SCIENCE OLYMPIAD™

Exploring the World of Science

Division C Rules Manual

Division C (Gr. 9-12)

WELCOME TO THE 2025 SCIENCE OLYMPIAD!

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

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

Division C (Grades 9-12) Membership Rules

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

Division B (Grades 6-9) Membership Rules

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

Students Below Grade Level Designations

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

Science Olympiad Team Membership

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

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

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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, Rules Corrections, Rules Clarifications, New Store Items, news, tips, resources, and other valuable information.

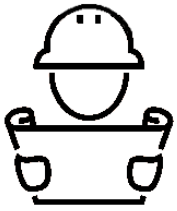
EVENT TYPE DESCRIPTIONS

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 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 as outlined in the 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, rule corrections and rule clarifications 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. **During the tournament, participants are only permitted to practice with any built or designed device at a Tournament event venue prior to competing if the Tournament Director makes the facilities open to all teams to practice.**
6. 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.
7. State and Regional Tournament Directors must notify teams of any site-dependent rule or other rule modification with as much notice as possible, ideally at least 30 days prior to the tournament.

AIR TRAJECTORY C

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

1. **DESCRIPTION:** Prior to the competition, teams will design, construct, and calibrate a single device capable of launching projectiles onto a target.

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

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

2. **EVENT PARAMETERS:**
   a. Each team must impound only one launch device, projectiles, **and calibration data (if prepared).** Items must be moveable by the participants without outside assistance. The device must be impounded with the mass(es) detached, which altogether must not exceed the limits in 3.b. **The calibration data are the only papers or notes that the competitors may bring into the competition area and must be impounded.**
   b. Each team may bring tools, supplies, writing utensils, and two stand-alone calculators (Class III) for use (these items need not be impounded).
   c. Participants must wear eye protection during device setup and operation. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
   d. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy.

3. **CONSTRUCTION PARAMETERS:**
   a. When ready-to-launch, the launch device, projectiles, stabilizing weights, and all other device components (except for tools / supplies) must fit in a 75.0 cm per side cube, in any orientation chosen by the team.
   b. The launching force must be entirely supplied by the gravitational potential energy from a falling mass less than or equal to 3.500 kg. Any part of the device whose potential energy decreases and provides launch energy is considered part of the mass, with the exception of items of nominal mass, such as strings and thin membranes/plastic container walls. The falling mass may consist of multiple discrete parts, which together count as the total mass.
   c. Devices will be inspected to ensure that there are no other energy sources. At the Event Supervisor's discretion, teams must disassemble devices after competing in order to verify this.
   d. During each launch, the gravitational potential energy must be converted to air pressure or air movement, which is then used to launch the projectile, either directly (e.g., pop gun style, etc.) or indirectly (e.g., using a pneumatic cylinder to swing an arm, etc.).
   e. All device air chambers must start each launch at ambient air pressure and must automatically return to ambient air pressure. Chambers are not required to automatically return to the same shape.
   f. **The competitors must design the device to trigger by using any part of an unsharpened #2 pencil with an unused eraser, provided by the Event Supervisor, to actuate a release mechanism for the falling mass. The pencil may be the release mechanism itself and may extend beyond the dimensions in 3.a. The device must remain in the ready-to-launch configuration without being touched until triggered by the #2 pencil. The trigger must not contribute any significant energy to the launch.**
   g. **Teams must provide a spherical projectile for their device to launch. The projectile must freely fall through a hole with a 3 inch diameter, but not fall freely through a hole with a 1 inch diameter. Also, the projectile must be made out of a material that will not damage floors. Examples of acceptable projectiles include, but are not limited to: ping pong balls, racquet balls, tennis balls, and low density foam balls. Golf balls are not allowed because they are too dense and could damage the floor. Multiple projectiles may be brought for use.**
   h. The launch device must be designed and operated in such a way to not damage or alter the floor.
   i. Electrical components are not allowed as part of the device or triggering device. However, electronic sighting devices, such as laser pointers, that are removed before launch are permitted.

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

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

b. When instructed by the event supervisor(s), teams must place their device at a location they select in the launch area. Teams may move devices within the launch area and/or adjust them in any way between and before shots. **Teams may change projectiles for each launch.**
c. No part of the launch device may extend outside of the launch area before or after a shot. If part of the launching device extends beyond the launch area during the launching action, it must return to and remain in the launch area immediately after the launch without assistance of the competitors.
d. Before each launch, teams must notify the event supervisor which target they have selected. **When triggering the device, competitors may not touch any part of the device or the triggering mechanism except the #2 pencil.** Any launch, even if unintended or not announced, will count as one of the four launches allowed to a team.
e. If the team tries to trigger the device and it does not go through a launch motion, it does not count as one of the team's four launches and the team must be allowed to adjust/reset the device if time allows.
f. After each launch the event supervisor will indicate to the team when they may approach the target to retrieve their projectile and make measurements to calibrate their device.
g. If the first shot at a target lands within 500 mm, a bucket shot may be requested in place of the second shot.
h. The supervisor will review with the team the data recorded on their scoresheet.
i. Teams who wish to file an appeal must leave their device with the event supervisor.

6. **COMPETITION AREA:**
   a. The competition area will consist of a near target **that is elevated** and a far target that is at ground level.
   b. The launch area is a rectangular area 1.5 m wide by 1.5 m long (parallel to the launch direction), designated by tape on the floor. Event Supervisors are recommended to use hard surfaces for the floor (e.g., concrete, hardwood, plywood) and not surfaces designed to minimize impact forces (e.g., turf, running tracks).
   c. Two targets, designated by tape on the floor or panels lying on the floor, must be placed in front of the launch area. Supervisors are encouraged to place sand, cat litter, or a similar substance on the ground and target surfaces to help indicate landing spots.
      i. The **near** target surface must be at least a 1.0 m by 1.0 m square and have a marked center point from which measurements will be taken.
      ii. The near target must be centered on an imaginary center line that bisects the launch area and is parallel to the launch direction. **Prior to the start of the competition, the event supervisor will determine the target elevation which will be the same for all teams.**
         (1) **Regional Level: The surface of the near target is either 0.5 m or 1.0 m above the ground.**
         (2) **State Level: The surface of the near target will be between 1.0 m and 1.5 m, inclusive, above the ground**
         (3) **National Level: The surface of the near target will be between 1.0 m and 2.0 m, inclusive, above the ground**
      iii. The far target, designated by tape on the floor, or panels lying on the floor, must be placed in front of the launch area. The target must have a minimum diameter/length/width of 1.00 m and is recommended to be a square shape. It must have a marked center point from which measurements will be taken.
   d. The marked centers of the targets must be between 2.00 m and 8.00 m in front of the launch area in intervals of 1.00 m for Regionals, 0.50 m for States, 10.0 cm for Nationals. A distance of at least 2.00 m (measured parallel to the imaginary center line) must separate the marked centers of the targets.
   e. The marked center of the far target may be anywhere up to 2.00 m in intervals of 0.5 m for Regionals, 0.25 m for States, and 0.10 m for Nationals to the right or left of the imaginary centerline.
   f. If requested, a bucket (≈5 gallon size, provided by the Event Supervisor) will be placed with the opening facing up anywhere between 2.00 m and 8.00 m in front of the launch area and anywhere up to 2.00 m to the right or left of the centerline. The bucket may only be on the course when requested so that it is not an obstacle. The bucket may not be the same location as the far target.
   g. Target locations, bucket location, **and near target elevation** must be announced only after impound is over and must be the same for all teams. Room ceiling height should be considered when setting the distances.

7. **SCORING:**
   a. High score wins. Final Score (FS) = Best NTS + Best FTS + BS (if any). A scoring spreadsheet is available at www.soinc.org.
   b. Near Target Score (NTS) = 2000 minus the straight-line distance, in mm, from the center of the initial projectile impact to the center of the target. Lowest possible NTS is 0.
      i. If no target is announced, or the shot is a bucket shot attempt, NTS = 0 for that shot.
      ii. Eligible impact locations for the near target include the floor, wall, support column, other target, or other objects.
      iii. The ceiling and objects affixed to or hanging from it are not eligible impact locations. Shots with projectiles hitting such areas will use the next eligible impact location contacted by the projectile.
      iv. **Participants must impact the elevated surface of the near target in order for a measurement to be taken. Failure to strike the target surface will result in an NTS = 0 for that shot.**
   c. Far Target Score (FTS) = 4000 minus the straight-line distance, in mm, from the center of the initial projectile impact to the center of the target. Lowest possible FTS is 0.
      i. If no target is announced, or the shot is a bucket shot attempt, FTS = 0 for that shot.
      ii. Eligible impact locations for the far target include the floor, wall, support column, other target, or other objects.
      iii. The ceiling and objects affixed to or hanging from it are not eligible impact locations. Shots with projectiles hitting such areas will use the next eligible impact location contacted by the projectile.
   d. Bucket Score (BS) – Hitting the bucket at first impact is worth 200 points. Making contact with the inside bottom surface is worth an additional 300 points (for a total of 500 points).
   e. If a team violates any of THE COMPETITION rules, their TS scores for that launch will be multiplied by 0.9.
   f. **Devices will be placed in tiers as follows:**
      i. **Tier 1: Device meets all construction parameters at the time of its first launch**
      ii. **Tier 2: Device still has a construction violation(s) at the time of its first launch**
      iii. **Tier 3: A team with its device and/or projectiles not impounded or uses calibration data notes that were not impounded**
   g. Teams that **are prohibited from launching** due to unsafe operation or **have a Final Score (FS) of 0** will **receive Participation Points only**.
   h. Participants will be informed before the next launch if they have received a penalty.
   i. Tiebreakers:
      i. 1st: highest sum of the Best NTS and Best FTS used for the FS;
      ii. 2nd: highest overall NTS or FTS;
      iii. 3rd: highest FTS not used for the FS;
      iv. 4th: highest NTS not used for the FS.

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

ANATOMY & PHYSIOLOGY C

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 **integumentary, skeletal, and muscular systems of the human body.**

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

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

3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Content topics will include:

   a. **INTEGUMENTARY – All levels should understand:**
      i. Functions of the integumentary system **(e.g., physical protection, Vitamin D synthesis, sensation, excretion, temperature regulation, role of the skin in innate immunity)**
      ii. Anatomy and **histological characteristics** of the layers of the skin
      iii. Anatomy and **histological characteristics** of the component parts of the skin: hair **(e.g., types, appearance, growth cycle),** nails, integumentary glands **(e.g., eccrine vs apocrine),** and sensory receptors
      iv. Skin color, skin texture, and the effects of aging on the skin
      v. **Dermatological features (e.g., freckles, moles, scales, calluses, birthmarks, fingerprints)**
      vi. The diseases on each level from the cell to the whole person as listed: **wounds affecting the skin (limited to burns and their classification, sunburn), allergens** (e.g., poison ivy, metals), human papillomavirus (HPV), **infections (limited** to boils, carbuncles, athlete's foot, impetigo, **erysipelas, cellulitis, Hansen's Disease, chickenpox, shingles), common inflammatory disorders** (limited to psoriasis, dermatitis), and skin cancer **(limited to melanoma, basal cell carcinoma, squamous cell carcinoma, Kaposi's sarcoma, Merkel cell carcinoma)**
      vii. Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

   State and National Level Only:
      viii. Cellular components of cutaneous immune system (e.g., dermal dendritic cells, dermal macrophages)
      ix. Additional disorders: immunologic and inflammatory disorders (limited to rosacea, vitiligo, bullous pemphigoid, Stevens-Johnson syndrome, erythema nodosum, erythema multiforme, alopecia)

   National Level Only:
      x. Additional disorders: **Congenital disorders (limited to albinism, xeroderma pigmentosum), systemic disorders and their effect on skin (limited to acanthosis nigricans), benign lesions (limited to actinic keratosis)**
      xi. Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)
      xii. Aspects of wound healing including, but not limited to: inflammation, necrosis, apoptosis, vasodilation, and clotting

   b. **SKELETAL SYSTEM – All levels should know and understand:**
      i. Bones of the axial and appendicular skeleton; label the basic surface anatomy of a bone as shown on a diagram and/or normal X-ray, CT and MRI
      ii. Name, structure and function of joint types and muscle, **tendon** and ligament attachments that surround the joints and the ranges of motion allowed by each type (e.g., ball and socket)
      iii. **Structure and microscopic function of bones, bone marrow and cartilage (e.g., storage, osteon, blood cell production)**
      iv. **Skeletal system role in calcium and phosphate balance**
      v. **Effect of hormones (e.g., PTH, vitamin D, estrogen) on the skeletal system**
      vi. **Cellular composition of bones (e.g., RANKL role in bone cell maturation), bone marrow and cartilage**
      vii. **Development and maturation of bones at the cellular and gross anatomical levels**
      viii. Types of vertebrae (e.g., cervical, thoracic and lumbar)
      ix. Characteristics and radiological features of bone diseases/disorders from the cell level to the whole person as listed: **osteoarthritis and rheumatoid arthritis (know how to distinguish both from one another), gout,** osteoporosis, **osteomalacia/rickets, scoliosis, kyphosis, lordosis, Tennis elbow, Golfer's elbow, cruciate ligament tears of the knee, meniscus tears of the knee, and septic arthritis**

x. The effects of exercise and aging on the skeletal system and the diseases mentioned
xi. **Fractures, including the** Salter-Harris fracture classification system, **causes, and treatments**

State and National Level Only:

xii. Additional diseases/disorders: spinal fractures **(including specific classes),** ankylosing spondylitis, achondroplasia, osteosarcoma, **and Ewing sarcoma**
xiii. Understanding the effect of bisphosphonates and denosumab on the skeletal system

National Level Only:

xiv. Additional diseases/disorders to know: **clinical effects of spinal stenosis, foraminal stenosis, and disc herniation on the nervous system, Osgood-Schlatter disease, plantar fasciitis, Paget disease of bone (osteitis deformans), osteoblastoma, giant cell tumor**
xv. Treatments and/or prevention for <u>all</u> conditions listed above (drugs, surgery, etc.).
xvi. **Label the bones and sutures of the skull. Know the foramina of the skull and what neurovascular structures pass through each**

c. **MUSCULAR SYSTEM - All levels should know:**
   i. **Functions of the muscular system (e.g., movement, blood circulation, heat production)**
   ii. The interaction of the skeletal and muscular systems to allow movement and **maintain posture**
   iii. **The cellular and gross anatomy of skeletal muscle, cardiac muscle and smooth muscle**
   iv. **Tension production (e.g., sarcomere length-tension relationship, muscle twitches, motor units)**
   v. **Physiology of the skeletal muscle contraction and relaxation (e.g., neuromuscular junction, excitation-contraction coupling, cross-bridge cycling)**
   vi. **Concepts of skeletal muscle actions (e.g., agonist, antagonist, synergist muscles) of different muscles on the 2025 National Major Skeletal Muscles List**
   vii. Location and identification (e.g., origin, insertion, function) of the muscles on the 2025 National Major Skeletal Muscles List
   viii. Exercise and aging effects on the cellular and gross anatomical structure of the muscular system
   ix. Muscle and tendon injuries and their prevention **(limited to strains and sprains)**
   x. The diseases on each level from the cell to the whole person as listed: **neuromuscular junction disorders (limited to myasthenia gravis, Lambert-Eaton myasthenic syndrome), immunologic and inflammatory disorders (limited to polymyalgia rheumatica, polymyositis, and dermatomyositis), infectious disorders (limited to** botulism, **tetanus, poliomyelitis), and pain syndromes (limited to fibromyalgia, chronic fatigue syndrome,** Carpal Tunnel Syndrome)

State and National Level Only:

   xi. **Energy metabolism in skeletal muscles (limited to phosphocreatine system, glycogen storage and consumption)**
   xii. **Cardiac and smooth muscle roles in the body (e.g., blood circulation, digestive motility)**
   xiii. **Additional diseases: rhabdomyolysis, Duchenne muscular dystrophy, myotonic dystrophy**

National Level Only:

   xiv. Nerve innervation for all muscles on the 2025 National Major Skeletal Muscles List
   xv. **Muscle reflexes (limited to Golgi tendon organ, muscle spindle fibers)**
   xvi. Additional diseases: **congenital disorders and iatrogenic disorders (limited to drug-induced myositis, malignant hyperthermia)**
   xvii. Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)
   xviii. **Effects of steroid medications on muscle health**

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

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

2025 NATIONAL SKELETAL MUSCLES LIST

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

Head and Neck

- Frontalis
- Orbicularis oris
- Orbicularis oculi
- Occipitofrontalis
- Zygomaticus major
- Masseter
- Sternocleidomastoid
- Trapezius
- Buccinator

Move the Upper Extremities

- Pectoralis major
- Latissimus dorsi
- Deltoid
- Teres major
- Biceps brachii
- Triceps brachii
- Brachialis
- Brachioradialis
- Palmaris longus
- Flexor carpi radialis
- Flexor digitorum superficialis
- Extensor carpi radialis
- Extensor digitorum
- Extensor digiti minimi
- Extensor carpi ulnaris
- Infraspinatus
- Supraspinatus
- Subscapularis
- Teres Minor

Muscles of the Trunk

- External intercostals
- Internal intercostals
- Transverse abdominis
- Rectus abdominis
- Serratus anterior
- Diaphragm

Move the Lower Extremities

- Iliopsoas
- Sartorius
- Gluteus maximus
- Gluteus medius
- Tensor fasciae latae
- Adductor longus
- Gracilis
- Semimembranosus
- Semitendinosus
- Biceps femoris
- Rectus femoris
- Vastus lateralis
- Vastus intermedius
- Vastus medialis
- Tibialis anterior
- Gastrocnemius
- Soleus
- Peroneus longus
- Peroneus brevis

ASTRONOMY C

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

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

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one of the following options containing information in any form from any source: a computer/tablet and a three-ring binder, two computers/tablets of any kind, or two three-ring binders.
   b. If three ring binders are used, they may be of any size and the information contained should be attached using the available rings. The information or pages may be removed during the event. Sheet protectors and laminated sheets are allowed.
   c. Each team may bring two stand-alone calculators (Class IV). 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. **Unauthorized, generative AI tools (e.g., ChatGPT, DALL-E) are not allowed to be used to generate answers under any circumstances during the event.** 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., event supervisors-supplied computer) for teams that did not bring a laptop/tablet.
3. **THE COMPETITION:** Using information which may include Hertzsprung-Russell diagrams, spectra, light curves, motions, cosmological distance equations and relationships, stellar magnitudes and classification, multi-wavelength images (gamma-ray, X-ray, UV, optical, IR, radio), charts, graphs and JS9 imaging analysis software, teams will compete in activities and answer questions related to:
   a. Stellar evolution including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, H I/II regions, molecular clouds, protostars, Herbig-Haro Objects, T Tauri variables, Herbig Ae/Be stars, planet formation, brown dwarfs, protoplanetary disks, debris disks, and exoplanets including but not limited to gas giants, **Neptunes, sub-Neptunes, super-Earths,** and terrestrial planets.
   b. Use orbital mechanics, Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of planetary systems; use parallax, spectroscopic parallax, and the distance modulus to calculate distances to stars and planetary systems; use the radial velocity, transit, and direct imaging methods to determine properties of exoplanets, use the radiation laws to answer questions relating to planetary surface temperatures and habitability.
   c. Identify and answer questions relating to the content areas outlined above for the following objects: **Orion Nebula, 30 Doradus, HD 80606b**, **WASP-17b, WASP-121b, LTT 9779b, GJ 1214b, K2-18b, TOI-270d, LHS 3844b, and systems: PSR B1257+12, WD 1856+534, 55 Cancri, Kepler-62, AU Microscopii, Epsilon Eridani.**
4. **SCORING:** All questions will have been assigned a predetermined number of points. The highest score wins. Selected questions will be used to break ties.

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

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

BUNGEE DROP C

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

1. **DESCRIPTION:** Each team will design, construct and calibrate a single elastic cord to conduct two separate drops at a given height(s) and attempt to get a drop mass placed in a bottle as close as possible to, but without touching, a landing surface.

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

IMPOUND: Yes **APPROXIMATE TIME:** 10 minutes

2. **EVENT PARAMETERS:**
   a. Each team must impound only one elastic cord to be used for both drops that terminates with a closed metal ring approximately 1/2 to 1 inch in diameter (e.g., a key ring) that will not open. Each team must also impound calibration data (if prepared), which are the only papers or notes that the competitors may bring into the competition area. Any tools used by teams to confirm heights, lengths, or mass during the time given for preparing their two drops must also be impounded.
   b. Supervisors will supply a drop mass that will consist of mass that will be placed in a 500-591 mL plastic bottle and an attachment mechanism (hook, clasp, carabiner, etc.) that will connect the team's bottom cord ring to the bottle. This drop mass will be the same for all drops. The drop mass will have a total mass between 50.0 g and 300.0 g and be in increments of 25.0 g at Regionals, 10.0 g at State, and 1.0 g at Nationals. The total drop mass value and length, including the attachment mechanism, will be posted immediately after impound. Supervisors will also provide a top anchoring system/extended platform with a release mechanism (e.g., a clamp) to attach the top end of the elastic cord, which all teams must use.
   c. Supervisors must provide an accurate system for determining how close drop mass gets to the landing surface during a drop, and whether or not it touched.
3. **THE COMPETITION:**
   a. No physical alterations may be made to elastic cords after impound (with the exception of marking drop locations on the cord before each drop).
   b. **The Elasticity Test:** While being suspended vertically, the bottom meter of the cord must stretch to at least 1.25 meters when a single 500 g mass is attached to this section and return to approximately its original length after the mass is removed. Any team that fails this elasticity test will be allowed to compete, but will be ranked behind all teams which pass the test. The cord may consist of more than one material (contest rubber, nylon, latex tubing, thread, sewing elastic, metal springs, etc.) and more than one strand as long as it meets the elasticity test. "Self-limiting-brake" mechanisms such as a separate, parallel, non-elastic strand that "brakes" the fall of the mass with little to no rebound are not permitted.
   c. The Drop: Teams will be given a total of 5 minutes to prepare their **elastic cord** in the holding area, followed immediately by 5 minutes to complete both drops.
   d. The Drop Heights:
      i. At Regionals both drop heights will be the same and will be between 2 and 5 meters inclusive at an interval of 25.0 cm.
      ii. At State both drop heights will be different and will be between 2 and 5 meters inclusive at an interval of 10.0 cm.
      iii. At Nationals both drop heights will be different and will be between 5 and 10 meters inclusive with all heights within the interval allowed.
      iv. The drop height values and drop instructions will be posted immediately after impound.
   e. **The Bonus Drop:** Teams with a drop distance within the following parameters (30.0 cm at Regionals, 20.0 cm at State, 10.0 cm at Nationals) for either of their drops **will be awarded** a bonus drop. The bonus drop will consist of using the same mass and dropping into a window determined by the Event Supervisor with a **height** dependent on the level of competition (30.0 cm at regionals, 20.0 cm at state, 10.0 cm at nationals). If the bottom of the mass in the bonus drop is in the window at its lowest point then the team earns a 0.80 multiplier on their final score. Teams can earn a maximum of one bonus drop and are given no additional time to complete the bonus drop.
4. **SCORING:**
   a. Low score wins. Final Score = (Drop distance 1 + Drop Distance 2) x Bonus Multiplier (if earned)
   b. The drop distance for a drop that does not strike the surface will be the distance between the lowest point of the bottle and the surface.

c. A drop that strikes the landing surface will be awarded a drop distance of one half of the drop height.
d. Teams that failed the elasticity test will rank below all those that passed the elasticity test.
e. Bonus Multiplier: 0.80x multiplier to final score if the team completes a Bonus Drop meeting the criteria in 3.e..
f. The first tiebreaker will be whether a team succeeded in the bonus drop. Second tiebreaker is the team with the lowest individual drop distance for either of their drops. Third tiebreaker is the team with the longest measurement for the elasticity test.

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

C

CHEMISTRY LAB C

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

1. **DESCRIPTION:** Teams will complete one or more tasks and answer a series of questions involving the scientific processes of chemistry focused in the areas of equilibrium and **chemical reactions/stoichiometry**.

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

CALCULATOR: Class III **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 (Class III).
   b. Each participant may bring one unique 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, with information on both sides in any form and from any source.
   c. Teams should bring any or all of the items listed on the Division C Chemistry Events Lab Equipment List, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
   d. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type, they will notify teams. Pants should be loose fitting; if the host has more specific guidelines, they will notify teams in advance of the tournament. Shoulder-length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials, or equipment will be penalized or disqualified.
   e. Supervisors will provide any required reagents, additional glassware, and/or references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).
3. **THE COMPETITION:**
   a. The competition will consist of a series of tasks focused in the areas of equilibrium and **chemical reactions/stoichiometry**. These tasks could include hands-on activities, questions on listed topics, interpretation of data (e.g., graphs, diagrams, tables), or observation of an established and running experiment.
   b. Teams may be asked to collect data using a probeware set-up demonstrated by the Supervisor(s). Following a demonstration of the sensors/probes, participants may be given data sets to interpret.
   c. Nomenclature, formula writing, & stoichiometry (mole conversions & percentage yield) are essential tools of chemistry & may be included in the event. Participants are expected to know the symbols & charges for: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate, & hydroxide. Participants should know how to use the "ite" form of anion (one less oxygen than the "ate" form). With a periodic table, participants should be able to obtain charges for monatomic ions (e.g., Na^{+}, S^{2-}).
   d. Equilibrium: Students must be able to write equilibrium reactions, predict the direction of a reaction using Le Châtelier's Principle, calculate an equilibrium constant, & use equilibrium constant to determine concentrations. Tasks will be chosen from the following:
      i. Use a titration or data of a weak acid/base with a strong acid/base to calculate an equilibrium constant.
      ii. Investigate an equilibrium reaction and determine what happens when it is stressed.
      iii. Stoichiometry of equilibrium reactions.
      iv. Construct/use a standard absorption curve to determine an equilibrium constant.
      v. Use a colorimeter to predict a curve.
      vi. State & Nationals: knowledge/application of equilibrium to separate chemicals may be included.
   e. Participants should understand the following about **Chemical Reactions/Stoichiometry**:
      i. Classification of reaction type.
      ii. Balancing reactions.
      iii. Reaction prediction (including predicting products of metathesis reactions, solubility, oxidation-reduction, total ionic and net ionic equations).
4. **SCORING:**
   a. High score wins. Points will be divided evenly between equilibrium and **chemical reactions/stoichiometry**.
   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; other resources are on the Event Pages at soinc.org.

CODEBUSTERS C

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 **CALCULATOR: Class I** **APPROXIMATE TIME:** 50 minutes

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

h. The first question of the exam will be timed.
   i. The first question will be the decoding of an Aristocrat as defined by 3.e.i.(1) and not 3.e.ii
   ii. A team member should signal when his or her team has broken the cryptogram.
   iii. Before the exam begins, the Event Supervisor will announce the nature of the signal that must be used (e.g., shouting "bingo", or quietly raising hand).
   iv. The time in seconds, to the precision of the device used, to solve the cryptogram will be recorded by the Event Supervisor or designee.
   v. If a team gets the timed question wrong, they may attempt to answer the question repeatedly without penalty. The timing bonus will be calculated from the start of the event until the question is successfully answered by the team with two or fewer errors, or until 10 minutes has elapsed. After 10 minutes, the timed question can still be answered but the timing bonus is zero.

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

j. For Cryptanalysis problems providing a "crib" (3.e.iii, 3.e.v, 3.f.iii, 3.f.v) with the exception of the Complete Columnar Cipher (3.e.viii, 3.f.vi), the placement of the "crib" on the ciphertext will be clearly identified.

4. **SCORING:**

a. The high score wins. Final Score = Exam Score + Timing Bonus + Special Bonus.

b. The scores for each question will be added together to determine the exam score.

c. Unless otherwise specified, the final points will be determined based on the number of errors found in the decoded plaintext as is appropriate to the question.
   i. Two or fewer errors will be scored as correct and result in full credit.
   ii. Each additional error results in a penalty of 100 points but the penalty will not exceed the value of the question. For example, a 400-point question with 5 errors earns 100 points [400 - 3(100)] whereas the same 400-point question with 7 errors would earn 0 points, not -100 points.

d. For answers involving the keyword or key phrase for a K1, K2 or K3 alphabet (3.e.ii) or Cryptarithm (3.e.vi), the final points will be determined based on the number of errors found in the keyword or key phrase
   i. Zero errors are required for full credit.
   ii. Each error results in a penalty of 100 points but the penalty will not exceed the value of the question. For example, a 500-point question with eight (8) errors would earn 0 points, not -300 points.

e. A Timing Bonus can be earned based on the number of seconds it takes a team to correctly decode the first question. The timing bonus is equal to 2 x (600 - number of seconds). For example, 6 minutes = 2 x (600-360) = 480 points.

f. A special Bonus can be earned by solving any of the questions marked as special bonus questions with no penalty points. The bonus will be awarded as follows: One solved = 150 points, Two solved = 400 points, All three solved = 750 points.

g. Scoring example: Team A earns 3600 points on the exam and solved the timed question in 435 seconds and solved one Special Bonus question

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

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

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

DISEASE DETECTIVES C

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

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

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

2. **EVENT PARAMETERS:**

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

3. **THE COMPETITION:**

   a. This event addresses three topics related to disease, injury, health, and disability in populations or groups of people. Each part should count approximately equally towards a team's final score. Questions should be process-oriented and involve skills in evaluation and interpretation. Matching pathogens with specific diseases (i.e. – What causes X disease?) or knowledge of signs, symptoms or epidemiologic characteristics such as incubation or latency periods or infectious dose is not part of this event. However, it is appropriate to provide this information as background information and expect competitors to be able to use it.

   b. The topics for this event are as follows:

      i. Background & Surveillance
         (1) Understand the Clinical Approach (health of individuals) vs Public Health Approach (health of populations)
         (2) Understand the history and development of epidemiology
         (3) Understand the roles of epidemiology in public health and the steps in solving health problems
         (4) Understand the Natural History and Spectrum of Disease. Understand in broad terms the impact of infectious (bacterial, viral, fungal, protist and prion diseases) and noninfectious causes of disease (such as accidents, exposures, and toxicities)
         (5) Understand the basic epidemiological and public health terms found in the glossary of CDC's Principles of Epidemiology in Public Health Practice (e.g., outbreak, epidemic, pandemic, surveillance, risk, vector, etc.)
         (6) Understand the role of Surveillance in identifying health problems, the 5-Step Process for Surveillance, and the types of surveillance and the attributes of a surveillance system

      ii. Outbreak Investigation
         (1) Analyze actual or hypothetical outbreaks given in case scenarios
         (2) Understand Experimental and Observational studies and the Types of Epidemiological Studies – (e.g., case control, cohort, ecological, cross-sectional). Know the advantages and disadvantages of each. Recognize various fundamental study designs and identify which is appropriate to use in analysis of presented outbreak scenarios
         (3) Identify the Steps in an Outbreak Investigation and how they guide hypothesis generation
         (4) Identify the problem using person, place, and time triad to formulate case definitions
         (5) Interpret epi curves, line listings, cluster maps, subdivided tables, PFGE gels, SNP mapping and the PulseNet concept
         (6) Understand the agent, host, environment triad and chain of transmission
         (7) Evaluate data by calculating and comparing simple rates and proportions such as attack rate, relative risk, odds-ratio, and explain their meaning. Determine whether presented data support hypotheses of disease within scenarios, and revise hypotheses as appropriate.
         (8) Apply the Bradford Hill Criteria for Verifying the Cause of presented outbreaks. Compare the accuracy of Bradford Hill criteria, Koch's and Evan's postulates, and newer causality models such as Directed Acyclic graphs, Sufficient/component cause models, and GRADE methods
         (9) Understand the concept of herd immunity. Be able to calculate and interpret herd immunity threshold, basic and effective reproductive numbers

(10) Recognize factors such as study design/biases, errors, and confounding that influence results. Be able to propose appropriate control or comparison groups and data collection methods, and recognize limitations. Be able to interpret and use confidence intervals for measures of association. Competitors need not be able to calculate these confidence intervals since this is most often done through computer programs. Understand and use methods such as stratification and adjusted rates. Know the experimental and observational methods used to calculate vaccine effectiveness and efficacy and be able to use them.
(11) Nationals Only: Suggest types of control & prevention measures for outbreaks and other public health problems.

iii. Patterns, Control, and Prevention
(1) Identify patterns and trends of epidemiologic data in charts, tables and graphs.
(2) Using given data, calculate disease risk and frequency ratio, proportion, incidence proportion (attack rate), incidence rate, prevalence death rate and mortality rate
(3) Understand the Strategies of Disease Control as they apply to given disease scenarios
(4) Understand Strategies for Prevention, including the Scope and Levels of Prevention,
(5) Propose a reasonable set of prevention strategies for public health problems within the scenarios provided, once the cause has been determined by your analyses
(6) Nationals Only: Identify the strengths and weaknesses of a set of proposed prevention strategies and analyze pre- and post-intervention data, to determine effectiveness of presented strategies.

4. **SCORING:**
a. High score wins. Selected questions may be used as tiebreakers.
b. Points will be assigned to the various questions and problems. Both the nature of the questions and scoring will emphasize an understanding that is broad and basic rather than detailed and advanced.
c. Depending on the problem, scoring may be based on a combination of answers, including graphs/charts, explanations, analysis, calculations, and closed-ended responses to specific questions. Critical reasoning skills and data interpretation with hypothesis generation will be evaluated.
d. Points will be awarded for both quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods.

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

In partnership with the Centers for Disease Control (CDC)

DYNAMIC PLANET C - GLACIERS

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

1. **DESCRIPTION:** Participants will demonstrate an understanding of the processes involving the cryosphere of the Earth, with an emphasis on glaciers.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring a binder of any size containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays, no material may be removed from the binder throughout the event.
   b. Each team may bring two stand-alone non-programmable, non-graphing calculators (Class II).
3. **THE COMPETITION:** Participants will be given one or more tasks presented as an exam and/or timed stations. Topics will include the following:
   a. Glacier formation
      i. Properties of ice (e.g., crystal structure, density)
      ii. Formation of glacial ice from snow, névé, firn
      iii. Glacial budget/mass balance: ablation and accumulation, equilibrium line
      iv. Glacial flow: influence of bed (e.g., basal sliding), and relation of flow to elevation and slope
   b. Types of glaciers & their geographic distributions:
      i. Valley/alpine (cirque, hanging, piedmont)
      ii. Ice sheet/continental, including ice stream, ice shelf, ice rise, ice cap, ice tongue
   c. Features in glacial ice:
      i. Crevasses, ogives, icefalls
      ii. Ice shelves and related processes (e.g., calving, marine ice sheet instability, ice shelf buttressing)
   d. Formation of landscape features by glaciers:
      i. Erosional – cirque, tor, U-shaped valley, hanging valleys, arêtes, horns, striations, Rôche moutonnée
      ii. Depositional – moraines (end/terminal, recessional, lateral, medial, ground), kames, drumlins, eskers, erratics
      iii. Lakes – tarns, the Great Lakes, Finger Lakes, kettles, moraine–dammed lakes, proglacial lakes
   e. Periglacial processes and landforms (e.g., permafrost, pingos)
   f. Sea ice (ice floe, draft vs freeboard, pressure ridge, formation (e.g., frazil ice, pancake ice))
   g. Glacial hydrology: surface melt, surface lakes, moulins, drainage and subglacial lakes
   h. Global connections of glaciation:
      i. Atmosphere – effect of greenhouse gases & aerosols on glaciation (e.g., amplified melting due to changes in albedo, release of gases from glacial melting)
      ii. Oceans – sea level change and ice sheet variation (thickness and extent)
      iii. Lithosphere – isostatic effects on Earth's crust
      iv. Planetary/orbital influence on glaciation (e.g., Milankovitch cycles)
   i. History of ice on Earth and its evidence (e.g., drop stones, striations, sedimentary deposits), limited to:
      i. Neoproterozoic snowball Earth
         (1) Late Paleozoic ice ages
         (2) Eocene Oligocene Transition and the impact of opening oceanic seaways such as the Drake Passage
      ii. Pleistocene Northern Hemisphere glaciation (e.g., Laurentide Ice Sheet retreat & melting history)
      iii. Recent records of cryospheric change (e.g., Larsen B, Thwaites Glacier, Amundsen Sea Embayment)
   j. Sedimentary sequences produced in glacial environments (e.g., varves, outwash vs till)
   k. Methods of studying glaciers & interpretation of related data:
      i. Altimetry, radar, optical imagery, seismology, and gravimetry
      ii. Ice cores as archives of past environments, including the use of gases, aerosols, and stable isotope compositions
   l. Glacial hazards, including but not limited to ice avalanches and glacial lake outburst floods

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

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

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

C

ECOLOGY C

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

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

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

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

3. **THE COMPETITION:**

   This event will be composed of three parts of approximately equal point value. The event will emphasize these process skills as they apply to ecology: defining variables; analyzing data from graphs and tables; presenting data in graphs and tables; forming hypotheses; making calculations and predictions. If stations are used, students must spend the same amount of time at each station.

   a. Part 1: Review of the General Principles of Ecology
      i. General Principles of Ecology - food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics (including density dependent/independent limiting factors, carrying capacity, doubling time, exponential/logistic growth and how to calculate population growth), extinction, selection and migration. At the regional and state level, the general ecological principles should focus on local and regional ecology.
      ii. **State and Nationals only:** life history strategies (e.g., age structure, survival curves, life tables, succession, R and K strategies)
   b. Part 2: Terrestrial Ecosystems
      i. Ecology of Deserts and Grasslands
      ii. Understand basic concepts of biodiversity (e.g., importance, different types)
      iii. **State and Nationals only:** Be able to apply knowledge of biodiversity (plot maps, simulations of selection effects on populations)
      iv. **Nationals only:** Understand terminology and be able to calculate biodiversity of sample data (species richness, Simpson index, Shannon-Wiener index)
   c. Part 3: Human Impact on Ecosystems
      i. Topics such as climate change, invasive species, acid deposition (including acid rain), erosion, and chemical contamination (pollution)
      ii. The pros and cons of using alternative energy and its effect on the environment
      iii. Understand the goals of conservation biology and how they can be **reached**
      iv. Reclamation of disturbed areas versus reintroduction of species
      v. **Adding Indigenous knowledge or traditional ecological knowledge (TEK) to our "toolkit"**
      vi. **State and Nationals only:** Be able to answer questions as they pertain to case studies

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

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

This event is supported by Corteva Agriscience

ELECTRIC VEHICLE C

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

1. **DESCRIPTION:** Teams design, build, and test one vehicle that uses electrical energy as its sole means of propulsion to travel as quickly as possible and stop close to a Target Point.

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

   IMPOUND: Yes **APPROXIMATE TIME:** 12 minutes

2. **EVENT PARAMETERS:**
   a. Each team must bring and impound one Vehicle (with batteries disconnected), alignment devices (if used), additional/spare parts, and paper or practice log (if used).
   b. Teams may bring tools which do not need to be impounded. Tools can be electronic. Spare parts and alignment devices are not tools and must be impounded. Laptops, tablets or other computers used for programming cannot be impounded.
   c. 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. Electrical energy used by the Vehicle 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. The batteries must be individual batteries and not a pre-assembled battery pack. Electronic sighting, alignment, or aiming devices may have their own separate power source.
   b. 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.
   c. The batteries and Vehicle must remain separate from the moment they are impounded until after the start of the team's time slot. At Impound, the batteries to be used must be stored in a method that will prevent a short circuit. Teams violating any of these conditions will have the opportunity to remedy the situation to the satisfaction of the Event Supervisor (ES) should time allow. The ES will instruct the teams when to install the batteries and prepare their Vehicle for its run.
   d. All energy for propulsion must be electric and come from the batteries. Any non-propulsive functions (e.g., braking system, steering) may be powered by either electric or non-electric storage devices. All sources of energy must be in easily accessible locations for inspection by the ES.
   e. Components (e.g., motors, gearboxes, motor controls, bodies, and chassis) may be purchased or made by the team members. Electronic components (i.e., solid-state devices such as transistors, integrated circuits, diodes, and microprocessors) are allowed.
      i. If a microprocessor is used, communicating over a WiFi or Bluetooth connection is not allowed during the competition.
   f. The distance from the front of the front wheel(s) to the back of the back wheel(s) must not be > 70.0 cm.
   g. The Vehicle width must not exceed 35.0 cm at any point.
   h. The Vehicle must have a Measurement Point (MP) for distance measurements at the front of the Vehicle.
      i. The MP may be made of any material (e.g. wooden skewer, toothpick, pencil, dowel). Examples include, but are not limited to: tip of a skewer/toothpick, tip of a pen, tip of a nail/paper clip/wire, corner of a wedge, the edge of a dowel.
      ii. The MP must be less than or equal to 1.0 cm above the Track.
      iii. The MP does not need to be the foremost part of the Vehicle, but its bottom must be easily accessible while the Vehicle is on the Track.
   i. Participants must design the activation trigger to be actuated by using any part of an unsharpened #2 pencil with unused eraser, provided by the ES, and the activation motion is perpendicular (vertical) to the floor.
   j. Sighting, aligning, and guiding devices are allowed, including those that use electricity. Labeled lasers are permitted - see the Laser Policy on www.soinc.org.
   k. The stopping mechanism must work automatically. The Vehicle must not be remotely controlled or tethered.
   l. All parts of the Vehicle must move as a whole; no anchors, tethers, tie downs, launching ramps, or other separate pieces are allowed. The only parts allowed to contact the floor during the run are wheels/treads, and any parts already in contact with the floor in the ready-to-run configuration. Pieces falling off during the run constitutes a Construction Violation.

4. **PRACTICE LOG: A Practice Log is recommended but not required. The Practice Log may contain paper for the competitors to use and must be impounded in order for the competitors to use during the competition.**

5. **THE TRACK:**
   a. The Track will be on a smooth, level, and hard surface. Refer to soinc.org for a diagram of the Track.
   b. The Event Supervisors must mark the track as follows:
      i. Start Point - an approximately 5 cm x 2.5 cm tape with the Start Point marked at the center of the tape.
      ii. Target Point - an approximately 5 cm x 2.5 cm tape with the Target Point marked at the center of the tape.
   c. The exact Target Distance from the Start Point to the Target Point will be between 7.00 m and 10.00 m. At Regionals/Invitationals the interval will be 0.25 m, for States 0.10 m, and for National 0.01 m. The exact distance will be chosen by the Event Supervisor and announced after the impound period is over.
   d. The Track will have a minimum of 1.5 m width and extend at least 1.0 m beyond the Target Point. More space may be available, but is not guaranteed.
   e. At the ES's discretion, more than one Track may be used. If so, the team may choose which Track they use, but must use the same Track for both runs.

6. **THE COMPETITION:**
   a. Only participants and the Event Supervisors will be allowed in the impound and track areas. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing and have left the event area.
   b. Unauthorized, generative AI tools (e.g., ChatGPT, DALL-E) are not allowed to be used to generate answers/code under any circumstances during the event.
   c. Teams have 8 minutes of Event Time to set up and start up to 2 runs. Vehicles in the ready-to-run configuration before the end of the Event Time will be allowed to complete a run.
   d. Electric and electronic tools are allowed.
   e. Participants may not use any AC outlet power during their Event Time.
   f. In the ready-to-run configuration, the Vehicle's Measurement Point must be over the Start Point.
   g. Teams may adjust their Vehicle (e.g., wiring, distance, aiming) within their Event Time, though the Event Supervisor may re-verify that the Vehicle meets specifications prior to each run. Timing is paused during any measurements made by the Event Supervisor.
   h. Teams may use their own measuring devices to verify the Track dimensions during their Event Time.
   i. Sighting, alignment, or aiming devices are permitted. If placed on the Track, these devices may only be used within the defined Track area. If placed on the Vehicle, they may be removed at the team's discretion. Devices remaining on the Vehicle will be considered part of the Vehicle. All other devices must be moved behind the Start Point prior to starting a run. The Laser Policy on www.soinc.org must be followed.
   j. 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.
   k. Substances applied to the Vehicle must be approved by the ES prior to use and must not damage or leave residue on the floor, Track and/or event area. Teams may clean the Track during their Event Time, but it must remain dry.
   l. Teams must start the Vehicle using any part of an unsharpened #2 pencil with an unused eraser, supplied by the Event Supervisor, in a motion approximately perpendicular to the floor, to actuate a trigger. Competitors can only use the #2 pencil to make contact with the Vehicle while actuating the trigger. The Vehicle must be able to remain at the starting position without being touched until triggered.
   m. If the Vehicle fails to actuate or move at the start of the run, then a run has not occurred. The Vehicle must move to be a measurable run. The team may continue to work on their device in order to attempt 2 runs within the Event Time.
   n. Once a run is started, teams must not follow their Vehicle and must wait until called by the Event Supervisor to retrieve their Vehicle. Timing resumes once the participants pick up their device or begin making their own measurements.

o. A run will be scored as a Failed Run if one of the following occurs. Construction and/or Competition Violations must still be recorded for Failed Runs.
   i. The Vehicle travels the wrong direction from the Start Point.
   ii. The Vehicle starts before the Event Supervisor is ready.
   iii. The Vehicle's distance or time cannot be measured (e.g., the participants pick it up before it is measured).
   iv. The team pushes the Vehicle down the track.
   v. A team having only one successful run during the 8-minute Event Time will be assessed a Failed Run for the 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 their data recorded.
q. Teams filing an appeal must leave their Vehicle and other impounded material in the event area.

7. **SCORING:**
   a. Each team's Final Score is the better of the 2 Run Scores + Final Score Penalties. Low score wins.
   b. Run Score = Distance Score + Time Score + Run Penalties
   c. Distance Score = 2.0 pts/cm x Vehicle Distance. The Distance Score for a Failed Run is 2500 points.
      i. The Vehicle Distance is a point-to-point measurement from the Vehicle Measurement Point to the Target Point, measured to the nearest 0.1 cm.
   d. Time Score = Run Time
      i. The Run Time begins when the team actuates the Vehicle and ends when the Vehicle comes to a complete stop.
      ii. The Run Time is recorded in seconds to the precision of the timing device used.
      iii. The Run Time will be recorded as 0.00 seconds for Failed Runs.
      iv. Three timekeepers should be utilized with the middle time used as the official Run Time.
   e. 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 also be assessed Competition and/or Construction violations.
   f. Final Score Penalties: Vehicle not Impounded: 5000 points added to the team's Final Score.
   g. Two or more teams tied with 2 Failed Run scores, without Competition or Construction Violations, will remain scored as ties. Other ties are possible.
   h. Tiebreakers in order: 1. Better Vehicle Distance of the scored run; 2. Lower Time Score of the scored run; 3. Better Vehicle Distance of the non-scored run; 4. Better Time Score of the non-scored run.

8. **SCORING EXAMPLES:**
   a. A Vehicle has 2 runs in the allotted time.
      i. In the 1st run, the Vehicle stopped 67.6 cm from the Target Point with a Run Time of 7.27 s
      ii. In the 2nd run, the Vehicle stopped 27.6 cm from the Target Point with a Run Time of 8.67 s

Distance Score	= 67.6 cm x 2.0 pts/cm	=	135.20
Time Score	= 7.27	=	7.27
1st Run Score		**=**	**142.47**
Distance Score	= 27.6 cm x 2.0 pts/cm	=	55.20
Time Score	= 8.67	=	8.67
2nd Run Score		**=**	**63.87**

Final Score = 2nd Run Score (Better Score) = 63.87 pts

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

ENTOMOLOGY C

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

1. **DESCRIPTION:** Students will be asked to identify insects and selected immature insects by order and family, answer questions about insects, and use or construct a dichotomous key.

   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, 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 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 2025 National Entomology List or a state or regional insect list if issued.**
   d. **Each team may bring a hand lens or magnifying glass.**
   e. **The Supervisor will provide an answer sheet and if needed, dissecting microscopes.**
3. **THE COMPETITION:**
   a. Teams will be asked to identify an insect's Order, Family or common name and answer a related question(s). Questions are **limited** to topics below and insects are **limited** to those listed on the 2025 National Entomology List
   b. Insect specimens or images (nymph or larva for selected orders and families) will be exhibited so that students will be able to see pertinent features with the unaided eye or a hand lens.
   c. For each specimen, students **will be** asked correlated questions that pertain to the insect's **internal and external anatomy**, ecology, economic characteristics, or management. Ecological characteristics may include habitats, adaptations to the environment, **behavior**, relationships (e.g., symbiosis and competition) with **animals, plants, and public health**, as well as **climate change impacts**.
   d. Economic characteristics may include beneficial or detrimental aspects of insects such as sources of food, medicine, chemicals, or nutrients, and insects as nuisance species.
   e. Management questions may pertain to pest/disease/invasive species concerns, Integrated Pest Management (IPM), conservation, and urban entomology.
   f. One of the **parts of the exam** may involve students using or formulating a simple dichotomous key to identify insects.
4. **SCORING:** The team with the highest score will determine the winner. Selected questions may be used as tiebreakers.

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

2025 NATIONAL ENTOMOLOGY LIST

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

Specimens will be limited to those on the Official list of 29 orders and 100 families. Orders or Families marked by an "*" require that the contestant be able to recognize larvae or nymph forms. The taxonomic scheme is based upon the Insects of North America Princeton Field Guide (2023).

Class Entognatha
- Order Protura - telsontails, proturans
- Order Collembola - springtails, snow fleas
- Order Diplura - diplurans

Class Insecta
- Order Archaeognatha - bristletails
- Order Zygentoma - silverfish, firebrats
- Order Ephemeroptera - mayflies
- Order Odonata - dragon/damselflies *
  - Family Aeshnidae - darners
  - Family Gomphidae - clubtails
  - Family Libellulidae - skimmers
  - Family Lestidae - spread-wing
  - Family Coenagrionidae - narrow-winged
- Order Blattodea - cockroaches/termites
- Order Mantodea - mantids
- Order Notoptera - ice crawlers
- Order Dermaptera - earwigs
- Order Plecoptera - stoneflies
- Order Orthoptera - grasshoppers & crickets
  - Family Tetrigidae - pygmy grasshopper
  - Family Acrididae - short-horned grasshoppers
  - Family Tettigoniidae - katydids
  - Family Gryllacrididae - camel crickets
  - Family Gryllidae - crickets/tree crickets
  - Family Gryllotalpidae - mole crickets
- Order Phasmatodea - walkingsticks
- Order Psocodea - Book/Bark Lice
- Order Hemiptera - true bugs
  - Family Corixidae - water boatmen
  - Family Notonectidae - backswimmers
  - Family Belostomatidae - giant water bugs
  - Family Nepidae - waterscorpions
  - Family Gelastocoridae - toad bugs
  - Family Gerridae - water striders
  - Family Cimicidae - bed bugs
  - Family Miridae - plant bugs
  - Family Reduviidae - assassin bugs
  - Family Phymatidae - ambush bugs
  - Family Tingidae - lace bugs
  - Family Lygaeidae - seed bugs
  - Family Coreidae - leaf-footed bugs
  - Family Pentatomidae - Stink bugs
  - Family Cicadidae - cicadas
  - Family Membracidae - treehoppers
  - Family Cercopidae - froghoppers, spittlebugs
  - Family Cicadellidae - leafhoppers
  - Family Fulgoridae - fulgorid planthoppers
  - Family Aphididae - aphids
  - Family Dactylopiidae - scale(twig or leaf)
- Order Thysanoptera - thrips
- Order Megaloptera - dobsonflies
- Order Neuroptera - lacewings, antlions
  - FamilyChrysopidae - green lacewings
  - Family Myrmeleontidae - antlions *

- Order Coleoptera-beetles
  - Family Cicindelidae-tiger beetles[1]
  - Family Carabidae-ground beetles
  - Family Dytiscidae-predaceous diving beetles
  - Family Gyrinidae-whirligig beetles
  - Family Hydrophilidae-water scavenger beetles
  - Family Histeridae-hister beetles
  - Family Staphylinidae-rove beetles
  - Family Silphidae-carrion beetles
  - Family Lucanidae-stag beetles
  - Family Passalidae-bess beetles
  - Family Scarabaeidae-dung beetles
  - Family Buprestidae-metallic wood-boring/ jewel beetles
  - Family Elateridae-click beetles
  - Family Lampyridae-fireflies
  - Family Cantharidae-soldier beetles
  - Family Lycidae-net-winged beetles
  - Family Cleridae-checkered beetles
  - Family Coccinellidae-lady-bird beetles (ladybugs)
  - Family Tenebrionidae–darkling beetles *
  - Family Meloidae-blister beetles
  - Family Cerambycidae-long-horned beetles *
  - Family Chrysomelidae-leaf beetles
  - Family Curculionidae-weevils
- Order Strepsiptera - Twisted-Wing Parasite
- Order Mecoptera-scorpionflies
  - Family Boreidae- snow scorpionflies
  - Family Panorpidae- common scorpionflies
- Order Raphidioptera - Snakeflies
  - Family Raphidiidae - Raphidiid Snakeflies
- Order Siphonaptera-fleas
- Order Diptera-true flies
  - Family Tipulidae-crane flies
  - Family Culicidae-mosquitoes*
  - Family Chironomidae-midges
  - Family Simuliidae- black flies
  - Family Stratiomyidae-soldier flies
  - Family Tabanidae-horse flies
  - Family Asilidae-robber flies
  - Family Bombyliidae-bee flies
  - Family Syrphidae-hover/flower flies
  - Family Tephritidae-fruit flies, huskfly
  - Family Drosophilidae-pomace flies, fruit/ vinegar flies
  - Family Muscidae-house flies
  - Family Hippoboscidae-louse flies
  - Family Calliphoridae- blow flies*
  - Family Tachinidae-tachinid flies
- Order Trichoptera-caddisflies*
- Order Lepidoptera-moths and butterflies
  - Family Sesiidae-clear winged moths
  - Family Tortricidae- Tortrix moths
  - Family Hesperiidae-skippers
  - Family Papilionidae-swallowtails*
  - Family Pieridae-whites, sulfurs
  - Family Lycaenidae- hairstreaks/blues
  - Family Nymphalidae-brush-footed butterflies
  - Family Danaidae-milkweed butterflies
  - Family Pyralidae- snout moths
  - Family Saturniidae-Giant Silkworm moths*
  - Family Sphingidae-sphinx/hawk moths, hornworms*
  - Family Erebidae - tiger/tussock moths
- Order Hymenoptera-bees/ants/wasps.
  - Family Tenthredinidae- common sawflies
  - Family Siricidae-horntails
  - Family Ichneumonidae-ichneumons
  - Family Cynipidae- gall wasps
  - Family Mutillidae- velvet-ants
  - Family Formicidae-ants
  - Family Vespidae-paper wasps, hornets, yellowjackets
  - Family Sphecidae - thread- waisted wasps
  - Family Colletidae- Plaster bees
  - Family Halictidae- Sweat bees
  - Family Megachilidae- leaf cutter bees
  - Family Apidae-bees

- Subclass Acari - Mites and Ticks
  - Order Ixodida - Ticks
    - Family Ixodidae - Hardbacked ticks

1 Depending on the resource, Cicindelidae-tiger beetles may be classified as part of Carabidae-ground beetles. For the purposes of this list, they are considered separate families

EXPERIMENTAL DESIGN C

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

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

   A TEAM OF UP TO: 3 **EYE PROTECTION:** C

   CALCULATOR: Class III **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Participants must bring goggles and writing utensils. Experiments will not require any other safety equipment.
   b. Teams may bring one timepiece, one linear measuring device, and one stand-alone calculator (Class III). Teams CANNOT use any of these as part of the experiment - they must only be used for their intended function.
   c. The Event Supervisor will provide each team with identical sets of materials either at a distribution center or in an individual container.
   d. The Event Supervisor must provide the 2 part reporting packet posted on the event page at soinc.org, for teams to record their experimental information and data.

3. **THE COMPETITION:**
   a. The teams must design, conduct, and report the findings of an experiment conducted on site that addresses the assigned question/topic area provided by the Event Supervisor. The assigned question/topic area should be the same for all teams and allow the participants to conduct experiments involving relationships between independent and dependent variables (i.e., height vs. distance).
   b. During the first 20 minutes of the event, participants will receive the assigned question/topic area, materials, and Part I of the report packet. Participants will focus on designing and conducting their experiment.
   c. After the first 20 minutes, participants will receive Part II of the report packet and will focus on analyzing their experiment and reporting findings. Participants may continue experimenting throughout the entire event.
   d. Each team must use at least two of the provided materials to design and conduct an experiment. Teams failing to use at least two items will have their final score multiplied by 0.95. The materials will be listed on the board or placed on a card for each team. If provided, both the card and the container will be considered part of the materials. The identity of the materials will be unknown until the start of the event.
   e. When a team finishes, all materials must be returned to the Event Supervisor including both parts of the report packet.

4. **SCORING:**
   a. High score wins. Scoring will be done using the Experimental Design Checklist found on the Science Olympiad website (soinc.org).
   b. Points will be awarded depending upon the completeness of the response. Zero points will be given for no responses as well as illegible or inappropriate responses.
   c. Ties will be broken by comparing the point totals in the scoring areas of the checklist in the following order:
      i. Analysis of Claim/Evidence/Reasoning
      ii. Procedure and Set-Up Diagrams
      iii. Variables
      iv. Data Table
      v. Graph
   d. Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
   e. Any team not using at least 2 of the provided materials will have their final score multiplied by 0.95.
   f. Any team not following clean-up procedures will have their final score multiplied by 0.95.
   g. Any team not addressing the assigned question/topic area will have their final score multiplied by up to 0.75 based on the extent to which the report deviates from the assigned topic.
   h. Any team not collecting data by conducting an experiment on-site **or falsifying/making up fake data** 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; other resources are on the Event Pages at soinc.org.

FORENSICS C

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

CALCULATOR: Class III **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each participant may bring one **unique** 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed.
   b. Each team may bring any or all of the items listed on the Division C Chemistry Events Lab Equipment List, posted on soinc.org, to use during this event and two stand-alone calculators (Class III). Teams not bringing these items may 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. 1M HCl
      iii. 1M NaOH
      iv. Benedict's solution
      v. a hot water bath
      vi. a Bunsen burner or equivalent BTU heat source to perform flame tests
      vii. a waste container
      viii. chromatography materials (e.g., beakers, Petri dishes, etc.)
      ix. a wash bottle with distilled water
   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.b. - e. and analysis of the evidence in Part 3.f. Analysis or questions can only be on the evidence topics included in the competition. The collected evidence and other data given may be used in a mock crime scene. The amount of evidence included will be according to the following table:

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

   b. Qualitative Analysis: Participants may be asked to identify the following substances: sodium acetate, sodium chloride, sodium hydrogen carbonate, sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid, and ammonium chloride (there will be no mixtures). All teams will have the same set of solids to identify.

c. Polymers: Participants may be asked to identify:
   i. Plastics: PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA, PC – Participants will not perform any burn tests on these plastics, but the Supervisor may provide burn test results on them.
   ii. Fibers: cotton, wool, silk, linen, nylon, spandex, polyester - burn tests will be permitted on the fibers.
   iii. Hair: human, bat, cow, squirrel, and horse - participants will need to know hair structure including medulla, cortex, cuticle, root and hair scale classification.

d. Chromatography/Spectroscopy: Participants will be expected to separate components using paper chromatography, TLC, and/or analyze mass spectra. Participants may be expected to measure R_f's.

e. Crime Scene Physical Evidence:
   i. Fingerprint Analysis: Participants will be expected to know the 8 specific fingerprint patterns (plain arch, tented arch, radial loop, ulnar loop, plain whorl, central pocket whorl, accidental whorl, and double loop whorl). Participants should also be familiar with the common fingerprint development techniques of dusting, iodine fuming, ninhydrin, and cyanoacrylate fuming. Participants should understand terminology such as bifurcation, ridges, island, enclosure, loop, whorl, and arch. Participants should be able to answer questions about skin layers and how fingerprints are formed. Participants may be asked questions on the different methods of detecting fingerprints and the chemistry behind each of these methods.
   ii. DNA: Participants may be asked to compare DNA chromatograms/electropherograms from materials found at the scene to those of the suspects. Participants will be expected to know how DNA is copied.
   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.

f. Analysis of the Crime: Participants will be asked to write an analysis of the crime scene explaining not only which pieces of evidence implicate which suspect(s) and why the suspect(s) was (were) chosen as the culprit(s), but also why the other suspects were not chosen. They will also answer any other crime scene analysis questions posed by the Event Supervisor.

g. Teams will dispose of waste as directed by the Event Supervisor.

4. **SCORING:**

a. High score wins. Time will not be used for scoring.

b. The score will be composed of the following elements (percentages given are approximate): Part 3.b. ≈ 20%, Part 3.c. ≈ 20%, Part 3.d. ≈ 15%, Part 3.e. ≈ 15%, and 3.f. ≈ 30%.

c. Ties will be broken by the highest score on the analysis of the crime scene, which includes the reasons why certain suspects have been eliminated or others remain in the pool of possible criminals.

d. A 10% penalty may be given if the area is not cleaned up as designated by the Event Supervisor.

e. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.

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

FOSSILS C

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

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

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one (1) magnifying glass and one (1) three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted.
   b. Each team may also have one commercially produced field guide which may be tabbed and annotated.
   c. In addition to the resource binder and field guide, each team may bring one (1) copy of the **2025** National Fossils List, which does not have to be secured in the binder and two stand-alone non-programmable, non-graphing calculators (Class II). **The Fossil List may be annotated.**
   d. Teams are not permitted to bring samples or specimens to the event.
   e. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder, except for the **2025 National Fossils List.**

3. **THE COMPETITION:**
   a. Where possible, participants will move from station to station, with the length of time at each station predetermined and announced by the Event Supervisor.
   b. Participants may not return to stations but may continue to work on their responses throughout.
   c. Stations will feature task-oriented activities emphasizing application of paleontological concepts.
   d. Identification will be limited to specimens on the **2025** Science Olympiad Fossil List, but other samples may be used to illustrate key concepts.
   e. Questions will be chosen from the following topics:
      i. Identification of fossil specimens on the **2025** National Fossils List
      ii. Taxonomic classification restricted to the hierarchy on the 2025 National Fossils List
      iii. Conditions that favor preservation of fossils (e.g., rapid burial, hard parts, low oxygen environment, escaping destruction)
      iv. Common modes of preservation **and how they occur, including:** petrification/petrifaction (e.g., permineralization & mineral replacement including silicification, pyritization, and phosphatization), cast, external vs. internal molds (steinkerns), imprints, carbonization, unaltered remains (e.g., shells, teeth)
      v. Uncommon modes of preservation: limited to encasement in amber, mummification, freezing, tar
      vi. Bias in the Fossil Record: animals with mineralized hard parts (skeletons or shells) more likely preserved than soft bodied animals; aquatic organisms more likely to be preserved than terrestrial (land) organisms
      vii. Determining the age of fossils and the rocks they are in through relative or absolute dating techniques.
         (1) Relative dating techniques: limited to law of superposition, original horizontality, cross-cutting relationships, unconformities, faunal succession, correlation of rock layers and/or fossils
         (2) Absolute dating techniques: radiometric dating, including half-life, **and** radioactive isotopes used; **limited to** Carbon 14, Potassium/Argon, Uranium/Lead **(U-238/Pb-206); emphasis on understanding how ages are determined using half life graphs and simple calculations, but not complex equations**
         (3) Limitations of relative and absolute dating in determining the age of fossils
         (4) Use of radiometric dating of igneous rocks and volcanic ash along with relative dating techniques to determine the age of fossils.
      viii. The Geologic Time Scale, its organization, major events, the 5 major mass extinctions, and the Pleistocene-Holocene extinction of megafauna. An official ***Science Olympiad Geologic Time Scale*** is posted at soinc.org & should be used for all competitions
      ix. Index Fossils: characteristics and use in determining the age of rocks & geologic formations

x. **Identification of** fossil-bearing sedimentary rocks and their significance in interpreting ancient environments and habitats; **limited to amber, chalk, chert, coquina, fossil limestone, sandstone, and shale**
xi. Modes of life and mobility: benthonic/benthic (infaunal vs epifaunal; sessile vs vagrant); planktonic/planktic; nektonic/nektic (swimmers); terrestrial
xii. Ecologic role and trophic level (role in food web): producers, filter/suspension feeder, predator, scavenger, deposit feeder (detritovore), herbivore
xiii. Differences in plant reproduction through seeds or spores.
xiv. Environments: marine (e.g., shallow marine/shelf, reef, lagoon, deep marine); terrestrial (e.g., tropical, temperate forest, grassland, wetlands, desert, taiga, tundra), fresh water (e.g., lakes, rivers, swamps)
xv. Mineral and organic components of exoskeletons, shells, and bones/teeth (e.g., calcite, aragonite, silica, chitin, biological apatite/calcium phosphate)
xvi. Adaptations and morphologic features and their implications (e.g., serrated sharp teeth in vertebrates indicate predatory behavior)
xvii. Significance of important paleontological discoveries (**e.g.,** non-avian dinosaurs with feathers; transitional species such as *Tiktaalik* and *Archaeopteryx*)
xviii. Paleontological significance of *Lagerstätten* (conservation and concentration) limited to: Burgess Shale, Beecher's Trilobite Bed, Mazon Creek, Ghost Ranch, Solnhofen Limestone, Yixian Formation (Liaoning), Green River Formation, and La Brea Tar Pits
xix. Major evolutionary events, trends, and transitions: (e.g., **Ediacaran biota,** Cambrian Explosion, Ordovician Radiation, Mesozoic Marine Revolution, Mesozoic-Cenozoic Radiation; suture patterns in cephalopods, fish to tetrapods transition, evolution of birds from dinosaurs, evolution of whales, evolution of horses)
xx. Convergent evolution: (e.g., fins in fish, marine reptiles, and mammals; wings in insects, pterosaurs, birds, and bats)
xxi. Interpretation of cladograms to show evolutionary relationships
xxii. Stromatolites, how they form, their role in the history of life and the development of Earth's atmosphere, including the Great Oxygenation Event
xxiii. Trace fossils (ichnofossils) as evidence of fossil behavior. Limited to trails, tracks & trackways, footprints, resting traces, borings, burrows, tubes, predation marks, and coprolites
(1) Use of dinosaur footprints to calculate hip height **and length** of animal
Formulas:
Hip Height = Length of Footprint x 4
Head to Tail Length = Length of Footprint x 10
(2) Use of dinosaur trackway to determine running or walking speed **of bi-pedal dinosaurs**
Formula:
Relative Speed Ratio: Stride Length divided by Hip Height
If the ratio is less than 2.0, the dinosaur was WALKING.
If the ratio is between 2.0 and 2.9, the dinosaur was TROTTING.
If the ratio is greater than 2.9, the dinosaur was RUNNING.

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

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

2025 NATIONAL FOSSILS LIST

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

KINGDOM PROTOZOA

FORAMS (Phylum Foraminifera)*

- Order Fusulinida (Fusulinids)*
  - **Genus *Triticites****
- Order Rotaliida*
  - Genus *Nummulites**

KINGDOM ANIMALIA

SPONGES (Phylum Porifera)*

- Genus *Astraeospongia* (calcareous sponge)*
- Genus *Hydnoceras* (glass sponge)*

BRYOZOANS (Phylum Bryozoa)

- Growth forms: branching, massive, fenestrate
  - Genus *Archimedes*
  - Genus *Rhombopora*

GRAPTOLITES (Phylum Hemichordata)*

- Order Dendroidea (benthic graptolites)*
- Order Graptoloidea (planktic graptolites)*

CORALS (Phylum Cnidaria)

- Order Tabulata (tabulate corals)
  - Genus *Favosites*
  - Genus *Halysites**
- Order Rugosa (rugose corals)
  - Genus *Heliophyllum (horn coral)*
  - Genus *Hexagonaria*
- Order Scleractinia (stony corals)
  - Genus *Septastrea*

ARTHROPODS (Phylum Arthropoda)

- **Order Radiodonta***
  - **Genus *Anomalocaris****
- Subphylum Crustacea (shrimp, lobsters, crabs, barnacles, ostracods)*
- Subphylum Chelicerata
  - Order Eurypterida (Eurypterids)
    - Genus *Eurypterus*
- Class Insecta (Insects)
- Class Trilobita (Trilobites)
  - Order Polymerida (Polymerids)
    - Genus *Cryptolithus*
    - Genus *Calymene*
    - Genus *Elrathia*
    - Genus *Isotelus**
    - Genus *Eldredgeops* (formerly *Phacops*)
  - Order Agnostida (Agnostids)
    - Genus *Peronopsis*

BRACHIOPODS (Phylum Brachiopoda)

- Class Inarticulata
  - Genus *Lingula*
- Class Articulata
  - Genus *Atrypa*
  - Genus *Composita*
  - Genus *Juresania**
  - Genus *Leptaena**
  - Genus *Mucrospirifer*
  - Genus *Platystrophia*
  - Genus *Rafinesquina*

MOLLUSKS (Phylum Mollusca)

- Class Bivalvia (clams, oysters, mussels)
  - Genus *Exogyra*
  - Genus *Gryphaea*
  - Genus *Pecten*
  - Genus *Glycymeris*
  - Genus *Astarte*
  - Genus *Nucula*
- Class Cephalopoda
  - Order Goniatitida (goniatites)*
  - Order Ceratitida (ceratites)*
  - Order Ammonitida (ammonites)
    - Genus *Baculites*
    - Genus *Dactylioceras*
  - Order Belemnitida (Belemnites)
    - Genus *Belemnitella*
  - Order Nautilida (Chambered Nautilus)
  - Order Orthocerida ("Orthoceras")
- Class Gastropoda (Snails)
  - Genus *Conus*
  - Genus *Cypraea*
  - Genus *Platyceras*
  - Genus *Turritella*
  - Genus *Worthenia*

ECHINODERMS (Phylum Echinodermata)

- Class Asteroidea (Starfish)*
- Class Blastoidea
  - Genus *Pentremites*
- Class Crinoidea (stems, columns, calyxes)
- Class Echinoidea (regular or irregular echinoids: sea urchins, sand dollars and heart urchins)
- Class Ophiuroidea (brittle stars)*

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

2025 NATIONAL FOSSILS LIST (CONT.)

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

VERTEBRATES (Phylum Chordata)

- Superclass Agnatha*
- (Jawless Fish) (Ostracoderms)*
- Class Placodermi (Armored Jawed Fish)
  - Genus *Bothriolepis*
  - Genus *Dunkleosteus*
- Class Chondrichthyes (Cartilaginous Fish)
  - Superorder Selachimorpha (Sharks)
    - Genus *Otodus* (formerly *Carcharocles/ Carcharodon*)
      - Species *O. megalodon*
  - Superorder Batoidea (Rays)*
- Superclass Osteichthyes (Bony Fish)
  - Class Actinopterygii (ray-finned)
    - Genus *Knightia*
    - Genus *Xiphactinus**
  - Class Sarcopterygii (lobe-finned)
    - Genus *Eusthenopteron*
    - Genus *Latimeria* (Coelacanth)
    - Genus *Tiktaalik*
- Class Amphibia (Amphibians)
  - Genus *Acanthostega*
  - Genus *Eryops*
  - Genus *Diplocaulus*
- Class Reptilia (Reptiles)
  - Order Crocodilia (crocodiles)*
  - Order Testudines (turtles)*
  - Order Ichthyosauria (Ichthyosaurs)
  - Order Squamata
    - Family Mosasauridae (Mosasaurs)
  - Order Plesiosauria (Plesiosaurs & Pliosaurs)
  - Order Pterosauria (Pterosaurs)
- Clade Dinosauria (Dinosaurs)
  - Order Saurischia (lizard-hipped)
    - Suborder Theropoda
      - Genus *Allosaurus*
      - Genus *Coelophysis*
      - Genus *Dilophosaurus*
      - Genus *Deinonychus**
      - Genus *Spinosaurus**
      - Genus *Tyrannosaurus*
      - Genus *Velociraptor*
    - Suborder Sauropodomorpha
      - Genus *Brachiosaurus*
      - Genus *Diplodocus*
      - Genus *Patagotitan**
      - Genus *Plateosaurus*
  - Order Ornithischia (bird-hipped)
    - Infraorder Ankylosauria
      - Genus *Ankylosaurus*
    - Infraorder Ceratopsia
      - Genus *Triceratops*
      - Genus *Protoceratops**
    - Infraorder Ornithopoda
      - Genus *Iguanodon*
      - Genus *Parasaurolophus*
      - Genus *Maiasaura*
    - Infraorder Pachycephalosauria
      - Genus *Pachycephalosaurus**
    - Infraorder Stegosauria
      - Genus *Stegosaurus*
  - Class Aves (Birds)
    - Genus *Archaeopteryx*
    - Genus *Titanis* (Terror Bird)
    - Genus *Hesperornis**

Clade Synapsida

- Stem Mammals/Proto-Mammals
  - Genus *Dimetrodon* (pelycosaurs)
  - Genus *Lystrosaurus* (therapsids)
  - Genus *Gorgonops* (therapsid)*
- Class Mammalia (Mammals)
  - Genus *Basilosaurus* (prehistoric whale)
  - Genus *Equus* (modern horse)
  - Genus *Mesohippus* (three-toed horse)
  - Genus *Australopithecus* (hominin)*
  - Genus *Homo* (hominin)
    - Species *H. neanderthalensis*
    - Species *H. erectus**
    - Species *H. sapiens*
  - Genus *Mammut* (Mastodon)
  - Genus *Mammuthus* (Mammoth)
    - Species *M. primigenius*
  - Genus *Megacerops* (brontothere)
  - Genus *Megalonyx* (Giant Ground Sloth)*
  - Genus *Smilodon* (saber-toothed cat)
  - Genus *Merycoidodon* (oreodont)*

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

KINGDOM PLANTAE

SEED PLANTS

SEED FERNS (Division Pteridospermatophyta)

Genus *Glossopteris*

Clade Angiosperms

FLOWERING PLANTS (Division Anthophyta)

Genus *Acer* (Maple)

Genus *Populus* (Aspen & Poplar)

Genus *Platanus* (Sycamore)

Clade Gymnosperms

GINKGOS (Division Ginkgophyta)

Genus *Ginkgo*

CONIFERS (Division Pinophyta)

Genus *Metasequoia*

NON-SEED PLANTS

CLUB MOSSES (Division Lycophyta)

Genus *Lepidodendron* (scale tree)

FERNS & HORSETAILS (Division Polypodiophyta)

Tree Ferns

Genus *Psaronius* (form leaf genus: *Pecopteris*)

Horsetails

Genus *Calamites* (form leaf genus *Annularis*)

TRACE FOSSILS

Limited to:

Trails, Tracks, Trackways, Borings, Burrows, Tubes, Predation marks, Coprolites, Stromatolites

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

GEOLOGIC MAPPING C

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

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

   A TEAM OF UP TO: 2 **CALCULATOR:** Class II **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. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays, no material may be removed from the binder throughout the event.
   b. Each team may bring two protractors, two rulers, and two stand-alone non-programmable, non-graphing calculators (Class II).

3. **THE COMPETITION:**

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

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

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

HELICOPTER C

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

1. **DESCRIPTION:** Prior to the tournament, teams will construct, collect data on test flights, analyze and optimize free flight rubber-powered **helicopters** 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 helicopters, Flight Log, transportation boxes, tools, and equipment.
   b. Teams must bring one or more Measurement Boxes; transportation and measurement boxes may be the same box.
   c. Event Supervisors will provide all other measurement tools and timing devices for scoring purposes.
3. **CONSTRUCTION PARAMETERS:**
   a. Helicopters 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. A flat balsa wood disc, large enough to cover a dime, must be the uppermost part of the helicopter, the part that would touch a flat ceiling first during the flight.
   c. Any materials except Boron filaments may be used in construction of the helicopter and boxes.
   d. The helicopter, in its flight configuration, must fit fully into a team-provided Measurement Box.
      i. The external dimensions of the Measurement Box must fit within a right, rectangular prism of 32.0 cm x 24.0 cm x 47.0 cm, including any external protuberances on the box.
      ii. Typically available 8-ream copy paper boxes should fit within the dimensions. The team is responsible for verifying their own boxes prior to the competition.
   e. "Flight configuration" means the helicopter is fully assembled and ready to fly. For example, no change in chord, span, length, or total lifting area can occur after removing the helicopter from its box and throughout the flight itself. Components that rotate during flight may be rotated such as propellers or rotors to allow the helicopter to fit into the box. The rubber motor(s) does not have to be on the helicopter or wound.
   f. The helicopter may use up to three fixed pitch rotors. There is no maximum limit on the number of blades or their chord. Rotors are defined as one or more separate lifting surfaces, referred to as blades, that contribute lift by rotating on a common path around a vertical axis. There must not be any other lifting surfaces.
   g. Total mass of the helicopter, excluding the rubber motor(s), must be 4.00 g or more.
   h. Participants must construct the rotors themselves. Commercially available rotors or propellers must not be used in whole or part. Commercial rotor thrust bearings may be used.
   i. The helicopter must be powered by rubber motor(s) of any mass. Motor(s) must be removable from the helicopter for check-in. Motors may be lubricated before and/or after check-in. Officials need not mass the motors.
   j. Participants may use any type of winder, but electricity may not be available.
   k. 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.
   l. Each helicopter must be labeled so that the Event Supervisor can easily identify to which team it belongs.
4. **FLIGHT LOGS:**
   a. Teams may present a Flight Log of recorded data for a Bonus. This data must include 6 or more parameters (3 required and at least 3 additional) with data for 10 or more test flights prior to the competition.
      i. The required parameters are:
         (1) Motor size before windup
         (2) Number of turns on the motor or torque at launch
         (3) Flight time
      ii. The team must choose 3 additional data parameters beyond those required (e.g., turns remaining at landing, estimated/recorded peak flight altitude, the motor torque at landing, propeller pitch, etc.).
   b. All logs will be returned to teams after inspection.
5. **THE COMPETITION:**
   a. The event will be held indoors. Tournament officials will announce the room dimensions (approximate length, width, and ceiling height) in advance of the competition. Tournament officials and the Event Supervisor are urged to minimize the effects of environmental factors such as air currents.

b. Once participants enter the cordoned off competition area to trim, practice, or compete, they must not receive outside materials (except as permitted by the Event Supervisor), assistance, or communication. Only participants may handle helicopters 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. Practice flights may occur throughout the competition but must yield to any official flight.
   iii. No practice flights will occur in the final half-hour of the event's last period, except for teams that declare a trim flight during their 10-minute Flight Period.
d. Check-in:
   i. Prior to check-in with the Event Supervisor, a self-check inspection station may be made available to participants for checking their Measurement Box(es), and helicopters.
   ii. At check-in, participants will present their helicopters in Measurement Box(es), and Flight Logs for inspection immediately prior to their Flight Period.
   iii. The Event Supervisor will verify the external dimensions of the Measurement Box(es) and that the helicopter fits fully inside the Measurement Box while in its flight configuration. The helicopter's overall dimensions must not change after being removed from the box. This may be verified by showing that the helicopter slides into and out of the box without changing shape at the discretion of the Event Supervisor.
   iv. The participants will remove the helicopter from the box to allow for the mass to be measured.
   v. All motor(s) will be collected and returned to the team at the start of their 10-minute Flight Period.
   vi. Only Participants should handle the helicopters or Measurement Box(es).
e. Flight Period:
   i. The 10-minute Flight Period begins when the Event Supervisor returns the motor(s) to the team.
   ii. Any flight beginning within the 10-minute Flight Period will be permitted to fly to completion.
   iii. Participants may make adjustments/repairs/trim flights during their official Flight Period.
   iv. Before each launch, participants must indicate to the Timers whether a flight is an official flight or a trim flight. A flight is considered official if a team fails to notify the Timer(s) of the flight's status.
   v. Teams must not be given extra time to recover or repair their helicopter.
   vi. Teams may make up to a total of 2 official flights using 1 or 2 helicopters.
   vii. Time aloft for each flight starts when the helicopter leaves the participant's hand and stops when any part of the helicopter touches the floor, the lifting surfaces no longer support the weight of the helicopter (such as the helicopter landing on a girder or basketball hoop) or the Event Supervisors otherwise determine the flight to be over.
   viii. Event Supervisors are strongly encouraged to utilize three (3) timers on all flights. The median flight time in seconds to the precision of the device used is the official time aloft.
   ix. Participants must not steer the helicopter during flight.
   x. Students must be on the floor to launch and must not use artificial aids to increase launch height.
   xi. In the unlikely event of a collision with another helicopter, a team may elect a re-flight. The decision to re-fly may be made after the helicopter lands. Timers are allowed to delay a launch to avoid a possible collision. The 10-minute Flight Period does not apply to such a flight.
f. If requested by the Event Supervisor, the participants must demonstrate that each helicopter still fits fully inside the Measurement Box(es) in the flight configuration. Teams may not manipulate the configuration of the helicopter in order to fit into the box except to rotate components that rotated during flight such as rotors. The helicopter's overall dimensions must not change after being removed from the box. Motor(s) may be removed from the helicopter 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 helicopter(s), Measurement Box(es), motor(s), and Flight Log in the event area.

6. **SCORING:**
   a. Highest Final Score wins. A team's Final Score is the larger of the team's Flight Scores.
   b. Flight Score for each official flight = Flight Time x Bonus (6.c.)
   c. Flight Log Bonus:
      i. Teams with a complete Flight Log with receive a 20% bonus multiplier (x 1.2)
      ii. Teams with a partial Flight Log will receive a 10% bonus multiplier (x 1.1)
      iii. Teams without a Flight Log will receive no bonus multiplier (x 1.0)
   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; other resources are on the Event Pages at soinc.org.

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

C

MATERIALS SCIENCE C

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

1. **DESCRIPTION:** Teams will build and bring 1 puck, complete lab activities and answer a series of questions related to the materials science of ceramics with an emphasis on chemical and crystalline structure, and behavior.

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

CALCULATOR: Class III **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each participant must bring safety equipment (e.g., goggles, lab coat, apron), an N95 mask, a writing implement, and may bring a stand-alone calculator of any type (Class III).
   b. Each participant may bring one unique 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, with information on both sides in any form and from any source.
   c. Teams should bring any or all of the items listed on the Division C Chemistry Events Lab Equipment List, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
   d. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type, they will notify teams. Pants should be loose fitting; if the host has more specific guidelines, they will notify teams in advance of the tournament. Shoulder-length or longer hair must be tied back. In addition, N95 masks must be worn in the room where the cement testing is being done. Participants removing safety clothing/ goggles or unsafely handling materials or equipment will be penalized or disqualified.
   e. Supervisors will provide any required reagents, additional glassware, and/or references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).
3. **CONSTRUCTION PARAMETERS:**
   a. Students will build a concrete puck 4.0 ± 0.2 cm in diameter out of whatever combination of Portland cement Type I or II, sand, gravel, and water they wish. **Pucks must be at least 10% Cement.** The puck must be totally dry. When any of the inside is found to be moist when the puck breaks/cracks, the puck will be disqualified. The puck may be up to 1.5 cm thick for Invitationals and Regionals, 1.0 cm thick for State, and 0.5 cm thick for Nationals. **Pucks breaking open during the drops and found to be moist inside will be disqualified, but pucks will not be deliberately cracked open at the end to check for moisture.**
4. **DESIGN LOG:**
   a. Teams must submit a Design Log with their puck.
   b. The Design log should contain the following four (4) sections:
      i. A front cover with school name, the team number for that competition, and the competitors' names.
      ii. A list of the components (including quantities or ratios of each) used in the construction of the puck.
      iii. A data table of at least 10 trials of different amounts of materials used for different pucks and how they performed.
      iv. A graph of the data from part iii
5. **THE COMPETITION:**

Part 1: Puck Testing

   a. Pucks will be dropped from heights starting at 20 cm at 20-cm intervals onto a cement or steel slab or floor until it cracks/chips/breaks, or a maximum of 100 cm is reached.
   b. Tournaments will specify ahead of time what the pucks will be dropped on.
   c. Puck testing may be done in the same room as the testing/lab activities, in which case everyone in the room must wear the N95 mask and goggles at all times, or the puck testing may be done in another area, in which case the masks and goggles only need to be worn in the area of the testing.
   d. **Pucks will be dropped by the students with a flat side of the puck down. The puck should have ~90° sides to the flat surfaces. Any visible change to the outside of the puck will be considered a failure and stop further testing.**
   e. Competitors have 1 minute to get ready for each drop. Teams may clean the surface the puck is being dropped onto during their Event Time, but it must remain dry.

Part 2: Written Test

The written test will focus on the chemical structure, crystalline structure, characterization, performance, processing, and applications of ceramic materials.

a. **Structure:** Crystalline structure, amorphous glasses, interatomic bonding, and cation-anion radii ratios. **State and National levels only may include:** grain boundaries, imperfections, atomic point defects, vacancy, interstitial cations, impurities, Frenkel defects, and Schottky defects
b. **Processing of ceramics/glasses:** Ceramic/glass fabrication methods, phase diagrams, TTT diagrams, porosity
c. **Characterization:** X-ray diffraction, optical and electron microscopies
d. **Mechanical properties:** Density, hardness, elastic modulus, flexural strength, compressive strength, fracture toughness, brittle fracture, calculation of stress and strain. **State and National Levels only may include:** calculation of elastic modulus, calculation of flexural strength
e. **Thermal & Electrical Properties:** Heat capacity, thermal expansion, thermal conductivity, thermal shock. **State and National Levels only may include:** insulation, electrical properties of ceramics including electrical conductivity, piezoelectricity, and dielectric properties.
f. **Applications of ceramics/glasses:** Types of ceramics/glasses and their uses

Part 3: Lab Activity

a. At least 1 lab activity must be performed in addition to the Puck Testing and Written Test. Topics for lab activities shall be consistent with topics listed under Part 2: Written Test. Refer to soinc.org for a list of core competencies for chemistry events.

6. **SCORING:**

a. High score wins. Total score = DL +PT +WT + LA
b. Design Log (DL) = 2 pts/section (8 pts max)
c. Puck Testing (PT) = 2 pts per survived drop (10 pts max)
d. Written Test (WT) = (written test score/highest test score) X 50 (50 pts max)
e. Lab Activities (LA) = (Lab activities score/highest lab activity score) x 32 (32 pts max)
f. Ties will be broken by pre-selected questions.

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

MICROBE MISSION C

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

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

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

3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Participants may be asked to perform simple laboratory procedures such as taking measurements using a microscope or using probes to collect data (sufficient information will be provided at the station to do so). **Questions should emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions.** The Event will cover the topics listed below without any overemphasis on any one particular topic. The list of topics is exhaustive.
   a. For each of the following topics, participants will be expected to use quantitative reasoning and computational skills, analyze and interpret experimental results, and draw evidence-based conclusions.
      i. Microscopy:
         (1) Describe the parts, functions, images, and sample preparation of bright-field, phase contrast, fluorescence, and electron (TEM & SEM) microscopes.
         (2) **Identify and explain which microscopy method is most appropriate to address a given hypothesis or experimental goal.**
         (3) Estimate the size of microbes using scale bars. Calculate magnification and resolution using power and numerical aperture data. Determine direct cell counts (in cells/ml) using a Neubauer counting chamber (exact chamber dimensions to be provided by the Exam writer).
      ii. Structure and Morphology:
         (1) Describe the basic structure, composition, and function of components of bacterial, archaeal, and eukaryotic (i.e., microalgal and fungal) cells (i.e., membrane, cell wall, flagella, pilus, fimbria, nucleoid, cytoplasm, and organelles) and of specialized structures in bacteria and eukaryotic microbes (i.e., gas vesicles, endospores, contractile vacuoles, eyespots, carboxysomes).
         (2) Contrast Gram (+), Gram (-), and acid-fast cells and explain the Gram stain procedure.
         (3) Describe basic structural components of viruses and their functions.
         (4) State and Nationals only: **Describe different forms of cell locomotion (swimming and gliding motility) and discuss chemotaxis and phototaxis.**
      iii. Culture and Growth:
         (1) Describe applications of different methods to culture bacteria (i.e., liquid vs. agar) and different media used to do this (i.e., selective vs. differential).
         (2) Interpret bacterial growth curves and discuss what is happening at each stage.
         (3) Describe how plate count data (i.e., CFUs) and optical density measurements are used to calculate the number of cells in a culture and population growth rate.
         (4) **Describe how major classes of antibiotics (i.e., penicillins, tetracyclines, beta-lactams, cephalosporins, and fluoroquinolones) target bacterial growth. State and Nationals only: Describe mechanisms of bacterial resistance to these antibiotic classes.**
         (5) Describe how sterilization and disinfection techniques (i.e., heat, ultraviolet radiation, filtration, and chemical) are able to compromise/eliminate microbes.
         (6) Understand the limitations of culture-based approaches to study microbes.
      iv. **Molecular Biology:**
         (1) Outline the steps of bacterial cell division (i.e., binary fission) and genome replication, including the function and properties of the origin of replication, DNA unwinding element, DnaA, and DNA polymerase. State and Nationals only: Outline the steps of rolling circle replication and identify microbes or agents that use this strategy.
         (2) Outline the steps of bacterial transcription and translation, including major enzymes involved.

(3) Explain how bacterial transcription is regulated as demonstrated in the lac and trp operons.
(4) State and Nationals only: Describe the properties and function of plasmids in bacteria. Discuss how recombinant DNA technology is used to produce useful products such as human insulin.

v. **Metabolism and Applications:**
(1) Describe microbial metabolic strategies based on carbon and energy sources.
(2) Describe the primary inputs and outputs of major metabolic processes (i.e., fermentation, oxygenic photosynthesis, nitrogen fixation) and where they occur in the cell.
(3) Describe the role of microbes in: fermentation in bread baking, soy sauce production, and sauerkraut production; photosynthesis in biofuel production; and nitrogen fixation in the rhizosphere. Connect these applications of microbes to the processes listed in (2).
(4) State and Nationals only: Describe the diversity of alternative electron donors and acceptors in microbial respiration and carbon fixation, using the Winogradsky column as a model system.

vi. **Evolution & Ecology:**
(1) Discuss the endosymbiotic theory of organellar evolution.
(2) Describe common adaptations to environmental extremes (i.e. temperature, salinity, pH).
(3) Describe lytic and lysogenic viral life cycles with examples from the **Microbes and Agents List.**
(4) Describe how genomic analysis can be used to determine the functional potential and evolutionary history of a microbe.
(5) **Outline the mechanisms of horizontal gene transfer** (i.e., transduction, conjugation, and transformation). Explain the role of horizontal gene transfer and viral infection in evolution.
(6) **Describe applications and limitations of 16S amplicon sequencing**, interpret data from 16S amplicon sequencing experiments (i.e., bacterial community composition, alpha diversity, beta diversity), outline how PCR is used to target specific genes in amplicon sequencing experiments.
(7) Identify and describe community interactions between microbes (i.e., cooperation/mutualism, commensalism, predation, parasitism). Explain how these interactions can be mediated by metabolic pathways.
(8) State and Nationals only: Describe applications and limitations of metagenomic and meta-transcriptomic sequencing, meta-proteomics and metabolomics. Identify which sequencing method is most appropriate to address a given hypothesis or experimental goal.
(9) State and Nationals only: Describe how restriction modification (RM) and CRISPR-cas systems are used by bacteria to defend against virus infection.

b. **Microbes and Agents List**: **Participants will be expected to be able to describe the general characteristics (i.e., life cycle/replication strategy, genome structure, and morphology). For disease-causing agents, identify what disease they cause. Otherwise, understand their environmental function**. **Microbes not listed here may be included on the exam, but sufficient background information will be provided to answer questions.**
i. Bacteria: *Escherichia coli, Rickettsia rickettsii, Mycobacterium leprae, Mycobacterium tuberculosis, Microcystis aeruginosa, Staphylococcus aureus, Helicobacter pylori*
ii. Archaea: *Pyrococcus furiosus, Methanococcus sp.*
iii. Eukaryotes: *Plasmodium falciparum, Saccharomyces cerevisiae, Nannochloropsis sp., Paramecium sp.*
iv. Viruses & other subcellular agents: Escherichia virus T4, Escherichia virus Lambda, Measles virus, Smallpox virus, SARS-CoV-2 virus, Human Immunodeficiency Virus, Major Prion Protein

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

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

OPTICS C

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

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

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

CALCULATOR: Class III **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. Participants may remove information or pages for their use during any part of the event.
   b. Each team may also bring tools, premade templates, supplies, writing utensils, and two calculators **(Class III)**.
   c. Teams must not bring lasers, mirrors, **other optical devices (aside from personal eyeglasses or contacts), or electronics (other than calculators).**
3. **THE COMPETITION:**

Part I: Written Test

   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The test will consist of at least 5 questions from each of the following areas:
      i. Reflection and refraction: Specular & diffuse reflection, **Law of Reflection**, index of refraction, Snell's law, critical angle, and prisms (deviation & dispersion)
      ii. Mirrors & lenses: Convex, concave, and plain mirrors and lenses; ray tracing; focal length; real, virtual, erect, and inverted objects and images; magnification
      iii. Color theory: Additive & subtractive color theory; primary & secondary colors; absorption & reflection
      iv. Structure and function of the human eye
      v. Lens maker's equation & thin lens approximation
      vi. Polarization: films & scattering, Brewster's angle
      vii. State & National Only:
         (1) Structure and function of microscopes, telescopes, and **sextants**
         (2) Structure and function of cameras, glasses, retro reflectors, and periscopes
         (3) Absorption spectra in films, chemicals, & dyes
         (4) Lasers: structure and function, coherent light
         (5) Correction of optical problems in human eyes using lasers
         (6) **Interference, diffraction, diffraction gratings, and iridescence**
         (7) **Optical concepts related to information storage and retrieval on CD/DVD media**
   d. Questions on the test will use the following mathematical content:
      i. **Math expectations for Regional Tournaments:**
         (1) Basic 2D geometry required for ray tracing. For example, parallel & perpendicular lines, rays, triangles (similar & congruent), and circles
         (2) Simple algebra manipulations, including solving one equation for one variable
         (3) **Basic trigonometry and vectors**
      ii. **Math expectations for State & National Tournaments:**
         (1) **All regional expectations**
         (2) **More sophisticated algebra, such as solving systems of equations for multiple variables**

Part II: Laser Shoot

   a. The objective is to reflect a laser beam with mirrors around barriers towards the Target Point located on the wall opposite the laser.
   b. The event supervisor must select a Target Point location that is the same for all teams. Teams must not be informed of the location until it is their turn to compete in Part II of the event.
   c. The Event Supervisor must test the beam's alignment before each team is permitted to see the **LSS (Laser Shoot Setup, as defined in Section 4).**
   d. All mirrors must be placed in a home position designated by the event supervisor before each team is permitted to see the LSS.

e. When a team is ready to begin, the event supervisor must give a countdown of "3, 2, 1 start" and start a timer. Event Supervisors must give teams a warning when 3 minutes have elapsed.
f. Competitors must make all measurements, calculations, and mirror placement/alignment within a 4-minute time period. Competitors may **place** between 1 and 5 moveable mirrors, **which may be placed on top of templates laid on the base of the LSS.**
g. Timing must stop when 4 minutes have elapsed or the competitors remove the material covering the face of one mirror. Competitors must not make any additional adjustments to the mirrors at that point other than to remove the mirror coverings. The Event Supervisor must not remove the coverings.
h. Competitors must not mark on or modify the LSS **or attach anything to it via adhesive.**
i. Competitors must not touch the laser **or barriers** or change **their** orientations and/or position**s, including for the purpose of placing templates. If they move any of these elements, the team will be assessed a competition penalty and the time for the Event Supervisor to reset the position comes out of the team's setup time.**
j. The laser must not be turned on until timing stops. Once turned on, the Event Supervisor must mark on the paper mounted above the metric scale where the laser strikes it to record the results. Participant tools/templates may remain on the LSS during this process.
k. **Additionally, the Event Supervisor must record the total number of gridlines (defined in 4.g.) the laser beam crosses over or touches from the first reflection from a student-positioned mirror to the beam's termination point. More than one reflection off a mirror (including the barrier mirror) will not be scored for the Team Line Score (TLS), as defined in 5.d, so each mirror should only be placed to have a single reflection off of it.**
l. The Event Supervisor will review with the team the Part II data recorded on their scoresheet.

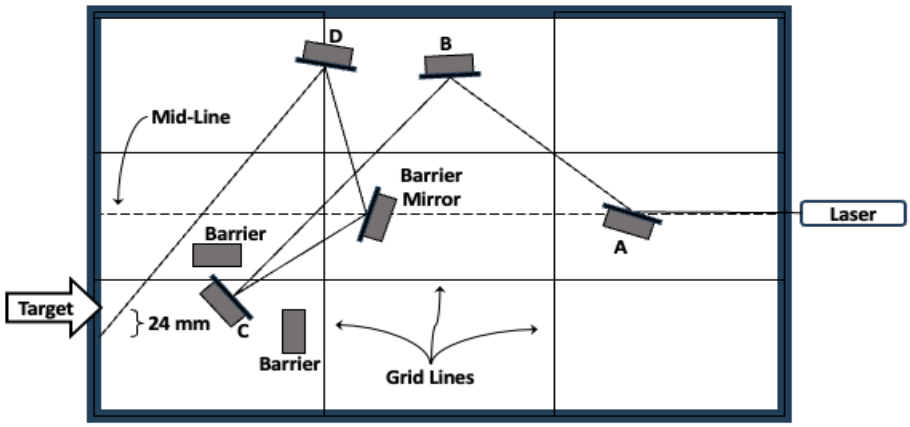
4. **<u>THE COMPETITION AREA</u>:**
a. Example setups are provided on the event page at www.soinc.org.
b. The Event Supervisor will provide the Laser Shoot Setup (LSS), including timers, laser, mirrors and barriers. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.
c. The LSS has a horizontal flat surface 56 ± 1.0 cm by 35 ± 1.0 cm enclosed by a 2 ± 0.5 cm thick wall. The bottom surface may be a table top. The height of the wall above the surface is 9 ± 1.5 cm.
d. Five (5) moveable flat mirrors with a width of 5.0 – 8.0 cm must be placed in the LSS and must be back-surface mirrors. Each mirror must be mounted so that it stands vertically (~90 degree angle to the bottom surface), does not have excess mounting material on its sides, has its approximate center at the level of the laser beam and can be easily relocated anywhere in the LSS by the competitors. The mirror faces must initially be covered with a cardboard sleeve or other easily removable non-reflecting, opaque material.
e. A laser is mounted through the approximate center of one of the 35 cm walls at a height of 1.5 - 6.0 cm above the bottom surface. The laser must be securely mounted such that it cannot be moved and the beam is perpendicular to the wall through which it is mounted. The Laser Policy on www.soinc.org must be followed. The laser must remain fixed throughout the entire event.
f. A midline is drawn on the LSS from a point directly below the emitting tip of the laser to a point directly below the center of the laser beam where it strikes the opposite wall.
g. **Additionally, gridlines will be finely drawn on the LSS bottom surface dividing the LSS bottom surface horizontally into three approximately equal rows and vertically into three approximately equal columns, creating 9 Zones of approximately equal dimensions on the bottom of the LSS. The gridlines should extend up the walls and top edges of the laser shoot so they can be seen if a team uses a template.**
h. A metric scale with a resolution of at least 1 mm must be attached horizontally to the other 35 cm wall opposite the laser at the level at which the laser strikes. One of the marks on the scale is the Target Point. A sheet of paper must be also fastened to the wall, with a mark on the paper indicating the Target Point location.
i. **Three barriers must be placed in the LSS and fixed in the same positions and orientations for all teams. One (called the Barrier Mirror) has construction similar to the mirrors discussed above, and is covered similarly. The other two are non-mirrored barriers with a width of 2.0 to 8.0 cm and tall enough to block the laser beam. One of the three must be placed somewhere along the midline to block the laser beam, but this barrier need not be the one with a mirror. All three barriers may face in any direction at any angle, but they must be positioned such that teams are able to redirect the laser and hit the target. Barriers may be placed on gridlines.**

5. **SCORING:**
   a. Final Score (FS) = ES + **LS** + AS + BS. The maximum possible FS is 100 points. High score wins. A scoring spreadsheet is available on the event page on www.soinc.org
   b. Exam Score (ES) = (Part I score / Highest Part I score of all teams) x 45 points
   c. **Line Score (LS) = (TLS / Highest TLS of all teams) x 20 points**
   d. **Team Line Score (TLS) = the total number of gridlines the laser beam crosses over or touches from the first student-placed mirror to its termination point (see 3.II.k) Some unique cases are scored as follows:**
      i. **Crossing the midline does not count as crossing a gridline.**
      ii. **If the beam crosses at the intersection of 2 gridlines, that counts as two lines crossed**
      iii. **If a beam hits a mirror or the barrier mirror exactly at one gridline, that counts as one line crossed and does not get counted again as the beam leaves the mirror. Similarly, if a beam travels along a gridline, that counts as one line crossed.**
      iv. **If the beam crosses a gridline once and then later in its path crosses the same gridline, that counts as two lines crossed.**
      v. **If a mirror is hit a 2nd time by the beam, the lines crossed immediately after that mirror's 2nd hit are not counted. However, after the beam hits another mirror, lines can continue to be counted.**
   e. **Accuracy Score (AS) = (TAS / Highest TAS) x 25 points**
   f. **Team** Accuracy Score (**TAS**) = (25 – accuracy(in mm)/10) points. The smallest possible **TAS** is 0.
      i. The accuracy is the horizontal distance from the Target Point to the center of where the laser strikes a wall. If the laser strikes another wall instead of the wall the Target Point is on, the accuracy is the sum of the straight-line measurements from the Target Point to the corner along one wall and along the other wall from the corner to the laser dot. **If the laser beam is split and the Event Supervisor determines one beam is brighter, the measurement will be made from the brighter beam. If both appear equal, the beam closer to the target will be used for the measurement.**
      ii. If the laser does not strike **any** wall, the **TAS** is 0, but the **TLS** and BS should still be calculated.
   g. Barrier Score (BS) = **10** points if the laser reflects off the barrier mirror **independent of how many gridlines have been crossed**
   h. Teams that are not allowed to compete in Part II due to unsafe operation of the LSS receive an AS, **LS** and BS of 0, but must still be allowed to compete in Part I.
   i. The AS, **LS**, and BS must be multiplied by 0.9 when calculating the Final Score if the team violates any of the rules in Section 3: THE COMPETITION.
   j. Ties are broken using designated question(s) on the written test. The Event Supervisor must identify tiebreakers to the Participants at the beginning of the competition period.

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

OPTICS C SCORING EXAMPLE

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



Barrier Score (BS) = 10 points for use of the barrier mirror
Team Accuracy Score (TAS) = 25 - (accuracy in mm/10).
The accuracy = 24mm, so TAS = 25 - (24/10) = 22.6 points
Team Line Score (TLS) = 11 points, divided as follows:

BEAM FROM	BEAM TO	EXPLANATION	POINTS
Laser	Mirror A	No points are scored until the beam reflects off a student-placed mirror (3.II.k)	0
Mirror A	Mirror B	Crosses Directly over the Intersection of 2 Gridlines (5.d.ii)	2
Mirror B	Mirror C	Crosses 3 Gridlines & the Midline. This part of the beam crosses 1 gridline that was previously crossed in the beam from A to B, but this is allowed and fully scored (5.d.iv). The Midline crossing scores nothing (5.d.i).	3
Mirror C	Barrier Mirror	Crosses 2 Gridlines	2
Barrier Mirror	Mirror D	Crosses 1 Gridline + Intersects a Mirror on a Gridline (5.d.iii)	2
Mirror D	Wall	Leaves the Mirror located on the Gridline, but does not get counted again (5.d.iii). Crosses 2 Gridlines to terminate on the wall	2

ROBOT TOUR C

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 (if prepared), **alignment device, robot program(s)**, and any additional/spare parts.
      i. **Laptops, tablets or other computers used for programming cannot be impounded.**
      ii. **The Robot's program(s) must be impounded. The program(s) can be impounded using the following storage media but not limited to these options: USB drive, SD card, Robot's flash memory.**
   b. The **impounded** Practice Log are the only papers or notes that the competitors may bring into the event area and **use during their time slot**.
   c. Teams may bring tools which do not need to be impounded. **Tools can be electronic. Spare parts and alignment devices are not tools and must be impounded.**
   d. **Teams are responsible for providing their own programming tools, cables and/or computers. The tournament or event supervisor will not be providing a computer to be used during the competition.**
3. **CONSTRUCTION PARAMETERS:**
   a. The Robot must be designed and programmed to navigate a track, travel to gate zones, and stop at a designated target point on the track.
   b. Electrical energy used by the Robot for any purpose, including propulsion, must be stored in a maximum of 6 (six) AA or AAA 1.2 to 1.5-volt common, commercially available batteries, individually labeled by the manufacturer. Rechargeable batteries are allowed. **The batteries must be individual batteries and not a pre-assembled battery pack.**
   c. Any battery containing lithium or lead acid is not permitted. Teams using these batteries will not be permitted to run and will receive only participation points.
   d. Batteries and Robot are to remain separate from the moment they are impounded until after the start of the team's time slot. At Impound, the batteries to be used must be stored in a method that will prevent a short circuit. 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. **A dowel or equivalent (e.g., pencil, pen)** must be attached to the front of the Robot. **The dowel's base dimension should be approximately ¼" to ⅜"**. 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's front bottom edge will be the Robot's Measurement Point for distance measurements. **The dowel may not rotate, pivot, extend, or move around the Robot.**
   f. The entire Robot in the ready-to-run configuration must fit in any orientation in a 30.0 cm by 30.0 cm space of any height.
   g. Teams may use sensors to provide information about the environment or the Robot's movements. **Sensors must be attached and connected to the Robot. Sensors may change their orientation like using a motor controlled by the Robot.**
   h. All parts of the Robot must move as a whole; no tethers or other separate pieces are allowed. The only parts allowed to contact the floor during the run are parts already in contact with the floor in the ready-to-run configuration. Pieces falling off during the run constitutes a construction violation.
   i. **The Robot's program can be one or multiple source code files. Multiple microprocessors are allowed.**
   j. **Sending the program to the robot is allowed using either a hardwire cable like an USB cable, Bluetooth connection, or a memory device like a SD card. Communicating to the Robot over a WiFi network is not allowed.**
   k. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on soinc.org
4. **PRACTICE LOG:** A Practice Log is recommended but not required. The Practice Log **may contain paper for the competitors to use and must be impounded in order for the competitors to use during the competition.**

5. **THE TRACK:**
   a. The track area will be a 2 meter **by 2.5 meter rectangular** area on a smooth, level, and hard surface. A PDF diagram of the track is available on the Event Page at soinc.org.
   b. The Outer Boundary Lines of the Track will be defined using the inside edge of 2.5 cm wide tape.
   c. The outside tape lines will be marked every 0.5 m or 50 cm for the imaginary lines within the track area. **There are three (3) imaginary lines in the vertical direction and four (4) imaginary lines in the horizontal directions for a total of seven (7) lines.** All imaginary lines are perpendicular to the outside tape lines. The imaginary lines will form **twenty (20)** square zones (approximately 50 cm x 50 cm) within the track area. It is recommended to use ¼" wide tape to mark all imaginary lines, but not required.
   d. The Start Point will be marked on the inside edge of the outer boundary tape line. The Start Point will be centered between any imaginary line and/or a perpendicular outer boundary tape line.
   e. The Target Point will be in the center of one of the **twenty (20) zones** defined by the imaginary lines and outer tape lines. The Target Point will be marked on approximately 2.5 cm x 2.5 cm tape with the Target Point marked at the center of the tape.
   f. **Up to ten (10) wooden 2x4 Obstacles** are placed on the track lines. The 2x4 can be placed on any imaginary line or outside tape lines. The 2x4s are placed centered between adjacent perpendicular track lines (outside or imaginary). The dimensions of the 2x4 obstacles are **approximately** 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 2.5 cm tape lines **unless the imaginary lines are marked by tape**. Each Gate Zone is approximately 50 cm by 50 cm square. The tape will be placed on the inside edge of the imaginary lines and/or the outer tape line to form the Gate Zone. The event supervisor will select the locations of the Gate Zones after impound. Each Gate Zone will be marked with a letter (Ex: "A", "B", "C", "D", …). **One Gate Zone will be marked with "Last" to identify as the Last Gate Zone Bonus.**
   h. **The Track Setup must contain a path clear of 2x4 Obstacles to enter all Gate Zones and reach the Target Point.**
   i. **The color of the tape used to mark the track is the choice of the Event Supervisor.**
   j. 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 **Target Time and the locations of the Start Point, Target Point, Obstacles, Gate Zones, and Last Gate** are chosen by the Event Supervisor (ES) and will be announced after the impound period is over. The number of Gate Zones will be **4 for Regionals, 5 for States and 6 for Nationals**. The Target Time will be chosen between **55 and 85** 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. **Unauthorized, generative AI tools (e.g., ChatGPT, DALL-E) are not allowed to be used to generate answers/code under any circumstances during the event.**
   d. Teams are allowed to make programming changes to achieve the **best score during their Setup Time and Track Time.**
      i. **The competitors must demonstrate to the Event Supervisor that they are only modifying the impounded Robot program.**
      ii. **Competitors can only modify the impounded source code file(s) to define the Robot's motions.**
      iii. **The Robot's program can use libraries stored on the programming tool (i.e., laptop or tablet) provided these libraries are not viewed or modified by the competitors during the event.**
      iv. **The programming tool (i.e., laptop or tablet) may download information from the Internet for updates or to program the Robot provided the competitors are not viewing the downloaded information. For example, the Arduino Software IDE is allowed to check the Internet for software updates. Using a web based programming interface to modify the impounded source code file(s) is allowed. Internet access may not be available at all competitions.**
      v. Competitors may view information created by the Robot's program after the run.
      vi. **Using a software simulation of the Robot to verify motions and / or run times is not permitted. Testing the Robot's program on hardware other than the Robot is not permitted. Graphical software representations of the Track or the Robot's motions are not permitted. Using software algorithms to modify the impounded program is not permitted.**

vii. **The Robot must remain autonomous and not be remotely controlled. The Robot cannot receive external instructions or information once a run starts.**

e. 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 programming changes. Teams have a maximum of 10 minutes for setup. All work must take place away from the track. **Batteries may be installed during Setup Time.** The teams are not permitted to test their Robot's movements on any surface during the Setup Time. **The Robot may only be tested provided the Robot is held by the competitors away from any surface and held stationary. The Team's Setup Time** starts after the completion of the inspections and the competitors are ready to begin the setup process. Competitors will notify the Event Supervisor when ready to move to the track.
   ii. Teams are given a maximum of 8 minutes for their Track Time. All actions described below must take place during their Track Time. The Track Time will not include time used by the Event Supervisor for measuring. If a run has started before the 8-minute period has elapsed, it will be allowed to run to completion. The recorded Track Time will stop at the end of the team's last run.

f. At the Event Supervisor's discretion Participants may use AC outlet power during their time slot but this may depend on event location.

g. **Competitors may measure any track dimension or distance as part of their Track Time.**

h. Teams may have up to 2 successful runs or 3 Failed Runs (whichever comes first).

i. **Alignment or sighting devices are permitted. These devices can be electric or electronic. If placed on the Track, they must be removed before each run.**

j. In the ready-to-run configuration, the Robot's Measurement Point must be over the Start Point with the Robot in any orientation. If the robot is starting from outside of the Track then the Robot's first movement must be to enter the Track area. The Robot must remain at the starting position without being touched.

k. Teams may adjust their Robot (e.g.: programming changes, physical modifications, etc.) **during either their Setup Time and Track Time**. The Event Supervisor may re-verify that the Robot meets specifications prior to each run.

l. **Teams cannot test on the floor of the Track on the day of the event.** Teams **can only** 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.

m. 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.

n. **Teams must activate a trigger on the Robot to start the run. The trigger may be, but not limited to, a pushbutton, power switch, micro switch, or a sensor. Competitors must use the unsharpened #2 pencil supplied by the event supervisor to actuate the trigger. Competitors can only use the #2 pencil to make contact with the Robot while actuating the trigger.**

o. **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.**

p. 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. **There may be a delay between the trigger action and the Robot moving.** If the robot does not move within 3 seconds after coming to a stop, the run is considered to have ended; the 3 seconds are not included in the Run Time. Any action occurring after that time does not count as part of the run. Movement is defined by the Robot's measurement point changing location on the track. The Event Supervisor is encouraged to use three timers. The middle time of the 3 timers must be the official Run Time. The Run Time must be recorded in seconds to the precision of the timing devices.

q. A Gate Zone Bonus is awarded for each Gate Zone entered in any order. Each Gate Zone may only be counted once. **The dowel is the only part of the Robot that must fully enter a Gate Zone to receive the bonus. The Robot may enter the Gate Zone forward, backwards or sideways to receive the bonus.**

r. 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.

s. A Stalling Penalty will be awarded for delaying movement actions **near the Target Point** with the intent to improve only the Time Score. Possible delaying actions can include but are not limited to: repeating a single or multiple movements, moving in small circles, or other motions designed to improve the Time Score only.
   i. **Near the Target Point is defined as occurring within the 50cm by 50cm Target Point square or any square surrounding the square with the Target Point.**
   ii. **Pauses between motions will not be penalized. Unless the motions between the pauses are repetitive as for example moving in a straight line with more than one pause during the straight line motion.**
   iii. An Event Supervisor may request the last run to be repeated to verify the presence of delaying movements. This repeat run will not count toward the team's Track Time or used for scoring.

t. **A run will be scored as a Failed Run if one of the following occurs. Construction and/or Competition Violations must still be recorded for Failed Runs.**
   i. **Competitors may ask to have the run recorded as a Failed Run. The Robot must be in motion to be declared as a Failed Run. If competitors declare a Failed Run during the 3 seconds of non-motion, the Robot must make another motion after the pause to be declared as a Failed Run.**
   ii. Does not finish within twice the target time.
   iii. The Robot exits the track area as determined by all Robot floor contact points being completely outside of the track's outer perimeter lines.
   iv. **A competitor picks up the robot after the robot stops moving and before the event supervisor gives permission to pick up the robot. In addition, the team's next successful run will receive a competition violation.**
   v. 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).
   vi. **At the end of the 8-minute Track Time, a team having less than 2 successful runs will have any remaining runs assessed as a Failed Run.**

u. **The Event Supervisor will review with teams their data recorded.**

v. Teams filing an appeal must leave their Robot **and other impounded material in the event 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. Successful 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 = **200** + (Target Time - Run Time) x 2
   ii. Run Time greater or equal to Target Time: Time Score = **200** + (Run Time - Target Time)

d. The Distance Score = Robot Distance x **2 pts/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. **Last Gate Bonus of -30 points is awarded for a run if the Gate Zone marked as Last is the final Gate Bonus awarded. The Robot may enter a previously awarded Gate Zone after receiving the Last Gate Bonus. When the Last Gate Bonus is awarded, the run will be awarded -15 points for the Gate and -30 points for the Last Gate (for a total of -45 points).**

g. Run Penalties:
   i. Contact Penalty: **70 points** added to each Run Score that has 1 or more contacts with the 2x4 Obstacles.
   ii. No 2x4 Obstacle Penalty: **50 points** added to all Run Scores when a team chooses to run without the 2x4 Obstacles.
   iii. Stalling Penalty: 20 points added to each Run Score with delaying movement actions.
   iv. Competition Violation: 150 points added to each Run Score that has 1 or more Competition Violations.
   v. Construction Violation: 300 points added to each Run Score that has 1 or more Construction Violations.

h. **Bonuses and penalties are awarded independent of each other. For example, a run score can have both the Gate Zone Bonus and the 2x4 Obstacle Penalty.**
i. Final Score Penalties:
   i. Robot's movements tested during Setup Time: 200 points added to the team's Final Score.
   ii. Robot **or Program** Not Impounded: **1500** points added to the team's Final Score.
j. Ties must be broken by this sequence:
   i. Lower Time Score on scored run
   ii. Lower Robot Distance on scored run
   iii. Higher number of Gate Zones entered on scored run
   iv. Lower Track Time used

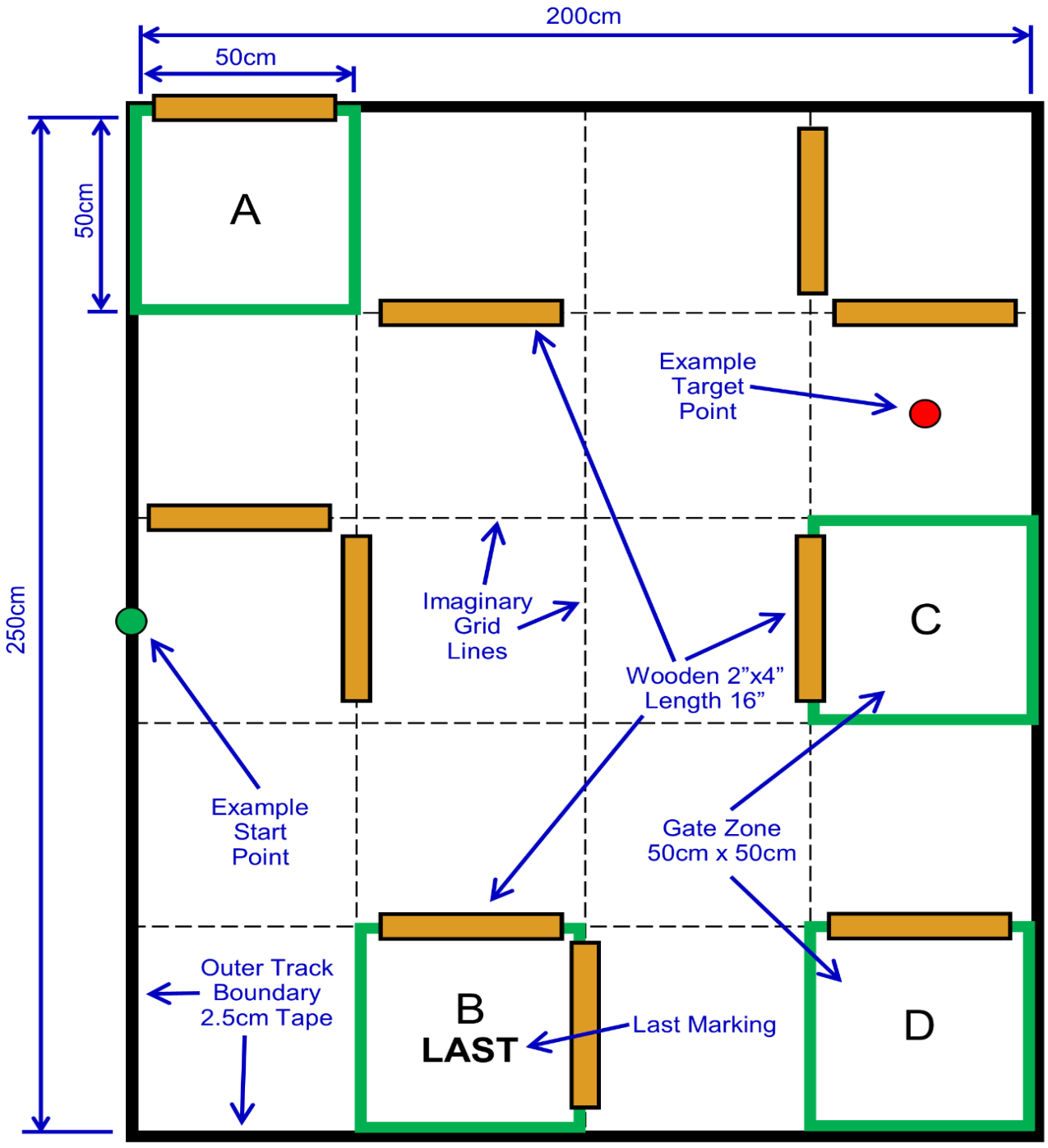
8. **SCORING EXAMPLE:** At a competition, the track has **4 Gates (A, B, C & D)**. **Gate A is the last Gate Zone.** Target Time is **73 seconds**. A team's Robot stopped 21.7 cm from the Target Point with a Run Time of **62.53 sec**. Gate Zones were entered in the following order "C" and "A". The team had a recorded Track Time of 7 minutes and 35 seconds.

Time Score	**= 200** + (73 - 62.53) x 2	**=**	**220.94**
Distance Score	= 21.7cm x **2.0 pts/cm**	=	43.40
Gate Bonus	= 2 Gates x -15 pts/Gate	=	-30.00
Last Gate Bonus	**= -30 pts**	**=**	**-30.00**
Run Score		=	**204.34**

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

EXAMPLE ROBOT TOUR TRACK

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



Note: Recommend using 1/4" wide tape for Imaginary Lines

TOWER C

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

1. **DESCRIPTION**: Teams will design and build a Tower (Structure) constructed of wood, bonded by adhesive, spanning a 20 cm square opening, able to support the loading block at least 50 cm above the test base with only 3 points of contact with the Test Base. Bonuses can be obtained by holding 15 kg and spanning a 29 cm circle (rather than the 20 cm square). The structure must meet the requirements specified in these rules to achieve the highest score, which is a combination of structural efficiency and bonus.

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

EYE PROTECTION: B **EVENT TIME:** 6 minutes

2. **EVENT PARAMETERS:**
   a. Each team is allowed to enter only one Structure, built prior to the competition.
   b. All participants must properly wear eye protection at all times (reference Eye Protection Policy found on www.soinc.org). Teams without proper eye protection will be immediately informed and given a chance to obtain eye protection if time allows. Participants not wearing proper eye protection will not be allowed to compete and be placed in Tier 3.
   c. Participants may NOT bring any equipment such as levels or squares.
   d. The Event Supervisor will provide all Test Apparatus (see Section 5) and tools/materials for measurement except for virtual tournaments, the teams must supply all Test Apparatus that fully meets the requirements of Section 5, any deviations from Section 5 will be scored as a construction violation for the team.
3. **CONSTRUCTION PARAMETERS:**
   a. The Structure must be a single assembly with no separate, loose, sliding, or detachable pieces, constructed of wood, and bonded by adhesive. No other materials are permitted.
      i. Wood is defined as the hard, fibrous substance making up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include bark, particleboard, wood composites, bamboo or grasses, paper, commercially laminated wood (i.e., plywood), or members formed of sawdust, wood shavings, and adhesive. Wood may never be painted, soaked, or coated in glue, color enhanced, or have tape/preprinted/paper labels affixed. Ink barcodes and/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. Structure design requirements:
      i. Must span a 20 cm x 20 cm opening on a Test Base (5.a.).
      ii. May only have 3 points of contact with the Test Base (5.a.) and each tower leg must be in its own quadrant, not shared with any other leg.
      iii. Must be placed on the Test Base surface such that the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base.
      iv. Must support the Loading Block (5.b.i.) a minimum of 50.0 cm above the Test Base. There is no maximum Tower height.
      v. The loading point on the Structure must be constructed to permit placement of the Loading Block (5.b.i.) on the tower and constructed such that only the Loading Block (5.b.i.) supports the chain and bucket.
      vi. **Bonus Points** (6.c.) can be obtained by designing the Tower to span a 29 cm diameter circle, centered on the 20 cm x 20 cm opening of the Test Base and holding 15.0 kg.
   c. Participants must be able to answer questions regarding the design, construction, and operation of the structure per the Building Policy found on www.soinc.org.
4. **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 (5.e.) so the Event Supervisor or Assistant can determine the mass, in grams, to the nearest 0.01 g or best precision available.
   c. The team will measure the Structure height using provided materials so the Event Supervisor or Assistant can determine if it meets or exceeds the minimum height (3.b.iv.) in cm to the nearest 0.1 cm.

d. The team must submit their Estimated Load Supported (6.e.i.) to be used as a tiebreaker.
e. No alterations, substitutions, or repairs may be made to the Structure once the check-in process has started.
f. Prior to Part II: Testing: the Event Supervisor will verify that the combined mass of the Loading Assembly with empty bucket does not exceed 1,500 g.
g. 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 Structure on the Test Base and assemble the Loading Block Assembly and bucket as required to load the Structure. If necessary, participants may disassemble the Loading Block Assembly but must re-assemble in the same order as presented by the Event Supervisor. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Structure to deflect.
d. The participants will be allowed to adjust the Structure until they start loading sand. Once loading of sand has begun, the Structure must not be further adjusted.
e. The Event Supervisor will check that the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base before loading begins.
f. The Event Supervisor before testing will verify:
    i. The Tower only has 3 points of contact with the Test Base and each tower leg must be in its own quadrant, not shared with any other leg.
    ii. That no part of the Tower's span touches or is supported within the 29 cm diameter circle for the Tower to qualify for the "Load Scored Bonus".
g. Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. The bucket may only be stabilized by using the tips of the provided Bucket Stabilizing Sticks (5.d.).
h. 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, or if any part of the load is supported by anything other than the Structure. Incidental contact of the chain/eyebolt with the structure is not a failure. At the Supervisor's discretion, sand may be removed from the bucket if pouring continued after the structure fails or time expires.
i. Once loading stops, any parts of the Structure in the bucket will be removed. The Load Supported (mass of the Loading Assembly and the sand in the bucket) will be recorded to the nearest gram or best precision available. The minimum Load Supported is the mass of the Loading Assembly. The maximum Load Supported is 15,000 g.
j. At the Event Supervisor's discretion, more than one Test Apparatus may be used.
k. The Event Supervisor will review with the team the data recorded on their scoresheet.
l. Teams who wish to file an appeal must leave their structure with the Event Supervisor.

5. **TEST APPARATUS:**

a. The Test Base shall be a solid, level surface as follows:
    i. At least 55.0 cm long x 32.0 cm wide, stiff enough that it does not bend noticeably when loaded.
    ii. Shall have a smooth, hard surface (e.g., metal, high-pressure plastic laminate).
    iii. Shall have an opening at its center approximately 20.0 cm x 20.0 cm.
    iv. Shall have a 29 cm circle drawn on the surface, centered on the 20 cm x 20 cm square opening. The surface outside the 29 cm circle shall be the Load Scored Bonus Zone.
    v. Shall be divided into 4 quadrants by drawing lines on the Test Base that extend from the corners of the 20 cm x 20 cm opening to the edge of the Test Base at 45 degrees as shown in Diagram 1.

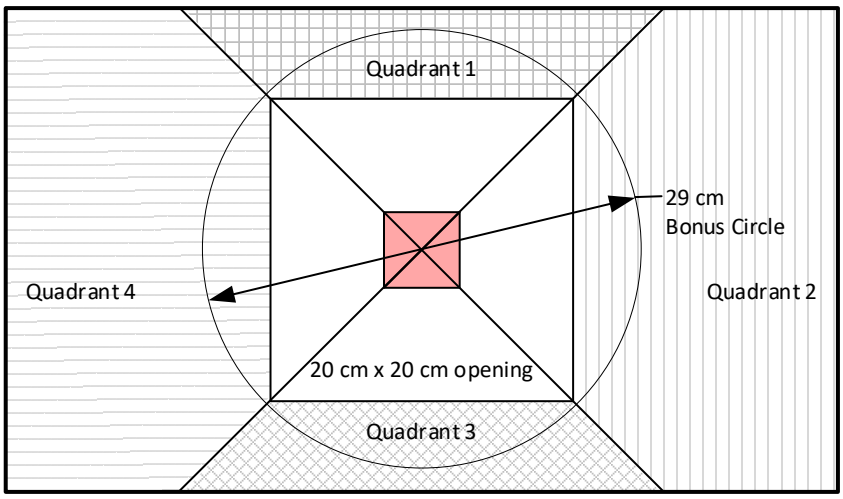


Diagram 1 – Test Base

b. The Loading Assembly will consist of:
   i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt.
   ii. A ¼ inch threaded eyebolt (1-inch nominal eye outside diameter), minimum 2 ¼ inch length to a maximum 4 ½ inch length, and a ¼ inch wing nut. The loading block must be mounted on the eye bolt and be trapped between the "eye" of the eye bolt and the wing nut. The loading block cannot sit on top of the wing nut or be loose.
   iii. A chain and S-hook that are suspended from the eyebolt on the Loading Block.
   iv. An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain.
   v. The total combined mass of the Loading Assembly may not exceed 1,500 g.
c. Sand: Load will be applied using sand or other clean, dry free-flowing material.
d. Two (2) Bucket Stabilizing Sticks each made from a piece of ½" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org.
e. Structure scale: Must be a digital scale. The scale shall have a minimum resolution of 0.1 grams; recommended resolution is of 0.01 gram.
f. Sand scale and load verification: Must be a digital scale. The scale shall have minimum resolution of 10 grams; recommended resolution is of 1 gram.

6. **SCORING:**
   a. High score wins. Score = [Load Score (g)/Mass of Structure (g)]
   b. The Load Score= Load Supported (4.II.i) + Load Scored Bonus (6.c.).
   c. Load Scored Bonus: Structures that ONLY contact the Test Base outside the 29 cm circle and holding 15.0 kg will earn a Bonus of 5,000 g.
   d. 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. For virtual meets, Test Apparatus not meeting requirements.
      iii. Tier 3: Unable to be loaded for any reason (e.g., cannot accommodate or hold Loading Assembly, failure to wear eye protection) and will be ranked by lowest mass.
   e. Ties are broken as follows:
      i. Estimated Load Supported closest to, without exceeding, the actual Load Supported
      ii. Lowest Structure mass
   f. Example score calculations:
      i. Structure 1: mass= 10.12 g, Load Supported= 12,134 g; No Load Scored Bonus = 1,199
      ii. Structure 2: mass= 10.12 g, Load Supported= 15,000 g + 5,000 g Load Scored Bonus = 1,976

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

This event is supported by the Cleveland-Cliffs Foundation and SkyCiv.

WIND POWER C

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

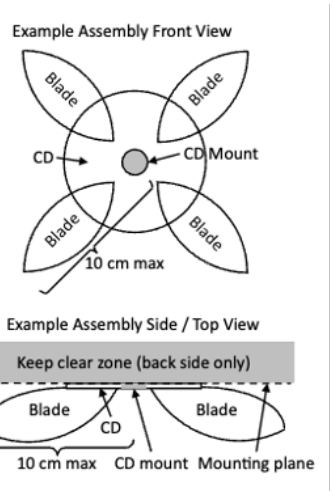
1. **DESCRIPTION:** Teams construct a blade assembly device prior to the tournament that is designed to capture wind power and complete a written test on the principles of alternative energy.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** No

   CALCULATOR: Class III **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. 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 calculators (Class III) for use during any part of the event.
   c. Each team may bring one pre-constructed blade assembly device.
   d. The Event Supervisor will provide the testing materials listed in the COMPETITION AREA section. **Teams should not bring these materials.**
   e. Competitors must wear eye protection during Part II. Teams without proper eye protection must be immediately informed and given an opportunity to obtain eye protection if time allows.
   f. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy.

3. **CONSTRUCTION PARAMETERS:**
   a. The blade assembly device consists of any kind and number of propeller/pinwheel/rotor blade(s) **and any other pieces** attached to a central disc. **The central disc must be either a mini (8.0 cm in diameter) or a standard (12.0 cm in diameter) commercially-made CD, DVD or Blu-Ray disc intended for data or media storage.**
   b. The central disc must fit on the mount found in a standard CD player. Modification of the disc is not allowed (except to affix the blades via tape, glue, etc.).
   c. When mounted, no part of the blade assembly may have a radial distance from the center of the axis of rotation of more than **10.0 cm**. Note: adjacent diagrams are not to scale.
   d. The blade assembly must be made of only nonmetallic, **nonmagnetic** substance(s). **Only the wind from the fan may power the blade assembly.**
   e. When initially mounted, no part of the blade assembly **including fastening materials** may extend **onto the back of the disc or** behind the mounting plane of the disc. There is no limit on how far forward the blade assembly may extend.
   f. **The device must be designed and operated in such a way as to not damage or alter the support stand or disc mount (e.g., due to excessive weight/torque, residue on the mount).**



4. **DESIGN LOG**: **Competitors are not required to submit a design log for scoring, but are encouraged to test and calibrate their blade assembly.**

5. **THE COMPETITION:**

   Part I: Written Test
   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of a variety of different question types (i.e., multiple choice, true-false, completion, or calculation).
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The test will consist of **roughly the same number of questions** from each of the following areas:
      i. Wind power rotor/fan blade design (e.g., types of designs, pros/cons of designs, ways to improve designs, sources of loss, **concepts related to blade design**)
      ii. Power generators (e.g., **types of generators, concepts related to generator design**)
      iii. Power storage (e.g., how is the power stored during charging and how is it used during discharge, concepts relating to methods of power storage)
      iv. Power transmission **and distribution** (e.g., ways electricity is transmitted, how power is lost in transmission, ways to reduce power loss)

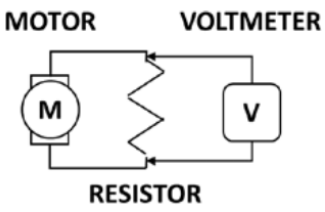
v. **Processes of siting and installing of commercial and individual wind applications, power transmission and distribution systems, and power storage systems**
vi. **Historical milestones of wind power development. Historical and current applications of wind power.** Environmental, ecological, and land use impacts of wind power

Part II: Device Testing

a. The blade assembly must be tested once with the fan at a low wind speed and once at a high wind speed**. It is recommended to conduct the low speed test first to ensure no device components detach before attempting the high speed test.**
b. Event Supervisors must check the blade assembly specifications before a team's blade testing period begins. Teams must be notified as soon as possible if a blade assembly does not meet specifications. Event Supervisors may prohibit blade assemblies from being tested if they will damage the testing setup.
c. Teams may modify the blade assembly during their Part II testing period, if time is available. This may be to bring the blade assembly into compliance with event specifications. **Once the blade assembly is determined to meet construction parameters, the rotor blades of the assembly cannot be swapped out for other blades. Doing so constitutes a construction violation.**
d. **Teams have 2 minutes and 15 seconds of set-up time preceding each Measurement Period to attach their blade assembly to the motor/generator mount and position it.** At the request of the students, the Event Supervisor must turn on or off the fan during the set-up to allow the students to better position the blade assembly relative to the fan. No voltage measurements are allowed to be made by or seen by the competitors during the **set-up** period. Teams are allowed to start and stop the blade assembly rotation and reposition the support stand during the **set-up** period.
e. No later than **the end of the set-up** period, with the fan already on and the blade assembly already rotating, the students must tell the Event Supervisor to begin a 30 second Measurement Period. The team must not touch, **modify, influence,** or reposition the blade assembly or support stand during the Measurement Period.
f. **No pieces of the blade assembly may detach while the device is spinning during either set-up time or Measurement Periods.**
g. The Event Supervisor must record the Maximum Voltage that occurs during the Measurement Period and inform the team of the result.
h. The Event Supervisor will review with the team the Part II data recorded on their scoresheet.
i. Teams filing an appeal regarding Part II must leave their blade assembly device in the competition area.

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

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



v. Device(s) to measure voltage across the load resistor. Voltage measurement devices that have 'peak hold' or 'max hold' functions are recommended.
c. The fan(s) must be mounted in a fixed position with the bottom of the grill at least 15 cm above the table.
d. There may be one or two test stations. If there are two, one must be used for all low wind speed tests and the other for all high wind speed tests. The load resistors **and motor/generators** at each station are allowed to be different, but must be consistent for all teams.
e. The motor/generator must be equipped with an adapter to accommodate a CD or, if the motor/generator is from a disc player, it must be removed from the disc player and mounted on the support stand.

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

a. Final Score (FS) = ES + LSS + HSS. The maximum possible FS is 100 points. High score wins. A scoring spreadsheet is available at www.soinc.org.
b. Exam Score (ES) = (Part I score / highest Part I score for all teams) x **50 points**

c. Low Speed Score (LSS) = (low speed test Max Voltage / Highest low speed test Max Voltage of all teams) x **25 points**
d. High Speed Score (HSS) = (high speed test Max Voltage / Highest high speed test Max Voltage of all teams) x **25 points**
e. If the team violates any of THE COMPETITION rules, the Max Voltage at that wind speed must be multiplied by 0.9 when calculating the Speed Score.
f. **The Speed Score for a Speed Trial must be zero (0) if a team:**
   i. **Cannot test their device safely**
   ii. **Cannot bring their device into compliance with the CONSTRUCTION PARAMETERS by the start of the Measurement Period**
   iii. **Is not prepared for the Measurement Period by 2 minutes, 15 second of setup (per rule 5.Part II.d.)**
   iv. **Fails to bring a blade assembly device.**
g. Teams with Speed Scores of 0 will be allowed to compete in Part I
h. Tiebreakers
   i. 1st – Best HSS
   ii. 2nd – Best LSS
   iii. 3rd – Specific Test Questions

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

This event is supported by ADM Cares.

WRITE IT DO IT C

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; other resources are on the Event Pages at soinc.org.

TRIAL EVENT RULES EXPLANATION

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 2024-2025 season, we are publishing a selection of Trial Events in the 2025 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 2025 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 2026 and beyond.

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

AERIAL SCRAMBLE

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

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

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

2. **EVENT PARAMETERS:**
   a. For Invitational and Regional competitions, teams must bring two unopened kits for inspection and their use. Only kits that, by design, are assembled without adhesives (i.e., Guillows Skystreak, AMA Alpha) and can be disassembled and reassembled to fly again will be accepted.
   b. At the State and National competitions, event supervisors will provide all airplane kits used in the event. Organizers will stipulate the airplane kit to be used in competition at least 2 weeks prior to the competition. Teams will choose two kits for the event from a selection of unopened standardized kits provided by the Event Supervisor. All teams must use the tournament provided standardized kit.
   c. Teams may bring up to 4 rubber motors, each not exceeding 2.0 grams.
   d. Teams may bring winders, assembly tools, fixtures (freestanding from airplanes), sandpaper, adhesive systems, thread, pins, tape, rubber O-rings for motors, clay and their logbook. All items must fit inside a single clear sided container with an approximate footprint of no more than 12” x 12”.
   e. Teams must bring a first aid kit that should contain at least 3 adhesive band-aids and any other first aid equipment the team feels is necessary.
   f. Additionally, teams must bring cutting boards and wax paper to cover any and all work surfaces.
   g. The items in 2.e. and 2.f. do not need to be included in the above referenced (2.d.) tool box.
   h. Any team not using a cutting board will receive a 20% deduction on their final score.
   i. Each team is responsible for their work site. Any debris must be disposed of, and the site cleaned and inspected before official flights are attempted.
   j. Teams will be allowed to attempt two (2) official flights for scoring.
3. **CONSTRUCTION PARAMETERS:**
   a. Only those materials found as part of the two kits will be allowed in model assembly. Glue, tape, pins or clay ballast may be added by teams and are considered as parts of each model.
   b. Boron, carbon fiber, extra wood or foam plastic materials are not allowed in the construction of the aircraft.
   c. The stock rubber motor may be replaced by other rubber elastic loops.
   d. Total mass without motor must be more than 10.0 grams and cannot exceed 25.0 grams.
   e. The wingspan cannot exceed 50.0 cm.
   f. Airplanes must use the propeller provided in the kit, which may not exceed 14.0 cm in diameter.
   g. Motors may have rubber O-rings and be lubricated after check-in.
   h. Airplanes will be labeled in such a way that can be identified by the participants in reference for their logbooks.
4. **THE COMPETITION:**
   a. The event will be held indoors. Tournament officials will announce the room dimensions (approx. length, width and ceiling height) in advance of the competition. Tournament Officials and Event Supervisors are urged to minimize the effects of environmental factors such as air currents. Rooms with minimal ceiling obstructions are preferred over very high ceilings.
   b. The event will be scheduled in hour time slots with no more than 10 teams competing in a time slot. The first 30 minutes will be devoted to complete primary check-in, model assembly and trim flights. The final 20 minutes will be to accomplish the team’s two official flights. These flights will occur in 2-3 team mass launches within a 4-minute scheduled window.
   c. At their scheduled time a team will enter a cordoned off competition area to begin Primary Check-In, where they:
      i. Sign-in and are scheduled, in sequence of their arrival, for an official flight time-slot, as well as receive from or have their model kits inspected by from the Event Supervisors depending upon the type of competition being held.

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

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

5. **SCORING:**

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase; 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 **CALCULATOR:** Class II **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

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

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 variable 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
   CALCULATOR: Class II **APPROXIMATE 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; other resources are on the Event Pages at soinc.org.

This event is sponsored by Corteva Agriscience

ENGINEERING CAD

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

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

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

2. **EVENT PARAMETERS:**
   a. Teams will use PTC Onshape on two computers with mice to create the model. Tournament directors will either provide devices or allow teams to bring their own devices depending on the tournament logistics.
   b. **Unauthorized, generative AI tools (e.g., ChatGPT, DALL-E) are not allowed to be used to generate answers under any circumstances during the event.**
   c. Teams must bring writing utensils
   d. No resource materials, except those provided by the Event Supervisor, may be used.
   e. Teams will be provided with a set of engineering drawings (either printed or online) and may receive a starting model that has some parts needed for building the finished model.

3. **THE COMPETITION:**
   a. Teams will CAD parts and an assembly based on the engineering drawings which specify the geometry, materials, and units for each part.
      i. For Regionals, teams will be required to model 2 to 3 components for 1 assembly.
      ii. For State and Nationals, teams will be required to model 4 to 6 components for 1 assembly.
   b. Teams will be required to answer questions about the drawing as well as mass, moment of inertia, and dimensions for individual parts and the completed assembly. Answers will need to be at a specified precision and units.
   c. Students on the team will work collaboratively on the model.

4. **SCORING:**
   a. The high score wins. Final Score = Test Score + Modeling Score.
   b. The test and modeling scores should be weight evenly such that: Max Test Score = Max Modeling Score
   c. Test scores will be based on the precision and/or accuracy of the answer to questions about the modeled parts and drawings.
   d. The scores for each test question will be added together to generate the Test Score.
   e. Modeling score for parts is determined by comparing the **mass** of named parts as specified in the engineering drawing to the correct values. A perfect match for the mass is 20 points and the minimum score is 0 for each part. Points for each part will be calculated as:

$$Individual\ Part\ Score = 20 - 100\ abs\left(\frac{Student_{mass} - Correct_{mass}}{Correct_{mass}}\right)$$

   f. Modeling score for assemblies is determined by comparing each component of the **center of mass** of the named assembly as specified in the engineering drawing to the correct values. A perfect match for the center of mass is 20 points and the minimum score is 0. Points for each assembly will be calculated as:

$$Individual\ Assembly\ Score = 20 - 100\left(\frac{1}{3}abs\left(\frac{Student_{center_x} - Correct_{center_x}}{Correct_{center_x}}\right) + \frac{1}{3}abs\left(\frac{Student_{center_y} - Correct_{center_y}}{Correct_{center_y}}\right) + \frac{1}{3}abs\left(\frac{Student_{center_z} - Correct_{center_z}}{Correct_{center_z}}\right)\right)$$

   g. The individual score for each part and assembly will be added together to generate the Modeling Score.
   h. Tiebreakers: The first tiebreaker is the model score; the team with the highest model score wins the tiebreaker. The second tiebreaker is modeling time; the team with lowest modeling time as measured from the creation of their document to the submission version wins the tiebreaker.

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

This event is sponsored by OnShape

HOVERCRAFT C

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

1. **DESCRIPTION:** Prior to the competition, participants will design, construct, and calibrate a self-propelled air-levitated vehicle that moves down a track.

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

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

2. **EVENT PARAMETERS:**
   a. Each team must impound only one vehicle, spare parts and **a Design Log for scoring**. **The vehicle must be impounded with the batteries stored separately and presented to the Event Supervisor for inspection.**
   b. Teams may bring tools, supplies, eye protection, and two **stand-alone** calculators (Class III) for use. These items need not be impounded.
   c. Participants must wear eye protection during device setup and operation. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
   d. **The Event Supervisor will provide the testing materials listed in the TRACK section. Teams should not bring their own track or ramp.**
   e. Participants must be able to answer questions regarding the design, construction, and operation of the vehicle per the Building Policy found on www.soinc.org.

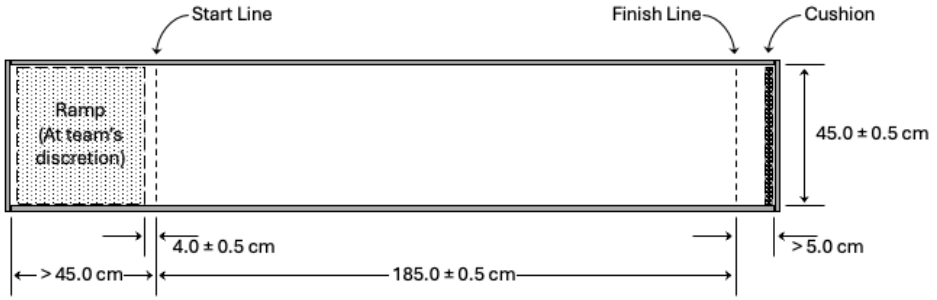
3. **CONSTRUCTION PARAMETERS:**
   a. The vehicle must fit into a 40.0 cm x 40.0 cm x 40.0 cm box when levitated on its inflated skirt. Vehicles must not modify or damage the track.
   b. The vehicle must levitate on a cushion of air as it moves down the track. Participants may be asked to demonstrate levitation by pushing the vehicle slightly down. If it then rises, it is levitating. Continuous contact of the inflated skirt with the base surface, occasional contact of other vehicle components with the base surface, or any contact with the inside edge of the side rails is permitted.
   c. The vehicle may have up to two motors, each rotating one propeller/impeller**.** All propellers/impellers**,** including under the device, must have shielding which prevents a 3/8" dowel from touching them.
   d. Commercial batteries, including rechargeables, not exceeding 9.0 V as labeled, may be used to energize the motors on the vehicle. **The label on each battery must be the manufacturer's original label and easily viewable by the Event Supervisor.** Multiple batteries may be connected together as long as the expected voltage across any **two** points does not exceed 9.0 V as calculated by their **individual** labels. The vehicle must not have any other energy sources. Batteries containing lithium or lead are prohibited.
   e. **All motors** must have a switch to permit safe starting **and stopping**. Relying on inserting batteries or twisting wires together to start is not allowed. **If more than one motor is used, they may be combined on the same switch or wired on separate switches.**
   f. Electrical components shall be limited to batteries, wires, motors **(including brushless motors)**, switches, resistors, potentiometers, capacitors, mechanical relays, fans, and blowers. Integrated circuits **(other than those that are an integral part of a commercial motor)** are not permitted.
   g. For timing **and measurement** purposes, the vehicle must have a 1/4" or larger **wooden** dowel vertically attached within 5.0 cm of its front edge such that the top end is at least 20.0 cm above the **track's** surface **when all motors are off**. **The dowel must be placed on the hovercraft so that it will be the first part of the vehicle to break a laser timing beam when the vehicle is traveling forward.**

4. **DESIGN LOG:**
   a. **Teams must submit a Design Log along with their device. The log must include the following:**
      i. **Materials used to construct the device.**
      ii. **A labeled diagram or picture that identifies and describes the parts of the device.**
      iii. **Any number of graphs and/or data tables showing the relationship between voltage and position for various device or testing setup configurations may be submitted, but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.**
      iv. **Graphs and/or tables may be computer generated or drawn by hand on graph paper.**
      v. **Each data series is counted as a separate graph unless the team indicates it should be scored otherwise.**
      vi. **A front cover labeled with the Team Name and the Team Number for the current tournament.**
   b. **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.**

c. **Teams are encouraged to have a duplicate of their Design Log, as the submitted copy may not be returned.**

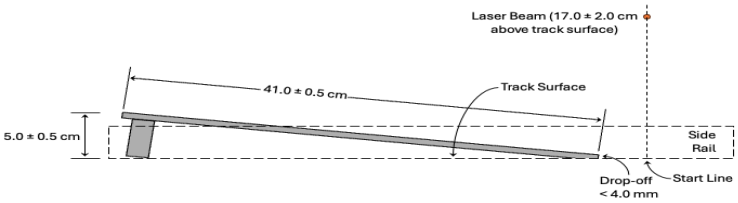
5. **THE COMPETITION:**
   a. **Vehicles violating rules 3c, 3d, or 3e or that are otherwise deemed unsafe in construction or operation by the Event Supervisor will not be allowed to run unless brought into compliance.**
   b. **Event Supervisors will check the vehicle specifications before the team's testing period. Teams must be notified as soon as possible if a vehicle is out of spec. Teams may modify the vehicle to bring it into compliance during their testing period.**
   c. **At the start of their testing period, each team will be given a Target Time (TT). The Target Time will be between 5.0-25.0 seconds in intervals of 2.0 seconds for Regionals, 1.0 second for States, and 0.5 seconds for Nationals. The TT will be the same for all teams.**
   d. Teams have a **testing period** of 8 minutes to adjust and repair their vehicle and make 5 **incomplete** or 2 **complete** runs; whichever comes first. Practice runs are not allowed.
   e. A**n incomplete** run occurs if a vehicle fails to move for 3 seconds **before crossing the finish line** or **the dowel** fails to cross the finish line within (**3 x TT)** seconds. Teams are not allowed to declare a run **as incomplete**. **A run is complete if it is not incomplete.**
   f. **If the vehicle's dowel does not cross the starting line within 3 seconds of launching, it does not count as a run (either complete or incomplete) and teams may reset.** A run will be counted in the scoring as long as it is started before the 8-minute period has elapsed.
   g. **If any part of the vehicle falls off during a run, the team incurs a construction penalty for the run.**
   h. To begin a run, the team will place their vehicle on the track **fully behind** the start line against a wood block **provided by** and placed by the Event Supervisor. The team then activates their vehicle's motor(s).
   i. **If they choose, teams may utilize an Event Supervisor-provided ramp (as described in 6.e) for the launching of their vehicle. In such cases, the Event Supervisor will place the ramp in the same position for all teams. Using the ramp will impact the team's score (7.c.iii), and the time for placing the ramp will come out of the 8-minute period. The team may change this decision for each run.**
   j. The team will give a countdown of "3, 2, 1, launch"; then the Event Supervisor will remove the wood block. Timing starts when the vehicle's dowel crosses the start line and stops when **the dowel** crosses the finish line. **If photogates are used, the dowel must be the first part of the vehicle to break the laser beams at both the start and finish lines.**
   k. The team must not touch their vehicle after the dowel crosses the starting line until it passes the finish line or the Event Supervisor declares **an incomplete** run**. If touched, the run is counted as complete with a DS and a TS of 0.**
   l. **If a run is declared incomplete, the Event Supervisor will record the distance from the finish line to the position of the dowel at the time the run was declared incomplete. The team's testing period time will pause while the Event Supervisor makes measurements and will resume when the measurement time is done.**
   m. The Event Supervisor will review with the team the data recorded on their scoresheet.
   n. A team filing an appeal must leave their vehicle in the competition area.

6. **THE TRACK:**



   a. The Event Supervisor will supply a **45.0** ± 0.5 cm wide and at least **240** cm long track on a non-carpeted floor or other firm base surface, such as a countertop or large board. The outside boundary of the track is composed of **rails** each with a height at least 30.0 mm (standard 2x4 framing studs recommended). The Event Supervisor will also supply a cushioned barrier to stop vehicles and a small wood block to hold the vehicle at the start line. Example setups are at www.soinc.org.

b. Each **rail** must be securely affixed to the floor, base, or each other.
c. The length of the timed portion of the track is fixed at **185.0** ± 0.5 cm. A start line must be marked that is at least **45.0** cm from the end of the track. The finish line must be marked **185.0 ± 0.5 cm from the start line** and a cushioned barrier at least **5.0** cm **past** it must block the channel.
d. A photogate timing system is highly recommended. **If used, the system will be installed at the start and finish 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 **median** time used as the official Run Time; lasers are recommended to be placed at the start and finish lines so the timekeepers only have to watch for the flash of light as the dowel cuts through the laser beam. **Time is recorded in seconds to the device precision if photogates are used, or to the tenth of a second if manual timers are used**.
e. **The Event Supervisor must provide a removable ramp that competitors may use for the launching of their vehicle. The ramp should have a smooth, flat surface and must span the width of the track between the rails. The height of the ramp is 5.0 ± 0.5 cm and the length of the ramp's surface is 41.0 ± 0.5 cm. When the ramp is placed on the track, the edge where the vehicle exits the ramp must be 4.0 ± 0.5 cm behind the start line. At the bottom of the ramp, where it meets the track surface, the transition should be reasonably smooth, with a drop-off from the ramp surface to the track surface of no more than 4.0 mm. See https://bit.ly/hovercraft2025 for information on how to build a ramp and track.**



f. Multiple tracks may be used to facilitate teams competing in a timely manner.

7. **SCORING:**
a. Final Score (FS) = **Best Run Score** + CS; maximum FS = 100. High score wins. A scoring rubric is available at www.soinc.org.
b. **Run Score = DS + TS**
c. **Distance Score (DS):**
   i. Complete Run: Distance Score = 30
   ii. **Incomplete Run: Distance Score = 30 x (185 - (distance from the finish line in cm)) / 185**
   iii. **If the ramp is utilized, the Distance Score is multiplied by 0.5 for that run.**
d. **Time Score (TS):**
   i. **Complete Run: Time Score = 60 x (1 - abs(runtime - TT)/(2 x TT))**
   ii. **Incomplete Run: Time Score = 0**
   iii. **The smallest possible Time Score is 0.**
e. One of the submitted graphs and/or tables, selected by the Event Supervisor, must be scored as follows for the Chart Score (CS, max of 10 points). Partial credit may be given.
   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, **axis titles**, units)
   iv. 0.5 points for each **distinct** graph or table turned in (up to 2 points total)
   v. **1** point for a labeled device diagram
   vi. **1 point for including a labeled front cover with team name and number**
f. Teams without any runs or that were prevented from running for unsafe operation receive participation points.
g. The TS and **DS** for a run will be multiplied by **0.6** if any CONSTRUCTION violation(s) were present **during that run** or if the team misses impound.
h. **A team violating any COMPETITION rules during a run will have their TS and DS multiplied by 0.9 for that run.**
i. Tie Breakers: 1st - **2nd Best Run Score**; 2nd - **2nd Best TS**; 3rd – **DS on 2nd Best Run; 4th - Fewest Incomplete Runs**

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

PROTEIN MODELING C

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

1. **DESCRIPTION:** Participants will use computer visualization and online resources to construct a physical model of a zinc finger DNA-binding protein. This year's event will focus on this small, repeating motif that recognizes a specific DNA sequence and regulates gene expression.

   A TEAM OF UP TO: 3 **IMPOUND:** Yes **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 along with writing utensils for each participant.
   b. Each team will impound a pre-built model of a Kaiso zinc finger.
   c. Event Supervisors will provide internet-connected computers, instructions for computer exploration of protein structure, and the written exams.

3. **THE COMPETITION:**

   Part I: The Pre-Built Model
   a. Participants will use the program JUDE (Jmol User Design Environment) to visualize Kaiso zinc finger (**Chain A, Residues 483-582**) based on data found in the **4f6m.pdb** file. The atomic coordinate data file can be downloaded for free from the RCSB Protein Data Bank (www.rcsb.org). A constructed model of this protein must be brought to all competitions; as the competition level increases, the scoring rubrics for the pre-built model will reflect higher expectations for model accuracy, detail, and enhancements. (See SCORING for more details.) JUDE can be accessed at learn.3dmoleculardesigns.com/digital-modeling-hub/jude_online_jmol for free.
   b. The pre-built model must be based on the protein's alpha carbon backbone display, using a scale of 2 cm per amino acid. Students may manually fold their pre-built model using Modeling Ties or comparable bendable material (Mini-Toobers, Kwik Twists, 12-gauge dimensional house wire, etc.).
   c. Three-dimensional (3D) printed materials may NOT be used to build the protein backbone but may be used for functionally relevant features.
   d. Participants will use materials of their choosing to add functionally relevant features to their model (e.g., selected amino acid sidechains, DNA, or associated molecules). These additions should highlight the significance of structure to the protein's function.
   e. When an amino acid sidechain is displayed, its chemical property should be annotated on the alpha-carbon of the backbone. For example, hydrophobic sidechains are yellow, hydrophilic white, acidic red, basic blue, and cysteine green.
   f. Participants must explain their functionally relevant features using clear and concise descriptions on a 4" x 6" notecard, in the form of a table with 3 columns, headed:
      i. What is displayed?
      ii. How is it displayed?
      iii. Why is it displayed?
   g. Teams may use both sides of the notecard, and information must be legible.
   h. All models, including all functionally relevant features, must fit within a 50.0 cm x 50.0 cm x 50.0 cm space.
   i. **The model must be sufficiently sturdy so that judges can remove it from any scaffolding or support, pick it up, and rotate it so that they can view it unobstructed from any angle and properly evaluate it.**
   j. Teams must deliver their pre-built model and 4" x 6" notecard for impounding. They may pick up pre-built models after the competition.

   Part II: Computer Exploration of Protein Structure
   a. Participants will explore a new protein structure onsite using JUDE (Jmol User Design Environment).
   b. The Event Supervisor will provide the computer and give the participants the PDB file of a new protein. the protein to be explored with JUDE.
   c. Participants will use JUDE to display the protein and answer questions about its structure.
   d. Participants may not visit websites outside of the JUDE environment.

   Part III: Written Exam
   a. Teams will complete a written exam consisting of multiple choice and short answer questions.

b. Topics addressed include:
   i. The principles of chemistry drive protein folding and stability.
   ii. Structure-function principles that explain how zinc fingers bind to specific DNA sequences and how this binding affects gene expression.
   iii. How modification of the DNA can affect zinc finger binding.

4. **SCORING:**
   a. High Score wins. The final score will be derived from all three parts of the competition:
   b. The pre-built model (Part I) accounts for 40% of the final score.
      i. The pre-built score is based on the accuracy and scale of the secondary structures, the tertiary arrangement of these structures, and the relevant functional features added.
      ii. Features that are irrelevant or do not explain the protein's structure/function relationship will not receive credit.
      iii. The pre-built model's scoring rubric will change with each competition's level.
         (1) For Regional competitions, scoring will be based primarily on the accuracy of the 3D folded structure of the protein's alpha-carbon backbone (secondary and tertiary structures).
         (2) For State competitions, 30% of the score awarded to the pre-built model will be based on functionally relevant features, such as the inclusion of key sidechains, substrates, nucleic acids, and so forth, that have been added to the alpha-carbon backbone model to explain the protein's function.
         (3) For the National competition, 50% of the score awarded to the pre-built model will be based on how the model interacts with DNA plus functionally relevant features such as the inclusion of key sidechains, substrates, nucleic acids, and so forth, that have been added to the alpha-carbon backbone model to explain the protein's function.
   c. The computer exploration of a protein structure (Part II) accounts for 30% of the event score
   d. The written exam (Part III) accounts for 30% of the event score.
   e. Ties will be broken using identified questions from the written exam (Part III).

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

This event is sponsored by 3D Molecular Designs.

DIV. C CHEMISTRY LAB EQUIPMENT LIST

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

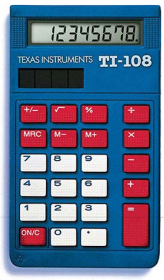
Each team may bring any or all of the items listed below for use in Division C Chemistry Events. Teams not bringing these items will be at a disadvantage as Event Supervisors will not provide the listed lab equipment. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the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

Item & Expected Use	Likely to be used in:			
	Chemistry Lab	Forensics	Environmental Chemistry	Materials Science
Box - Containing all of the kit materials	X	X	X	X
Graduated Cylinders (10 - 100 mL) - Measuring volumes	X		X	
Beakers (50 - 500 mL) - Doing reactions, developing chromatograms	X	X	X	X
Erlenmeyer Flasks (10 - 250 mL) - Doing reactions	X		X	
Test Tubes - Mix Chemicals, heat chemicals	X	X	X	X
Test Tube Brush - Clean Test Tubes	X	X	X	X
Test Tube Holder - Holds test tubes for heating	X	X	X	
Test Tube Rack - Hold Test Tubes	X	X	X	X
Spot Plates - For semi-micro scale reactions, testing solubility, pH	X	X	X	
Petri Dishes - Doing reactions, developing chromatograms	X	X	X	X
Slides - To put hairs, crystals, or fibers on for use with a microscope		X		
Cover Slips - To cover & prevent items from coming off slides		X		
Droppers - Add small amounts of liquids to reactions	X	X	X	X
Spatulas or spoons - Getting small amounts of solids out of containers	X	X	X	X
Metal Tongs, Forceps, or Tweezers – Holding & retrieving objects	X	X	X	X
Stirring Rods - Stirring mixtures	X	X	X	X
Thermometer - Determining the temperature of a solution	X	X	X	
pH paper/meter - Test acidity or alkalinity of solution	X	X	X	
Hand Lens - Magnification of small items for identification		X		
Flame Loop – For identification of ions in a compound		X		
Filter Paper - Filter solids from liquids	X		X	
Funnel - Hold Filter Paper	X		X	
9V battery - Electrolysis	X		X	X
Alligator Clip Wires - Connecting meters to metals	X		X	X
Nail - Electrolysis	X		X	X
Piece of Cu metal - Electrolysis	X		X	X
Piece of Zn metal - Electrolysis	X		X	X
Multimeter - Measuring current, voltage, and resistivity	X		X	X
9V or less Battery Conductivity Tester - Determining ionic strength of solution	X	X	X	X
Calipers-mechanical, not digital - Measuring lengths very precisely	X			X
Paper Towels - Cleaning	X	X	X	X
Pencil - Writing, Marking Chromatogram		X		
Ruler - Measuring lengths		X		
Magnets – For extraction and identification of iron filings	X	X	X	X
Cobalt Blue Glass – To filter out any sodium that might contaminate flame test from hands		X		

CALCULATOR CLASS DESCRIPTIONS

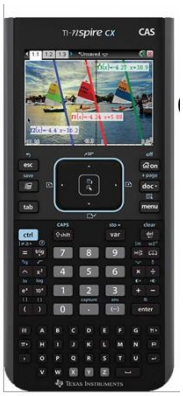
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

The following document was prepared to offer some guidance to teams as they select calculators for use in different Science Olympiad events. **The calulator class listed in the event rules is the most complex calculator level allowed for the event. It is acceptable to use a lower calculator class in the event (e.g., Class III calculator is allowed for the event students are therefor allowed to use a class I, class II or class III calculator).** 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.



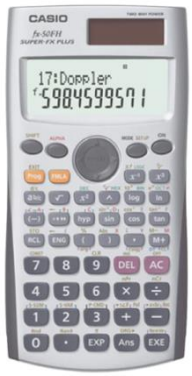
Class I - Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators are the most basic type of calculators and often look like the one shown to the right. These calculators are limited to the four basic mathematics functions and sometimes square roots. These calculators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

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

AVAILABLE TEAM RESOURCES

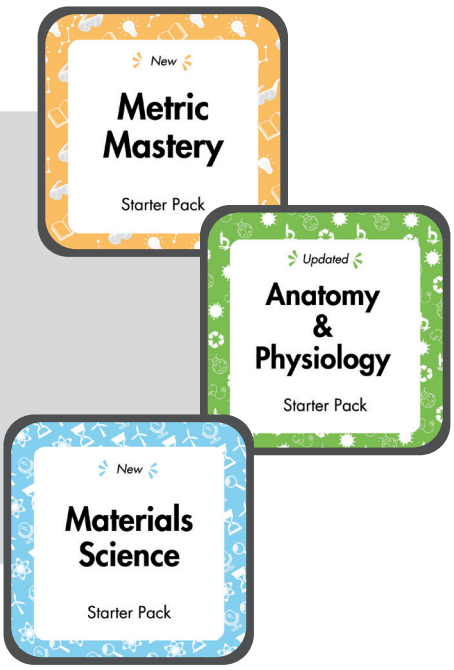
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

STORE OFFERINGS FOR 2025

STORE.SOINC.ORG

STARTER STACKS & PACKS

Use these resources to kick off your 2025 season! Starter Packs include notes and practice tests for individual events. Build your own Stacks for any of your specific events to save money.



NATIONAL TEST PACKETS

Check out the tests from the 2024 National Tournament! You can access packets that include tests, answer keys, and results from the past five National Tournaments.

UPCOMING EVENTS

- **10/5/24 -** The ***Virtual Student Workshop*** offers students the chance to interact with SO alums and receive presentations about their specific events. This one-day event lasts five hours and provides an excellent chance for students to excel in the 2025 season.
- **7/8/25 - 7/10/25** In our ***Virtual Bootcamp*** participants gain early access to the 2026 Rules, engage with experts, and choose sessions that fit their interests. Registration includes instructional videos, live sessions and a hard copy draft of the 2026 Rules.
- **7/16/25 - 7/18/25** The ***Summer Build Clinic*** provides a deep dive into the new events for the 2026 season. This is a great opportunity to collaborate with presenters and other coaches, as well as gain hands-on experience for the upcoming season. This event is for coaches, not students.

NATIONAL TOURNAMENT SCHEDULE

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

2025 National Tournament Division C Schedule
University of Nebraska - Lincoln
Lincoln, Nebraska Saturday, May 24, 2025

Event	7:00 – 8:00 AM	8:00 - 9:00 AM	9:10 – 10:10 AM	10:20 – 11:20 AM	12:00 – 1:00 PM	1:10 – 2:10 PM	2:20 – 3:20 PM	7:30– 9:30 PM
Air Trajectory	Impound	Self-Schedule						
Anatomy & Physiology		11-20	21-30	31-40	41-50	51-60	1-10	
Astronomy		11-20	21-30	31-40	41-50	51-60	1-10	
Bungee Drop	Impound	Self-Schedule						
Chemistry Lab		21-30	31-40	41-50	51-60	1-10	11-20	
Codebusters		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		41-50	51-60	1-10	11-20	21-30	31-40	
Ecology		51-60	1-10	11-20	21-30	31-40	41-50	
Electric Vehicle	Impound	Self-Schedule						
Entomology		21-30	31-40	41-50	51-60	1-10	11-20	
Experimental Design		1-10	11-20	21-30	31-40	41-50	51-60	Closing Ceremony
Forensics		41-50	51-60	1-10	11-20	21-30	31-40	
Fossils		31-40	41-50	51-60	1-10	11-20	21-30	
Geologic Mapping		1-10	11-20	21-30	31-40	41-50	51-60	
Helicopter		Self-Schedule						
Materials Science		51-60	1-10	11-20	21-30	31-40	41-50	
Microbe Mission		1-10	11-20	21-30	31-40	41-50	51-60	
Optics		11-20	21-30	31-40	41-50	51-60	1-10	
Robot Tour	Impound	Self-Schedule						
Tower		Self-Schedule						
Wind Power		31-40	41-50	51-60	1-10	11-20	21-30	
Write It, Do It		41-50	51-60	1-10	11-20	21-30	31-40	

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: University of Nebraska-Lincoln (2025 National Tournament Host), Michigan State University (2024 National Tournament Host), NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network, Science Olympiad USA Foundation, Avantor Foundation, Ward's Science, Corteva Agriscience, Ramboll, Cleveland-Cliffs Foundation, Combined Federal Campaign, Double Good Foundation, Google, ADM Cares, Amcor Cares Foundation, Cambridge Centre for International Research, Centers for Disease Control and Prevention (CDC), Discovery Education 3M Young Scientist Challenge, InGenius Prep, National Free Flight Society, North American Association for Environmental Education, National Oceanic and Atmospheric Administration, Onshape, SkyCiv, Texas Instruments, TKS World, University of Delaware, Catalent, Investing in Communities and Yale Young Global Scholars. Strategic Partners: Japan Science and Technology Agency, mHUB, Midnight Science Club, Million Women Mentors, MxD Digital Manufacturing Institute, NBC Universal Foundation, STEMConnector.

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

Science Olympiad

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