SCIENCE OLYMPIAD™

Exploring the World of Science

Division C Rules Manual

Division C (Gr. 9-12)

WELCOME TO THE 2017 SCIENCE OLYMPIAD

This Rules Manual will help you prepare to compete in any of the 400 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. The Rules Manuals are also available in the iTunes and Google Play Stores.

Division C (Grades 9-12) Membership Rules

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

Division B (Grades 6-9) Membership Rules

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

Students Below Grade Level Designations

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

Science Olympiad Team Membership

Science Olympiad requires that all teams (up to 15 members) competing in any Science Olympiad Tournament (Invitational, Regional, State or National) must be a member of Science Olympiad and pay the national fee (currently $60, paid as part of the state membership). There is no exception to this requirement, regardless of what teams from the same school are called (Varsity, JV, Alternate Team, Extra Team, Team Two, Team B). No school, region or state Science Olympiad organization is allowed to alter or amend these national membership requirements. Please see the Science Olympiad Copyrights and Use statement outlining use of Science Olympiad Rules and procedures at sanctioned tournaments.

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

SCIENCE OLYMPIAD
DIVISION C RULES MANUAL

Table of Contents

- Please read the **General Rules** on the back inside cover - they apply to all events. Note: all changes are in **bold**.
- Coaches: Please remember to register early for the Science Olympiad Summer Institute – it sold out last year!
- Please visit the official Science Olympiad web site: www.soinc.org for **Clarifications/Rules Changes**, FAQs, New Store Items, Membership Information, News, Team Size Requirements, and other valuable information, tips and resources.

ANATOMY & PHYSIOLOGY

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

1. **DESCRIPTION:** Understand the anatomy and physiology of the **human body** systems below.

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

2. **EVENT PARAMETERS:** Each team may bring only one 8.5" x 11" two-sided page of information in any form from any source and up to 2 non-programmable, non-graphing calculators.

3. **THE COMPETITION**: The test is limited to the following topics:

   a. **NERVOUS SYSTEM - All levels should know:**
      i. The Brain - major regions and their functions
      ii. Identification of simple encephalographic wave forms
      iii. Neural Impulses - cellular anatomy and physiology of glial and supporting cells, synapses and neurotransmitters, action potential generation and propagation, ionic basis of the cellular membrane potential, cellular anatomy and physiology of neurons
      iv. Central Nervous System - organization of the spinal cord, purpose/functions of sleep
      v. Peripheral Nervous System - neuroganglia, action of sensory and motor neurons, understand differences in and purposes of parasympathetic, sympathetic, somatic, and sensory systems
      vi. Disorders: Epilepsy, Alzheimer's Disease, Multiple Sclerosis, Parkinson's Disease, Cerebral Palsy, Shingles (herpes zoster), Glaucoma, Pink Eye (conjunctivitis)
      vii. Effects of the drugs: alcohol, caffeine, nicotine, and marijuana on the nervous system

      National Level Only:
      viii. The Brain - anatomy and physiology of brain function including function and role of specific nuclei clusters and tracts, theories of dreaming, neural impulses - retrograde signaling, purpose and principles of MRIs and EEGs
      ix. Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

   b. **SENSE ORGANS - All levels should know:**
      i. Types of sensory receptors, General Senses vs. Special Senses
      ii. Mechanisms for the General Senses of touch, pressure, pain, temperature, itch, and proprioception
      iii. Sense Organs – regions of each of the Special Sense Organs and their functions
      iv. Physiology of sight, hearing, balance, smell, and taste
      v. Disorders: myopia, hyperopia, presbyopia, nyctalopia, astigmatism, conjunctivitis, color blindness, otitis media

      National Level Only:
      vi. Neural pathways for vision, depth perception, and hearing
      vii. Additional Disorders: Diabetic Retinopathy, Macular Degeneration, Glaucoma, Otosclerosis, Presbycusis, Meniere's Disease plus treatments and/or prevention of all conditions listed above

   c. **ENDOCRINE SYSTEM - All levels should know:**
      i. The three classes of hormones – steroids, peptides, and amines
      ii. Mechanisms of hormone action – water soluble vs. fat soluble
      iii. Endocrine related problems – hypersecretion, hyposecretion
      iv. Hormone producing glands, their hormones and the functions of each
      v. Disorders: diabetes mellitus, hypoglycemia, Graves' disease, goiter

      National Level Only:
      vi. Endocrine cycles and negative feedback, Autonomic nervous system control of endocrine function
      vii. Additional Disorders: Cushing's Syndrome, Addison's Disease, and Myxedema, Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

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

Recommended Resources: All reference and training resources including the in-depth **Anatomy and Physiology CD (APCD)** and the introductory **Bio/Earth CD (BECD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

THIS EVENT IS SPONSORED BY THE SOCIETY FOR NEUROSCIENCE (www.sfn.org)

ASTRONOMY

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

1. **DESCRIPTION:** Teams will demonstrate an understanding of stellar evolution and **Type Ia supernova events.**

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

2. **EVENT PARAMETERS:** Each team may bring either two computers (of any kind) or two 3-ring binders (any size) containing information in any form from any source, or one binder and one computer. The materials must be inserted into the rings (notebook sleeves are permitted). Each team member is permitted to bring a programmable calculator.

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 (X-ray, UV, optical, IR, radio), charts graphs and **DS9/JS9 imaging analysis software**, teams will complete activities and answer questions related to:

   a. Stellar evolution, including **stellar classification,** spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, **red giants, white dwarfs (oxygen & helium), neutron stars, planetary nebulas, accretion disks, Type Ia supernovas, dwarf novas, AM CVn systems, Mira variable Stars, globular clusters.**

   b. Use Kepler's laws of rotation and circular motion to answer questions relating to the orbital motions of **binary systems**; use parallax, spectroscopic parallax, the distance modulus **and Hubble's law to calculate distances to Type Ia supernovas.**

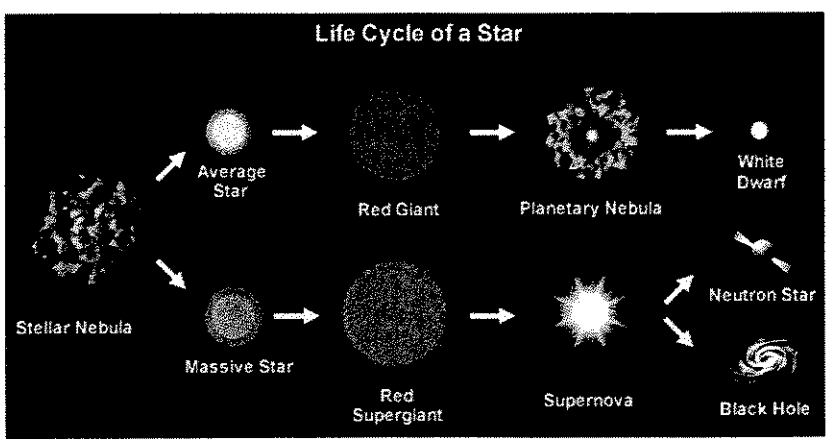
   c. Identify and answer questions relating to the content areas outlined above for the following objects: **J075141/J174140, NGC 2392, SNR 0509-67.5, Omicron Ceti, SN 2011fe, SNR G1.9+0.3, NGC 2440, Henize 2-248, Henize 3-1357 (Stingray Nebula), Tycho's SNR, SS Cygni, M15, HM Cancri, Sirius A & B, NGC 1846.**

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: All reference and training resources including the **Astronomy CD** are available on the Official Science Olympiad Store or Website at www.soinc.org, chandra.harvard.edu/photo/index.html; www.stsci.edu/hst/; apod.nasa.gov/apod/astropix.html; public.nrao.edu/; www.spitzer.caltech.edu/

THIS EVENT IS SUPPORTED BY:

NASA's Universe of Learning Astrophysics STEM Learning & Literacy Network



CHEMISTRY LAB

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

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

A TEAM OF UP TO: 2 **EYE PROTECTION: C** **APPROX. TIME:** 50 min.

2. **EVENT PARAMETERS**:
   a. **Students:** Each student must bring safety equipment and a writing implement and each team may bring two non-camera capability calculators and five 8.5" x 11" sheets of paper that may contain information on both sides in any form from any source (sheet protectors are permitted).
   b. **Supervisors:** Must provide reagents/glassware/references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).
   c. **Safety Requirements:** Students 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 a host requires a specific type they must notify teams). Long hair, shoulder length or longer, must be tied back. Students who unsafely remove their safety clothing/goggles or are observed handling any of the material or equipment in an unsafe manner will be penalized or disqualified from the event.

3. **THE COMPETITION**:
   a. The competition will consist of a series of tasks similar to those in first year high school courses. These tasks could include hands-on activities, questions about each topic, interpretation of experimental data (graphs, diagrams, etc.), or observation of an experiment set up & running.
   b. Supervisors are encouraged to use computers or calculators with sensors/probes. Teams may be asked to collect data using probe ware that has been set up & demonstrated by the Supervisor or they may provide students with data sets collected by such sensors/probes following demonstration of the data collection. Data will be presented in a tabular and/or graphic format & students will be expected to interpret the data.
   c. Students should be aware that nomenclature, formula writing & stoichiometry are essential tools of chemistry & may be included in the event. Stoichiometry includes mole conversions & percentage yield. For purposes of nomenclature & formula writing, students are expected to know the symbols & charges for the following ions: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate & hydroxide. Students should know how to use the "ite" form of anion (one less oxygen than the "ate" form). Students should be able to use the periodic table to obtain the charge for monatomic ions (e.g., Na^{+}, S^{2-}).

4. **SAMPLE QUESTIONS**:
   a. Gases: Students will complete experimental tasks and answer questions related to the physical properties of gases, effect of greenhouse gases and ozone depletion on our climate, behavior of gases described by the following: Avogadro's Law, Boyle's Law, Charles' Law, Dalton's Law, Gay-Lussac's law, Graham's Law, and the ideal gas law. Activities may include: determine the: density of a gas, partial pressure of a gas, molar mass of a gas, relative rates of diffusion. Examine the relationship between: pressure and volume, pressure and temperature, temperature and volume.
   b. **Thermodynamics:** Students should understand the following concepts: direction of heat flow; endothermic and exothermic processes; units of heat measurement (joules, calories, etc.); heat capacity; calorimetry; enthalpy change; thermochemical equations; heat of fusion & solidification; heats of vaporization & condensation; phase diagrams; heat of solution; heat of combustion; heats of reaction; standard heat of formation & heat of reaction; and associated calculations. Activities may include: determine specific heat of metal (coffee cup calorimeter), ΔH of a reaction (acid/base) (endo/exo), determine specific heat of liquid, experiment based on heat exchange between water samples, heat of fusion of ice, heat of combustion of a candle. **State or National level only** may include: Gibbs free energy and entropy and Hess's Law (calorimetry adding hydrate and nonhydrate).

5. **SCORING**: **Approximately** Gases 50% and **Thermodynamics 50%.** Time may be limited at each task, but will not be used as a tiebreaker or for scoring. Ties will be broken by pre-selected questions.

Recommended Resources: All reference and training resources including the **Chem/Phy Sci CD (CPCD)** are available on the Official Science Olympiad Store or Website at www.soinc.org

DISEASE DETECTIVES

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

1. **DESCRIPTION:** Students will use their investigative skills in the scientific study of disease, injury, health, and disability in populations or groups of people with a focus on **Food Borne Illness.**

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:** Each team may bring one 8.5"x11" sheet of paper that may contain information on both sides in any form from any source and up to two non-programmable, non-graphing calculators.
3. **THE COMPETITION: Sample Problems and Resources** may be found at http://www.soinc.org
   a. This event combines a basic understanding of biological and physical agents that cause disease with an ability to analyze, interpret, evaluate and draw conclusions from simple data and communicate results to peers. Students should be able to distinguish between infectious and non-infectious health burdens.
   b. A broad definition of health will be used for this event. Potential topics include health and illnesses (mental, physical, infectious, chronic, environmental, societal, genetic, injuries and health behaviors).
   c. This event will include questions based on:
      i. Study design and data collection, creating graphic displays of data, interpreting trends and patterns of epidemiologic data and communicating results.
      ii. **C Division only** (<10% of test): May include recognizing and accounting for potential sources of error, direct and indirect rate adjustment, stratified analysis (e.g., Mantel-Haenszel test) and use of statistical methods to describe data and test hypotheses involving qualitative and quantitative data.
   d. Students will be presented with one or more descriptions of public health problems.
   e. Based on these descriptions, they will be expected to do the following:
      i. Generate hypotheses and recognize various fundamental study designs.
      ii. Evaluate the data by calculating and comparing simple rates and proportions.
      iii. Identify patterns, trends and possible modes of transmission, sources or risk factors.
      iv. Recognize factors such as study design/biases that influence results (more for Div. C-less for B).
      v. Propose interventions based on promoting positive health behaviors, eliminating or reducing risks of environmental exposures, or disrupting clearly identifiable chains of transmission.
      vi. Translate results/findings into a public health/prevention message for identified populations at risk.
   f. Students will also be expected to:
      i. Define basic epidemiological and public health terms (e.g., outbreak, epidemic, pandemic, surveillance, risk, vector, fomite, zoonosis, etc.).
      ii. Recognize various categories of disease causing agents & give examples of illnesses caused by each.
      iii. Recognize and understand differences among the major groups of infectious agents (e.g., viruses, bacteria, protistans, fungi and animals).
      iv. Recognize examples of various epidemiologic and public health phenomena such as types of outbreaks and modes of transmission.
   g. Calculations and mathematical manipulations should be part of the competition. Data may be contrived or modified to make it more appropriate for this age group as long as it does not radically alter results or interpretation.
   h. Process skills may include hypothesis, observations, inferences, predictions, variable analysis, data analysis, calculations, and conclusions.
   i. The level of questioning for B/C competitions should reflect the age-appropriateness for the two groups.
   j. The event format may be exam-based, station-based or a combination of both.
4. **SCORING:**
   a. Points will be assigned to the various questions and problems. Both the nature of the questions and scoring rubric should emphasize an understanding that is broad and basic rather than detailed and advanced.
   b. 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.
   c. Points should be awarded for both quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods.
   d. Highest number of points will determine the winner. Selected questions may be used as tiebreakers.

Recommended Resources: All reference and training resources including the **Disease Detectives CD** are available at http://www.soinc.org

THIS EVENT IS SPONSORED BY THE U.S. CENTERS FOR DISEASE CONTROL AND PREVENTION

DYNAMIC PLANET

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

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

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

2. **EVENT PARAMETERS:** Each team may bring four 8.5" x 11" sheets of paper that may contain information on both sides in any form from any source. Each **participant** may **also** bring **a "non-graphing" calculator.**

3. **THE COMPETITION:** Participants will be presented with one or more tasks presented as an exam and/or timed stations. An emphasis will be placed on the NGSS Science and Engineering Practices shown on soinc.org. Topics will include the following:
   a. History of the theory of plate tectonics, including key scientists.
   b. Identification of Earth's layers - crust, lithosphere, mantle, asthenosphere.
   c. Types of plates, boundaries and margins - with specific examples. Identification of tectonic boundaries from paleogeographic reconstructions.
   d. Types of tectonic basins, processes that form them, and the nature of the sedimentary record for each (rift basin, back arc basin, foreland basin, intermontane basin).
   e. Driving forces of plate tectonics - mantle convection, mantle plumes, subduction.
   f. Plate movement and impacts of plate movement - Wilson Cycle, terranes, orogenic belts, past supercontinents, convergence, divergence, transform motion, associated faults, opening and closing of ocean gateways and landbridges (with impacts on biota).
   g. Aulacogens and hot spots.
   h. Isostatic adjustments - plate thickness, and the impact of mass wasting and glaciation. Hypsometry and the elevation/depth of continental and oceanic crust.
   i. Natural hazards due to plate tectonics - earthquakes, volcanoes, tsunamis and landslides.
   j. Magma formation - geological settings, chemistry, and properties.
   k. Geologic history of North America: Evolution of the North American craton, Rocky Mountains, Appalachian Mountains and Yellowstone Hot Spot.
   l. Interpretation of geophysical data to understand plate tectonics including brittle and ductile deformation in rocks, magnetic anomalies, gravity anomalies, stress, and seismicity.
   m. Engineering and societal practices to mitigate hazards and protect human life in tectonically active areas.

4. **REPRESENTATIVE TASKS:**
   a. Given a map of selected islands and seamounts of the Hawaiian chain accompanied by the approximate age and distance from the Island of Hawaii for each, participants may be asked to plot the movement of the Pacific Plate on a graph and respond to interpretative questions, including calculations, related to that graph.
   b. Using a paleogeographic reconstruction of the late Cretaceous identify the location of major plate boundaries represented (http://cpgeosystems.com/paleomaps.html).
   c. Given a rate of erosion of rock, estimate the actual movement of the mountaintops over time due to isostatic rebound.
   d. Deconstruct geological event histories from block diagrams.

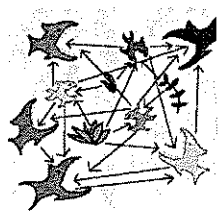
5. **SCORING:** Points will be awarded for the quality and accuracy of responses. Ties will be broken by the accuracy and/or quality of answers to pre-selected questions.

Recommended Resources: All reference and training resources including the **Dynamic Planet CD (DPCD)** and the **Bio/Earth CD (BECD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org.

ECOLOGY

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

1. **DESCRIPTION**: Students will answer questions involving content knowledge and process skills in the area of ecology and adaptations in featured North American biomes.
   A TEAM OF UP TO: 2 **APPROXIMATE TIME**: 50 Minutes
2. **EVENT PARAMETERS:** Each team may bring only one 8.5" x 11" two-sided page of information in any form from any source and up to 2 non-programmable, non-graphing calculators.



3. **THE COMPETITION:**
   This event will be composed of three sections of approximately equal point value. The event will emphasize these process skills as they apply to ecology: defining variables; analyzing data from graphs and tables; presenting data in graphs and tables; forming hypotheses; making calculations and predictions. If stations are used, students must spend the same amount of time at each station.
   a. Part 1: Review of the General Principles of Ecology
      i. General Principles of Ecology - food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics (including density dependent/independent limiting factors, carrying capacity, doubling time, exponential/logistical growth and how to calculate population growth), extinction, selection and migration. At the regional and state level, the general ecological principles should focus on local and regional ecology.
      ii. **Division C State and Nationals only:** life history strategies (e.g., age structure, survival curves, life tables, succession, R and K strategies)
   b. Part 2: Terrestrial Ecosystems
      i. **Ecology of the Tundra, Taiga and Deciduous Forests** (next year's focus: Deserts and Grasslands)
      ii. Understand basic concepts of biodiversity
      iii. **Div. C State and Nationals only:** Be able to apply knowledge of biodiversity (plot maps, simulations of selection effects on populations)
      iv. **Div. C Nationals only:** Understand terminology and be able to calculate biodiversity of sample data (species richness, Simpson index, Shannon-Wiener index)
   c. Part 3: Human Impact on Ecosystems
      i. Topics such as climate change, invasive species, acid rain, erosion, and pollution
      ii. The pros and cons of using alternative energy and its effect on the environment
      iii. Understand the goals of conservation biology and how they can be obtained
      iv. Reclamation of disturbed areas versus reintroduction of species
      v. **Division C State and Nationals only:** Be able to answer questions as they pertain to case studies
4. **SAMPLE QUESTIONS:**
   Division B:
   a. From the description of community interactions, create a food web. Then predict what would happen to the food web if the primary producers were greatly reduced in number by a disease.
   b. Given a description of the interaction between two species, identify the type of community interaction.
   c. List three ways a tundra is different than a taiga.
   d. Compare a tundra with a taiga. What kinds of adaptations may be common in both environments? How are the organisms in each environment adapted for the rates of nutrient recycling that you would expect to find?
   Division C:
   e. Given a complex food web, create a trophic pyramid and determine the amount of energy in each level when given a quantity of energy entering the producer level.
   f. Students are given a graph depicting the changes in two interacting populations of different species in a habitat. Predict which population is the predator and which is the prey. Give reasons for your choices.
   g. Determine the population growth rate for an area given r (rate of increase) and N (number of individuals).
   h. Students are given three age structures and asked to determine which population has the highest birth rate, death rate, doubling time, and mean age.
5. **SCORING:** Questions will be assigned point values. Students will be ranked from highest to lowest score. Ties will be broken by pre-determined tiebreaker questions.
   Recommended Resources: All reference and training resources including the **Ecology CD (ECCD)** and the **Bio/Earth CD (BECD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org.

ELECTRIC VEHICLE

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

1. **DESCRIPTION:** Teams must 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 **TIME:** 8 minutes
2. **CONSTRUCTION PARAMETERS:**
   a. The vehicle must be designed to travel between 9.00 - 12.00 meters and come to a complete stop. The exact distance in these intervals (0.50 m for Regionals; 0.10 m for States; 0.01 m for National) must be chosen by the Event Supervisor (ES) and will not be announced until the impound period is over.
   b. Electrical energy used within the vehicle for any purpose must be stored in common, commercially available batteries labeled with their voltage by the manufacturer. Lead acid batteries are not allowed.
   c. Batteries may be connected in parallel or series as long as the voltage across any two points ≤ 9 V as stated by the manufacturer labels. Batteries need not be installed until immediately prior to the run.
   d. **All energy for propulsion must be electric and come from the batteries. Any non-propulsive functions (ex: 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 may be purchased or made by the team members. Electronic components are allowed.
   f. The wheels/treads in the ready-to-run configuration must fit in a **30.0** x 60.0 cm space of any height.
   g. A single **approximately** ¼" dowel must be attached to the front end of the vehicle. The dowel must be approximately perpendicular to the floor and be the leading part of the vehicle at all times except for a dowel attachment device of ≤ 2.0 cm extending beyond the front of the dowel. The dowel must extend ≥ 20.0 cm from the floor to trigger the photogate system whose lasers are placed 17.0 ± 2.0 cm above the floor. The bottom of the dowel must be ≤ 1.0 cm from the track's surface so that its front bottom edge will be the vehicle's Measurement Point for distance measurements.
   h. Competitors must start the vehicle by using any part of an unsharpened #2 pencil with an unused eraser (provided by the ES) to actuate a button or switch by pushing it perpendicular to the floor.
   i. Sighting/aiming devices may use electricity and may be placed on the track but must be removed before each run. If mounted on the vehicle they may be removed at the team's discretion prior to each run. **Labeled** lasers are permitted - see Laser Policy on www.soinc.org.
   j. The only parts allowed to contact the floor during the run are wheels/treads and those parts in contact with the floor in ready-to-run position. Pieces falling from the vehicle are a construction violation.
   k. The vehicle must not be remotely controlled or tethered and must stop automatically.
   l. Competitors 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. **THE TRACK:**
   a. At the ES's discretion, more than one track may be used. Teams must be given the option to choose which track they will use. Both runs by a team must be made on the same track. All tracks must be on a smooth, level, and hard surface. **Please refer to soinc.org for a diagram of the track.**
   b. The ES must use approximately 2.5 cm wide tape. The **Start Point** and **Target Point** must be clearly marked on 5 cm long tape. **The Bonus Line is marked with tape halfway between the Start Point and Target Point extending perpendicular from an imaginary center line at least 1.0 m to the right when facing the Target Point. The Timing Lines are marked with tape at least 1.5 m long,** 0.50 m and 8.50 m from the Start **Point, centered on and perpendicular to the imaginary center line.** The edge of the tape closer to the starting point defines these lines. See www.soinc.org
   c. **BONUS: Two weighted cans with diameters 7.0 – 8.0 cm, height $\geq$ 10.5 cm are positioned standing upright with their centers on the Bonus Line. The outer can is placed by the ES so that its leftmost edge is 1.0 m from the imaginary center line. Prior to each run the competitors place the inner can at a distance of their choice between the imaginary center line and the outer can. The ES will then record the inner distance between the two cans along the Bonus Line. All parts of the vehicle must travel between the two cans to earn the Bonus. There is no penalty for the vehicle touching the cans. The cans must be removed from the track if the team does not want to attempt the bonus for a specific run.**
   d. A photogate timing system is highly recommended. **If used, it must be set across the track at a minimum distance of 1.50 m between the laser and the gate, and at least a single backup timer must be used for those runs that do not trigger the system.** See www.soinc.org for information. If no photogate system is available, it is recommended that two lasers and three timers be used with the middle time being official.
4. **PRACTICE LOG: Teams must record at least 10 practice runs with at least 3 parameters. The parameters must include distance, time, and any additional parameter. Logs must be impounded.**

5. **THE COMPETITION:**
   a. Teams filing an appeal must leave all impounded material with the ES.
   b. The vehicle, batteries, and spare parts must be impounded before the start of the competition. Tools **(including laptops)**, data and calculating devices need not be impounded.
   c. Only competitors and supervisors must be allowed in the impound and track areas. Once competitors enter the event area, they must not leave or receive outside assistance, materials, or communication. **Competitors may not use AC outlet power during their 8 minutes.**
   d. Teams are given 8 minutes to set up their vehicle and complete up to 2 runs. Vehicles in the ready-to-run configuration starting before the end of the 8 minute time period will be allowed to complete a run.
   e. In the ready-to-run configuration, **the vehicle's Measurement Point must be over the Start Point**. The vehicle must remain **in the ready-to-run configuration** without being touched.
   f. Teams may adjust their vehicle before each run (e.g., change its speed, distance, directional control, change batteries) within their 8 minutes providing the vehicle continues to meet specifications.
   g. Teams may use their own measuring devices to verify the track dimensions during their 8 minutes. **They must not roll the vehicle on the floor of the event track the day of the event without tournament permission. If permitted, only team members may be present.**
   h. **Substances applied to the vehicle must not damage the floor or leave residue on the track and/or event area and be approved by the ES prior to use.** During their **8 minute** time, competitors may clean the track but it must remain dry at all times.
   i. If the vehicle does not move upon actuation, it does not count as a run and the team may request to set up for another run, but must not be given additional time.
   j. **The vehicle must not be propelled backwards at any time during the run.**
   k. Run time starts when the dowel of the vehicle reaches the 0.50 m Line and ends when it passes the 8.50 m Line. The Run Time must be recorded in seconds to the precision of the timing device used.
   l. Once the vehicle starts a run, the competitors must not follow it but must wait until called by the ES.
   m. The team's 8 minute time is paused when the vehicle stops to allow for the supervisor's measurements **and when the bonus distance is being measured**. Timing resumes once the competitors pick up their vehicle or begin making their own measurements.
   n. If the vehicle dowel passes the 0.50 m Line but stops before the 8.50 m Line, the Run Time, which ends when the vehicle comes to a complete stop, is recorded. The run is scored with a Competition Violation.
   o. If a photogate system is used and either the dowel passes the 8.50 m Line outside of the timing system or the vehicle hits part of the system but its dowel still passes the 8.50 m Line, the run is valid and does not have a Competition Violation. A backup timer stops time when the dowel passes the 8.50 m line.
   p. A Failed Run occurs if a second run does not occur in the 8 minutes, or if the time or distance cannot be measured for a vehicle (e.g., it starts before the ES is ready, if the competitors pick it up before it is measured, or it moves but does not go at least 0.50 m).
   q. **The ES must verify with the team the correct recording of data on the team scoresheet.**

6. **SCORING:**
   a. Low Final Score wins. The Final Score is the lower of the 2 Run Scores. The Final Score for any vehicle with one Failed Run must be the other Run Score.
   b. Run Score for each run = Run Time + Distance Score - **Bonus** + Penalties. Negative scores allowed.
   c. Distance Score = point-to-point distance from Measurement Point to Target Point to the nearest 0.1 cm
   d. **Bonus = 0.2 x (110 – distance between the cans to the nearest 0.1 cm as detailed in 3.b.)**
   e. **Teams with incomplete practice logs must incur a Penalty of 250 points. Teams without impounded practice logs must incur a Penalty of 500 points.**
   f. Each Competition Violation must incur a Penalty of 1000 points per occurrence for that run (max. of 4000 pts).
   g. Each Construction Violation must incur a Penalty of 5000 points for that run (max. of 15000 pts).
   h. A vehicle not impounded during the impound period must incur 10000 pts penalty for each run.
   i. Ties must be broken by this sequence: 1. Lower non-used Run Score; 2. Lower Run Time of the better run; 3. Lower Distance Score of the better run.
   j. Teams not completing any runs within the 8 mins. or have 2 Failed Runs receive participation points.

Recommended Resources: Reference and training resources including the **Electric Vehicle DVD (EVD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

THIS EVENT IS SPONSORED BY LOCKHEED MARTIN

EXPERIMENTAL DESIGN

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

1. **DESCRIPTION**: This event will determine a team's ability to design, conduct, and report the findings of an experiment actually conducted on site.

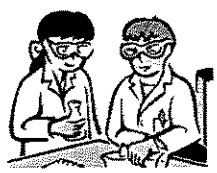
   A TEAM OF UP TO: 3 **EYE PROTECTION**: C **APPROXIMATE TIME**: 50 minutes

2. **EVENT PARAMETERS**: Students must bring goggles and a writing instrument(s) and may bring a timepiece, a ruler, and any kind of calculator. Chemicals that require other safety clothing will not be used.

3. **THE COMPETITION**:
   a. Supervisors must provide teams with identical sets of materials at a distribution center or in a container. 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 is to remain unknown until the start of this event and will be the same for each team. The students must use at least two of the provided materials to design and conduct an experiment.
   b. The supervisor must assign a question/topic area that determines the nature of the experiment. The assigned question/topic area should be the same for all teams and allow students to conduct experiments involving relationships between independent and dependent variables (like height vs. distance).
   c. Supervisors must provide teams with an outline based on the Checklist titles listed below for recording their experiment with additional paper to record data, graphs and procedures.
   d. When the teams are finished, all materials must be returned to the event supervisor along with all written materials. The content of the report must be clearly stated and legible.

4. **SCORING**: Scoring of the event will be done using the checklist below or the expanded one on the website. Zero points will be given for an inappropriate or no response. Points will be awarded dependent upon the completeness of the response. High score wins. Ties will be broken by comparing the point totals in the scoring areas in the following order: Total points for 1-Variables, 2-Procedure, 3-Analysis of Results, 4-Graph, 5-Data Table. Any student not following proper safety procedures will be asked to leave the room and will be disqualified from the event. Any team not addressing the assigned question or topic area will be ranked behind those who do, because not conducting an experiment is a violation of the spirit of the event.

EXPERIMENTAL DESIGN CHECKLIST



a. Statement of Problem: Experimental Question (4 Points)
b. Hypothesis: Including prior knowledge that contributed to hypothesis (8 Points)
c. Variables:
   i. Independent Variable: Factor being manipulated (6 Points)
   ii. Dependent Variable: Factor being measured which responds (6 Points)
   iii. Constants: (Controlled Variables) Factors that are purposefully kept the same (8 Points)
d. Experimental Control (where applicable): (Standard of Comparison) (4 Points)
e. Materials (6 Points)
f. Procedure: Including Diagrams (12 Points)
g. Qualitative Observations During Experiment & Summary of Results: (8 Points)
h. Quantitative Data: including Data Table and for C only use of Significant Figures (12 Points)
i. Graphs: (10 Points)
j. Statistics: Div. B&C: e.g., average (mean), median, mode, range, standard deviation, line of best-fit or other relevant statistics that teams choose (6 Points)
k. Analysis of Results: Interpretation (8 Points)
l. Possible Experimental Errors including identified human errors (6 Points)
m. Conclusion: Include why your results did or did not support the hypothesis: (8 Points)
n. Recommendations for Further Experimentation Based on Your Data & Practical Applications: (8 Points)

Hints: Statement of problem should not have a yes or no answer and should be specific to the experiment being conducted and is not the same as the assigned topic area. Experiments should be simple and have only one independent and one dependent variable and should consist of repeated trials. Variables should be operationally defined.

Recommended Resources: All reference and training resources including the **Experimental Design Guide CD (EXCD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

FORENSICS

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

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

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

2. **EVENT PARAMETERS:**

a. **Students** may bring only these items:
   i. test tubes (brushes & racks), or any devices in which they can perform the tests
   ii. droppers
   iii. funnel(s) and filter paper
   iv. pH or litmus paper
   v. spatulas, plastic spoons, and/or stirring rods
   vi. 9-volt or less conductivity tester (no testers will be allowed that run on AC current)
   vii. thermometer
   viii. flame test equipment (nichrome wire, cobalt blue glass, etc.)
   ix. slides & cover slips
   x. hand lens
   xi. writing instruments
   xii. a pencil and ruler (for chromatograms)
   xiii. paper towels
   xiv. metal tongs
   xv. Each team may bring 5 pages (both sides) containing information in any form from any source (sheet protectors are permitted).
   xvi. Two non-camera calculators

   Note: Students not bringing these items will be at a disadvantage. The Supervisor will not provide them.

b. **Supervisor will provide**:
   i. iodine reagent (I_2 dissolved in KI solution)
   ii. 2M HCl
   iii. 2M NaOH
   iv. Benedict's solution
   v. a hot water bath
   vi. a Bunsen burner or equivalent BTU heat source to perform flame tests
   vii. a waste container
   viii. chromatography materials (e.g., beakers, Petri dishes, etc.)
   ix. a wash bottle with distilled water

c. **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

d. **Safety Requirements:** Students 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 a host requires a specific type they must notify teams). Long hair, shoulder length or longer, must be tied back. Students who unsafely remove their safety clothing/goggles or are observed handling any of the material or equipment in an unsafe manner will be penalized or disqualified from the event.

3. **THE COMPETITION:**

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

a. **Qualitative Analysis**: Substances to identify: 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.

b. **Polymers**: Students may be asked to identify:
   i. **Plastics**: PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA, PC - students may not perform any burn tests on these polymers, but the supervisor may provide burn test results on these plastics.
   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 hair - students will need to know hair structure including medulla, cortex, cuticle, and root.

c. **Chromatography/Spectroscopy**: Students will be expected to separate components using paper chromatography, TLC, and/or analyze mass spectra. Students may be expected to measure Rƒs.

d. **Crime Scene Physical Evidence**:
   i. **Fingerprint Analysis:** Students 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). Students should also be familiar with the common fingerprint development techniques of dusting, iodine fuming, ninhydrin, and cyanoacrylate fuming. Students should understand terminology such as bifurcation, ridges, island, enclosure, loop, whorl, and arch. Students should be able to answer questions about skin layers and how fingerprints are formed. Students may be asked questions on the different methods of detecting fingerprints and the chemistry behind each of these methods.
   ii. **DNA**: Students may be asked to compare DNA chromatograms/electropherograms from materials found at the scene to those of the suspects. Students will be expected to know how DNA is copied. See http://nobelprize.org/educational_games/chemistry/pcr/index.html
   iii. **Glass analysis**: Students 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**: Students 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**: Students 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**: Students 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**: Students may be asked to match tire tracks or footprints found at the scene to tires or shoes of the suspects. Students 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:** Students 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 students 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:** Students may be asked to match the striations on bullets or casings found at the crime scene and fired from a given gun.

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

f. The collected evidence and other data given could be used in a mock crime scene.

4. **SCORING**:
   a. Team with the highest 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.a. 20%, Part 3.b. 20%, Part 3.c.15%, Part 3.d. 15%, and 3.e. 30%.
   c. Tiebreaker: 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.

Recommended Resources: Reference and training resources including the **Forensics CD (FRCD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

GAME ON

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

1. **DESCRIPTION:** This event will determine a team's ability to design and build an original computer game incorporating the theme provided to them by the supervisor using the program Scratch.

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

2. **EVENT PARAMETERS:** No Internet access outside of the Scratch program is allowed. No external resources **or computer programs** of any kind are allowed. No pre-constructed games, game assets or files are allowed.

   a. Teams must bring a writing instrument(s) and may bring:
      i. Headset(s) to assist in testing audio
      ii. A microphone to assist in recording original audio
   b. Supervisors must provide:
      i. A computer capable of running Scratch. Tournaments Directors are encouraged to provide computer specifications to the teams as early as possible
      ii. A broad theme to build their original computer game around
      iii. Scrap paper

3. **THE COMPETITION:**

   a. The supervisor must assign the teams a broad theme that the original computer game will be built around. The theme must be the same for all teams and allow students to build games involving some scientific principles associated with the theme.
   b. Students will use the Scratch program (available for download from http://scratch.mit.edu) to create an original computer game based on the assigned theme.
   c. When teams are finished, they must save their game following the supervisor's instructions in the specified format in a designated location (i.e., USB drive, desktop, online repository).

4. **SAMPLE GAME THEMES**: Some game themes that have been used in the past that are not intended for current tournament use: Wave, Fire, Gravity, Silly sports, Frogs, Newton's Second Law, **Light**.

5. **SCORING:** Scoring of the event will be done using the **Game On Rubric** found on www.soinc.org.

   a. Points will be awarded based on the coding and/or game play of the items.
   b. Zero points will be awarded for items not being present in the game or inappropriate content.
   c. Any team caught using outside resources or accessing the internet outside of the scratch program will be asked to leave the room and be disqualified from the event.
   d. Any team not addressing the assigned theme in their game will be ranked behind those who do, because not addressing the theme is a violation of the spirit of the competition.
   e. High Score wins. Ties will be broken by comparing the point totals in the scoring areas in the following order: Total points for 1 - Game Mechanics, 2 - Game Play, 3 - User Control, 4 - Balanced Play, 5 - Overall Impression/Originality.

Recommended Resources: All reference and training resources including the **Game On DVD (GMD)** and the Game On Rubric are available on the Official Science Olympiad Store or Website at http://www.soinc.org

HELICOPTERS

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

1. **DESCRIPTION:** Prior to the tournament teams design, construct, and test free flight rubber-powered helicopters to achieve maximum time aloft.

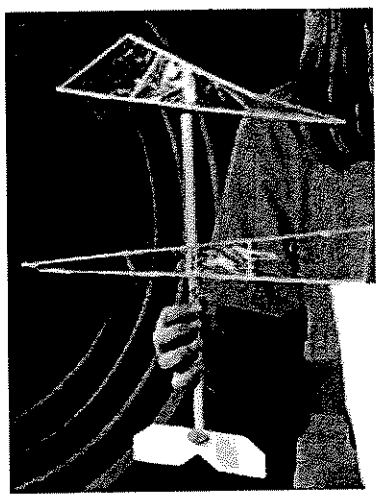
   A TEAM OF UP TO: 2 **IMPOUND:** None **TIME:** 8 minutes

2. **EVENT PARAMETERS:**
   a. Teams bring up to 2 helicopters. Teams may bring any tools and their flight log.
   b. Event Supervisors must provide all measurement tools and timing devices.

3. **CONSTRUCTION PARAMETERS:**
   a. Helicopters may be constructed from published plan(s), commercial kits and/or a student's design.
   b. **Competitors must not use any components with** pre-glued joints or pre-covered surfaces.
   c. 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.
   d. Any materials except Boron filaments may be used in construction of the helicopter.
   e. Total mass of the helicopter throughout the flight, excluding the rubber motor, must be **2.5** g or more.
   f. The helicopter may use up to three fixed pitch rotors, not exceeding a maximum diameter of **20.0** cm. 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. **A path is defined as volumetric space in which the rotating rotor exists while rotating around a central axis. Blades which are offset vertically, but still rigidly connected do not count as single bladed rotors.**
   g. If a single-bladed rotor is used, the maximum radius from the center of rotation to the blade tip must be less than **12.5** cm. This does not include any non-lift generating counterweights.
   h. Competitors 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. Each helicopter must be labeled so the Event Supervisor can easily identify to which team it belongs.
   k. Competitors must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org

4. **THE COMPETITION:**
   a. The event must be held indoors. Tournament officials must 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. Rooms with minimal ceiling obstructions are preferred over very high ceilings.
   b. Once competitors enter the cordoned off competition area to trim, practice, or compete they must not receive outside assistance, materials, or communication. Teams violating this rule must be ranked below all other teams. Spectators must be in a separate area.
   c. During inspection each team must present a flight log of recorded data. Data must include 6 or more parameters (3 required and at least 3 additional) for 10 or more test flights prior to the competition. The required parameters are: 1. Motor size before windup, 2. Number of turns on the motor at launch, and 3. Flight time. The team must choose 3 additional data parameters beyond those required (e.g., turns remaining after landing, estimated/recorded peak flight height, the motor torque at launch, etc.).
   d. At the Event Supervisor's discretion:
      i. Multiple official flights may occur simultaneously according to the Event Supervisor's direction.
      ii. Test flights may occur throughout the contest but must yield to any official flight.
      iii. No test flights will occur in the final half-hour of the event's last period, except for teams that declare a trim flight during their 8-minute flight period.

e. A self-check inspection station may be made available to competitors for checking their helicopters prior to being checked by the Event Supervisor.
f. Competitors may use any type of winder, but electricity may not be available.
g. Competitors must present their event materials (helicopter(s), motor(s), and log) for inspection immediately prior to their 2 official flights. Event supervisors are strongly urged to return flight logs after inspection. Timers must follow and observe teams as they are winding their motors.
h. Teams may make up to a total of 2 official flights using 1 or 2 helicopters.
i. After check-in teams must be given an 8-minute Flight Period, starting when their first flight (trim or official) begins. Any flight beginning within the 8-minute period will be permitted to fly to completion. Competitors may make adjustments/repairs/trim flights during their official 8-minute period. Competitors must declare to the Timers before any launches during their Flight Period whether it is an official flight or trim flight. If teams do not indicate the flight type before the launch, it must be considered official. Teams must not be given extra time to recover or repair their helicopters.
j. Time Aloft for each flight starts when the helicopter leaves the competitor's hand and stops when any part of the helicopter touches the floor, the rotors no longer support the weight of the helicopter (such as the helicopter landing on a girder or basketball hoop) or the judges otherwise determine the flight to be over.



k. Event Supervisors are strongly encouraged to utilize 3 Timers on all flights. The middle value of the 3 Timers must be the official Time Aloft for that flight, recorded in seconds to the precision of the device used.
l. Competitors must not steer the helicopter during flight.
m. 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 eight-minute period does not apply to such a flight.
n. **The Event Supervisor must verify with the team the correct recording of data on the team scoresheet.**

5. <u>SCORING:</u> The score is the Team's longest single flight time. High score wins. Ties will be broken by the longest non-scored flight time.
   a. **Teams receive a 25% bonus added to their flight time for every single-bladed rotor assembly (up to 3) on the helicopter (max 75%).**
   b. Teams with incomplete flight logs must have 10% of their flight time deducted from each flight.
   c. Teams without flight logs must have 30% of their flight time deducted from each flight.
   d. Teams that violate a rule under "CONSTRUCTION" or "THE COMPETITION" that does not have a specific penalty must be ranked after all teams that do not violate those rules.

<u>**Recommended Resources:**</u> Reference and training resources including the **Helicopters DVD** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

THIS EVENT IS SPONSORED BY THE ACADEMY OF MODEL AERONAUTICS
http://www.modelaircraft.org/

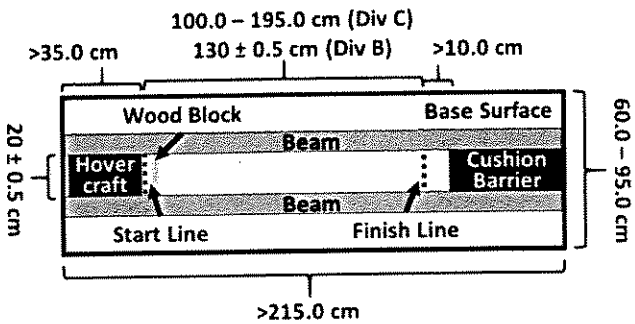
HOVERCRAFT

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

1. **DESCRIPTION**: Competitors may construct a self-propelled air-levitated vehicle with up to two battery-powered motors that turn one propeller each to levitate and move the vehicle down a track. Competitors must also be tested on their knowledge of classic mechanics and related topics.

   A TEAM OF UP TO: 2 **EYE PROTECTION**: B **IMPOUND**: Yes **APPROXIMATE TIME**: 50 minutes

2. **EVENT PARAMETERS**:
   a. All reference materials to be used during all parts of the competition must be initially secured in a 3-ring binder so that regardless of orientation, none can fall out.
   b. Competitors may bring writing utensils and any type of calculators for use during any part of the event.
   c. The vehicle must be placed in a box (vehicle and box must be labeled with the team name and tournament specific team number) and must be impounded. Tools and supplies do not need to be impounded.
   d. Competitors must wear eye protection during Part II. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
3. **THE TRACK**: Example setups are provided on the event page on www.soinc.org
   a. The supervisor must supply two 8' long beams each with a width and height at least 30.0 mm (standard 2x4 metal framing studs recommended to ensure straightness), a cushioned barrier to stop vehicles, a small wood block to hold back the vehicle at the starting line, and a base surface at least 215.0 cm long and between 60.0 and 95.0 cm wide (standard 8' long table or countertop recommended).
   b. Each beam must be clamped or securely affixed to the base with the widest side in contact with the base to form the track side rails. There must be a gap of 20 ± 0.5 cm between them to form the vehicle track.
   c. At one end of the track, a start line must be marked that is at least 35.0 cm from the edge of the track.
   d. At the other track end, the finish line must be marked (see 5.e for location) and a cushioned barrier at least 10.0 cm from the finish line must block the channel.
   e. Multiple tracks may be used to facilitate all teams competing in a timely manner, but the dimensions and specifications of all tracks must be the same.



4. **CONSTRUCTION**:
   a. The vehicle may be made of any material, but must not modify the track.
   b. The length of the vehicle must be between 15.0 and 30.0 cm and cannot exceed 30.0 cm during the run (including any inflated skirts). The vehicle, excluding dowel (see 4.g), must be less than 20.0 cm tall with the propellers in motion when non-levitated.
   c. The mass of the vehicle (including batteries and dowel) must be no more than 2000.0 grams.
   d. It is recommended that the vehicle be adjustable to accommodate variations in track rail width and height.
   e. The vehicle must have no more than two motors each rotating one propeller. Propellers must have shielding with holes less than ¼" in diameter, which the event supervisor must test by trying to pass a ¼" dowel through them.
   f. The entire vehicle, including the propeller(s) and required shielding, must not exceed 19.5 cm in width.
   g. The vehicle must have a 1/4" or larger dowel vertically attached within 5.0 cm of its front edge such that the top end is between 30.0 and 35.0 cm above the lowest vehicle surface.
   h. Commercial batteries, not exceeding 9.0 V as labeled, may be used to energize the motors on the vehicle. Multiple batteries may be connected together as long as the expected voltage across any points does not exceed 9.0 V as calculated by their labels. The vehicle must not have any other energy sources.
   i. Brushless motors and integrated circuits are not permitted.
   j. The vehicle must be levitated on a cushion of air as it moves down the track. Inflated skirts may remain in contact with the base surface, other vehicle components may occasionally contact the base surface, and continuous contact with the inside edge of the side rails is permitted. Competitors may be asked to demonstrate levitation by pushing the vehicle slightly down. If it then rises it is levitated.
   k. Vehicles must have an electric switch to permit safe starting. A stopping system to stop vehicle motion or shut off the motor is recommended.
   l. Competitors must be able to answer questions regarding the design, construction, and operation of the vehicle per the Building Policy found on www.soinc.org.

5. **THE COMPETITION**:

Part I: Written Test

a. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
b. Teams must be given a minimum of 20 minutes to complete a written test.
c. Questions may be multiple choice, true-false, completion, or calculation problems.
d. The competition must consist of at least five questions from each of the following areas:
   i. Newton's Laws of Motion: inertia, force, impulse, action-reaction
   ii. Kinematics: projectile velocity, speed, acceleration, position
   iii. Kinetic energy: calculation, momentum, non-relativistic
   iv. Air cushioned vehicles and applications: history, design, capabilities
   v. Fluid mechanics (Division C only): density, buoyancy, viscosity, Bernoulli's principle, Pascal's law

Part II: Vehicle Testing

e. The length of the timed portion of the track is between 100.0 and 195.0 cm (Division C) / fixed at 130 ± 0.5 cm (Division B). Supervisors must mark the distance on the track.
f. The target time is between 5.0 and 25.0 s. The event supervisor must announce the exact length (Division C only) and time after impound, which must be the same for all teams.
g. Event supervisors must check vehicle specifications during impound or right before a team's testing period begins. Teams must be notified as soon as possible if a vehicle does not meet specifications. Event supervisors may also recheck specifications after a successful run (e.g., to remeasure the mass).
h. Teams must have a total of 8 minutes to adjust and repair their vehicle, and make 5 failed or 2 successful runs (whichever comes first). Event supervisors must give teams a warning at 7 minutes.
i. Teams may modify the vehicle during the impound period or their 8 minutes vehicle testing period, if time is available. This may be to bring the vehicle into compliance with the event specifications.
j. Prior to starting the first run, and without actually turning on the motor, teams must demonstrate a safe starting and stopping process. Vehicle testing period timing must not stop for this demonstration.
k. To begin a run, competitors must place their vehicle on the track directly before the start line. Event supervisors must place a small wood block in front of the vehicle to keep it from moving.
l. When ready, competitors may turn on their motors and indicate that their vehicle is ready.
m. Teams must not touch the vehicle after motors are turned on until the vehicle passes the finish line or the event supervisor declares the run as a failed run.
n. The students must give a countdown of "3, 2, 1, launch". The event supervisor must then release the vehicle by removing the small wood block. Timing must start when the dowel crosses the start line and stop when it crosses the finish line.
o. Supervisors are encouraged to use photogates for more precise timing and use at least one back-up manual timer. If only manual timers are utilized, 3 timers are recommended. The middle value of the 3 timers must be the officially recorded time. Time is recorded in seconds to the device precision.
p. A run must count as long as it is started before the 8-minute period has elapsed.
q. A failed run occurs if a vehicle does not meet construction specifications when timing for that run starts, fails to move for 3 seconds at any time, fails to cross the finish line within triple the target time, or any part of the vehicle falls off. After a failed run, the team must be allowed to repair and restart their vehicle if time remains in the 8-minute period, for a maximum of 5 failed runs.
r. Teams filing an appeal regarding Part II must leave their vehicle in the competition area.
s. The supervisor must verify with the team the correct recording of Part II data on the team scoresheet.

6. **SCORING:** A scoring rubric is available on the event page on www.soinc.org

a. Mass Score (MS) = (mass of vehicle / mass of heaviest successful vehicle of all teams) x 25 points.
b. Time Score (TS) = (1-(abs (run time – target time) / run time)) x 25 points. The smallest possible TS is 0.
c. Teams with no successful runs or that are disqualified for unsafe operation receive a TS and MS of 0. Teams must still be allowed to compete in Part I.
d. The mass of the vehicle must be multiplied by 0.7 when calculating the MS if any construction violation(s) are corrected during the Part II testing period or if the team misses impound.
e. The TS for a successful run must be multiplied by 0.9 when calculating the Final Score if the team violates any of the rules in THE COMPETITION during that run. Rule violations during failed runs do not result in this penalty.
f. Exam Score (ES): (Part I score / Highest Part I score for all teams) x 50 points
g. Final Score (FS) = MS + best run TS + ES. The maximum possible FS is 100 points. High score wins.
h. Tie Breakers: 1st - Best ES; 2nd - Best MS; 3rd – Best other successful run TS; 4th - specific test questions

Recommended Resources: All reference and training resources including the **Hovercraft DVD** and the **Chem/Phy Science CD** are available on the Official Science Olympiad Store or Website at www.soinc.org

HYDROGEOLOGY

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

1. **DESCRIPTION:** Students will manipulate a groundwater computer model, answer questions about groundwater concepts, and evaluate solutions, based on hydrogeological evidence, to reduce anthropogenic effects on groundwater.

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

2. **EVENT PARAMETERS:**
   a. **The local supervisor will provide needed equipment and the test for Part 1. The Groundwater Foundation will provide the Hydrogeology Challenge scenario URL, background notes, answer sheets, keys and other resources for Parts 1 & 2 if requested.**
   b. Students may bring a calculator, writing utensils, a protractor and each team may bring one 8.5"x11" sheet of paper that may contain information on both sides in any form from any source.

3. **THE COMPETITION:** Students will be given Parts 1 - 3 at the beginning of the event and have 50 minutes to complete them in any order. Students will complete Parts 2 & 3 using a scenario **provided by the supervisor or The Groundwater Foundation if requested**. See http://groundwater.beehere.net for sample computer model program and practice scenarios.
   a. **Part 1**: Students take a written test that must consist of at least one question related to each of the following areas: the fundamentals of groundwater and hydrogeology, surface-groundwater interactions, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Questions can be multiple choice, true/false, fill in the blank, or short answer.
   b. **Part 2**: Students will use and manipulate the scenario provided by the supervisor. Static pumping conditions will be used in the scenario to answer questions.
      i. Supervisors will provide the Hydrogeology Challenge scenario URL to students.
      ii. Students must fully complete the scenario for three wells in static conditions. The three wells will be provided by the supervisor (For example: Wells A, B, and C).
      iii. Students will submit results online.
   c. **Part 3**: The supervisor will provide a **situation in which a contaminant is introduced.** Students will: 1) evaluate the risk of contamination to wells in the Hydrogeology Challenge scenario, 2) explain any and all assumptions that were made in their analysis, and 3) complete a Remediation Techniques Table.
      i. The **situation** must include the following: a **contaminant** (from the Contaminant Table found online), a **contamination** source to be located at one well**, and at least one well must be pumping water (non-static conditions)**. The **situation** may include **information on** well types, well uses, and/or any other information the supervisor deems relevant.
      ii. Students will manipulate the Hydrogeology Challenge scenario to determine which wells are at risk of contamination and approximately how long until the contamination may occur.
      iii. Students will fill out a Remediation Techniques Table for the given **situation** (see example table online). The supervisor will provide the remediation techniques in the Remediation Techniques Table. The student will have to fill out**:** the remediation technique definition, whether the technique is in-situ or ex-situ, the type of technique (chemical, biological, etc.), the **relative** cost of the technique (low, medium, or high), and whether the technique is applicable to the contamination given in the **situation**. Students and supervisors may use the Remediation Table for Hydrogeology (located online) as a guide, but are not limited to the techniques listed in this resource.
      iv. Students will use their results from the Hydrogeology Challenge and Remediation Techniques Table to answer questions about the **situation**. Questions can be multiple choice, true/false, fill in the blank, or short answer.

4. **SCORING:** Highest total score wins. **(Part 1 = 30%, Part 2 =10%, Part 3 = 60%).** First tiebreaker: highest score on Part 3. Second tiebreaker: highest score on pre-selected questions from Part 1. Answers must include units where appropriate.

Recommended Resources: All reference and training resources including the **Hydrogeology DVD (HGD)** and the **Problem Solving and Technology CD (PTCD)** are available on the Official Science Olympiad Store or Website at www.soinc.org. For rules questions go to FAQs and for more information or help go to www.groundwater.org/so.html

THIS EVENT IS SPONORED BY THE GROUNDWATER FOUNDATION

INVASIVE SPECIES

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

1. **DESCRIPTION:** This event will test student knowledge of invasive species in local and national ecosystems.

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

2. **EVENT PARAMETERS:**

Each **team** may bring one 3-ring binder (any size) containing pages of information in any form from any source. *Note: Currently there is no field guide that includes all of the invasive species. In preparation for this exam students should consider preparing a resource binder based on invasive species on the **Official List** and those identified by their state or regional director **by November 1st**.

3. **THE COMPETITION:**

a. Each team will be given an answer sheet on which they will record answers to each section.
b. The competition may be run as stations and/or as a PowerPoint presentation.
c. Specimens/pictures will be lettered or numbered at each station. The event could include live and preserved specimens, skeletal material, recordings of songs, and slides or pictures of specimens.
d. Participants should be able to do basic identification to the level indicated on the Official List. States may have a state or regional list. See your state web site. No more than 50% of the competition will require providing common or scientific names.
e. Each specimen/picture will have one or more questions accompanying it on some aspect of its life history, distribution, anatomy and physiology, reproduction, habitat characteristics, ecology, diet, behavior, history, control methods, laws and regulation.
f. The ecology questions may pertain to any ecological aspect of the species, including invasive behavior, habitat, niche, trophic level, or adaptive anatomy.
g. The National competition will be based on **National Invasive Species Official List.**

4. **SAMPLE QUESTIONS:**

a. Place in-order the life cycle pictures of a zebra mussel.
b. Which invasive plant (common name) is also a problem host for soybean aphids? (Common Buckthorn)
c. Which genus of trees is threatened by the *Agrilus* genus in America? (*Fraxinus*)

5. **SCORING:**

Points will be awarded for the quality and accuracy of responses. High score wins. Ties will be broken by the accuracy and/or quality of responses to several pre-identified questions.

Recommended Resources: All reference and training resources including the **Bio/Earth CD (BECD)** are available on the Official Science Olympiad Store or Website at www.soinc.org There is no universal field guide to the invasive species of the United States - see http://www.invasivespeciesinfo.gov/unitedstates/

THIS EVENT IS SPONSORED BY ORKIN

MATERIALS SCIENCE

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

1. **DESCRIPTION**: Teams will answer a series of questions or complete tasks involving the science processes of chemistry focused in the areas of Materials Science.
   A TEAM OF UP TO: 2 **EYE PROTECTION**: C **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS**:
   a. **Teams** may bring: two non-camera calculators, writing utensils and 5 pages (both sides) containing information from any source (sheet protectors are allowed).
   b. **Event Supervisors** will provide: any materials needed for lab stations.
   c. **Safety Requirements**: Students 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 a host requires a specific type they must notify teams). Long hair, shoulder length or longer, must be tied back. Students who unsafely remove their safety clothing/goggles or are observed handling any of the material or equipment in an unsafe manner will be penalized or disqualified from the event.
3. **THE COMPETITION**:
   a. The competition will focus on: evaluating the mechanical performance of materials and the intermolecular forces of materials.
   b. The event will consist of an activity or activities with supporting questions.
   c. Students will interpret data by preparing data tables and constructing graphs of the data.
   d. All measurements must be recorded with correct significant figures and units. All calculations must also include correct significant figures and units.
4. **LABS**: Material Performance & Atomic/Molecular Structure Topics are limited to:
   a. **General properties of material classes (metals, ceramics, polymers, composites)**: i. **Physical characteristics** (density, strength, thermal properties, etc.), ii. **Manufacturing techniques and natural occurrences**, iii. **Chemical composition** (elements, bonds, etc.)
   b. **Material characterization techniques**: i. **Visual** (optical and electron microscopy), ii. **Physical tests**: Stiffness of material (Young's Modulus), Breaking strength of a material (Yield Strength), Surface Area/Volume ratio, Permanent deformation of material under constant load (Creep Rate), Resistance to flow (Viscosity). For State and National tournaments: Resistance to fracture (Fracture toughness), Resistance to repetitive strain (Fatigue Limit), Stiffness under shear load (Shear Modulus), Transverse, inherent strain (Poisson's Ratio), Bulk Modulus. iii. **Material selection for specific applications** (choosing the best material for an application based off of a list of materials and their properties)
   c. **Intermolecular Forces and Surface Chemistry**: i. **Chemical tests**: Surface Chemistry, surface tension, contact angle. ii. **Crystal Structures**; Ionic, Covalent, Crystalline, Semi-Crystalline, Amorphous, Common atomic packing (FCC, BCC, HCP, Simple Cubic), Atomic packing factor (Geometry only)
5. **SAMPLE QUESTIONS**: See Science Olympiad (www.soinc.org) website for Sample Questions
   a. **Material Performance Relationships**:
      i. Using an apparatus provided by the event supervisor: generate a stress vs. strain curve, and calculate Young's modulus, identify the yield strength and offset yield strength.
      ii. For a ceramic material, what types of bonds are generally formed, and how does this contribute to properties such as density, hardness, and brittleness
   b. **Intermolecular Forces and Surface Chemistry:**
      i. Based on droplet characteristics, characterize the hydrophobicity or hydrophilicity of the provided surfaces. For example, students may be asked to identify unknown surfaces or rank the hydrophobicity of the provided surfaces.
      ii. Using the Wilhelmy plate apparatus and the provided equation, determine the surface tension of a liquid. Evaluate changes in surface tension with the application of surfactants or other liquids.
      iii. Students may be provided images to measure contact angles, evaluate boiling points of liquids, perform polymer melt tests for crosslinking, and will answer questions related to these measurements.
6. **SCORING**: **Material Performance (lab and written exam) 50% and Intermolecular Forces (lab and written exam) 50%.** All ties will be broken by pre-selected questions chosen by the supervisor.
   Recommended Resources: All reference and training resources including the **Chem/Phy Science CD (CPCD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

MICROBE MISSION

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

1. **DESCRIPTION**: Teams will answer questions, solve problems, and analyze data pertaining to microbes.

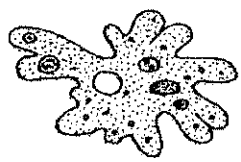
   A TEAM OF UP TO: 2 **EYE PROTECTION**: C **APPROXIMATE TIME**: 50 Minutes

2. **EVENT PARAMETERS**: Students must provide goggles and may bring non-programmable calculators. Each team may bring one 8.5" x 11" sheet of paper that may contain information on both sides in any form from any source. Measurements must be made to the precision of the device.

3. **THE COMPETITION**: The event may be run as timed stations. Students will be given questions pertaining to different types of microbes. Some questions/stations may involve the actual use of a microscope. If no microscopes are available, high quality photographs with appropriate scales may be used instead. Most questions should emphasize age/division appropriate process skills such as: data interpretation from graphs and tables, use of a dichotomous key, drawing conclusions, calculations, metric conversions, determining actual size of the organism, inferences, and making observations. Students may be asked to perform simple laboratory procedures as measurements or using probes (sufficient information will be provided at the station). Possible live specimens may include only baker's yeast, ciliates, amoebae, lichens, and algae. Pictures & prepared slides are appropriate for all microbial types.

   Regional and State Tournaments (B & C): The competition should cover all of the topics and not emphasize just one area such as microbial disease. **Note: Disease questions must be restricted to the 2017 Microbial Diseases on www.soinc.org.**

   a. Different kinds of microscopes and their uses. Parts and their function of light microscopes, principles of microscopy, and magnification and field of view determination.
   b. Recognition and function of nucleus, mitochondria and chloroplasts, and their possible microbial origin.
   c. Differences (e.g., size, environment, structure, prokaryotic vs. eukaryotic, etc.) among prions, viruses, bacteria, Archaea, fungi, algal and animal like protists, and parasite worms.
   d. Roles of microbes in commercial production, spoilage, preservation & decomposition of various foods.
   e. Diseases caused by different kind of microbes and the treatment/prevention of these diseases.
   f. Estimation/calculation of size based on scales in pictures or microscopic information and amount of the visual field occupied.
   g. Growth curves; graph interpretation.
   h. Beneficial microbes vs. Dangerous microbes.



   Division C (only)

   i. Names for and recognition of various bacterial shapes
   j. Gram stain uses and difference between gram$^+$ & gram$^-$
   k. Important aspects of spores & cysts

   National Tournament (B & C)

   l. All state/regional level material
   m. Resistance to various antimicrobial agents
   n. Role of microbes in the causes of plant diseases
   o. Causes and effects of microbial population explosions
   p. Microbial competition

4. **SAMPLE QUESTIONS**:
   a. Provide two differences among bacteria, viruses, and fungi.
   b. Using the following key, determine (from pictures) which cell, A, B, or C is considered an alga.
   c. Based on the following graph, determine which organism is best suited for growth in acid environment.
   d. A cell is observed through a light microscope at 4x magnification. The cell takes up about half of the visual field. What is the approximate length of this organism?
   e. Students observe a picture of a plate with different colonies on it. Based on the color of the colony, how many different kinds of organisms do you detect? Which type of organism appears to be the most prevalent?
   f. From this picture identify the organelle, its function, and state which type of microbe it is unique to.
   g. What type of microbe is involved in the production of most breads?
   h. What type of microbe is responsible for polio?
   i. Based on the following graph, what will be the microbial population/ml after 3.5 hours of growth?
   j. Match the disease with the type of organism that causes it.

5. **SCORING**: Highest score will determine the winner. Selected questions may be used as tiebreakers.

Recommended Resources: All reference and training resources including the **Microbe Mission CD** are available on the Official Science Olympiad Store and Website at http://www.soinc.org.

THIS EVENT IS SPONSORED BY DUPONT

OPTICS

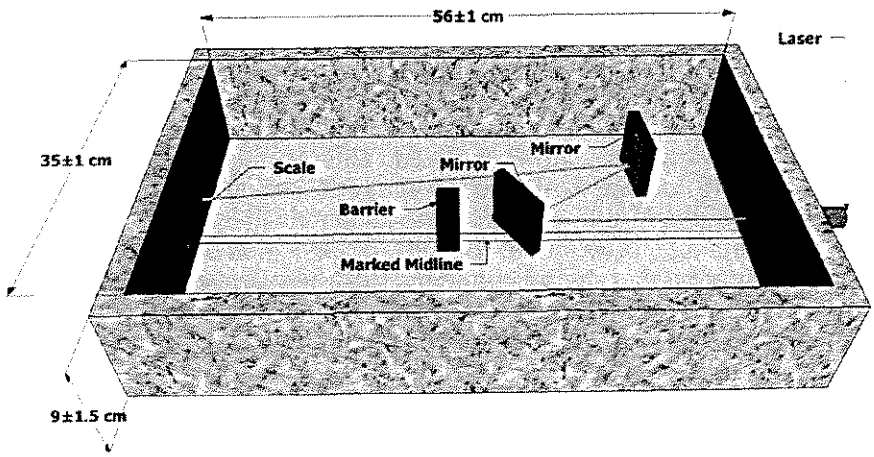
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION**: Teams must participate in an activity involving positioning mirrors to direct a laser beam towards a target. Teams must also be tested on their knowledge of geometric and physical optics.

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

2. **EVENT PARAMETERS**:
   a. All reference materials to be used during all parts of the competition must be initially secured in a 3-ring binder, so that regardless of orientation none can fall out.
   b. Competitors may bring any measuring tools, premade templates, writing utensils and any type of calculators for use during any part of the competition. Competitors must not bring lasers or mirrors.

3. **LASER SHOOT SETUP**: Example setups are available on the event page on www.soinc.org
   a. The event supervisor must provide the Laser Shoot Setup (LSS), including laser, mirrors and barriers. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.
   b. 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.



   c. 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.
   d. 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.
   e. 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. The event supervisor must test the beam's alignment before each team is permitted to see the LSS.
   f. A metric scale with a resolution of at least 1 mm must be attached horizontally to the other 35 cm wall 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.
   g. A barrier must be placed somewhere along the midline to block the laser beam (non-perpendicular angles permitted). In Division C only, 2 additional barriers must be placed elsewhere in the LSS.
   h. Barrier(s) must have a width of 2.0 to 8.0 cm and be tall enough to block the laser beam. They must be fixed in the same position and orientation in the LSS for all teams. One barrier must have a mirror similar to the others attached to one side and covered similarly. Competitors must not adjust the mirror's position. In Division C, any of the three barriers may have the mirror.

4. **THE COMPETITION**:
   Part I: Written Test
   a. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   b. Teams must be given a minimum of 20 minutes to complete a written test.

c. Questions may be multiple choice, true-false, completion, or calculation problems.
d. The competition must consist of at least two questions from each of the following areas:
   i. Law of reflection: specular, diffuse
   ii. Refraction: index of refraction. In Division C also Snell's law & critical angle
   iii. Prism: deviation, dispersion
   iv. Convex, concave, and plain mirrors: ray tracing, focal length, real object, images (real/virtual, erect/inverted, magnification)
   v. Convex and concave lens: ray tracing, focal length, real object, images (real/virtual, erect/inverted, magnification). In Division C also thin lens & lensmaker's equations
   vi. Operating principles of optical equipment: microscopes, telescopes, cameras, glasses
   vii. Visible spectrum: primary/secondary colors, additive/subtractive, absorption/reflection
   viii. Structure and function of the parts of the human eye
   ix. Polarization of light using polarizing films or by scattering
   x. Optical absorption spectra: films, chemicals, dyes

   Division C at State and National Tournaments only:
   xi. Ray tracing of two perpendicular or parallel plane mirrors: corner reflector, periscope
   xii. Ray tracing or measurement to find the focal length of a lens system: real and virtual objects and images (erect/inverted, magnification)
   xiii. Lasers: theory of operation, difference between coherent and non-coherent light

Part II: Laser Shoot

e. The objective is to reflect a laser beam with mirrors around barriers towards the Target Point.
f. 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.
g. All mirrors must be placed in a home position designated by the event supervisor before each team is permitted to see the LSS.
h. 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.
i. Competitors must make all measurements, calculations, and mirror placement/alignment within a 4 minute time period. Competitors may choose to use between 1 and 5 moveable mirrors.
j. 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 other mirror coverings. The supervisor must not remove the coverings.
k. Competitors must not mark on or modify the LSS.
l. Competitors must not touch the laser or change its orientation and/or position.
m. 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. Competitor tools/templates may remain on the LSS during this process.
n. The supervisor must verify with the team the correct recording of Part II data on the team scoresheet.

5. **SCORING:** A scoring rubric is available on the event page on www.soinc.org
   a. Test Score (TS) = (Part I score / Highest Part I score of all teams) x 50 points
   b. Mirrors Score (MS) = # moveable mirrors the laser reflects off of x 4 points. The max possible MS is 20.
   c. Accuracy Score (AS) = (25 – (accuracy (in mm)/10)) points. The smallest possible AS is 0.
   d. 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.
   e. If the laser does not strike a wall, AS is 0, but the MS and BS should still be calculated.
   f. Teams that are disqualified for unsafe operation receive an AS, MS and BS of 0, but must still be allowed to compete in Part I.
   g. The AS, MS, and BS must be multiplied by 0.9 when calculating the Final Score if the team violates any of the rules in THE COMPETITION.
   h. Barrier Score (BS) = 5 points if the laser reflects off the barrier mirror
   i. Final Score (FS) = TS + MS + AS + BS. The maximum possible FS is 100 points. High score wins.
   j. Ties are broken using designated question(s) on the written test. The supervisor must identify the tiebreaker to the competitors at the beginning of the competition period.

Recommended Resources: All reference and training resources including the **Chem/Phy Sci CD** are available on the Official Science Olympiad Store or Website at www.soinc.org

REMOTE SENSING

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

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

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

2. **EVENT PARAMETERS**: Each participant may bring one 8.5" x 11" two-sided sheet of paper containing any information from any source. Each participant may bring a metric ruler, a protractor, and any kind of (non-graphing) calculator, but no other resources.

3. **THE COMPETITION**: The event will consist of questions and activities testing concepts related to the collection and use of remote sensing data to observe and study climate change processes in the Earth system. Each of the following topic areas should compose approximately 25% of the test:

   a. Remote sensing instrumentation and physics: active vs. passive sensors; optical and infrared imagers; radiometers; LiDAR; precipitation radar; blackbody radiation; Planck function, Wein's Law; Stefan-Boltzmann Law; beam attenuation; absorption and scattering by aerosols; refraction and refractive indices; scattering
   b. Interpretation of remote sensing images and data sets from NASA A-Train satellites: Atmospheric and sea-surface temperature (AMSR-E); global mean temperature; energy flux (CERES); optical, infrared and Doppler radar imagery of clouds and precipitation (MODIS, CALIPSO, CLOUD-SAT); CO_2 cycle (OCO-2); ocean color and ocean productivity (MODIS); aerosol scattering, absorption and optical depth (MODIS); detection of trace gas concentrations by satellites (OCO-2, AURA) and LiDAR
   c. Climate processes and climate change: greenhouse gases (concentrations and distribution) and trace gas concentrations; clouds and radiation; aerosol forcing; carbon cycle; surface albedo; comparison of remote sensing data with climate model data
   d. Using, applying and interpreting the output of small-scale models of planetary energy balance

4. **REPRESENTATIVE ACTIVITIES**:
   a. Compare visible and IR satellite images of clouds to interpret relationships between clouds and outgoing radiation, and to explain how clouds influence the Earth's radiative balance.
   b. Given information characterizing the extinction coefficient of a layer of dust in the atmosphere and the observed reduction in outgoing radiation, calculate the thickness of the dust layer.
   c. Use data from NASA's OCO-2 satellite to determine CO_2 concentrations in different latitudinal bands, modify a simple energy balance model to include an idealized greenhouse gas response to these CO_2 concentrations, and show how this affects global atmospheric temperature.

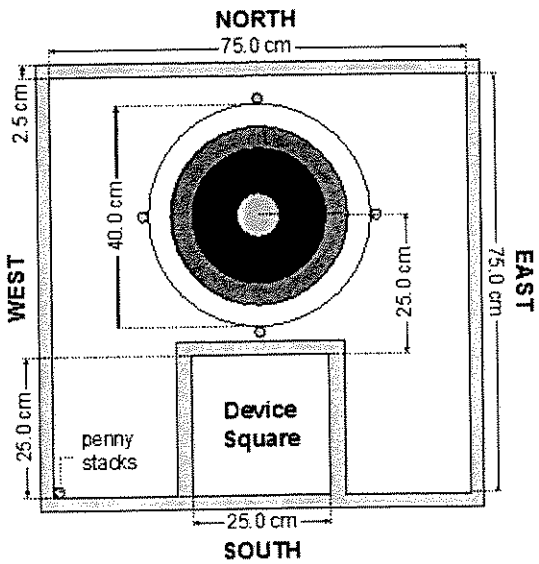
5. **SCORING**: Points will be awarded for the quality and accuracy of responses. Ties will be broken by the accuracy and/or quality of answers to selected questions.

Recommended Resources: All reference and training resources including the **Remote Sensing CD** and the **Bio/Earth CD** are available on the Official Science Olympiad Store or Website at www.soinc.org. Students are encouraged to explore these models of the Earth's energy to understand the earth's radiation budget and event supervisors are encouraged to use the output from these models in their exams to illustrate key concepts: climatemodels.uchicago.edu/modtran/, forecast.uchicago.edu/Projects/full_spectrum.html, www.shodor.org/master/environmental/general/energy/index.html

ROBOT ARM

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

1. **DESCRIPTION:** Prior to the competition, teams must design, build, document, and test one robotic device to move **U.S. Lincoln cents (pennies)**.
   A TEAM OF UP TO: 2 **IMPOUND:** No **EYE PROTECTION:** B **APPROX. TIME:** 10 min.
2. **EVENT PARAMETERS:** Teams must provide one Device. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows, otherwise not be allowed to compete and scored as a no-show. The Supervisor provides the Competition Area and **pennies**.
3. **CONSTRUCTION PARAMETERS:** The Device includes the Arm(s), remote control box(es) (e.g. **wireless, hard-wired**, etc.), **their associated connections**, and optional separate power supply.
   a. The Arm(s) may be attached to a Base. **In the ready-to-run position,** all parts (except the control box(es), separate power supplies, and their connections) must fit inside an imaginary **25**.0 cm x **25**.0 cm x 100.0 cm high rectangular prism. The Device must be attached to the Device Square only by the force of gravity.
   b. Commercial kits may be used, but each must have at least one functional modification, **of which** the lack of **the modification** will result in the Device working differently or not working.
   c. While pneumatics are permitted, storage devices must not start with positive gauge pressure.
   d. Only commercial batteries, not exceeding 14.4 volts as labeled, may be used to energize each of the Device's electrical circuits. Multiple batteries may be connected in series or parallel as long as the expected voltage output across any **two** points does not exceed 14.4 volts as calculated using their labeled voltage. Teams must be able to show the Event Supervisors (ES) the labeled voltage. All energy storage devices must be contained in the Device, power supply, or controller(s). **Lead-acid batteries are not allowed. Laptops/tablets not connected to a wall outlet may be used to control the Device and their internal voltage does not need to be checked.**
   e. Competitors must go to www.soinc.org to check legal and permitted frequencies for radio-controlled equipment for surface devices.
   f. Students must be able to answer questions regarding the design, construction, and operation of the Device per the Building Policy (see www.soinc.org) and Technical Documentation in 4.a.-c.
4. **TECHNICAL DOCUMENTATION** (must be submitted with the Device at check-in and include):
   a. Illustration (photos, drawings, etc.) of the basic structure of the Device with labels (consistent with the Operating Description) that must show: i. All actuators; ii. All energy sources; iii. All controls used to interact with the Device.
   b. Operating Description: i. Device reaction to each control input, ii. Tentative/proposed plan of movement (i.e., which pennies will be moved, how the Device plans to move the pennies).
   c. Written Practice Log: Record at least 10 runs of at least 3 parameters including score and time.
5. **COMPETITION AREA:** The Competition Area is a 75.0 cm x 75.0 cm square marked using the **inside** edge of tape approx. 2.5 cm wide. The ES must designate each of the 4 sides as North, East, South, and West. The surface of the competition area may be any nominally flat board, floor surface, table, etc. See www.soinc.org for an expanded view of Competition Area.
   a. The inside edge of tape is used to mark a **25.0** cm x **25.0** cm square (the "Device Square") inside of, centered on, and sharing the South edge of the Competition Area.
   b. **A standard 40 cm archery target following FITA standards (or a printout of it) is taped down on all sides or marked onto the Competition Area. The center of the target is 25 cm north of the Device Square's northern inside edge, centered between the west and east edges of the Competition Area. Concentric circles of radii 4.0 cm, 8.0 cm, 12.0 cm, 16.0 cm, and 20.0 cm separating the target into zones must be visible.**
   c. **Five stacks of pennies, with 10 pennies each, heads side up, are placed such that one stack is tangent to, and outside of each of the west, north, east, and south edges of the 20.0 cm radius circle. One stack is also placed just inside the southwest corner of the Competition Area.**



6. **COMPETITION**:
   a. At check-in, the ES will inspect and measure the Device, select **6** items from the Technical Documentation, and have the competitors point them out on their Device.
   b. **Teams will be given 3 minutes for each of two runs.**
   c. **Prior to the first run** teams will have 2 minutes of Preparation Time to set up and test their Device in the Competition Area. **There will be 2 minutes between the two runs to reset the robot and board.**
   d. Prior to **each** run, the Device must be in the Device Square in the ready to run configuration.
   e. Prior to **each** run, the ES must verify the timekeepers and competitors are ready. Three (3) Timers are suggested, recording the middle time as the Run Time. The ES will then count aloud "1, 2, 3, Go". Teams will have 3 minutes, starting from the word "Go", to complete the task of moving the **pennies.**
   f. **Pennies and Target** must not be damaged and must remain usable for other teams.
   g. The run must stop (and the time recorded to the precision of the Timers) when any of the following occurs (none of these actions will move the team to a lower tier):
      i. 3 minutes **for each run** has elapsed from the word "Go"
      ii. The competitors say "Science"
      iii. The competitors contact the Competition Area a second time after being warned once
      iv. The competitors impart energy directly into the Arm, Base, or **pennies**
      v. Any end effectors are moved by anything besides stored energy in the Device
      vi. Any part of the Device (except for end effectors and connections to control boxes) touching the Device Square surface in the ready to run configuration exits the Device Square
      vii. **Any part detaches from the Device**
   h. All **pennies** must be scored based on where they are at the end of the run when time is stopped.
   i. Teams who wish to file an appeal must leave their Technical Documentation and Device with the ES.
   j. **The ES must verify with the team the correct recording of data on the team scoresheet.**
7. **SCORING:** High score wins. At the end of a run, **points** are awarded based on the **pennies** in the specified scoring areas **and any Bonus**. **The total points for the best single run will be the Run Score.**
   a. Teams must receive the following points for each **penny lying completely flat, heads-up on the competition area** at the end of the Competition Time **by being in specific zones. These zones, as described in 5.b., are listed by their radius from the center of the target below. Any pennies in multiple zones and/or touching the line separating two zones as determined by the ES will receive points of the lesser point-value zone. Any penny under or over another penny or not visible to the ES must not receive any points.**

	< 4.0cm	4.0cm-8.0cm	8.0cm-12.0cm	12.0cm-16.0cm	16.0cm-20.0cm	> 20.0cm
Regional	5	4	3	2	1	0
State	10	7	5	3	1	0
National	15	10	7	3	1	0

   b. **Each penny satisfying 7.a. but tails up receives twice the point value listed in 7.a.**
   c. **Bonus: Teams receive 10 Bonus Points if all parts of the Arm(s) and optional Base are within the vertical space above the Device Square at the end of the run.**
   d. **Final Score = Run Score x Penalty Multiplier(s)**
   e. For each item incorrectly identified in 6.a. a Penalty Multiplier of 0.98 will be assessed. (Max 6 times)
   f. For Incomplete Technical Documentation a Penalty Multiplier of 0.95 will be assessed.
   g. For no Technical Documentation a Penalty Multiplier of 0.80 will be assessed.
   h. Ties are broken by 1) Best non-scored run; 2) Shortest Run Time of best single run; 3) Shortest Run Time of non-scored run.
   i. Tiers:
      i. Tier 1: Devices that meet all requirements.
      ii. Tier 2: Devices with only Competition violations.
      iii. Tier 3: Devices with any Construction violations or both Competition and Construction violations.
      iv. Participation Points only: Devices that violate the frequency rules; that have no capability, by design or construction, to score points via moving pennies; or are unable to compete.

Recommended Resources: All resources including the **Robot Arm DVD (RAD)** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

THIS EVENT IS SPONSORED BY LOCKHEED MARTIN

ROCKS & MINERALS

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

1. **DESCRIPTION**: Teams will demonstrate their knowledge of rocks and minerals.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME**: 40-50 Minutes

2. **EVENT PARAMETERS**: Each **team** may bring one magnifying glass and one 3-ring binder (any size) containing pages of information in any form from any source.

3. **THE COMPETITION**:

   a. Emphasis will be placed upon task-oriented activities. Participants will move from station to station, with the length of time at each station predetermined and announced by the event supervisor. Participants may not return to stations, but may change or add information to their original responses while at other stations.
   b. Written descriptions as to how a specimen might react were it to be tested with HCl may be provided. HCl will not be used or provided.
   c. Identification will be **limited to specimens** appearing on the **Official Science Olympiad Rock and Mineral List** (see www.soinc.org), but other rocks or minerals may be used to illustrate key concepts.
   d. Tournament Directors may include up to five additional specimens important to their own state. If additional specimens are to be included, all teams must be notified **no later than three weeks prior to the competition.**

4. **REPRESENTATIVE TOPICS (may include, but are not limited to)**:

   Minerals:
   a. Identification
   b. Properties: hardness, luster, streak, cleavage/fracture, density, etc.
   c. Classification: see list
   d. Chemical composition
   e. Mineral habit (e.g., botryoidal, hexagonal, prismatic, bladed)
   f. Methods & environments of formation
   g. Economic importance (e.g., ores, industrial uses, jewelry)

   Rocks:
   h. Identification
   i. Rock cycle
   j. Classification: sedimentary, igneous and metamorphic
   k. Environments of formation
   l. Texture and composition
   m. Bowen's reaction series
   n. Grade of metamorphism

5. **REPRESENTATIVE STATION ACTIVITIES**:

   a. Using the materials provided, fingernails included, determine the relative hardness of each of these six minerals. List the specimens, by name and number, in order of increasing hardness.
   b. Match each metamorphic rock with the parent rock from which it may have been formed.

6. **SCORING**: Total scores will determine rankings in this event. Ties will be broken by the accuracy or quality of responses to preselected questions.

Recommended Resources: All reference and training resources including the **Rock & Mineral Teaching Guide (RMCD),** the **Bio/Earth CD (BECD)** and the **National Audubon Society Field Guide to North American Rocks and Minerals** are available on the Official Science Olympiad Store or Website at www.soinc.org, and the **Rocks and Minerals kits** (*excluding only silver, gold, and diamond) may be ordered from Ward's Science Olympiad Kits.

TOWERS

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 and build a Tower meeting requirements specified in these rules to achieve the highest structural efficiency.
   A TEAM OF UP TO: 2 **IMPOUND:** NO **EYE PROTECTION:** B **MAXIMUM TIME:** 6 minutes
2. **EVENT PARAMETERS:**
   a. Each team is allowed to enter only one Tower, built prior to the competition.
   b. All competitors must properly wear eye protection at all times. Competitors without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows, otherwise not be allowed to compete and be ranked in Tier 4.
   c. The Event Supervisor must provide the Test Apparatus (4.).
3. **CONSTRUCTION PARAMETERS:**
   a. The Tower must span a 20 cm x 20 cm opening on a Test Base (4.a.) and may be placed on the Test Base surface in any configuration such that the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base. **Bonus points (6.b.) 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. (No part of the tower may touch or be supported within the 29 cm circle).**
   b. **The Tower must support the Loading Block (4.b.i.) a minimum of 50.0 cm (Div. B) or 60.0 cm (Div. C) above the Test Base. There is no maximum Tower height.**
   c. The loading point on the Tower must be constructed to permit placement of the Loading Block (4.b.i.) and suspended chain (4.b.iii) on and through the Tower, to support the bucket (4.c.).
   d. The Tower must be constructed such that only the Loading Block (4.b.i.) supports the chain and bucket.
   e. The Tower may not be braced against any edge of the Test Base (4.a.) for lateral support at any time.
   f. No portion of the Tower is allowed to extend below the top surface of the Test Base (4.a.) prior to testing.
   g. The Tower must be a single structure, with no separate or detachable pieces.
   h. The Tower must be constructed of wood and bonded by adhesive. No other materials are permitted.
      i. **Wood is defined as the hard fibrous substance that makes 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, commercial plywood, members formed of sawdust and adhesive, or paper labels.
      ii. There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated without restriction by the team.
      iii. Adhesive is defined as a substance used to join two or more materials together. Any commercially available adhesive may be used. Adhesives include, but are not limited to: glue, cement, cyanoacrylate, epoxy, hot melt, polyurethane and super glues. Adhesive tapes are not allowed.
   i. Students must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org
4. **TEST APPARATUS:** Supplied by the Event Supervisor
   a. The Test Base must be a solid, level surface as follows:
      i. be at least 55 cm long x 32 cm wide.
      ii. have a smooth, hard, low-friction surface (e.g. hardwood, metal, high-pressure plastic laminate) and be stiff enough that it does not bend noticeably when loaded.
      iii. have a 20 cm x 20 cm square opening at its center.
      iv. **have a 29 cm circle drawn on the surface, centered on the 20 cm x 20 cm square opening**
   b. The Loading Block Assembly must consist of:
      i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt.
      ii. ¼" threaded eyebolt (1" nominal eye outside diameter), no longer than 3", and a ¼" wing nut.
      iii. A chain and S-hook that are suspended from the Loading Block Assembly.
   c. An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain.
   d. Sand or other clean, dry free-flowing material (hereafter "sand").
   e. Bucket Stabilizing Sticks – Two (2) stabilization sticks, each made up of a piece of ½" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org
   f. At the Event Supervisor's discretion, more than one Test Apparatus may be used.
5. **COMPETITION:**
   a. **Check-In**
      i. The structure height must be assessed by the Event Supervisor to assure it meets or exceeds the minimum Tower height (3.b.) in cm to the nearest 0.1 cm.

ii. Team members must place their structures on the scale for the Event Supervisor to determine the structure mass, in grams to the nearest 0.01 g.
iii. **The team must submit their Load Scored estimate for the load supported to be used as a tie breaker (6.e). Load supported includes the Loading Block Assembly, bucket and sand.**
iv. No alterations, substitutions, or repairs may be made to the structure after check-in for competition. Once teams enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.

b. **Testing**
i. The Event Supervisor must verify that the combined mass of the Loading Block Assembly, bucket and sand, is at least 15,100 g but no more than 15,200 g prior to testing.
ii. Team members will have a maximum of 6 minutes to setup their Tower and test it to maximum load, failure, or run out of time.
iii. Team members must place the Tower on the Test Base and assemble the Loading Block Assembly and bucket as required to load the Tower. Team members may disassemble the Loading Block Assembly if necessary. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Tower to deflect.
iv. Team members must be allowed to adjust the Tower until they start loading sand. Once loading of sand has begun, the Tower must not be further adjusted.
v. **The Event Supervisor must verify that no part of the Tower's span touches or is within the 29.0 cm diameter circle for the Tower to qualify for the "Load Scored Bonus".**
vi. Team members must 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 team members is NOT allowed. Teams choosing to stabilize the bucket must use the bucket stabilization sticks (4.e.). Only the tips of the springs may touch the bucket.
vii. Loading must stop immediately when a failure occurs or when time expires. The Event Supervisor must remove any parts of the structure that have fallen into the bucket and remove any sand added after failure or time expiration.
viii. Towers that fail before supporting 15,000 g must be scored according to the actual weight supported at time of failure (6.a.), measured to the nearest gram or best precision available. Failure is defined as the inability of the Tower to carry any additional load, or if any part of the load is supported by anything other than the Tower. Incidental contact between the chain/eyebolt and the structure is not failure.
ix. Teams who wish to file an appeal must leave their Tower with the Event Supervisor.
x. **The Event Supervisor must verify with the team the correct recording of data on the team scoresheet.**

6. **SCORING:**
a. The Load Scored is the measured load supported, including the Loading Block Assembly, bucket and sand, but may not exceed 15,000 g. The least possible Load Scored must be the mass of the Loading Block Assembly. Towers that cannot support the Loading Block Assembly must be ranked in Tier 4.
b. **Load Scored Bonus: Towers spanning the 29 cm diameter circle receive a 2,000 gram bonus.**
c. Score = [Load Scored (g) + **Load Scored Bonus** (g)] / Mass of Tower(g)
d. Towers must be scored in four tiers as follows:
i. Tier 1: meeting all the Construction Parameters and no Competition Violations.
ii. Tier 2: with one or more Competition Violations.
iii. Tier 3: with Construction Violations or both Competition and Construction Violations.
iv. Tier 4: unable to be loaded for any reason (e.g., cannot accommodate Loading Block, or failure to wear eye protection), and must be ranked by: 1. Lowest mass; 2. Tallest height.
e. Ties are broken by this sequence: **1. Load Scored estimate (5.a.iii) closest to actual Load Scored (6.a) without going over Load Scored,** 2. Lowest Tower mass
f. Example score calculations:
i. Tower 1: mass = 15.12 g, load supported = 12,134 g, Bonus = NO; Score = 802.5
ii. Tower 2: mass = 15.12 g, load supported = 12,134 g, Bonus = YES; Score = 934.8
iii. Tower 3: mass = 12.32 g, load supported = 13,213 g; Bonus = NO; Score = 1072.5
iv. Tower 4: mass = 12.32 g, load supported = 13,213 g; Bonus = YES; Score = 1234.8

Recommended Resources: Reference and training resources including the **Tower DVD (TWRD)** are available on the Official Science Olympiad Store or Website at www.soinc.org

THIS EVENT IS SPONSORED BY ARCELORMITTAL

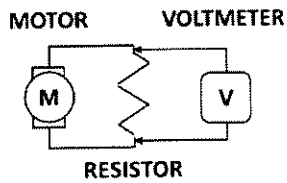
WIND POWER

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

1. **DESCRIPTION:** Teams may build a blade assembly that consists of any kind of propeller/pinwheel/rotor attached to a compact disc (CD), which will be used to capture wind power. Teams must also be tested on their knowledge regarding alternative energy.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** Yes **APPROX. TIME:** 50 minutes

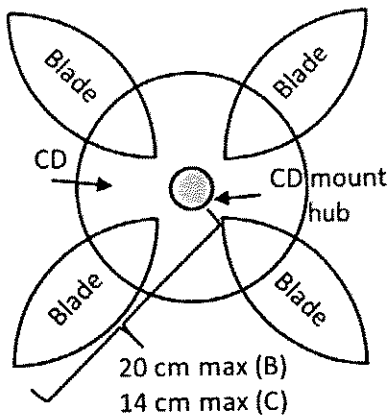
2. **EVENT PARAMETERS:**
   a. All reference materials to be used during **all parts** of the competition must be **initially** secured in a 3-ring binder so that regardless of orientation none can fall out. Materials such as pencils, pens, protractors, rulers, **any type of** calculators, and any other similar tools may also be used during the **event**.
   b. The blade assembly must be placed in a box (assembly and box must be labeled with the team name and competition #) and must be impounded. Tools and supplies do not need to be impounded.
   c. Competitors must wear eye protection during Part I. Teams without proper eye protection must be immediately informed and given an opportunity to obtain eye protection if time allows.
   d. The supervisor must provide the testing materials listed below (Example setups are provided on the event page on www.soinc.org), which must be the same for all teams:
      i. One or two 20" multispeed box fan(s) to be used as the wind source (**recommended fans listed on www.soinc.org)**
      ii. Support stand(s) that allow for vertical and horizontal adjustments of the blade assembly
      iii. Motor/generator(s) mounted to the support stand(s), **with axis of rotation approximately parallel to that of the fan**
      iv. Load resistor(s) between 5 and **25** ohms **(1/4 Watt or greater)** wired in parallel with the motor/generator that must have the same value for all teams
      v. Device(s) to measure voltage across the load resistor



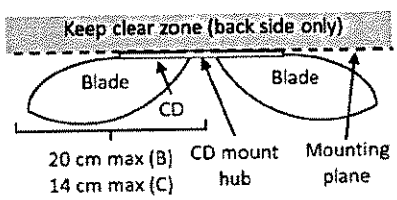
   e. The motor/generator must be equipped with an adapter to accommodate a standard 12.0 cm CD or if the motor/generator is from a CD player, it must be removed from the CD player and mounted on the support stand.

3. **CONSTRUCTION:**
   a. Each team may bring one pre-constructed blade assembly attached to a 12.0 cm **diameter** CD **(teams must not bring the testing materials listed in 2.d.)**. Note: adjacent diagrams do not show CD to scale.
   b. The CD must fit on the mount found in a standard CD player. Modification of the CD is not allowed (except to affix the blades **via tape, glue, etc.**).
   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 20 cm (Div B) / 14 cm (Div C).
   d. The blade assembly must be made of only nonmetallic substance(s).
   e. Commercial kits or third party designs may be used, but must have at least one functional modification, defined as a modification such that the lack of it will result in the assembly working differently or not working.
   f. When **initially** mounted, no part of the blade assembly may extend behind the mounting plane of the CD. This is to ensure clearance with the motor/generator and support stand. There is no limit on how far forward the blade assembly may extend.
   g. Competitors must be able to answer questions regarding the design, construction, and operation of the blade assembly per the Building Policy found on www.soinc.org.

Example Assembly Front View



Example Assembly Side / Top View



4. **THE COMPETITION:**
   Part I: Device Testing
   a. The blade assembly must be tested once with the fan at a high wind speed and once at a low wind speed. There may be one or two test stations. If there are two, one must be used for all high wind speed tests and the other for all low wind speed tests. The load resistors at each station are allowed to be different, but must be consistent for all teams.
   b. The fan(s) must be mounted in a fixed position with the bottom of the grill at least 15 cm above the table.

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

Part II: Written Test

k. Teams must be given a **minimum of** 20 minutes to complete a written test.
l. Questions may be multiple choice, true-false, completion, or calculation problems.
m. Unless otherwise requested, answers must be provided in metric units with appropriate significant figures.
n. The test must consist of at least 5 questions **from** each **of** the following areas:
   i. Wind power rotor/fan blade design (e.g., types of designs, pros/cons of designs, ways to improve designs, sources of loss)
   ii. Power generator general questions (e.g., generator design for wind, nuclear, coal, gas, solar, or hydroelectric power plants)
   iii. Power storage questions (e.g., how is the power stored during charging and how is it used during discharge, concepts relating to methods of power storage)
   iv. Power transmission questions (e.g., ways electricity is transmitted, how power is lost in transmission, ways to reduce power loss)
   v. Historical wind power designs (e.g., types of windmills, usage, design pros/cons)

5. **SCORING: A scoring rubric is available on the event page on www.soinc.org**
   a. If the blade assembly stops turning for a period of 10 or more seconds during the measurement period, has any pieces that detach from the assembly, or the team **violates any of THE COMPETITION rules**, the **Max Voltage** at that wind speed must be multiplied by **0.9** when calculating the **Final** Score.
   b. **Both Max Voltages must be multiplied by 0.7 when calculating the Final Score if any construction violation(s) are corrected during either Part I testing periods or if the team misses impound.**
   c. A team's Final Score must be determined as follows (with highest score winning) =
      25 x (Part I low speed Max Voltage / Highest Part I low speed Max Voltage of all teams) +
      25 x (Part I high speed Max Voltage / Highest Part I high speed Max Voltage of all teams) +
      50 x (Part II score / Highest Part II score of all teams)
   d. The **Max Voltages** must be zero if a team is disqualified for unsafe operation, modifying a CD, or fails to bring a blade assembly. Teams must still be allowed to compete in Part II.
   e. Ties must be broken by: 1st the highest high-speed voltage; 2nd the highest low speed voltage.

Recommended Resources: All reference and training resources including the **Wind Power DVD** are available on the Official Science Olympiad Store or Website at http://www.soinc.org

WRITE IT/DO IT

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

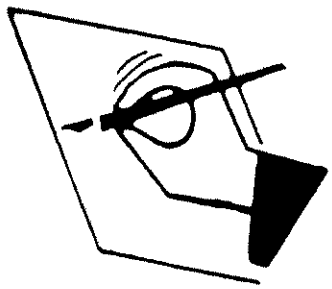
1. **DESCRIPTION**: One student will write a description of an object and how to build it, and then the other student will attempt to construct the object from this description.

   A TEAM OF: 2 **APPROXIMATE TIME**: 55 Minutes

2. **THE COMPETITION**:

   a. A student is shown an object (which may be abstract, but is the same for all teams and ideally one per team) 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.).

   b. One student 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. 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.** Students 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.

   c. The supervisor of the event will pass the description to the remaining team member who will take the description and attempt to recreate (build) the original object in twenty (20) minutes.

   d. Supervisors will attempt to use different materials than the materials that were used last year.

3. **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: All reference and training resources including the Problem Solving and Technology CD are available on the Official Science Olympiad Store or Website at www.soinc.org

GENERAL RULES

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

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

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

Tentative Schedule for the 2017 National Tournament at the Wright State University, Dayton, Ohio

Event	7:00 to 8:00 am	8:15 to 9:15 am	9:30 to 10:30 am	10:45 to 11:45 am	noon to 1:00 pm	1:15 to 2:15 pm	2:30 to 3:30 pm
Anatomy and Physiology		1-10	11-20	21-30	31-40	41-50	51-60
Astronomy		41-50	51-60	1-10	11-20	21-30	31-40
Chemistry Lab		1-10	11-20	21-30	31-40	41-50	51-60
Disease Detectives	All Teams						
Dynamic Planet		1-10	11-20	21-30	31-40	41-50	51-60
Ecology		51-60	1-10	11-20	21-30	31-40	41-50
Electric Vehicle	Impound	online schedule					
Experimental Design	All Teams						
Forensics		21-30	31-40	41-50	51-60	1-10	11-20
Game On		41-50	51-60	1-10	11-20	21-30	31-40
Helicopters		online schedule					
Hovercraft	Impound	online schedule					
Hydrogeology		31-40	41-50	51-60	1-10	11-20	21-30
Invasive Species		41-50	51-60	1-10	11-20	21-30	31-40
Materials Science		31-40	41-50	51-60	1-10	11-20	21-30
Microbe Mission		31-40	41-50	51-60	1-10	11-20	21-30
Optics		51-60	1-10	11-20	21-30	31-40	41-50
Remote Sensing		21-30	31-40	41-50	51-60	1-10	11-20
Robot Arm		online schedule					
Rocks & Minerals		11-20	21-30	31-40	41-50	51-60	1-10
Towers		online schedule					
Wind Power	Impound	11-20	21-30	31-40	41-50	51-60	1-10
Write It Do It		11-20	21-30	31-40	41-50	51-60	1-10

SCIENCE OLYMPIAD™

Exploring the World of Science

Science Olympiad wishes to acknowledge the following business, government and education leaders for partnering with our organization. Working together, we can increase global competitiveness, improve science and technology literacy and prepare the STEM workforce of the future. Thanks to: Wright State University (2017 National Tournament Host), University of Wisconsin-Stout (2016 National Tournament Host), ArcelorMittal, Combined Federal Campaign, NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network, Lockheed Martin, NBC Universal Foundation, Ward's Science, ACE Hardware, Centers for Disease Control and Prevention (CDC), Discovery Education 3M Young Scientist Challenge, DuPont Center for Philanthropy and Education, DuPont Pioneer, National Marine Sanctuary Foundation, National Oceanic and Atmospheric Administration (NOAA), Orkin/Rollins, Texas Instruments, VWR Foundation, Academy of Model Aeronautics, Chandra X-Ray Center, Investing in Communities, MAKE Magazine, Society for Neuroscience (SfN) and Yale Young Global Scholars. Strategic Partners: American Association for the Advancement of Science (AAAS), Digital Manufacturing and Design Innovation Institute (DMDII), The Groundwater Foundation, Hardware Science, Japan Science and Technology Agency, Maker Education Initiative, Million Women Mentors and Milwaukee School of Engineering (MSOE).

See the Science Olympiad website: www.soinc.org for current information regarding Summer Institutes, Teaching Guides, CDs, DVDs, and Standards

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