which one formed in the lowest energy environment?
   h. Classify the specimens into igneous, sedimentary, or metamorphic based on observable characteristics and state one reason for each classification.

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

2023 ROCKS AND MINERALS LIST

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

MINERALS

Borate Family
Ulexite

Carbonate Family
Aragonite
Azurite
Calcite
Dolomite
Malachite
Rhodochrosite*

Native Element Family
Copper
Diamond
Gold
Graphite
Silver
Sulfur

Halide Family
Fluorite
Halite[4]

Oxide/Hydroxide Families
Corundum
Goethite/Limonite
Hematite
Magnetite
Pyrolusite*
Rutile*
Zincite*

Phosphate Family
Apatite
Pyromorphite*
Turquoise*
Vanadinite*

Sulfate Family
Barite
Celestite*
Gypsum[4] varieties:
- Alabaster (massive)
- Satin Spar (fibrous)
- Selenite (crystalline)

Sulfide Family
Bornite*
Chalcopyrite
Galena
Pyrite
Sphalerite
Stibnite*

Silicate Family
Apophyllite*
Beryl
Epidote
Kaolinite
Kyanite
Olivine
Quartz varieties:
- Aventurine
- Agate
- Amethyst
- Chalcedony
- Citrine*
- Jasper*
- Milky Quartz
- Opal
- Rock Crystal
- Rose Quartz
- Smoky Quartz*

Sodalite
Staurolite
Stilbite*
Talc
Topaz
Tourmaline Group[1]
- Willemite*
- Zircon*

Amphibole Group
- Actinolite*
- Hornblende
- Tremolite*

Feldspar Group
- Plagioclase feldspars
  - Albite
  - Labradorite
- Potassium feldspars
  - Amazonite
  - Orthoclase/Microcline (pink)[2]

Garnet Group[1]
- Almandine

Mica Group
- Biotite
- Lepidolite*
- Muscovite

Pyroxene Group
- Augite
- Rhodonite*
- Spodumene*

ROCKS

IGNEOUS ROCKS
Andesite
Basalt
Diorite
Gabbro
Granite
Obsidian
Pegmatite
Peridotite
Pumice
Rhyolite
Scoria
Syenite
Tuff

SEDIMENTARY ROCKS
Banded Iron Formation
Bauxite[3]
Breccia
Chert/Flint
Conglomerate
Diatomite
Dolostone
Rock Salt (Halite)[4]
Rock Gypsum[4]
Shale
Coal varieties:
- Anthracite
- Bituminous
- Lignite

Limestone varieties:
- Chalk
- Coquina
- Fossil Limestone
- Oolitic Limestone
- Travertine

Sandstone varieties:
- Arkose
- Greywacke
- Quartz Sandstone

METAMORPHIC ROCKS
Amphibolite
Gneiss
Marble
Phyllite
Quartzite
Schist Varieties:
- Garnet Schist
- Mica Schist
- Talc Schist (Soapstone)

Serpentinite
Slate

*Specimens marked with an asterisk (*) are for State and National Tournaments
1 - Garnet and Tourmaline varieties should be identified at the group level, except for Almandine.
2 - This pink variety of feldspar should be identified as Potassium feldspar and not specifically as Orthoclase or Microcline.
3 - Bauxite has been reclassified as a sedimentary rock.
4 - Rock Salt and Rock Gypsum for identification purposes are considered the same, respectively, as the minerals Halite and Gypsum and do not need to be distinguished.

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 straight 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), a Practice & Design Log, and additional/spare parts.
   b. Teams may bring data and a stand-alone calculator of any type along with **non-electronic** tools which do not need to be impounded.
   c. 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.
   d. 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 and falling mass, in the ready-to-run configuration, must completely fit within an imaginary rectangular box with a 75.0 cm x 75.0 cm base and a 50.0 cm height.
   c. All energy used to propel the Vehicle must come from a falling mass not to exceed 1.50 kg. The mass must be part of the energy propulsion system and need not travel with the Vehicle. 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.
   e. The egg must rest on two (2) ¼" 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 ¼" 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. One or more violations of this paragraph counts as a single Construction Violation.
   g. The Event Supervisor 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 Event Supervisor 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 Event Supervisor when attached. The egg must be the foremost point of the Vehicle. At the Event Supervisor's discretion, the egg may be placed inside a thin transparent plastic bag.
   h. Conversion of the falling mass' gravitational potential energy is permissible, but any additional sources of kinetic energy must be in their lowest energy state in the ready-to-run configuration. 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.
   i. Competitors must design the Scrambler to start by using any part of an unsharpened #2 pencil with an unused eraser, provided by the Event Supervisor, 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.

j. 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 position. All wheels must be in contact with the floor at launch. Pieces falling off during the run constitutes a Construction Violation.
k. No electrical or electronic devices may be used on the Scrambler, its alignment devices, or any tools (with the exception of any type of calculator).

4. **PRACTICE & DESIGN LOGS:**
   a. Teams must submit a Practice Log along with their Scrambler. The log must include the following:
      i. The submitted Practice Log must contain recorded data covering 4 or more parameters (3 required and at least 1 additional) for 10 or more test runs prior to the competition.
      ii. The required parameters are Target Distance, Vehicle Distance from Target, and Time.
      iii. The additional, 4th parameter (e.g., # of axle turns for braking, alignment angle, or other adjustment to enable the Vehicle to score better) is chosen by the Team.
   b. Teams must also submit a Design Log. The log must include the following:
      i. The materials used to construct the Scrambler.
      ii. A labeled diagram or picture that identifies and describes the parts.
      iii. 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.
         (1) Information about the tool hardware, software, materials, and supplies used
         (2) 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.
         (3) Descriptions of how the team constructed the final device from the tool created components
   c. **A front cover labeled with the Team Name and the Team Number for the current tournament.**
   d. **All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured or be considered incomplete. SI units should be the default standard.**
   e. All logs will be returned to teams after inspection.

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 Line will be the back edge (furthest from the Terminal Barrier) of a piece of tape approximately 2.5 cm wide and 1.00 m long. The approximate center of the Start Line must be marked on the tape by the Event Supervisor. The tape should be perpendicular to the imaginary Center Line connecting the center of the Start Line and the center of the TB.
   c. The Terminal Barrier (TB) must be a hard, flat, vertical wall at least 25.0 cm tall, placed perpendicular to the imaginary Center Line. The exact Target Distance from the Start Line to the TB will be between 8.00 m and 11.00 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 Event Supervisor and will be announced after the impound period is over. The TB must be at least 1.0 m long.
   d. Two Timing Lines are marked with pieces of tape approximately 2.5 cm wide and at least 1.00 m long, at distances of 0.25 m and 7.25 m from the Start Line, centered on and perpendicular to the imaginary Center Line. The edges of the tape closest to the Start Line defines those lines.
   e. 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. 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.
   f. At the Event Supervisor'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.b.).
   d. In the ready-to-run configuration, the pointed tip of the egg must be placed even with the Start Line anywhere along its length. All parts of the Scrambler must be behind the Start Line when the release mechanism is actuated. The Scrambler must remain at the starting position without being touched until triggered by the #2 pencil.
   e. Teams may adjust their Scrambler (e.g., directional control) within their Event Time; the Event Supervisor may re-verify that the Scrambler meets specifications prior to each run. Timing is paused during any measurements made by the Event Supervisor. 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 Scrambler, 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 Event Supervisor 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 Event Supervisor 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 0.25 m Timing Line but stops before the 7.25 m Timing Line, it is considered a Competition Violation. The Event Supervisor records the run measurement.
   m. If the egg is broken (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 scored as a Failed Run.
   n. If any part of the Vehicle (besides the egg) touches the TB, it is considered a Competition Violation.
   o. A Failed Run can occur if the Vehicle starts before the Event Supervisor is ready, if its distance or time cannot be measured (e.g., it starts before the Event Supervisor is ready, if it moves but does not go at least 0.25 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.
   p. The Event Supervisor will review with teams the data recorded on their scoresheet.
   q. Teams filing an appeal must leave their Scrambler, Practice Log, and Design Log in the event area.

7. **SCORING:**
   a. Each team's Final Score is the better of the 2 Run Scores + any 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 = 1pt./cm x Vehicle Distance. The Distance Score for a Failed Run is 1100 points.
   e. The Vehicle Distance is a point-to-point measurement from the center of the TB 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 0.25 m Timing Line and ends when it passes the 7.25 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 0.25 m Timing Line but stops before the 7.25 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:
   i. Incomplete Practice Log: 25 points added to the team's Final Score.
   ii. Incomplete Design Log: 25 points added to the team's Final Score.
   iii. Missing or not Impounded Practice Log: 150 points added to the team's Final Score.
   iv. Missing or not Impounded Design Log: 150 points added to the team's Final Score.
   v. 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.

8. **SCORING EXAMPLE:**

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.
- The team's Practice Log is incomplete.

1st run's Run Score:	Time Score:	14.54 (7.27 x 2)
	Distance Score:	67.6
	1st Run Score:	82.14
2nd run's Run Score:	Time Score:	17.34 (8.67 x 2)
	Distance Score:	27.6
	2nd Run Score:	44.94
Final Score	= 2nd Run Score + Incomplete Practice Log Penalty	
	= 44.94 + 25 pts = 69.94 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

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.
   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. Per the Digital Fabrication section of that policy, teams may use 3D printers, laser cutters, CNC mills, and other similar machines as a tool to construct all or part of their device. Teams are encouraged to design customized tool files/models (e.g., CAD, STL, OBJ) from scratch and should review the complete policy on www.soinc.org for more details and examples**.

3. **CONSTRUCTION PARAMETERS:**
   a. When ready-to-launch, the launch device, projectiles, stabilizing weights, and all other device components (except for tools / supplies) must fit in a 60.0 cm per side cube, in any orientation chosen by the team.
   b. The launch force must be supplied by non-metallic elastic solids such as rubber bands/tubing, wood, plastic, or bungee cords. Devices will be inspected to ensure that there are no other energy sources. At the supervisor's discretion, teams must disassemble devices after competing in order to verify this.
   c. The triggering device is not considered part of the device and activating it must not contribute significant energy to the launch. It must extend out of the launch area, allow for competitors to remain at least 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.
   d. **Teams must provide unmodified (labeling is permitted) tennis, racquet, and/or Ping Pong balls to be used as projectiles.** Teams may change projectiles for each launch.
   e. The launch device must be designed and operated in such a way to not damage or alter the floor.
   f. Electrical components are not allowed as part of the device or triggering device**. 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 arm position, 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.

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 that is elevated and a far target that is 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).
   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. Prior to the start of the competition the event supervisor will determine the target elevation which will be the same for all teams.**
         (1) **At the Regional level, the near target must be elevated so that the surface of the target is either 0.5 meters or 1.0 meters above the ground. The target surface must be at least a 1.0 meter by 1.0 meter square and have a marked center point that measurements will be taken from.**
         (2) **At the State level, the target elevation will be some value between 1.0 m and 1.5 m off the ground.**
         (3) **At Nationals, the target elevation will be some value between 1.0 m and 2.0 m.**
      ii. **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 are recommended to be a square shape. It must have a marked center point that measurements will be taken from.**
   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 must separate the targets.
   e. The **marked center of the** far target may be anywhere up to 2.00 m in intervals of 0.5 m for Regionals, 0.25 m for States, and 0.10 m for Nationals to the right or left of the imaginary centerline.
   f. If requested, a bucket (≈5 gallon size, provided by the Event Supervisor) will be placed with the opening facing up anywhere between 2.00 m and 8.00 m in front of the launch area and anywhere up to 2.00 m to the right or left of the centerline. The bucket may only be on the course when requested so that it is not an obstacle. **The bucket may not be the same location as the far target.**

g. **Target locations, bucket location, and near target elevation** must be announced only after impound is over and must be the same for all teams. Room ceiling height should be considered when setting the distances.

7. **SCORING:**
   a. High score wins. Final Score = Best Near TS + Best Far TS + CS + BS (if any). A scoring spreadsheet is available at www.soinc.org.
   b. Target Score (TS) = **4000** (for the near one) or **2000** (for the far one) minus the straight-line distance, in mm, from the center of the initial projectile impact to the **center of the** target. Lowest possible TS is 0.
      i. If no target is announced, or the shot is a bucket shot attempt, TS = 0 for that shot.
      ii. Eligible impact locations for the far target include the floor, wall, support column, other target, or other objects.
      iii. **Participants must impact the elevated surface of the near target in order for a measurement to be taken. Failure to strike the target surface will result in a failed shot. TS = 0 for that shot.**
      iv. **The ceiling and objects affixed to or hanging from it are not eligible impact locations. Shots with projectiles hitting such areas will use the next eligible impact location contacted by the projectile.**
   c. Chart Score (CS) - One of the submitted graphs and/or tables, selected by the event supervisor, must be scored per items i., ii. and iii. below. Partial credit may be given. Max possible CS is 400.
      i. 60 points for including data spanning at least one variable range listed in 4.a.iii.
      ii. **55** points for including at least 10 data points in each data series
      iii. **40** points for proper labeling (e.g., title, units)
      iv. 30 points for each graph or table turned in (up to 120 points total as long as they are not the same)
      v. **45** points for including a labeled device picture or diagram
      vi. 50 points for including at least 2 example calculations
      vii. **30 points for submitting a properly formatted Design Log containing all the required elements described in Section 4**
   d. Bucket Score (BS) – Hitting the bucket at first impact is worth **200** points. Making contact with the inside bottom surface is worth an additional **300** points (for total of **500** points).
   e. If a team violates any THE COMPETITION rules, their TS scores will be multiplied by 0.9.
   f. If any CONSTRUCTION violation(s) are corrected during the allotted competition period, or if the team misses impound, their TS scores will be multiplied by 0.7. **If a team is unable to fix the construction violation(s), they may still be permitted 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).**
   g. Teams disqualified for unsafe operation or that do not have a device will have TS and BS scores of 0.
   h. Participants will be informed before the next launch if they have received a penalty.
   i. Tiebreakers:
      i. 1st: highest sum of the two TSs used for the FS;
      ii. 2nd highest overall TS;
      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

WIFI LAB

1. **DESCRIPTION:** Teams must construct an antenna device prior to the tournament that is designed to transmit/receive a signal at 2.4 GHz and complete a written test on the principles of electromagnetic wave propagation.

   A TEAM OF UP TO: 2 **IMPOUND:** No **EYE PROTECTION:** 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.
   c. Each team must **bring** their device, a **Design Log**, and copies of graphs and/or tables for scoring.
   d. Bonus points are given for devices **brought** in a labeled box.
   e. The event supervisor will provide the testing materials listed in the COMPETITION AREA section.
   f. **Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy. Per the Digital Fabrication section of that policy, teams may use 3D printers, laser cutters, CNC mills, and other similar machines as a tool to construct all or part of their device. Teams are encouraged to design customized tool files/models (e.g., CAD, STL, OBJ) from scratch and should review the complete policy on www.soinc.org for more details and examples.**

3. **CONSTRUCTION PARAMETERS:**
   a. Each team may bring one pre-constructed antenna device.
   b. The device must fit within a 15.0 cm x 15.0 cm x 15.0 cm cube during all parts of the competition and must be supported solely by the backplane and the SMA-Female connector mounted in the backplane.
   c. The device must include an SMA-Male connector that can be connected to the backplane connector.
   d. The device may be constructed of any materials except for commercial antenna parts or magnets.
   e. The device must be entirely passive; no batteries, AC power or other energy sources are permitted.
   f. The device must be designed and operated in such a way to not damage or alter the backplane or SMA-F connector (e.g., due to excessive weight/torque, residue on the **backplane**). Devices are recommended to weigh less than 300 g.

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 power and distance 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 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 five questions from each of the following areas:
   i. The Electromagnetic Spectrum, radio waves, and EM wave propagation
   ii. Relating velocity, wavelength, and frequency for waves
   iii. Common antenna designs, compare/contrast different types of antennas
   iv. State and National Only - Mathematical questions involving common antenna designs
   v. State and National Only - Gain patterns, the **radar equation**, impedance, bandwidth, noise, and information

Part II: Device Testing

a. **Event Supervisors can establish a maximum distance that will be announced on the morning of the competition.**
b. **Event Supervisors will inform teams of the connection threshold value immediately before teams begin their 5-minute testing period.**
c. Teams have a total of 5 minutes to adjust and repair their device, and make 3 connection attempts. Event Supervisors will give teams a warning at 4 minutes. Devices that do not meet the construction specs will not be allowed to be tested until brought into spec.
d. Once the 5-minute testing period begins, teams may select a starting distance (at 50.0 cm intervals) at which to have the Event Supervisor place the receiver unit.
e. Prior to each connection attempt, teams may connect, disconnect, modify or adjust their antenna device on the backplane. Teams may not move the transmitting device, which is defined as the backplane, tripod, and wires and connections to the router. During the process, teams may ask the supervisor to confirm if the antenna has established a connection with the transmitter. The supervisor must provide only a yes or no response. The team may not ask the supervisor again during the attempt after receiving a yes response.
f. Once a team is ready for testing, they must step at least 5 feet away from the device, and notify the Event Supervisor.
g. The Event Supervisor will then measure the average dBm reading over a 10 second period using the receiver unit. Modifications are not allowed during the measurement period.
h. **The Event Supervisor will inform teams of their average signal strength value after the 10-second measurement period but before students select their next distance.**
i. Connection with the receiver is defined by an average (over 10 seconds) measured dBm reading equal to or higher than the threshold dBm reading obtained by the Supervisor's 3.1 cm monopole antenna.
j. If connection was achieved, the team may elect to move the receiver to a farther distance for their next attempt. If connection was not achieved, they may elect to move the receiver to a closer distance for their next attempt but must not be allowed to move to a farther distance for their next attempt.
k. Event Supervisors must record the distance of all attempts and whether the connection was successful.
l. Teams that achieve connection at the longest possible distance (as determined by the competition venue) must have their average dBm reading recorded as a bonus.
m. The Supervisor will review with the team the Part II data recorded on their scoresheet.
n. Teams filing an appeal regarding Part II must leave their device in the competition area.

6. **COMPETITION AREA:**

a. Example setups are provided on the event page at www.soinc.org
b. The Event Supervisor will provide the testing materials listed below, which will be the same for all teams:
   i. A transmitter that supplies a 2 mW, 2.4 GHz, **802.11** encoded signal (e.g., a standard WiFi access point/router with external antennas)
   ii. A ≈30.0 cm x ≈30.0 cm x ≈0.5 cm backplane constructed of a non-conducting, low-dielectric material such as MDF, wood, or particle board (the backplane) attached to a tripod with an SMA-Female connector in the middle
   iii. Adapters and an antenna cable to connect the transmitter to the backplane

iv. A receiver that can display the received power in dBm with at least -80 dBm sensitivity (WiFiInfoView https://www.nirsoft.net/utils/wifi_information_view.html is recommended for PCs and the Wi-Fi Scanner Tool that is native in Mac OS X.)
v. A 3.1 cm **monopole antenna made of conductive material** for setting the connection threshold dBm value

c. Tournament personnel are encouraged to provide a long space for device testing and share room specifications with all participants at least two weeks before the competition.
d. The Event Supervisor will set up the transmitter and receiver on surfaces that are of equal height and at least 50.0 cm above the floor. Once positioned, the setup must stay the same for all teams.
e. Prior to the start of competition, the Event Supervisor will test their provided 3.1 cm monopole antenna at a distance of 3.0 m to determine the connection threshold dBm reading.

7. **SCORING:**
a. Final Score (FS) = ES + AS + CS + MB + **SB**. The maximum possible FS is 100 points. 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. Antenna Score (AS) = (greatest successful distance / greatest successful distance for all teams) x **40** points
d. 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 5 m distance
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. 2 points for **submitting a complete Design Log**
e. Max Bonus (MB) = If multiple teams achieve connection at the maximum distance, the team with the highest dBm reading at the maximum distance will receive a bonus of **five (5)** points.
f. **Submission** Bonus (**SB**) = 3 points if device is **brought** in a box labeled with team name & number
g. AS must be zero if a team has no successful connection attempts, is disqualified for unsafe operation, or fails to bring a device. Such teams will be allowed to compete in Part I.
h. **If any CONSTRUCTION violation(s) are corrected during the competition block, their connection distance will be multiplied by 0.7 when calculating AS.**
i. A team violating any COMPETITION rules during a successful attempt will have their connection distance for that attempt multiplied by 0.9 when calculating AS.
j. Tie breakers:
i. 1st - Best AS;
ii. 2nd - Best dBm at max distance;
iii. 3rd – # of successful connections;
iv. 4th – 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 Events

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 2022-2023 season, we are publishing a selection of Trial Events in the 2023 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 2023 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 2024 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

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

1. **DESCRIPTION:** Teams will design and test a Bridge 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 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 Bridge 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 Bridge must be on the non-negative-y side of the xz-plane prior to load testing. The Bridge 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 Bridge 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 Bridge 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, $y = 10.0$ cm, $z = \pm 2.5$ cm) for Division B and ($x = \pm 2.5$ cm, $y = 15.0$ cm, $z = \pm 2.5$ cm) for Division C.
      iii. 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 Bridge in SkyCiv. Participants may test their Bridge 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 Bridge before submission.
   e. SkyCiv will load all Area Loads evenly and stop loading when failure occurs. Failure is defined as any member of the Bridge 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 Bridge (g).
   b. The Load Score = Load Supported (4.e.) + Bonus.
   c. Bridges that have a Load Supported of 15,000 g will earn a Bonus of 5,000 g.
   d. Bridges 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 Bridge 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

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

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 at 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, Design Log, 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 must contain only one robot program that is the starting program for the Robot.
   b. The Practice Log and Design 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 do not need to be impounded. Tools may include a stand-alone non-programmable, non-graphing calculator as defined in the calculator policy found on www.soinc.org.
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 8 (eight) AA 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 submitted in a non-metallic container free of any items that might cause 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" round wooden dowel must be attached to the front of the Robot. When the Robot is in the ready-to-run configuration, 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. The dowel attachment device may not extend more than 0.5 cm beyond the front of the dowel. 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. 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.
   h. 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 & DESIGN LOGS:**
   a. Teams must submit a Practice Log along with their Robot. The log must include the following:
      i. Recorded data covering 4 or more parameters (3 required and at least 1 additional) for 10 or more test runs prior to the competition.
      ii. The required parameters are Target Distance, Robot Distance from Target, and Run Time.
      iii. The additional, 4th parameter (e.g., path taken, gates, navigation strategy, or other adjustment to enable the Robot to score better) is chosen by the Team.
   b. Teams must also submit a Design Log. The log must include the following:
      i. The materials used to construct the Robot
      ii. A labeled diagram or picture that identifies and describes the parts.

iii. 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.
   (1) Information about the tool hardware, software, materials, and supplies used
   (2) 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
   (3) Descriptions of how the team constructed the final device from the tool created components

c. Each log must have a front cover labeled with the Team Name and the Team Number for the current Tournament or be considered incomplete.
d. All numerical values should be labeled with standard units (e.g., SI or English) appropriate to the dimension being measured or be considered incomplete. SI units should be the default standard.
e. All logs will be returned to the teams after inspection.

5. **THE TRACK:**
   a. The track area will be a 2.0 meter by 2.0 meter square area on a smooth, level, and hard surface. See website for track diagram PDFs.
   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 imagery lines within the track area. There are three (3) imagery lines in both vertical and horizontal directions for a total of six (6) lines. All imagery lines are perpendicular to the outside tape lines. The imagery lines will form sixteen (16) square zones (50 cm x 50 cm) within the track area.
   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 imagery 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 imagery 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 imagery lines. The 2x4 can be placed on any imagery line within the track area. The 2x4 can only be placed on one imagery line and cannot contact another imagery line. 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 a 50 cm by 50 cm square. The tape will be placed on the inside edge of the imagery 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 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 40 and 70 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.
      i. If a laptop is the programming unit, then the competitors 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. 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 must stop at 8 minutes.
e. Competitors may not use AC outlet power during their time slot
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. 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. 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 dowel rod and dowel's attachment device must be the first part of the robot to travel into 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 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).
p. 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.
q. A team filing an appeal must leave their Robot and programming unit/USB in the competition area.

7. **<u>SCORING</u>:**
   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 = (Target Time - Run Time) x 2
   ii. Run Time greater or equal to Target Time: Time Score = (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. Competition Violation: 150 points added to each Run Score that has 1 or more Competition Violations.
   iv. Construction Violation: 300 points added to each Run Score that has 1 or more Construction Violations.
g. Final Score Penalties:
   i. Incomplete Practice Log: 25 points added to the team's Final Score.
   ii. Incomplete Design Log: 25 points added to the team's Final Score.
   iii. Missing or not Impounded Practice Log: 150 points added to the team's Final Score.
   iv. Missing or not Impounded Design Log: 150 points added to the team's Final Score.
   v. Robot's movements tested during Setup Time: 200 points added to the team's Final Score.
   vi. Robot Not Impounded: 5000 points added to the team's Final Score.
h. Ties must be broken by this sequence: 1. Lower Time Score on scored run; 2. Lower Robot Distance on scored run. 3. Higher number of Gate Zones entered on scored run. 4. Lower Track Time used. 5. Next better non-scored run score.

SCORING EXAMPLE: At a competition, the track has 3 Gates (A, B & C). Target Time is 43s. A team's Robot stopped 21.7 cm from the Target Point with a Run Time of 58.53 sec. Gate Zones "C" and "A" were entered. The team had a recorded Track Time of 7 minutes and 35 seconds. Valid Practice and Design logs were impounded.

Time Score	= (58.53 – 43)	=	15.53
Distance Score	= 21.7cm x 1.0 pts/cm	=	21.7
Gate Bonus	= 2 Gates x -15 pts/Gate	=	-30.00
Log Penalty	= 0	=	0.00
Run Score		**=**	**7.23**

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

SOLAR POWER

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

WRITE IT CAD 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 in a computer-aided design (CAD) software from this description.

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

2. **EVENT PARAMETERS:**
   a. Only the text-editing software used to write the description and the CAD software are allowed. Tournament officials will determine if the software will be provided by the team or the Event Supervisor. No materials or resources are allowed.
   b. Tournament officials must announce the specific CAD software used at the tournament at least 1 month in advance. At the National Tournament, Write It CAD It will be run as a Trial Event using the free version of **OnShape (onshape.com)**. Any team interested in competing in this Trial Event will need to have their own OnShape account prior to the tournament.
   c. **Participants may use alphabetic languages other than English with prior approval of the Event Supervisor/Tournament Director. Teams wishing to use a language other than English should contact the Tournament Director and request this accommodation at least two weeks prior to the Tournament.**
3. **THE COMPETITION:**
   a. One participant (the writer) from each team is shown images (e.g. screenshots) of an object from different angles. Event Supervisors must provide image/screenshots from sufficient angles for the team to reconstruct the object. The object and images are the same for all teams, and the object is built in a CAD software.
   b. The writer has twenty-five (25) minutes to type 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, underlining, italicizing, bolding, or scientific symbols that fit within the context of the written description are allowed.
   d. The writer will send their description as a TXT, DOC/DOCX or PDF file to the Event Supervisor.
   e. The Event Supervisor will send the description by the writer and a CAD file with the various pieces to the second team member who will take the description and attempt to recreate (build) the original object in twenty (20) minutes. The CAD file will have all the pieces required to recreate the original object and no additional pieces. These pieces will have been moved and rotated. All teams will receive the same CAD file.
   f. The Event Supervisor will provide instructions for how the builder should submit their completed CAD file.
   g. Each participant in this event is expected to work independently of his or her partner. There should be no sharing of information or communication between partners with the exception of files that are shared through the Event Supervisor. Any communication between partners will result in the disqualification of the team from this event.
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. Time for the construction phase will be used as a tiebreaker. This time is recorded as the duration between when the Event Supervisor sends the builder the CAD file with description and when the Event Supervisor receives the submitted CAD file from the builder.

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

Other Helpful Information

CHEMISTRY RECOMMENDED LAB EQUIP.

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

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

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

CALCULATOR CLASS DESCRIPTIONS

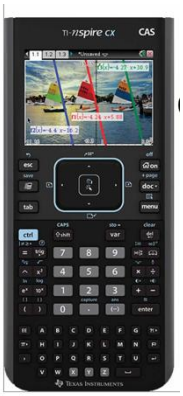
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

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.

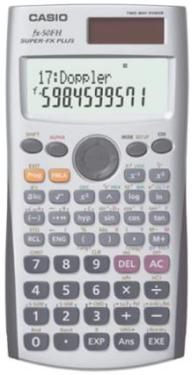
Class I - Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators
are the most basic type of calculators and often look like the one shown to the right. These calculators are limited to the four basic mathematics functions and sometimes square roots. These calculators 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
Anatomy & Physiology		X	X		
Astronomy		X	X	X	X
Bridge	X				
Cell Biology		X	X		
Chemistry Lab		X	X	X	
Codebusters		X			
Detector Building		X	X	X	
Disease Detectives		X	X		
Dynamic Planet		X	X	X	
Environmental Chemistry		X	X		
Experimental Design		X	X	X	
Fermi Questions	**X**				
Flight	**X**				
Forensics		X	X	X	
Forestry	**X**				
Green Generation		X	X		
It's About Time		X	X	X	
Remote Sensing		X	X		
Rocks & Minerals	X				
Scrambler		**X**	**X**	**X**	
Trajectory		X	X	X	
WiFi Lab		X	X	X	
Write It Do It	X				
Trial Events					
Aerial Scramble	X				
Agricultural Science		X	X		
Botany		X	X		
Cybersecurity	X				
Digital Structures		X	X		
Home Horticulture		X	X	X	
Mission Possible	**X**				
Robot Tour		X	X	X	
Solar Power		X	X	X	
Write It CAD It	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

MY SO

A 9-month, calendar-based set of supports to engage and keep you engaged in Science Olympiad at home, at school and afterschool.

Each themed month will contain free resources like Lesson Plans for popular Science Olympiad events you can use at home or at school; Science Olympiad STEM Sessions, webinars and Workshop Wednesdays covering all the latest in STEM; and free STEM Quizzes that will test your knowledge and get you ready for the competitive season! **MY SO** can be used as a standalone or to support your Science Olympiad season.

For more information about MY SO, please visit www.soinc.org/myso

LESSON PLAN [First Wednesday of the month]
STEM SESSION [Third Wednesday of the month]
STEM QUIZ [Last Tuesday of the month]

2022-2023 ACADEMIC YEAR

SEPTEMBER 2022

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	**7**	8	9	10
11	12	13	14	15	16	17
18	19	20	**21**	22	23	24
25	26	**27**	28	29	30	

CRAVE THE WAVE, WIFI LAB, SOUNDS OF MUSIC

OCTOBER 2022

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	**5**	6	7	8
9	10	11	12	13	14	15
16	17	18	**19**	20	21	22
23	24	**25**	26	27	28	29
30	31					

FORESTRY

NOVEMBER 2022

Su	Mo	Tu	We	Th	Fr	Sa
		1	**2**	3	4	5
6	7	8	9	10	11	12
13	14	15	**16**	17	18	19
20	21	22	23	24	25	26
27	28	**29**	30			

FORENSICS & CRIME BUSTERS

DECEMBER 2022

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	**7**	8	9	10
11	12	13	14	15	16	17
18	19	20	**21**	22	23	24
25	26	**27**	28	29	30	31

CYBERSECURITY

JANUARY 2023

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	**4**	5	6	7
8	9	10	11	12	13	14
15	16	17	**18**	19	20	21
22	23	24	25	26	27	28
29	30	**31**				

ANATOMY & PHYSIOLOGY

FEBRUARY 2023

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	**28**				

ASTRONOMY & SOLAR SYSTEM

MARCH 2023

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	**15**	16	17	18
19	20	21	22	23	24	25
26	27	**28**	29	30	31	

DISEASE DETECTIVES

APRIL 2023

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	**5**	6	7	8
9	10	11	12	13	14	15
16	17	18	**19**	20	21	22
23	24	**25**	26	27	28	29
30						

AGRICULTURAL SCIENCE

MAY 2023

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	**3**	4	5	6
7	8	9	10	11	12	13
14	15	16	**17**	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

WHEELED VEHICLE & SCRAMBLER

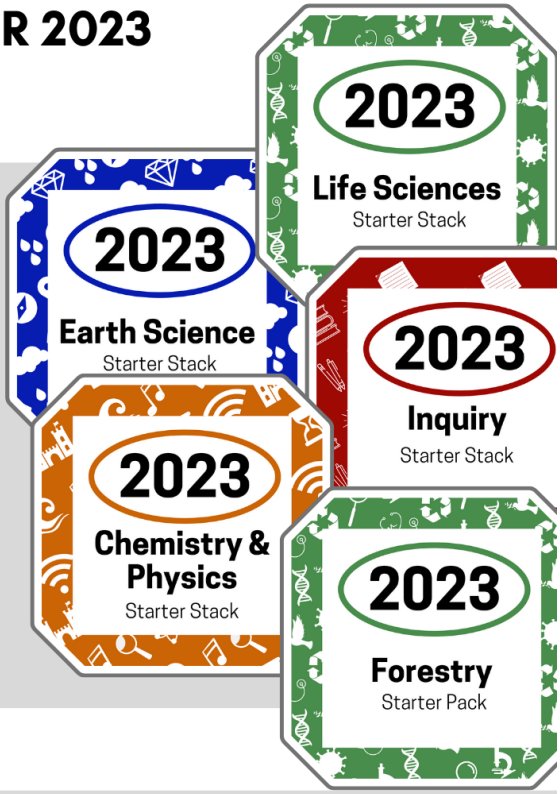
SCIENCE OLYMPIAD
Exploring the World of Science

STORE OFFERINGS FOR 2023

STORE.SOINC.ORG

STARTER STACKS & PACKS

Use these resources as a starting point for your season as you tackle the 2023 Events! Each Starter Pack contains notes & practice tests for the Event, and the Starter Stack bundles notes & practice tests for every event in the topic area.

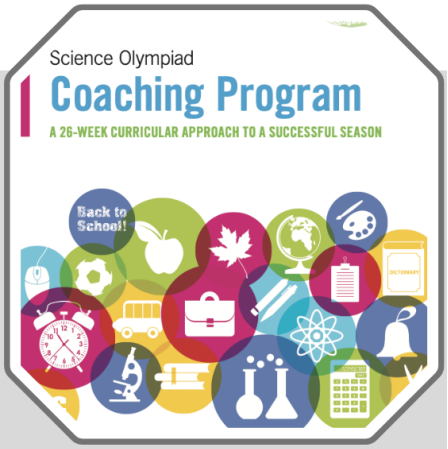


NATIONAL TEST PACKETS

Try out the test from the National Tournament! Packets with tests, answer keys, and results from the past 5 National Tournaments are available.

COACHING PROGRAM

Coaches - this one is for you! The Coaching Program is a step-by-step guide to coaching Division B & C teams that includes a comprehensive coach's manual, 26 weeks of lesson plans (total of 52 hours of lessons), and a resource appendix with handouts and worksheets. Use this to help lay out your season and orient yourself to all things Science Olympiad!



DOUBLEGOOD POPCORN

SCIENCE OLYMPIAD'S FUNDRAISING PARTNER

Fundraise for your team by selling popcorn and earn **50%** of the profit. All product ships directly to customers! Set up your fundraiser + learn more at soinc.org/doublegood

ward's science

Official Science Olympiad kits!

Kits will be available for the following 2023 Events

- Bridge
- Can't Judge a Powder
- Chemistry (Div. B)
- Chemistry (Div. C)
- Chem Lab
- Crime Busters
- Detector Building
- Flight
- Forensics
- Rocks & Minerals
- Scrambler
- Wheeled Vehicle

NATIONAL TOURNAMENT SCHEDULE

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

2023 National Tournament Schedule
Wichita State University; Wichita, Kansas
Saturday, May 20 2023

Event	7:00 – 8:00 AM	8:15 - 9:15 AM	9:30 – 10:30 AM	10:45 – 11:45 AM	12:00 – 1:00 PM	1:15 – 2:15 PM	2:30 – 3:30 PM	7:30– 9:30 PM
Anatomy & Physiology		51-60	1-10	11-20	21-30	31-40	41-50	Closing Ceremony
Astronomy		41-50	51-60	1-10	11-20	21-30	31-40	
Bridge		Self-Schedule						
Cell Biology		1-10	11-20	21-30	31-40	41-50	51-60	
Chem Lab		31-40	41-50	51-60	1-10	11-20	21-30	
Codebusters		41-50	51-60	1-10	11-20	21-30	31-40	
Detector Building		21-30	31-40	41-50	51-60	1-10	11-20	
Disease Detectives		31-40	41-50	51-60	1-10	11-20	21-30	
Dynamic Planet		21-30	31-40	41-50	51-60	1-10	11-20	
Environmental Chemistry		1-10	11-20	21-30	31-40	41-50	51-60	
Experimental Design		1-10	11-20	21-30	31-40	41-50	51-60	
Fermi Questions		51-60	1-10	11-20	21-30	31-40	41-50	
Flight		Self-Schedule						
Forensics		51-60	1-10	11-20	21-30	31-40	41-50	
Forestry		41-50	51-60	1-10	11-20	21-30	31-40	
Green Generation		21-30	31-40	41-50	51-60	1-10	11-20	
It's About Time	Impound	11-20	21-30	31-40	41-50	51-60	1-10	
Remote Sensing		11-20	21-30	31-40	41-50	51-60	1-10	
Rocks & Minerals		51-60	1-10	11-20	21-30	31-40	41-50	
Scrambler	Impound	Self-Schedule						
Trajectory		Self-Schedule						
WiFi Lab		31-40	41-50	51-60	1-10	11-20	21-30	
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: Wichita State University (2023 National Tournament Host), Caltech (2022 National Tournament Partner), 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, Intel, Kinder Morgan Foundation, North American Association for Environmental Education (NAAEE), National Oceanic and Atmospheric Administration (NOAA), National Eye Institute, Texas Instruments, ThermoFisher Scientific, University of Delaware, Hikma Pharmaceuticals, 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 Institutes, Official Kits from Ward's Science and print plus digital items in the Science Olympiad Store

Science Olympiad

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