SCIENCE OLYMPIAD™

Exploring the World of Science

Division C Rules Manual

Division C (Gr. 9-12)

WELCOME TO THE 2018 SCIENCE OLYMPIAD

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

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

Division C (Grades 9-12) Membership Rules

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

Division B (Grades 6-9) Membership Rules

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

Students Below Grade Level Designations

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

Science Olympiad Team Membership

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

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

SCIENCE OLYMPIAD
DIVISION C RULES MANUAL

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 one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source along with two non-programmable, non-graphing calculators **dedicated to computation**.
3. **THE COMPETITION:**
   Participants will complete a written test limited to the following topics. **Topics listed in *italics* will only be assessed at the National Tournament.**
   a. **RESPIRATORY SYSTEM:**
      i. Anatomy and functions of the respiratory system
      ii. Mechanisms of pulmonary ventilation
      iii. Patterns of breathing
      iv. Measures of pulmonary ventilation
      v. Gas exchange and O_2 transport including oxygen disassociation curves
      vi. Effects of exercise and high altitude on the respiratory system
      vii. Understand disorders: COPD, asthma, emphysema, pneumonia, sleep apnea and cystic fibrosis
      viii. *Additional diseases/disorders of: tuberculosis, pulmonary edema, Pleurisy, small cell and non-small cell lung cancer*
      ix. *Blood chemistry and the respiratory rhythm*
      x. *Regulation of the respiratory system*
      xi. *Ability to read a spirogram as related to pulmonary ventilation*
      xii. *Treatments and/or preventions (drugs, surgery, etc.) for ALL conditions listed above*
   b. **DIGESTIVE SYSTEM:**
      i. Anatomy and functions of the digestive system
      ii. Basic anatomy of the component parts of the alimentary canal and accessory organs of digestion
      iii. Anatomy of the four layers of the wall of the alimentary canal
      iv. Comparison of the lining of the esophagus, stomach, small intestine and large intestine
      v. Compare and contrast mechanical and chemical digestion
      vi. Physiology of chemical digestion of proteins, fats and carbohydrates
      vii. Effects of exercise and obesity on the digestive system
      viii. The diseases on each level from the cell to the whole person as listed: stomach & duodenal ulcers, cancers of the digestive system, diarrhea, lactose intolerance, hepatitis, appendicitis
      ix. *Additional diseases: diverticular disease, GERD, Crohn's Disease and celiac disease*
      x. *The function of the liver and pancreas in the digestive system, including Kupffer cell function*
      xi. *Treatments and/or prevention (drugs, surgery, etc.) for ALL conditions listed above*
   c. **IMMUNE SYSTEM:**
      i. Anatomy and functions of the immune system
      ii. Anatomy and physiology of nonspecific defense system
      iii. Anatomy and physiology of specific defense system
      iv. Physiology of the immune response and allergic reactions
      v. Role of the lymph system in immunity
      vi. Disorders: immunodeficiencies (HIV/AIDS), autoimmune diseases (multiple sclerosis, rheumatoid arthritis & Grave's Disease), and hypersensitivities (contact dermatitis)
      vii. *Types of Organ Transplants and Prevention of Rejection (allograft and autograft)*
      viii. *Additional disorder: systemic lupus erythematosus and psoriatic arthritis*
      ix. *Treatments and/or prevention for ALL conditions listed above*
4. **SCORING:** High score wins. Selected questions will be used to break ties.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Anatomy and Physiology CD and Bio/Earth Science CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY THE SOCIETY FOR NEUROSCIENCE

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 II** Supernova Events.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one of the following sources of information:
      i. two computers/tablets of any kind;
      ii. one computer/tablet and one three-ring binder; or,
      iii. two three-ring binders
   b. If three-ring binders are used, they may be of any size containing information in any form and from any source, attached using the available rings. The information may be removed during the event.
   c. Each team may bring two calculators of any type **dedicated to computation** to use during the event.
   d. No Internet access is allowed during any part of this event.

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, **HII regions, red supergiants, Cepheids, semiregular variables, luminous blue variables, hypergiants, Wolf-Rayet stars,** neutron stars, **magnetars, pulsars, stellar mass black holes, eclipsing binaries, X-ray & gamma-ray binary systems, Type II supernovas.**
   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, and the distance modulus **to calculate distances to Type I and Type II Cepheids, and Hubble's law to calculate distances to galaxies**.
   c. Identify and answer questions relating to the content areas outlined above for the following objects: **RCW 103, IC 443, Alpha Orionis, HR 5171 A, SN W49B, ASASSN-15lh, AG Carinae, S Doradus, SN 1987A, Geminga, NGC 6357, NGC 7822, M82 X-2, PSR B0355+54, DEM L241, Circinus X-1.**

4. **SCORING:**
   a. The high score wins. All questions will have been assigned a predetermined number of points.
   b. Selected questions will be used to break ties.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Astronomy CD, Bio/Earth Science CD and Audubon Night Sky Guide; other resources are on the event page at soinc.org

THIS EVENT IS SPONSORED 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 **Physical Properties** and thermodynamics.

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

2. **EVENT PARAMETERS**:
   a. Each student must bring safety equipment (e.g., goggles, lab coat, apron) and a writing utensil. Each team may bring two calculators of any type **dedicated to computation** and five 8.5" x 11" sheets of paper that may contain information on both sides in any form and from any source.
   b. 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. Shoulder length hair, 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.
   c. Supervisors must provide reagents/glassware/references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).

3. **THE COMPETITION**:
   a. The competition will consist of a series of tasks similar to those in **introductory** high school courses. These tasks could include hands-on activities, questions about each topic, interpretation of experimental data (i.e., graphs, diagrams), or observation of an already set-up and running experiment. **Approximately 50% of the questions/activities will relate to Physical Properties and 50% will relate to Thermodynamics.**
   b. Supervisors are encouraged to use computers or calculators with sensors/probes. Teams may be asked to collect data using probeware 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-}).
   d. **Students should understand the following Physical Property concepts: density; color; conductivity; boiling & melting points; electrical resistance; elasticity/brittleness; heat capacity; specific heat; solubility; magnetism; extensive (amount of matter) & intensive (type of matter) properties.**
   e. Students should understand the following Thermodynamic 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.
   f. **Concepts that may only be addressed at the State or National level include***: Gibbs free energy, entropy, and Hess's Law (calorimetry adding hydrate and non-hydrate).*

4. **SAMPLE QUESTIONS/ACTIVITIES**:
   a. **Use density to identify an unknown metal.**
   b. **Determine the density of a liquid using a pycnometer.**
   c. **Separate a mixture by physical properties (e.g., magnetism, solubility).**
   d. Determine specific heat of metal (coffee cup calorimeter).
   e. Determine ΔH of an acid/base or endothermic/exothermic reaction.
   f. Determine specific heat of liquid based on heat exchange between water samples.

5. **SCORING**: High score wins. Time may be limited at each task, but will not be used as a tiebreaker or for scoring. Selected questions may be used as tiebreakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Chem/Phy Science CD; other resources are on the event page at soinc.org.

DISEASE DETECTIVES

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

1. **DESCRIPTION:** Participants will use their investigative skills in the scientific study of disease, injury, health, and disability in populations or groups of people 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" x 11" sheet of paper that may contain information on both sides in any form and from any source along with two **calculators of any type dedicated to computation**.
3. **THE COMPETITION:**
   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. Participants 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. The event format may be exam-based, station-based or a combination of both.
   d. The level of questioning for B/C competitions should reflect the age-appropriateness for the two groups.
   e. 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. **Division C 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 hypothesis involving qualitative and quantitative data.
   f. Participants will be given one or more descriptions of public health problems and be expected to:
      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; **this will be emphasized more for Division C and less so for Division 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.
   g. Participants 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.
   h. Calculations and mathematical manipulations will be part of the competition. Data may be contrived or modified to make it appropriate for the age group as long as it does not radically alter results or interpretation.
   i. Process skills may include hypothesis, observations, inferences, predictions, variable analysis, data analysis, calculations, and conclusions.
   j. Sample Problems and Resources may be found at www.soinc.org
4. **SCORING:**
   a. High score wins. Selected questions may be used as tiebreakers.
   b. Points will be assigned to the various questions and problems. Both the nature of the questions and scoring will emphasize an understanding that is broad and basic rather than detailed and advanced.
   c. Depending on the problem, scoring may be based on a combination of answers, including graphs/charts, explanations, analysis, calculations, and closed-ended responses to specific questions.
   d. Points will be awarded for both quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Disease Detectives CD and Bio/Earth Science CD; other resources are on the event page at 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:** Participants will demonstrate an understanding of the large-scale processes affecting the structure of Earth's crust.

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

2. **EVENT PARAMETERS:** Each team may bring four 8.5" x 11" sheets of paper that may contain information on both sides in any form and from any source. Each team may bring two non-programmable, non-graphing calculators **dedicated to computation** to use during the event.

3. **THE COMPETITION:** Participants will be given one or more tasks presented as an exam and/or timed stations. An emphasis will be placed on the interconnectivity of Earth's processes **in relation to global and environmental changes in the past, present, and future**. Topics will include the following:
   a. History of the theory of plate tectonics, including key scientists.
   b. Identification of Earth's layers - crust, lithosphere, mantle, asthenosphere.
   c. Driving forces of plate tectonics, types of plates, boundaries and margins.
   d. Types of tectonic basins, processes that form them, and the nature of the sedimentary record for each.
   e. Plate movement and impacts of plate movement - Wilson Cycle, terranes, orogenic belts, past supercontinents, convergence, divergence, transform motion, and associated faults.
   f. Continental drift's role on opening and closure of ocean gateways and land-bridges, with specific reference to ocean circulation changes, climate changes, and biotic migrations.
   g. Isostatic adjustments - plate thickness, and the impact of mass wasting and glaciation. Hypsometry and the elevation/depth of continental and oceanic crust.
   h. Recognition of natural hazards due to plate tectonics, and their mitigation.
   i. Magma formation - geological settings, chemistry, and properties.
   j. Geologic history of North America: Evolution of the North American craton, Rocky Mountains, Appalachian Mountains and Yellowstone Hot Spot.
   k. Interpretation of geophysical data to understand plate tectonics including brittle and ductile deformation in rocks, magnetic anomalies, gravity anomalies, stress, and seismicity.
   l. Geophysical tools to obtain data to interpret physical structure of the Earth.
   m. Geological settings of ores, hydrothermals, hydrocarbons in relation to tectonic processes and features.

4. **SAMPLE QUESTIONS/TASKS:**
   a. Using maps and available datasets, plot the horizontal movement of lithospheric features and respond to interpretative questions, including calculations.
   b. Using a paleogeographic reconstruction of the late Cretaceous identify the location of major plate boundaries represented (https://deeptimemaps.com/).
   c. Deconstruct geological event histories from cross sections and block diagrams.
   d. Interpret expression of Earth's surface features from topographic/bathymetric maps and satellite data.
   e. Given a rate of loading or unloading of ice sheets, estimate vertical lithospheric movement due to isostatic adjustments.
   f. Interpretation of magnetic and gravity anomalies to infer subsurface geological features.

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Dynamic Planet CD and Bio/Earth Science CD; other resources are on the event page at soinc.org.

ECOLOGY

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

1. **DESCRIPTION:** Participants 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 one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source along with two non-programmable, non-graphing calculators **dedicated to computation**.

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 will 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.
      ii. **Divisions B & C: Invitationals, Regionals, & State:** The general ecological principles should focus on local and regional ecology
      iii. **Divisions B & C: State and Nationals**: 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 Deserts and Grasslands**
      ii. Understand basic concepts of biodiversity
      iii. **Divisions B & C: State and Nationals**: Understand terminology and be able to calculate biodiversity of sample data - species richness, Simpson index, Shannon-Wiener index
      iv. **Divisions B & C: State and Nationals**: Be able to apply knowledge of biodiversity - plot maps, simulations of selection effects on populations
   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 what the goals of conservation biology are and how they can be obtained
      iv. Reclamation of disturbed areas versus reintroduction of species
      v. **Division C only: State and Nationals**: Be able to answer questions pertaining 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. Provide three reasons how a grassland is different than a desert.
   d. Compare a grassland with a desert. 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. High score wins. Ties will be broken by pre-determined tiebreaker questions.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Ecology CD and Bio/Earth Science CD; other resources are on the event page at soinc.org.

EXPERIMENTAL DESIGN

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

1. **DESCRIPTION:** This event will determine the participants' 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:**
   a. Participants must bring goggles and writing utensils. Chemicals that require other safety clothing will not be used.
   b. **Each Division B team** may bring a timepiece, **one linear measuring device,** and a **non-programmable non-graphing calculator dedicated to computation**.
   c. **Each Division C team** may bring a timepiece, **one linear measuring device,** and a **dedicated calculator of any kind dedicated to computation**.
   d. **The event supervisor will provide each team** with identical sets of materials **either at a** distribution center or in an individual container.
   e. The event supervisor will supply an outline, based on **the Experimental Design Checklist posted on the event page at www.soinc.org, to follow when** recording their experiment along with additional paper to record data, graphs and procedure.

3. **THE COMPETITION:**
   a. **The teams must design, conduct, and report the findings of an experiment actually conducted on site that addresses the assigned question/topic area provided by the event supervisor.** The assigned question/topic area should be the same for all teams and allow the **participants** to conduct experiments involving relationships between independent and dependent variables (i.e., height vs. distance).
   b. **Each team must use at least two of the provided materials to design and conduct an experiment.** The materials will be listed on the board or placed on a card for each team. If provided, both the card and the container will be considered part of the materials. The identity of the materials will be unknown until the start of the event.
   c. When a team finishes, all materials must be returned to the event supervisor along with all written materials **and reports**.

4. **SCORING:**
   a. High score wins.
   b. Scoring will be done using the **Experimental Design Checklist** found on the Science Olympiad website (www.soinc.org).
   c. Points will be awarded depending upon the completeness of the response. Zero points will be given **for no responses as well as illegible or inappropriate responses**.
   d. Ties will be broken by comparing the point totals in the scoring areas in the following order:
      i. Variables
      ii. Procedure
      iii. Analysis of Results
      iv. Graph
      v. Data Table
   e. Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
   f. Any team not addressing the assigned question or topic area will be ranked behind those who do address the assigned question.
   g. Any team not conducting an experiment (i.e., preforming a dry lab) will be ranked behind those who do conduct an experiment.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Experimental Design CD and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

FERMI QUESTIONS

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

1. **DESCRIPTION:** Teams provide answers to a series of "Fermi Questions"; science related questions that seek fast, rough estimates of a quantity, which is either difficult or impossible to measure directly.
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. The participants must bring writing utensils. No other materials or resources are allowed.
   b. The event supervisor will provide the questions, scrap paper, and answer sheets with identifying units.

3. **THE COMPETITION:**
   a. Each team will have the same amount of time to answer as many questions as possible.
   b. All teams competing in a given time block will be quizzed together and will be given no feedback during the contest.
   c. All answers are to be written to the correct power of ten (exponent) as follows:
      i. For a number in the form $Cx10^E$, the guide for rounding of the coefficient (C) is: if C is 5 or greater (to 9.99...), round C up to 10. For example, if the number is 5.001×10^3, the correct power of ten is 4. Responses recorded as 5.001×10^3 on the answer sheet will be marked as incorrect.
      ii. If C is below 5 (and greater than 1), round C down to 1. For example, if the number is 4.99×10^6, you record 6 as your answer.
   d. Positive exponents are the default. For negative exponents, the minus (-) sign must be included in the answer. If the number is $1.5x10^{-3}$, the correct power of ten is -3.
   e. Teams are allowed to finish before the allotted time: they should hand in their answer sheet, have the time recorded by the event supervisor, and exit the room quietly.

4. **SAMPLE QUESTION/TASK**
   a. "How many drops of water are there in Lake Erie?" requires an estimate of the volume of a drop, the volume of Lake Erie from its approximate dimensions and conversion of units to yield an answer.
   b. "What is the mass of helium gas is required to fill the Goodyear Blimp?" requires an estimate of the volume of the Goodyear Blimp, the number of helium molecules, and the mass of those molecules to yield an answer.
   c. "How many birds are in the Amazon Rain Forest?" requires an estimate of the number of birds on the planet and the surface of the planet covered by the Amazon Rain Forest to yield an answer.

5. **SCORING:**
   a. High score wins.
   b. Ties are broken by counting the highest number of answers that receive five (5) points. If the number of 5-point answers is the same, the number of 3-point answers will be used. Time is used as the third tiebreaker, if needed.

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

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Problem Solving/Technology CD; other resources are on the event page at 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, participants will perform a series of tests which 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. Teams may bring only these items:
      i. test tubes with 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. a pencil and ruler (for chromatograms)
      xii. paper towels
      xiii. metal tongs
      xiv. writing utensils
      xv. five 8.5" x 11" sheets of paper that may contain information on both sides in any form and from any source
      xvi. two calculators **of any type dedicated to computation**

      Note: Teams 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. Participants must wear goggles**,** an apron or a lab coat, and have skin covered from the neck down to the wrist and toes. Gloves are optional; but if a host requires a specific type they must notify teams. Shoulder length or longer hair must be tied back. Participants 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 evidence from Parts 3.c.-f. and analysis of the evidence in Part 3.g. Analysis or questions can only be on the evidence topics included in the competition. The amount of evidence included will be according to the following table:

Level	# Part c samples	# Part d samples	Part e chromatograms	Part f	Part g
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. The collected evidence and other data given could be used in a mock crime scene.
   b. **Qualitative Analysis**: Participants may be asked to identify the following substances: sodium acetate, sodium chloride, sodium hydrogen carbonate, sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid, and ammonium chloride (there will be no mixtures). All teams will have the same set of solids to identify.
   c. **Polymers**: Participants may be asked to identify:
      i. **Plastics**: PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA, PC - Participants will not perform any burn tests on these 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.

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

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Forensics CD and Chem/Phy Science CD; other resources are on the event page at 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 **and Game type** 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 utensil(s) and may bring:
      i. Headset(s) to assist in testing audio
      ii. A microphone to assist in recording original audio
   b. Supervisors will provide:
      i. A computer capable of running Scratch. Tournament Directors are encouraged to provide computer specifications to the teams as early as possible
      ii. A broad theme **and the type of game** to build their original computer game around
      iii. Scrap paper

3. **THE COMPETITION:**
   a. The supervisor must assign the teams a broad theme **and the type of game** that the original computer game will be built around. The theme **and the type of game** must be the same for all teams and allow students to build games involving some scientific principles associated with the theme.
   b. **The Supervisor will choose from the following game types for the students to build their game**
      i. **Invitational and Regional game types: (a) Collection, (b) Maze, (c) Avoidance**
      ii. **State game types: (a) Any invitational and regional game type, (b) Shooting (c) Racing, (d) Building**
      iii. **National Game types: (a) Any combination of 2 regional or state game types, (b) a two-player game of any previous single game type**
   c. 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.
   d. 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:**
   a. Scoring of the event will be done using the Game On Rubric found on www.soinc.org.
   b. Points will be awarded based on the coding and/or game play of the items.
   c. Zero points will be awarded for items not being present in the game or inappropriate content.
   d. 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.
   e. Any team not addressing the assigned theme **and/or game type** in their game will be ranked behind those who do, because not addressing the theme **and/or game type** is a violation of the spirit of the competition.
   f. High score wins. Ties will be broken by comparing the point totals in the scoring areas in the following order:
      i. Game Mechanics
      ii. Game Play
      iii. User Control
      iv. Balanced Play
      v. Overall Impression/Originality

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Game On Video and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY CODE.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 **EVENT TIME:** 8 minutes

2. **EVENT PARAMETERS:**
   a. Teams may bring up to 2 helicopters, any tools, and their flight log.
   b. Event Supervisors will 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. Participants 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 upper most 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 **3.00** g or more.
   f. The helicopter may use up to three fixed pitch rotors, not exceeding a maximum diameter of **30.00** 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.
   g. Participants must construct the rotors themselves. Commercially available rotors or propellers must not be used in whole or part. Commercial rotor thrust bearings may be used.
   h. Participants may use any type of winder, but electricity may not be available.
   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. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found at www.soinc.org.

4. **THE COMPETITION:**
   a. The event will be held indoors. Tournament officials will announce the room dimensions (approximate length, width and ceiling height) in advance of the competition. Tournament officials and the event supervisor are urged to minimize the effects of environmental factors such as air currents. Rooms with minimal ceiling obstructions are preferred over very high ceilings.
   b. Once participants enter the cordoned off competition area to trim, practice, or compete they must not receive outside assistance, materials, or communication. **Only participants may handle helicopter components until the event ends.** Teams violating this rule will be ranked below all other teams. Spectators will 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 or torque on the motor at launch, 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 landing, 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 participants for checking their helicopters prior to being checked by the event supervisor.
   f. Participants will present their helicopter(s), motor(s), and flight log for inspection immediately prior to their **Preflight Period**.
   g. All motors that meet specifications will be collected at check-in and will be **re-issued** to the team only for their **Preflight Period** and 8-minute **Flight Period**. **Time taken during the Preflight Period will impact a team's final score (see 5.b.).** Timers will follow and observe teams as they are winding their motors. Event supervisors are strongly encouraged to return flight logs after inspection.

h. A teams' **Preflight Period ends with their first flight, trim or official, which starts their** 8-minute Flight Period **or 9 minutes passes after their motor has been returned; whichever comes first**.
i. Any flight beginning within the 8-minute Flight Period will be permitted to fly to completion. Teams may make adjustments/repairs/trim flights during their official 8-minute Flight Period. Teams must declare to the Timers before any launches during their 8-minute Flight Period whether it is an official flight or trim flight. If teams do not indicate the flight type before the launch, it will be considered official. Teams will not be given extra time to recover or repair their helicopters.
j. Teams may make up to a total of 2 official flights using 1 or 2 helicopters.
k. Time aloft for each flight starts when the helicopter leaves the participant's hand and stops when any part of the helicopter touches the floor, the rotors no longer support the weight of the helicopter (such as the helicopter landing on a girder or basketball hoop) or the Timers determine the flight to be over.
l. Event supervisors are strongly encouraged to utilize three (3) timers on all flights. The middle value of the three (3) timers must be the official Time Aloft for that flight, recorded in seconds to the precision of the device used.
m. Participants must not steer the helicopter during flight.
n. 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 8-minute Flight Period does not apply to such a flight.
o. The supervisor will review with the team data being recorded on their scoresheet.

5. **SCORING:**
   a. The base score is the Team's longest single flight time. Ties will be broken by the longest non-scored flight time.
   b. **Once a team has been re-issued their motors, prior to their 8-minute Flight Period, a timing official will start a Preflight Period stopwatch. If their first helicopter flight, trim or official, is launched within 3 minutes of the return of motors a 5% bonus will be added to the base score. If the 8-minute Flight Period begins between 3 minutes and 6 minutes, no bonus is awarded. If the 8-minute Flight Period begins after 6 minutes, 10% will be deducted from the base score. After 9 minutes have passed since the return of motors the 8-minute Flight Period will start.**
   c. **Teams with a helicopter with non-coaxial rotors whose axes of rotation are separated by at least the radius of the rotors (e.g., Chinook or Piasecki style) must have their recorded flight time multiplied by 2.5 for scoring purposes.**
   d. **A bonus of 10% of the flight time will be added to the flight time of a helicopter that has the surface of at least one blade between the leading and trailing edges and between the outermost and next inboard rib on each rotor marked with a black marker or covered with black tissue. If no ribs are present, the whole surface must be black.**
   e. Teams with incomplete flight logs must have 10% of their flight time deducted from each flight.
   f. Teams without flight logs must have 30% of their flight time deducted from each flight.
   g. 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.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Helicopters Video and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY THE ACADEMY OF MODEL AERONAUTICS

HERPETOLOGY

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

1. **DESCRIPTION:** This event will test knowledge of amphibians and reptiles.

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

2. **EVENT PARAMETERS:**
   Each team may bring one Official National List along with one commercially produced field guide, which may be annotated and tabbed, or one three-ring binder of any size containing information in any form and from any source attached using the available rings. The information may be removed during the event.

3. **THE COMPETITION:**

   a. Each team will be given an answer sheet on which they will record answers to each section.
   b. Specimens/pictures will be lettered or numbered at each station. The event may include living and preserved specimens, skeletal materials and slides or pictures of specimens.
   c. Each specimen will have one or more questions accompanying it on some aspect of its life history, distribution, etc.
   d. Participants should be able to do basic identification and answer taxonomy questions to the level indicated on the Official National Herpetology List as well as demonstrate knowledge of anatomy and physiology, reproduction, habitat characteristics, ecology, diet, behavior, conservation, class, sounds and biogeography.
   e. States may have a modified state or regional list which will be posted on the state website no later than November 1st.
   f. No more than 50% of the competition will require giving common or scientific names (class, order or genus as indicated on the Official List).
   g. The questions will be distributed between amphibians and reptiles with an emphasis placed on turtles and snakes with fewer questions on crocodilians.
   h. The National competition will be based on the Official National Herpetology List.

4. **SAMPLE ACTIVITIES:**

   a. Identify the order, family, and genus of the provided sample.
   b. Based on the dental structure of this organism, predict the type of food this organism eats.
   c. What conclusion can be drawn about the habitat(s) of the given specimens?
   d. Which of these animals does not fit within this family?
   e. What unique anatomical feature distinguishes the animal shown in the picture?
   f. Compare and contrast a crocodile with an alligator.

5. **SCORING:** High score wins. Selected questions may be used as tie-breakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Bio/Earth Science CD, Taxonomy CD and Field Guide to Amphibians and Reptiles; other resources are on the event page at soinc.org.

HOVERCRAFT

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

1. **DESCRIPTION:** Participants will be tested on their knowledge of classical mechanics and related topics as well as their ability to construct a self-propelled air-levitated vehicle that moves down a track.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** Yes **APPROX. TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. **Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. The information may be removed during the written test portion of the event.**
   b. Participants may bring writing utensils and **two calculators of any type dedicated to computation** for use during any part of the event.
   c. The vehicle, **as well as any graphs/tables submitted**, must be labeled with the team name and tournament specific team number and must be impounded. **Bonus points are given for vehicles impounded in a box.** Tools, supplies, **and three-ring binders** do not need to be impounded.
   d. **Prior to competition, teams must calibrate their device by preparing graphs and/or tables showing the relationship between time and distance for various device configurations. A labeled device picture or diagram should be included.**
      i. **Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.**
      ii. **Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each must be on a separate sheet of paper. A template is available at www.soinc.org.**
      iii. **Teams are encouraged to have a duplicate set to use as those submitted may not be returned.**
   e. Participants must wear eye protection during Part II. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
   f. Participants must be able to answer questions regarding the design, construction, and operation of the vehicle per the Building Policy found on www.soinc.org.
3. **CONSTRUCTION:**
   a. The vehicle may be made of any material and **have any mass but must fit into a 40.0 cm x 40.0 cm x 40.0 cm box when levitated with any inflated skirt. Vehicles must not modify or damage the track.**
   b. The vehicle must levitate on a cushion of air as it moves down the track. Participants may be asked to demonstrate levitation by pushing the vehicle slightly down. If it then rises, it is levitating. Continuous contact of the inflated skirt with the base surface, occasional contact of other vehicle components with the base surface, or **any contact** with the inside edge of the side rails is permitted.
   c. The vehicle may have up to two motors each rotating one **propeller/impeller**. **All propellers/impellers**, **including under the device,** must have shielding **which prevents a 3/8" dowel from touching them.**
   d. **For timing purposes,** 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 **at least 20.0 cm** above the lowest vehicle surface.
   e. **The vehicle may carry a mass consisting of up to 16 standard, unopened rolls of U.S. pennies provided by the event supervisor (50 pennies per roll, mass ≅ 125 g; 16 rolls ≅ 2 kg).**
   f. Commercial batteries, **including rechargeables**, 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. **Batteries containing lithium or lead are prohibited. Battery use must follow the Battery Policy at www.soinc.org.**
   g. **Electrical components shall be limited to batteries, wires, motors, switches, resistors, potentiometers, capacitors, mechanical relays, fans, and blowers.** Brushless motors and integrated circuits are **not permitted unless they are an integral part of or embedded into commercially available fans used for cooling electronics or computers.**
   h. Vehicles must have a switch to permit safe starting. **Relying on inserting batteries or twisting wires together to start is not allowed. A stopping system is recommended.**
4. **THE COMPETITION:**
   Part I: Written Test
   a. **Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.**
   b. The **written test will** 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. ***Division C only - Fluid mechanics: density, buoyancy, viscosity, Bernoulli's principle, Pascal's law***
   c. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   Part II: Vehicle Testing
   d. Teams have a total of 8 minutes to adjust and repair their vehicle and make 5 failed or 2 successful runs; whichever comes first. Supervisors will give a warning at 7 minutes. **Practice runs are not allowed.**

e. 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 **45 seconds**, or any part of the vehicle, **including pennies**, falls off. **Teams are not allowed to declare a run a failed run.**
f. A run will count as long as it is started before the 8-minute period has elapsed.
g. The length of the track of the timed portion is **fixed at 165.0 ± 0.5 cm for Division B and variable** between **165.0** and **260.0** cm for Division C. Supervisors will mark the distance on the track and **provide** the length (Division C only) **during the vehicle testing.** The distance will be the same for all teams.
h. The target time is **15.0 seconds.** Supervisors are encouraged to use photogates for timing **with** at least one back-up manual timer. If only manual timers are used, **two (2) lasers** and three (3) timers are recommended **with the middle value being** the officially recorded time. Time is recorded in seconds to the device precision.
i. Supervisors will check vehicle specifications during impound or right before a team's testing period. Teams must be notified as soon as possible if a vehicle is out of spec. Teams may modify the vehicle to bring it into compliance during impound or their 8-minute testing period if time is available.
j. **Participants will be allowed to select between 0 and 16 full rolls of pennies to load on their vehicle during the testing period. The rolls of pennies must be placed on the vehicle so that they may not fall off during a run. The number of rolls used may be changed between runs.**
k. **Participants are not allowed to unroll, break, or alter the packaging of the pennies nor are they allowed to use any adhesives (e.g.; glue, tape) to affix the penny rolls to the vehicle.**
l. To begin a run, a team will place their vehicle, **including the penny load,** on the track at the start line **against the wood block placed by the supervisor. A team then activates their vehicle's motor(s).**
m. The team will give a countdown of "3, 2, 1, launch"; then the supervisor **will remove the wood block.** Timing **starts** when the vehicle's dowel crosses the start line and **stops** when it crosses the finish line.
n. The team must not touch a vehicle **after the dowel crosses the starting line** until **it** passes the finish line or the supervisor declares a failed run**. If touched, the run is successful with a TS and a MS of 0.**
o. The supervisor will review with the team the Part II data recorded on their scoresheet.
p. **A team** filing an appeal regarding Part II must leave their vehicle in the competition area.

5. **THE TRACK:**
   a. The supervisor will supply **a 60.0 ± 2.5 cm wide and at least 215.0 cm long track on a non-carpeted floor or other firm base surface, such as a countertop or large board. The outside boundary of the track is composed of** beams each with a width and height of at least 30.0 mm (standard 2x4 framing studs recommended). **The supervisor will also supply** a cushioned barrier to stop vehicles **and** a small wood block to hold the vehicle at the start line. Example setups are at www.soinc.org.
   b. Each beam must be securely affixed to the **floor,** base, **or each other**.
   c. A start line must be marked that is at least **45.0** cm from the end of the track. The finish line must be marked (see 4.g. for location) and a cushioned barrier at least **5.0** cm **past** it must block the channel.
   d. Multiple tracks, **with similar dimensions,** may be used to facilitate teams competing in a timely manner.
6. **SCORING:**
   a. Final Score (FS) = **best run** MS + best run TS + ES **+ CS + IB;** maximum FS = 100. High score wins. **The MS and TS may come from different successful runs.** A scoring rubric is available at www.soinc.org.
   b. Mass Score (MS) = **(# of penny rolls/maximum # of penny rolls used in a successful run across ALL teams)** x **21** points.
   c. Time Score (TS) = **21 - (0.7)(abs(runtime - 15))** points. The smallest possible TS is 0.
   d. Exam Score (ES): (Part I score / Highest Part I score for all teams) x **45** points.
   e. **One of the submitted graphs and/or tables, selected by the event supervisor, must be scored as follows for the Chart Score (CS, max of 10 points). Partial credit may be given.**
      i. **2 points for including data spanning at least one variable range (e.g. distance, load)2 points for including at least 10 data points**
      ii. **2 points for proper labeling (e.g. title, team name, units)**
      iii. **0.5 points for each graph or table turned in (up to 2 points total as long as they are not the same)**
      iv. **2 points for a labeled device picture or diagram**
   f. **Impound Bonus (IB) = 3 points if vehicle is impounded in a box labeled with team name & number.**
   g. Teams without successful runs or disqualified for unsafe operation receive a TS and MS of 0. Teams still compete in Part I.
   h. The number of penny rolls 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.
   i. **A team violating any COMPETITION rules during a successful run will have their TS multiplied by 0.9 when calculating the Final Score.** Rule violations during failed runs do not result in this penalty.
   j. Tie Breakers: 1st - Best ES; 2nd - Best MS; 3rd - Best other successful run TS; 4th - specific test questions.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Hovercraft Video and Chem/Phy Science CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY LOCKHEED MARTIN

MATERIALS SCIENCE

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

1. **DESCRIPTION:** Participants will complete lab activities and answer a series of questions related to the materials science of **polymers and plastics** with an emphasis on chemical structure, reactivity and behavior.
   A TEAM OF UP TO: 2 **EYE PROTECTION: C** **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring two **calculators of any type dedicated to computation** and **two** 8.5" x 11" sheets of paper that may contain information on both sides in any form and from any source.
   b. Each participant must bring safety equipment (e.g., goggles, lab coat, apron) and a writing utensil.
   c. Participants must wear goggles**,** an apron or a lab coat, and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if a host requires a specific type they must notify teams. Shoulder length or longer hair must be tied back. Participants 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.
   d. Supervisors must provide reagents/glassware/equipment needed for the lab activities.

3. **THE COMPETITION:**
   a. The competition will focus on the chemical structure, synthesis, characterization, performance, processing and applications of polymeric materials.
   b. The event will consist of a written exam accompanied by **at least one lab activity or station where** participants are asked to collect or interpret data.
   c. **Structure and synthesis topics: Organic chemistry nomenclature of alkanes, alkenes, alkynes, alcohols, esters, ethers, aromatics, ketones, amides, amines, and carboxylic acids. Common polymer terminology and vocabulary such as block polymer, monomer, branched, linear, network, entanglement, thermoplastic, thermoset, elastomer, adhesive, catalyst, initiator, additives, abbreviations and trade names of common polymers, natural polymers, recycling codes. Concepts that may only be addressed at the State or National level include:** ***Identification of the mechanisms of synthetic reactions such as addition, condensation, stereoisomerisms (including geometric), isotactic, syndiotactic and atactic.***
   d. **Characterization, performance, processing and application topics: density, optical properties, gas permeability, molecular weight, size and distribution, heat capacity, solubility, crystallinity, melting and glass transition points, fracture, crazing, viscoelastic materials, molding, extrusion, casting, foams, fibers, films, coatings, latex, resin, stress-strain behavior, materials selection, stiffness of material (Young's modulus), breaking strength of a material (yield strength), resistance to flow (viscosity), transverse strain (Poisson's ratio) and microscopy. Concepts that may only be addressed at the State or National level include:** ***Infrared spectroscopy, mechanism of deformation and strengthening of polymers, permanent deformation of material under constant load (creep rate).***

4. **SAMPLE QUESTIONS/ACTIVITIES:**
   a. Which type of polymer is typically a thermoplastic and flexible?
   b. Draw three repeating units for the polymer made by condensation of the following molecules.
   c. Show the initiation, propagation and termination steps for the following addition polymerization.
   d. Why are plasticizers commonly used?
   e. Determine the density, solubility and melting properties of polymers.
   f. Synthesize a cross-linked polymer and determine the modulus properties.
   g. Interpret infrared data to identify an unknown plastic.
   h. Measure the creep rate and viscosity of the provided samples.
   i. Measure strain at different temperatures.

5. **SCORING: Highest score from the combined written and lab sections will determine the winner. Selected questions may be used as tiebreakers.**

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Chem/Phy Science CD; other resources are on the event page at soinc.org.

MICROBE MISSION

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

1. **DESCRIPTION:** Teams will answer questions, solve problems, and analyze data pertaining to microbes.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C **APPROXIMATE TIME:** 50 Minutes
2. **EVENT PARAMETERS:**
   a. Participants must bring goggles.
   b. Each team may bring one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source and two non-programmable, non-graphing calculators **dedicated to computation**.
3. **THE COMPETITION:**
   a. Participants will apply age appropriate scientific process skills, perform simple laboratory procedures such as measurements, or use probes to collect data based on the information provided to answer the given questions, possibly at timed stations, pertaining to different types of microbes.
   b. 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.
   c. Live specimens are limited to: baker's yeast, ciliates, amoebae, and algae. Pictures & prepared slides are appropriate for all microbial types.
   d. The competition will cover all of the following topics and not emphasize just one area such as microbial disease. Disease questions will be restricted to the 2018 Microbial Diseases on www.soinc.org. **Topics listed in *italics* will only be assessed at the National Tournament.**
      i. Different kinds of microscopes and their uses. Parts & function of the light microscopes, principles of microscopy, and magnification and field of view determination
      ii. Estimation/calculation of size based on scales in pictures or microscopic information and amount of the visual field occupied
      iii. Identification and function of nuclei, mitochondria, chloroplasts, and their possible microbial origin
      iv. Differences (e.g., size, environment, structure, prokaryotic vs. eukaryotic, etc.) among prions, viruses, bacteria, Archaea, fungi, algae and **protozoans**, and **parasitic** worms
      v. **Names for and recognition of various bacterial shapes**
      vi. Diseases caused by microbes, their treatment/prevention, **and resistance to these treatments**
      vii. **Measuring bacterial growth,** growth curves, and graph interpretation
      viii. Beneficial microbes
      ix. **Isolation of bacteria by streaking and serial dilution**
      x. **Division C only -** Gram stain uses and difference between $Gram^+$ & $Gram^-$
      xi. **Division C only -** Important aspects of spores & cysts
      xii. *Causes and effects of microbial population explosions*
      xiii. *Microbial competition **and communication***
      xiv. ***Microbiomes***
      xv. ***Biofilms***
   e. Measurements must be made to the precision of the device.
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 acidic environment.
   d. **What is the approximate length of an organism that takes up about half of the visual field when observed through a light microscope at 400x magnification?**
   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 **are** the most prevalent?
   f. From a given picture identify the organelle, its function, and to which type of microbe it is unique.
   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. **Given data, determine the minimum inhibitory concentration of an antibiotic.**
   k. **Compare and contrast the given microbes based on their properties**.
5. **SCORING:** High score wins. Selected questions may be used as tiebreakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Microbe Mission CD and Bio/Earth Science CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY DUPONT and DUPONT PIONEER

MISSION POSSIBLE

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

1. **DESCRIPTION:** Prior to the competition, competitors will design, build, test, and document a Rube Goldberg®-like device that completes a required action through an optional series of specific actions.

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

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

2. **EVENT PARAMETERS:**
   a. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not compete and be ranked in Tier 3.
   b. Each device must pass a safety inspection before operation.
   c. Event supervisors will need meter sticks, stopwatches, and measuring tape.
   d. Uncontrolled flames, as well as hazardous liquids, gases and materials (e.g., rat traps, lead objects, combustible fuses) and unsafe handling of chemicals will not be permitted. No flammable gases allowed. Devices with potential hazards or safety concerns must not be permitted to run unless safety concerns are resolved to the satisfaction of the event supervisor; otherwise they must receive only participation points.
3. **CONSTRUCTION PARAMETERS:**
   a. During operation, device dimensions can be no greater than 60.0 cm (D) x 60.0 cm (W) x 60.0 cm (H).
   b. The device must begin with the Start Action and end with the Final Action as listed in Section 4.a. and 4.c.
   c. The device must be designed and constructed to consecutively execute a sequence of actions from one action to another, including the mechanical timing step.
   d. All actions used for scoring must be visible. The top and at least one vertical wall must be open or transparent for viewing all actions.
   e. Any action in the device not designed to contribute to the completion of the Final Action will not count for points. Parallel and dead-end actions are not allowed.
   f. Each movable/adjustable physical object in the device must be utilized by at most one assigned action.
   g. Other non-scorable actions may be incorporated into the device but must contribute to the completion of the Final Action, receive no points and be listed on the Action Sequence List (ASL).
   h. Energy devices (i.e., springs/mousetraps) may be set prior to starting the device.
   i. No electrical or spring timers are allowed. An electrical or spring timer is defined as a scorable or non-scorable action that is powered by electricity or a spring that takes longer than 10 seconds.
   j. 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 the labeled voltage. All energy storage devices must be contained in the device. Batteries will not be counted as a scorable chemical reaction. **All use of batteries must comply with the Science Olympiad Battery Policy at www.soinc.org.**
   k. 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. **THE COMPETITION:**
   a. **Start Action** (100 points) – Participants must detach and remove a magnet from the device; this action of detaching the magnet must begin the chain of events due to the removal of the magnetic force.
   b. **Scorable Actions** (50 points each) – Participants may have up to 12 scorable unique actions to count for points.
      i. Use a chemical reaction that inflates a balloon so that the balloon strikes an object that originally was at least 20 cm away from the balloon, so that the action of striking the object continues the sequence of events.
      ii. Use an endothermic action that begins the next action as a result of the reduction in temperature.
      iii. Use an exothermic action that produces light to activate a photocell and begins the next action.
      iv. Add water to a closed container so that it completes an electric circuit and begins the next action.
      v. Use an infrared beam where the transmitter and receiver are at least 20 cm apart to begin the next action.
      vi. Use light to initiate a chemical reaction to begin the next action.
      vii. Use a Pulley system with an ideal mechanical advantage (IMA) of at least 7, that lifts an object that is at least 500 g at least 10 vertical cm before the object initiates the next action.
      viii. Use a Pulley system that has an ideal mechanical advantage (IMA) of 0.50 that lifts an object that is at least 500 g at least 10 vertical cm before the object initiates the next action.
      ix. Use the mechanical advantage of all 3 classes of levers in sequence to begin the next action.
      x. Flip an unmodified US quarter airborne so that it goes from heads up to tails up and begins the next action.
      xi. Use a thermal reaction which expands a gas to activate the next action.
      xii. Activate a student-made electromagnet that begins the next action.
   c. **Final Action** (250 points) – The device must play a recording of the phrase "The End" to signal the end

of the run. This phrase must be clearly audible, and demonstrated for the judges prior to the run.

d. An **Action Sequence List** (**ASL)** must be submitted to the event supervisor at impound. ASL must be a legible, neat, and an accurate documentation of each scorable and non-scorable action of the device's operation. Scorable and non-scorable actions must be numbered and documented in the ASL and correspondingly labeled in the device. Scoring will be based only on the tasks listed in the ASL. See www.soinc.org for an example of the format required.
e. The Target Operation Time is 60 seconds at Regionals/Invitationals, 61 to 90 seconds at State, and 91 to 120 seconds at Nationals. For State and National tournaments, time will be announced at setup and will be the same for all teams.
f. Timing and scoring begins when a competitor pulls a magnet from the device. Timing stops when the beginning of the word "END" is heard or when 180.0 seconds elapse, whichever comes first.
g. To receive Bonus Points, participants must designate an action, either scorable or non-scorable, taking over 30 seconds that does not use electricity or springs for power.
   i. A 1 point bonus will be awarded for every full second past 30 seconds.
   ii. If the task is chemical, the bonus will be 2 points per second over 30.
   iii. The timer must successfully start the next task for any bonus points to count.
   iv. For State/National tournaments, the team must demonstrate how this timer is adjusted to account for the increased length of Target Operation Time for the bonus points to count.
h. If the device stops, jams, or fails, the participants will be allowed to "adjust" it to continue operation. Obvious stalling will result in disqualification.
i. If a participant completes a scorable action or makes an adjustment that leads directly to the completion of the action, then that action will not count for points, even if it is part of the Final Action.
j. If an action starts out of the ASL order, all actions skipped in the listed sequence, even if completed, earn zero (0) points.
k. The supervisor will review with teams the data and tier recorded on the scoresheet.

5. **SCORING:**
   a. High score wins.
   b. For each of the following, 25 points should be awarded (100 points maximum):
      i. The ASL is submitted on time at device impound.
      ii. The ASL uses the format specified on www.soinc.org.
      iii. The ASL is 100% accurate of intended scorable and non-scorable actions.
      iv. The scorable & non-scorable actions within the device are labeled as in the ASL.
   c. For each of the following, 50 points should be awarded:
      i. Participants use no more than 30 minutes to set up their device.
      ii. The first time each unique action is successfully completed as described.
   d. Award 100 points for completing the Start Action and 250 points for completing the Final Action.
   e. Award 100 points if the device only uses 1 battery source.
   f. Award 2 points for each full second (rounded down) of operation up to the Target Operation Time.
   g. Award 1 point per full second past 30 seconds for a non-electrical or non-spring timer if all conditions are met and the Final Action is successfully completed. (2 points if chemical)
   h. Award 0.1 point for each 0.1 cm that the device dimensions are under 60.0 cm in each axis. (e.g., Device measures 40.0 cm x 38.9 cm x 52.4 cm; receives 20.0 + 21.1 + 7.6 = 48.7 points)
   i. Teams receive only participation points for impounding a device but not competing, unsafe devices, devices that are remotely timed/controlled, or devices that fail to operate autonomously after starting.
6. **PENALTIES:**
   a. Deduct 1 point for each full second (rounded down) that the device operates past the Target Operation Time up to 180.0 seconds (whichever occurs first).
   b. Deduct 25 points for each dimension of the device that exceeds 60 cm.
   c. Deduct 50 points for the first solid or liquid that leaves the measured dimensions of the device.
   d. Deduct 150 points for each electrical or spring timing action in the device
   e. Deduct 15 points for each time the device is touched or adjusted during the operation time.
7. **TIERS:**
   a. Tier 1: Devices without any violations
   b. Tier 2: Devices with construction violations (excluding dimension violations) or competition violations
   c. Tier 3: Devices impounded after the deadline or participants without eye protection
8. **TIEBREAKERS:**
   Ties are broken as follows: a) Fewest penalty points and b) Smallest overall dimension (L+D+H) of the device.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Mission Possible Video and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY LOCKHEED MARTIN

MOUSETRAP VEHICLE

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

1. **DESCRIPTION:** Teams design, build, and test a vehicle using one or two snap mousetraps as its sole means of propulsion that can push a plastic cup forward, reverse direction, and come to a stop behind the start point.
   A TEAM OF UP TO: 2 **IMPOUND:** Yes **EYE PROTECTION:** B **EVENT TIME:** 8 min
2. **EVENT PARAMETERS:**
   a. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not be allowed to compete.
   b. Participants may bring a calculator of any type dedicated to computation and non-electric tools to work on their vehicle.
3. **CONSTRUCTION PARAMETERS:**
   a. Participants will construct a vehicle where all propulsive energy must come from one or two 6.0 cm x 12.0 cm base or smaller snap mousetraps. Mousetraps must retain all of their original parts and structural integrity. Altering the structural integrity of the mousetrap is prohibited including welding, bending, and cutting. Items may be added to each mousetrap through methods including, but not limited to soldering, taping, tying, gluing, and clamping. Added items cannot increase the potential energy of the unmodified mousetrap. Up to 4 holes may be drilled in each mousetrap only to attach it to the vehicle.
   b. Conversion of the mechanical energy of each mousetrap's spring is permissible, but any additional sources of kinetic energy must be at their lowest states in the ready-to-run configuration.
   c. The vehicle must not be remotely controlled or tethered and must stop and reverse automatically.
   d. Electric/electronic components and devices are not permitted.
   e. A ¼" diameter or larger round dowel must be attached to the vehicle approximately perpendicular to the floor. The bottom of the dowel must be ≤ 1.0 cm from the track's surface.
   f. Wheels/treads in their entirety in the ready-to-run configuration must fit in a 50.0 cm x 50.0 cm space of any height. Axles, drive arms, and other parts of the vehicle may extend beyond these parameters.
   g. There must be a trigger to start the vehicle that is designed so that the actuation of it by a pencil is perpendicular (vertical) to the floor. The vehicle must remain at the starting position without being touched until triggered.
   h. Only non-electric sighting/aiming devices are permitted. If placed on the track, they must be removed before each run. If placed on the vehicle, they may be removed at the team's discretion.
   i. All parts of the vehicle must move as a whole. The only parts allowed to contact the floor during the run are wheels/treads, drive string(s), and those parts already in contact with the floor in the ready-to-run configuration. Pieces falling from the vehicle are a construction violation. The plastic cup is not considered part of the vehicle.
   j. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.
4. **PRACTICE LOG:**
   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. The vehicle, spare parts, and logs will be impounded before the start of the competition. Tools, data, and calculating devices need not be impounded.
   b. Only participants and supervisors will be allowed in the impound and track areas. Once participants enter the event area, they must not leave or receive outside assistance, materials, or communication.
   c. Participants have 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. Participants may not use AC outlet power during their 8 minutes.
   d. Teams will place a 16-oz. plastic cup provided by the supervisor upside down to cover the Start Point (SP). The SP can be anywhere under the cup as long as it is completely covered. In the ready-to-run configuration, the vehicle's dowel must touch the cup. The cup must remain in contact with the track at all times.
   e. Teams may adjust their vehicle before each run (e.g. change mousetraps, distance, directional control) within their 8 minutes providing the vehicle continues to meet specifications. The team's 8-minute time is paused when the vehicle stops to allow for the supervisor's measurements. Timing resumes once the participants pick up their vehicle or begin making their own measurements. Teams may use their own measuring devices to verify the track dimensions during their 8 minutes.
   f. Teams must not roll the vehicle on the floor of the event track the day of the event without tournament permission. If permitted, only participants may be present.
   g. Substances applied to the vehicle must be approved by the supervisor prior to use, must not damage the floor, or leave residue on the track and/or event area. During their 8-minute time, participants may clean the track but it must remain dry.

h. Run Time starts when the participants actuate the trigger using any part of an unsharpened #2 pencil with an unused eraser provided by the event supervisor.
i. Once the run starts, participants must move off the track and not follow the vehicle until called by the supervisor.
j. Run Time ends when the vehicle comes to a complete stop; recoils are considered part of the Run Time. If the vehicle does not move within 3 seconds after coming to a stop, the run is considered to have ended. The 3 seconds are not included in the Run Time. Any action occurring after that time does not count as part of the run.
k. The event supervisor is encouraged to use three timers. The middle time of the 3 timers must be the official Run Time. The Run Time must be recorded in seconds to the precision of the timing device.
l. If the vehicle does not move upon actuation, it does not count as a run and the participants may set up for another run, but must not be given additional time.
m. A Failed Run occurs if a second run does not occur in the 8 minutes, if the time or distance cannot be measured for a vehicle (e.g., it starts before the event supervisor is ready, if the participants pick it up before it is measured) or if any part of the cup is not at least 0.5 m from the SP on its initial forward motion.
n. At the supervisor's discretion, more than one track may be used. Participants will be given the choice of which track they will use. Both runs by a team must be made on the same track.
o. A team filing an appeal must leave their vehicle in the competition area.
p. The supervisor will review with the team the data and the tier recorded on their scoresheet.

6. **THE TRACK:**
   a. All tracks will be at least 1.0 m wide on a smooth, level, and hard surface. Please refer to www.soinc.org for a diagram of the track.
   b. The event supervisor will use tape, approximately 2.5 cm wide and approximately 5 cm long, to mark the SP and the Vehicle Target Point (VTP). The VTP must be 2.00 m – 4.00 m behind the SP. Exact distance in these intervals: Regional - 0.50 m, State - 0.10 m, National - 0.01 m, will be chosen by the supervisor and announced after the impound period.
   c. The supervisor will use two parallel lengths of tape, at least 1.00 m long and the same width as above, to mark the Minimum Cup Travel Distance of 0.50 m and the Cup Target Line (CTL) of 3.0 m away from the SP in the opposite direction of the VTP. Both lengths of tape must be perpendicular to the imaginary line connecting the SP and the VTP. The edge of both tapes closest to the SP must be at 0.50 m and 3.00 m.

7. **SCORING:**
   a. The Lowest Final Score wins. The lower of the 2 Run Scores is the Final Score. The Final Score for any vehicle with one Failed Run must be the other Run Score.
   b. Run Score for each run = 2 x Vehicle Distance + Cup Distance Score + Run Time (in sec) + Penalties.
   c. Vehicle Distance = point-to-point distance, in cm to the nearest 0.1 cm, from the VTP to the closest part of the dowel. If the dowel covers the VTP, the Vehicle Distance is 0 cm.
   d. Cup Distance Score = the point-to-line distance of the cup at final resting position to the CTL.
      i. If the entire cup in any orientation ends up past the CTL, the Cup Distance Score = 0.
      ii. If the cup stops off to the side beyond the extent of the marked CTL tape, the line should be extended to check if the cup would have passed the line.
      iii. If the entire cup does NOT pass the CTL, then the Cup Distance is a point-to-line distance, in cm to the nearest 0.1 cm, from the point of the cup furthest from the CTL to the CTL plus 300.
      iv. If the cup tips over during a run, measurement is made from where the cup comes to rest.
   e. Teams with incomplete practice logs will incur a Penalty of 250 points.
   f. Teams without impounded practice logs will incur a Penalty of 500 points.
   g. Each competition violation incurs 2000 penalty points per occurrence for that run (8000 points max).
   h. Each construction violation incurs 5000 penalty points per occurrence for that run (15000 points max).
   i. A vehicle not impounded during the impound period will incur a penalty of 10000 points for each run.
   j. Ties will be broken by this sequence: (1) Lower Cup Distance Score; (2) Lower Vehicle Distance; (3) Lower Run Time; (4) lower Run Score of the other run.
   k. Teams not completing any runs within the 8 minutes or having 2 Failed Runs receive participation points.

Scoring Example: The run took 20.21 seconds. The cup came to rest 42.4 cm from the CTL. The dowel was 35.8 cm away from the VTP.

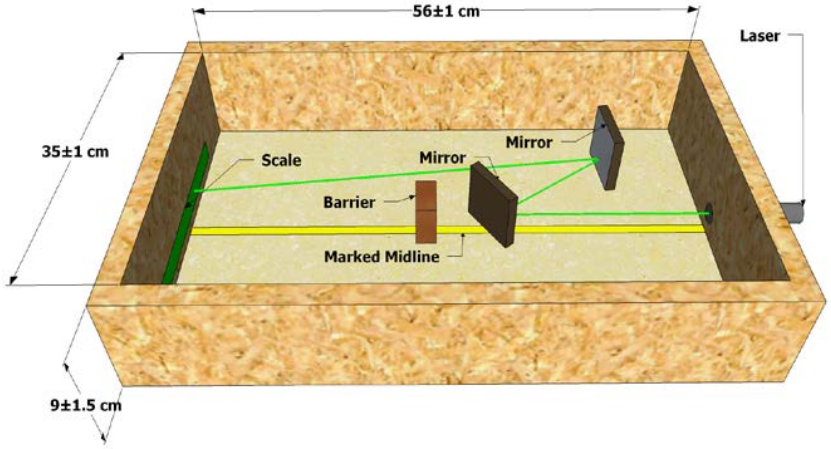
Run Score = 2 x 35.8 (Vehicle Distance) + 342.4 (Cup Distance Score) + 20.21 (Time Score) = 434.21

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Mousetrap Vehicle Video and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

OPTICS

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

1. **DESCRIPTION**: Teams participate in an activity involving positioning mirrors to direct a laser beam towards a target and are 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. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings; which may be removed during the event.
   b. Participants may bring any measuring tools, premade templates, writing utensils and two calculators of any type **dedicated to computation** for use during any part of the competition.
   c. Participants must not bring lasers or mirrors.
3. **LASER SHOOT SETUP**:
   a. Example setups are available on the event page at www.soinc.org.
   b. The event supervisor will provide the Laser Shoot Setup (LSS), including laser, mirrors and barriers.
   c. The LSS has a horizontal flat surface 56 ± 1.0 cm by 35 ± 1.0 cm enclosed by a 2 ± 0.5 cm thick wall. The bottom surface may be a table top. **A black surface with a ferrous metal component to which magnets will adhere is recommended. Directions and resources on how to retrofit an existing LSS can be found at www.soinc.org.** The height of the wall above the surface is 9 ± 1.5 cm.
   d. Five moveable flat mirrors with a width of 5.0 – 8.0 cm must be placed in the LSS and must be **front-surface mirrors or back-surface mirrors 1/16 of an inch or less thick.** 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 participants. **In order to facilitate measurements by competitors, no part of the mirror support may extend in front of the reflective surface.** The mirror faces must initially be covered with a cardboard sleeve or other easily removable non-reflecting, opaque material. **The mirrors may have magnets affixed to them to secure them in place on a ferrous metal bottom surface of the LSS.**



   e. A laser is mounted through the approximate center of one of the 35 cm walls at a height of 1.5 - 6.0 cm above the bottom surface. The laser must be securely mounted such that it cannot be moved and the beam is perpendicular to the wall through which it is mounted. The laser must remain fixed throughout the entire event. The Laser Policy on www.soinc.org must be followed.
   f. A midline is drawn on the LSS from a point directly below the emitting tip of the laser to a point directly below the center of the laser beam where it strikes the opposite wall.
   g. A metric scale with a resolution of at least 1 mm must be attached horizontally to the other 35 cm wall at the level at which the laser strikes. One of the marks on the scale is the Target Point. A sheet of paper must be also fastened to the wall, with a mark on the paper indicating the Target Point location.
   h. The barrier(s) must have a width of 2.0 - 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. The barrier(s) must have a mirror similar to the others attached to one side and covered similarly.
   i. **For Division B only,** a barrier must be placed somewhere along the midline to block the laser beam (non-perpendicular angles permitted).
   j. **For Division C only, three barriers must be placed in the LSS. One will be** somewhere along the midline to block the laser beam (non-perpendicular angles permitted). **The other two will be placed elsewhere in the LSS.**
4. **THE COMPETITION**:
   Part I: Written Test
   a. **Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.**
   b. The competition will consist of at least two questions from each of the following areas. **Topics in *italics* are for Division C only and will be exclusively assessed at State and National Tournaments**.

i. Law of reflection: specular, diffuse
ii. Refraction: index of refraction
iii. Prism: deviation, dispersion
iv. Convex, concave, and **plane** mirrors: ray tracing, focal length, real object, images (real/virtual, erect/inverted, magnification)
v. Convex and concave lenses: ray tracing, focal length, real object, images (real/virtual, erect/inverted, magnification)
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 **that produce images and color perception**
ix. Polarization of light using polarizing films or by scattering
x. Optical absorption spectra: films, chemicals, dyes
xi. *Ray tracing **off** 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*

c. Unless otherwise requested, answers must be in metric units with appropriate significant figures

Part II: Laser Shoot

d. The objective is to reflect a laser beam with mirrors around barriers towards the Target Point.
e. **The event supervisor will select a Target Point location and home position for the mirror(s) that is the same for all teams. Teams will be informed of the Target Point when it is their turn to compete in Part II.**
f. All mirrors **will** be placed in the **designated** home position before each team is permitted to see the LSS.
g. **The supervisor will demonstrate the beam's alignment before each team begins their laser shoot.**
h. When a team is ready to begin, the event supervisor **will** give a countdown of "3, 2, 1 start" and **then** start a timer. Event Supervisors **will** give teams a warning when 3 minutes have elapsed.
i. Participants must make all measurements, calculations, and mirror placements/alignments within a 4-minute time period. Participants may choose to use between 1 and 5 moveable mirrors.
j. Timing stops when 4 minutes have elapsed or the **participants intentionally** remove the material covering the face of one mirror. Participants must not make any additional adjustments to the mirrors other than to remove the other mirror and **barrier** coverings**.** The supervisor must not remove coverings.
k. Participants must not mark on or modify the LSS **nor adjust/move the barrier(s) position.**
l. Participants 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. **Only the intended, normally reflected, path of the laser will be counted (e.g. secondary beams due to beam splitting or halos must be ignored).** Participant tools/templates may remain on the LSS during this process.
n. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.
o. The supervisor will review with the team the data recorded for Part II on their scoresheet.

5. **SCORING:**

a. A scoring rubric is available on the event page on www.soinc.org.
b. Final Score (FS) = TS + MS + AS + BS. The maximum possible FS is 100 points. High score wins.
c. Test Score (TS) = (Part I score / Highest Part I score of all teams) x **60 points**
d. Mirrors Score (MS) = # moveable mirrors the laser reflects off of x **2 points**. The max possible MS is **10**.
e. Accuracy Score (AS) = (**15** – (accuracy (in mm)/10)) points. The smallest possible AS is 0.
f. **Accuracy** is the horizontal distance from the Target Point to the center of where the laser strikes on **the 35 cm Target Wall**. If the laser strikes another wall, accuracy is the sum of the straight-line measurements from the Target Point to the corner along one wall and along the other wall from the corner to the laser dot. **If the laser does not strike a wall, AS is 0, but the MS and BS are calculated.**
g. **Division B -** Barrier Score (BS) = **15 points** if the laser reflects off the barrier mirror
h. **Division C - Barrier Score (BS) = # of barrier mirrors the laser reflects off of x 5 pts; max pts. possible is 15.**
i. Teams disqualified for unsafe operation receive an AS, MS and BS of 0**, but still compete in Part I.**
j. **Violations of rules in the COMPETITION section result in the AS, MS, and BS being multiplied by 0.9 when calculating the Final Score.**
k. **Ties are broken using test question(s) designated by the supervisor at the start of the competition.**

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Optics Video and Chem/Phy Science CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY CREOL, THE COLLEGE OF OPTICS AND PHOTONICS, UNIVERSITY OF CENTRAL FLORIDA, SPIE, AND THE OSA FOUNDATION

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:**
   a. Each team may bring **four** 8.5" x 11" sheets of paper that contain information on both sides in any form and from any source.
   b. Each participant may bring a metric ruler, a protractor, **and a non-programmable, non-graphing calculator dedicated to computation.**

3. **THE COMPETITION:**
   a. The event will consist of questions and activities testing concepts related to the collection and use of remote sensing data to observe and study climate change processes in the Earth system.
   b. The test should be divided equally, approximately 25 % on each, across the following topic areas:
      i. Remote sensing instrumentation and physics: active vs. passive sensors; optical and infrared imagers; radiometers; LiDAR; **radar altimetry;** precipitation radar; blackbody radiation; Planck function, Wein's Law; Stefan-Boltzmann Law; beam attenuation; absorption and scattering by aerosols; refraction and refractive indices; scattering
      ii. Interpretation of remote sensing images and data sets from the following satellites: Atmospheric and sea-surface temperature (**GOES-16, ATMS and CrIS on NPP**); global mean temperature; energy flux (CERES **on NPP**); optical, infrared and Doppler radar imagery of clouds and precipitation (MODIS, CALIPSO, CloudSat); CO_2 cycle (OCO-2); aerosol scattering, absorption and optical depth (MODIS); detection of trace gas concentrations by satellites (OCO-2, AURA); **sea level rise and surface waves (radar altimeters, especially Topex-Poseidon, Jason-1 and Jason-3).**
      iii. 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
      iv. Using, applying, and interpreting the output of small-scale models of planetary energy balance

4. **SAMPLE QUESTIONS/TASKS:**
   a. Use a comparison of visible and IR satellite images of clouds to interpret relationships between clouds and outgoing radiation, and to explain how clouds influence the Earth's radiative balance.
   b. Given information characterizing the extinction coefficient of a layer of dust in the atmosphere and the observed reduction in outgoing radiation, calculate the thickness of the dust layer.
   c. Modify a simple energy balance model to include an idealized greenhouse gas response to these CO_2 concentrations and show how this affects global atmospheric temperature.
   d. **Interpret a pair of radar altimeter returns to look at differences in significant wave height.**

5. **SCORING:** High score wins**.** Points will be awarded for the quality and accuracy of responses. Selected questions may be used as tiebreakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Remote Sensing CD and Bio/Earth Science CD; other resources are on the event page at soinc.org.

ROCKS & MINERALS

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

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

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

2. **EVENT PARAMETERS:**

   Each team may bring one magnifying glass and one three-ring binder of any size containing information in any form and from any source **attached using the available rings; which may be removed during the event.**

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Rocks and Minerals CD, Bio/Earth Science CD and Audubon Field Guide to Rocks and Minerals; other resources are on the event page at soinc.org. A Rocks and Minerals kit, excluding silver, gold, and diamond, may be ordered from Ward's Science Olympiad Kits (wardsci.com).

THERMODYNAMICS

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

1. **DESCRIPTION:** Teams must construct an insulating device prior to the tournament that is designed to retain heat and complete a written test on thermodynamic concepts.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. The information may be removed during the event. Each team may also bring tools, supplies, writing utensils, and two calculators of any type dedicated to computation for use during any part of the event. These items need not be impounded.
   b. Each team must impound: their insulating device; 2 identical, unaltered, glass or plastic, standard (height ~1.4 times the diameter) 250 mL beakers; and copies of graphs and/or tables for scoring.
   c. Event supervisors will supply the hot water, devices for transferring measured volumes from the water source to the team's beakers, ice water, thermometers, or probes (recommended). Non-contact thermometers are allowed.
   d. Prior to competition, teams must calibrate their devices by preparing graphs and/or tables showing the relationship between elapsed cooling time and ending water temperature for various quantities of water and starting water temperatures. A labeled device picture or diagram should be included.
      i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
      ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each must be on a separate sheet of paper. A template is available at www.soinc.org.
      iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned.
   e. Participants must wear eye protection during Part I. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
   f. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. **CONSTRUCTION:**
   a. Devices may be constructed of and contain any materials except for the following prohibited materials: asbestos, mineral wool, and/or fiberglass insulation.
   b. **For Division B,** the device must fit within a 20.0 cm x 20.0 cm x 20.0 cm cube.
   c. **For Division C,** the device must fit within a 15.0 cm x 15.0 cm x 15.0 cm cube.
   d. Within the device, participants must be able to insert and remove a beaker that they supply (see 2.b.).
   e. The device must also easily accommodate the insertion and removal of a thermometer/probe into the beaker via a hole at least 1.5 cm in diameter all the way through directly above the beaker. The top surface of the hole must be less than 12 cm above the inside bottom surface of the beaker. The hole must remain open and unobstructed during the competition.
   f. Devices will be inspected to ensure that there are no energy sources (e.g., no electrical components, small battery powered heaters, chemical reactions, etc.) to help keep the water warm. At the event supervisor's discretion, teams must disassemble their devices at the end of the testing period in order to verify the materials used in construction.
   g. All parts of the device must not be significantly different from room temperature at impound.

4. **THE COMPETITION:**
   Part I: Device Testing
   a. At the start of each competition block, the event supervisors must announce the temperature of the source water bath (60^{o} to 90^{o} C), the volume of water to be used (50 to 150 mL, in 25 mL increments at Regional competitions, 10 mL at State competitions, 1 mL at the National competition) and the amount of cooling time allowed (**Division B: 30.0 minutes; Division C: 20.0 to 40.0 minutes).** These variables will be the same for all teams**.**
   b. The event supervisor will also announce the current room temperature.
   c. At the start of the competition block, teams will be given 5 minutes to set up or modify their devices and use their graphs and/or tables to begin temperature prediction calculations. Devices that do not meet the construction specs will not be allowed to be tested until brought into specification.
   d. Each team, in a staggered sequence, must have the set amount of water poured into each of their 2 beakers, one of which they must then insert into their device, the other must be placed on an open surface next to the device. Nothing must be placed under or immediately around the external beaker. Teams may

secure and/or close access panels with fastening materials after inserting the beaker. Event supervisors must record the time each team receives their water. Teams may utilize their own thermometers to measure the starting water temperature in their beakers.

e. Teams may elect to add up to 50 mL of water from an ice bath to their internal beaker immediately after receiving the hot water for bonus points. Each team may choose their own volume.
f. Teams will use their graphs and/or tables to calculate the temperature of the water in their beaker at the end of the cooling time. They must provide the supervisors with their estimate prior to beginning part II.
g. At the end of the cooling period, the event supervisor will record the temperature in each beaker to the best precision of the available instrument. Supervisors may leave thermometers/probes in the devices and the un-insulated beakers for the entire cooling period, but will announce if they will do so before impound. Otherwise they will first insert a thermometer/probe into the un-insulated beaker, wait at least 20 seconds, and record the resulting temperature. The event supervisor will then wipe any residual water off the thermometer/probe and repeat the same process with the beaker inside of the participants' device. Multiple thermometers/probes may be used at the supervisor's discretion.
h. The supervisor will review with the team the Part I data recorded on their scoresheet.
i. Teams filing an appeal regarding Part I must leave their device in the competition area.

Part II: Written Test

j. Teams will take a test on thermodynamic concepts during the remaining time after all devices have been loaded with water. All teams will have the same amount of time to take the test.
k. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
l. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
m. The test will consist of at least five questions from each of the following areas:
   i. Temperature scales and conversions, definitions of heat units
   ii. Thermal conductivity, heat capacity, specific heat, latent heat, phases of matter, entropy, enthalpy
   iii. Thermodynamic laws and processes (e.g. Carnot cycle and efficiency, adiabatic, isothermal)
   iv. The history of thermodynamics

5. **SCORING:**
   a. High score wins.
   b. All scoring calculations are to be done in degrees Celsius.
   c. The Final Score = TS + CS + HS + PS + IWB; a scoring spreadsheet is at www.soinc.org.
      i. Test Score (TS) = Part II score / Highest Part II score for all teams) x 45 points
      ii. Chart Score (CS) = max of 10 points
      iii. The Heat Score (HS) = (HRF / Highest HRF of all teams) x 15 points; HRF (Heat Retention Factor) = (internal beaker water temp / external beaker water temp)
      iv. Prediction Score (PS) = (PE / Highest PE of all teams) x 25 points; PE (Prediction Estimate) = (1-(abs (final internal beaker water temp - predicted internal beaker water temp) / final internal beaker water temp)). The minimum PS score possible is 0 points
      v. Ice Water Bonus (IWB) = (volume of ice water in ml /10) points
   d. One of the submitted graphs and/or tables selected by the event supervisor, must be scored as follows for the Chart Score. Partial credit may be given.
      i. 2 points for including data spanning at least one variable range listed in 4.a.
      ii. 2 points for including at least 10 data points
      iii. 2 points for proper labeling (e.g. title, team name, units)
      iv. 0.5 points for each graph or table turned in (up to 2 points total as long as they are not the same)
      v. 2 points for including a labeled device picture or diagram
   e. If a team violates any COMPETITION rules, their HRF, PE, and IWB values will be multiplied by 0.9 when calculating the scores.
   f. If any CONSTRUCTION violation(s) are corrected during the Part I testing period, or if the team misses impound, the HRF, PE, and IWB values will be multiplied by 0.7 when calculating the scores.
   g. Teams that are disqualified for unsafe operation or do not bring an insulating device receive zero points for their HRF, PE, and IWB scores. Teams will be allowed to compete in Part II.
   h. Tie Breakers: 1st - Best TS; 2nd - Best HS; 3rd - Best PS; 4th - Best IWB

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Chem/Phy Science CD; other resources are on the event page at soinc.org.

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 **EVENT TIME:** 6 minutes

2. **EVENT PARAMETERS:**
   a. Each team is allowed to enter only one Tower, built prior to the competition.
   b. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows, Participants without eye protection will not be allowed to compete and be placed in Tier 4.
   c. The Event Supervisor will provide the Test Apparatus described in **Section 5**.

3. **CONSTRUCTION PARAMETERS:**
   a. The Tower must be a single structure, with no separate or detachable pieces, constructed of wood and bonded by adhesive. No other materials are permitted.
      i. Wood is defined as the hard-fibrous substance making up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include: bark, particleboard, wood composites, bamboo or grasses, paper, commercial plywood, members formed of sawdust and adhesive. **Wood may never be painted, color enhanced, or have preprinted/paper labels affixed. Ink barcodes or markings from the construction process may be left on wood.**
      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.
   b. The Tower must span a 20 cm x 20 cm opening on a Test Base (5.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.c.) can be obtained by designing the Tower to span a 29-cm diameter circle, centered on the 20 cm x 20 cm opening of the Test Base.
   c. The Tower must support the Loading Block (5.b.i.) a minimum of 50.0 cm (Division B) or 60.0 cm (Division C) above the Test Base. There is no maximum Tower height.
   d. **The portion of the Tower more than 25.0 cm (Division B) or 20.0 cm (Division C) above the Test Base must pass through an 8.0 cm diameter opening or hole (5.f.).**
   e. The loading point on the Tower must be constructed to permit placement of the Loading Block (5.b.i.) and suspended chain (5.b.iii) on and through the Tower, to support the bucket (5.c.).
   f. The Tower must be constructed such that only the Loading Block (5.b.i.) supports the chain and bucket.
   g. The Tower may not be braced against any edge of the Test Base (5.a.) for lateral support at any time.
   h. No portion of the Tower is allowed to extend below the top surface of the Test Base (5.a.) prior to testing.
   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. **COMPETITION:**
   a. **Check-In**
      i. **The team will measure the Tower height using provided materials** so the event supervisor can determine if it meets or exceeds the minimum Tower height (3.c.) in cm to the nearest 0.1 cm.
      ii. **The team will verify the size restriction (3.d) by passing an 8-cm diameter circular ring gauge freely over the section of the Tower and measuring to the point where the ring rests. The ring may not be forced over any tight spots. If the ring is not level when in the resting position, the measurement will be to the high point of the ring. The ring will be removed before testing.**
      iii. The team will place their Tower on the scale so the event supervisor can determine the mass, in grams to the nearest 0.01 g.
      iv. The team must submit their Estimated Load Scored (6.b.) to be used as a tie breaker (6.e.).
      v. No alterations, substitutions, or repairs may be made to the Tower after check-in for competition.
      vi. The event supervisor will verify that the combined mass of the Loading Block Assembly, bucket and sand, is at least 15,100 grams but no more than 15,200 grams prior to testing.
   b. **Testing**
      i. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
      ii. Participants will have 6 minutes to setup and test their Tower to maximum load or failure.
      iii. The participants must place the Tower on the Test Base and assemble the Loading Block Assembly and bucket as required to load the Tower. If necessary, participants may disassemble the Loading Block Assembly. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Tower to deflect.

iv. The event supervisor **throughout testing (e.g., just prior to loading sand, during loading)** will verify that no part of the Tower's span touches or is supported within the 29.0 cm diameter circle for the Tower to qualify for the "Load Scored Bonus".
v. The participants will be allowed to adjust the Tower until they start loading sand. Once loading of sand has begun, the Tower must not be further adjusted.
vi. Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. Teams choosing to stabilize the bucket must only use the tips of the bucket stabilization sticks (5.e.) to touch the bucket.
vii. Loading stops immediately when a failure occurs or when time expires. The event supervisor will remove any parts of the Tower in the bucket or any sand added after failure or time expiration.
viii. Towers that fail before supporting 15,000 g will 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 any part of the load being supported by anything other than the Tower. Incidental contact by the chain/eyebolt with the Tower is not failure.
ix. At the event supervisor's discretion, more than one Test Apparatus may be used.
x. Teams who wish to file an appeal must leave their Tower with the event supervisor.
xi. The supervisor will review with the team the data recorded on their scoresheet.

5. **TEST APPARATUS:**
   a. The Test Base will be a solid, level surface with the following characteristics:
      i. be at least 55 cm long x 32 cm wide, with a 20 cm x 20 cm square opening at its center
      ii. have a smooth, hard, low-friction surface (e.g. hardwood, metal, high-pressure plastic laminate) which is stiff enough that it does not bend noticeably when loaded
      iii. 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
   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. Two (2) Bucket Stabilizing Sticks each made from 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. **A circular ring gauge with an inside diameter of 8.0 to 8.1 cm, not weighing more than 10 g, that retains its shape and flatness when handled. See the event page at www.soinc.org for designs.**

6. **SCORING:**
   a. Score = [Load Scored (g) + Load Scored Bonus (g)] / Mass of Tower (g). High score wins.
   b. The Load Score is the measured load supported, including the Loading Block Assembly, bucket and sand, but may not exceed 15,000 g. The lowest Load Scored is the mass of the Loading Block Assembly.
   c. Load Scored Bonus: Towers spanning the 29 cm diameter circle receive a **5,000** g bonus. No part of the Tower may touch or be supported within the 29 cm circle **throughout testing to earn the Bonus Points**.
   d. Towers will be placed 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 will be ranked: 1st - Lowest mass; 2nd - Greatest height.
   e. Ties are broken as follows: 1. Estimated Load Scored (4.a.iv.) closest to, without exceeding, the actual Load Scored (6.b.), 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 = 1,133.2
      iii. Tower 3: mass = 12.32 g, load supported = 13,213 g; Bonus = NO; Score = 1,072.5
      iv. Tower 4: mass = 12.32 g, load supported = 13,213 g; Bonus = YES; Score = 1,478.3

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Towers Video and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

THIS EVENT IS SPONSORED BY ARCELORMITTAL

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: The Science Olympiad Store (store.soinc.org) carries the Problem Solving/Technology CD; other resources are on the event page at 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 Division C Schedule for the 2018 National Tournament at Colorado State University, Ft. Collins, CO

EVENT	7:00- 8:00	8:15- 9:15	9:30-10:30	10:45-11:45	12:15-1:15	1:30-2:30	2:45-3:45
Anatomy & Physiology		31 - 40	41 - 50	51 - 60	1 - 10	11 - 20	21 - 30
Astronomy		1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60
Chem Lab		21 - 30	31 - 40	41 - 50	51 - 60	1 - 10	11 - 20
Disease Detectives	1 - 60						
Dynamic Planet		31 - 40	41 - 50	51 - 60	1 - 10	11 - 20	21 - 30
Ecology		21 - 30	31 - 40	41 - 50	51 - 60	1 - 10	11 - 20
Experimental Design		51 - 60	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50
Fermi Questions	1 -60						
Forensics		51 - 60	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50
Game On		1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60
Helicopters		Self-Schedule Online					
Herpetology		11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	1 - 10
Hovercraft	Impound	Self-Schedule Online					
Materials Science		41 - 50	51 - 60	1 - 10	11 - 20	21 - 30	31 - 40
Microbe Mission		1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60
Mission Possible	Impound	Self-Schedule Online					
Mousetrap Vehicle	Impound	Self-Schedule Online					
Optics		11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	1 - 10
Remote Sensing		21 - 30	31 - 40	41 - 50	51 - 60	1 - 10	11 - 20
Rocks & Minerals		31 - 40	41 - 50	51 - 60	1 - 10	11 - 20	21 - 30
Thermodynamics	Impound	41 - 50	51 - 60	1 - 10	11 - 20	21 - 30	31 - 40
Towers		Self-Schedule Online					
Write It Do It		41 - 50	51 - 60	1 - 10	11 - 20	21 - 30	31 - 40

SCIENCE OLYMPIAD™

Exploring the World of Science

Science Olympiad wishes to acknowledge the following business, government and education leaders for partnering with our organization. Working together, we can increase global competitiveness, improve science and technology literacy and prepare the STEM workforce of the future. Thanks to: Colorado State University (2018 National Tournament Host), Wright State University (2017 National Tournament Host), ArcelorMittal, NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network, Combined Federal Campaign, Lockheed Martin, DuPont Center for Collaborative Research and Education, DuPont Pioneer, NBC Universal Foundation, Ward's Science, Google, ACE Hardware, Centers for Disease Control and Prevention (CDC), CREOL, The College of Optics and Photonics, University of Central Florida, SPIE and the OSA Foundation, Discovery Education 3M Young Scientist Challenge, National Marine Sanctuary Foundation, National Oceanic and Atmospheric Administration (NOAA), Potbelly Sandwich Works, Texas Instruments, VWR Foundation, Academy of Model Aeronautics, Investing in Communities, MAKE Magazine, SkyCiv, Society for Neuroscience (SfN) and Yale Young Global Scholars. Strategic Partners: Code.org, Digital Manufacturing and Design Innovation Institute (DMDII), Hardware Science, Japan Science and Technology Agency and Million Women Mentors (MWM).

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

Science Olympiad

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