



Exploring the World of Science

2021
**SCIENCE OLYMPIAD
SUMMER INSTITUTE**

2022 DRAFT RULES

July 11 – 16, 2021



SCIENCE OLYMPIAD SUMMER INSTITUTE WELCOME & WORKSHOP OVERVIEW

Dear Summer Institute Participants:

Welcome to Science Olympiad Summer Institute! We are excited that you have chosen to join us for our first ever remote Summer Institute. We continue to be inspired by your dedication to Science Olympiad as well as your spirit of innovation. We hope the week ahead will be filled with new knowledge and the opportunity to make new connections and newfriends. We would like to share some details and information with you that will make it easier to navigate this remote workshop.

This year we have taken our traditional 45-minute Summer Institute sessions and broken them into two separate parts. For every event you will find a 15- to 20-minute prerecord session as well as a 30-minute LIVE session. Each of these sessions will be addressing different aspects of the event. During the prerecorded session, the presenter will be introducing you to the event along with its rules and changes that have been made to them. Additionally, these sessions will address things like important content for the event, skills successful students should possess or develop, and resources that you might find helpful. These sessions will be available to you on the Summer Institute platform at any time. It is recommended that you try and watch the prerecorded sessions prior to attending a LIVE session for that event.

The 30-minute LIVE sessions will take place Monday through Thursday from 10:00 AM to 12:00 PM CDT. Each day we will start with a new, or returning event, that will be in both Divisions for the 2022 season. We have set the schedule this way to not only allow coaches that may be coaching both Divisions to be able to experience the new incoming content but also this format allows all attendees to gather in one place to start our day. If there are any schedule changes or major workshop announcements we will be making them during this LIVE session. After that first half hour, the workshop will continue with multiple concurrent sessions each half hour. In the 30-minute LIVE session for an event, you will be able to interact with the presenter and your fellow attendees through discussions, the exploration of resources, and delve deeper into the event's content. We will also be offering 30-minute LIVE sessions that focus on the coaching aspects of Science Olympiad. In these sessions you'll get ideas on how to arrange practices, recruit team members, build your team's strategy, and keep your team motivated throughout the season. Last but least, we will be offering a virtual Build Room where you can stop in to learn about building materials, device designs, and ask questions about building technique.

If you should have specific questions about whether or not something is allowed or how specific language in the rules should be interpreted we ask that you submit those questions to be answered during the detailed rules discussion that will be held LIVE on Friday. We adopted this format a few years ago to maximize the time that you had with the presenters to understand both the event structure and its content as well as to make sure that we consistently answered questions that impacted multiple events. If you should have any questions that you would like to submit, you can do so using the link in the Summer Institute platform or by visiting XXXXX. Likewise, should you have a recommended edit to the draft rules , you can do so using the link in the Summer Institute platform or by visiting XXXXX.

We hope that what you learn during the week will be helpful to you and your team. If you need any help or have any questions, please let us know what you need.

Jenny & John
Science Olympiad



WELCOME TO THE 2022 SCIENCE OLYMPIAD!

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

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

Division C (Grades 9-12) Membership Rules

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

Division B (Grades 6-9) Membership Rules

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

Students Below Grade Level Designations

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

Science Olympiad Team Membership

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

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

SCIENCE OLYMPIAD KITS AND RESOURCES AVAILABLE NOW!

Please visit store.soinc.org to purchase 2021 print manuals, video downloads, test packets and other event resources for Division B, Division C and Elementary Science Olympiad. Order officially licensed Science Olympiad Kits, supplies and parts for a variety of 2021 Science Olympiad events with your Fall Early Bird Savings: Save 12% on your Ward's Science Olympiad Kit order at wardsci.com/scienceolympiad with promo code SOVIP2020. Don't wait! This limited-time offer ends 12/31/20.



Science Olympiad Store: 866-312-3999
Ward's Science: 800-962-2660



TOURNAMENT FORMATS

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

While the COVID-19 situation still changes daily, Science Olympiad has developed a series of models for tournaments which will allow State Chapters to start the season with enough options and flexibility to provide registered Science Olympiad teams with a safe and positive experience, no matter how students are learning or how local situations evolve. These models are the result of thoughtful conversations that spanned the entire Science Olympiad community. We would like to thank everyone for their candor, thoughtfulness, and creativity. In the end, we feel we were able to create options that acknowledge that circumstances vary across the US while maintaining the spirit and goals of the organization.

In-Person, Single-Location Tournaments - The Gold Standard

The expectation for the 2022 season is that if health conditions in your region/state allow for traditional in-person, single-location tournaments, your State Chapter will provide that experience for teams, qualifying them all the way through to our 2022 Science Olympiad National Tournament in partnership with the California Institute of Technology on May 14, 2022. In order to achieve this expectation, our State Chapters are ready to provide accommodations due to local public health regulations. Additionally, participants will be asked to sign a COVID-19 release.

Satellite SO

This is a new model that accounts for situations where students are physically attending school, but large public gatherings in a single location are prohibited. A Satellite SO Tournament will take place over the course of a few days after school with each team competing from their own school. This format requires that Tournaments use tech tools that schools and teachers have been using these last few months like Zoom, Google Classroom, Google Meet, Microsoft Teams and Facebook Live that have opened up new ways to communicate, learn and gather for events. This model presents shortfalls when compared to a traditional tournament, especially with regard to the scope of hands-on activity, but it capitalizes on the amount of time Science Olympiad teams are encouraged to spend in months-long preparation for competition – building, breaking, studying, making binders, taking quizzes, and prepping log books. Teams will need to accept these limitations willingly, understand the academic honor code will be in full force, and that they will need to abide by a safety agreement provided by Science Olympiad, Inc.

Mini SO

This model accounts for situations where students are unable to physically attend school and are distance learning from their homes by allowing some events to be run at home. Since students will be at home without faculty supervision, no hands-on events will be allowed to run. A chart showing acceptable events can be found online at soinc.org. As with Satellite SO, this model presents shortfalls when compared to a traditional tournament, especially with regard to the scope of hands-on activity. Teams will need to accept these limitations willingly and understand the academic honor code will be in full force. This model can be delivered through a variety of tech platforms, via email, or even postal mail if needed.

EVENT TYPE DESCRIPTIONS



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

A Science Olympiad tournament typically consists of 23 different events, and those 23 events can be classified into one of four event types. This information is being provided so that Science Olympiad participants can more easily identify events that they may enjoy competing in, regardless of the event content. Coaches can approach coaching from the perspective of event type as opposed to event content, and teams can be aware of how the format of the tournament might affect available events. The symbol to the left of each description has been added to the upper right-hand corner of each Event Rule to identify the event type.



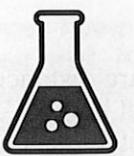
Core Knowledge Event: An event where participants are given a set of topics that they are expected to research and master the factual content. Mastery is demonstrated at a tournament by taking a paper-pencil, station, and/or computer test.

Core Knowledge Events can be run regardless of the tournament format that has been chosen by the State Chapter and the Tournament Director.



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

In some cases, Build Events may or may not be run depending upon the format of Science Olympiad tournament being conducted. The Tournament Director will make these decisions to ensure safety and fairness for all teams. If a Build Event is not to be run at a tournament, the Tournament Director will notify all teams in advance of the given tournament.



Laboratory/Hands-On Event: An event where participants are given a general topic in which they will be expected to deepen their content knowledge of the topic and associated research techniques prior to the tournament. At the tournament they will be assessed by the completion of a hands-on task, which may or may not require a written report, within a defined timeframe.

Depending upon the format of Science Olympiad Tournament being held, there may be some alterations to or cancellation of Lab Events. To the greatest extent possible, Tournament Directors will work to ensure Lab Events are conducted, though that may mean hands-on activities are omitted and participants will work with previously collected data. The Tournament Director will make these decisions to ensure safety and fairness for all teams. If a Lab Event is altered or not to be run at a tournament, the Tournament Director will notify all teams in advance of the given tournament.



Hybrid Event: An event which combines elements from two or more of the above event types. The most common combination mixes elements of a Core Knowledge Event with elements of a Build or Lab Event.

As with the previous events, Hybrid Events may be altered to fit the format of the Science Olympiad Tournament being held. This may mean that Lab or Build elements of the event are modified or not conducted. The Tournament Director will make these decisions to ensure safety and fairness for all teams. If a Hybrid Event is altered or not to be run at a tournament, the Tournament Director will notify all teams in advance of the given tournament.

GENERAL RULES



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

GENERAL RULES, CODE OF ETHICS, AND SPIRIT OF THE PROBLEM

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

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

COVID-19 PANDEMIC RULES MODIFICATIONS

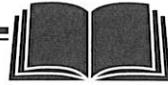
The COVID-19 pandemic requires that some general modifications be made to the Event Rules listed in this manual in order to permit Science Olympiad competitions to continue in a way that reflects best public health, disease prevention, and personal safety practices. The modifications listed here will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

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



ANATOMY & PHYSIOLOGY

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



- DESCRIPTION:** Participants will be assessed on their understanding of the anatomy and physiology for the human Nervous, Sense Organs, and Endocrine systems.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

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

- THE COMPETITION:**

Participants will complete a written test limited to the following topics.

- Nervous System:**

- The Brain - major regions and their functions
- Identification of simple encephalographic wave forms
- Neural Impulses - cellular anatomy and physiology of glial and supporting cells, synapses and neurotransmitters, action potential generation and propagation, ionic basis of the cellular membrane potential, cellular anatomy and physiology of neurons
- Central Nervous System - organization of the spinal cord, purpose/functions of sleep
- Peripheral Nervous System - neuroganglia, action of sensory and motor neurons, understand differences in and purposes of parasympathetic, sympathetic, somatic, and sensory systems
- Disorders: Epilepsy, Alzheimer's Disease, Multiple Sclerosis, Parkinson's Disease, Cerebral Palsy, Shingles (herpes zoster), Glaucoma, Pink Eye (conjunctivitis)
- Effects of the drugs: alcohol, caffeine, nicotine, and marijuana on the nervous system
- National Tournament Only:
 - The Brain - anatomy and physiology of brain function including function and role of specific nuclei clusters and tracts, theories of dreaming, neural impulses - retrograde signaling, purpose and principles of MRIs and EEGs
 - Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

- Sense Organs:**

- Types of sensory receptors, General Senses vs. Special Senses
- Mechanisms for the General Senses of touch, pressure, pain, temperature, itch, and proprioception
- Sense Organs – regions of each of the Special Sense Organs and their functions
- Physiology of sight, hearing, balance, smell, and taste
- Disorders: myopia, hyperopia, presbyopia, nyctalopia, astigmatism, conjunctivitis, color blindness, otitis media
- National Tournament Only:
 - Neural pathways for vision, depth perception, and hearing
 - Additional Disorders: Diabetic Retinopathy, Macular Degeneration, Glaucoma, Otosclerosis, resbucusis, Meniere's Disease plus treatments and/or prevention of all conditions listed above

- Endocrine System:**

- The three classes of hormones – steroids, peptides, and amines
- Mechanisms of hormone action – water soluble vs. fat soluble
- Endocrine related problems – hypersecretion, hyposecretion
- Hormone producing glands, their hormones and the function of each
- Disorders: diabetes mellitus, hypoglycemia, Graves disease, goiter
- National Tournament Only:
 - Endocrine cycles and negative feedback
 - Autonomic nervous system control of endocrine function
 - Addison's Disease, and Myxedema, Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

- SCORING:**

- High score wins.
- Selected questions will be used to break ties.

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



ASTRONOMY

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



- DESCRIPTION:** Teams will demonstrate an understanding of **Variability of Low & Mid-Mass Stars.**

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

- EVENT PARAMETERS:**

- Each team may bring one of the following options containing information in any form and from any source:
 - two three-ring binders;
 - a computer/tablet and a three-ring binder; or,
 - two computers/tablets, of any kind.
- 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.
- 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 the calculator app or other program on their device in place of a stand-alone calculator.
- Participants using computers/tablets as a resource should have all information stored so that it is available to them offline. **However, teams may be asked to access a dedicated NASA image analysis website to answer some JS9 questions. If so, supervisors will provide an alternative (e.g., proctor-supplied computer or screen shots) for teams that did not bring a laptop/tablet.**

- THE COMPETITION:**

Using information which may include Hertzsprung-Russell diagrams, spectra, light curves, motions, cosmological distance equations and relationships, stellar magnitudes and classification, multi-wavelength images (gamma-ray, X-ray, UV, optical, IR, radio), charts, graphs and JS9 imaging analysis software, teams will complete activities and answer questions related to:

- Stellar and galactic evolution including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, proto-stars, T Tauri variables, Herbig-Haro (HH) objects, red giants, Mira variables, RR Lyrae variables, carbon stars, white dwarfs, planetary nebulae, neutron stars, dwarf & recurrent novas, Type Ia supernovas, magnetic cataclysmic variables (MCVs).
- Use orbital mechanics, Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of binary and multiple star systems; use parallax, spectroscopic parallax, period-luminosity relations, and the distance modulus to calculate distances to RR Lyraes, and Type Ia supernovas; use hydrostatic equilibrium and the Stefan-Boltzmann law to answer questions relating to stellar structure and interiors.
- Identify and answer questions relating to the content areas outlined above for the following objects:

i. HOPS 383	x. IC 4593
ii. HH 24-26	xi. U Antliae
iii. V1331 Cyg	xii. LP 40-365
iv. HBC 672	xiii. ASASSN-16oh
v. Orion Nebula	xiv. V Sagittae
vi. Alpha Tauri	xv. AR Scorpii
vii. RR Lyrae	xvi. SDSS 1035+0551
viii. Mira	xvii. Tycho's SNR
ix. ESO 577-24	

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

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



BIO PROCESS LAB

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



- DESCRIPTION:** This event is a lab-oriented competition involving the fundamental science processes of a middle school life science/biology lab program.

A TEAM OF UP TO: 2

EYE PROTECTION: C **APPROXIMATE TIME:** 50 minutes

(See NEW Eye Protection C on www.soinc.org)

- EVENT PARAMETERS:**

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

- THE COMPETITION:**

This event will consist of a series of lab stations. Each station will require the use of process skills to answer questions and/or perform a required task such as formulating and/or evaluating hypotheses and procedures, using scientific instruments to collect data, making observations, presenting and/or interpreting data, or making inferences and conclusions.

- SAMPLE STATIONS:**

- Formulating and/or evaluating hypotheses and procedures.
- Making predictions.
- Making observations and collecting data by measuring length, volume, temperature, pH, and mass using a variety of traditional and electronic tools (e.g., rulers, calipers, pipettes, graduated cylinders, balances, thermometers, and electronic probes).
- Using compound microscopes and stereomicroscopes as measurement and identification tools.
- Interpreting data in the form of tables, charts, graphs, food labels, food webs, flow charts, pedigrees, karyotypes, etc.
- Making simple calculations such as area, density, percentages, averages (mean, median, mode).
- Determining genetic ratios and probabilities.
- Using or formulating a taxonomic/dichotomous key.
- Using indicators.
- Making inferences and conclusions based upon data and observations.

- SCORING:**

- High score wins.
- Points will be awarded for correct answers and/or proper technique.
- Selected questions will be used to break ties.

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



BRIDGE

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



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

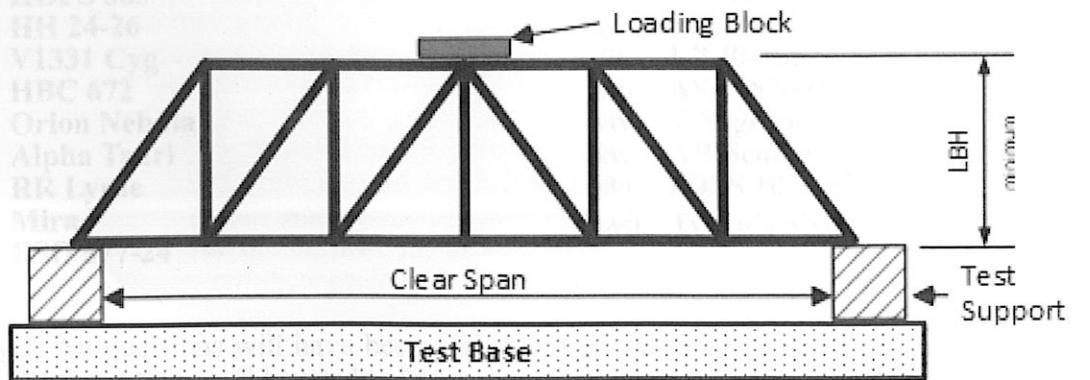
A TEAM OF UP TO: 2 **IMPOUND:** NO **EYE PROTECTION:** B **EVENT TIME:** 6 minutes

2. EVENT PARAMETERS:

- Each team is allowed to enter only one Structure, built prior to the competition.
- All participants must properly wear eye protection at all times. Participants not wearing proper eye protection will not be allowed to compete and be placed in Tier 3.
- Participants may NOT bring any equipment such as levels or squares.
- The Event Supervisor will provide the Test Apparatus (see Section 5) and tools/materials for measurement.

3. CONSTRUCTION PARAMETERS:

- The Bridge must be a single structure with no separate, loose, sliding, or detachable pieces, constructed of wood, and bonded by adhesive. No other materials are permitted.
 - Wood is defined as the hard, fibrous substance making up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include bark, particleboard, wood composites, bamboo or grasses, paper, commercially laminated wood (i.e., plywood), or members formed of sawdust, wood shavings, and adhesive. Wood may never be painted, soaked, or coated in glue, color enhanced, or have tape/preprinted/paper labels affixed. Ink barcodes or markings from the construction process may be left on the wood.
 - There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated by the team without restriction.
 - 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.
- The Bridge must be designed to sit on top of the Test Supports and support the Loading Assembly at the center of the spanned opening.
- Division B: The Bridge must be designed to hold the Loading Block at a Loading Block Height (LBH) of at least 10 cm above the Test Supports and must be able to pass a 7 cm high by 4 cm wide object through the Bridge. The Clear Span will be 35 cm.
- Division C: The Bridge must be designed to hold the Loading Block at a loading Block Height (LBH) of at least 15 cm above the Test Supports and must be able to pass a 12 cm high by 7 cm wide object through the Bridge. The Clear Span will be 45 cm.
- Before loading, no portion of the Bridge may be below the plane defined by the top of the Test Supports.
- Participants must be able to answer questions regarding the design, construction, and operation of the structure per the Building Policy found on www.soinc.org.



4. THE COMPETITION:

Part I: Check-In

- The team must present their Structure for inspection & measurement.
- The team must place their Structure on the scale so the Event Supervisor can determine the mass, in grams to the nearest 0.01 g or best precision available.
- The team must submit their estimated Load Supported (4.Part II.h.) to be used as a tiebreaker.



BRIDGE (CONT.)

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

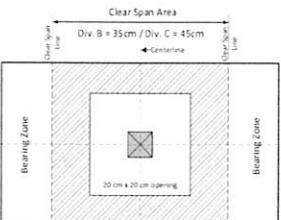
- No alterations, substitutions, or repairs may be made to the Structure after the check-in process has started.
- Prior to Part II: Testing, the Event Supervisor will verify that the combined mass of the Loading Assembly and sand is at least 15,100 g, but no more than 15,200 g.

Part II: Testing

- Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
- Participants will have 6 minutes to set up and test their Structure to maximum load or failure.
- The participants must place the Structure on the Test Supports within the Bearing Zone of the Test Apparatus. They will then place the Loading Assembly as required to load the Structure. If necessary, participants may disassemble & reassemble the Loading Assembly. If the Loading Assembly is disassembled & reassembled it must retain the original sequence with no loose pieces and the opposing force must always be on the bottom of the Loading Block. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the structure to deflect.
- The participants will be allowed to adjust the Structure until they start loading sand. Once loading of sand has begun, the Structure must not be further adjusted.
- Prior to loading, the Event Supervisor will verify that:
 - The Test Supports are properly placed on the Test Base
 - The Structure is placed properly on the Test Supports and the loading point must be within 2 cm of the center of the span.
 - No portion of the bridge is below the top of the Test Supports for the entire length of the Bridge.
- Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. The bucket may only be stabilized by using the tips of the provided Bucket Stabilizing Sticks (5.d.). The bridge may deflect below the top of the Loading Supports but may not touch the Clear Span Area.
- Loading stops immediately when the Structure Failure occurs, or time expires. Structure Failure is defined as the inability of the Structure to carry any additional load, if any part of the load is supported by anything other than the Structure or the Structure touches the Clear Span Area. Incidental contact of the chain/eyebolt with the structure is not a failure.
- Once loading stops, any parts of the Structure in the bucket will be removed. The Load Supported (mass of the Loading Assembly and the sand in the bucket) will be recorded to the nearest gram or best precision available. The minimum Load Supported is the mass of the Loading Assembly. The maximum Load Supported is 15,000 g.
- At the Event Supervisor's discretion, more than one Test Apparatus may be used. Teams may be given a choice of which apparatus they will use.
- The Event Supervisor will review with the team the data recorded on their scoresheet.
- Teams who wish to file an appeal must leave their structure with the Event Supervisor.

5. TEST APPARATUS:

- The Test Base shall be a solid, level surface as follows:
 - At least 55.0 cm long x 32.0 cm wide, stiff enough that it does not bend noticeably when loaded
 - Shall have a smooth, hard surface (e.g., metal, high-pressure plastic laminate)
 - Shall have an opening at its center approximately 20.0 cm x 20.0 cm
 - A Centerline and parallel Clear Span Lines shall be marked across the width of the surface of the Test Base. The Centerline shall divide the Test Base in half; Clear Span Lines to each side of the center line at 17.5 cm for Division B (35 cm span), or 22.5 cm for Division C (45 cm span) to indicate the Bearing Zones.





BRIDGE (CONT.)

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



- b. The Test Supports shall meet the following requirements:
 - i. Two identical, unfixed supports will be supplied
 - ii. Must be at least 1-1/2 inches by 1-1/2 inches by 6 inches but not greater than 2 inches by 2 inches by 6 inches
 - iii. Made of a material that it does not noticeably compress when loaded and have smooth, hard surfaces (e.g., hard wood, metal, high-pressure plastic laminate)
 - iv. Must be able to rest flat on the Test Base
- c. The Loading Assembly will consist of:
 - i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt
 - ii. ¼ inch threaded eyebolt (1-inch nominal eye outside diameter), minimum 2 ¼ inch length to a maximum 4 ½ inch length, and a ¼ inch wing nut. The loading block must be mounted on the eye bolt and be trapped between the “eye” of the eye bolt and the wing nut. The loading block cannot sit on top of the wing nut or be loose.
 - iii. A chain and S-hook that are suspended from the eyebolt on the Loading Block
 - iv. An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain
 - v. The total combined mass of the Loading Assembly may not exceed 1.5 kg
- d. Sand: sand or other clean, dry free-flowing material.
- e. Two (2) Bucket Stabilizing Sticks each made from a piece of ½" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org.

6. SCORING:

- a. High score wins. Score = Load Score (g)/Mass of Structure (g).
- b. The Load Score= Load Supported (4.Part II.h)+ Bonus (6.c).
- c. Structures that have a Load Supported of 15,000 g will earn a Bonus of 5,000 g.
- d. Structures will be placed in three tiers as follows:
 - i. Tier 1: Holding any load and meeting all construction parameters and competition requirements
 - ii. Tier 2: Holding any load with any violations of the construction parameters and/or competition requirements
 - iii. Tier 3: Unable to be loaded for any reason (e.g., cannot accommodate or hold Loading Assembly, failure to wear eye protection) and will be ranked by lowest mass
- e. Ties are broken as follows:
 - i. Estimated Load Supported closest to, without exceeding, the actual Load Supported
 - ii. Lowest Structure mass
- f. Examples score calculations:
 - i. Structure 1: mass= 10.12 g, Load Supported= 12,134 g; Score= 1,199
 - ii. Structure 2: mass= 12.32 g, Load Supported= 15,000 g + 5,000 g (Bonus) = 20,000 g; Score= 1,623

A. THE COMPETITION
Part I: Check-In
a. The team must present the following items:
b. The team must place the following items in the box:
c. The team must submit the following items:



CELL BIOLOGY

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



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

A TEAM OF UP TO: 2

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

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

3. THE COMPETITION:

- a. The competition may be administered at a series of lab-practical stations such as demonstrations, experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Content topics will include:

Regional and State Tournament Topics		
Biological monomers and polymers	Cellular homeostasis (pH, osmolarity etc.)	Enzymes and inhibition
Bioenergetics, metabolic networks, fermentation products and uses	Cell organelles / structures and their functions in eukaryotes and prokaryotes	Cell wall structure and diversity in all domains of life
Membrane structure and function including lipid rafts, transport	Vesicle formation, fusion	Cell cycle and mitosis, role of cyclins and kinases
Apoptosis and cancer	C3 vs. C4 vs. CAM plants	Cell communication, membrane receptors, and signal transduction

National Tournament Topics (Regional & State topics + the following)		
Traditional fluorescence microscopy and TIRF microscopy	Carcinogens, the hallmarks of cancer	Cell cytoskeleton and intracellular trafficking
Induced pluripotent stem cells	Host/virus interactions	Protein folding and related diseases
Cellular basis of common medicines (antibiotics, chemotherapy, insulin, etc.)	Genomics and medicine/human health	Bioethics relating to above topics

- b. Process skills may include writing hypotheses, determining independent and dependent variables, controlling variables, graphing, analyzing data, interpreting results as well as using and applying technologies.
- c. Questions pertaining to the exact amount of ATP produced during cellular respiration must not be used as the amount of ATP produced varies within a cell.

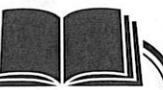
4. SAMPLE QUESTIONS:

- a. Using models, photographs, or illustrations of structures such as organic molecules and cell organelles, identify the structure and describe its function or role in life processes.
- b. Using a light microscope, estimate cell size and determine the 3-dimensional shape of cells. Relate the size and shape of a cell to its function.



CELL BIOLOGY (CONT.)

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



- c. Analyze a graph showing cyclin levels and describe cell cycle effects of these cyclins.
- d. Contrast healthy cells to cells infected with viruses, cancerous cells using images and/or descriptions of cellular processes.
- e. Label structures present in eukaryotic and prokaryotic cell membranes.
- f. Identify substances such as protein, carbohydrates, lipids and vitamin C using reagent tests or data provided.

5. SCORING:

- a. Each correct response will be assigned a point value. The highest score wins.
- b. Selected questions may be used as tiebreakers.

Recommended Resources: All reference and training resources including the in-depth Cell Biology CD (CLCD) and the introductory Bio/Earth CD (BECD) are available on the Official Science Olympiad Store



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 Aqueous Solutions and Oxidation/Reduction.

A TEAM OF UP TO: 2

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- a. Each participant must bring safety equipment (e.g., goggles, lab coat, apron), a writing implement, and may bring a stand-alone calculator of any type.
- b. Each participant may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, with information on both sides in any form and from any source.
- c. Teams should bring any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
- d. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
- e. 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. 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 Oxidation/Reduction Chemistry concepts:
 - i. Writing and balancing half reactions
 - ii. Oxidation numbers
 - iii. Balancing redox reactions in neutral, acidic, and basic solutions
 - iv. Calculating standard cell potentials using a table of standard reduction potentials
 - v. State and Nationals Only - knowledge of fuel cells, knowledge & application of the Nernst equation & common storage batteries may be included
- e. Participants should understand the following about Aqueous Solutions:
 - i. Principles, properties, terms, and definitions concerning aqueous solutions
 - ii. Calculate solution concentration given quantities of solute and solvent
 - iii. Calculate the amount of material needed to achieve a specific concentration
 - iv. Different measurements of concentration (e.g., molarity, molality, mass percentage, and parts per million) and how to calculate each
 - v. State and Nationals Only: conversions between concentration units

4. SAMPLE QUESTIONS/ACTIVITIES:

- a. Titrations to determine percent composition, molarity, and/or molecular mass.
- b. Given an unbalanced Redox equation, students should be able to determine the 2 half reactions and balance the equation.
- c. Given the data/watching a running Redox titration, students should be able to determine the endpoint of the titration and the number of moles of target ion in the titration.
- d. Use freezing point depression to determine the molar mass of a solute.
- e. Identify and explain factors that affect solution formation.
- f. Determine whether a solution is saturated, unsaturated, or supersaturated.

5. SCORING:

- a. High score wins. Points will be divided evenly between Aqueous Solutions and Oxidation/Reduction.
- 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.



CODEBUSTERS

B

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

1. **DESCRIPTION:** Teams will cryptanalyze and decode encrypted messages using cryptanalysis techniques for historical and modern advance ciphers.

TEAMS OF UP TO: 3

EVENT TIME: 50 minutes

2. EVENT PARAMETERS:

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

3. THE COMPETITION:

- a. This event consists of participants using cryptanalysis techniques and advanced ciphers to decrypt and encrypt messages on a written exam.
- b. All teams will begin the event simultaneously at the indication of the Event Supervisor.
- c. Teams must not open the exam packet nor write anything prior to the "start" signal, nor may they write anything after the "stop" signal.
- d. Participants are allowed to separate the pages of the test to be free to answer the questions in any order, working individually or in groups, attempting whichever of the questions seem right for them.
- e. The code types that may be used on the exam at Invitational and Regional competitions are as follows:
 - i. the Atbash Cipher (in English, not Hebrew)
 - ii. the Caesar Cipher, also called a shift cipher.
 - iii. Mono-alphabetic substitution using 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 – encrypting plaintext or decrypting ciphertext given the a and b values.
 - v. the Vigenère Cipher – encrypting plaintext or decrypting ciphertext given a key.
 - vi. the Baconian Cipher – decrypting ciphertext encoded with the a b values represented as one or more letters, glyphs, symbols, or character rendering variations (e.g., bold, underline, italic).
 - vii. Xenocrypt - no more than one cryptogram can be in Spanish
 - viii. the Pollux and Morbit Ciphers – decrypting Morse code ciphertext encoded as digits and spaces given the mapping of at least 6 of the digits.
 - ix. The Rail Fence Cipher – decrypting transposed text given the number of rails.
- f. The code types that may be used on the exam at State and National competitions are as follows:
 - i. All Invitational and Regional code types
 - ii. Xenocrypt - at the state and national levels, at least one cryptogram will be in Spanish.
 - iii. Cryptanalysis of the Vigenère cipher with a "crib" of at least 5 plaintext characters
 - iv. Cryptanalysis of the Affine Cipher with a "crib" of at least 2 plaintext characters.
 - v. Cryptanalysis of The Pollux and Morbit Ciphers with a "crib" of at least 4 plaintext characters
 - vi. Cryptanalysis of The Rail Fence Cipher with a "crib" of at least 5 plaintext characters and a range for the rails.
- g. For aristocrats, patristocrats, and xenocrypts: no letter can ever decrypt to itself.
- h. No more than 2 cipher questions will be an encryption on the exam.
- i. The exam packet will include a resource sheet with the Morse Code Table, English/Spanish letter frequencies, Vigenère table, Baconian mapping and modulus inverse tables as needed for the questions on the exam.
- j. The first question of the exam will be timed.
 - i. The first question will be the decoding of an Aristocrat as defined by rules 3e.iii.(1) or 3.e.iii.(2).
 - 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.



CODEBUSTERS (CONT.)

B

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

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

4. SCORING:

- a. The high score wins. Final score = Exam score + Timing Bonus.
- b. Based on difficulty of the question, correct answers for each question will earn 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. 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 $4 \times (600 - \text{number of seconds})$. For example, 6 minutes = $4 \times (600-360) = 960$ points.
- d. Scoring example: Team A earns 3600 points on the exam and solves the timed question in 435 seconds.

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

- e. 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 attempted.

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



CODEBUSTERS

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



- DESCRIPTION:** Teams will cryptanalyze and decode encrypted messages using cryptanalysis techniques for historical and modern advanced ciphers.

A TEAM OF UP TO: 3

APPROXIMATE TIME: 50 minutes

- EVENT PARAMETERS:**

- Teams must bring writing utensils and may bring up to three (3) stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators.
- No resource materials, except those provided by the Event Supervisor, may be used.
- The Event Supervisor will provide scratch paper for each team to use.

- THE COMPETITION:**

- This event consists of participants using cryptanalysis techniques and advanced ciphers to decrypt and encrypt messages on a written or computer based exam.**
- Teams will begin the event simultaneously at the indication of the Event Supervisor.
- Teams must not open the exam packet nor write anything prior to the "start" signal, nor may they write anything after the "stop" signal.
- Participants are allowed to separate the pages of the test to be free to answer the questions in any order, working individually or in groups, attempting whichever of the questions seem right for them.
- The code types that may be used on the exam at Invitational and Regional competitions are as follows:
 - the Caesar Cipher, also called a shift cipher.
 - Monoalphabetic substitution using K1, K2, K3, or random alphabets as defined by the American Cryptogram Association (ACA).**
 - Aristocrats with a hint - messages with spaces included
 - Aristocrats - messages with spaces included, but without a hint
 - Aristocrats - messages with spaces and hints, but including spelling/grammar errors
 - Aristocrats - messages with spaces and including spelling/grammar errors but no hints
 - Patristocrats with a hint - messages with spaces removed, and with a hint
 - Patristocrats - messages with spaces removed, but without a hint
 - Affine Cipher - encrypting plaintext or decrypting ciphertext given the a and b values
 - Vigenère Cipher- Encrypting plaintext or decrypting ciphertext given a key
 - Baconian Cipher - decrypting ciphertext encoded with the a and b values represented as one or more letters, glyphs, symbols, or character rendering variations (e.g., bold, underline, italic).
 - Xenocrypt - no more than one cryptogram can be in Spanish
 - Hill Cipher - Encrypting plaintext or decrypting ciphertext given a 2x2 decryption matrix.
 - Pollux and Morbit Ciphers - decrypting Morse code ciphertext encoded as digits and spaces given the mapping of at least 6 of the digits.
 - The Rail Fence cipher – Decryption transposed text given the number of rails and an unknown offset.**
- The code types that may be used on the exam at State and National competitions are as follows:
 - All Invitational and Regional code types
 - Xenocrypt - at the state and national levels, at least **two cryptograms** will be in Spanish.
 - Cryptanalysis of the Vigenère cipher with a "crib" of at least 5 plaintext characters
 - the Hill Cipher - Encrypting plaintext with a 2x2 encryption matrix or decrypting ciphertext with a 3x3 decryption matrix.
 - Cryptanalysis of the Affine Cipher with a "crib" of at least 2 plaintext characters.
 - Cryptanalysis of The Pollux and Morbit Ciphers with a "crib" of at least 4 plaintext characters.
 - Cryptanalysis of the Porta Cipher with a "crib" of at least 4 plaintext characters.**
 - Cryptanalysis of The Rail Fence Cipher with a "crib" of at least 5 plaintext characters and a range for the rails and offset.**
- For aristocrats, patristocrats, and xenocrypts, no letter can ever decrypt to itself.
- For aristocrats and patristocrats encoded using a K1, K2 or K3 alphabet, the answer requested on the test can be the keyword or key phrase used to construct the alphabet instead of the deciphered text.**
- No more than 2 cipher questions will be an encryption on the exam.
- The exam packet will include a resource sheet with the Morse Code Table, English/Spanish letter frequencies, Vigenère table, Baconian mapping and modulus inverse tables as needed for the questions on the exam.



CODEBUSTERS (CONT.)

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

- The first question of the exam will be timed.
 - The first question will be the decoding of an Aristocrat as defined by 3.e.ii.(1) or 3.e.ii.(2).
 - A team member should signal when his or her team has broken the cryptogram.
 - 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).
 - The time in seconds, to the precision of the device used, to solve the cryptogram will be recorded by the Event Supervisor or designee.
 - If a team gets the timed question wrong, they may attempt to answer the question repeatedly without penalty. The timing bonus will be calculated from the start of the event until the question is successfully answered by the team with two or fewer errors, or until 10 minutes has elapsed. After 10 minutes, the timed question can still be answered but the timing bonus is zero.

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

- SCORING:**

- The high score wins. Final Score = Exam Score + Timing Bonus + **Special Bonus**.
- Based on the difficulty of the question, correct answers for each question will earn a clearly indicated number of points.
 - The general point distribution by question type is:
 - An "easy question" = 100-150 pts
 - A "medium question" = 200-300 pts
 - A "hard question" = 350-500 pts
 - A "very hard question" = 550-700 pts
 - For questions such as cryptograms, with answers composed of letters, the final points will be determined based on the number of errors found in the decoded plaintext
 - Two or fewer errors will be scored as correct and result in full credit.
 - Each additional error results in a penalty of 100 points.
 - The penalty will not exceed the value of the question. For example, a 400-point question with 5 errors earns 100 points whereas the same 400-point question with 7 errors would earn 0 points, not -100 points.
 - For answers involving the keyword or key phrase for a K1, K2 or K3 alphabet, the final points will be determined based on the number of errors found in the keyword or key phrase
 - Zero errors are required for full credit.
 - Each additional error results in a penalty of 100 points.
 - The penalty will not exceed the value of the question. For example, a 400-point question with 5 errors earns 100 points whereas the same 400-point question with 7 errors would earn 0 points, not -100 points.
- 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 $4 \times (600 - \text{number of seconds})$. For example, 6 minutes = $4 \times (600-360) = 960$ points.
- A Special Bonus can be earned by solving any of the questions marked as special bonus questions with two or fewer errors. The bonus will be awarded as follows: One solved = 150 points, Two solved = 400 points, All three solved = 750 points.**
- Scoring example: Team A earns 3600 points on the exam and solved the timed question in 435 seconds.

Exam Score	=	3600 points
+Timing Bonus $4(600-435)$	=	660 points
		Final Score
		4260 points

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

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





CRAVE THE WAVE

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



- DESCRIPTION:** In this event competitors must demonstrate knowledge and process skills needed to solve problems and answer questions regarding all types of waves and wave motion.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- a. Competitors may bring reference materials, writing utensils, protractors, rulers, and any type of calculators.
 - b. All reference materials must be secured in a 3-ring binder, so that regardless of orientation nothing can fall out.
- 3. THE COMPETITION:**
- a. The competition must consist of both hands-on tasks and questions related to waves. 25-50% of the score must be from the practical portion (hands-on tasks), and 50-75% must be from the theoretical portion (written questions). No single question may count for more than 10% of the score.
 - b. The event supervisor may provide some mathematical relationships, but the competitors are expected to demonstrate an understanding of the concepts outlined below. The competition must consist of at least one task/question from each of the following areas (at indicated regional (R), state (S), and national (N) levels):
 - c. General wave characteristics (R,S,N), e.g. wavelength, amplitude, frequency, period.
 - d. Wave types (R,S,N), e.g. transverse, longitudinal, surface, torsional waves.
 - e. Wave phenomenon (R,S,N), e.g. sound & light – reflection, standing waves, constructive and destructive interference, refraction, effect of media, diffraction, doppler effect
 - f. Electromagnetic waves (R,S,N), e.g. electromagnetic spectrum, relationship between frequency and wavelength; wave energy; standard wavelength bands, their uses and dangers; and how waves are used in communication.
 - g. Spectroscopy (R,S,N), e.g. primary colors of light – reflection, refraction, use with filters, absorption spectra and emission spectra and their use in astronomy, primary colors of pigments.
 - h. Earthquake/seismic waves (S,N), e.g. p-waves, s-waves, Rayleigh waves, Love waves, surface waves
 - i. Boundary effects (N), e.g. breaking ocean waves, tsunamis.

4. SAMPLE STATIONS:

- a. Regional level
 - i. Label the parts of a wave, determine frequency, period or wavelength of a wave.
 - ii. Determine the angle of refraction of a prism.
 - iii. Measure and label the angles of incidence and **reflection** and the normal of a mirror.
 - iv. Listen to a recording and determine in which direction (toward or away) a truck is moving.
 - v. Given papers with colored circles and a flashlight hidden inside a black box, determine the color of the filter over the flashlight.
 - vi. Using a recording of two trucks determine which one is moving faster.
- b. State level - given p-wave and s-wave diagrams determine the distance to the epicenter.
- c. National level - label and describe the action of a breaking wave.

5. SCORING:

- a. Points must be awarded for the accuracy and quality of the responses. High score wins.
- b. Ties must be broken using pre-selected questions.

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

* Converting metric units, for example MHz → kHz * Standing wave demo
 * Dimensional Analysis and conversions
 * Sci Not
 * Alg I + Geo necessary. Also, sin + cos problems
 * Know constants
 * Have many images of EM spectrum, use 1st 20 from google



CRIME BUSTERS

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



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

A TEAM OF UP TO: 2

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- a. Each participant may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed **and one stand-alone non-programmable, non-graphing calculator**.
- b. Each team may bring any or all of the items listed as Recommended Lab Equipment for Division B Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage. The Supervisor will not provide them.
- c. Teams may bring only specified items. Other items not listed are prohibited. The Event Supervisors will check each team's equipment, confiscate non-allowed items, and have the right to penalize the team up to 10% if additional equipment is brought to the event.
- d. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
- e. The Supervisor will provide:
 - i. Iodine reagent (KI solution)
 - ii. 1M HCl
 - iii. Chromatography materials plus containers
 - iv. Waste container(s)
 - v. Wash bottle with distilled water (no more than 250 mL)
- f. The Supervisor may provide:
 - i. Other equipment (e.g., microscope, probes, calculator, 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 additional 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 3.c. (i-iii)	Limit on Mixtures from Part 3.c.i. only	Part 3.d.	Part 3.e.	Part 3.f.	Part 3.g.
Regional	6-15	Up to 2 of 2 solids with *	5-7	1 type	1-2 topics	Required
State	10-18	2-4 of 2-3 solids with *	7-10	1-2 types	2-3 topics	Required
National	14-20	2-6 of 2-3 solids with *	10-15	1-3 types	2-4 topics	Required

- b. The collected evidence and other data given may be used in a mock crime scene.
- c. Qualitative Analysis: Participants will identify evidence (unknowns) by performing tests such as solubility, acidity, magnetic property, color, density, and odor. Every team will have the same set of unknowns (evidence). The scenario will identify which containers hold mixtures and if the mixtures are made of two or three materials. The unknown common materials will be taken from the following lists.
 - i. Solids: Anhydrous sodium acetate, yeast, vitamin C (ascorbic acid), *calcium carbonate (powdered limestone), *table salt (NaCl), *sugar (crystal), *flour, *calcium sulfate dihydrate (gypsum), *cornstarch, *baking soda, *powdered gelatin, *powdered Alka-Seltzer®, *sand (white).
 - ii. Non-Powdered Metals: aluminum, iron, zinc, magnesium, copper, tin.
 - iii. Liquids: lemon juice, rubbing alcohol (isopropyl), household ammonia (3%), water, vinegar, hydrogen peroxide (3%).
- d. Polymer Testing/Natural and Man-made Substances: Participants will demonstrate their skill in analyzing



CRIME BUSTERS (CONT.)

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



evidence from a variety of sources such as:

- i. **Hair - Identify human, dog, and cat.**
- ii. **Fibers - Identify animal, vegetable, or synthetic.**
- iii. Recyclable Plastics - PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA. Burn tests will not be conducted but burn results may be provided.
- e. Paper Chromatography: Participants will analyze evidence from paper chromatography (ink pens, juices, Kool-Aid®, etc.). The paper chromatogram(s) will be collected with the score sheet. **Participants may be expected to measure Rfs.**
- f. Crime Scene Physical Evidence: Participants will also demonstrate their skill in analyzing evidence from a variety of other sources such as:
 - i. Fingerprints: Participants may be asked to identify different patterns on fingerprint evidence such as the difference between whorls, loops, and arches.
 - ii. DNA evidence: Participants may be asked to compare DNA chromatograms/electropherograms from materials found at the scene to those of the suspects.
 - iii. Shoeprints & tire treads: Participants may be asked to compare prints and make conclusions such as direction and speed of travel. No calculations are expected to be performed.
 - iv. Soil: Participants may be given the composition of soil found at the scene or on the suspects and asked to determine if this implicates any of the suspects.
 - v. Spatters: Analyze spatter patterns for speed and direction of impact. No calculations are expected to be performed.
- g. Analysis: 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. SAMPLE QUESTIONS AND ACTIVITIES:

- a. When HCl is put with baking soda, what evidence is there of a reaction?
- b. Will a plastic with a density of 1.14 g/mL sink or float in a 10% salt solution ($D=1.07$)?
- c. When Alka-Seltzer reacts with water, is heat released or taken in?"

5. SCORING:

- a. The team with the highest score wins. Time will not be used for scoring.
- b. The score will be composed of the following elements (percentages given are approximate):
 - i. 3.c. = 50%
 - ii. 3.d. = 10%
 - iii. 3.e. = 5%
 - iv. 3.f. = 10%
 - v. 3.g. = 25%
- vi. Actual point values will be shown at each question.
- c. The tiebreakers in order are the score from:
 - i. Part 3.g.
 - ii. Part 3.c.
 - iii. Part 3.d.
- d. A penalty of up to 10% may be given if the area is not cleaned up as instructed by the Event Supervisor.
- e. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.

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

DETECTOR BUILDING



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



1. **DESCRIPTION:** Teams will build a durable Conductivity Device that will accurately measure and display both voltage and concentrations of NaCl in parts per million (ppm) from 0 to 5000 ppm of different water samples.

A TEAM OF UP TO: 2

IMPOUND: No

EYE PROTECTION: None

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- a. Each team may bring one participant-constructed, conductivity-sensing Device with a laptop or a calculator for programming/display, two calculators of any type, and one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted.
- b. Event Supervisors will provide multiple approximately 4 ounce of saltwater samples of known concentrations in disposable cups with lids. The cups should have approximately a 7 cm wide mouth and a depth of 4 cm.
- c. Regional Competition will test 3 unknown concentrations. State and National Competition will test 4 different concentrations.
- d. Teams must be able to answer questions regarding the design, construction, programming, and operation of the Device per the Building Policy found at www.soinc.org.

3. CONSTRUCTION PARAMETERS:

- a. Devices must be built using a microcontroller or microcontroller board (e.g., TI Innovator, Raspberry Pi, Arduino, Micro:bit), a display, LED lights, and a participant-built sensor/probe. The sensor must produce a voltage which varies according to the temperature of the water. The Device may be connected to a laptop and/or calculator. WiFi/Internet connection is not allowed at any time during competition.
- b. The sensor must be team constructed from fundamental electronic components. No pre assembled boards may be used. The entire sensor including wires/cables, must be at least 30.0 cm in length. The sensor's end must be small enough to be fit through an opening of 7.0 cm and immersible up to 4.0 cm in the water samples.
- c. The Device must have a digital display that clearly shows voltage, and the salt concentration in ppm to the nearest unit value. This can be displayed on a laptop or calculator. If needed, the Device may use a code library for the LCD display only. If the team chooses to use a laptop for display purposes it CANNOT be used for the Written Test portion of the event.
- d. The Device must also be able to indicate the specific concentration zone using three separate LEDs - one red, one green, and one blue. RGB LEDs may be used but must be wired for only one color. The exact concentration range of each zone will be not be revealed until teams enter to compete, and may be different for different rotations. At States / Nationals, zones may require more than one color to be displayed at the same time.
- e. The Device must have a digital readout that clearly displays the temperature in degrees Celsius and the potential in Volts. This can be displayed on a laptop or calculator. If teams choose to use a laptop for display purposes this laptop may not be used on the written exam.
- f. The Device must also be able to indicate the specific temperature zone using three separate LEDs - one red, one green, and one blue. RGB LEDs may be used, but must be wired for only one color. The exact temperature range of each zone will be not be revealed until teams enter to compete, and may be different for teams. At State and/or Nationals, zones may require more than one color to be displayed at the same time.
- g. Teams must not use electrical outlets at any time during the competition. If the Device is not powered by a connected laptop or calculator, then the Device must be powered by commercially available batteries. Multiple batteries may be connected in series or parallel as long as the expected voltage output across any two points does not exceed 12 Volts as calculated using each battery's voltage (as labeled by the manufacturer).
- h. Each Device must be clearly labeled with the team name and team number.

4. DESIGN LOG:

- a. Teams must submit a Design Log with their Device.



DETECTOR BUILDING (CONT.)

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



b. This Design Log should contain the following 7 Sections:

- i. A top-down photograph of the Device with labels identifying all the components and detailing their functions. This section should also include a brief summary explaining how the Device was constructed.
- ii. A data table with at least 10 trials showing the sensor voltage reading versus the corresponding **in ppm using their fixed resistor(s) in the voltage divider. If multiple fixed resistors are tried, include the data and graphs of all potential resistors.**
- iii. Scatter-plot graph of this data with **concentration in ppm on the Y-axis** and voltage on the X-axis.
- iv. Function graph of the mathematical model supported by the data overlaid on scatter-plot of the data.
- v. Equation of the above the mathematical model used to convert measured voltage to the corresponding temperatures in °C highlighted for easy identification.
- vi. **Printout of the program with its code highlighted showing this exact mathematical equation or its code implementation converting voltage to ppm.**
- vii. **On the same program printout, highlight the code that will illuminate the appropriate LED(s) according to their assigned concentration ranges.**

5. THE COMPETITION:

Part I: Device Testing

- a. Only participants and Event Supervisors are allowed in the competition areas. Once participants enter the event area, they must not leave or receive outside assistance, materials, or communication.
- b. **For Regional, Tournaments the Event Supervisors will provide each team with three labeled samples of known concentrations, 4 samples will be provided at State/Nationals.**
- c. Teams may modify their code (e.g., alter the LED code to match the posted **concentration zone**) during the setup time.
- d. **At all Tournaments, teams will have 10 minutes to set up their Device and modify their code.**
- e. **After the setup/calibration time, the teams will rotate through the three different stations at Regional, and four at State/National where they will use their Device to measure the Concentration of each labeled sample. Each team will be allowed a maximum of 2 minutes for each of the 3 or 4 sample determinations. The Event Supervisor will record the voltage and the concentration in ppm to nearest whole number displayed by the Device, along with the LED color displayed at each station.**
- f. **Event Supervisors should exchange concentration samples at the end of each round to prevent contaminations. Actual concentration will not be revealed until the end of the day's competition.**
- g. Teams who wish to file an appeal regarding Part I must leave their Design Log and Device in the competition area.

Part II: Written Test

- a. Teams will be given a written test to assess their knowledge of the theories behind the event. Teams may use the entire time block to take the written test. The written test will be limited to the following topics:
 - i. **Voltage divider and the effect of different fixed resistor and the output voltage recorded.**
 - ii. **The effect of temperature, van Hoff factor, and electrolysis on the reported results.**
 - iii. **The conversion from the analog reading and voltage.**
 - iv. **The relationship between concentration unit like TDS, mg of NaCl, Molarity, and ppm.**
 - v. **Theory of LEDs, working principles, and applications.**
 - vi. **The process of calibration - working with raw data and determining real world relationships.**
 - vii. **Operational knowledge of basic Device components.**
- b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
- c. While working on the written test teams are not allowed to use any laptops they may have brought with them.

6. SCORING:

- a. Teams with the highest Total Score wins.



DETECTOR BUILDING (CONT.)

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



b. A Total Score for each team will be determined as follows:

- i. **Total Concentration Accuracy Score (Maximum 60 points-45 at Regional).**
Accuracy Score = $60/45$ pts - (total of the relative error of the 3 or 4 concentration measurements x multiplier)
 - (1) Maximum relative error x multiplier per station is 15.0
 - (2) Regional Multiplier = 20
 - (3) State Multiplier = 30
 - (4) National Multiplier = 40
- ii. **Correct LED colors (Maximum 12-16 points)** 4 points are awarded for the correct LED colors (as determined by the concentration measured by the Device) at each station.
- iii. Design Log (Maximum 28 points) 4 points are awarded for each correct section of the Design Log as well as being able to answer questions about each section.
- iv. Written Test (Maximum 30 points)

c. Tiebreakers: a) the lowest sum of the total **Relative Error**; b) highest written test score; c) shortest time for the written test.

d. Teams with any construction or competition violations will be ranked behind teams without violations.

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



DISEASE DETECTIVES

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



- 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

- EVENT PARAMETERS:**

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

- THE COMPETITION:**

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

Part I: Background & Surveillance

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

Part II: Outbreak Investigation

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

Part III: Patterns, Control, and Prevention

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

- SCORING:**

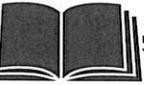
- High score wins. Selected questions may be used as tiebreakers.
- Points will be assigned to the various questions and problems. Both the nature of the questions and scoring will emphasize an understanding that is broad and basic rather than detailed and advanced.
- Depending on the problem, scoring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

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



DYNAMIC PLANET

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



- DESCRIPTION:** Students will use process skills to complete tasks related to Earth's fresh waters..

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

- EVENT PARAMETERS:**

- Each team may bring one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs, and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder throughout the event.
- Each team may bring two stand-alone calculators of any type.

- THE COMPETITION:**

- Participants will be presented with questions which may include one or more tasks at a workstation or a timed station-to-station format.
- The participants will be expected to use process skills (e.g., communicating, classifying, inferring, measuring, observing, predicting, and using number relationships) to answer questions on the following topics:
 - Interpretation of fresh water features shown on USGS topographic maps
 - Stream drainage systems: stream order, drainage patterns, main channel, tributaries and watersheds
 - Channel types: braided, meandering, straight and calculations of sinuosity
 - Sediment: weathering, erosion, clast forms and sizes, transportation, capacity and competence, deposition
 - River valley forms and processes: geology, gradient, base level, floodplain features, dynamic equilibrium, nick points, waterfalls, stream capture, deltas and fans
 - Perennial and intermittent stream flow, stream gauging and monitoring, stream flow calculations, discharge, load, floods, recurrence intervals, (Division C only: Chezy and Manning equations)
 - Groundwater: zone of aeration, zone of saturation, water table, porosity, permeability, aquifers, confining beds, Darcy's Law (Division C only) and hydraulic gradient, water table contour lines, flow lines, capillarity, recharge and discharge, saltwater intrusion, and interactions between surface and groundwater
 - Karst features: sinkholes, solution valleys, springs, disappearing streams, caves
 - Lake formation and types: faulting, rifting, volcanic action, glaciation, damming of rivers, changes over time
 - Lake features: inflow and outflow, physical and chemical properties, stratification, shorelines, waves
 - Wetlands: interactions between surface and groundwater in the evolution of bogs and marshes
 - Destruction/Effects of land use changes, dams and levees: sedimentation, down-cutting, diversion of water, flooding, ecological changes
 - Hydrologic cycle and water budgets: precipitation, runoff, evaporation
 - Pollution: types, sources, transport
 - Critical zone hydrology: infiltration, evapotranspiration, soil moisture, permafrost, pingos

- REPRESENTATIVE ACTIVITIES:**

- Analyze and interpret features and actions of a stream or river appearing on a topographic map including watershed boundaries, elevation, gradient, direction of flow, drainage pattern, valley shapes, erosional landscapes, and depositional features.
- Construct a water table contour map and indicate the direction of groundwater movement.
- Analyze data on the thermal structure of a lake and determine how the stratification changes seasonally.
- Given a geologic map, cross section, or lithologic sequence, determine pattern of water flow and storage, optimal reservoir siting.

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



ELECTRIC WRIGHT STUFF

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



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

A TEAM OF UP TO: 2

IMPOUND: No

EVENT TIME: 8 minutes

2. EVENT PARAMETERS:

- Teams may bring up to 2 airplanes, any tools, and their flight log.
- Event Supervisors must provide all measurement tools and timing devices.

3. CONSTRUCTION PARAMETERS:

- Airplanes may be constructed from published plans, commercial kits, **competitors' designs, and/or other sources of design**. Kits must not contain any pre-glued joints or pre-covered surfaces.
- Any materials except Boron filaments may be used in construction of the airplane.
- Total mass of the airplane throughout the flight must be **9.5g including capacitor**.
- The wing must not exceed 45.0 cm horizontally projected wingspan and must not exceed 9.0 cm chord (straight line distance from leading edge of wing to trailing edge, parallel to the fuselage). The horizontal stabilizer must not exceed 28.0 cm horizontal projected span and must not exceed 7.0 cm chord.**
- The propeller assembly may be built by the competitor(s) or purchased pre-assembled. The propeller must be a single two-bladed propeller. Variable-pitch propellers that include mechanisms to actively change the blade diameter or angle must not be used.
- A capacitor not to exceed 3.0V, 5.0F must power a DC motor. The motor must directly drive the propeller. Gearboxes are not permitted. The capacitor must be charged with no more than 3.0V sourced from up to two 1.5V alkaline cells no larger than "D" size. The capacitor label and charging battery label must be visible and must show the manufacturer ratings. Electronics, such as speed controllers or voltage limiters, are not permitted.**
- The airplane(s) must be labeled so that the Event Supervisor can easily identify to which team it belongs.**
- 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:

- The event must be held indoors. Tournament officials must announce the room dimensions (approximate length, width and ceiling height) in advance of the competition. Tournament officials and the Event Supervisor are urged to minimize the effects of environmental factors such as air currents. Rooms with minimal ceiling obstructions are preferred over very high ceilings.
- Once competitors enter the cordoned off competition area to trim, practice, or compete they must not receive outside assistance, materials, or communication. Teams violating this rule must be ranked below all other teams. Spectators must be in a separate area.
- During inspection each team must present a flight log of recorded data. Data must include 6 or more parameters (3 required and at least 3 additional) for 10 or more test flights prior to the competition. The required parameters are: **1) Charging duration (seconds) or capacitor voltage at launch, 2) Flight Time, and 3) estimated or measured altitude. The team must choose at least 3 additional data parameters beyond those required (e.g. charge remaining after landing, decalage measurements, center of gravity, etc.).**
- At the Event Supervisor's discretion:
 - Multiple official flights may occur simultaneously according to the Event Supervisor's direction.
 - Test flights may occur throughout the contest but must yield to any official flight.
 - 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.
- A self-check inspection station may be made available to competitors for checking their airplanes prior to check-in with the Event Supervisor.
- Competitors must present their event materials (airplanes, motors, and logs) for inspection immediately prior to their 2 official flights. Timers must follow and observe teams as they are charging their capacitors.
- Teams may make up to a total of 2 official flights using 1 or 2 airplanes.



ELECTRIC WRIGHT STUFF (CONT.)

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



- After check-in teams must be given an 8-minute Flight Period, starting when their first flight (trim or official) begins. Any flight beginning within the 8-minute period will be permitted to fly to completion. Competitors may make adjustments/repairs/trim flights during their official 8-minute period. Before their launches, competitors 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 Timer(s) of the flight's status. Teams must not be given extra time to recover or repair their airplanes.
- All chargers will be collected at check-in and will be re-issued to the team only for their Preflight Period and 8-minute Flight Period. Time taken during the Preflight Period will impact a team's final score (see 5.b.). Timers will follow and observe teams as they are charging their capacitors. Event Supervisors will return flight logs after inspection.**
- Time Aloft for each flight starts when the airplane leaves the competitor'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 judges otherwise determine the flight to be over.
- Before the preflight period, the team must demonstrate their capacitors are discharged by connecting to the motor and the propeller does not turn.**
- Event Supervisors are strongly encouraged to utilize 3 Timers on all flights. The median flight time in seconds to the precision of the device used, recorded by the 3 Timers, is the official time aloft.
- A team's Preflight Period ends with their first flight, trim or official, which starts their 8-minute Flight Period or if 2 minutes passes after their charger has been returned, whichever comes first.**
- Competitors must not steer the airplane during flight.
- 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.**
- 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 eight-minute period does not apply to such a flight.

5. SCORING:

- The base score is the Team's longest single flight time. Ties will be broken by the longest non-scored official flight time.
- 10% of the flight time will be added to flight time of the airplane that has a colored panel on the wing that is at least the length of the wing chord and at least between 2 wing ribs.
- If their first airplane flight (powered or unpowered), trim or official, is launched within 2 minutes of the return of the charger a 5% bonus will be added to the base score. After 2 minutes have passed since the return of the charger, the 8-minute Flight Period will start and no bonus will be awarded.**
- Teams with incomplete flight logs must have 10% of their flight time deducted from each flight.
- A bonus of 10% of the flight time will be added to the flight time of an airplane that has the entire surface of the wing between at least 2 ribs 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.**
- Teams that violate a rule under "CONSTRUCTION" or "THE COMPETITION" that does not have a specific penalty must be ranked after all teams that do not violate those rules.

Recommended Resources: Reference and training resources including the Wright Stuff CD (WSCD) and the Wright Stuff DVD (PROD) are available on the Official Science Olympiad Store or Website at <http://www.soinc.org>



ENVIRONMENTAL CHEMISTRY

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



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

A TEAM OF UP TO: 2

EYE PROTECTION: C

EVENT TIME: 50 minutes

2. **EVENT PARAMETERS:**

- Teams should bring pencils for graphing and answering questions, a ruler (12-15 in.) for best fit line approximation, two stand-alone non-programmable, non-graphing calculators, and one three-ring binder of any size containing information in any form and from any source attached using the available rings. Sheet protectors are permitted. Participants may not remove information or pages during the event.
- Event Supervisors will provide samples to be tested and **any** other reagents, glassware, information (e.g., periodic table, charts, instrumentation) are appropriate for the task(s) participants are asked to perform.
- Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
- Teams should bring any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.

3. **THE COMPETITION:**

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

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

4. **SAMPLE QUESTIONS/TASKS:**

- Teams may answer questions concerning the standardized curves in general.

Standard Curve: Participants may be given a standard of known concentration and asked to make a series of dilutions. The dilutions will then be read and recorded. Values will be entered and teams with the better R^2 value (i.e. - value closest to $R^2 = 1.000$) may be awarded additional points or used as a tie breaker at the discretion of the event supervisor.



ENVIRONMENTAL CHEMISTRY (CONT.)

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



- Teams may answer questions about how to choose the appropriate wavelength for a particular analyte.
- Teams may answer questions about the relationship between absorbance and transmission.
- When given data, teams may have to recreate the standardized curve and use it to determine unknown values. These values will then be used to answer questions about permit limits, violations, etc. Any question where a comparison must be made, with respect to limits, will have those limits provided by the event supervisor.

- Teams will be required to generate by hand a standardized curve (graph paper required – 10 sq/in.).
- All teams must include on their graph the best fit line and its equation.
- Teams may be asked questions about the best fit lines.
- Teams may be asked questions about the Clean Water Act (*CWA 1972 or 1977*) – (pages 1-59 of “*Introduction to the Clean Water Act*” or *CWA 1972*, pages 150-234 of “*The Clean Water Act*” 1977, & ALL pages (86 total) of the Wastewater Operator Certification Manual).

5. **SCORING:**

- The team with the highest score wins.
- Time will not be used for scoring but could be part of the event.
- Ties may be broken by the accuracy of the standardized curves, or selected questions chosen by the event supervisor. In other words, the closer the R^2 value is to 1.000 for standardized curves, the greater the points awarded.
- A penalty of up to 10% will be applied if the team’s area is not cleaned up as instructed by the event supervisor.

Recommended Resources: Resources for this event can be found on the event page at soinc.org.



EXPERIMENTAL DESIGN

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



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

A TEAM OF UP TO: 3

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- Participants must bring goggles and writing utensils. Experiments will not require any other safety equipment.
- Division B teams may bring one timepiece, one linear measuring device, and one stand-alone non-programmable non-graphing calculator.
- Division C teams may bring one timepiece, one linear measuring device, and one stand-alone calculator of any type.
- The Event Supervisor will provide each team with identical sets of materials either at a distribution center or in an individual container.
- 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:

- The teams must design, conduct, and report the findings of an experiment conducted on site that addresses the assigned question/topic area provided by the Event Supervisor. The assigned question/topic area should be the same for all teams and allow the participants to conduct experiments involving relationships between independent and dependent variables (i.e., height vs. distance).
- During the first 20 minutes of the event, participants will receive the assigned question/topic area, materials, and Part I of the report packet. Participants will focus on designing and conducting their experiment.
- After the first 20 minutes, participants will receive Part II of the report packet and will focus on analyzing their experiment and reporting findings. Participants may continue experimenting throughout the entire event.
- 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.
- When a team finishes, all materials must be returned to the Event Supervisor including both parts of the report packet.

4. SCORING:

- High score wins. Scoring will be done using the Experimental Design Checklist found on the Science Olympiad website (soinc.org).
- 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.
- Ties will be broken by comparing the point totals in the scoring areas of the checklist in the following order:
 - J. Analysis of Claim/Evidence/Reasoning
 - E. Procedure and Set-Up Diagrams
 - C. Variables
 - G. Data Table
 - H. Graph
- Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
- Any team not following clean-up procedures will have their final score multiplied by 0.95.
- Any team not addressing the assigned question/topic area will have their final score multiplied by 0.75.
- Any team not collecting data by conducting an experiment on-site will have their final score multiplied by 0.25.

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

EXPERIMENTAL DESIGN CHECKLIST

B



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



2021 Experimental Design Division B Checklist

(Note: The maximum points available for each task are shown.)

Part I – Design and Construction of the Experiment (58 pts)

A. Statement of the Problem (2 pts)

- Statement addresses the experiment including variables (Not a yes/no question)**

B. Hypothesis (6 pts)

- Statement predicts a relationship between the independent and dependent variables
 Statement gives specific direction to the prediction(s) (e.g., a stand is taken)
 A rationale is given for the hypothesis.

C. Variables (16 pts)

- a. Independent Variable (IV) (6 pts)**
 Correctly identified and defined
 Levels of IV given
- b. Dependent Variable (DV) (4 pts)**
 Correctly identified and defined
- c. Controlled Variables & Constant (CV) (6 pts)**
 First CV correctly identified
 Second CV correctly identified
 Constant correctly identified

D. Materials (4 pts)

- All materials are listed and quantified**
 No extra materials are listed

E. Procedure and Set-up Diagrams (14 pts)

- Procedure is presented in list form**
 Procedure is in a logical sequence
 Steps for repeated trials are included
 Multiple diagrams of setup are provided
 All diagrams are appropriately labeled
 Enough information is given so another could repeat procedure

F. Qualitative Observations (6 pts)

- Observations about procedure provided**
 Observations about the results provided
 Observations given throughout the course of the experiment

G. Quantitative Data - Data Table (10 pts)

- All raw data is provided**
 A condensed data table showing only the data to be graphed provided
 Tables and columns labeled properly
 All data has units
 Example calculations for derived variables are given

Part II – Data, Analysis and Conclusions (66 pts)

H. Graph (12 pts)

- Appropriate Graph is provided**
 Graph properly titled and labeled
 Appropriate scale and units included

I. Statistics (14 pts)

- Statistics of Central Tendency (i.e., best fit, median, mode, mean)**
 One example calculation is given for each statistic including units
 Statistics of Variation (i.e., min, max, range)
 Calculations are accurate

J. Analysis of Claim/Evidence/Reason (CER) (18 pts)

- Statistics Claim completed logically**
 Statistics Evidence completed logically
 Statistics Reasoning completed logically
 Outliers Claim completed logically
 Outliers Evidence completed logically
 Outliers Reasoning completed logically
 Data Trend Claim completed logically
 Data Trend Evidence completed logically
 Data Trend Reasoning completed logically

K. Possible Experimental Errors (8 pts)

- One specific error is identified and effect on results discussed.**
 Second specific error is identified and effect on results discussed.

L. Conclusion (8 pts)

- Hypothesis is re-stated**
 Hypothesis Claim completed logically
 Hypothesis Evidence completed logically
 Hypothesis Reasoning completed logically

M. Recommendations for Future Experimentation (6 pts)

- Suggestions to improve the experiment are given**
 Suggestions for practical applications of experiment are given
 Suggestions for future experiments are given

School: _____ **Team#** _____

Point Total: _____ /124

Deduction multiplier(s): _____

Non-clean up (0.95), Off topic (0.75), or Non-lab (0.25)

Final Score: _____



EXPERIMENTAL DESIGN

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



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

A TEAM OF UP TO: 3

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- Participants must bring goggles and writing utensils. Experiments will not require any other safety equipment.
- Division B teams may bring one timepiece, one linear measuring device, and one stand-alone non-programmable non-graphing calculator.
- Division C teams may bring one timepiece, one linear measuring device, and one stand-alone calculator of any type.
- The Event Supervisor will provide each team with identical sets of materials either at a distribution center or in an individual container.
- 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:

- The teams must design, conduct, and report the findings of an experiment conducted on site that addresses the assigned question/topic area provided by the Event Supervisor. The assigned question/topic area should be the same for all teams and allow the participants to conduct experiments involving relationships between independent and dependent variables (i.e., height vs. distance).
- During the first 20 minutes of the event, participants will receive the assigned question/topic area, materials, and Part I of the report packet. Participants will focus on designing and conducting their experiment.
- After the first 20 minutes, participants will receive Part II of the report packet and will focus on analyzing their experiment and reporting findings. Participants may continue experimenting throughout the entire event.
- 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.
- When a team finishes, all materials must be returned to the Event Supervisor including both parts of the report packet.

4. SCORING:

- High score wins. Scoring will be done using the Experimental Design Checklist found on the Science Olympiad website (soinc.org).
- 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.
- Ties will be broken by comparing the point totals in the scoring areas of the checklist in the following order:
 - L. Analysis of Claim/Evidence/Reasoning
 - F. Procedure and Set-Up Diagrams
 - C. Variables
 - H. Data Table
 - I. Graph
- Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
- Any team not following clean-up procedures will have their final score multiplied by 0.95.
- Any team not addressing the assigned question/topic area will have their final score multiplied by 0.75.
- Any team not collecting data by conducting an experiment on-site will have their final score multiplied by 0.25.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries 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.



2021 Experimental Design Division C Checklist

(Note: The maximum points available for each task are shown.)

Part I – Design and Construction of the Experiment (66 pts)

A. Statement of the Problem (2 pts)

- Statement addresses the experiment including variables (Not a yes/no question)**

B. Hypothesis (6 pts)

- Statement predicts a relationship between the independent and dependent variables
 Statement gives specific direction to the prediction(s) (i.e., a stand is taken)
 A rationale is given for the hypothesis.

C. Variables (20 pts)

- a. Independent (IV) & Dependent (DV) Variable (12 pts)
 IV Correctly identified and defined
 Levels of IV given
 DV Correctly identified and defined

- b. Controlled Variables (CV) & Constants (8 pts)
 First CV correctly identified
 Second CV correctly identified
 First Constant correctly identified
 Second Constant correctly identified

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

- SOC logically identified for the experiment
 Reason given for selection of SOC

E. Materials (4 pts)

- All materials are listed and quantified
 No extra materials are listed

F. Procedure and Set-up Diagrams (14 pts)

- Procedure is presented in list form
 Procedure is in a logical sequence
 Steps for repeated trials are included
 Multiple diagrams of setup are provided
 All diagrams are appropriately labeled
 Procedure detailed enough to repeat experiment accurately

G. Qualitative Observations (6 pts)

- Observations about procedure provided
 Observations about the results provided
 Observations given throughout the course of the experiment

H. Quantitative Data - Data Table (10 pts)

- All raw data is provided
 Condensed data table with only the data to be graphed is provided
 Tables and columns labeled properly
 All data has units
 Example calculations for derived variables are given

Part II – Data, Analysis and Conclusions (94 pts)

I. Graph (12 pts)

- Appropriate Graph is provided
 Graph properly titled and labeled
 Appropriate scale and units included

J. Statistics (14 pts)

- Statistics of Central Tendency used (i.e., best fit, median, mode, mean)
 One example calculation is given for each statistic with units
 Statistics of variation are included (i.e., minimum, maximum, range, standard deviation)
 Calculations are accurate

K. Significant Figures (12 pts)

- Data is reported using correct significant figures
 Graph completed using correct significant figures
 Statistics are reported using correct significant figures

L. Analysis of Claim/Evidence/Reasoning (18 pts)

- Statistics Claim completed logically
 Statistics Evidence completed logically
 Statistics Reasoning completed logically
 Outliers Claim completed logically
 Outliers Evidence completed logically
 Outliers Reasoning completed logically
 Data Trend Claim completed logically
 Data Trend Evidence completed logically
 Data Trend Reasoning completed logically

M. Possible Experimental Errors (8 pts)

- One specific error is identified and effect on results discussed.
 Second specific error is identified and effect on results discussed.

N. Conclusion (8 pts)

- Hypothesis is re-stated
 Hypothesis Claim completed logically
 Hypothesis Evidence completed logically
 Hypothesis Reasoning completed logically

O. Applications & Recommendations for Further Use (6 pts)

- Suggestions to improve the experiment given
 Suggestions for practical applications of experiment are given
 Suggestions for future experiments are given



EXPERIMENTAL DESIGN CHECKLIST (CONT.)

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



P. Abstract (16 pts)

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Contains the Statement of the Problem and Hypothesis
Describes the research procedure
Includes major findings and conclusion |
|--|--|

School: _____ Team# _____

Point Total: _____ /160

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

Final Score: _____

(revised 8/23/2019)



FOOD SCIENCE

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



1. **DESCRIPTION:** Participants will answer questions on food chemistry with a **focus on sugars**. In addition, participants will build a hydrometer capable of measuring sugar solutions between 1-10% (mass/volume).

A TEAM OF UP TO: 2

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. **EVENT PARAMETERS:**

- a. Each participant may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with writing utensils, and a stand-alone non-programmable, non-graphing calculator.
- b. Each team may bring any or all of the items listed as Recommended Lab Equipment for Division B Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage. The Supervisor will not provide them.
- c. Teams may bring only specified items. Other items not listed are prohibited. The Event Supervisors will check each team's equipment, confiscate non-allowed items, and have the right to penalize the team up to 10% if additional equipment is brought to the event.
- d. Each team must bring a participant-made **hydrometer** capable of measuring salt concentrations between 1-10% (mass/volume). Any **hydrometer** calibration data must be included on the 8.5" x 11" sheet(s) of paper mentioned in 2.a.
- e. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
- f. The Event Supervisor will provide chemicals, foodstuff, a source of water and balances/equipment/materials to do laboratory activities.

3. **THE COMPETITION:**

Part I: Written/Lab Test

- a. The competition will consist of a written exam and/or lab activities covering the following topics:
 - i. **types of sugar, sweeteners, and enzymes**
 - ii. food preservation processes
 - iii. **testing of foods (sugars, starches, fats, proteins)**
 - iv. **how cooking changes foods chemically**
 - v. citric acid cycle
 - vi. **essential fats, vitamins, and proteins in foods**
 - vii. new nutrition labeling regulations
 - viii. **allergens in foods**
 - ix. **Crystallization and nucleation**
 - x. leavening agents
 - xi. **cold water candy tests (both temperature and sugar concentrations-thread to burnt sugar stages)**
 - xii. water activity
 - xiii. density

Part II: Hands-On Testing

- a. Participants will be expected to perform at least one of the following tests at an Invitational or Regional Tournament, at least two of the tests at the State Tournament, and all three of the tests at the National Tournament. The Event Supervisor for the tournament will decide which tests are conducted. All teams at the same tournament will perform the same test(s). The possible tests are:
 - i. **Determine the sugar content in 1-2 samples using the participant-made hydrometer.**
 - ii. **Determine the cold water stage of a sugar solution.**
 - iii. **Determine if a solution has a reducing sugar in it or not.**
- b. Teams must build, calibrate, bring, and demonstrate a hydrometer capable of measuring **sugar water (most likely sucrose)** concentrations between 1-10% (mass/volume).
 - i. 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 at least **350 mL of sugar water** solution.



FOOD SCIENCE (CONT.)

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

- ii. Teams will be expected to estimate the percent **sugar** measured by their device to the nearest tenth of a percent. Full credit will be given $\pm 1\%$ at Regionals and $\pm 0.5\%$ at State/Nationals. Calibration solutions may or may not be provided by the Event Supervisor.
- iii. A detailed rubric is available on the soinc.org website.

4. SAMPLE ACTIVITIES AND QUESTIONS:

- a. Use a new food label to determine the number of calories from fat in the product.
- b. Determine the moisture content in percentage of a food where the original and dried weight are given.
- c. Determine the temperature range the sugar mixture was heated to based on the cold water stage seen.
- d. Of the following experimental setups of fermentation with balloons indicating carbon dioxide production, which flask has fructose?
- e. Why does diet pop float & regular pop sink, but a pack of regular mayonnaise floats higher than light?
- f. What percentage is the sugar concentration in a solution that has been heated to brown liquid stage?

5. SCORING:

- a. High score wins.
- i. Part I counts for 60% of a team's overall score.
- ii. In Part II, bringing a **hydrometer** counts for 10% of the team's score. If one test is done, it counts for 30% of the team's score. If two tests are done they each count for 15% of the team's score. If all three tests are done, each count for 10% of the team's score.
- 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 from Part I.
- 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 (CPCC); other resources are on the event page at soinc.org.

Regionals and State/Nationals



FORENSICS

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



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

A TEAM OF UP TO: 2

EYE PROTECTION: C

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- a. Each participant may bring one 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed.
- b. Each team may bring any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org, to use during this event and two stand-alone calculators of any type. Teams not bringing these items will be at a disadvantage. The Supervisor will not provide them.
- c. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament. Shoulder length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials or equipment will be penalized or disqualified.
- d. The Supervisor will provide:
 - i. iodine reagent (I_2 dissolved in KI solution)
 - ii. 2M HCl
 - iii. 2M NaOH
 - iv. Benedict's solution
 - v. a hot water bath
 - vi. a Bunsen burner or equivalent BTU heat source to perform flame tests
 - vii. a waste container
 - viii. chromatography materials (e.g., beakers, Petri dishes, etc.)
 - ix. a wash bottle with distilled water
- 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 may be used in a mock crime scene.
- c. Qualitative Analysis: Participants may be asked to identify the following substances: sodium acetate, sodium chloride, sodium hydrogen carbonate, sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid, and ammonium chloride (there will be no mixtures). All teams will have the same set of solids to identify.
- d. Polymers: Participants may be asked to identify:
 - i. Plastics: PETE, HDPE, non-expanded PS, LDPE, PP, PVC, PMMA, PC – Participants will not perform any burn tests on these plastics, but the Supervisor may provide burn test results on them.
 - ii. Fibers: cotton, wool, silk, linen, nylon, spandex, polyester - burn tests will be permitted on the fibers.
 - iii. Hair: human, bat, cow, squirrel, and horse - participants will need to know hair structure including medulla, cortex, cuticle, and root.



FORENSICS (CONT.)

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



- 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. Participants may be asked questions on the different methods of detecting fingerprints and the chemistry behind each of these methods.
 - ii. DNA: Participants may be asked to compare DNA chromatograms/electropherograms from materials found at the scene to those of the suspects. Participants will be expected to know how DNA is copied. See <http://educationalgames.nobelprize.org/educational/chemistry/pcr/>
 - iii. Glass analysis: Participants may be asked to use index of refraction to determine the type of a glass found broken at a crime scene. They may be asked to analyze which hole or fractures occurred before others based on a piece of glass available for examination or a picture of a piece of glass.
 - iv. Entomology: Participants may be asked to identify how long an animal has been dead based on the type of insects found on the body at the scene.
 - v. Spatters: Participants may be asked to analyze actual spatters or photographs of spatters to determine the angle and velocity with which the liquid approached the solid object bearing the spatter & the spatter origin direction.
 - vi. Seeds and Pollen: Participants may be asked to compare pictures of seeds/pollen found at the scene with either seeds/pollen found on the suspects or seeds/pollen from different country regions.
 - vii. Tracks and Soil: Participants may be asked to match tire tracks or footprints found at the scene to tires or shoes of the suspects. Participants may be given the composition of soil found at the scene or on the suspects and asked to determine if this implicates any of the suspects.
 - viii. Blood: Participants may be asked to identify the ABO blood type using artificial blood (Event Supervisor required to provide instructions on how the typing system works) or participants may be asked to identify if a blood sample, either prepared microscope slide or pictures of microscope slide, is human, avian, mammalian, or reptilian/amphibian.
 - ix. Bullet striations: Participants may be asked to match the striations on bullets or casings found at the crime scene and fired from a given gun.
 - g. Analysis of the Crime: Participants will be asked to write an analysis of the crime scene explaining not only which pieces of evidence implicate which suspect and why the suspect(s) was (were) chosen as the culprit(s), but also why the other suspect(s) were not chosen. They will also answer any other crime scene analysis questions posed by the Event Supervisor.
 - h. Teams will dispose of waste as directed by the Event Supervisor.

4. SCORING:

- a. High score wins. Time will not be used for scoring.
- b. The score will be composed of the following elements (percentages given are approximate):
 - c. Part 3.c. ≈ 20%, Part 3.d. ≈ 20%, Part 3.e. ≈ 15%, Part 3.f. ≈ 15%, and 3.g. ≈ 30%.
 - d. 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.
 - e. A 10% penalty may be given if the area is not cleaned up as designated by the Event Supervisor.
 - f. 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.



GRAVITY 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 one Vehicle and Ramp that uses the Vehicle's gravitational potential energy as its sole means of propulsion to reach a target as accurately as possible.

A TEAM OF UP TO:

EYE PROTECTION: None

IMPOUND: Yes

EVENT TIME: 10 minutes

2. EVENT PARAMETERS:

- a. Each team must bring and impound one Vehicle, one Ramp, alignment devices (if used), a Practice Log, and additional/spare parts as well as counterweights used to secure the Ramp. Teams from the same school may share a Ramp if it is compatible with their Vehicle.
- b. Teams may bring data and a stand-alone calculator of any type along with **non-electronic** tools which do not need to be impounded.
- c. Teams must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. CONSTRUCTION PARAMETERS:

- a. All propulsive energy must come from the gravitational potential energy of the mass of the Vehicle. The entire Vehicle must start from an elevated, non-horizontal position on the team's Ramp. A release mechanism must be included as part of the Ramp to hold the Vehicle in the ready-to-run configuration until triggered by the participants.
- b. Conversion of the Vehicle's gravitational potential energy is permissible, but any additional sources of kinetic energy must be in their lowest energy state in the ready-to-run configuration. Pre-loaded energy storage devices may be used to operate other Vehicle functions (e.g., braking system) as long as they do not provide kinetic energy to propel the Vehicle.
- c. The Vehicle's total mass must not exceed 2.000 kg.
- d. Electronic components and electric devices are not permitted.
- e. **A jumbo paperclip (i.e. the large ones) must be attached to the front of the Vehicle and bent so that ONE end of it is pointing down toward the surface of the Track between 7/16" and 1/2" above it. The paperclip must clear the 3/8" dowel placed across the Track. The end of the paperclip must be easily accessible by the Event Supervisor - no part of the Vehicle, except the wheels, may extend more than 0.5 cm beyond it. It will be the Vehicle's Measurement Point for distance measurements.**
- f. The Vehicle and the Ramp including the release mechanism, in the ready-to-run configuration, must completely fit within an imaginary rectangular box with a 50.0 cm x 50.0 cm base and a height of 100.0 cm. A starting pencil used as part of the release mechanism may extend beyond the dimensions of the imaginary box. A sighting/aiming device, if left on the Ramp or Vehicle in the ready-to-run configuration, must fit within the imaginary box.
- g. All parts of the Vehicle must move as a whole; no anchors, tethers, or other separate pieces are allowed. The only parts of the Vehicle allowed to contact the floor during the run are wheels/treads. Pieces falling off the Vehicle or Ramp during the run constitutes a construction violation.

4. PRACTICE LOG:

- a. The Practice Log must include 3 or more parameters (2 required and at least 1 additional) for 10 or more practice runs. The required parameters are the Target Distance and the Vehicle Distance from Target. Each team must choose an additional 3rd parameter beyond those required (e.g., # of axle turns for braking, alignment angle) to test. Logs must include the Team name and number.
- b. Logs must be impounded and will be 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 to compete, they must not leave or receive outside assistance, materials, or communication.
- b. Teams have 10 minutes of Event Time to set up and start up to 3 runs. Vehicles in the ready-to-run configuration before the end of the Event Time will be allowed to complete a run.
- c. **Electric/electronic** tools must not be used except for the calculator (2.b.).
- d. In the ready-to-run configuration, the Vehicle and Ramp must be entirely behind the Start Line. The Vehicle and Ramp must remain at the starting position without being touched.



GRAVITY VEHICLE (CONT.)

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



- e. Teams may adjust their Vehicle or Ramp (e.g.; change the Vehicle's mass, distance, directional control) within their Event Time; the Event Supervisor may re-verify that the Vehicle and Ramp 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-electronic** measuring devices to verify the Track dimensions during their Event Time.
- f. Only **non-electronic** sighting/aiming devices are permitted. If placed on the Track, they must be removed before each run. If placed on the Vehicle or Ramp, they may be removed at the team's discretion. Sighting and aiming devices left on the Vehicle during its run must not cause the Vehicle's mass to exceed 2.000 kg.
- g. 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.
- h. Substances applied to the Vehicle or Ramp must be approved by the Event Supervisor prior to use and must not damage or leave residue on the floor, Track and/or event area. Teams may clean the Track during their Event Time but it must remain dry.
- i. Teams must start their Vehicle by using any part of an unsharpened #2 pencil with an unused eraser, supplied by the Event Supervisor, to actuate a release mechanism on the Ramp. The pencil may be used as all or part of the release mechanism and can extend outside of the dimensions defined in 3.f. While actuating the release mechanism, teams must not touch or push the Vehicle nor the Ramp. Actuating the release mechanism must not impart additional energy to the Vehicle. Once they start a run, teams must not follow their Vehicle and must wait until called by the Event Supervisor to retrieve their Vehicle.
- j. If the vehicle does not move upon actuation of the release mechanism, it does not count as a run. The team may continue to work on their device in order to attempt 3 runs within the Event Time.
- k. A Failed Run can occur if the Vehicle starts before the Event Supervisor is ready, if its distance cannot be measured (e.g., the participants pick it up before it is measured), or if the team pushes the vehicle down the track. If a team has a Failed Run, any Construction and/or Competition violations must be recorded for that Run as well. A team having only one successful run during the 10 minute Event Time will be assessed a Failed Run for a 2nd run score. If the Vehicle does not move during the Event Time, the team will be assessed 2 Failed Runs.
- l. Teams filing an appeal must leave their Vehicle, Ramp, and Practice Log in the event area.

6. THE TRACK:

- a. The Track will be on a smooth, level, and hard surface. Refer to soinc.org for a diagram of the Track.
- b. The Start Point is marked on a piece of tape approximately 2.5 cm wide, on the edge of the tape closest to the Target Point. This front edge will be the Start Line. The tape should extend at least 0.50 m on either side of the Start Point, perpendicular to the imaginary center line connecting the Start and Target Point.
- c. The Target Point will be marked on a piece of approximately 5.0 cm by 2.5 cm tape. The exact Target Distance from the Start Point to the Target Point will be between **2.00** m and **5.00** m. At Regionals the interval will be 0.50 m, for States 0.25 m, and for Nationals 0.05 m. The Target Distance will be chosen by the Event Supervisor and will be announced after the impound period is over.
- d. **A single $\frac{3}{8}$ " hardwood round dowel will span the Track 1.00 m from the Start Line perpendicular to the imaginary center line connecting the Start and Target Point. The dowel must extend at least 0.50 m on either side of the Start Point. The dowel must be securely taped and/or weighed down at its ends to hold it in place.**
- 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. Each team's Final Score is the sum of their 2 best Run Scores out of their 3 runs + any Final Score Penalties. Low score wins.
- b. The Run Score for each run = Distance Score + Run Penalties
- c. The Distance Score = 1pt./cm x Vehicle Distance. The Distance Score for a Failed Run is 2500 points.
- d. The Vehicle Distance is the point-to-point distance from the Vehicle's Measurement Point to the Target Point in centimeters measured to the nearest 0.1 cm.
- e. **The Time Score for each run is the time it takes from when the Gravity Vehicle begins to move down the ramp until it comes to a complete stop recorded to the nearest 0.1 s. The Time Score will be used as a tiebreaker.**



GRAVITY VEHICLE (CONT.)

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



- f. Run Penalties:
 - i. Competition Violation: 1500 points added to each Run Score that has 1 or more Competition Violations.
 - ii. Construction VIolation: 3000 points added to each Run Score that has 1 or more Construction Violations.
- g. Final Score Penalties:
 - i. Incomplete Practice Log: 250 points added to the team's Final Score.
 - ii. Missing or not Impounded Practice Log: 500 points added to the team's Final Score.
 - iii. Vehicle Not Impounded: 10000 points add to the team's Final Score.
- h. Two or more teams tied with 2 Failed Run scores, without Competition or Construction Violations, will remain scored as ties. Other ties are possible.
 - i. Tiebreakers in order: 1. Better Vehicle Distance of the 2 scored runs; 2. Lower Time Score of the Better Vehicle Distance of the 2 scored runs; 3. Better Vehicle Distance of the non-scored run.

SCORING EXAMPLE:

A Vehicle does 3 runs in the allotted time but the team's Practice Log is incomplete.
 The 1st run has 2 Competition Violations, a Time Score of 4.3 s and a Vehicle Distance of 57.8 cm.
 The 2nd run has a Competition Violation, a Time Score of 3.9 s and a Vehicle Distance of 143.9 cm.
 The 3rd run has no Violations, a Time Score of 4.1 s and a Vehicle Distance of 87.5 cm.

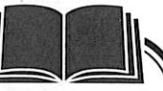
$$\begin{array}{lll} \text{1st run's Run Score: } & 57.8 \text{ pts} + 1500 \text{ pts} & = 1557.8 \text{ pts} \\ \text{2nd run's Run Score: } & 143.9 \text{ pts} + 1500 \text{ pts} & = 1643.9 \text{ pts (highest number of points, not counted in Final Score)} \\ \\ \text{3rd run's Run Score: } & 87.5 \text{ pts} & \\ \text{Final Score} & = \text{1st run's Run Score} + \text{3rd run's Run Score} + \text{Incomplete Practice Log} & \\ & = 1557.8 \text{ pts} + 87.5 \text{ pts} + 250 \text{ pts} = 1895.3 \text{ pts} & \end{array}$$

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



GREEN GENERATION

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



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

A TEAM OF UP TO: 2

IMPOUND: No

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

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

- THE COMPETITION:** This event will be composed of three sections of approximately equal point value. This may include analysis, interpretation or use of charts, graphs and sample data. Note: Green Generation is designed for a two year rotation – the first year (**2022**) will cover aquatic issues, air quality issues and climate change while the second year (**2023**) will cover terrestrial issues and population growth issues.

a. Part 1: Review of the General Principles of Ecology

- i. General Principles of Ecology – food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics, species diversity and indicator species and **invasive species (2022 and 2023)**
- ii. Overview of Aquatic Environments – freshwater, estuaries, marine (**2022**)

b. Part 2: Problems resulting from human impacts on the quality of our environment

- i. Aquatic Environmental Issues – Water Pollution, Ocean Dead Zones, Water Diversion, Overfishing and **Habitat Destruction, Impacts on Excess Nutrients (2022)**
- ii. Air Quality Issues – Acid rain, Air Pollution, Nuclear Pollution **Atmospheric Deposition (2022)**
- iii. Climate Change – Effects on Plants, Animals, and Ecosystems, Greenhouse Effect, and Ozone Depletion (**2022**)

c. Part 3: Solutions to reversing/reducing human impacts that harm our environment

- i. Legislation and Economic Opportunity for Solving Problems (Div. C) (**2022 and 2023**)
- ii. Sustainability Strategies – Environmental Stewardship of Aquatic Ecosystems (**2022**)
- iii. Bioremediation Strategies (**2022**)
- iv. **Pollution Prevention**
- v. **Green Infrastructure**

4. SCORING:

- a. High score wins.
- b. Selected questions will be used to break ties.
- c.

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



IT'S ABOUT TIME

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

- DESCRIPTION:** Teams will answer questions related to time and they may construct and bring one non-electrical device to measure time intervals between 10 and 300 seconds.

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

2. EVENT PARAMETERS:

- a. The event supervisor must hide from view any clocks present in the competition room.
- b. **Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings.** Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.

- c. **Each team may also bring tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event.** These items need not be impounded.

- d. **Each team must impound only one device and all components that are integral to its operation (e.g. water, sand, etc.), a device diagram, and copies of graphs and/or tables for scoring.** Components needed to set up, calibrate, and clean up (e.g. tools, clean-up supplies, reference materials, other time keeping devices) need not be impounded.

- e. The impounded device and any storage boxes must be clearly marked with the team's school name and competition number. At impound, the device and all impounded components must be able to fit into an 80.0 cm x 80.0 cm x 80.0 cm cube and be moveable by the competing team members without outside assistance. The device may become larger once setup for **Part II**.

- f. The device must be designed and operated in such a way that it does not damage or alter the competition area.

- 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.

- h. The device must be constructed to be able to provide a distinct audible and/or visual signal at the end of a competitor set time period.

- i. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between elapsed times and device configuration parameters. A labeled device diagram should be included.

- i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.

- ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph. A template is available at www.soinc.org.

- iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned.

3. CONSTRUCTION:

- a. Examples of acceptable non-electrical devices include water or sand glasses, simple or torsional pendulums, or oscillating springs.

- b. Commercial counters, tally devices, timepieces or their parts are not allowed. Commercial balances, scales, test tubes, beakers, graduated cylinders, and burets are not considered counters and are allowed.

- c. The device must NOT utilize any electrical components, physiological functions (e.g., pulse rate) or chemical reactions except for a battery-operated electronic balance or scale used solely to determine mass. Competitors must not be an integral part of the device, but may interact with it during operation (e.g., they can make adjustments, move containers, count specific actions, etc.).

- d. The device must be constructed to contain spillage.

- e. The device must be constructed to minimize possible impacts on other teams when running (e.g., as quiet as possible, occupies a reasonable amount of space when set up, etc.).

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. Questions may be multiple choice, true-false, completion, or calculation problems.
- c. Unless otherwise requested, answers must be in metric units with appropriate significant figures.



IT'S ABOUT TIME (CONT.)

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



- d. The test must consist of at least **four** questions from each of the **four** following areas. Test questions are subject to the limits listed in "Mathematics Knowledge Allowed in Division C Tests" posted on soinc.com:
- i. Time standards (e.g., UTC, sidereal time, leap years/seconds, **time zones**, **daylight savings time**, **text-based time formats**, and the **Gregorian, Hebrew, Islamic, Julian, and Persian calendars**)
 - ii. Physics of modern timekeeping devices (e.g., atomic clocks, quartz clocks, electronic oscillations)
 - iii. Historical time keeping devices (e.g. pendulum clocks, water clocks, sundials, **ancient astronomical observatories**, early clocks and watches, **primary timekeeping mechanisms**)
 - iv. Waves and frequencies (e.g., electromagnetic waves, frequency analysis, harmonics, normal modes, resonance)
 - v. **State and Nationals only** - Dynamical systems (e.g., **equations of motion**, planetary motion, gravity, relativity, half-life)
 - vi. **State and Nationals only** - Computer representations of time, methods of time synchronization, and situations in which accurate time keeping has significant impact, e.g., navigation, GPS, security protocols, and signal multiplexing

Part II: Device Testing

- a. Teams must be allowed to interact with their device before, during, between and after the time trials, **except while the device is actively timing a time trial**.
- b. The event supervisor must pre-select a different target time (as described under SCORING) for each of 3 time trials. The same times must be used for all teams. **Teams must be informed of the selected intervals at the start of their competition block**. Time trials must run in the order listed in the SCORING section.
- c. **At the start of the competition block, teams will be given 5 minutes to setup or modify their devices and use their graphs and/or tables to calibrate them.** Devices that do not meet construction specs will not be allowed to be tested until brought into specification. All other time keeping devices (e.g., watches, cell phones, etc) must then be collected by the event supervisor prior to the start of the time trials.
- d. While all teams are working on Part I, the Event Supervisor will individually call each team to a station. Multiple identical stations may be used.
- e. Prior to the start of a teams time trials, the team must demonstrate the audible and/or visual signal that the device makes when it is done timing an interval.
- f. Event Supervisors are strongly encouraged to utilize 3 Timers on all time trials. The median time in seconds to the precision of the device used, recorded by the 3 Timers, is the official time trial value. The Event Supervisor will make sure 3 timers are ready and then signal a team member to make a loud announcement of, "3, 2, 1, START!" Then a team member will proceed to start the device. Timers will stop when the device signal is audible and/or visual.
- g. Teams must then have at least 90 seconds at Regionals, 60 seconds at States, 30 seconds at Nationals to configure and prepare their device for the next time trial.
- h. Teams must completely clean up before leaving the competition area.
- i. The Supervisor will review with the team the Part II data recorded on their scoresheet.
- j. Teams filing an appeal regarding Part II must leave their device in the competition area.

5. SCORING:

- a. High score wins; Final Score (FS) = ES + TT1 + TT2 + TT3 + CS. The maximum possible FS score is 100 points. A scoring spreadsheet is available at www.soinc.org.
- b. Teams must start with the points listed below per time trial (TT), for a total of 45 possible points for TT1 + TT2 + TT3.
- c. Points must be deducted from the initial points as described below. The score for a trial must NOT be less than zero. There must not be any carry-over of penalty points between trials. The trial interval ranges and points deducted are:

Time Trial #	Time Interval Range	Points Deducted / ± 0.1 sec error	Initial Points
Trial 1	10 to 90 sec	0.3 pts. per 0.1 sec	15
Trial 2	60 to 300 sec	0.2 pts. per 0.1 sec	15
Trial 3	10 to 300 sec	0.1 pts. per 0.1 sec	15

- d. Exam Score (ES) = (Part I score / Highest Part I score for all teams) x 45 points.



IT'S ABOUT TIME (CONT.)

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



- e. **Chart Score (CS):** One of the submitted graphs/tables, selected by the Event Supervisor, is scored using i., ii., and iii., described below for a maximum of 6 points. Four (4) additional CS points are available via items iv. and v. Partial credit may be given. A device must be present to receive a CS.
 - i. 2 points for including data spanning the possible time range
 - ii. 2 points for including at least 10 data points in each data series
 - iii. 2 points for proper labeling (e.g., title, team name, units)
 - iv. 0.5 points for each distinct graph or table turned in (up to 2 points total). Different test runs with the same variables measured are considered distinct graphs or tables
 - v. 2 points for including a labeled device diagram
- f. If a team violates a COMPETITION rule, their TT1, TT2, and TT3 scores will be multiplied by 0.9.
- g. If any CONSTRUCTION violation(s) are corrected during the competition block, or if the team misses impound, their TT1, TT2, and TT3 will be multiplied by 0.7.
- h. Teams with no device, no time estimates, or that do not make an honest attempt to utilize a device to determine the time periods receive TT1, TT2, and TT3 of 0. Such teams will be allowed to compete in Part I (the written test).
- i. Tiebreakers: 1st - best score from Time Trial 3, 2nd - designated question from the test.

Recommended Resources: All reference and training resources including the It's About Time DVD (TIMD) and the Chem/Phy Sci CD are available on the Official Science Olympiad Store or Website at <http://www.soinc.org>



METEOROLOGY

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



- DESCRIPTION:** Participants will use scientific process skills and quantitative analysis to demonstrate an understanding of the factors that influence world climate and climate change through the interpretation of climatological data, graphs, charts and images.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- Each team may bring two stand-alone calculators of any type & two 8.5" x 11" sheets of paper, which may be in individual sheet protectors sealed by tape or laminated, that may contain information on both sides in any form & from any source without any annotations or labels affixed.
- Teams will not be required to bring any additional supplies or materials for any hands-on task, demonstration or lab exercise.

3. THE COMPETITION:

The questions will address the following weather and climate topics: The questions will address the following weather and climate topics:

- Understanding of weather vs. climate
- Composition and evolution of the Earth's atmosphere:
 - Natural and anthropogenic greenhouse gases, and their sources
 - Anthropogenic sulfate and black carbon aerosols, and volcanic particulates, and their impacts as climate forcing agents
 - The ozone layer and the evolution of the ozone hole
- Earth's radiative energy balance:
 - Shortwave and longwave radiation, albedo and emissivity
 - Impacts of high versus low clouds on climate: shortwave and longwave cloud effects, cloud composition (ice or water) effect on climate
 - Definition and examples of climate feedbacks that change radiative balance: Water vapor feedback, sea ice-albedo feedback
 - "Understanding how changes in greenhouse gases and aerosols change the radiative budget using online RRTM Earth energy budget model; available at <http://climatemodels.uchicago.edu/rrtm/>
- Oceanic and atmospheric circulation mechanisms that affect climate:
 - Semi-permanent pressure cells, the three-cell model of atmospheric circulation, and the Walker cell
 - Thermohaline circulation and wind-driven oceanic currents, ocean heat transport and connections between sea surface temperature trends and local climate patterns
- Climatic zones and their causes:
 - Understand the connection between climate and vegetation
 - Understand and be able to interpret climatographs, and trends and their significance
 - Effects of latitude, longitude, elevation (topography) and urbanization on climate
 - Heat capacity: effects of land masses, bodies of water, soil composition and soil moisture on climate
- Recent climate trends:
 - Modern temperature trends through use of temperature records and datasets (e.g., berkeleyearth.org)
 - Influence of ENSO on climate & typical weather patterns associated with ENSO
 - Sea level rise and its causes
- Understand climate reconstructions from different methods (e.g., sediment cores, ice cores, tree rings, speleothems, others)
- Projected changes in climate:
 - Climate sensitivity and how it is estimated
 - Representative Concentration Pathways
 - Understanding and interpreting climate change projections from models



METEOROLOGY (CONT.)

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

4. SAMPLE QUESTIONS/TASKS:

- Predict the climate zones of a hypothetical island continent given its topography, latitude, and longitude.
- Examine a climatograph & determine if this might be a climate windward or leeward of a mountain range or city.
- Interpret a diagram of the elements in the sea ice-albedo feedback, including arrows and plus/minus signs to indicate direction and type.
- Use a time series from theberkeleyearth.org dataset to estimate temperature trend.
- Compare historical normals from NOAA, through time (e.g., new 1991 - 2020 vs. 1981 - 2010 and prior instances of normals).
- Examine whether or not trends are present/exist in the climatology of extreme weather events, using graphs and data.

- SCORING:** High score wins. Points will be awarded for the quality of responses, the quality of supporting reasoning, and use of scientific technique. Pre-identified questions will be used as tiebreakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Meteorology CD, the Bio/Earth Science CD, and the *Audubon Weather* meteorology field guide; other resources are on the event page at soinc.org.



MISSION POSSIBLE

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



1. **DESCRIPTION:** Prior to the competition, participants design, build, test, and document a Rube Goldberg®-like Device that completes required Start and Final Actions through a series of specific actions.

A TEAM OF UP TO: 2

IMPOUND: State & National only

EYE PROTECTION: C

SET-UP TIME: 30 minutes for points

MAXIMUM RUN TIME: 3 minutes

2. EVENT PARAMETERS:

- a. At State and National Tournaments, teams must impound their Device along with any tools or parts that they will use during their set-up time or run. Electric outlet access will not be available.
- b. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not compete.
- c. Each Device must pass a safety inspection before operation. Devices with potential hazards or safety concerns must not be permitted to run unless safety concerns are resolved to the satisfaction of the Event Supervisor, otherwise they must receive only participation points.
- d. Event Supervisors will need their own eye protection (i.e.; safety glasses), meter sticks, stopwatches, and measuring tape.
- e. Participants must be able to answer questions regarding the design, construction, and operation of the Device per the Building Policy found on www.soinc.org.

3. CONSTRUCTION PARAMETERS:

- a. General Requirements:
 - i. During operation, the Device's outer dimensions should be no greater than 60.0 cm (L) x 60.0 cm (D) x 60.0 cm (H). Devices with a dimension greater than 1 meter will not be allowed to run.
 - ii. All actions used for scoring must be visible and/or verifiable. The top and at least two vertical walls must be open or transparent for viewing all actions. Actions must be consecutive. Parallel and/or dead-end actions will not count for points. Any action in the Device not designed to contribute to the completion of the Final Action will not count for points.
 - iii. **All marbles in the device must be glass spheres with a diameter between 1 - 3 cm. The marbles may be taped or tied, but not glued or altered in any other way.**
 - iv. Each movable/adjustable physical object in the Device must be utilized by at most one assigned action. An object at the end of one action may initiate the next action, but must not go beyond the initiation of the second action. (The initial marble may start the first action, as described, but must then remain at rest **on the "base" of the device until it is struck** in the Final Action.)
 - v. Sensitive components (i.e.; springs/mousetraps, dominoes) may be set/placed just before starting the Device.
 - vi. **Use of electricity is prohibited anywhere in the device.**
 - vii. Candles, flames, matches, hazardous liquids, lead objects (even if encased), gases, and hazardous materials (e.g., rat traps, combustible fuses, dry ice, liquid nitrogen) and unsafe handling of chemicals will not be permitted.
 - viii. **If a marble is to start the next action, the actual marble (not what is holding or attached to it) must initiate the next action.**
- b. Start Action: (100 points) - Participants must drop a marble (3.a.iii.) into the Device from a point completely above the Device. The marble must fall into the Device and initiate the next action, and come to rest on the "base" of the device and not be touching anything other than the "base". **The base of the device must be a hard, flat horizontal plane that may be covered with cloth or felt. There must be no grooves or channels to guide the marble(s) on the "base".**
- c. Scorable Actions: (50 points each) – Participants may have up to 12 scorable unique actions to count for points. Participants may attempt, none, some, or all of these actions in any order.
 - i. **Use a falling marble to operate a wheel & axle to raise another marble 10 cm. that then initiates the next action.**
 - ii. **Use a marble to knock over a series of 3 dominoes so the last domino moves another marble to initiate the next action.**
 - iii. **Use a wedge to separate two touching marbles so that one moves 20 cm. from its spot and then initiates the next action.**
 - iv. **Use water to raise a marble at least 5 cm. that then rolls out of the container to initiate the next action.**
 - v. **Use a falling marble to raise a 3rd class lever that raises another marble 5 cm. that then initiates the next action.**



MISSION POSSIBLE (CONT.)

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



- vi. **Use a 1st class lever to raise a cup containing at least 10 marbles 10 cm. before the cup initiates the next action.**
- vii. **Use a single marble to hit a chain of 5 touching marbles so that the last marble moves at least 10 cm. and then initiates the next action.**
- viii. **Drop 5 marbles into a cup, one at a time, so that the last marble causes a pulley system with IMA of 3 to raise an object at least 10 cm. before the object initiates the next action.**
- ix. **Push or pull a marble up an inclined plane with an IMA of at least 2 so that the marble is vertically raised at least 10 cm. before it initiates the next action.**
- x. **Launch a marble completely out of and above the device so that it reenters the device at least 20 cm away from where it left the device, then it strikes an object which initiates the next action.**
- xi. **Use falling marbles to turn a paddlewheel. The wheel must make at least one full revolution before triggering the next action.**
- xii. **Use an Archimedes screw to raise a marble 20 cm vertically before the marble triggers the next action.**
- d. Final Action:
 - i. After all other planned scorable actions have been attempted, the marble from the Start Action in 3.b. must be struck so that it rolls, unguided, at least 30 horizontal cm on the "base" of the device from its original resting position and stops on its own on the "base" and within the device. (250 points)
 - ii. If the team chooses, they can place another marble 30 cm. from the first marble. This marble also must be free-standing on the "base" of the device. If the first marble strikes the second one and both stop rolling and stay within the device, then an additional 100 points will be awarded. To receive the points neither marble is allowed to touch anything other than the "base" once both have stop rolling.
 - iii. If a 20 cm. diameter circle is drawn with the second marble at its center and the second marble completely leaves the circle after being hit by the first marble, then another 75 points will be awarded if neither marble leaves the device. The second marble is allowed to hit a wall and return into the circle.
 - iv. If all parts of 3.d.iii. are successfully completed and the first marble remains completely in the 20 cm. circle, then 50 more points will be awarded.
- e. Action Sequence List (ASL):
 - i. An Action Sequence List (ASL) must be submitted to the Event Supervisor at impound for States & Nationals. At Regional Tournaments, ASLs should be provided to Event Supervisors just prior to the start of competition.
 - ii. An ASL is a written documentation of all the actions within the Device. Its purpose is to allow the Event Supervisor to follow along the chain of events while the Device is running.
 - iii. Each scorable action in 3.c. may only earn points once in the ASL. 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).
 - iv. All scorable and non-scorable actions must be numbered in the Device, and correspondingly numbered in the ASL.
 - v. An example of an ASL can be found on www.soinc.org.

4. THE COMPETITION:

- a. The Target Operation Time is 60 seconds at Regionals/Invitations, 61 to 90 seconds at State, and 91 to 120 seconds at Nationals. For State and National tournaments, time will be announced after impound is over and at setup. The target time will be the same for all teams at State and Nationals.
- b. **Timing and scoring begin when a participant drops the first marble (3.b.) into the Device. Timing stops when the marble from the Start Action is struck by the device, or after 180 seconds have elapsed, whichever comes first. After the 1st marble is struck, the only points awarded are those related to the final task.**
- c. Participants may designate one sand timer, an action taking over 10 seconds, to be eligible for bonus points. This timer must not be one of the scorable actions.
 - i. A 1-point bonus will be awarded for every full second the sand timer runs before the Target Operation Time. The timer may run past the Target Operation Time but will not receive points for the duration after the Target Operation Time.





MISSION POSSIBLE (CONT.)

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



- ii. The timer must successfully initiate the next action for any bonus points to count.
- iii. For State/National tournaments, the team must demonstrate how this timer is adjusted to account for the increased length of Target Operation Time for the bonus points to count.
- d. If the Device stops, jams, or fails, the participants will be allowed to adjust it to continue operation up to three times. An adjustment may consist of multiple physical touches and is only completed once the Device runs again on its own. Obvious adjusting only to stall or impact operation time will result in disqualification.
- e. If a participant completes a scorable action or makes an adjustment that leads directly to the completion of that action, then that action will not count for points, even if it is part of the Final Action.
- f. If an action starts out of the ASL order, all actions skipped in the listed sequence, even if completed, earn zero (0) points.
- g. The Supervisor will review with teams the data recorded on the scoresheet.
- h. Teams filing an appeal must leave their Device and ASLs in the event area.

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 for State and National tournaments
 - ii. The ASLs are legible and 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 unique action in 3.c. is successfully completed as described
- d. Award 100 points for completing the Start Action
- e. Award 250 points for completing the Final Action as described in 3.d.i.
- f. **Award 100 points for the first marble hitting a second marble as described in 3.d.ii.**
- g. **Award 75 points if the second marble completely leaves the 20cm. circle as described in 3.d.iii.**
- h. **Award 50 points if the first marble completely remains in the circle after knocking the second marble out of the circle**
- i. Award 2 points for each full second (rounded down) of operation up to the Target Operation Time
- j. Award 1 point per full second that a **sand** timer runs before the Target Operation Time if all conditions are met and the next action is initiated by the timer
- k. 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 for each dimension is 30 points, for a total of 90 points (**Only at in-person tournaments.**)
- l. Award 75 points for a Device that has no adjustments during operation
- m. Teams failing to impound their device on-time will be ranked after all teams that impounded on-time.
- n. Teams receive only participation points for impounding a Device but not competing, unsafe Devices, Devices with a dimension greater than 1 meter, or Devices that are remotely timed/controlled

6. PENALTIES:

- a. Deduct 1 points 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 cm
 - ii. If the top and 2 vertical walls are not open or transparent
 - iii. For each time the Device is adjusted during operation, up to 3 times. If the Device stops or fails after the third adjustment, scoring stops and the operation time will be scored as 180 seconds.
- c. Deduct 50 points if any solid or liquid leaves the measured dimensions of the Device.
- d. **Devices that use electricity within the device will not be allowed to run.**

7. TIEBREAKERS:

Ties are broken as follows: a) Fewest penalty points; b) Smallest overall dimension (L+D+H) of the Device.

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



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 one Vehicle using **one or two mousetrap(s)** as its sole means of propulsion to reach a target point as accurately as possible.

A TEAM OF UP TO: 2

IMPOUND: Yes

EVENT TIME: 10 minutes

2. EVENT PARAMETERS:

- a. Each team must bring and impound one Vehicle, alignment devices (if used), a Practice Log, and additional/spare parts. The vehicle must be impounded with the mousetrap in its lowest potential energy state compared to an unmodified mousetrap.
- b. Teams may bring data and a stand-alone calculator of any type and non-electric tools which do not need to be impounded.
- c. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not be allowed to compete and will receive participation points.
- d. Teams must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. CONSTRUCTION PARAMETERS:

- a. All propulsive energy must come from **one or two snap mousetrap(s)** with a 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. The mousetrap must retain all of its original parts and structural integrity. Altering the structural integrity of the mousetrap is prohibited, including welding, bending, and cutting. Items may be added to the 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 the mousetrap to attach it to the Vehicle.
- b. Conversion of the mechanical energy of the mousetraps is permissible, but any energy converters must be at their lowest energy states in the ready-to-run configuration. Pre-loaded energy storage devices may be used to operate other Vehicle functions (e.g., braking system) as long as they do not provide kinetic energy to propel the Vehicle.
- c. Electronic components and electric devices are not permitted except for calculators.
- d. **The vehicle must have an unbent jumbo paper clip, one point of which will serve as the Measurement Point, attached to the front of the Vehicle such that the point extends forward of all other parts of the Vehicle (including the wheels) and to within 1 cm of the track's surface, which will serve as the Measurement Point. The drive arm, if used, and drive string may extend beyond the Measurement Point.**
- e. In the ready-to-run configuration, all wheels/treads (in their entirety) must fit in a 40.0 cm x **60.0** cm space of any height and any orientation. Axles, drive arms, and other parts of the Vehicle may extend beyond these parameters.
- f. All parts of the Vehicle must move as a whole; no anchors, tethers, tie downs, launching ramps, or other separate pieces are allowed. The only parts allowed to contact the floor during the run are wheels/treads, drive string(s), and any parts already in contact with the floor in the ready-to-run configuration. Pieces falling off during the run constitutes a construction violation.

4. PRACTICE LOG:

- a. The Practice Log must include 3 or more parameters (2 required and at least 1 additional) for 10 or more practice runs. The required parameters are: Target Distance and Vehicle Distance from Target. Each team must choose an additional 3rd parameter beyond those required (e.g., # of axle turns for braking, alignment angle) to test. **As time is not a factor in scoring, it is not a valid third parameter.** Logs must include the Team name and number.
- b. Logs must be impounded and will be returned when the team is called to compete.



MOUSETRAP VEHICLE (CONT.)

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



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 to compete, they must not leave or receive outside assistance, materials, or communication.
- b. Teams have 10 minutes of Event Time to set up and start up to 3 runs. Vehicles in the ready-to-run configuration before the end of the Event Time will be allowed to complete a run.
- c. Electric tools must not be used except for the calculator in 2.b.
- d. In the ready-to-run configuration, the Vehicle's Measurement Point must be over the Start Point. The Vehicle must remain at the starting position without being touched.
- e. Teams may adjust their Vehicle (e.g., change mousetraps, distance, aiming) within their Event Time, though the Event Supervisor may re-verify that the Vehicle meets specifications prior to each run. Timing is paused during any measurements made by the Event Supervisor. Timing resumes once the participants pick up their Vehicle or begin making their own measurements. Teams may use their own **non-electronic** measuring devices to verify the Track dimensions during their Event Time.
- f. Only **non-electric/non-electronic** 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.
- g. 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.
- h. Substances applied to the Vehicle must be approved by the Event Supervisor prior to use and must not damage or leave residue on the floor, Track and/or event area. Teams may clean the Track during their Event Time but it must remain dry.
- i. Teams must start the Vehicle using any part of an unsharpened #2 pencil with an unused eraser, supplied by the Event Supervisor, in a motion approximately perpendicular to the floor, to actuate a trigger. They may not touch the Vehicle to start it, hold it while actuating the trigger, or "push" the Vehicle to get it started. Once they start a run, the participants must not follow their Vehicle and wait until called by the Event Supervisor to retrieve their Vehicle.
- j. **The Vehicle must travel forward so that the Measurement Point clearly passes the 1 m line, reverse direction, and come to a stop with the Measurement Point at the Target Point located behind the Start Point.**
- k. If the vehicle does not move upon actuation of the trigger, it does not count as a run. The team may continue to work on their device in order to attempt 3 runs within the Event Time.
- l. A Failed Run can occur if the Vehicle starts before the Event Supervisor is ready, if its distance cannot be measured (e.g., the participants pick it up before it is measured), or if the team pushes the vehicle down the track. If a team has a Failed Run, any Construction and/or Competition violations must be recorded for that Run as well. A team having only one successful run during the 10 minute Event Time will be assessed a Failed Run for a 2nd run score. If the Vehicle does not move during the Event Time, the team will be assessed 2 Failed Runs.
- m. **If the vehicle does not reverse within 3 seconds after coming to a stop, the run is considered to have ended.**
- n. **Failure to reverse or failure to pass the 1 m Line is a Competition Violation.**
- o. **Once the Vehicle begins a run, the competitors must move outside the lane, not follow the Vehicle, and wait until called by the Event Supervisor to retrieve their Vehicle following measurement.**
- p. The Event Supervisor will review with the team the data and penalties recorded on their scoresheet.
- q. Teams filing an appeal must leave their Vehicle and Practice Log in the event area.

6. THE TRACK:

- a. The Track will be on a smooth, level, and hard surface. Refer to soinc.org for a diagram of the Track.
- b. **The Event Supervisors must mark the track as follows:**
 - i. **Start Point - An approximately 5.0 cm by 2.5 cm piece of tape with the Start Point marked at the center of the tape.**
 - ii. **1 m Line - A line of 2.5 cm tape, in FRONT of the Start Point, approximately 70 cm long, placed perpendicular to an extended imaginary line connecting the Start Point to the Target Point. The center of the line must be on the extended imaginary line. The edge of the tape farthest from the Start Point must be 1.0 m from the Start Point.**
 - iii. **Target Point - An approximately 5.0 cm by 2.5 cm piece of tape with the Target Point marked at the center of the tape placed BEHIND the Start Point.**



MOUSETRAP VEHICLE (CONT.)

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



- c. **The exact Target Distance from the Start Point to the Target Point will be between 1.00 m and 4.00 m. At Regionals the interval will be 0.5 m, for States 0.25 m, and for National 0.05 m.**
 - d. At the Event Supervisor's discretion, more than one Track may be used. If so, the team may choose which Track they want to use, but must use the same Track for both runs.
- ## 7. SCORING:
- a. Each team's Final Score is the sum of their 2 best Run Scores out of their 3 runs + any Final Score Penalties. Low score wins.
 - b. **Run Time begins with the first movement of the Vehicle and ends when the Vehicle comes to a complete stop (including recoil). The RunTime is recorded in seconds to the precision of the timing device used and may be used as a tiebreaker.**
 - c. The Run Score for each run = Distance Score + Run Penalties
 - d. The Distance Score = 1pt./cm x Vehicle Distance. The Distance Score for a Failed Run is 2500 points.
 - e. The Vehicle Distance is the point-to-point distance from the Measurement Point to the Target Point in centimeters measured to the nearest 0.1 cm.
 - f. Run Penalties:
 - i. Competition Violation: 1500 points added to each Run Score that has 1 or more Competition Violations.
 - ii. Construction VIolation: 3000 points added to each Run Score that has 1 or more Construction Violations.
 - g. Final Score Penalties:
 - i. Incomplete Practice Log: 250 points added to the team's FInal Score.
 - ii. Missing or not Impounded Practice Log: 500 points added to the team's Final Score.
 - iii. Vehicle Not Impounded: 10000 points add to the team's Final Score.
 - h. Two or more teams tied with 2 Failed Run scores, without Competition or Construction Violations, will remain scored as ties. Other ties are possible.
 - i. Tiebreakers in order: 1. Better Vehicle Distance of the 2 scored runs; 2. Shortest Run Time of the better scored run; 3. Better Vehicle Distance of the non-scored run.

8. SCORING EXAMPLE:

A Vehicle has 3 runs in the allotted time.

The 1st run has 2 CompetitionViolations and a Vehicle Distance of 57.8 cm.

The 2nd run has a CompetitionViolation and a Vehicle Distance of 143.9 cm.

The 3rd run has no Violations and a Vehicle Distance of 87.5 cm.

The team's Practice Log is incomplete.

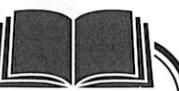
$$\begin{aligned}
 \text{1st run's Run Score: } & 57.8 \text{ pts} + 1500 \text{ pts} &= 1557.8 \text{ pts} \\
 \text{2nd run's Run Score: } & 143.9 \text{ pts} + 1500 \text{ pts} &= 1643.9 \text{ pts} \text{ (highest points, not counted in Final Score)} \\
 \text{3rd run's Run Score: } & 87.5 \text{ pts} \\
 \text{Final Score} & = \text{1st run's Run Score} + \text{3rd run's Run Score} + \text{Incomplete Practice Log} \\
 & = 1557.8 \text{ pts} + 87.5 \text{ pts} + 250 \text{ pts} = 1895.3 \text{ pts}
 \end{aligned}$$

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.



ORNITHOLOGY

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



- DESCRIPTION:** Participants will be assessed on their knowledge of North American birds.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- Each team may bring one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source along with one commercially produced field guide not contained in the binder. Sheet protectors, lamination, tabs and labels are permitted in both the binder and field guide.
- If the event features a rotation through a series of stations where the participants interact with samples, specimens or displays; no material may be removed from the binder throughout the event.
- In addition to a binder, each team may bring one unmodified and unannotated copy of either the **2022 National Bird List** or a **2022 Official State Bird List** which does not have to be secured in the binder.

3. THE COMPETITION:

- The competition may be run as timed stations and/or as a timed slides/PowerPoint presentation.
- Specimens/pictures will be lettered or numbered at each station. The event may include preserved specimens, skeletal material, recordings of songs, and slides or pictures of specimens.
- For each station, Regional tournaments will have questions about 1 bird per station, State tournaments will use no more than 2 birds per station, and the National Tournament may use 3 or more birds per station.
- Each team will be given an answer sheet on which they will record answers to each question.
- No more than 50% of the competition will require giving order, family, and/or common name.
- Participants should be able to do basic identification to the level indicated on the Official List. States may have a modified state or regional list. See your state web site.
- States may have a modified state or regional list which will be posted on the state website no later than November 1st.
- The National competition will be based on the **2022 National Bird List**.
- Each specimen will have one or more questions accompanying it on some aspect of its life history, distribution, anatomy and physiology, reproduction, habitat characteristics, ecology, diet, behavior, conservation and biogeography.
- The ecology questions may pertain to any ecological aspect of the species, including behavior, habitat, niche, symbiotic relationships, trophic level, adaptive anatomy such as bill size and shape, migration, distribution or occurrence (e.g., rare, common, special concern, endangered).

4. SAMPLE ACTIVITIES:

- Identify the order, family, and/or common name of the provided sample.
- What conclusion can be drawn about the habitat(s) of the given specimens?
- Which of these animals does not fit within this taxon?
- What unique anatomical feature distinguishes the animal shown in the picture?
- Consider the potential impact of human activities on the survival of birds.

5. SCORING:

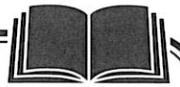
- High score wins.
- Selected questions may be used as tiebreakers.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Bio/Earth Science CD, Taxonomy CD, and *Peterson's Field Guide to Birds of North America*; other resources are on the event page at soinc.org.



2022 NATIONAL BIRD LIST

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



Kingdom – ANIMALIA

Phylum – CHORDATA

Subphylum – VERTEBRATA

Class - AVES

Family Group (Family Name)

Common Name

ORDER: Anseriformes

Ducks, Geese, and Swans (*Anatidae*)

Black-bellied Whistling-duck

Snow Goose

Canada Goose

Trumpeter Swan ♂

Wood Duck

Mallard ♂

Northern Shoveler

Green-winged Teal

Canvasback

Hooded Merganser

ORDER: Galliformes

Partridges, Grouse, Turkeys, and Old

World Quail (*Phasianidae*)

***Ring-necked Pheasant**

Ruffed Grouse ♂

Wild Turkey

New World Quail (*Odontophoridae*)

Northern Bobwhite ♂

ORDER: Gaviiformes

Loons (*Gaviidae*)

Red-throated Loon

Common Loon ♂

ORDER: Podicipediformes

Grebes (*Podicipedidae*)

Pied-billed Grebe

Red-necked Grebe

ORDER: Procellariiformes

Albatrosses (*Diomedeidae*)

Laysan Albatross

Shearwaters and Petrels

(*Procellariidae*)

Northern Fulmar

ORDER: Cathartiformes

New World Vultures (*Cathartidae*)

Turkey Vulture

California Condor

ORDER: Pelecaniformes

Pelicans (*Pelecanidae*)

American White Pelican

Bitterns, Herons, and Allies (*Ardeidae*)

American Bittern ♂

Great Blue Heron

Snowy Egret

Green Heron

Black-crowned Night-heron

Ibis and Spoonbills

(*Threskiornithidae*)

Roseate Spoonbill

ORDER: Suliformes

Cormorants (*Phalacrocoracidae*)

Double-crested Cormorant

Darters (*Anhingidae*)

Anhinga

Frigatebirds (*Fregatidae*)

Magnificent Frigatebird

ORDER: Ciconiiformes

Deep-water Waders (*Ciconiidae*)

Wood Stork

ORDER: Falconiformes

Caracaras and Falcons (*Falconidae*)

Crested Caracara

American Kestrel

Peregrine Falcon

ORDER: Accipitriformes

Osprey (*Pandionidae*)

Osprey

Hawks, Kites, Eagles, and Allies

(*Accipitridae*)

Bald Eagle ♂

Northern Harrier

Cooper's Hawk

Red-tailed Hawk ♂

Golden Eagle

ORDER: Columbiformes

Pigeons and Doves (*Columbidae*)

Mourning Dove ♂

Common Ground-Dove

***Rock Pigeon**

ORDER: Cuculiformes

Cuckoos, Roadrunners, and Anis

(*Cuculidae*)

Black-billed Cuckoo ♂

Greater Roadrunner

ORDER: Gruiformes

Rails, Gallinules, and Coots (*Rallidae*)

Clapper Rail

Sora ♂

Purple Gallinule

American Coot

Cranes (*Gruidae*)

Whooping Crane ♂

ORDER: Charadriiformes

Lapwings and Plovers (*Charadriidae*)

American Golden-Plover

Killdeer ♂

Oystercatchers (*Haematopodidae*)

American Oystercatcher

Stilts and Avocets (*Recurvirostridae*)

Black-necked Stilt

American Avocet

Sandpipers, Phalaropes, and Allies

(*Scolopacidae*)

Spotted Sandpiper

Ruddy Turnstone

Dunlin

Wilson's Snipe

American Woodcock

Gulls, Terns, and Skimmers (*Laridae*)

Laughing Gull ♂

Ring-billed Gull

Herring Gull

Least Tern

Caspian Tern

Black Tern

Black Skimmer

Auks, Murres, and Puffins (*Alcidae*)

Common Murre

Tufted Puffin

ORDER: Columbiformes

Pigeons and Doves (*Columbidae*)

Mourning Dove ♂

Common Ground-Dove

***Rock Pigeon**

1) Special Characters: ♂ indicates vocalizations that may be tested & * indicates an introduced, widespread Species

2) The taxonomic scheme is based upon the 7th edition Checklist of North American Birds, American Ornithologists' Union, and www.allaboutbirds.org
Cornell University Laboratory of Ornithology.



2022 NATIONAL BIRD LIST

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



ORDER: Strigiformes
Barn Owls (*Tytonidae*)
Barn Owl
Typical Owls (*Strigidae*)
Great Horned Owl ♂
Snowy Owl
Barred Owl ♂
Screech Owl

ORDER: Caprimulgiformes
Nightjars and Allies (*Caprimulgidae*)
Chuck-will's-widow ♂
Common Nighthawk

ORDER: Apodiformes
Swifts (*Apodidae*)
Chimney Swift
Hummingbirds (*Trochilidae*)
Ruby-throated Hummingbird ♂

ORDER: Coraciiformes
Kingfishers (*Alcedinidae*)
Belted Kingfisher ♂

ORDER: Piciformes
Woodpeckers and Allies (*Picidae*)
Red-headed Woodpecker
Yellow-bellied Sapsucker
Downy Woodpecker
Northern Flicker ♂
Pileated Woodpecker

ORDER: Passeriformes
Tyrant Flycatchers (*Tyrannidae*)
Olive-sided Flycatcher
Eastern Phoebe
Vermilion Flycatcher
Great Crested Flycatcher ♂
Eastern Kingbird
Scissor-tailed Flycatcher
Shrikes (*Laniidae*)
Loggerhead Shrike
Vireos (*Vireonidae*)
Warbling Vireo
Red-eyed Vireo
Jays and Crows (*Corvidae*)
Steller's Jay
Blue Jay ♂
Black-billed Magpie
American Crow ♂
Common Raven
Larks (*Alaudidae*)

Horned Lark
Swallows (*Hirundinidae*)
Purple Martin
Cliff Swallow
Barn Swallow
Chickadees and Titmice (*Paridae*)
Black-capped Chickadee ♂
Tufted Titmouse ♂
Nuthatches (*Sittidae*)
Red-breasted Nuthatch ♂
White-breasted Nuthatch
Creepers (*Certhiidae*)
Brown Creeper
Wrens (*Troglodytidae*)
Cactus Wren
Marsh Wren
Carolina Wren ♂
Dippers (*Cinclidae*)
American Dipper
Kinglets (*Regulidae*)
Golden-crowned Kinglet
Ruby-crowned Kinglet
Gnatcatchers (*Polioptilidae*)
Blue-gray Gnatcatcher
Thrushes (*Turdidae*)
Eastern Bluebird
Wood Thrush ♂
American Robin ♂
Mockingbirds and Thrashers (*Mimidae*)
Gray Catbird
Northern Mockingbird ♂
Brown Thrasher
Waxwings (*Bombycillidae*)
Cedar Waxwing
Wood-Warblers (*Parulidae*)
Yellow Warbler
Magnolia Warbler
Yellow-rumped Warbler
Black-throated Green Warbler
Black-and-white Warbler
American Redstart
Ovenbird
Kentucky Warbler
Common Yellowthroat ♂
New World Sparrow (*Passerellidae*)
Spotted Towhee ♂
Black-chinned Sparrow
Lark Sparrow
Harris's Sparrow
White-crowned Sparrow

Chipping Sparrow
Dark-eyed Junco
Longspurs and Buntings (*Calcariidae*)
Lapland Longspur
Snow Bunting
Cardinals and Allies (*Cardinalidae*)
Northern Cardinal ♂
Indigo Bunting
Painted Bunting
Scarlet Tanager
Blackbirds (*Icteridae*)
Bobolink
Red-winged Blackbird ♂
Western Meadowlark ♂
Yellow-headed Blackbird
Common Grackle
Brown-headed Cowbird
Baltimore Oriole ♂
Fringillids and Allies (*Fringillidae*)
Red Crossbill
American Goldfinch
Evening Grosbeak
House Finch
Pine Siskin
Old World Sparrows (*Passeridae*)
***House Sparrow**
Old World Starlings (*Sturnidae*)
***European Starling**

1) Special Characters: ♂ indicates vocalizations that may be tested & * indicates an introduced, widespread Species

2) The taxonomic scheme is based upon the 7th edition Checklist of North American Birds, American Ornithologists' Union, and www.allaboutbirds.org
Cornell University Laboratory of Ornithology.



PING PONG PARACHUTE

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



1. **DESCRIPTION:** Prior to the tournament, teams will design, build, and bring **up to three** bottle rockets to the tournament to launch a ping pong ball attached to a parachute to stay aloft for the greatest amount of time.

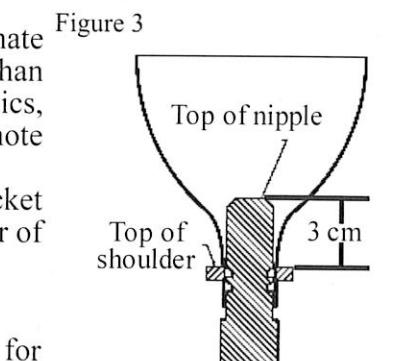
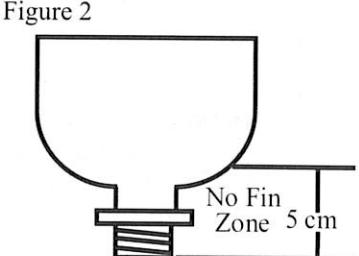
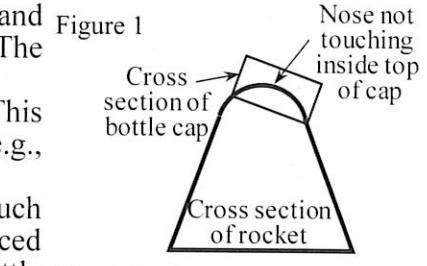
A TEAM OF UP TO: 2 IMPOUND: No EYE PROTECTION: B EVENT TIME: 8 minutes

2. EVENT PARAMETERS:

- a. Teams must provide **up to three rockets, three unaltered ping pong balls and three parachutes.**
- b. Parachutes must be attached to ping pong balls with tape only. The ping pong ball attached to the parachute assembly makes up the parachute payload system.
- 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 compete.
- d. Event Supervisors must provide a launcher (that uses a Schrader valve), an air pump, a pressure gauge, and timing devices. Teams may bring their own manual bicycle pump with a pressure gauge to use, but it must attach to the launcher provided by the Event Supervisor.
- e. This event should be held inside with a high ceiling (greater than 20 feet recommended). Tournament directors must provide the ceiling height (in feet) to teams at least 1 month in advance. Extreme care must be taken to protect the floor and ceiling of any inside facilities used for practice and competition.

3. CONSTRUCTION PARAMETERS:

- a. Rocket pressure vessels must be made from a single **20 oz** or less plastic carbonated beverage bottle with a nozzle opening internal diameter of approximately 2.2 cm (a 1/2-inch Schedule 40 PVC pipe must fit tightly inside the nozzle opening) and a standard neck height from flange to bottle's opening of under 1.6 cm. The bottle label must be presented at check in.
- b. The structural integrity of the pressure vessel must not be altered. This includes, but is not limited to: physical, thermal or chemical damage (e.g., cutting, sanding, using hot or super glues, spray painting).
- c. The nose of the rocket must be rounded or blunt at the tip and designed such that when a standard bottle cap (~3.1 cm diameter x 1.25 cm tall) is placed on top of the nose, no portion of the nose touches the inside top of the bottle cap (see Figure 1).
- d. Only tape must be used to attach fins and other components to the outside of the pressure vessel. Nothing may be added to or placed on the inside of the pressure vessel. No glues of any type may be used on the pressure vessel. Metal of any type is prohibited anywhere on the rocket or parachute payload system.
- e. Fins and other parts added to the bottle must be 5 cm or higher above the level of the bottle's opening, to ensure rockets fit on the launcher (see Figure 2).
- f. All energy imparted to the rocket/parachute payload system must originate from air pressure provided by the tire pump; no water. Gases other than air, explosives, liquids including water, chemical reactions, pyrotechnics, electrical devices, elastic powered flight assists, throwing devices, remote controls, and tethers are prohibited at any time.
- g. At the National Event the launcher nipple will extend into the rocket 1.173 in +/- 0.02 in (3.0 cm +/- 0.5 cm) above the top side of the shoulder of the bottle (see Figure 3).



4. PRACTICE LOG:

- a. During inspection, each team must present a flight log of recorded data for each rocket **design**. Data must include 5 or more parameters (3 required and at least 2 additional) for 15 or more test flights prior to the competition for each rocket. The required parameters are: 1) pressure (psi), 2) estimated/recorded peak flight height (feet), 3) time aloft (seconds). The additional parameters are chosen by the team (examples include: # fins, parachute diameter, etc.).



PING PONG PARACHUTE (CONT.)

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



- b. Rockets without a flight log or an incomplete log will NOT be launched." Change to Rockets without a flight log will be penalized with a -10 second penalty. All graphs in the flight log must be presented as a .xlsx format (Excel).

5. THE COMPETITION:

- a. Teams must arrive at the competition site ready to launch with proper eye protection to have their rocket(s) inspected for safety.
- b. Teams will have **8 minutes to make a total of three launches using the same rocket or three different rockets.**
- c. When called to launch, teams will load their rocket onto the launcher. Once the rocket is loaded, but NOT pressurized, teams will place the parachute payload system on or in the rocket. After the payload parachute system is loaded it cannot be manipulated. Teams will then pressurize the rocket to the pressure (psi) of choice based on their practice log data. At no time should the pressure vessel (bottle) be pressurized beyond the lesser value of **50 psi** or the maximum pressure determined by the Event Supervisor for safe operations given ceiling height at the tournament location. The Event Supervisor will check the gauge on the pump to ensure the rocket is pressurized to the psi chosen and justified by the team's data.
- d. The Event Supervisor will make sure 3 timers are ready and then signal a team member to make a loud announcement of, "3, 2, 1, LAUNCH!" Then a team member will proceed to launch the rocket. After launching, the team will prepare for the next launch.
- e. Timing begins when the rocket separates from the launcher and stops when the parachute payload system lands.
- f. If the parachute payload system does not separate from a rocket, timing is from when the rocket separates from the launcher to when any part of rocket touches the ground.
- g. If any part of a rocket or parachute payload system hits the ceiling or any part connected to the ceiling (e.g., a rafter, light, basketball hoop), then timing is stopped at the instant of contact.
- h. If a rocket fails to separate from the launcher because of a problem with the supplied launcher then the launch never occurred and the launch can be restarted.
- i. All times for each launch MUST be recorded for breaking ties. Time aloft is recorded in hundredths of a second. The middle value is the officially recorded time.
- j. Teams filing an appeal must leave their rocket(s), parachute payload system(s), and Practice Log(s) in the event area.

6. SCORING:

- a. Ranking is determined by the sum of the two greatest times of flight of the 3 launches.
- b. Rockets and/or parachute payload systems violating 2.c, 3.a.-f will not be launched. Rockets violating rules 4.a.-b. will be penalized with a -10 second penalty. Teams unable to make any launches will receive participation points only.
- c. Ties will be broken by the greatest time aloft of the parachute payload system from each team's un-scored 3rd launch.

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



REMOTE SENSING

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



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

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

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

3. THE COMPETITION:

- a. The event will consist of questions and activities testing concepts related to the collection and use of remote sensing data to observe and study climate change processes in the Earth system.
- b. The test should be divided equally, approximately 25 % on each, across the following topic areas:
 - i. Remote sensing instrumentation and physics: active vs. passive sensors; optical and infrared imagers; radiometers; LiDAR; radar altimetry; precipitation radar; blackbody radiation; Planck function, Wein's Law; Stefan-Boltzmann Law; beam attenuation; absorption and scattering by aerosols; refraction and refractive indices; scattering, **gravity**.
 - ii. Interpretation of remote sensing images and data sets from the following satellites: Atmospheric and sea-surface temperature (GOES-16, ATMS and CrIS on NPP); global mean temperature; energy flux (CERES on NPP); optical, infrared and Doppler radar imagery of clouds and precipitation (MODIS, CALIPSO, CloudSat); CO₂ cycle (OCO-2); aerosol scattering, absorption and optical depth (MODIS); detection of trace gas concentrations by satellites (OCO-2, AURA); sea level rise and surface waves (radar altimeters, especially Topex-Poseidon, Jason-1 and Jason-3, **Grace**).
 - iii. Climate processes and climate change: greenhouse gases (concentrations and distribution) and trace gas concentrations; clouds and radiation; aerosol forcing; carbon cycle; surface albedo; comparison of remote sensing data with climate model data
 - iv. Using, applying, and interpreting the output of small-scale models of planetary energy balance

4. SAMPLE QUESTIONS/TASKS:

- a. Use a comparison of visible and IR satellite images of clouds to interpret relationships between clouds and outgoing radiation, and to explain how clouds influence the Earth's radiative balance.
- b. Given information characterizing the extinction coefficient of a layer of dust in the atmosphere and the observed reduction in outgoing radiation, calculate the thickness of the dust layer.
- c. Modify a simple energy balance model to include an idealized greenhouse gas response to these CO₂ concentrations and show how this affects global atmospheric temperature.
- d. Interpret a pair of radar altimeter returns to look at differences in significant wave height.
- e. Interpret signals of changes in groundwater storage from **Grace** gravity data.

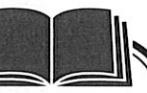
- 5. **SCORING:** High score wins. Points will be awarded for the quality and accuracy of responses. Selected questions may be used as tiebreakers.

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



ROAD SCHOLAR

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



- DESCRIPTION:** Participants will answer interpretive questions that may use one or more state highway maps, USGS topographic maps, Internet-generated maps, a road atlas, or satellite/aerial images.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

- EVENT PARAMETERS:**

- Teams may bring two stand-alone non-programmable, non-graphing calculators, protractors, rulers, other measuring devices, USGS Map Symbol Sheet, and hard copies of other information in any form and from any source along with colored marking devices consistent with the colors utilized on USGS topographic maps. The equipment and reference materials may be in a container.
- The event supervisor will provide all required maps and images. Participants may NOT write on the maps. If a student-generated map is included, a one mile-square PLSS section will be printed on the answer sheets. Graphing axis will be provided for profile problems. Event supervisors will check the accuracy of scales on reproduced maps or images prior to competition.

- THE COMPETITION:** The satellite images, highway, and quadrangle maps may be from one or more states. The event may be presented in a storyline format. Satellite/aerial photos will be in the visible light spectrum. Items marked with an asterisk (*) should be written at an introductory level for Regional Tournaments.

Topics/Concepts Assessed

- a. Topographic Map
 - i. Map features
 - ii. Map marginal information: location/series/scale/index/legend
 - iii. Map symbols
 - iv. Distances between features (English and Metric)
 - v. Contours
 - vi. Elevation of features and symbols
 - vii. Direction of stream flow
 - viii. Coordinate systems of map features with correct formats
 - (1) Public Land Survey System (PLSS)
 - (2) Sector Reference System
 - (3) Latitude/Longitude in degrees, minutes, & seconds
 - (4) Universal Transverse Mercator (UTM)
 - ix. Azimuths and bearings
 - x. Magnetic declination
 - xi. Survey control marks (control stations and spot elevations)
 - xii. Graticule tick marks / graticule intersections
 - xiii. Topographic map profiles*
 - xiv. Slope (feet per 100 feet)*
- b. Highway Map

Topographic map topics may also be present on highway maps.

 - i. Map legend/tables/index
 - ii. Map features/symbols
 - iii. Map grid system
 - iv. Distance between features
 - v. City/Regional insets
 - vi. Geographic coordinates in decimal degrees
- c. Student-Created Map
 - i. Map scales
 - ii. USGS topographic map symbols and colors
 - iii. Distances
 - iv. Azimuths and bearings
 - v. Public Land Survey System
- d. Satellite Photos/Internet Maps
 - i. Feature identification
 - ii. Distances and scales
 - iii. Photo time-of-day identification
 - iv. Internet map symbols
 - v. Road travel between points
 - vi. **Inferences based on satellite photos**

- SAMPLE QUESTIONS/TASKS:**

- Use the map index to identify the map coordinates of Cedarville.
- Use the Detroit inset map to compute the distance in miles and tenths along the roads from the Museum of Art to Cobo Arena.
- What does it tell us if contour lines are very close together in an area?
- By observing shadows, estimate the time of day that this satellite image was captured.

- SCORING:**

- High score wins. Values of questions may be weighted.
- Ties will be broken by the accuracy and quality of answers to pre-selected questions.

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



ROCKS AND MINERALS

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



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

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 Minutes

- EVENT PARAMETERS:**

- Each team may bring the Science Olympiad Official Rock and Mineral List, and one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted.
- 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 other than the Science Olympiad Official Rock and Mineral List. Each team may bring one magnifying glass.

- THE COMPETITION:**

- Emphasis will be placed upon task-oriented activities such as identification of rocks and minerals based on observations of properties and characteristics, interpretation of graphs and charts, analyzing data, etc.
- Where possible, participants will move from station to station, with the length of time at each station predetermined and announced by the event supervisor. Participants may not return to stations, but may change or add information to their original responses while at other stations.
- Identification will be limited to specimens appearing on the Official Science Olympiad Rock and Mineral List (see www.soinc.org), but other rocks or minerals may be used to illustrate key concepts. Tournament Directors may include up to five additional specimens important to their own state. If additional specimens are to be included, all teams must be notified no later than three weeks prior to the competition.
- If identification of a specimen is not possible through observation, key characteristics/properties of the specimen will be provided.
- Written descriptions as to how a specimen might react were it to be tested with HCl may be provided. HCl will not be used or provided nor will competitors be allowed to do a taste test.

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

- a. **Minerals:**
 - i. Identification - specimens used should show observable properties. Where observable properties are insufficient to identify a specimen, other diagnostic characteristics will be provided.
 - ii. Physical Properties - color, hardness, luster, streak, cleavage/fracture, density/specific gravity/heft, diaphaneity, tenacity.
 - iii. Other properties - reaction with acid, fluorescence, magnetism, smell, taste, double refraction, piezoelectricity, radioactivity.
 - iv. Mineral habit - limited to acicular (needlelike), bladed, botryoidal, cubic, dendritic, dodecahedral, drusy, geodic, hexagonal, hopper, massive, micaceous, octahedral, prismatic, radiating, rosette, stalactitic, and tabular.
 - v. Chemical composition.
 - vi. Polymorphs (e.g. diamond/graphite and orthoclase/microcline).
 - (1) Division C Only - Solid solution series (e.g. feldspar ternary diagrams).
 - vii. Classification - mineral families based on composition. (see Rock and Mineral List).
 - (1) Mineral groups (e.g. feldspars, garnet, tourmaline) - similarities of chemical composition and shared properties.
 - (2) Division C Only - Silicate classifications and their structures (e.g. phyllosilicates/sheet silicates).
 - viii. Methods of formation (e.g. hydrothermal, crystallization, evaporites)
 - ix. Minerals associated with rock-forming environments (e.g. evaporite minerals in sedimentary settings; mafic minerals in oceanic crust; minerals that form under metamorphic conditions)
 - x. Bowen's Reaction Series – relationship between mineral crystallization and temperature in magma
 - xi. Economic importance and uses of minerals (e.g. ores, industrial uses, jewelry)
- b. **Rocks:**
 - i. Identification - specimens used should show observable characteristics. Where observable characteristics are insufficient to identify a specimen, other diagnostic characteristics will be provided (e.g. fine-grained rocks)



ROCKS AND MINERALS (CONT.)

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

- ii. Classification - igneous, sedimentary, and metamorphic including observable diagnostic characteristics that facilitate classification (e.g. glassy or vesicular texture in igneous; rounded grains, fossils, or layers in sedimentary; and foliation or banding in metamorphic)
 - iii. Igneous:
 - (1) Textures - including but not limited to aphanitic (fine-grained), glassy, vesicular, porphyritic, pyroclastic, phaneritic (coarse-grained), pegmatitic
 - (2) Composition and essential minerals - felsic, intermediate, mafic, ultramafic
 - (3) Intrusive and extrusive environments - including but not limited to batholith, dike, sill, volcanic neck, lava flow, pyroclastic flow, laccolith
 - (4) Relationship between textures and environments of formation (e.g. intrusive/plutonic, extrusive/volcanic and relative rates of solidification.)
 - iv. Sedimentary:
 - (1) Textures - limited to clastic (detrital), chemical, and biochemical/organic
 - (2) Composition and essential minerals
 - (3) Grain sizes (e.g. clay, silt, sand, pebble, cobble, boulder), sorting, and shape
 - (4) Relationship between textures and composition to environments of deposition
 - (5) Environments of deposition - including, but not limited to alluvial fan, delta, river/stream, swamp, floodplain, beach, shallow marine, deep marine
 - (6) Primary sedimentary structures (eg. plane bedding, cross-bedding, ripple marks, mud cracks, graded bedding, fossil tracks & trails) and their implications about depositional processes
 - v. Metamorphic:
 - (1) Textures - foliated and non-foliated
 - (2) Mineral composition
 - (3) Protoliths (parent rocks)
 - (4) Regional and contact metamorphism
 - (5) Grade of metamorphism and metamorphic index minerals (e.g. chlorite, epidote, garnet, staurolite, kyanite, sillimanite)
 - (6) Division C Only - Relationship of temperature, pressure, depth to types of metamorphism and metamorphic facies (e.g. hornfels, zeolite, greenschist, amphibolite, granulite, eclogite) based on interpretation of graphs and charts
 - (7) Division C Only - Environments of metamorphism in the context of plate tectonics - Regional metamorphism and mountain building at convergent continental-continental boundary; blueschist and eclogite formation in subduction zones; greenstone/greenschist formation from basalt or gabbro at ocean crust divergent boundaries
 - c. Rock Cycle – emphasis on the geologic processes that form rocks (eg. melting and solidification; uplift, erosion & deposition; burial, compaction & cementation; heat & pressure resulting in recrystallization & deformation)
 - d. Economic importance and uses of rocks
5. **SAMPLE ACTIVITIES:**
- a. List the mineral specimens, by name and number, in order of increasing hardness.
 - b. Match each metamorphic rock with the parent rock from which it may have been formed.
 - c. Based on the texture of the metamorphic rocks, list the specimens in order from lowest to highest grade of metamorphism.
 - d. Based on the provided diagram of igneous environments, at which location would the sample have formed?
 - e. Based on the grain size of the shale, sandstone, and conglomerate, which one formed in the lowest energy environment?
 - f. Classify the specimens into igneous, sedimentary, or metamorphic based on observable characteristics and state one reason for each classification.
6. **SCORING:** High score wins. Selected questions will be used to break ties.

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



2022 ROCK AND MINERAL LIST

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

MINERALS

Borate Family

Ulexite

Carbonate Family

Aragonite

Azurite

Calcite

Dolomite

Malachite

Rhodochrosite*

Native Element Family

Copper

Diamond

Gold

Graphite

Silver

Sulfur

Halide Family

Fluorite

Halite⁴

Oxide/Hydroxide Families

Corundum

Goethite/Limonite

Hematite

Magnetite

Pyrolusite*

Rutile*

Zincite*

Phosphate Family

*Apatite Group*¹

Pyromorphite*

Turquoise*

Vanadinite*

Sulfate Family

Barite

Celestite*

*Gypsum*⁴ varieties:

Alabaster (massive)

Satin Spar (fibrous)

Selenite (crystalline)

Sulfide Family

Bornite*

Chalcopyrite

Galena

Pyrite

Sphalerite

Stibnite*

Silicate Family

Apophyllite*

Beryl

Epidote

Kaolinite

Kyanite

Olivine

Quartz varieties:

Aventurine

Agate/Onyx

Amethyst

Chalcedony

Citrine*

Jasper*

Milky Quartz

Opal

Rock Crystal

Rose Quartz

Smoky Quartz*

Sodalite

Staurolite

Stilbite*

Talc

Topaz

*Tourmaline Group*¹

Willemite*

Zircon*

Amphibole Group

Actinolite*

Hornblende

Tremolite*

Feldspar Group

Plagioclase feldspars

Albite

Labradorite

Potassium feldspars

Amazonite

Orthoclase/Microcline (pink)²

*Garnet Group*¹

Almandine

Mica Group

Biotite

Lepidolite*

Muscovite

Pyroxene Group

Augite

Rhodonite*

Spodumene*

ROCKS

IGNEOUS ROCKS

Andesite

Basalt

Diorite

Gabbro

Granite

Obsidian

Pegmatite

Peridotite

Pumice

Rhyolite

Scoria

Syenite

Tuff

SEDIMENTARY ROCKS

Banded Iron

Bauxite³

Breccia

Chert

Conglomerate

Diatomite

Dolostone

Rock Salt (Halite)⁴

Rock Gypsum⁴

Shale

Coal varieties:

Anthracite

Bituminous

Lignite

Limestone varieties:

Chalk

Coquina

Fossil Limestone

Oolitic Limestone

Travertine

Sandstone varieties:

Arkose

Greywacke

Quartz Sandstone

METAMORPHIC ROCKS

Amphibolite

Gneiss

Marble

Phyllite

Quartzite

Schist Varieties:

Garnet Schist

Mica Schist

Talc Schist (Soapstone)

Serpentine

Slate

Specimens marked with an asterisk () are for State and National Tournaments

1 - Apatite, Garnet, and Tourmaline varieties should be identified at the group level, except for Almandine.

2 - This pink variety of feldspar should be identified as Potassium feldspar and not specifically as Orthoclase or Microcline.

3 - Bauxite has been reclassified as a sedimentary rock.

4 - Rock Salt and Rock Gypsum are monomineralic rocks. For identification purposes they are considered the same as the minerals Halite and Gypsum and do not need to be distinguished.



SOLAR SYSTEM

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



- DESCRIPTION:** Students will demonstrate an understanding and knowledge of **planet formation and structure** in our solar system and how it relates to that observed in **extrasolar systems**.
A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 Minutes

- EVENT PARAMETERS:** Each team may bring two 8.5" x 11" sheets of paper that may contain information on both sides in any form and from any source. This information may be used during any part of the event.

3. THE COMPETITION:

- Participants must be knowledgeable about the different types of terrestrial **and gaseous** planets, **moons, and minor bodies** in the Solar System, their **formation, structure, and properties**, and the typical surface and **atmospheric** features of these planets as they appear on diagrams, plots, maps, or images.
- Participants must be knowledgeable about the **formation, structure, and properties** of various types of **terrestrial and gaseous exoplanets, including, but not limited to; hot Jupiters, mini-Neptunes, and super-Earths**, and be able to **compare and contrast them with those of the Solar System planets**.
- Participants must be knowledgeable about the **formation, structure, and properties** of the objects listed below. If applicable, they may be asked to identify and analyze surface **and/or atmospheric** features on these objects as they appear on diagrams, plots, maps, or images.
 - Solar System Objects: **Venus, Jupiter, Saturn, Uranus, Neptune, Io, Iapetus, Triton, Pluto, Arrokoth (2014 MU69)**
 - Extrasolar Systems/Planets: HL Tauri, HIP 67522b, TOI-561, Kepler 138, K2-18b**
- Participants may also be tested on the following topics:
 - Planet formation and internal and atmospheric structure and evolution of terrestrial **and gaseous** planets **within and beyond** the Solar System.
 - Scientific questions addressed by relevant planetary missions and observatories, including, but not limited to; **Magellan, Galileo, Juno, Cassini, Voyager 2, New Horizons, ALMA, Kepler, and TESS**.
 - Qualitative understanding of orbital mechanics and gravitational interactions between objects, including, but not limited to; Kepler's Laws, planetary migration, and tidal forces.**
 - Exoplanet detection and characterization techniques (limited to transits, radial velocity, and direct imaging).**
 - Internal, surface, and atmospheric compositions and structures for each of the objects outlined in (c).**

4. SAMPLE PERFORMANCE TASKS:

- Given a set of images of a particular feature, identify the specific name of the feature, how old that feature might be, and explain how the feature was formed.
- Describe the internal structure of an object and explain how this internal structure was determined from spacecraft data.**
- Given radial velocity and transit data for a hypothetical exoplanet, compare and contrast its likely physical properties and formation mechanism with a given planet from our Solar System.**

- SCORING:** High score wins. Each task or question will be assigned a predetermined number of points. Selected questions will be used to break ties.

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



SOUNDS OF MUSIC

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



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

A TEAM OF UP TO: 2

IMPOUND: No

EYE PROTECTION: None

APPROXIMATE TIME: 50 minutes

2. EVENT PARAMETERS:

- Each team may bring one three-ring binder of any size containing information in any form and from** any source attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
- Each team may also bring writing utensils and two stand-alone calculators of any type for use during any part of the event.
- Teams may bring a personal tuner, which may be an app on their cell phone, for use during set up. Access to an electrical outlet is not guaranteed.
- If testing a stringed device, a team may bring rosin.
- Prior to the competition, teams must tune their device to play the eight notes of a one-octave major scale of the team's choosing. A log describing the process of tuning one pitch must be submitted.**
- 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:

- The device may be constructed of and contain any materials except for the following: electric or electronic components, toys, professional, instruments, or parts taken from or built for toy or professional, instruments (e.g., bells, whistles, mouthpieces, reeds or reed blocks, audio-oscillators, tuning pegs, etc.). The only exception is that strings (professional instrumental or otherwise) of any type are permitted.
- The device must be able to play an ascending major scale beginning on any note between F2 and C5 (inclusive), chosen by the team. (A4 = 440 Hz).**
- The device must also be able to play one additional pitch above the scale's range in order to play the four bar refrain of "Yankee Doodle". The song excerpt (attached at the end of the rules) must be played in 25 seconds and must be played within one octave.**
- The energy to produce the pitches must come from the participants and may not be stored. Participants may not hum or sing to cause the device to produce its pitches.
- 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.
- Devices must use the same type of sound-producing components for all portions of the competition.

4. THE COMPETITION:

Part I: Written Test

- 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.
- Unless otherwise requested, answers must be in metric units with appropriate significant figures.
- The test will consist of at least three questions from each of the following areas:
 - Basic principles of acoustics (including concepts from aeroacoustics, architectural acoustics, bioacoustics, electroacoustics, speech, and underwater acoustics), (e.g. hearing, human ear, noise generated by air movement, turbulence, building and auditorium acoustics, animal calls, how sound affects animals, recording and reproduction of sound, natural and man-made sounds underwater).**
 - Sound wave theory (basic conceptual ideas and basic algebraic calculations, e.g. superposition, constructive and destructive interference, beats, doppler effect, wave velocity equation, speed of sound in various media, standing waves, plane waves, reflection, refraction, propagation)**
 - Fundamental elements of musical sound, perception, and resonance (e.g. pitch, amplitude, harmonics, overtones, open and closed pipes, strings, membranes)**
 - The design, function, and construction of various instrument types (e.g. how it makes sound, what determines the pitch, how is volume changed) (e.g. string, brass, woodwind, percussion,**



SOUNDS OF MUSIC (CONT.)

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



- v. and keyboard instruments)
- vi. Notes, major scales, intervals, time signatures, tempos, and common music terms
- vi. Regional exams may not have more than 50% mathematical questions and must follow math limits posted at soinc.com
- d. Additional topics for States and National Exams:
 - i. Environmental noise, psychoacoustics (e.g. noise and vibration caused by various forms of transportation and recreational activities, relationship between sound and cognition, noise cancellation)
 - ii. Sound wave theory (intermediate conceptual ideas and intermediate algebraic calculations - e.g. interaction of multiple sound waves, boundary effects, echos, sonar, radar, Helmholtz resonators, impedance, sound pressure)
 - iii. Elements of musical sound, perception, and resonance (timbre, sound quality, dissonance and consonance, complex tones, harmony, combination tones)
 - iv. The design, function, and construction of various instrument types (knowledge of common parts of various instruments, how the parts interact and affect overall instrument performance, materials used in construction) (less common instruments)
 - v. Notes, major and minor scales, solfege, intervals and chords, time signatures, tempos, less common music terms
 - vi. State and National exams may not have more than 75% mathematical questions and must follow math limits posted at soinc.com

Part II: Device Testing

- a. Device testing should take place in a room separate from the Part I written test to minimize disruption and to ensure the accuracy of the device readings.
- b. Devices will be evaluated on their ability to produce accurate pitches. A recommended pitch measuring software program is available on the event page at soinc.org.
- c. Teams will have two minutes to set up their device. During the two minutes, teams may use their personal 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 set up the device.
- d. At the end of the two minutes, the team's 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).
- e. 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 and what note they will start on. Participants must know the octave number of their starting pitch.
 - ii. Participants will play one pitch at a time, holding it for a duration of 3 seconds as indicated by signals from the Event Supervisor. For devices with a quick decay time, multiple attacks on the pitch are allowed (e.g., striking a bar with a mallet or plucking a string multiple times). The pitch measurement will be the average value during the 3 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. The microphone may be moved as close as necessary to the device to register the pitch. If a pitch is so soft that it cannot register on the measurement equipment, the device scores zero for that Individual Pitch Score or Bonus.
 - iv. If the device is unable to play some of the required pitches, the participants must notify the Event 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.
- f. Once the Pitch Score Test is completed the participants will conduct their Song Score Test.
 - i. No alterations of the device are allowed between the Pitch and Song Score tests.
 - ii. Participants will select a starting note from the range encompassed by the pitch test scale.
 - iii. **Participants must play the "Yankee Doodle" refrain within 25 seconds.**
 - iv. The Song Score test is scored based on ability to play the song within the time and the Event Supervisor's perception of the rhythmic and pitch accuracy of the song.
 - v. The Event Supervisor will review with the teams the Part II data recorded on their scoresheet.



SOUNDS OF MUSIC (CONT.)

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



- h. Teams filing an appeal regarding Part II must leave their device in the competition area.

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 + SS;
 - 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) The IPS score varies by tournament level:
 - a. Regionals: If $C \leq 10$, IPS = 4.5; If $C > 10$, IPS = $5 - 0.05 \times C$
 - b. States: If $C \leq 7$, IPS = 4.5; If $C > 7$, IPS = $5 - 0.1 \times C$
 - c. Nationals: If $C \leq 3$, IPS = 4.5; If $C > 3$, IPS = $5 - 0.2 \times C$
 - (4) The minimum IPS score is 0 no matter the level of the tournament.
 - iv. Song Score (SS) = (Device Song Score / Highest Device Song Score of all teams) x 15 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 (partial points may be awarded):
 - i. 2 points – For a list of materials used in the device
 - ii. 2 points – For including data comparing pitch accuracy to changes made to an appropriate design element (e.g., pitch vs length of tubing) in order to tune one pitch
 - iii. 2 points – For including at least 5 data points in tuning the one pitch
 - iv. 2 points – For proper labeling (e.g., title, team name, units, team number)
 - v. 2 points – For including a labeled picture showing how to play different pitches (e.g., a fingering chart)
 - vi. LS = 0 if no device is brought to the event
 - d. The Device Song Score points will be assigned as follows (partial points may be awarded):
 - i. 5 points – Rhythmic accuracy
 - ii. 5 points – Pitch accuracy
 - iii. 5 points – Was the song played within 15 seconds from the start of playing
 - e. If a team violates any COMPETITION rules, their IPS values will be multiplied by 0.9 when calculating the scores.
 - f. If any CONSTRUCTION violation(s) are corrected during the Part II setup period, the IPS values will be multiplied by 0.7 when calculating the scores.
 - g. 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, SS, and Bonus scores. Teams will be allowed to compete in Part I.
 - h. Ties will be broken using the following categories in the listed order:
 - i. Best PS
 - ii. Best SS
 - iii. Best TS
 - iv. Questions on the written test

"Yankee Doodle" excerpt:

Note that the excerpt may be transposed into an appropriate key.



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.



STORM THE CASTLE

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



- DESCRIPTION:** Prior to the competition, teams will design, construct, and calibrate a single device capable of launching projectiles onto a target and collect data regarding device parameters and performance.

A TEAM OF UP TO: 2 EYE PROTECTION: B IMPOUND: Yes APPROX. TIME: 10 minutes

2. EVENT PARAMETERS:

- Prior to the competition teams must collect and record launch device performance and calibration data.
- Each team may bring tools, supplies, writing utensils, and stand-alone calculators of any type for use (these items need not be impounded). Each team must impound only one launch device and design log. Items must be moveable by the competitors without outside assistance.
- Event Supervisors will provide the projectiles, counterweights, and target.
- Participants must wear eye protection during device setup and operation. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
- 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:

- When ready-to-launch, the launch device, projectiles, stabilizing weights, **counterweights**, and all other device components (except for tools / supplies) must fit in a 65.0 cm per side cube, in any orientation chosen by the team.
- The triggering device is not considered part of the device and activating it must not contribute significant energy to the launch. It must extend out of the launch area, allow for competitors to remain at least 75cm away from the launch area, and does not need to return to the launch area after launch. The triggering device must not pose a danger due to flying parts or excessive movement outside of launch area.
- The launch device must be constructed to accommodate the supervisor provided counterweights and projectiles (see Section 6 for details). Teams may not modify the counterweights or projectiles.
- The launch force must be entirely supplied by the gravitational potential energy from the supervisor provided falling counterweights. The device, without the counterweight and projectile, must not contribute energy to the launch. This includes any part of the device whose potential energy decreases, with the exception of items of nominal mass, such as strings and thin rods. Devices will be inspected to ensure that there are no other energy sources. At the supervisor's discretion, teams must disassemble devices after competing in order to verify this. Example violations, allowable types, and mechanisms for testing for added energy are available on soinc.org.
- The launch device must be designed and operated in such a way to not damage or alter the floor.
- Electrical components are not allowed as part of the device or triggering device.

4. DESIGN LOG:

- Teams must submit a design log showing collected device data, which should contain:
 - One or more photos and/or diagrams of the device with labels identifying all the major components and detailing their function, along with a brief summary of how the device was built.
 - Any number of graphs and/or tables showing the relationship between various parameters such as arm position or projectile mass and impact position. Graphs/tables may be computer generated or hand drawn on graph paper. Each data series counts as a separate graph. A template is at www.soinc.org.
 - Example calculations showing how to use the graphs/tables to adjust the device for a target position.
- The team must indicate up to four graphs/tables to be scored, otherwise the first four provided are scored.
- All pages of the design log must be affixed together, such as via three ring binder, staples, or paperclips.
- Design logs will be returned to the team after they are done competing.

5. THE COMPETITION:

- Each team will have 8 minutes to set up, adjust and calibrate their device, and to launch a max of 2 shots with each counterweight. Measurement time required by the supervisor is not included in the allotted time. Devices that do not meet the construction specs will not be allowed to launch until brought into spec.



STORM THE CASTLE (CONT.)

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



- When instructed by the event supervisor(s), teams must place their device at a location they select in the launch area. Competitors must not be within 75 cm of the launch area or in front of the front edge of the launch area during a launch. They may touch only the part of the triggering device that extends at least 75cm outside of the launch area.
- Teams may move devices within the launch area and/or adjust them in any way between and before shots.
- No part of the launch device may extend outside of the launch area before or after a shot. If part of the launching device extends beyond the launch area during the launching action, it must return to and remain in the launch area immediately after the launch without assistance of the competitors.
- Before the first launch with each counterweight, the team must notify the supervisor of the desired position of the target (only 0.5 m increments allowed).
- Before each launch, teams must notify the event supervisor. Any launch, even if unintended or not announced, will count as one of the four launches allowed to a team.
- If the team tries to trigger the device and it does not go through a launch motion, it does not count as one of the team's four launches and the team must be allowed to adjust/reset the device if time allows.
- After each launch the event supervisor will indicate to the team when they may approach the target to make measurements to calibrate their device.
- If a team hits the target, they may request the target be moved to a new location (in 0.5 m increments).
- Supervisors must be responsible for retrieving projectiles and returning them to the team between each launch if less than 2 projectiles of each type are initially provided to the team.
- The supervisor will review with the team the data recorded on their scoresheet.
- Teams who wish to file an appeal must leave their device and design log with the event supervisor.

6. COMPETITION AREA:

- The launch area is a rectangular area 1.0m wide by 1.0m long (parallel to the launch direction), designated by tape on the floor. Tape must also be placed 75cm away from the sides and back of the launch area. Supervisors are recommended to use hard surfaces for the floor (e.g., concrete, hardwood, plywood).
- The target will be a ~5 gallon bucket, with the opening facing up.**
- The supervisor will set the target at a distance selected by the team so that two sides of the target are parallel with a straight line from the center of the Launch Area to the center of the target.
- The 2 separate counterweights must consist of a 0.5 kg (light) and 1.5 kg (heavy) mass at the regional level. At State and National Tournaments the light mass must be between 0.5-1.5 kg and the heavy mass must be between 1.5-2.5 kg. For all levels the masses must have a standard 1" open hook bolt on top. For all levels, each counterweight with hook must fit inside a 15.0 cm cube.**
- The projectile used for light mass trials will be a standard unmodified racquetball. The projectile used for heavy mass trials will be a standard unmodified tennis ball.**
- Target and counterweight must be announced only after impound is over and must be the same for all teams.

7. SCORING:

- A scoring spreadsheet is available at www.soinc.org
- High score wins. Final Score = Best Light LS + Best Heavy LS + CS.
 - Launch Score (LS) = TD - 3 x AS + B. Lowest possible LS is 0
 - Target Distance (TD) = distance, in cm, from the center of the front of the launch area to the target center.
 - Accuracy Score (AS) = straight line distance, in cm, from the projectile initial impact location to the target
 - Eligible impact locations include the floor, wall, support column, target, or other objects. The ceiling and objects affixed to or hanging from it are not eligible impact locations. Shots with projectiles hitting such areas will use the next eligible impact location contacted by the projectile.
 - If the projectile hits the target on initial impact AS = 0.
 - Bonus (B) = Hitting the target at first impact is worth $0.15 \times TD$ points. Making contact with the inside bottom surface is worth an additional $0.15 \times TD$ points (for a total of $0.30 \times TD$ points).



STORM THE CASTLE (CONT.)

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



- f. Chart Score (CS) - One of the submitted graphs and/or tables, selected by the event supervisor, must be scored per items i., ii. and iii. below. Partial credit may be given. Max possible CS is 40.
 - i. 6 points for including data spanning at least one variable range listed in 4.a.ii.
 - ii. 6 points for including at least 10 data points in each data series
 - iii. 6 points for proper labeling (e.g., title, team name, units)
 - iv. 3 points for each graph or table turned in (up to 12 points total as long as they are not the same)
 - v. 5 points for including a labeled device picture or diagram
 - vi. 5 points for including at least 2 example calculations
- g. If a team violates any THE COMPETITION rules, their LS scores will be multiplied by 0.9.
- h. If any CONSTRUCTION PARAMETERS violation(s) are corrected during the allotted competition period, or if the team misses impound, their LS scores will be multiplied by 0.7.
- i. Teams disqualified for unsafe operation or that do not have a device that is brought into specs during the allotted competition period will have LS scores of 0.
- j. Participants will be informed before the next launch if they have received a penalty.
- k. Tiebreakers: 1st: best LS; 2nd second best LS; 3rd third best LS



TRAJECTORY

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

- 1. **DESCRIPTION:** Prior to the competition, teams will design, construct, and calibrate a single device capable of launching projectiles onto a target and collect data regarding device parameters and performance.
- A TEAM OF UP TO: 2 EYE PROTECTION: B IMPOUND: Yes APPROX. TIME: 10 minutes**
- 2. **EVENT PARAMETERS:**
 - a. Prior to competition teams must collect and record launch device performance and calibration data.
 - b. Each team may bring tools, supplies, writing utensils, and **two** stand-alone calculators of any type for use (these items need not be impounded). Each team must impound only one launch device, design log, and any projectiles. Items must be moveable by the competitors without outside assistance.
 - c. Participants must wear eye protection during device setup and operation. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
 - d. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.
- 3. **CONSTRUCTION PARAMETERS:**
 - a. When ready-to-launch, the launch device, projectiles, stabilizing weights, and all other device components (except for tools / supplies) must fit in a 60.0 cm per side cube, in any orientation chosen by the team.
 - b. The launch force must be supplied by non-metallic elastic solids such as rubber bands/tubing, wood, plastic, or bungee cords. Devices will be inspected to ensure that there are no other energy sources. At the supervisor's discretion, teams must disassemble devices after competing in order to verify this.
 - c. The triggering device is not considered part of the device and activating it must not contribute significant energy to the launch. It must extend out of the launch area, allow for competitors to remain at least 75cm away from the launch area, and does not need to return to the launch area after launch. The triggering device must not pose a danger due to flying parts or excessive movement outside of launch area.
 - d. Teams must provide unmodified (labeling is permitted) tennis, racquet, Ping-Pong, and/or light weight plastic or foam golf balls to be used as projectiles. Teams may change projectiles for each launch.
 - e. The launch device must be designed and operated in such a way to not damage or alter the floor.
 - f. Electrical components are not allowed as part of the device or triggering device.
- 4. **DESIGN LOG:**
 - a. Teams must submit a design log showing collected device data, which should contain:
 - i. One or more photos and/or diagrams of the device with labels identifying all the major components and detailing their function, along with a brief summary of how the device was built.
 - ii. Any number of graphs and/or tables showing the relationship between various parameters such as arm position or projectile mass and impact position. Graphs/tables may be computer generated or hand drawn on graph paper. Each data series counts as a separate graph. A template is at www.soinc.org.
 - iii. Example calculations showing how to use the graphs/tables to adjust the device for a target position.
 - b. The team must indicate up to four graphs/tables to be scored, otherwise the first four provided are scored.
 - c. All pages of the design log must be affixed together, such as via three ring binder, staples, or paperclips.
 - d. Design logs will be returned to the team after they are done competing.
- 5. **THE COMPETITION:**
 - a. Each team will have 8 minutes to set up, adjust and calibrate their device, and to launch a max of 2 shots at each target. Measurement time required by the supervisor is not included in the allotted time. Devices that do not meet the construction specs will not be allowed to launch until brought into spec.
 - b. When instructed by the event supervisor(s), teams must place their device at a location they select in the launch area. Competitors must not be within 75 cm of the launch area or in front of the front edge of the launch area during a launch. They may touch only the part of the triggering device that extends at least 75cm outside of the launch area.
 - c. No part of the launch device may extend outside of the launch area before or after a shot. If part of the launching device extends beyond the launch area during the launching action, it must return to and remain in the launch area immediately after the launch without assistance of the competitors.
 - d. Teams may move devices within the launch area and/or adjust them in any way between and before shots.
 - e. Before each launch, teams must notify the event supervisor which target they have selected. Any launch, even if unintended or not announced, will count as one of the four launches allowed to a team.



TRAJECTORY (CONT.)

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



- f. If the team tries to trigger the device and it does not go through a launch motion, it does not count as one of the team's four launches and the team must be allowed to adjust/reset the device if time allows.
- g. After each launch the event supervisor will indicate to the team when they may approach the target to retrieve their projectile and make measurements to calibrate their device.
- h. If the first shot at a target lands within 500mm, a bucket shot may be requested in place of the second shot.
- i. The supervisor will review with the team the data recorded on their scoresheet.
- j. Teams who wish to file an appeal must leave their device and design log with the event supervisor.

6. COMPETITION AREA:

- a. The launch area is a rectangular area 1.0m wide by 1.5m long (parallel to the launch direction), designated by tape on the floor. Tape must also be placed 75cm away from the sides and back of the launch area. Supervisors are recommended to use hard surfaces for the floor (e.g., concrete, hardwood, plywood).
- b. Two targets, designated by tape on the floor or panels lying on the floor, must be placed in front of the launch area. Targets must have a minimum diameter / length / width of 1.00m and are recommended to be a square shape. Supervisors are encouraged to place sand, cat litter, or a similar substance in the area around the targets to help indicate landing spots.
- c. The targets must be between 2.00m and 8.00m in front of the launch area (intervals of 1.00m for
- d. Regionals, 0.50m for States, 10.0cm for Nationals). A distance of at least 2.00m must separate the targets.
- e. The near target must be centered on an imaginary centerline that bisects the launch area and is parallel to the launch direction.
- f. The far target may be anywhere up to 2.00 m (in intervals of 0.5 m for Regionals, 0.25 m for States, and 0.10 cm for Nationals) to the right or left of the imaginary centerline.
- g. If requested, a bucket (~5 gallon size, provided by the supervisor) will be placed (opening facing up) anywhere between 2.00m and 8.00m in front of the launch area and anywhere up to 2.00m to the right or left of the centerline. The bucket may only be on the course when requested so that it is not an obstacle.
- h. Target and bucket locations and sizes must be announced only after impound is over and must be the same for all teams. Room ceiling height should be considered when setting the distances.

7. SCORING:

A scoring spreadsheet is available at www.soinc.org

- a. High score wins. Final Score = Best Close TS + Best Far TS + CS + BS (if any).
- b. Target Score (TS) = 2000 (for the close one) or 4000 (for the far one) minus the straight line distance, in mm, from the center of the initial impact of the projectile to the target. Lowest possible TS is 0.
 - i. If no target is announced, or the shot is a bucket shot attempt, TS = 0 for that shot.
 - ii. Eligible impact locations include the floor, wall, support column, other target, or other objects. The ceiling and objects affixed to or hanging from it are not eligible impact locations. Shots with projectiles hitting such areas will use the next eligible impact location contacted by the projectile.
- c. Chart Score (CS) - One of the submitted graphs and/or tables, selected by the event supervisor, must be scored per items i., ii. and iii. below. Partial credit may be given. Max possible CS is 400.
 - i. 60 points for including data spanning at least one variable range listed in 4.a.ii.
 - ii. 60 points for including at least 10 data points in each data series
 - iii. 60 points for proper labeling (e.g., title, team name, units)
 - iv. 30 points for each graph or table turned in (up to 120 points total as long as they are not the same)
 - v. 50 points for including a labeled device picture or diagram
 - vi. 50 points for including at least 2 example calculations
- d. Bucket Score (BS) – Hitting the bucket at first impact is worth 100 points. Making contact with the inside bottom surface is worth an additional 200 points (for total of 300 points).
- e. If a team violates any THE COMPETITION rules, their TS scores will be multiplied by 0.9.
- f. If any CONSTRUCTION PARAMETERS violation(s) are corrected during the allotted competition period, or if the team misses impound, their TS scores will be multiplied by 0.7.
- g. Teams disqualified for unsafe operation or that do not having a device that is brought into specs during the allotted competition period will have TS and BS scores of 0.
- h. Participants will be informed before the next launch if they have received a penalty.
- i. Tiebreakers: 1st: highest sum of the two TSs used for the FS; 2nd highest overall TS; 3rd highest Far TS not used for the FS; 4th highest Near TS not used for the FS



WIFI LAB

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



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

A TEAM OF UP TO: 2

IMPOUND: Yes

APPROX. TIME: 50 minutes

2. EVENT PARAMETERS:

- a. Each team may bring one three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
- b. Each team may also bring tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event. These items need not be impounded.
- c. Each team must impound their device, a device diagram, and copies of graphs and/or tables for scoring. Bonus points are given for devices impounded in a labeled box.
- d. The event supervisor will provide the testing materials listed in the COMPETITION AREA section.
- e. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. CONSTRUCTION PARAMETERS:

- a. Each team may bring one pre-constructed antenna device.
- b. The device must fit within a 15.0 cm x 15.0 cm x 15.0 cm cube during all parts of the competition and must be supported solely by the backplane and the SMA-Female connector mounted in the backplane.
- c. The device must include an SMA-Male connector that can be connected to the backplane connector.
- d. The device may be constructed of any materials except for commercial antenna parts or magnets.
- e. The device must be entirely passive; no batteries, AC power or other energy sources are permitted.
- f. The device must be designed and operated in such a way to not damage or alter the backplane or SMA-F connector (e.g. due to excessive weight/torque, residue on the metal sheet, etc.). Devices are recommended to weigh less than 300 g.
- g. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between power and distance for various device or testing setup configurations. A labeled device diagram should be included.
 - i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
 - ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph. A template is available at www.soinc.org.
 - iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned

4. THE COMPETITION:

Part I: Written Test

- a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
- b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
- c. The test will consist of at least five questions from each of the following areas:
 - i. The Electromagnetic Spectrum, radio waves, and EM wave propagation
 - ii. Relating velocity, wavelength, and frequency for waves, with emphasis on radio waves
 - iii. Common antenna designs, compare/contrast different types of antennas
 - iv. STATE AND NATIONAL ONLY - Mathematical questions involving common antenna designs
 - v. STATE AND NATIONAL ONLY - Gain patterns, the wave equation, impedance, bandwidth, noise, and information

Part II: Device Testing

- d. Teams have a total of 5 minutes to adjust and repair their device, and make 3 connection attempts. Event Supervisors will give teams a warning at 4 minutes. Devices that do not meet the construction specs will not be allowed to be tested until brought into spec.
- e. Once the 5 minute testing period begins, teams may select a starting distance (at 50.0 cm intervals) at which to have the Event Supervisor place the receiver unit.



WIFI LAB (CONT.)

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



- f. Prior to each connection attempt, teams may connect, disconnect, modify or adjust the device and the position of the device and metal sheet relative to the transmitter. Teams must not move the transmitter. During this process, teams may ask the supervisor to **confirm if the antenna has established** a connection with the transmitter. The supervisor must provide only a yes or no response. The team may not ask the supervisor again during that attempt after receiving a yes response.
- g. Once a team is ready for testing, they must step at least 5 feet away from the device, and notify the Event Supervisor.
- h. The Event Supervisor will then measure the average dBm reading over a 10 second period using the receiver unit. Modifications are not allowed during the measurement period.
- i. Connection with the receiver is defined by an average (over 10 seconds) measured dBm reading equal to or higher than the threshold dBm reading obtained by the Supervisor's 3.1 cm monopole antenna.
- j. If connection was achieved, the team may elect to move the receiver to a farther distance for their next attempt. If connection was not achieved, they may elect to move the receiver to a closer distance for their next attempt but must not be allowed to move to a farther distance for their next attempt.
- k. Event Supervisors must record the distance of all attempts and whether the connection was successful.
- l. Teams that achieve connection at the longest possible distance (as determined by the competition venue) must have their average dBm reading recorded as a bonus.
- m. The Supervisor will review with the team the Part II data recorded on their scoresheet.
- n. Teams filing an appeal regarding Part II must leave their device in the competition area.

5. COMPETITION AREA:

- a. Example setups are provided on the event page at www.soinc.org
- b. The Event Supervisor will provide the testing materials listed below, which will be the same for all teams:
 - i. A transmitter that supplies a 2 mW, 2.4 GHz, 802.15.4 encoded signal (e.g. a standard WiFi access point / router with external antennas)
 - ii. **A ~30.0 cm x ~30.0 cm x ~0.5 cm backplane constructed of a non-conducting, low-dielectric material such as MDF, wood, or particle board (the backplane) attached to a tripod with an SMA-Female connector in the middle**
 - iii. Adapters and an antenna cable to connect the transmitter **to the backplane**
 - iv. **A receiver that can display the received power in dBm with at least -80 dBm sensitivity (WiFiInfoView https://www.nirsoft.net/utils/wifi_information_view.html is recommended for PCs and the Wi-Fi Scanner Tool that is native in Mac OS X.)**
 - v. A 3.1 cm monopole antenna for setting the connection threshold dBm value
- c. Tournament personnel are encouraged to provide a long space for device testing and share room specifications with all participants at least two weeks before the competition.
- d. The Event Supervisor will set up the transmitter and receiver on surfaces that are of equal height and at least 50.0 cm above the floor. Once positioned, the setup must stay the same for all teams.
- e. Prior to the start of competition, the Event Supervisor will test their provided 3.1 cm monopole antenna at a distance of 3.0 m to determine the connection threshold dBm reading.

6. SCORING:

- a. Final Score (FS) = ES + AS + CS + IB + MB. The maximum possible FS is 100 points. A scoring spreadsheet is available at www.soinc.org.
- b. Exam Score (ES) = (Part I score / highest Part I score for all teams) x 45 points
- c. Antenna Score (AS) = (greatest successful distance / greatest successful distance for all teams) x 38 points
- d. Chart Score (CS) - One of the submitted graphs/tables, selected by the Event Supervisor, is scored using i., ii., and iii., described below for a maximum of 6 points. Four (4) additional CS points are available via items iv. and v. Partial credit may be given.
 - i. 2 points for including data spanning at least 5m distance
 - ii. 2 points for including at least 10 data points in each data series
 - iii. 2 points for proper labeling (e.g. title, team name, units)
 - iv. 0.5 points for each distinct graph or table turned in (up to 2 points total). **Different test runs with the same variables measured are considered distinct graphs or tables.**
 - v. 2 points for including a labeled device diagram



WIFI LAB (CONT.)

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



- e. Impound Bonus (IB) = 3 points if device impounded in a box labeled with team name & number
- f. Max Bonus (MB) = If multiple teams achieve connection at the maximum distance, the team with the highest dBm reading at the maximum distance will receive a bonus of four points.
- g. AS must be zero if a team has no successful connection attempts, is disqualified for unsafe operation, or fails to bring a device. Such teams will be allowed to compete in Part I.
- h. If any CONSTRUCTION violation(s) are corrected during the competition block, or if the team misses impound, their connection distance will be multiplied by 0.7 when calculating AS..
- i. A team violating any COMPETITION rules during a successful attempt will have their connection distance for that attempt multiplied by 0.9 when calculating AS.
- j. Tie breakers: 1st - Best AS; 2nd - Best dBm at max distance; 3rd – # successful connections; 4th - specific test questions

Recommended Resources: All reference and training resources are available on the Official Science Olympiad Store and Website at <http://www.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: No

APPROXIMATE TIME: 11 minutes

2. **EVENT PARAMETERS:**

- a. Teams may bring up to 2 airplanes, any tools, their flight log, and two stand-alone calculators of any type.
- b. Event Supervisors will provide all measurement tools and timing devices.
- c. 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. Airplanes may be constructed from published plans, commercial kits, **competitors' designs, and/or other sources of 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 wing must not exceed 45.0 cm horizontally projected wingspan and must not exceed 9.0 cm chord (straight line distance from leading edge of wing to trailing edge, parallel to the fuselage). The horizontal stabilizer must not exceed 28.0 cm horizontal projected span and must not exceed 7.0 cm chord.**
- 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. The maximum diameter of the propeller is **24.0 cm**. Variable-pitch propellers that include mechanisms to actively change the blade diameter or angle must not be used.
- f. **A rubber motor not to exceed a mass of 1.50g, including any attachments such as O-rings, must be the sole power for the airplanes after release. It will be massed separately from the airplane. Motors may be lubricated before and/or after check-in. Up to 6 motors may be checked in.**
- 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.

4. **THE COMPETITION:**

- a. The event will be held indoors. Tournament officials will announce the room dimensions (approximate length, width and ceiling height) in advance of the competition. Tournament officials and the Event Supervisor are urged to minimize the effects of environmental factors such as air currents. Rooms with minimal ceiling obstructions are preferred over very high ceilings.
- b. Once participants enter the cordoned off competition area to trim, practice, or compete they must not receive outside assistance, materials, or communication. Only participants may handle 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. During inspection, each team must present a flight log of recorded data. Data must include 6 or more parameters (3 required and at least 3 additional) for 10 or more test flights prior to the competition. The required parameters are: 1) motor size before windup, 2) number of turns on the motor 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/recoded peak flight height, the motor torque at landing, etc.).
- d. At the Event Supervisor's discretion:
 - i. Multiple official flights may occur simultaneously according to the Event Supervisor's direction.
 - ii. Test flights may occur throughout the contest but must yield to any official flight.
 - iii. No test flights will occur in the final half-hour of the event's last period, except for teams that declare a trim flight during their 8-minute Flight Period.
- e. A self-check inspection station may be made available to participants for checking their airplanes prior to check-in with the Event Supervisor.
- f. Participants will present their event materials (airplanes, motors, and logs) for inspection immediately prior to their Preflight Period.
- g. All motors will be collected at check-in and will be re-issued to the team only for their Preflight Period and 8-minute Flight Period. Time taken during the Preflight Period will impact a team's final score (see 5.b.). Timers will follow and observe teams as they are winding their motors. Event Supervisors will return flight logs after inspection.



WRIGHT STUFF (CONT.)

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



- 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.
- p. Teams filing an appeal must leave their airplane(s) and Practice Log in the event area.

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 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 entire surface of the wing between at least 2 ribs or at least one of the wingtip 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.



WRITE IT DO IT

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



- 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:

- The participant who will be doing the writing must bring a writing utensil.
- No other materials or resources are allowed.

3. THE COMPETITION:

- 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.
- 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.
- 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.
- The Event Supervisor will pass the description to the second team member who will take the description and attempt to recreate (build) the original object in twenty (20) minutes.
- Supervisors will attempt to use different materials than the materials that were used last year.

4. SCORING:

- 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.
- Each individual piece will receive points as applicable for: proper size, color, location, orientation, and/or connection.
- 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.
- Students drawing a subsection of the model will be ranked in Tier 2. Drawing a picture of the model will result in disqualification.
- 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.

CHEMISTRY RECOMMENDED LAB EQUIP. B



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

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

Item & Expected Use	Likely to be used in:			
	Crime Busters	Can't Judge a Powder	Food Science	Potions and Poisons
Box - Containing all of the kit materials	X	X	X	X
10 ml Graduated Cylinder - Measuring volumes		X	X	X
25 ml Graduated Cylinder - Measuring volumes		X	X	X
100 ml Graduated Cylinder - Measuring volumes		X	X	X
50 ml Beakers - Doing reactions, developing chromatograms	X	X	X	X
100 ml Beakers - Doing reactions, developing chromatograms		X	X	X
250 ml Beakers - Doing reactions, developing chromatograms		X	X	X
400 ml Beakers - Doing reactions, developing chromatograms	X	X	X	X
50 ml Erlenmeyer Flasks - Doing reactions		X	X	X
125 ml Erlenmeyer Flasks - Doing reactions		X	X	X
250 ml Erlenmeyer Flasks - Doing reactions		X	X	X
Test Tubes - Mix Chemicals, heat chemicals	X	X	X	X
Test Tube Brush - Clean Test Tubes	X	X	X	X
Test Tube Holder - Holds test tubes for heating	X	X	X	X
Test Tube Rack - Hold Test Tubes	X	X	X	X
Petri Dishes - Doing reactions, developing chromatograms	X	X	X	X
Spot Plates - Doing reactions in semi-micro scale, testing solubility, pH	X	X	X	X
Slides - To put hairs, crystals, or fibers on for use with a microscope	X			
Cover Slips - To prevent items from coming off slides	X			
Droppers - Add small amounts of liquids to reactions	X	X	X	X
Spatulas or spoons - Getting small amounts of solids out of containers	X	X	X	X
Stirring Rods - Stirring mixtures	X	X	X	X
Thermometer - Determining the temperature of a solution		X	X	X
Metal Tongs, Forceps, or Tweezers - Holding objects, retrieving objects from liquids	X	X	X	X
pH or Litmus paper - Test acidity or alkalinity of solution	. X	X	X	X
Hand Lens - Magnification of small items for identification	X	X		
9V or less Battery Conductivity Tester - Determining ionic strength of solution		X	X	X
Paper Towels - Cleaning	X	X	X	X
Pencil - Writing, Marking Chromatogram	X	X	X	X
Ruler - Measuring lengths	X	X	X	X
Magnets – For extraction and identification of iron filings	X	X	X	X



CHEMISTRY RECOMMENDED LAB EQUIP.

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

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

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



CALCULATOR CLASS DESCRIPTIONS

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

The following document was prepared to offer some guidance to teams as they select calculators for use in different Science Olympiad events. By no means are the calculators listed here inclusive of all possible calculators; instead they are offered as common examples. The decisions of the event supervisors will be final.

Class I - Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators

are the most basic type of calculators and often look like the one shown to the right. These calculators are limited to the four basic mathematics functions and sometimes square roots. These calculators can often be found at dollar stores.



Class II - Stand-alone non-programmable, non-graphing calculators

look like the calculator to the right or simpler. There are hundreds of calculators in this category but some common examples include: CASIO FX-260, Sharp EL-501, and TI-30X.



Class III- Stand-alone, programmable, graphing calculators and stand-alone non-graphing, programmable calculators

often look like the calculator shown on the right. Some examples are: Casio 975 0/9850/9860, HP 40/50/PRIME, and TI 83/84/89/NSPIRE/VOYAGE.

To identify a stand-alone non-graphing, programmable calculators
Are look for the presence of the 'EXE' button, the 'Prog' button, or
a 'file' button. Examples include but are not limited to: Casio Super
FXs, numerous older Casio models, and HP 35S. A calculator
of this type with the buttons labeled is shown to the right.



PROG Button



EXE Button

Class IV - Calculator applications on multipurpose devices (e.g., laptop, phone, tablet, watch)

are not allowed unless expressly permitted in the event rule.





EYE PROTECTION GUIDE

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

This resource was created to help teams comply with the Science Olympiad Policy on Eye Protection adopted on July 29, 2015 and posted on the Science Olympiad Website (soinc.org).

Participant/Coach Responsibilities: Participants are responsible for providing their own protective eyewear. Science Olympiad is unable to determine the degree of hazard presented by equipment, materials and devices brought by the teams. Coaches must ensure the eye protection participants bring is adequate for the hazard. All protective eyewear must bear the manufacturer's mark Z87. At a tournament, teams without adequate eye protection will be given a chance to obtain eye protection if their assigned time permits. If required by the event, participants will not be allowed to compete without adequate eye protection. This is **non-negotiable**.

Corresponding Standards: Protective eyewear used in Science Olympiad must be manufactured to meet the American National Standards Institute (ANSI) standard applicable at its time of manufacture. The current standard is ANSI/ISEA Z87.1-2015. Competitors, coaches and event supervisors are not required to acquire a copy of the standard. The information in this document is sufficient to comply with current standards. Water is not a hazardous liquid and its use does not require protective eyewear unless it is under pressure or substances that create a hazard are added.

Compliant Eyewear Categories: If an event requires eye protection, the rules will identify one of these three categories. Compliance is simple as ABC:

CATEGORY A

- Description: Non-impact protection. They provide basic particle protection only
- Corresponding ANSI designation/required marking: Z87
- Examples: Safety glasses; Safety spectacles with side shields; and Particle protection goggles (these seal tightly to the face completely around the eyes and have direct vents around the sides, consisting of several small holes or a screen that can be seen through in a straight line)

CATEGORY B

- Description: Impact protection. They provide protection from a high inertia particle hazard (high mass or velocity)
- Corresponding ANSI designation/required marking: Z87+
- Example: High impact safety goggles

CATEGORY C

- Description: Indirect vent chemical/splash protection goggles. These seal tightly to the face completely around the eyes and have indirect vents constructed so that liquids do not have a direct path into the eye (or no vents at all). If you are able to see through the vent holes from one side to the other, they are NOT indirect vents
- Corresponding ANSI designation/required marking: Z87 (followed by D3 is the most modern designation but, it is not a requirement)
- Example: Indirect vent chemical/splash protection goggles

Examples of Non-Compliant Eyewear:

- Face shields/visors are secondary protective devices and are not approved in lieu of the primary eye protection devices below regardless of the type of vents they have.
- Prescription Glasses containing safety glass should not be confused with safety spectacles. "Safety glass" indicates the glass is made to minimize shattering when it breaks. Unless these glasses bear the Z87 mark they are not approved for use.

Notes:

1. A goggle that bears the Z87+ mark and is an indirect vent chemical/splash protection goggle will qualify for all three Categories A, B & C
2. VisorGogs do not seal completely to the face, but are acceptable as indirect vent chemical/splash protection goggles