ANATOMY & PHYSIOLOGY

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

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

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

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

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. **CARDIOVASCULAR SYSTEM:**
      i. Anatomy and **physiology** of the cardiovascular system
      ii. The Heart - chambers and valves of the heart, electrical stimulation of myocardial tissue, pacemaker tissue, interpreting ECG (EKG) readings **on strips**
      iii. Blood Vessels – **structure and function of** arteries, arterioles, veins, venules, capillaries, **including the functionality of Startling's forces in the capillaries**
      iv. Blood - plasma, hematocrit, red blood cells, oxygen transport, hemoglobin **and cooperative binding of oxygen**, platelets and blood clotting, regulation of blood plasma volume and acidity, blood typing & basic genetics of ABO, Rh, blood types
      v. Measurement of the pulse rate and blood pressure **with appropriate instrumentation**
      vi. Calculations include systolic and diastolic pressure, mean arterial pressure, stroke volume & cardiac output
      vii. Effects of exercise, smoking, alcohol, caffeine, and drugs on the cardiovascular system
      viii. Understand disorders: Congestive Heart Failure, Atrial Fibrillation, Myocardial Infarction, Atherosclerosis, Bradycardia, and Tachycardia
      ix. *Treatments and/or prevention for all **disorders** listed above **as well as disseminated intravascular coagulation and capillary leak syndrome***
      x. ***Lethal & non-lethal cardiac strip (EKG) pattern interpretation:***
         (1) ***Division B only: Atrial Fibrillation, Pulseless Electrical Activity, Ventricular Tachycardia***
         (2) ***Division C only: Torsades, Premature Ventricular Contractions, Supraventricular Tachycardia***
   b. **LYMPHATIC SYSTEM:**
      i. Anatomy and **physiology** of the lymphatic system
      ii. **Similarities and differences between Primary, Secondary, and Tertiary lymphoid tissues**
      iii. **General Lymphatic structures -** lymph nodes, lymph ducts, lymphatic capillaries, tissue fluid
      iv. **Structure and function of the Thymus**
      v. **Structure and function of the Spleen**
      vi. **Understand disorders: Lymphedema, Hodgkin lymphoma, non-Hodgkin lymphoma, Lymphadenopathy**
      vii. ***GI Contributions to Immune Function and Absorption of Fats/Lipids in the tract***
      viii. ***Treatments and/or prevention for all disorders listed above***
   c. **EXCRETORY SYSTEM:**
      i. Anatomy and **physiology** of the excretory system
      ii. Basic anatomy of the urinary system including kidneys, ureters, bladder, and urethra
      iii. Structure and function of the nephron
      iv. Formation of urine, **Gross Filtration Rate** calculation, tubular secretion, and tubular absorption
      v. Understand disorders: **Kidney stones, Urinary Tract Infections, Glomerulonephritis, Renal failure**, **Incontinence**
      vi. *Additional diseases: Prostatitis, and BPH (Benign Prostatic Hyperplasia), **Glomerulosclerosis***
      vii. *Treatments and/or prevention for all **disorders** listed above*

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the **updated** 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 **in normal & starburst galaxies**.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one of the following **options containing information in any form and from any source**:
      i. two three-ring binders;
      ii. a computer/tablet and a three-ring binder; or,
      iii. two computers/tablets, of any kind.
   b. If three ring binders are used they may be of any size and the information contained should be attached using the available rings. The information or pages may be removed during the event. Sheet protectors and laminated sheets are allowed.
   c. Each team may bring **two stand-alone calculators of any type** to use during the event. **If the participants are using a computer/tablet they may use a calculator app or other program on their device in place of a stand-alone calculator.**
   d. No Internet access is allowed during any part of this event. **Participants using computers/tablets as a resource should have all information stored so that it is available to them off-line**.

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 **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, **star formation**, Cepheids, **RR Lyrae stars, Type Ia &** Type II supernovas, neutron stars, pulsars, stellar mass black holes, **supermassive black holes**, X-ray & gamma-ray binary systems, **ultraluminous X-ray sources (ULXs), globular clusters, stellar populations, normal & starburst galaxies, galactic structure and interactions, gravitational waves**.
   b. Use Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of binary systems **and galaxies**; use parallax, spectroscopic parallax the distance modulus, **the period-luminosity relationship**, Hubble's law and **the Tully-Fisher relationship** to calculate distances.
   c. Identify and answer questions relating to the content areas outlined above for the following objects:
      i. **M51/NGC 5195**
      ii. **IC 10**
      iii. **SPT 0346-52**
      iv. **M81/M82**
      v. **ESO 137-001**
      vi. **SN2014**
      vii. **Phoenix Cluster**
      viii. **NGC 4993**
      ix. **47 Tucanae/X9**
      x. **Chandra deep field-south**
      xi. **Cen A**
      xii. **M100**
      xiii. **Abell 400/NGC 1128/3C 75**
      xiv. **Antennae Galaxies**
      xv. **Sagittarius A***

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 and Bio/Earth Science CDs; other resources are on the event page at soinc.org.

THIS EVENT IS SUPPORTED BY NASA'S UNIVERSE OF LEARNING ASTROPHYSICS STEM LEARNING AND LITERACY NETWORK

BOOMILEVER

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

1. **DESCRIPTION:** Teams will design and build a Boomilever meeting requirements specified in these rules **to support a minimum load** and 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 Boomilever, 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 proper eye protection will not be allowed to compete and be placed in Tier 4.
   c. **Participants may NOT bring any equipment such as levels or squares**.
   d. The Event Supervisor will provide the Test Apparatus (see Section 5) **and tools/materials for measurement**.

3. **CONSTRUCTION PARAMETERS:**
   a. The Boomilever 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, commercially **laminated wood (i.e. plywood)**, or members formed of sawdust and adhesive. Wood may never be painted, color enhanced, or have **tape**/preprinted/paper labels affixed. Ink barcodes or markings from the construction process may be left on the wood.
      ii. There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated by the team without restriction.
      iii. Adhesive is a substance used to join two or more materials together **and may be used only for this purpose**. Any commercially available adhesive may be used (e.g., glue, cement, cyanoacrylate, epoxy, hot melt, polyurethane and super glues). Adhesive tapes are not allowed.
   b. **The Boomilever must be designed to attach to the testing wall using the Mounting Hook (5.a.ii.)**.
   c. **The Boomilever must support the Loading Assembly (5.b.) at the loading point which must be between 40 cm and 45 cm from the testing wall (4.Part II.e.ii.)**.
   d. **The loading point on the Boomilever must be constructed to permit placement of and completely support the Loading Assembly (5.b.)**.
   e. **Before and throughout loading, no portion of the Boomilever may touch the testing wall below the Contact Depth Line which is more than 20 cm (Div. B) or 15 cm (Div. C) below the center of the hole for the Mounting Hook (5.a.iii.).**
   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.

4. **THE COMPETITION:**

   Part I: Check-In
   a. **The team will present their Boomilever for inspection & measurement using materials provided.**
   b. The team will place their Boomilever on the scale so the event supervisor can determine the mass, in grams to the nearest 0.01 g.
   c. The team must submit their Estimated Load Score (6.b.) to be used as a tie breaker (6.d.).
   d. No alterations, substitutions, or repairs may be made to the Boomilever after the check-in process is started.
   e. The event supervisor will verify that the combined mass of the Loading Assembly and sand is at least 15,100 g but no more than 15,200 g prior to testing.

   Part II: Testing
   a. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
   b. Participants will have 6 minutes to setup and test their Boomilever to maximum load or failure.
   c. The participants must place the Boomilever on the Testing Wall and assemble the Loading Assembly as required to load the Boomilever. If necessary, participants may disassemble the Loading Assembly. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Boomilever to deflect.

d. The participants will be allowed to adjust the Boomilever until they start loading sand. Once loading of sand has begun, the Boomilever must not be further adjusted.
e. **The event supervisor will verify the Boomilever is placed properly for testing:**
   i. **Only attached to the Testing Wall by the Mounting Hook (5.a.ii.)**
   ii. **The loading point meets requirements as measured horizontally from the Testing Wall to the centerline of the chain on the Loading Assembly (5.b.)**
   iii. **No portion of the Boomilever touches the Testing Wall below the Contact Depth line (3.e.)**
f. Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. The bucket may only be stabilized by the using the tips of the **provided** bucket stabilizing sticks (5.d.).
g. Loading stops immediately when the **Boomilever touches below the Contact Depth line (3.e.)**, failure occurs, or when time expires; any parts of the Boomilever in the bucket when loading stops will be removed.
h. Boomilevers that fail before supporting 15,000 g will be scored according to the actual **load** supported at time of failure **(6.b.)**, measured to the nearest gram or best precision available. Failure is defined as the inability of the Boomilever to carry any additional load or any part of the load being supported by anything other than the Boomilever. Incidental contact by the chain/eyebolt with the Boomilever is not failure.
i. More than one Test Apparatus may be used. Teams will be given a choice of which apparatus they will use.
j. Teams who wish to file an appeal must leave their Boomilever with the event supervisor.
k. The supervisor will review with the team the data recorded on their scoresheet.

5. **TEST APPARATUS:**
   a. The Testing Wall must be as follows:
      i. **Vertical, solid, and rigid surface with dimensions minimum of 40.0 cm wide x 30.0 cm high. Constructed of ¾" grade plywood or other suitable material, with a smooth, hard, low friction surface that does not bend when loaded**.
      ii. **The Mounting Hook must be 4" steel J-bolt made of ¼" nominal round stock, have a 5/8" nominal inside hook diameter with a threaded ¼" mounting end [e.g., National Hardware barcode stock number N232-892 (UPC 038613228917), ¼" by 4" or exact equivalent shall be used]**.
      iii. **One Mounting Hook must be attached to the Testing Wall by the Supervisor with the "opening" up and installed to allow 2.5 cm +/- 0.1 cm clearance between the wall and the closest edge of the Hook. The Hook must be secured in place with a hex nut and flat washer on the front side and a wing nut and flat washer on the back side of the Testing Wall. The Hook must be horizontally aligned by centering between the sides of the Testing Wall approximately 5.0 cm below its top. The centerlines of the holes must be visible on the face of the Testing Wall.**
      iv. **A horizontal Contact Depth line must be clearly visible on the Testing Wall. It must be drawn below the centerline of the hole for the Mounting Hook as defined in rule 3.e.**
   b. The **Loading Assembly** will consist of:
      i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt
      ii. 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
      iv. **An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain**.
   c. Sand or other clean, dry free-flowing material (hereafter "sand").
   d. 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.

BOOMILEVER (CONT.)

6. **SCORING:**
   a. **High score wins. Score = Load Score (g)/Mass of Boomilever (g)**.
   b. The Load Score is the measured load supported, including the Loading Assembly (5.b.) and sand, but may not exceed 15,000 g. **The lowest Load Score is the mass of the Loading Assembly**.
   c. Boomilevers will be placed in four tiers as follows:
      i. Tier 1: **Holding 3,000 g or more** and no violations
      ii. Tier 2: **Holding less than 3,000 g** and no violations
      iii. Tier 3: **Holding any load** with any violations
      iv. Tier 4: Unable to be loaded for any reason (e.g., cannot accommodate Loading Block, Loading Assembly, or failure to wear eye protection) and will be ranked by Lowest mass
   d. Ties are broken as follows:
      i. Estimated Load Score (4.Part I.c.) closest to, without exceeding, the actual Load Score (6.b.)
      ii. Lowest Boomilever mass
   e. Example score calculations:
      i. Boomilever 1: mass = 15.12 g, load supported = 12,134 g, Score = 802.5
      ii. Boomilever 2: mass = 12.32 g, load supported = 13,213 g; Score = 1,072.5

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

THIS EVENT IS SPONSORED BY ARCELORMITTAL

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 **Acids & Bases**.

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

2. **EVENT PARAMETERS:**
   a. Each participant must bring safety equipment (e.g., goggles, lab coat, apron), a writing implement, and **may bring a stand-alone non-programmable, non-graphing calculator**.
   b. Each team may bring **one** 8.5" x 11" sheet of paper, **in a sheet protector or laminated**, with information on both sides in any form and from any source **along with any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.**
   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, the host will notify teams if a specific type is required). Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified from the event.
   d. Supervisors will provide any required reagents, additional glassware, and/or references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).

3. **THE COMPETITION:**
   a. The competition will consist of a series of tasks similar to those in first year high school courses. These tasks could include hands-on activities, questions on listed topics, interpretation of data (e.g., graphs, diagrams, tables), or observation of an established and running experiment.
   b. Teams may be asked to collect data using a probeware set-up demonstrated by the supervisor(s). Following a demonstration of the sensors/probes, participants may be given data sets to interpret.
   c. Nomenclature, formula writing, & stoichiometry (mole conversions & percentage yield) are essential tools of chemistry & may be included in the event. Participants are expected to know the symbols & charges for: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate, & hydroxide. Participants should know how to use the "ite" form of anion (one less oxygen than the "ate" form). With a periodic table, participants should be able to obtain charges for monatomic ions (e.g., Na^{+}, S^{2-}).
   d. Participants should understand the following **Acid-Base Chemistry concepts**:
      i. **Properties & Uses of Common Acids and Bases**
         (1) **Acids - (HCl, HNO_3, H_2SO_4, H_3PO_4, H_2CO_3, acetic, and ascorbic acid)**
         (2) **Bases - ($NaOH$, KOH, $Ca(OH)_2$, $Mg(OH)_2$, and $NH_3(aq)$)**
         (3) **Acid/Base indicators and how they are used; pH ranges and color changes will be provided. Questions will not address theories of how indicators work.**
      ii. **Titrations to determine percent composition, molarity, and/or molecular mass.**
      iii. **Additional calculations will be limited to K_a, K_b, pH, pOH, and dilution.**
      iv. **Acid & Base reactions will be limited to metals, carbonates, bicarbonates, sulfites, bisulfites, oxides, & neutralizations.**
      v. **State and Nationals only: calculations or questions about buffers**.
   e. Participants 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.

4. **SAMPLE QUESTIONS/ACTIVITIES:**
   a. **Determination of the density of a liquid using a pycnometer**.
   b. Separate a mixture by physical properties (magnetism, solubility, etc.).
   c. **Titrations to determine percent composition, molarity, and/or molecular mass.**
   d. **Given a pH indicator and the results of a test determine the pH of a solution.**
   e. **Identify the pH indicator that should be used to monitor the pH change in a given experiment**.

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

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

CIRCUIT LAB

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

1. **DESCRIPTION:** Participants must complete tasks and answer questions about electricity and magnetism.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** None. **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. Participants may remove information or pages for their use during the event.
   b. Each team may also bring writing utensils, and two stand-alone calculators of any type for use during any part of the event.
   c. Event supervisors must provide any material & measurement devices required for the hands-on tasks.
   d. Participants may bring their own basic multimeters for use in place of provided ones at the discretion of the event supervisor.

3. **THE COMPETITION:**

   Part I: Written Test
   a. The written test consisting of multiple choice, true-false, completion, or calculation questions/problems will assess the team's knowledge of electricity and magnetism.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The test will consist of at least one question from each of the following areas:
      i. Historical perspective of the electricity discoveries made by Volta, Ohm, Tesla, Hertz, & Faraday
      ii. Properties of electric charge/fields, sources/hazards of static electricity, Coulomb's Law, capacitance
      iii. Direct current (DC) characteristics, sources, uses, simple circuit diagrams, DC hazards
      iv. Alternating current (AC) characteristics, sources, uses, AC hazards
      v. Concepts and units of current, voltage, resistance, power, energy, and using Ohm's law
      vi. Magnetic poles/fields, electromagnets, transformers, motors/generators, right-hand rule
      vii. Electrical control devices including 3-way light switch circuits
      viii. Simple measurements, constructions, and configurations of a circuit and individual components
      ix. Fundamental characteristics and operation of a light emitting diode (LED)
      x. **Division C only** - Simple circuit analysis using Kirchhoff's Voltage & Current Laws
      xi. **Division C only** - Basic digital logic and digital logic operations
      xii. **Division C only** - Time constant of a RC circuit
      xiii. **Division C only** - Electrical characteristics of a silicon PN junction
      xiv. **Division C only** - Basics and application of Operational Amplifiers (OpAmps)
   d. Topics not included in the competition are: semiconductors, AC circuit theory, inductance, non-linear devices, three-state logic gates, sequential logic, and oscilloscopes.

   Part II: Hands-On Tasks
   a. The hands-on portion will consist of at least one task at a station(s) for the teams to complete.
   b. Participants must be familiar with the operation of breadboards and how to use them.
   c. The hands-on tasks, or stations, may include but are not limited to:
      i. Determine the value of a mystery resistor in a circuit using only voltage measurements.
      ii. Calculate the power supplied to a circuit.
      iii. Given some wires, batteries, resistors, and 2 LEDs, hook them up so the LEDs are equally bright.
      iv. Construct an electromagnet using some wire, a bolt and battery.

4. **SCORING:**
   a. High score wins.
   b. Points will be awarded for correct answers, measurements, calculations, and data analysis. Supervisors are encouraged to provide a standard form for competitors to show measurements/calculations.
   c. The written portion of the competition will account for 50-75% of each team's score. No single question will count for more than 10% of the total points possible on the written test.
   d. The hands-on portion of the competition will account for the remaining 25-50% of each team's score.
   e. Ties will be broken using pre-selected task(s)/question(s) that will be noted on the written test.

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.

THIS EVENT IS SPONSORED BY THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

CODEBUSTERS

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

1. **DESCRIPTION:** Teams will cryptanalyze (decode) encrypted messages using cryptanalysis techniques and show skill with advanced ciphers by encrypting or decrypting a message.

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

2. **EVENT PARAMETERS:**
   a. Teams must bring writing utensils with an eraser **and may bring up to three (3) stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators**.
   b. No resource materials, except those provided by the event supervisor, may be used.
   c. **The event supervisor will provide scratch paper for each team to use**.

3. **THE COMPETITION:**
   a. **This event consists of participants using cryptanalysis techniques and advanced ciphers to encrypt or decrypt messages on a written exam**.
   b. Teams will begin the event simultaneously at the indication of the event supervisor.
   c. Teams must not open the exam packet nor write anything prior to the "start" signal, nor may they write anything after the "stop" signal.
   d. Participants are free to answer the questions in any order, working individually or in groups, attempting whichever of the questions seem right for them.
   e. **The code types that may be used on the exam at Invitational and Regional competitions are as follows**:
      i. Atbash Cipher (in English, not Hebrew)
      ii. The Caesar Cipher, also called a shift cipher.
      iii. Mono-alphabetic substitution (can use K1, K2, or random alphabets as defined by the **American Cryptogram Association (ACA)**
         (1) Aristocrats with a hint - messages with spaces included, and with a hint
         (2) Aristocrats - messages with spaces included, but without a hint
         (3) Aristocrats - messages with spaces and hints, but including spelling/grammar errors
         (4) Aristocrats - messages with spaces and including spelling/grammar errors but no hints
         (5) Patristocrats with a hint - messages with spaces removed, and with a hint
         (6) Patristocrats - messages with spaces removed, but without a hint
      iv. Affine cipher - encryption only (i.e. producing the ciphertext for a given plaintext & key)
      v. The Vigenère Cipher - encryption/decryption only, not cryptanalysis (i.e. producing the ciphertext for a given plaintext & key, or the plaintext given a ciphertext & key)
      vi. The Baconian cipher, and its variants
      vii. Xenocrypt - no more than one cryptogram can be in Spanish
      viii. Mathematical Cryptanalysis of the Hill Cipher - either producing a decryption matrix given a 2x2 encryption matrix or computing a decryption matrix given 4 plaintext-ciphertext letter pairs.
   f. **The code types that may be used on the exam at State and National competitions are as follows**:
      i. All Invitational and Regional code types
      ii. The running-key cipher
      iii. Cryptanalysis of the Vigenère cipher with a "crib" (a known-plaintext attack)
      iv. The RSA Cipher
      v. The Hill Cipher - encrypting with a 2x2 or 3x3 encryption matrix provided, or decrypting with a 2x2 or 3x3 decryption matrix provided.
      vi. Xenocrypt - at the state and national levels, at least one cryptogram will be in Spanish.
      vii. Mathematical Cryptanalysis of the Affine Cipher
   g. For aristocrats, patristocrats, and xenocrypts: no letter can ever encrypt to itself.
   h. **For all but one question, the event supervisor will identify which cipher is to be used**.
   i. The first question of the exam will be timed.
      i. The first question will be the decoding of a mono-alphabetic substitution cryptogram, it will be either an Aristocrat with or without a hint.
      ii. A team member should signal when his or her team has broken the cryptogram.
      iii. Before the exam begins, the event supervisor will announce the nature of the signal that must be used (e.g., shouting "bingo", or quietly raising hand).
      iv. The time in seconds, **to the accuracy of the device used**, to solve the cryptogram will be recorded by the event supervisor or designee.

v. If a team gets the timed question wrong, they may attempt to answer the question repeatedly without penalty. The timing bonus will be calculated from the start of the event until the question is successfully answered by the team, or until 10 minutes has elapsed. After 10 minutes, the timed question can still be answered but the timing bonus is zero.

4. **SCORING:**
   a. The high score wins. Final score = Exam score + timing bonus.
   b. Based on difficulty, each question will be worth a clearly indicated number of points.
      i. **The general point distribution by question type is**:
         (1) An "easy question" = 100-150 pts
         (2) A "medium question" = 200-300 pts
         (3) A "hard question" = 350-500 pts
         (4) A "very hard question" = 550-700 pts
      ii. For questions such as cryptograms, with answers composed of letters, **the final points will be determined based on the number of errors found**
         (1) **Two or fewer errors** will result in full credit
         (2) Each additional error results in a penalty of 100 points
         (3) The penalty will not exceed the value of the question. For example, a 400-point question with 5 errors is worth 100 points whereas the same 400-point question with 7 errors would be worth 0 points, not -100 points.
      iii. For questions whose answers are numbers, the answer is either correct or incorrect.
      iv. The scores for each question will be added to determine the exam score.
   c. **A Timing Bonus can be earned based on the number of seconds it takes a team to correctly decode** the first question. The timing bonus is equal to 4 x (600 - number of seconds). For example, 6 minutes = 4(600-360) = 960 points.
   d. Tie Breakers: For teams that are tied, select questions predetermined by the event supervisor, will be used to break the tie using the following criteria in this order: score, degree of correctness and number attempted.
   e. Scoring example: Team A earns 3600 points on the exam and solves the timed question in 435 seconds.

Exam Score	=	3600 pts.
Timing Bonus 4 x (600 - 435)	=	660 pts.
Final Score		4260 pts.

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.

DESIGNER GENES

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

1. **DESCRIPTION:** Participants will solve problems and analyze data or diagrams using their knowledge of the basic principles of genetics, molecular genetics, and biotechnology.

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

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

3. **THE COMPETITION:**
   a. This event may be run as stations and could include observations, inferences, predictions, data analysis, and calculations. **Questions/tasks will be equally allocated to not overemphasize a particular topic.**
   b. **This event will test participants' knowledge of molecular genetics in both bacteria and eukaryotes including basic principles of genetics as well as the following topics**:

Regional & State Tournament Topics		**National Tournament Topics** (all Regional & State topics + the following)
Monohybrid cross	Dihybrid cross	Pedigree construction &analysis
Dominant & recessive alleles	Sex-linked traits	Production of gametes with Abnormal #'s of chromosomes
Genotype vs. phenotype	Pedigree analysis	Trihybrid cross (probability analysis)
Human sex determination	Multiple alleles	Analysis of karyotypes for deletion, addition, translocation
Gene - Protein relationship	DNA structure & replication	**Mutations**
Mitosis, Meiosis & gamete formation	Transcription & translation	Multifactorial traits &Epistasis
Human karyotypes analysis for nondisjunction disorders	Co-dominance & incomplete dominance	**PCR**
Components of a gene	Sanger sequencing	**Random vs. targeted mutagenesis**
Mechanism of DNA replication, including roles of enzymes	DNA fingerprinting & **RFLP analysis**	**Post-transcriptional RNA processing & regulation**
Mechanism of gene expression, including roles of enzymes	Gene therapy, **CRISPR-Cas technology**	RNA-Seq, **Tn-Seq, & their uses**
Promoter **structure**	DNA microarrays	DNA repair
Molecular consequences of mutations	**Plasmid cloning, selection, & isolation**	Comparison of Next Generation Sequencing Platforms
Organelle DNA	Phylogenetics	Epigenetics

4. **SAMPLE QUESTIONS:**
   a. Given a gel electrophoresis set up and running, or photographs showing results of a gel, with the lanes labeled: mother, child, male 1 and male 2.
      i. According to the results, who is the possible father of the child?
      ii. Why do the bands of DNA in the photograph end up at different locations within their lanes?
      iii. What is the size of fragment 3 in Lane 3?
   b. Given a sequence of coding strand DNA, what is the sequence of the corresponding RNA?
   c. Using the genetic code, what would be the sequence of amino acids made from this RNA?
   d. What would be the consequence of mutating the -10 region of a prokaryotic promoter?

5. **SCORING:**
   a. Highest number of correct solutions will determine the winner.
   b. Selected questions may be used as tiebreakers.

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

THIS EVENT IS SPONORED BY CORTEVA AGRISCIENCE

DISEASE DETECTIVES

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

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

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

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

3. **THE COMPETITION:**
   a. **This event has been reorganized into three parts with each part counting approximately equally towards a team's final score.**

   Part I: Background & Surveillance
   a. Understand the Clinical Approach (health of individuals) and Public Health Approach (health of populations)
   b. Understand the roles of epidemiology in public health and the steps in solving health problems
   c. Understand the Natural History and Spectrum of Disease and the Chain of Infection
   d. Understand the basic epidemiological and public health terms (e.g., outbreak, epidemic, pandemic, surveillance, risk, vector)
   e. Understand the role of Surveillance in identifying health problems, the 5 step Process for Surveillance and the types of Surveillance

   Part II: Outbreak Investigation
   a. Analyze an actual or hypothetical outbreak
   b. Understand the Types of Epidemiological Studies – Experimental and Observational
   c. Be able to identify the Steps in an Outbreak Investigation
   d. Identify the problem using person, place, and time triad – formulate case definition
   e. Interpret epi curves, line listings, cluster maps, and subdivided tables
   f. Generate hypotheses using agent, host, and environment triad
   g. Recognize various fundamental study designs and which is appropriate for this outbreak
   h. Evaluate the data by calculating and comparing simple rates and proportions as attack rate, relative risk, odds-ratio, and explaining their meaning
   i. Apply the Bradford Hill Criteria for Verifying the Cause of this outbreak
   j. **Division C Only**: Recognize factors such as study design/biases, errors, and confounding variables that influence results
   k. **Division C, Nationals Only**: Suggest types of control & prevention measures for this outbreak

   Part III: Patterns, Control, and Prevention
   a. Identify patterns, trends of epidemiologic data in charts, tables, and graphs
   b. Using given data, calculate disease risk and frequencies as a ratio, proportion, incidence proportion (attack rate), incidence rate, prevalence, or mortality rate
   c. Understand the Strategies of Disease Control
   d. Understand Strategies for Prevention - the Scope and Levels of Prevention
   e. **Division C Only**: Propose a reasonable set of prevention strategies for a public health problem once the cause has been determined
   f. **Division C, Nationals Only**: Identify the strengths and weaknesses of a set of proposed prevention strategies

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

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

THIS EVENT IS SPONSORED BY THE CENTERS FOR DISEASE CONTROL (CDC)

DYNAMIC PLANET

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

1. **DESCRIPTION:** Students will use process skills to complete tasks related to glaciers, glaciation, and long-term climate change.

   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 containing information on both sides in any form and from any source. The sheets may be **laminated** or in sheet protectors without annotations affixed.
   b. Each team may bring two **stand-alone non-programmable, non-graphing** calculators.

3. **THE COMPETITION:**
   Participants will be presented with one or more tasks, many requiring the use of process skills (e.g., observing, classifying, measuring, inferring, predicting, communicating, and using number relationships) from the following topics:
   a. Glacier formation: Properties of ice, ice crystal structure, and formation of glacial ice from snow & firn
   b. Glacial mass-balance and flow: ablation and accumulation zones, equilibrium line, influence of bed (wet or dry, bare rock, and sediment), and relation of flow to elevation and gradient
   c. Glacier/ice sheet types and forms: valley/**alpine (cirque, hanging, piedmont)**, ice sheet/**continental including** ice stream, ice shelf, ice rise, ice cap, ice tongue, & the geographic distribution **of these features**
   d. Glacial features: crevasses, ogives, icefalls, what they are, & what they indicate about flow and melt
   e. Formation of landscape features:
      i. Erosional - cirque, tor, U-shaped valley, hanging valleys, aretes, horns, **striations & grooves, and Rôche moutonnée**
      ii. Depositional – moraines **(end/terminal, recessional, lateral, medial, ground),** kettles, kames, drumlins, eskers, and **erratics**
   f. Glacial hydrology: Surface melt, surface lakes, moulins, drainage and subglacial lakes, & Jökulhlaups
   g. Global connections of glaciation:
      i. Atmosphere - greenhouse gases, insolation, and aerosols
      ii. Oceans - sea level change and ice sheet variation
      iii. Lithosphere - Isostatic effects on Earth's crust
   h. History of ice on Earth:
      i. Neoproterozoic snowball Earth
      ii. Late Paleozoic ice ages
      iii. Eocene Oligocene Transition and the impact of opening oceanic seaways
      iv. Pleistocene onset of Northern Hemisphere glaciation
   i. Ice cores as archives of past environments including gases, aerosols, and stable isotope composition
   j. Sedimentary sequences produced in glacial environments in the marine and terrestrial realms
   k. Milankovitch cycles' role in producing climate cyclicity and role in dating
   l. The Laurentide Ice Sheet retreat & melting history; impact on river drainage; and oceanic circulation
   m. Modeling rates and size of ice sheet changes (e.g., marine ice sheet instability, ice shelf buttressing)
   n. Methods of studying glaciers & what they tell you: Altimetry, radar, Landsat, seismology, and gravity
   o. Recent records of cryospheric change: (e.g., Larsen B, Kilimanjaro, Amundsen Sea Embayment)

4. **SAMPLE QUESTIONS/TASKS:**
   a. Analyze and interpret glacial features on a USGS topographic map or satellite image.
   b. Analyze a geologic map of glacial deposits to determine the sequence of events over the course of several episodes of advance and retreat.
   c. Interpret oxygen isotope data from a marine sediment core to identify changes in sea level caused by global ice volume changes.
   d. Apply glaciological principles to predict where one might find meteorites in ice fields.

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

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

THIS EVENT IS SPONSORED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

EXPERIMENTAL DESIGN

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

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

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

2. **EVENT PARAMETERS:**
   a. Participants must bring goggles and writing utensils. Chemicals that require other safety clothing will not be used.
   b. Division B teams may bring one timepiece, one linear measuring device, and one **stand-alone** non-programmable non-graphing calculator.
   c. Division C teams may bring one timepiece, one linear measuring device, and one **stand-alone** calculator of any type.
   d. The event supervisor will provide each team with identical sets of materials either at a distribution center or in an individual container.
   e. The event supervisor will supply a report packet, based on the Experimental Design Checklist posted on the event page at soinc.org, for recording their experimental information and data.

3. **THE COMPETITION:**
   a. The teams must design, conduct, and report the findings of an experiment 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. **During the first 20 minutes of the event, participants will receive the assigned question/topic area, materials, and the first half of the report packet so they can focus on designing and conducting their experiment**.
   c. **After the first 20 minutes, participants will receive the last half of the report packet and while they may continue experimenting, participants will also begin to analyze their data and report findings**.
   d. 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.
   e. 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. Scoring will be done using the Experimental Design Checklist found on the Science Olympiad website (soinc.org).
   b. Points will be awarded depending upon the completeness of the response. Zero points will be given for no responses as well as illegible or inappropriate responses.
   c. Ties will be broken by comparing the point totals in the scoring areas in the following order:
      i. Variables
      ii. Procedure
      iii. Analysis of Results (Claim, Evidence, & Reason)
      iv. Graph
      v. **Raw** Data Table
   d. Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
   e. **The final score of a team will be multiplied by 0.95 if they do not follow cleanup procedures.**
   f. **The final score of a team will be multiplied by 0.75 if their experiment does not address the assigned question/topic area.**
   g. **The final score of a team will be multiplied by 0.25 if they do not conduct an experiment (i.e., performing a dry lab, making up data or trials).**

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

EXPERIMENTAL DESIGN CHECKLIST

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

Part I - Design and Construct Experiment

A. Hypothesis (6 pts)

② ① ⓪ Statement predicts a relationship or trend **between the independent and dependent variables**
② ① ⓪ Statement gives specific direction to the predictions(s) (e.g., a stand is taken)
② ① ⓪ A rationale is given for the hypothesis.

B. Variables (**16 pts**)

a. Independent Variable (IV) (6 pts)
② ① ⓪ IV correctly identified
② ① ⓪ IV operationally defined
② ① ⓪ At least three levels of IV given

b. Dependent Variable (DV) (**4** pts)
② ① ⓪ DV correctly identified
② ① ⓪ DV operationally defined

c. Controlled Variables (CV) (**6** pts)
② ① ⓪ One CV correctly identified
② ① ⓪ Two CVs correctly identified
② ① ⓪ Three CVs correctly identified

C. Experimental Control (Standard of Comparison) (4 pts)

② ① ⓪ SOC correctly identified and makes logical sense for the experiment
② ① ⓪ Reason given for selection of SOC

D. Materials (6 pts)

② ① ⓪ Materials listed separately from procedure
② ① ⓪ All materials used are listed
② ① ⓪ **No extra materials are used**

E. Procedure with Diagrams (12 pts)

② ① ⓪ Procedure well organized
② ① ⓪ Procedure is in a logical sequence
② ① ⓪ Repeated trials
② ① ⓪ Diagram of the experimental setup provided
④ ③ ② ① ⓪ Enough information is given so another could repeat procedure

F. Qualitative Observations (8 pts)

② ① ⓪ Observations about results given
② ① ⓪ Observations about procedure/deviations
② ① ⓪ Observations about results not directly relating to Dependent Variable or other data
② ① ⓪ Observations given throughout the course of the experiment

G. Quantitative Data - Data Table (10 pts)

② ① ⓪ All raw data is given
② ① ⓪ All data has units
② ① ⓪ Table(s) labeled properly
② ① ⓪ **Reports most relevant data**
② ① ⓪ All data reported using correct figures (significant figures C Division only)

(revised 08/22/18)

Part II – Data, Analysis and Conclusions

H. Graphs (10 pts)

② ① ⓪ Appropriate type of graph used
② ① ⓪ Graph has title
② ① ⓪ Graph labeled properly (axes/series)
② ① ⓪ Units included
② ① ⓪ Appropriate scale used

I. Statistics (6 pts)

② ① ⓪ **Age-appropriate statistics (i.e., best fit, average/mean, median, mode) are used**
② ① ⓪ Example calculations are given with appropriate units
② ① ⓪ **Calculations are accurate**

J. Analysis and interpretation of data (10 pts)

② ① ⓪ All data discussed and interpreted
② ① ⓪ Unusual data points commented on
② ① ⓪ Trends in data explained and interpreted
② ① ⓪ **Interpretations based on statistics used are accurate**
② ① ⓪ Enough detail is given to understand data and all statements must be supported by the data.

K. Possible Experimental Errors (6 pts)

② ① ⓪ Possible reasons for errors are given
② ① ⓪ Important info about data collection given
② ① ⓪ Effect errors had on data discussed

L. Conclusion (8 pts)

② ① ⓪ Hypothesis is evaluated according to data
② ① ⓪ Hypothesis is re-stated
② ① ⓪ Reasons to accept/reject hypothesis given
② ① ⓪ All statements are supported by the data

M. Applications & Recommendations for Further Use (8 pts)

② ① ⓪ Specific suggestions to improve the experiment are given
② ① ⓪ Suggestions for other ways to look at hypothesis are given
② ① ⓪ Suggestions for future experiments are given
② ① ⓪ Practical application(s) of experiment are given

Team #: _____

School Name: _____

Point Total: _____**/106**

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

Final Score: _____

FERMI QUESTIONS

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

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

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

2. **EVENT PARAMETERS:**
   a. The participants must bring writing utensils. No other materials or resources are allowed.
   b. The event supervisor will provide the questions, scrap paper, and answer sheets with identifying units.
3. **THE COMPETITION:**
   a. Each team will have the same amount of time to answer as many questions as possible.
   b. All teams competing in a given time block will be quizzed together and will be given no feedback during the contest.
   c. All answers are to be written to the correct power of ten (exponent) as follows:
      i. For a number in the form $Cx10^E$, the guide for rounding of the coefficient (C) is: if C is 5 or greater (to 9.99...), round C up to 10. For example, if the number is 5.001×10^3, the correct power of ten is 4. Responses recorded as 5.001×10^3 on the answer sheet will be marked as incorrect.
      ii. If C is below 5 (and greater than 1), round C down to 1. For example, if the number is 4.99×10^6, you record 6 as your answer.
   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 QUESTIONS/TASKS:**
   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, in grams, 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

   c. 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, students will perform a series of tests. These tests, along with other evidence or test results, will be used to solve a crime.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring **any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org, to use during this event and two stand-alone non-programmable, non-graphing calculators**. Participants not bringing these items will be at a disadvantage. The supervisor will not provide them.
   b. **Each participant may bring an 8.5" x 11" sheet of paper** that may contain information on both sides in any form and from any source. **This sheet** of paper may be laminated or placed in a sheet protector.
   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. Long hair, shoulder length or longer, 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. 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
   e. The supervisor may provide:
      i. other equipment (e.g., a microscope, probes, etc.)
      ii. candle & matches if fibers given
      iii. differential density solutions or other method of determining density of polymers if plastics given
      iv. reagents to perform other tests

3. **THE COMPETITION:**
   a. The competition will consist of evidence from **Parts 3.c. - f.** and analysis of the evidence in **Part 3.g**. Analysis or questions can only be on the evidence topics included in the competition. The amount of evidence included will be according to the following table:

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

   b. The collected evidence and other data given could be used in a mock crime scene.
   c. **Qualitative Analysis:** Participants may be asked to identify the following substances: sodium acetate, sodium chloride, sodium hydrogen carbonate, sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid, and ammonium chloride (there will be no mixtures). All teams will have the same set of solids to identify.
   d. **Polymers:** Participants may be asked to identify:
      i. **Plastics:** PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA, PC – Participants will not perform any burn tests on these plastics, but the supervisor may provide burn test results on them.
      ii. **Fibers:** cotton, wool, silk, linen, nylon, spandex, polyester - burn tests will be permitted on the fibers.
      iii. **Hair:** human, bat, cow, squirrel, and horse hair - participants will need to know hair structure including medulla, cortex, cuticle, and root.
   e. **Chromatography/Spectroscopy:** Participants will be expected to separate components using paper chromatography, TLC, and/or analyze mass spectra. Participants may be expected to measure R_fs.

f. **Crime Scene Physical Evidence:**
   i. **Fingerprint Analysis:** Participants will be expected to know the 8 specific fingerprint patterns (plain arch, tented arch, radial loop, ulnar loop, plain whorl, central pocket whorl, accidental whorl, and double loop whorl). Participants should also be familiar with the common fingerprint development techniques of dusting, iodine fuming, ninhydrin, and cyanoacrylate fuming. Participants should understand terminology such as bifurcation, ridges, island, enclosure, loop, whorl, and arch. Participants should be able to answer questions about skin layers and how fingerprints are formed. 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. Students may be given the composition of soil found at the scene or on the suspects and asked to determine if this implicates any of the suspects.
   viii. **Blood:** 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 students may be asked to identify if a blood sample, either prepared microscope slide or pictures of microscope slide, is human, avian, mammalian, or reptilian/amphibian.
   ix. **Bullet striations:** Participants may be asked to match the striations on bullets or casings found at the crime scene and fired from a given gun.

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

h. Teams will dispose of waste as directed by the event supervisor.

4. **SCORING:**
   a. High score wins. Time will not be used for scoring.
   b. The score will be composed of the following elements (percentages given are approximate): 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.
   e. A penalty of up to 10% may be given if a team brings **prohibited lab equipment to the event**.

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

FOSSILS

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

1. **DESCRIPTION: Teams use fossils to date and correlate rock units as well as demonstrate their knowledge of ancient life by completing tasks related to fossil identification and classification.**

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one magnifying glass, **the Science Olympiad Official Fossil List** and one **standard 3-inch** or smaller, 3-ring binder containing information in any form and from any source attached using the available rings.
   b. **If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder.**

3. **THE COMPETITION:**
   a. Participants will move from station to station, with the length of time at each station predetermined and announced by the event supervisor.
   b. Participants may not return to stations but may continue to work on their responses throughout.
   c. Emphasis will be placed upon task-oriented activities at each station.
   d. Identification will be limited to **specimens** on **the Science Olympiad Official Fossil List**, but other **samples** may be used to illustrate key concepts. Questions will be chosen from the following topics:
      i. Identification of all fossil specimens on **the Science Olympiad Official Fossil List**
      ii. Taxonomic classification **restricted to the hierarchy on the Science Olympiad Official Fossil List**
      iii. Conditions required for a plant or an animal to become fossilized
      iv. Common modes of preservation: **petrification/petrifaction** (e.g., permineralization & mineral replacement including **silicification and pyritization**), cast/mold, imprints, **carbonization**, **unaltered remains**
      v. Uncommon modes of preservation: encasement in amber, mummification, freezing
      vi. Relative dating: law of superposition, original horizontality, cross cutting relationships, unconformities
      vii. Absolute dating: radiometric dating, half-life, carbon dating, volcanic ash layers
      viii. **The** Geologic Time Scale, **its organization, major events, the 5 major mass extinctions, and the Pleistocene-Holocene extinction of megafauna. An official Science Olympiad Geologic Time Scale is posted at soinc.org & should be used for all competitions.**
      ix. Index Fossils: **characteristics and use in determining the age of rocks & geologic formations**
      x. Fossil bearing sedimentary rocks: limestone, shale, sandstone, mudstone, coquina
      xi. Modes of life: filter feeder, predator, scavenger, deposit feeder, benthic, pelagic
      xii. Environments: **shallow marine, deep** marine, terrestrial, fresh water
      xiii. Mineral and organic components of **exoskeletons**, shells, and **bones/teeth** (e.g., calcite, aragonite, silica, chitin, **biological apatite**)
      xiv. Adaptations and morphologic features of major fossil groups
      xv. Important paleontological discoveries (**i.e., non-avian dinosaurs with feathers; transitional species such as *Tiktaalik* and *Archaeopteryx***)
      xvi. ***Lagerstätten* (conservation and concentration) and their significance, limited to: Burgess Shale, Beecher's Trilobite Bed, Mazon Creek, Ghost Ranch, Solnhofen Limestone, Yixian Formation (Liaoning), Green River Formation, and LaBrea Tar Pits**
      xvii. **Fossils as evidence for evolutionary trends and patterns such as morphologic adaptations within groups and major evolutionary events (i.e., Cambrian explosion, fish to tetrapods, dinosaurs to birds, whales, horses)**

4. **SAMPLE QUESTIONS/TASKS:**
   a. Identify each fossil, record its mode of preservation, the type of rock the sample is embedded in, and the geologic period it represents.
   b. List samples in order from oldest to most recent.
   c. Based on the fossil and rock associations, determine the environment in which the organism lived.
   d. Construct a range chart and determine the age of the fossil assemblage.

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

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

OFFICIAL FOSSIL LIST

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

KINGDOM PROTOZOA
Phylum Foraminifera (Forams)
1) Order Fusulinida (Fusulinids)
2) Genus *Nummulites*

KINGDOM ANIMALIA
INVERTEBRATES:
Phylum Porifera (Sponges)
3) Genus *Astraeospongia* (calcareous sponge)
4) Genus *Hydnoceras* (glass sponge)

Phylum Bryozoa
(Growth forms: branching, massive, fenestrate)
5) Genus *Archimedes*
6) Genus *Rhombopora*

Phylum Hemichordata
7) Class Graptolithina (Graptolites)

Phylum Cnidaria
Class Anthozoa (Horn & Colonial Corals)
8) Genus *Favosites*
9) Genus *Halysites*
10) Genus *Heliophyllum*
11) Genus *Hexagonaria*
12) Genus *Septastraea*

Phylum Arthropoda
13) Subphylum Crustacea (shrimp, lobster, crabs, barnacles, **ostracods**)
14) Order Eurypterida (Eurypterids)
15) Class Insecta (Insects)
Class Trilobita (Trilobites)
16) Genus *Cryptolithus*
17) Genus *Calymene*
18) Genus *Elrathia*
19) Genus *Isotelus*
20) Genus ***Eldredgeops*** (formerly *Phacops*)

Phylum Brachiopoda
Class Inarticulata:
21) Genus *Lingula*
Class Articulata:
22) Genus *Atrypa*
23) Genus *Composita*
24) Genus *Juresania*
25) Genus *Leptaena*
26) Genus *Mucrospirifer*
27) Genus *Platystrophia*
28) Genus *Rafinesquina*
29) Order *Rhynchonellida*

Phylum Mollusca
Class Bivalvia (**clams, oysters, mussels**)
30) Genus *Exogyra*
31) Genus *Gryphaea*
32) Genus *Pecten*
33) Genus ***Glycymeris***
Class Cephalopoda
34) Subclass Ammonoidea (**Ammonoids**) (**Goniatites, Ceratites, Ammonites**)
35) Genus *Baculites*
36) Genus *Dactylioceras*
Subclass Coleoidea
Order Belemnitida (**Belemnites**)
37) **Genus *Belemnitella***
Subclass Nautiloidea (Nautiloids)
38) Genus *Nautilus*
39) Genus *Orthoceras*
Class Gastropoda (Snails)
40) Genus *Conus*
41) Genus *Cypraea*
42) Genus *Platyceras*
43) Genus *Turritella*
44) Genus *Worthenia*

Phylum Echinodermata
45) Class Asteroidea (**Starfish**)
Class Blastoidea
46) Genus *Pentremites*
47) Class Crinoidea (stems, columns, calyxes)
48) Class Echinoidea (**regular or irregular echinoids including** sea urchins, sand dollars and heart urchins)
49) Class Ophiuroidea (brittle stars)

VERTEBRATES:
Phylum Chordata
Subphylum Vertebrata
Class Placodermi (Armored Jawed Fish)
50) Genus **Bothriolepis**
51) Genus **Dunkleosteus**
Class Chondrichthyes (Cartilaginous Fish)
52) Superorder Selachimorpha (Sharks)
53) Genus ***Carcharodon***
54) Genus *Carcharocles* (formerly *Carcharodon)*
55) Species *C. megalodon*
56) Superorder Batoidea (Rays)

Note: Numbers indicate that members of that taxon rank should be identifiable to that level. For ranks not underlined, indented ranks are in the rank above it.

Last Updated: 08/08/18

OFFICIAL FOSSIL LIST (CONT.)

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

Superclass Osteichthyes (Bony Fish)
- 57) Class Actinopterygii (ray-finned)
- Class Sarcopterygii (lobe-finned)
  - 58) Order Coelacanthiformes (Coelacanth)
  - 59) Genus *Tiktaalik*

Class Amphibia (**Amphibians**)
- 60) Genus *Acanthostega*
- 61) Genus *Eryops*
- 62) Genus *Diplocaulus*

Class Reptilia (**Reptiles**)
- 63) Order Ichthyosauria (Ichthyosaurs)
- 64) Family Mosasauridae (Mosasaurs)
- 65) Order Plesiosauria (Plesiosaurs **& Pliosaurs**)
- 66) Order Pterosauria (Pterosaurs)

Clade Dinosauria (**Dinosaurs**)
- Order Saurischia (lizard-hipped)
  - 67) Genus *Allosaurus*
  - 68) **Genus *Diplodocus***
  - 69) Genus *Coelophysis*
  - 70) **Genus *Dilophosaurus***
  - 71) Genus *Plateosaurus*
  - 72) Genus *Velociraptor*
  - 73) Genus *Tyrannosaurus*
- Order Ornithischia (bird-hipped)
  - 74) Genus *Iguanodon*
  - 75) Genus *Parasaurolophus*
  - 76) Genus *Stegosaurus*
  - 77) Genus *Triceratops*
  - 78) **Genus *Ankylosaurus***
  - 79) Genus *Dracorex*
- Class Aves (**Birds**)
  - 80) Genus *Archaeopteryx*
  - 81) **Genus *Titanis* (Terror Bird)**

Clade Synapsida
- **Mammal-like reptiles**
  - 82) Genus *Dimetrodon* (**pelycosaurs**)
  - 83) Genus *Lystrosaurus* **(therapsids**)
- Class Mammalia (**Mammals**)
  - 84) Genus *Basilosaurus* **(prehistoric whale)**
  - 85) Genus *Equus* **(modern horse)**
    - Genus *Homo* **(human)**
      - 86) Species *H. neanderthalensis*
  - 87) Genus *Mammut* (Mastodon)
  - 88) Genus *Mammuthus* (Mammoth)
  - 89) Genus *Megacerops* **(Brontothere)**
  - 90) Genus *Mesohippus* **(three-toed horse)**
  - 91) Genus *Smilodon* **(saber-toothed cat)**

KINGDOM PLANTAE

Phylum Anthophyta (**Flowering plants**)
- 92) Genus *Acer*
- 93) Genus *Populus*
- 94) Genus *Platanus*

Phylum Ginkgophyta (Ginkgos)
- 95) Genus *Ginkgo*

Phylum Lycopodiophyta (Club Mosses)
- 96) Genus *Lepidodendron* (scale tree)

Phylum Pinophyta (Conifers)
- 97) Genus *Metasequoia*

98) Phylum Sphenophyta (Horsetails)
- 99) Genus *Calamites*
- 100) Genus *Annularia*

Phylum Pteridospermatophyta (Seed Ferns)
- 101) Genus *Glossopteris*

Phylum Pteridophyta (True Ferns)
- 102) **Genus *Pecopteris***

OTHER

Trace Fossils:
- Trails, Tracks, Trackways,
- Borings, Burrows, Tubes
- Predation marks, Repair scars
- Coprolites

Stromatolites

Amber/copal

Petrified wood

Sedimentary Rocks
- Coquina
- Limestone (**Chalk/Fossil limestone**)
- Sandstone
- Shale
- Mudstone/Siltstone

Note: Numbers indicate that members of that taxon rank should be identifiable to that level. For ranks not underlined, indented ranks are in the rank above it.

Last Updated: 08/08/18

GEOLOGIC MAPPING

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

1. **DESCRIPTION:** Teams will demonstrate understanding in the construction and use of topographic maps, geologic maps, and cross sections, and their use in forming interpretations regarding subsurface structures and geohazard risks **especially with respect to subduction zones**.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings.
   b. **If the event features a rotation through a series of laboratory stations in which the participants interact with samples, specimens, or displays, no material may be removed from the binder while at or in-between laboratory stations.**
   c. Each team should bring a geologic compass, protractor, ruler, colored pencils, and an equal-area projection stereonet with tracing paper and pin.
   d. **In addition, each team** is permitted **one stand-alone non-programmable, non-graphing calculator.**

3. **THE COMPETITION:**
   The event may be composed of a test, stations, or a combination of both that will require the use of knowledge and relevant skills including observing, classifying, measuring, inferring, predicting, and using relationships from the following topics:
   a. Topographic and geologic maps
   b. Plate tectonics, rock formation, Earth structure, Earth history, lithologies, and geological principles
   c. Major structural elements, fold geometries, fault types, erosional patterns, intrusion types, subsurface geometries, and depositional and deformation sequences
   d. Cross-sections of topographic profiles, projections of mapped features, and stereonet projections
   e. Bed thicknesses, orientations of planes from points, and map projection types
   f. Geohazards types and methods to assess, monitor, and mitigate the associated risks
   g. **Major structural elements and processes associated with subduction zones, spanning before the oceanic trench to volcanic arc**

4. **SAMPLE QUESTIONS/TASKS:**
   a. Use a topographic map to construct a topographic profile.
   b. Use stratigraphic column, geologic map, topographic profile, strike and dip, and bed thickness measurement to construct a cross-section of sub-surface structures.
   c. Determine the order of events based on geological principles.
   d. Assess geohazard risks based on interpretation of geologic and topographic maps, knowledge of lithologies, tectonic setting, and seismic history.
   e. Use a geologic compass to take measurements of strike and dip as well as plunge and trend of planes and lines.
   f. **Use structural elements, geologic and topographic maps, surface and sub-surface lithologies and seismic records to reconstruct the evolution of a given plate boundary**.

5. **SCORING:**
   a. The high score wins. All questions will have been assigned a predetermined number of points.
   b. Pre-identified questions will be used as tiebreakers.

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

HERPETOLOGY

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

1. **DESCRIPTION: Participants will be assessed on their knowledge** of amphibians and reptiles.
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each team may bring one **2019** Official National Herpetology List as well as one **two-inch or smaller standard** binder containing information in any form and from any source attached using the available rings.
   b. **The 2019 Official National Herpetology List does not have to be secured in the binder.**
   c. **If the event features a rotation through a series of laboratory stations in which the participants interact with samples, specimens, or displays no material may be removed from the binder while at, or in-between, laboratory stations.**
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, 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, **taxonomy**, sounds, and biogeography.
   e. No more than 50% of the competition will require giving common or scientific names (class, order, **suborder, family**, or genus as indicated on the Official National Herpetology List).
   f. The questions will be distributed between amphibians and reptiles.
   g. The National competition will be based on the **2019** Official National Herpetology List.
   h. **The taxonomic scheme of the 2019 Official National Herpetology List is based upon a combination of traditional and current categories designed to utilize familiar terms widely used in published resources available to the students.**
   i. States may have a modified state or regional list which will be posted on the state website no later than November 1st.
4. **SAMPLE ACTIVITIES:**
   a. Identify the order, **suborder**, family, **and/or** genus of the provided sample.
   b. What conclusion can be drawn about the habitat(s) of the given specimens?
   c. Which of these animals does not fit within this **taxon**?
   d. What unique anatomical feature distinguishes the animal shown in the picture?
   e. **Consider the potential impact of human activities on the survival of amphibians and reptiles.**
5. **SCORING:**
   a. High score wins.
   b. Selected questions may be used as tiebreakers.

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

OFFICIAL NATIONAL HERPETOLOGY LIST

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

Class
Order
- **Family**
  - ***Genus (species-none listed*) - common name**

Class Reptilia
Crocodylia – crocodiles and alligators
- **Crocodylidae - crocodiles**
- **Alligatoridae – alligators and caiman**

Testudines (Chelonia) - turtles
- **Chelydridae - snapping turtles**
- **Kinosternidae - musk and mud turtles**
- **Emydidae - box, pond and marsh turtles**
  - ***Terrapene* - box turtles**
  - ***Actinemys* – western pond turtles**
  - ***Malaclemys* - diamondback terrapins**
  - ***Graptemys* - map turtles**
  - ***Trachemys* - sliders**
  - ***Chrysemys* - painted turtles**
  - ***Pseudemys* – cooters and redbellies**
  - ***Clemmys* – spotted turtle**
  - ***Glyptemys* – wood turtle and bog turtle**
  - ***Deirochelys* – chicken turtle**
  - ***Emydoidea* – Blanding's turtle**
- **Testudinidae - tortoises**
- **Cheloniidae - sea turtles**
- **Trionychidae – soft shelled turtles**

Squamata – lizards and snakes

SUBORDER LACERTILA OR SAURIA - LIZARDS
- **Gekkonidae – gecko lizards**
- **Polychridae – anoles**
  - ***Anolis* - anoles**
- **Iguanidae – iguanids**
  - ***Iguana* – green iguana**
  - ***Dipsosaurus* – desert iguana**
  - ***Sauromalus* – chuckwalla**
- **Crotaphytidae – Collared lizards**
- **Phrynosomatidae – earless, spiny, tree, side-blotched and horned lizards**
  - ***Sceloporus* – spiny lizards**
  - ***Cophosaurus* & *Holbrookia* – earless lizards**
  - ***Uma* – fringe toed lizards**
  - ***Urosaurus* & *Uta* – tree and side blotched lizards**
  - ***Phrynosoma* – horned lizards**
- **Lacertidae – wall lizards**
- **Teiidae – whiptails**
  - ***Cnemidophorus* – racerunners and whiptails**
- **Scincidae – skinks**
  - ***Eumeces* – skinks**
- **Anguidae – glass lizards and alligator lizard**
  - ***Ophisaurus* – glass lizards**
  - ***Gerrhonotus* – alligator lizard**
- **Helodermatidae – gila monster**

SUBORDER SERPENTES (Ophidia) - SNAKES
- **Leptotyphlopidae – blind snakes**
- **Boidae**
  - ***Charina* – rubber boa and rosy boa**

OFFICIAL NATIONAL HERPETOLOGY LIST

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

- **Colubridae – typically harmless snakes**
  - ***Nerodia* – water snakes and salt marsh snakes**
  - ***Storeria* – brown snakes and redbelly snakes**
  - ***Thamnophis* – garter, ribbon, lined snakes**
  - ***Heterodon* – hog-nosed snakes**
  - ***Diadophis* – ringneck snakes**
  - ***Coluber* – racers**
  - ***Masticophis* – coachwhips and whipsnakes**
  - ***Opheodrys* – green snakes**
  - ***Elaphe* – rat snakes**
  - ***Pituophis* – pine, bull and gopher snakes**
  - ***Lampropeltis* – king and milk snakes**
  - ***Tantilla* – crowned and blackhead snakes**
- **Elapidae – coral snakes**
- **Hydrophiidae – sea snakes**
- **Viperidae – (subfamily viperinae) pit vipers**
  - ***Agkistrodon* – copperhead and cottonmouths**
  - ***Sistrurus* –massasaugas and pigmy rattlesnakes**
  - ***Crotalus* – rattlesnakes**

Class Amphibia

Caudata (Urodela) - salamanders

- **Cryptobranchidae – hellbenders**
- **Dicamptodontidae – giant salamanders**
- **Proteidae – mudpuppies and water dogs**
- **Rhyacotritonidae – torrent or seep salamanders**
- **Amphiumidae – amphiumas**
- **Sirenidae – sirens**
- **Ambystomatidae – mole salamanders**
- **Salamandridae – newts**
- **Plethodontidae – lungless salamanders**
  - ***Desmognathus* – dusky salamanders & kin**
  - ***Plethodon* – woodland salamanders & kin**
  - ***Ensatina* - ensatina**
  - ***Aneides* – green/climbing salamanders**
  - ***Batrachoseps* – slender salamanders**
  - ***Hydromantes* – web-toed salamanders**
  - ***Hemidactylium* – four-toed salamanders**
  - ***Gyrinophilus* – spring salamander**
  - ***Pseudotriton* – red and mud salamanders**
  - ***Eurycea* – brook salamanders**
  - ***Typhlomolge* – Texas and Blanco blind salamanders**

Anura (Salientia) – frogs and toads

- **Scaphiopodidae – spadefoot toads**
  - ***Scaphiopus* - spadefoot toads**
- **Bufonidae – true toads**
  - ***Anaxyrus* – American toad & oak toad**
- **Hylidae – treefrogs**
  - ***Hyla* - gray treefrog & green treefrog**
  - ***Pseudacris* – western chorus frog, ornate chorus frog & spring peeper**
  - ***Acris* – cricket frogs**
- **Ranidae – true frogs**
  - ***Lithobates* – bullfrog, green frog, northern leopard frog & wood frog**
- **Microhylidae – narrow-mouthed toads**
  - ***Gastrophryne* – narrow-mouthed toads**

Note: The taxonomic scheme is based upon a combination of traditional and current categories (designed to utilize familiar terms widely used in published resources available to the students)

MISSION POSSIBLE

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

1. **DESCRIPTION:** Participants 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.
   b. Each device must pass a safety inspection before operation.
   c. Devices with potential hazards or safety concerns will not be permitted to run unless safety concerns are resolved to the satisfaction of the Event Supervisor; otherwise they must receive only participation points.
   d. Event Supervisors will need meter sticks, stopwatches, balance/scale, and measuring tape.

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. All actions used for scoring must be visible **and/or verifiable**. The top and at least two vertical walls must be open or transparent for viewing all actions.
   c. 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 **and will not count for points**.
   d. Each movable/adjustable physical object in the device must be utilized by at most one assigned action.
   e. 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).
   f. Energy devices (i.e., springs/mousetraps) may be set prior to starting the device.
   g. **Use of electricity is limited to Scorable Actions ii., v., xi. and raising the Final Action platform**.
   h. Only commercial batteries, not exceeding **9** 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 **9** 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. **Non-compliant batteries must be removed prior to device operation**.
   i. **Arduinos, Raspberry Pis, or Programmable components are not allowed**. Timers must not be powered by electricity or springs. A timer is defined as a scorable or non-scorable action that takes longer than 10 seconds.
   j. **Candles**, flames, **matches**, **cell phones**, hazardous liquids, gases, materials (e.g., rat traps, lead objects, combustible fuses, **dry ice**, **liquid nitrogen**, **flammable gas**), and unsafe handling of chemicals are not permitted.
   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) – **From completely above the device, the participants must drop an unaltered Ping-Pong ball into the device, causing a standard, unmodified golf ball to move, starting the next action**.
   b. **Scorable Actions** (50 points each) – Participants may have up to 12 scorable unique actions to count for points.
      i. Use **vinegar and baking soda** to inflate a balloon so that the **unguided** balloon strikes an object that originally was at least 20 cm away from the balloon causing **the object to initiate the next action**.
      ii. Use an endothermic action that initiates the next action as a result of the reduction in temperature.
      iii. **Drop two effervescent heartburn relief tablets into water so the reaction triggers the next action**.
      iv. Add water **to a container to raise a golf ball located in the same container at least 5 cm so that the golf ball rolls out of the top of the container and initiates the next action**.
      v. Use an infrared beam where the transmitter and receiver are at least 20 cm apart to initiate the next action.

vi. **Push or pull an object with a mass ≥ 500 g at least 10 vertical cm up an inclined plane with an IMA ≥ 2 before the object initiates the next action**.
vii. Use a pulley system with an ideal mechanical advantage (IMA) of at least **3** to lift an object with a mass ≥ 500 g at least 10 vertical cm before the object initiates the next action.
viii. Use the mechanical advantage of all 3 classes of levers in sequence to initiate the next action.
ix. **Use gravity to clearly rotate a screw at least two full rotations so that it operates as a screw converting rotational force into linear force and moves an object at least 2 cm before that object initiates the next action. The screw must be marked so its rotational movement is clearly visible**.
x. Launch an unmodified US quarter out of the top boundary of the device, so that it falls back into the device and initiates the next action. When the device is in the ready to run position, the quarter must be heads up. After the quarter is launched out of the device, lands back in, **and initiates** the next action the quarter must be tails up.
xi. **Use electricity to directly or indirectly break a string or fishing line so that the breaking of the line initiates the next action.**
xii. **Remove a magnet from a surface so that a magnetic object falls due to the removal of the magnetic force. That object must initiate the next action.**

c. **Final Action** (250 points) – **The device must raise a perfectly square platform that is between 5.0-10.0 cm on each side, a vertical distance of at least 20.0 cm before it becomes the highest point of the device. The platform must be a single surface that is hard, non-tacky, and smooth with no lip on any of its edges. On the platform must be a freestanding, upright standard 9V battery which is not attached to the platform or any other part of the device. The action is complete when the top surface of the platform and the battery are above the entire device and movement stops. Only the battery can be supported by the platform and this action may not count as the timer.**
d. **Two** Action Sequence Lists (ASLs) must be submitted to the Event Supervisor at impound. The ASLs must be legible, neat, and an accurate documentation of each intended scorable and non-scorable action of the device's operation. Scorable and non-scorable actions must be numbered and documented in the ASLs and correspondingly labeled in the device. Scoring will be based only on the Scorable Actions listed in the ASLs. Example ASLs may be found on the event page at soinc.org.
e. The Target Operation Time is 60.0 seconds at Regionals/Invitationals, 61.0 to 90.0 seconds at State, and 91.0 to 120.0 seconds at Nationals. For State/Nationals the time will be announced at setup and will be the same for all teams.
f. Timing and scoring begin when a participant **drops the Ping-Pong ball into the device**. Timing stops when **the platform stops moving** or when 180.0 seconds elapse, whichever comes first. **If the device stops after 3 touches or the platform never stops moving, the time will be scored as 180.0 seconds**.
g. Participants must designate **a timer,** an action taking over **10.0** seconds that does not use electricity or springs for power, **to be eligible for bonus points**.
i. **A 1-point bonus will be awarded for every full second the timer operates before the Target Operation Time. The timer must run for at least 30 seconds to earn points. The timer may run past the Target Operation Time but will not receive points for the duration after the Target Operation Time.**
ii. The timer must successfully start the next Scorable Action for any bonus points to count.
iii. For State/National tournaments, the team must demonstrate how this timer is adjusted to account for the increased length of Target Operation Time for the bonus points to count.
h. If the device stops, jams, or fails, the participants will be allowed to "**touch**/adjust" the device up to three times to continue operation. **A single "touch" may consist of multiple touches and ends once the device runs again on its own**. 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 ASL order, all actions skipped in the listed sequence, even if completed, earn zero pts.
k. The supervisor will review with teams the data recorded on the scoresheet.

5. **SCORING:**
a. High score wins.

b. Award 25 points for each of the following: (100 points maximum):
   i. The ASLs are submitted on time at device impound.
   ii. The ASLs use the format specified on www.soinc.org.
   iii. The ASLs are 100% accurate of intended scorable and non-scorable actions.
   iv. The scorable & non-scorable actions within the device are labeled as in the ASLs.
c. Award 50 points for each of the following:
   i. Participants use no more than 30 minutes to set up their device.
   ii. The first time each action in **4.b.** is successfully completed as described.
d. Award 100 points for completing the Start Action.
e. Award 250 points for completing the Final Action **if the battery is freestanding and untouched at the end of the run. If the battery tips on a side, but still remains on the platform, only award 150 points if all other requirements are met. If the battery falls off the platform, no Final Action points will be awarded.**
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 that a non-electrical or non-spring timer runs before the Target Operation Time if all conditions are met and the next action is initiated by the timer.
h. Award 0.1 point for each 0.1 cm that the device dimensions are under 60.0 cm in each axis. The maximum score awarded will be 90 points.
i. Award 75 points for a device that has no touches.
j. Teams receive only participation points for impounding a device but not competing, unsafe devices, or devices that are remotely timed/controlled.

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:
      i. for each dimension of the device that exceeds 60.0 cm, **excluding the Final Action**
      ii. **if the top and 2 vertical walls are not open or transparent**
      iii. for each **touch/adjust up to 3 times. If the device stops after the third touch, it will not be allowed to be touched/adjusted and the time will be scored as 180.0 seconds.**
   c. Deduct 50 points for the first solid or liquid that leaves the measured dimensions of the device, **excluding 4.b.x. and the Final Action**
   d. Deduct 150 points for each:
      i. electrical or spring timing action in the device that takes longer than 10.0 seconds, except raising the Final Action platform
      ii. **action where electricity is used where it is not allowed. The action will also not count for points.**
   e. Devices impounded after the deadline will be scored after devices impounded on time.

7. **TIEBREAKERS:**
   a. Ties are broken as follows:
      i. Fewest penalty points
      ii. Smallest overall dimension (L+D+H) of the device

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Mission Possible Video Download 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 to push a **paper** cup forward, reverse direction, and stop **as close as possible to a Vehicle Target Point.**

   A TEAM OF UP TO: 2 **IMPOUND:** Yes **EYE PROTECTION:** B **EVENT TIME:** 8 minutes

2. **EVENT PARAMETERS:**
   a. **Each team must bring and impound a single vehicle, a practice log, and any additional/spare parts**.
   b. **Teams** may bring a **stand-alone** calculator of any type, data, and non-electric tools for their vehicle which do not need to be impounded.
   c. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not be allowed to compete.

3. **CONSTRUCTION PARAMETERS:**
   a. **Teams** will construct a vehicle where all propulsive energy must come from one or two snap mousetraps **of base 6.0 cm x 12.0 cm or smaller. No part of the jaw/hammer may extend more than 1.0 cm beyond the base.** 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 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. **An approximately** ¼" diameter round **wooden** 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 **and be easily accessible by the Event Supervisor**.
   f. Wheels/treads in their entirety in the ready-to-run configuration must fit in a **40.0** cm x 40.0 cm space of any height. Axles, drive arms, and other parts of the vehicle may extend beyond these parameters.
   g. 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.
   h. 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 **any** parts already in contact with the floor in the ready-to-run configuration. Pieces falling from the vehicle are a construction violation. The cup is not considered part of the vehicle.
   i. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

4. **PRACTICE LOG:**
   a. **Teams must record the vehicle distance, cup distance, and run time of at least 10 practice runs while varying at least one vehicle parameter (e.g., # of string wraps around the axle) for each run.**
   b. Logs will be impounded and **returned when the team is called to compete**.

5. **THE COMPETITION:**
   a. Only participants and the event 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.
   b. Teams have 8 minutes to set up their vehicle and complete up to 2 runs. Vehicles in the ready-to-run configuration before the end of the 8-minute time period will be allowed to complete a run. Teams may not use AC outlet power during their 8 minutes.
   c. **The Event Supervisor will provide a 3-oz. paper cup that is at least 5.0 cm tall. Teams must place the cup** upside down to cover the Start Point. The Start Point can be anywhere under the cup as long as it is completely covered.
   d. In the ready-to-run configuration, the vehicle's dowel must touch the cup, **and the vehicle must remain at the starting position without being touched**.

MOUSETRAP VEHICLE (CONT.)

e. Teams may adjust their vehicle (e.g. change mousetraps, distance, directional control) within their 8 minutes, **though the Event Supervisor may re-verify that the vehicle meets specifications prior to each run. Timing is paused during any measurements made by the Event Supervisor**. Timing resumes once the participants pick up their vehicle or begin making their own measurements. Teams may use their own non-electric/electronic measuring devices to verify the track dimensions during their 8 minutes.
f. Teams must not roll the vehicle on the floor of the track on the day of the event without tournament permission. If permitted, only participants may be present.
g. Substances applied to the vehicle must be approved by the Event Supervisor prior to use, must not damage or leave residue on the floor, track and/or event area. During their 8-minute time, teams may clean the track but it must remain dry.
h. Participants must start the vehicle using any part of an unsharpened #2 pencil with an unused eraser, supplied by the Event Supervisor, **in a motion approximately perpendicular to the floor**, to actuate a trigger. They may not touch the vehicle to start it, hold it while actuating the trigger, or "push" the vehicle to get it started. Once the run starts, participants must not follow the vehicle until called by the Event Supervisor.
i. A Failed Run occurs **for any run that** does not occur in the 8 minutes or if the time or distance cannot be measured for a vehicle (e.g., the run starts before the event supervisor is ready, the participants pick it up before it is measured, **the vehicle runs backward at the start of its run**). **The vehicle failing to reverse direction does not result in a Failed Run or a violation**.
j. If the vehicle does not move upon actuation, it does not count as a run and the team may set up for another run but will not be given additional time.
k. A team filing an appeal must leave their vehicle in the competition area.

6. **THE TRACK:**
   a. **A track needs a minimum width of 2.0 m** on a smooth, level, and hard surface. **There is no maximum width**. A diagram of the track can be found on the event page at www.soinc.org.
   b. **The Start Point (SP), Cup Target Point (CTP), and Vehicle Target Point (VTP) will be marked on tape approximately 2.5 cm wide and approximately 5.0 cm long. The CTP will be 8.00 m from the SP.**
   c. **The VTP will be between the SP and the CTP.**
      i. **The centerline distance (along the imaginary line connecting the SP and CTP) between the VTP and CTP, will be in intervals of 0.10 m in these ranges: Regional - 1.00 to 2.00 m, State - 2.00 to 4.00 m, National - 4.00 to 6.00 m.** The centerline distance will be chosen by the Event Supervisor and announced after the impound period.
      ii. **The VTP will be offset to the right side of the imaginary center line when facing the CTP by the following distances: Regional - 0.10 m, State - 0.25 m, National - 0.50 m.**
   d. The event supervisor is encouraged to use three timers. The middle time of the 3 timers must be the official Run Time. The Run Time must be recorded in seconds to the precision of the timing devices.
   e. At the event supervisor's discretion, more than one track may be used. If so, the team may choose which track they use, but must use the same track for both runs.

7. **SCORING:**
   a. The Lowest Final Score wins. The lower of the 2 Run Scores is the Final Score.
   b. Run Score for each run = Vehicle Distance + **2 x** Cup Distance + Run Time (in sec) + Penalties.
   c. Vehicle Distance = the point-to-point distance, in cm to the nearest 0.1 cm, from the VTP to the **front bottom edge** of the dowel.
   d. Cup Distance = the **point-to-point distance, in cm to the nearest 0.1 cm, from the CTP to the closest part of the cup. If the cup covers the CTP, the Cup Distance is 0.0 cm.** If the cup tips over during a run, measurement is made from where the cup comes to rest.
   e. Run Time starts when the vehicle begins to move and 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.
   f. Teams with incomplete practice logs will incur a Penalty of 250 points.
   g. Teams without impounded practice logs will incur a Penalty of 500 points.

MOUSETRAP VEHICLE (CONT.)

h. **Tiers:**
   i. **Tier 1: A run with no violations.**
   ii. **Tier 2: A run with any competition violations.**
   iii. **Tier 3: A run with any construction violations.**
   iv. **Tier 4: A vehicle not impounded during the impound period.**

i. **Teams who cannot complete a run within 8 minutes or have 2 Failed Runs will be given participation points.**

j. Ties will be broken by this sequence:
   i. Lower Cup Distance
   ii. Lower Vehicle Distance
   iii. Lower Run Time
   iv. Lower Run Score of the other run

k. Scoring Example: The run took 20.21 seconds. The cup came to rest 10.4 cm from the CTP. The dowel was 35.2 cm away from the VTP and the vehicle incurred no Penalties.

Vehicle Distance	35.2 cm =	35.2 pts.
Cup Distance	2 x 10.4 cm =	20.8 pts.
Run Time	20.21 seconds =	20.21 pts.
+ Penalties	0 =	0.0 pts.
Run Score		76.21 pts.

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

THIS EVENT IS SPONSORED BY LOCKHEED MARTIN

PROTEIN MODELING

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

1. **DESCRIPTION:** Students will use computer visualization and online resources to construct physical models of the **CRISPR Cas9 protein,** that is being engineered to edit plant and animal cell genomes, and answer a series of questions about the chemistry of protein folding and the interaction of structure and function for model proteins.

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

2. **EVENT PARAMETERS:**
   a. Each participant must bring a pencil or pen for the exam, a marker for marking the toobers, a metric ruler with cm marks, and one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source. This sheet may be contained in a sheet protector or laminated.
   b. Each team must impound a pre-built model of a portion of the CRISPR Cas9 protein along with a 4" x 6" note card describing functionally relevant features (see 3.Part I.b.-f.).
   c. Supervisors will provide all other materials for on-site model construction and test.

3. **THE COMPETITION:**

Part I: The Pre-Built Model

   a. Participants will use the program Jmol/JSmol to visualize a model of residues 1-85 of the CRISPR Cas9 protein, based on the coordinate data found in the 4un3.pdb file. The 4un3.pdb file can be accessed for free from the RCSB Protein Data Bank (www.rcsb.org). Jmol/JSmol can be accessed at http://cbm.msoe.edu/scienceOlympiad/designEnvironment/prebuild.html for free.
   b. Using this visualization, participants should build a model based on the alpha carbon backbone of the protein with a scale of 2 cm per amino acid using Mini-Toobers® or another comparable bendable material (e.g., Kwik Twists, 12-gauge dimensional house wire, etc.).
   c. Participants will use materials of their own choosing to add functionally relevant features to their model (e.g. selected amino acid sidechains, DNA or associated molecules). Additions to the model should highlight the significance of structure to function of the protein.
   d. Participants must explain their functionally relevant features using clear and concise descriptions on a 4" x 6" notecard, in the form of a table with 3 columns, headed:
      i. What is displayed
      ii. How it is displayed
      iii. Why it is important
   e. Three Dimensional (3D) printed materials may NOT be used to build the protein backbone but may be used for functionally relevant features.
   f. All models, including all functionally relevant features, must fit within a 61.0 cm x 61.0 cm x 61.0 cm space.
   g. The model must be sufficiently sturdy that judges can pick it up and rotate it for judging. Teams may pick up all pre-build models after the competition.

Part II: The On-Site Model Build

   a. On-site, participants will build a physical model of a selected region of a specific protein using materials provided by the event supervisor. Resources listed below will provide background information about the molecules that may be built at all levels of competition.
   b. Each team will use a computer provided by the event supervisor to access the Jmol/JSmol application and use the appropriate coordinate files on it to guide their model construction.
   c. The event supervisor will provide identical computers to all teams along with all construction materials for the model (Kwik Twists, 12-gauge dimensional house wire, Mini-Toobers®, amino acid sidechains, crosslinkers, plastic red & blue end caps, etc.)
   d. Any model not handed to the judges by the end of the team's scheduled event session will not be accepted for scoring.

Part III: The On-Site Written Exam

   a. Teams will complete a written exam consisting of multiple choice and short answer questions.
   b. Topics addressed include:
      i. the principles of chemistry that drive protein folding
      ii. the structural and functional relationships of the modeled proteins; both pre-built and on-site.

4. **SCORING:**
   a. High Score wins. Final score will be derived from all three parts of the competition:
      i. The pre-built model (Part I) will count for 40% of the final score and be scored based on the accuracy and scale of the secondary structures, as well as the relevant functional features added to the model (e.g., sidechains, DNA, or associated molecules). As the competition level increases, the scoring rubrics for the pre-built model will reflect higher expectations for model accuracy, detail, and addition of relevant functional features. Features that are not relevant or do not explain the structure/function relationship of the protein will not receive credit.
      ii. The on-site built model (Part II) will count for 30% of the final score. The on-site built protein model will be scored based on accuracy of folding the model and positioning specific amino acid sidechains.
      iii. The written exam (Part III) will count for 30% of the final score. The exam will be scored for accuracy.
   b. Ties will be broken using identified questions from the written exam.

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

THIS EVENT IS SPONSORED BY THE MILWAUKEE SCHOOL OF ENGINEERING (MSOE)

SOUNDS OF MUSIC

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

1. **DESCRIPTION:** Teams must construct and tune one device prior to the tournament based on a 12-tone equal tempered scale and complete a written test on the physics of sound.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** None
   IMPOUND: No **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. Participants may remove information or pages for their use during the event.
   b. Each team may also bring writing utensils and two stand-alone calculators of any type for use during any part of the event.
   c. Teams may bring a personal tuner, this may be an app on their cell phone, for use during set up. Access to an electrical outlet is not guaranteed.
   d. If testing a string instrument, a team may bring rosin.
   e. Prior to the competition, teams must tune their device to play consecutively the eight notes of a one octave major scale of the teams' choice. A log describing the process of tuning one pitch must be submitted.
   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 PARAMETERS:**
   a. The instrument may be constructed of and contain any materials except for the following prohibited materials: electric or electronic components, toy or professional instruments or parts of such instruments (e.g., bells, whistles, mouthpieces, reeds or reed blocks, audio-oscillators, tuning pegs, etc.). The only exception is that strings (instrumental or otherwise) of any type are permitted.
   b. One or both, if required by device design, participant(s) must be able to play all the notes of a one octave major scale of the team's choosing. All notes of the scale must lie between F2 and F5. (A4 = 440 Hz)
   c. Competitors may not hum or sing to cause the device to produce its pitch.
   d. Each device must fit within a 60.0 cm x 60.0 cm x 100.0 cm box when brought into the competition area and be moveable by the participants without outside assistance. Devices may become larger once set up.

4. **THE COMPETITION:**

Part I: Written Test

   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The test will consist of at least three questions from each of the following areas:
      i. General principles of acoustics (e.g., wave theory, Bernoulli Effect)
      ii. Basic terminology regarding sound, sound production, and related science terms
      iii. Fundamental elements of musical sound, perception, and resonance
      iv. The design, function, and construction of the instrument types (e.g., how it makes sound, what determines the pitch, how is volume changed)
      v. Notes, major scales, and intervals

Part II: Device Testing

   a. Device testing should take place in a room separate from the Part I written test to minimize disruption to and to ensure the accuracy of the device readings.
   b. Devices will be evaluated on their ability to produce accurate pitches and a large in-tune dynamic volume.
   c. The supervisor will mark a distance 1.0 m away from the testing equipment beyond which the participants may set up their device.
   d. Participants will have two minutes to set up their device, which may face any direction, but no part of the device or the participants may be closer than 1.0 m to the testing equipment. During the two minutes, Participants may use their own tuner, including a cell phone app, to adjust the pitches on their device. One participant may continue working on the written test if not needed to play or setup the device.
   e. At the end of the two minutes, the participants' tuner must be put away. Failure to do so will result in a construction violation. No further alterations of the device are allowed other than those that would occur naturally while playing different pitches (such as covering different holes with fingers or moving a slide).
   f. Once the device is ready, or the two-minute set-up period has expired, the participants will begin their Pitch Score Test:

i. Participants will inform the event supervisor which major scale they are playing, whether they are playing it ascending or descending and what note they will start on (e.g., F3 or F4 in playing an F major scale).
ii. Participants will play one pitch at a time, holding it for a duration of 5 seconds as indicated by signals from the event supervisor. For devices with a quick decay time, multiple attacks on the pitch are allowed (for example, striking a bar multiple times with a mallet or plucking a string). The pitch measurement will be the best value during the 5 seconds. Participants will wait until the supervisor records the measured pitch frequency and indicates that they may proceed before playing the next note in the sequence.
iii. If the device is so quiet that the equipment has trouble registering the pitch, the supervisor may move the microphone closer to the participants' setup for the Pitch Test only.
iv. If the device is unable to play some of the required pitches, the participants must notify the supervisor before playing the first note which pitches in the sequence will be skipped. Otherwise it will be assumed that the participants are playing the next note in the scale sequence. Points will be awarded per note.

g. Once the Pitch Score Test is completed the participants will conduct their Volume Score Test to determine the maximum volume of their device:
i. No alterations of the device are allowed between the pitch and volume tests. If the supervisor moved the test equipment closer for the pitch test, it must be moved back to its original location (1.0 m away).
ii. Participants will select a single note from the pitch test. Participants will play the pitch for 5 seconds; multiple attacks on the pitch are allowed. The event supervisor will score the loudest volume reached during the 5 seconds.
iii. If the volume exceeds 85 dB, the supervisor will stop the testing and a volume of 85 dB will be recorded.

h. The event supervisor will review with the teams the Part II data recorded on their scoresheet.

5. **SCORING:**
a. High score wins. A complete scoring rubric is available on the Sounds of Music page on soinc.org
b. The Final Score = TS + LS + PS + VS;
i. Test Score (TS) = (Part I score / Highest Part I score for all teams) x 45 points
ii. Log Score (LS) = max of 10 points
iii. Pitch Score (PS) = (Sum of IPS for the Device / Highest IPS Sum for all teams) x 36 points
IPS (Individual Pitch Score for each pitch) =
(1) C (cents) = abs |cents off the target frequency|.
(2) IPS for skipped pitches = 0
(3) If $C \leq 5$, IPS = 4.5; If $C > 5$, IPS = 5 - 0.1 x C, with a minimum IPS score of 0
iv. Volume Score (VS) = (Device max dB / Highest dB over all teams) x 9 points

c. The log must track the iterations of calibrating one pitch on the device. The Log Score (LS) points will be assigned as follows:
i. 2 pts - For a list of materials used in the device
ii. 2 pts - For including data comparing pitch accuracy to an appropriate design element change (e.g., pitch vs length of tubing)
iii. 2 pts - For including at least 5 data points
iv. 2 pts - For proper labeling (e.g. title, team name, units)
v. 2 pts - For including a labeled picture showing how the device changes for the different pitches (ex. a fingering chart)
vi. LS = 0 if no device is brought to the event.

d. If a team violates any COMPETITION rules, their IPS and max dB values will be multiplied by 0.9 when calculating the scores.
e. If any CONSTRUCTION violation(s) are corrected during the Part II setup period, the IPS and max dB values will be multiplied by 0.7 when calculating the scores.
f. Teams that are disqualified for unsafe operation, do not bring a device, or whose device does not meet construction parameters at the end of their setup time receive zero points for their PS and VS scores. Teams will be allowed to compete in Part I.
g. Ties will be broken using the following categories in the listed order: 1) Best PS, 2) Best VS, 3) Best TS, and 4) Questions on the written test

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

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 **APPROXIMATE TIME:** 50 Minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. **Participants may remove pages during the event**.
   b. Each team may also bring tools, supplies, writing utensils, and two **stand-alone** calculators of any type for use during any part of the event. These items need not be impounded.
   c. Each team must impound: their insulating device; **an** unaltered, glass or plastic, standard (height ~1.4 times the diameter) 250 mL beaker; **a device diagram and** copies of graphs and/or tables for scoring.
   d. Event supervisors will supply the hot water, devices for transferring measured volumes of water, **cotton balls**, and thermometers or probes (recommended).
   e. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship **between water temperature and testing parameters**. A labeled device picture/diagram should be included.
      i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
      ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. **Each data series counts as a separate graph**. A template is available at www.soinc.org.
      iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned.
   f. 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.
   g. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. **CONSTRUCTION PARAMETERS:**
   a. Devices may be constructed of and contain anything **except** the following materials/components: asbestos; mineral wool; fiberglass insulation; **commercially available thermoses/coolers/vacuum sealed devices**.
   b. The device must fit within a:
      i. 20.0 x 20.0 x 20.0 cm cube for Division B
      ii. 15.0 x 15.0 x 15.0 cm cube for Division C
   c. Within the device, participants must be able to insert and remove a beaker that they supply (see 2.c.).
   d. The device must also allow putting a thermometer/probe into the beaker via a hole **≥ 0.50 inches** in diameter all the way through directly above the beaker. The hole's top surface must be < 12 cm above the inside bottom beaker surface. **The hole's bottom surface may be inside the beaker but must not contact the water. Teams may plug the hole with a single cotton ball provided by the supervisor**.
   e. Devices will be inspected to ensure that there are no energy sources (e.g., electric components, battery powered heaters, chemical reactions, etc.) to help keep the water warm. At the event supervisor's discretion, teams must disassemble devices after testing in order to verify the construction materials.
   f. 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 supervisor will announce the volume of water (**Regionals: 100 mL; States: 75 - 125 mL, 25 mL increments; Nationals: 75 - 125 mL, 5 mL increments**) and the cooling time (Div. B: **25.0** mins; Div. C: **20.0-30.0** mins, **1-minute increments**). These parameters will be the same for all teams.
   b. The event supervisor will announce the temperature of the source water bath (60 - **75** ºC) and the current room temperature. **Supervisors will do their best to keep this the same for all teams but must announce the actual values (in case of minor fluctuations) at the start of each competition block**.
   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. **The supervisor, using his/her own measuring device, will dispense the volume of water into each team's beaker. A team may elect to install a beaker in a device prior to this but must leave sufficient access to the beaker**. Teams may secure/close access panels with fastening materials after **receiving water, but must do so in a manner to not delay dispensing to other teams**. Supervisors must record the time each team receives water and the room and source water temperature when dispensed.
e. 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. **After receiving water, teams will be given at least 3, but no more than 5 minutes to make their final predictions. During this time, teams may use their own thermometers to measure the starting water temperature in their beaker, but after this time must remove them**.
f. At the end of the cooling period, the supervisor will record the ending time and the temperature in the beaker to the best precision of the available instrument. Supervisors may leave thermometers/probes in the devices for the entire cooling period but will announce if they will do so before impound. Otherwise they will insert a thermometer/probe into **the beaker in the device**, wait at least 20 seconds, and record the resulting temperature. Multiple thermometers/probes may be used at the supervisor's discretion.
g. The supervisor will review with the team the Part I data recorded on their scoresheet.
h. Teams filing an appeal regarding Part I must leave their device in the competition area.

Part II: Written Test

a. Teams will take a test on thermodynamics during the remaining time after all devices receive water.
b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
c. 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.
d. The test will consist of at least **three** questions from each of the following areas:
   i. The history of thermodynamics
   ii. **Definition of temperature**, temperature scales and conversions, definitions of heat units
   iii. **Phases of matter, phase transitions, phase diagrams, latent heat, ideal gas law**
   iv. **Kinds of heat transfer, thermal conductivity, heat capacity, specific heat**
   v. Thermodynamic laws and processes (e.g., Carnot cycle and efficiency, adiabatic, isothermal)
   vi. **Division C only: Radiant exitance, entropy, enthalpy**

5. **SCORING:**

a. High score wins. All scoring calculations are to be done in degrees Celsius (°C).
b. The Final Score = TS + CS + HS + PS; a scoring spreadsheet is available at www.soinc.org.
c. Test Score (TS) = (Part II score / Highest Part II score for all teams) x 45 points
   i. Chart Score (CS) = max of 10 points
   ii. Heat Score (HS) = **20 x (lowest k of all teams) / k**, **where k is from Newton's law of cooling: k = - (1 / cooling time) x ln((start water temp - room temp) / (final water temp - room temp))**
   iii. Prediction Score (PS) = **25 - 2.5*abs(prediction - final temp)**. The minimum PS possible is 0 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.Part I.a.**
   ii. 2 points for including at least 10 data points **in each data series**
   iii. 2 points for proper labeling (e.g. title, team name, units)
   iv. 0.5 points for each 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 **PS score** will be multiplied by 0.9 and **their k will be multiplied by 1.1** when calculating the scores.
f. If any CONSTRUCTION violation(s) are corrected during Part I, or if the team misses impound, their **PS** will be multiplied by 0.7 and their **k will be multiplied by 1.4** when calculating the scores.
g. Teams disqualified for unsafe operation or do not having a conforming insulating device at the start of Part I receive zero points for their **HS and PS** scores. Teams will be allowed to compete in Part II.
h. Tie Breakers will be applied in the following order: i. Best TS, ii. Best PS, iii. Best HS.

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.

WATER QUALITY

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

1. **DESCRIPTION:** Participants will be assessed on their understanding and evaluation of aquatic environments.

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source along with two stand-alone non-programmable, non-graphing calculators, and one salinometer/hydrometer. The sheet of paper may be laminated or contained in a sheet protector.
   b. Participants must wear eye protection during Competition Part III: Water Monitoring and Analysis (3.Part III.). Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.

3. **THE COMPETITION:**
   a. Each part of the competition will count for approximately 1/3 of the final score.
   b. Scenarios and tasks will be drawn from freshwater locales (e.g., lake, pond, river) and may require analysis, interpretation or use of charts, graphs, and sample data as well as equipment use, collecting and interpreting data, measuring, analyzing data, and making inferences.

   Part I: Freshwater Ecology
   a. This part will consist of multiple choice, matching, fill-in-the-blank and/or short answer questions to assess participant knowledge in areas such as: aquatic ecology, water cycle, nutrient cycling, aquatic chemistry and its implications for life, potable water treatment, wastewater treatment, aquatic food chains/webs, community interactions, population dynamics, watershed resource management issues, sedimentation pollution, and harmful species.
   b. **Division C - State and Nationals only** content includes: life history strategies (e.g., age structure, survival curves, life tables, succession, R and K strategies).

   Part II: Macroflora and Fauna Identification
   a. Participants should be able to identify the immature & adult macroinvertebrates and aquatic nuisance organisms listed below by common name and know their importance as indicators of water/wetland quality.
      i. Class 1 – Pollution Sensitive: Caddisfly, Dobsonfly, Gilled Snails, Mayfly, Riffle Beetle, Stonefly, Water Penny, Water Scorpion
      ii. Class 2 – Moderately Sensitive: Aquatic Sowbug, Crane Fly, Damselfly, Dragonfly, Scuds
      iii. Class 3 – Moderately Tolerant: Blackfly, Flatworm, Leeches, Midge, Water Mite
      iv. Class 4 – Pollution Tolerant: Air Breathing Snail, Midge Fly Bloodworm, Deer/Horse Fly, Tubifex
      v. Class 5 – Air Breathing: Back Swimmer, Giant Water Bug, Mosquito, Predacious Diving Beetle, Water Boatman, Water Strider, Whirligig Beetle
      vi. Aquatic Nuisance Plants: Purple Loosestrife, Eurasian Water Milfoil, and Water Hyacinth
      vii. Aquatic Nuisance Animals: Zebra Mussel, Spiny Water Flea, Asian Tiger Mosquito, & Asian Carp
   b. **Division C teams** are expected to know their general ecology, life cycles, and feeding habits of the immature & adult macroinvertebrates and aquatic nuisance organisms listed above.

   Part III: Water Monitoring and Analysis
   a. Teams must build, calibrate, bring and demonstrate a salinometer/hydrometer capable of measuring saltwater (most likely NaCl) concentrations between 1-10% (mass/volume). Points for salinity testing will be approximately 5% of the total score.
   b. There are no restrictions on size except that the team must build the device to operate within a standard 400 – 600 mL beaker filled with the saltwater solution.
   c. Teams will be expected to estimate the percent salinity measured by their device to the nearest tenth. Full credit will be given ±1% at Regionals and ±0.5% at State/Nationals. Calibration solutions may or may not be provided by the event supervisor.
   d. Participants should be able to understand and interpret data related to testing procedures as well as reasons for collecting data related to salinity, pH, phosphates, turbidity, dissolved oxygen, temperature, nitrates, fecal coliform, total solids, biochemical oxygen demand, and their relationship to one another. No actual, physical tests will be performed on these topics.

4. **SCORING:**
   a. High score wins. Points will be assigned to the various questions and problems.
   b. Selected questions may be used as tiebreakers.

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

WRIGHT STUFF

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 monoplanes 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 airplanes, any tools, and their flight log.
   b. Event Supervisors will provide all measurement tools and timing devices.

3. **CONSTRUCTION PARAMETERS:**
   a. Airplanes may be constructed from published plans, commercial kits, and/or a student's design. Kits must not contain any pre-glued joints or pre-covered surfaces.
   b. Any materials except Boron filaments may be used in construction of the airplane.
   c. Total mass of the airplane throughout the flight, excluding the rubber motor, must be **8.00** g or more.
   d. The airplane must be a monoplane (one wing defined as the single largest surface) and the horizontally projected wingspan must not exceed **35.0** cm. The maximum wing chord (straight line distance from leading edge of wing to trailing edge, parallel to the fuselage) of the wing must be **7.0** cm or less.
   e. The propeller assembly may be built by the participants or purchased pre-assembled. It may include a propeller, a shaft, a hanger, and/or a thrust bearing. Variable-pitch propellers that include mechanisms to actively change the blade diameter or angle must not be used.
   f. A rubber motor may be of any mass **and must be the sole power for the airplanes after release**.
   g. Participants may use any type of winder, but electricity may not be available.
   h. The airplane(s) must be labeled so that the event supervisor can easily identify to which team it belongs.
   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. **THE COMPETITION:**
   a. The event will be held indoors with tournament officials announcing the room dimensions (approximate length, width, and ceiling height) in advance of the competition. Tournament officials will do their best to minimize the effects of environmental factors (i.e., air currents). Rooms with minimal ceiling obstructions are preferred over very high ceilings.
   b. Once participants enter the cordoned off competition area to practice, to trim, for inspection, or to compete they must not receive outside assistance, materials, or communication. Only participants may handle aircraft components until the event ends. Teams violating this rule will be ranked below all other teams. Spectators will be in a separate area.
   c. A self-check inspection station may be made available to participants for checking their airplanes prior to check-in with the event supervisor.
   d. Participants will present their **airplanes, motors, and logs** for inspection immediately prior to their Preflight Period.
   e. Participants' flight log of recorded data must include 6 or more parameters (3 required and at least 3 additional) for 10 or more test flights prior to the competition. The required parameters are: 1) motor size before windup, 2) number of turns on the motor or torque 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).
   f. 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.
   g. All motors will be collected **during inspection** and 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 team's Preflight Period ends with their first flight, trim or official, which starts their 8-minute Flight Period or if 3 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. Participants may make adjustments/repairs/trim flights during their official 8-minute Flight Period. Before their launches, participants must indicate to the Timers whether a flight is official or a trim flight. A flight is considered official if a team fails to notify a Timer(s) of the flight's status. Teams must not be given extra time to recover or repair their airplanes.
j. Teams may make up to a total of 2 official flights using 1 or 2 airplanes.
k. Time aloft for each flight starts when the airplane leaves the participant's hand and stops when any part of the airplane touches the floor, the lifting surfaces no longer support the weight of the airplane (such as the airplane landing on a girder or basketball hoop), or the supervisors otherwise determine the flight to be over.
l. Event supervisors are strongly encouraged to utilize three (3) timers on all flights. The median flight time in seconds to the precision of the device used is the official time aloft.
m. Participants must not steer the airplane during flight.
n. In the unlikely event of a collision with another airplane, a team may elect a re-flight. The decision to re-fly may be made after the airplane 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 verify with the team the data being recorded on their scoresheet.

5. **SCORING:**
   a. The base score is the Team's longest single official flight time. Ties will be broken by the longest non-scored official flight time.
   b. **Motors, collected at inspection, will be held by the event supervisor until they are returned to the team signaling the start of the Preflight Period.** 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 airplane flight **(powered or unpowered)**, trim or official, is launched within 3 minutes of the return of motors a 5% bonus will be added to the base score. After 3 minutes have passed since the return of motors, the 8-minute Flight Period will start **and no bonus will be awarded**.
   c. A bonus of 10% of the flight time will be added to the flight time of an airplane that has the surface of the wing between at least 2 ribs of the leading and trailing edges or at least one of the wing tip fences completely marked with black marker or black tissue. If no ribs are present, the whole surface must be black.
   d. Teams with incomplete flight logs will have 10% of their flight time deducted from each flight.
   e. Teams without flight logs will have 30% of their flight time deducted from each flight.
   f. Teams that violate a rule under "CONSTRUCTION" or "THE COMPETITION" that does not have a specific penalty will be ranked after all teams that do not violate those rules.

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

THIS EVENT IS SPONSORED BY THE ACADEMY OF MODEL AERONAUTICS (AMA)

WRITE IT DO IT

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

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

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

2. **EVENT PARAMETERS:**
   a. **The participant who will be doing the writing must bring a writing utensil.**
   b. **No other materials or resources are allowed.**

3. **THE COMPETITION:**
   a. **One participant from each team** is shown an object, which may be abstract but is the same for all teams, built from, but not limited to, such items as science materials, inexpensive materials (e.g., straws, push pins, Styrofoam balls, paper cups, Popsicle sticks, etc.) or commercial sets (e.g., K'nex, Tinker Toys, Lego, Lincoln Logs, etc.). **This participant is not allowed to touch the object unless the event supervisor permits it**.
   b. **The participant viewing the object** has twenty-five (25) minutes to write a description of the object and how to build it. There will be no advantage to finishing early.
   c. Drawings and diagrams of the model or subsections of the model are not allowed. Numerals, words and single letters that fit within the context of the written description are allowed. The participant may use abbreviations and do not have to define the abbreviation. Editing, punctuation, or scientific symbols that fit within the context of the written description are allowed.
   d. The 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.
   e. Supervisors will attempt to use different materials than the materials that were used last year.

4. **SCORING:**
   a. The team that builds the object nearest to the original and has a written description with no drawings or diagrams will be declared the winner.
   b. Each individual piece will receive points as applicable for: proper size, color, location, orientation, and/or connection.
   c. Pieces that are connected correctly beyond an incorrect connection will be counted in the score. No penalty will be assessed for parts that were not used.
   d. Students drawing a subsection of the model will be ranked in Tier 2. Drawing a picture of the model will result in disqualification.
   e. Time for the construction phase will be used as a tiebreaker.

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

Detector Building 2018 Trial Event Rules

Inquiry Committee

1. **DESCRIPTION:** Teams must design, build, program, and a test an instrument that will measure changes in temperature and display the measurement using the appropriate units.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** None
   IMPOUND: Yes **APPROXIMATE TIME:** 10 minutes

2. **EVENT PARAMETERS:**
   a. Teams must bring their device, design & testing log, any tools required, and whatever resources (e.g. laptop) needed to program their device to respond to the changing environmental conditions.
   b. Event supervisors will provide the necessary equipment to test each device's ability to detect and signal changes in temperature at a set standard as well as across a changing temperature range.

3. **CONSTRUCTION PARAMETERS**:
   a. Each year, the environmental condition (e.g. Light Level, Sound Level, Motion, pH, CO_2 concentration, O_2 concentration) to be measured will be identified in the Event Rules. The environmental condition to be measured will be the same for all teams and at all tournaments. At each tournament, the event supervisor will inform the teams which ranges the device should be programmed to detect. These ranges will be the same for all teams at that tournament.
   b. Devices should be built using a microcontroller (e.g. TI Innovator, Raspberry Pi, Arduino), a display, LED lights, an alarm, and a sensor/probe that produces a voltage dependent on the physical stimulus provided. The device maybe connected to a laptop, or other handheld device, powered by battery without built-in/internal environmental sensors/probes that functions as a display or programming interface device. The sensor/probe should be made water proof for total immersion. Sensor/probe may not be constructed using pre-calibrated, preassembled sensors/probes (e.g. Vernier, PASCO).
   c. The device, and any associated elements, must function on an independent power supply. No element can be plugged into an electrical outlet at any time during the competition.
   d. The device must be calibrated to detect the selected environmental condition for that year. In addition, the device must respond differently to two different ranges of the designated environmental condition through the use of LED lights and/or an alarm. The exact ranges of the environmental condition detected will be provided to the competitors at the start of their 10-minute time.
   e. Teams will also need to submit a Design Log with their device at Check-In. This Design Log should contain:
      i A detail drawing or illustration of the device identifying all the components and their function.
      ii An explanation of the programing language used, a written copy of the programing code that is used to operate the device, and an indication of, as well as a source for, any programing code that was not originally written or developed by the competitors.
      iii The mathematical modeling function and the calculations used to convert the sensor/probe output voltage into the calibrated output shown on the device display.
      iv A written practice log that details at least 10 trails of the device for 2 different ranges of the environmental condition indicating the range of the environmental condition detected, the time it took to detect that condition, and the responses, or alarms, produced.
   f. Each device, and associated impounded items, must be labeled so the event supervisor can easily identify to which team they belong.
   g. Competitors must be able to answer questions regarding the design, construction, programing, and operation of the device per the Building Policy found at www.soinc.org.

4. **THE COMPETITION:**
   a. The device, power supply, spare parts, design log, and other materials must be impounded before the start of the competition. Tools need not be impounded.
   b. Only competitors and event supervisors are allowed in the impound and competition areas. Once competitors enter the event area, they must not leave or receive outside assistance, materials, or communications.
   c. Teams are given 10 minutes to set up their device and complete 3 trials:
      i detection of an unknown constant (e.g.; the temperature of a water bath)
      ii detection of a broad-range of changing temperature (e.g.; the change in temperature of a water bath from 20°C to 35°C)
      iii detection of a narrow-range of changing temperature (e.g.; the change in temperature of a water bath from 35°C to 40°C)

d. Devices activated for any trial before the end of the 10-minute time period will be able to complete the trial.
e. At no point during a trial may the device be connected to a power supply.
f. Teams may adjust their device before each trial (e.g. adjust the program, reset an alarm, clean a detector, charge the device) within their 10 minutes providing the device continues to meet specifications.
g. A trial will begin when the Team activates their device and continue until the device detects the identified environmental measurement or range (i.e. the specified temperature). At that point, the event supervisor will stop the 10-minute timer and record the measurement value displayed on the device as well as the value measured by an appropriate device provided by the event supervisor. The values will be recorded to the precision of the device.
h. The event supervisor will then reset conditions to allow for a second trial. Once the environment is ready the 10-minute timer will restart and competitors will be able to make any adjustments or reset their device. Upon completion of the second trial, the 10-minute timer will be stopped and preparations made for a third trial.
i. At any point where the specified environmental value or range have been exceeded without the detector performing the indicated alarm the team can notify the event supervisor that they would like to declare a Failed Run. The team can then deactivate their device and make adjustments through the 10-minute timer still continues.
j. The supervisor will review with teams the data and tiering recorded on the scoresheet.
k. Teams who wish to file an appeal must leave their design log and sensor with the event supervisor.

5. **SAMPLE TASK**:
The students could build their detector using a TI Innovator hub as the microcontroller, a TI NSPIRE calculator as the display device, and a LM19 Analog Temperature Sensor. The event supervisor would start the team's trials by having them use their device to measure the temperature of an unknown solution. After recording the data from this trial, the event supervisor tells the team that the device needs to identify when the solution has a temperature between 25°C and 40°C. The timer begins and the participants would program their device to flash a green LED when the solution has a temperature between 25°C and 40°C. Once the run is completed and data recorded, the timer stops and the event supervisor would then tell the participants that the device now needs to detect when the solution has a temperature between 70°C and 75°C. The timer begins and the participants would program their device to flash a red LED when 70°C is exceeded and stay flashing until 75°C is exceeded. Once the run is completed, the timer stops and the event supervisor would then record the data and share results with the participants.

6. **SCORING:**
a. Team with the lowest Total Score wins.
b. A Total Score for each team will be determined as follows:
   i Unknown Score: The percent error during the unknown measurement trial x 40 points
   ii Broad-Range Score: The percent error during the broad-range trial x 20 points
   iii Narrow-Range Score: The percent error during the narrow-range trial x 40 points
c. Devices determined to be in violation of construction rules 3.b or 3.c will not be tested.
d. If there is a tie, the lowest average percent error across all three trials should be used to break it. If a second tie-breaker is needed the time remaining on the 10-minute event timer should be used.
e. Teams that do not successfully complete the three trials will be ranked behind teams that do complete the three trials.

Recommended Resources:
TI-Innovator Hub:
https://education.ti.com/en/products/micro-controller/ti-innovator
Raspberry Pi:
https://en.wikipedia.org/wiki/Raspberry_Pi
https://www.raspberrypi.org/help/videos/