SCIENCE OLYMPIAD™

Exploring the World of Science

Division C Rules Manual

Division C (Gr. 9-12)

WELCOME TO THE 2020 SCIENCE OLYMPIAD!

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

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

Division C (Grades 9-12) Membership Rules

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

Division B (Grades 6-9) Membership Rules

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

Students Below Grade Level Designations

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

Science Olympiad Team Membership

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

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

SCIENCE OLYMPIAD
DIVISION C RULES MANUAL

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

GENERAL RULES

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) 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, rules 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.

ANATOMY & PHYSIOLOGY

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

1. **DESCRIPTION:** Participants will be assessed on their understanding of the anatomy and physiology for the human **Integumentary, Skeletal, and Muscular** systems.

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

2. **EVENT PARAMETERS:**

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

3. **THE COMPETITION:**

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

   a. **INTEGUMENTARY SYSTEM**:
      i. Functions of the Integumentary System
      ii. Anatomy of the layers of the skin, the component parts of the skin and sensory receptors
      iii. Skin Color and Texture, Hair and Nails, Integumentary Glands and the effects of aging on the skin
      iv. The diseases on each level from the cell to the whole person as listed: burns, allergies to allergens (i.e., poison ivy, metals), infections (i.e., boils, carbuncles, athlete's foot, impetigo) and skin cancer
      v. **National Tournament Only:**
         (1) Additional disorders: Psoriasis, human papilloma virus (HPV), other types of dermatitis & scabies
         (2) Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

   b. **SKELETAL SYSTEM:**
      i. Bones of the axial and appendicular skeleton; label the basic surface anatomy of a bone as shown on a diagram and/or normal X-ray, CT and MRI
      ii. Name, structure and function of joint types and muscle and ligament attachments that surround the joints and the ranges of motion allowed by each type (e.g., ball and socket)
      iii. Structures of bones in cross-section
      iv. Cellular composition, structure and function of bones, bone marrow and cartilage
      v. Development and maturation of bones at the cellular and gross anatomical levels
      vi. How to distinguish between types of vertebrae (e.g., cervical, thoracic and lumbar)
      vii. Characteristics and radiological features of bone diseases/disorders from the cell level to the whole person as listed: osteoarthritis, osteoporosis, fractures, disc herniation, scoliosis, anterior cruciate ligament tears, medial collateral ligament damage
      viii. The effects of exercise and aging on the skeletal system and the diseases mentioned
      ix. **National Tournament Only:**
         (1) Additional diseases/disorders: spinal stenosis, achondroplasia, juvenile rheumatoid arthritis, spinal fractures, ankylosing spondylitis, and osteosarcoma
         (2) Treatments and/or prevention for <u>all</u> conditions listed above (drugs, surgery, etc.)
         (3) Label the bones of the skull. Know the foramina of the skull and what passes through each
         (4) Salter-Harris fracture classification system

   c. **MUSCULAR SYSTEM:**
      i. The interaction of the skeletal and muscular systems to allow movement
      ii. Muscle fibers - the cellular and gross anatomy of skeletal muscle, cardiac muscle & smooth muscle
      iii. Physiology of the skeletal muscle contraction system and the neuromuscular junction
      iv. How the skeletal muscles move bone, maintain posture, and produce heat
      v. Skeletal muscle actions – origin, insertion, interactions of different muscles
      vi. Location and identification, including origin, insertion, and function, of the major skeletal muscles of the body listed on the **2020 Science Olympiad Major Skeletal Muscle List**
      vii. Exercise and aging effects on the cellular and gross anatomical structures of the muscular system
      viii. Muscle and tendon injuries and their prevention (i.e., strains and sprains)
      ix. The diseases on each level from the cell to the whole person as listed: Poliomyelitis, Muscular Dystrophies, Myasthenia gravis, tetanus, myositis

x. **National Tournament Only:**
   (1) Kinds of muscle contraction
   (2) Classes of muscle fibers and their functions
   (3) Cardiac and smooth muscle roles in the body
   (4) Role of the nervous system in muscle function
   (5) Muscle sensory systems (e.g., spindles and Golgi tendon organs)
   (6) Additional diseases: Carpal Tunnel Syndrome, Botulism, Fibromyalgia, and Chronic fatigue syndrome
   (7) Treatments and/or prevention for all conditions listed above (drugs, surgery, etc.)

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

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

2020 Science Olympiad Major Skeletal Muscles

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

Move the Upper Extremities
- Pectoralis major
- Latissimus dorsi
- Deltoid
- Teres major
- Biceps brachii
- Triceps brachii
- Brachialis
- Brachioradialis
- Palmaris longus
- Flexor carpi radialis
- Flexor digitorum superficialis
- Extensor carpi radialis
- Extensor digitorum
- Extensor digiti minimi
- Extensor carpi ulnaris

Muscles of the Trunk
- External Intercostals
- Internal Intercostals
- Transverse abdominis
- Infraspinatus
- Rectus abdominis
- Serratus anterior
- Diaphragm

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

ASTRONOMY

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

1. **DESCRIPTION:** Teams will demonstrate an understanding of **Star and Galaxy Formation and Evolution.**
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each team may bring one of the following options containing information in any form and from any source:
      i. two three-ring binders;
      ii. a computer/tablet and a three-ring binder; or,
      iii. two computers/tablets, of any kind.
   b. If three ring binders are used they may be of any size and the information contained should be attached using the available rings. The information or pages may be removed during the event. Sheet protectors and laminated sheets are allowed.
   c. Each team may bring two stand-alone calculators of any type to use during the event. If the participants are using a computer/tablet they may use the calculator app or other program on their device in place of a stand-alone calculator.
   d. **Participants using computers/tablets as a resource should have all information stored so that it is available to them offline**.
   e. **At the Event Supervisor's discretion, teams may access a dedicated NASA image analysis website (e.g., js9.si.edu) to answer JS9 questions. If so, teams with computers/tablets will be allowed to use the Internet. Supervisors will provide an alternative (e.g., proctor-supplied computer or screen shots) for teams that did not bring a computer/tablet.**
3. **THE COMPETITION:**
   Using information which may include Hertzsprung-Russell diagrams, spectra, light curves, motions, cosmological distance equations and relationships, stellar magnitudes and classification, multi-wavelength images (gamma-ray, X-ray, UV, optical, IR, radio), charts, graphs and JS9 imaging analysis software, teams will complete activities and answer questions related to:
   a. Stellar **and galactic** evolution including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, neutron stars, stellar mass and supermassive black holes, Type Ia supernovas, **galactic structure and interactions, quasars, AGNs, galaxy clusters and groups of galaxies,** gravitational waves, **gravitational lensing, dark matter and energy, warm-hot intergalactic medium (WHIM), and the Cosmic Microwave Background (CMB).**
   b. Use Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of galaxies; use the distance modulus, **Type Ia supernovas,** Hubble's law **and redshift** to **answer questions about Hubble's constant and the recessional velocities of and** distances to galaxies.
   c. Identify and answer questions relating to the content areas outlined above for the following objects:
      i. **SN UDS10Wil**
      ii. **NGC 2623**
      iii. **GRB 150101B**
      iv. **JKCS 041**
      v. **MACS J0717.5+3745**
      vi. **MACS J1149.5+2223**
      vii. **Bullet Cluster (1E 0657-56)**
      viii. **H1821+643**
      ix. **GOODS-S 29323**
      x. **H2356-309**
      xi. **The 3 Quasars**
         152156.48+520238.5
         153714.26+271611.6
         222256.11-094636.2
      xii. **PSS 0133+0400**
      xiii. **PSS 0955+5940**
      xiv. **GW151226**
      xv. **M87**
      xvi. **3C 273**
4. **SCORING:** All questions will have been assigned a predetermined number of points. The highest score wins. Selected questions will be used to break ties.

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

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

BOOMILEVER

1. **DESCRIPTION:** Teams will design and build a Boomilever meeting requirements specified in these rules to achieve the highest structural efficiency.

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

2. **EVENT PARAMETERS:**
   a. Each team is allowed to enter only one Boomilever, built prior to the competition.
   b. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without proper eye protection will not be allowed to compete and be placed in Tier **3**.
   c. Participants may NOT bring any equipment such as levels or squares.
   d. The Event Supervisor will provide the Test Apparatus (see Section 5) and tools/materials for measurement.

3. **CONSTRUCTION PARAMETERS:**
   a. The Boomilever must be a single structure with no separate or detachable pieces, constructed of wood, and bonded by adhesive. No other materials are permitted.
      i. Wood is defined as the hard, fibrous substance making up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include: bark, particleboard, wood composites, bamboo or grasses, paper, commercially laminated wood (i.e. plywood), or members formed of sawdust and adhesive. Wood may never be painted, color enhanced, or have tape/preprinted/paper labels affixed. Ink barcodes or markings from the construction process may be left on the wood.
      ii. There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated by the team without restriction.
      iii. Adhesive is a substance used to join two or more materials together and may be used only for this purpose. Any commercially available adhesive may be used (e.g., glue, cement, cyanoacrylate, epoxy, hot melt, polyurethane, and super glues). Adhesive tapes are not allowed.
   b. The Boomilever must be designed to attach to the Testing Wall (5.a.) using the Mounting Hook.
   c. The Boomilever must **be designed to** support the Loading Assembly (5.b.) so that the loading point **(the centerline of the chain)** is between 40 cm and 45 cm from the Testing Wall.
   d. Before and throughout loading, no portion of the Boomilever may touch the Testing Wall **between the Contact Width Lines (5.a.v.) or** below the Contact Depth Line (5.a.iv.).
   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.

4. **THE COMPETITION:**

   Part I: Check-In
   a. The team **must** present their Boomilever for inspection & measurement.
   b. The team **must** place their Boomilever on the scale so the Event Supervisor can determine the mass, in grams to the nearest 0.01 g or best precision available.
   c. The team must submit their Estimated **Load Supported** (4.Part II.h.) to be used as a tiebreaker.
   d. No alterations, substitutions, or repairs may be made to the Boomilever after the check-in process has started.
   e. **Prior to Part II: Testing,** the Event Supervisor will verify that the combined mass of the Loading Assembly and sand is at least 15,100 g, but no more than 15,200 g.

   Part II: Testing
   a. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
   b. Participants will have 6 minutes to setup and test their Boomilever to maximum load or failure.
   c. The participants must place the Boomilever on the Testing Wall and assemble the Loading Assembly as required to load the Boomilever. If necessary, participants may disassemble & reassemble the Loading Assembly **but must not adjust the Mounting Hook**. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Boomilever to deflect.
   d. The participants will be allowed to adjust the Boomilever until they start loading sand. Once loading of sand has begun, the Boomilever must not be further adjusted.
   e. Prior to loading, the Event Supervisor will verify that the Boomilever is placed properly:
      i. Only attached to the Testing Wall by the Mounting Hook.

  - ii. The loading point (3.c.) is between 40 cm and 45 cm from the Testing Wall as measured horizontally to the centerline of the chain (5.a.iv.).
  - iii. No portion of the Boomilever touches the Testing Wall **between the Contact Width Lines (5.a.v.) or** below the Contact Depth Line.

f. Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. The bucket may only be stabilized by using the tips of the provided Bucket Stabilizing Sticks (5.d.).

g. **Loading stops immediately when the Boomilever touches the Testing Wall between the Contact Width Lines (5.a.v.) or below the Contact Depth Line (5.a.iv.), failure occurs, or time expires. Failure is defined as the inability of the Boomilever to carry any additional load, or if any part of the load is supported by anything other than the Boomilever. Incidental contact of the chain/ eyebolt with the Boomilever is not failure.**

h. **Once loading stops, any parts of the Boomilever 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.**

i. **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.

j. The Event Supervisor will review with the team the data recorded on their scoresheet.

k. Teams who wish to file an appeal must leave their Boomilever with the Event Supervisor.

5. **<u>TEST APPARATUS</u>:**

a. The Testing Wall must be as follows:
  - i. Vertical, solid, and rigid surface **at least** 40.0 cm wide x 30.0 cm high. Constructed of ¾" grade plywood or other suitable material, with a smooth, hard, low friction surface that does not bend when loaded.
  - ii. The Mounting Hook must be a 4" steel J-bolt made of ¼" nominal round stock, have a 5/8" nominal inside hook diameter with a threaded ¼" mounting end [e.g., National Hardware barcode stock number N232-892 (UPC 038613228917), ¼" by 4" or exact equivalent shall be used].
  - iii. The Mounting Hook must be attached to the Testing Wall by the Event Supervisor with the "opening" up and installed to allow 2.5 cm +/- 0.1 cm clearance between the wall and the closest edge of the Hook. The Hook must be secured in place with a hex nut and flat washer on the front side and a wing nut and flat washer on the back side of the Testing Wall. The Hook must be approximately 5.0 cm below the top of the Testing Wall and halfway between the sides. The horizontal and vertical centerlines of the hole must be marked on the face of the Testing Wall.
  - iv. A horizontal Contact Depth Line must be clearly visible on the Testing Wall. It must be drawn **20 cm for Division B or 15 cm for Division C** below the center of the hole for the Mounting Hook.
  - v. **Two vertical Contact Width Lines must be clearly visible on the Testing Wall. They will be drawn 4.0 cm to the right and left side of the center of the hole for the Mounting Hook.**

b. The Loading Assembly will consist of:
  - i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt
  - ii. ¼" threaded eyebolt (1" nominal eye outside diameter), **minimum 2 ¼" length to a maximum 4 ½" length**, and a ¼" wing nut
  - 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**

c. **Sand**: sand or other clean, dry free-flowing material.

d. Two (2) Bucket Stabilizing Sticks each made from a piece of ½" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org.

6. **SCORING:**
   a. High score wins. Score = Load Score (g)/Mass of Boomilever (g).
   b. **The Load Score = Load Supported (4.Part II.h) + Bonus**.
   c. **Boomilevers that have a Load Supported of 15,000 g will earn a Bonus of 5,000 g.**
   d. Boomilevers 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 Boomilever mass
   f. Example score calculations:
      i. **Boomilever 1: mass = 10.12 g, Load Supported = 12,134 g; Score = 1,199**
      ii. **Boomilever 2: mass = 12.32 g, Load Supported = 15,000 g + Bonus = 5,000 g = 20,000 g; Score = 1,623**

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

This event is sponsored by ArcelorMittal

CHEMISTRY LAB

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

1. **DESCRIPTION:** Teams will complete one or more tasks and answer a series of questions involving the science processes of chemistry focused in the areas of **Aqueous Solutions** and Acids & Bases.

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

2. **EVENT PARAMETERS:**
   a. Each participant must bring safety equipment (e.g., goggles, lab coat, apron), a writing implement, and may bring a **stand-alone** 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 along with any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
   c. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes. Gloves are optional, 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. Supervisors will provide any required reagents, additional glassware, and/or references that are needed for the tasks (e.g., Periodic Table, table of standard reduction potentials, any constants needed).

3. **THE COMPETITION:**
   a. The competition will consist of a series of tasks similar to those in first year high school courses. These tasks could include hands-on activities, questions on listed topics, interpretation of data (e.g., graphs, diagrams, tables), or observation of an established and running experiment.
   b. Teams may be asked to collect data using a probeware set-up demonstrated by the Supervisor(s). Following a demonstration of the sensors/probes, participants may be given data sets to interpret.
   c. Nomenclature, formula writing, & stoichiometry (mole conversions & percentage yield) are essential tools of chemistry & may be included in the event. Participants are expected to know the symbols & charges for: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate, & hydroxide. Participants should know how to use the "ite" form of anion (one less oxygen than the "ate" form). With a periodic table, participants should be able to obtain charges for monatomic ions (e.g., Na^+, S^{2-}).
   d. Participants should understand the following Acid-Base Chemistry concepts:
      i. Properties & Uses of Common Acids and Bases
         (1) Acids - (HCl, HNO_3, H_2SO_4, H_3PO_4, H_2CO_3, acetic, and ascorbic acid)
         (2) Bases - ($NaOH$, KOH, $Ca(OH)_2$, $Mg(OH)_2$, and $NH_3(aq)$)
         (3) Acid/Base indicators and how they are used; pH ranges and color changes will be provided. Questions will not address theories of how indicators work.
      ii. Acid & Base reactions will be limited to metals, carbonates, bicarbonates, sulfites, bisulfites, oxides, & neutralizations
      iii. Titrations to determine percent composition, molarity, and/or molecular mass
      iv. Additional calculations will be limited to K_a, K_b, pH, pOH, and dilution
      v. **State and Nationals Only**: calculations or questions about buffers
   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 a pH indicator and the results of a test determine the pH of a solution.
   c. Identify the pH indicator that should be used to monitor the pH change in a given experiment.
   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 Acids & Bases.
   b. Time may be limited at each task but will not be used as a tiebreaker or for scoring.
   c. Ties will be broken by pre-selected questions.
   d. A penalty of up to 10% may be given if the area is not cleaned up as instructed.
   e. A penalty of up to 10% may be given if a team brings prohibited lab equipment to the event.

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

CIRCUIT LAB

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

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

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

3. **THE COMPETITION:**

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

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

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

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

This event is sponsored by Institute of Electrical and Electronics Engineers (IEEE)

CODEBUSTERS

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

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

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

2. **EVENT PARAMETERS:**
   a. Teams must bring writing utensils and may bring up to three (3) stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators.
   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. 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 Caesar Cipher, also called a shift cipher.
      ii. 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
         (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
      iii. **the Affine Cipher - encrypting plaintext or decrypting ciphertext given the a and b values**
      iv. the Vigenère Cipher- **Encrypting plaintext or** decrypting ciphertext given a key
      v. the Baconian Cipher - **decrypting ciphertext encoded with the a and b values represented as one or more letters, glyphs, symbols, or character rendering variations (e.g., bold, underline, italic).**
      vi. Xenocrypt - no more than one cryptogram can be in Spanish
      vii. the Hill Cipher - **Encrypting plaintext or decrypting ciphertext** given a 2x2 **decryption** matrix.
      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.**
   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. the RSA Cipher
      v. the Hill Cipher - **Encripting plaintext or decrypting ciphertext** with a 2x2 **encryption matrix** or 3x3 decryption matrix provided
      vi. Cryptanalysis of the Affine Cipher **with a "crib" of at least 2 plaintext characters**
      vii. **Cryptanalysis of The Pollux and Morbit Ciphers with a "crib" of at least 4 plaintext characters**
   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 3.e.ii.(1) or 3.e.ii.(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 precision of the device used, to solve the cryptogram will be recorded by the Event Supervisor or designee.

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

4. **SCORING:**

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

b. Based on the 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 in the decoded plaintext

(1) Two or fewer errors will **be scored as correct and** 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 **earns** 100 points whereas the same 400-point question with 7 errors would **earn** 0 points, not -100 points.

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

c. A Timing Bonus can be earned based on the number of seconds it takes a team to correctly decode the first question. The timing bonus is equal to 4 x (600 - number of seconds). For example, 6 minutes = 4 x (600-360) = 960 points.

d. 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

e. 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.

DESIGNER GENES

SCIENCE OLYMPIAD

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

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

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

2. **EVENT PARAMETERS:**

   Each team may bring one 8.5" x 11" sheet of paper, **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. This event may be run as stations and can include observations, inferences, predictions, data analysis, and calculations. Questions and tasks should be distributed equally so that there is not an over-emphasis on a particular area.
   b. This event will test participants' knowledge of molecular genetics in both bacteria and eukaryotes including the basic principles of genetics as well as the following topics.

Regional and State Tournament Topics		
Mono-, Di-, and Trihybrid crosses	Pedigree construction and analysis	Phylogenetics
Dominant & Recessive Alleles Genotype vs. phenotype	Multiple alleles & Sex-linked traits	DNA fingerprinting and RFLP analysis
Human sex determination	Co-dominance & incomplete dominance	PCR
Gene to protein relationship	Mechanism of gene expression, including roles of enzymes	DNA microarrays
Mitosis, Meiosis and gamete formation	Multifactorial traits and Epistasis	Gene therapy, CRISPR-Cas technology
Human karyotypes analysis	Molecular consequences of mutations	Sanger sequencing
Prokaryotic and eukaryotic promoter structure	DNA structure & mechanism of replication	Plasmid cloning, selection, and isolation
Components of a gene	Transcription & Translation	Organelle DNA
National Tournament Topics (Regional & State topics + the following)		
Epigenetics	DNA repair	RNA-Seq, Tn-Seq, and their uses
Random vs. targeted mutagenesis	Post-transcriptional RNA processing and regulation	Comparison of Next Generation Sequencing Platforms

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

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

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

This event is sponsored by Corteva Agriscience

DETECTOR BUILDING

1. **DESCRIPTION:** Teams will build a durable temperature-sensing Device that will accurately measure, and display temperatures between 0°C to 75°C to determine the temperature of four different water samples.

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

   IMPOUND: No **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one participant-constructed, temperature-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. At Regional tournaments, teams must bring their own digital Calibration Thermometer, accurate to the 0.1 degree Celsius, to calibrate their equipment and use as a reference during the event.
   c. Event Supervisors will provide warm water and ice water for calibration, water samples, and containers (e.g., paper cups, Styrofoam cups, bowls). At the State and National Competition, the Event Supervisors will provide each team with a digital Calibration Thermometer to reference and calibrate their sensor against.
   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), 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 constructed from one of the following two fundamental electronic components -- NTC/PTC thermistor or a legal analog output temperature device. Examples of legal and illegal sensors can be found on the event page at www.soinc.org. The sensor must not be constructed using preassembled sensors/probes that are already in a waterproof housing. (e.g., Vernier, PASCO, pre-assembled circuit boards or kits). The sensor and wires/cables, together, must be a minimum of 30.0 cm in length, small enough to be fit through an opening of 5.0 cm, and the end must be immersible up to 15.0 cm in water.
   c. 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.
   d. 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.
   e. 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).
   f. 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.
   b. This Design Log should contain:
      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 and the Sensor waterproofed.
      ii. A data table with at least 10 trials showing the sensor voltage reading versus the corresponding temperature values in °C.
      iii. Scatter-plot graph of this data with temperature on the Y-axis and voltage on the X-axis.
      iv. Function graph of mathematical model supported by the data overlaid on scatter-plot of the data.
      v. Equation of the above mathematical model used to convert measured voltage to the corresponding temperatures in °C highlighted for easy identification.
      vi. Printout of program with code highlighted showing this exact mathematical equation converting voltage to temperature °C.

vii. Program with the code highlighted that will illuminate the appropriate LED(s) according to their assigned temperature 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. At the Regional Tournament, the teams will provide their own Calibration Thermometer for calibration and testing. For State/National Tournaments the Event Supervisors will provide each team with their own Calibration Thermometer (a standard digital thermometer), which will stay with the team throughout calibration and testing. Different teams may have different Calibration Thermometers.
c. Teams may modify their code (e.g., alter the LED code to match the posted temperature zones) during the setup time.
d. At the Regional Tournament, teams will have 10 minutes to setup their device and modify their code. For State/National Tournaments, once teams receive their Calibration Thermometer, they will have a total of 20 minutes to setup, modify their code, and calibrate their Device against their Calibration Thermometer. Teams will be allowed to use their Design Log to aid with calibration. Warm water (< 75°C), ice water, and containers to hold and/or mix the water will be available for teams to use.
e. After the setup/calibration time, the teams will rotate through the four different stations where they will use their Device to measure the water temperature. Each team will be allowed a maximum of 2 minutes for each of the 4 temperature determinations. The Event Supervisor will record the voltage and temperature displayed by the Device to the nearest 0.1°C, the LED color displayed by the Device, and the temperature displayed by the Calibration Thermometer to the nearest 0.1°C.
f. Event Supervisors should do their best to keep the water sample temperatures the same for all teams, but fluctuations are acceptable as each team will be scored relative to their Calibration Thermometer.
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. Relationships between resistance, voltage, and temperature (~25%)
   ii. Theory of LEDs, working principles, and applications (~25%)
   iii. The process of calibration - working with raw data and determining real world relationships (~25%)
   iv. Operational knowledge of basic Device components (~25%)
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.
b. A Total Score for each team will be determined as follows:
   i. Total Temperature Accuracy Score (Maximum 60 points).
      Accuracy Score = 60 pts - (total absolute error of the 4 temperature measurements x multiplier)
      (1) Maximum absolute error x multiplier per station is 15.0
      (2) Regional Multiplier = 2
      (3) State Multiplier = 3
      (4) National Multiplier = 4
   ii. Correct LED colors (Maximum 20 points) 5 points are awarded for the correct LED colors (as determined by the temperature 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 absolute temperature errors; b) highest written test score.
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.

This event is sponsored by Texas Instruments

DISEASE DETECTIVES

SCIENCE OLYMPIAD

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

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

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

2. **EVENT PARAMETERS:**
   Each team may bring one 8.5" x 11" sheet of paper, **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:**
   This event has been reorganized into three parts with each part counting approximately equally towards a team's final score.

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

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

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

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

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

This event is sponsored by Centers for Disease Control (CDC)

DYNAMIC PLANET

1. **DESCRIPTION**: Teams will complete tasks related to physical and geological oceanography.
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS**:
   a. Each team may bring **one 2” or smaller** three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs, and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder throughout the event.
   b. Each team may bring two stand-alone calculators of **any type**.
3. **THE COMPETITION**:
   a. Participants will be presented with **questions which may include one or more tasks at a workstation or a timed station-to-station format**.
   b. 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:
      i. Seawater: composition, density, variations in salinity, and sources of salts
      ii. Shortwave and longwave radiation, sensible and latent heat fluxes, geothermal heat, and heat transport
      iii. Water temperature, pressure, and the three-layer structure of ocean water
      iv. Topographic features found at continental margins, estuaries, ocean basins, and mid-ocean ridges
      v. Processes and features of tectonic plate motion in ocean basins and patterns of age of the ocean floor
      vi. Distribution of chemicals (e.g., nutrients, oxygen, metals) in the ocean, as well as vertical and horizontal structure
      vii. Formation of fringing reefs, barrier reefs, and atolls
      viii. Waves: Motion, height, wavelength, period, fetch, swell, surf, and tsunamis
      ix. Surface currents: Warm and cold currents, Coriolis effect, and gyres
      x. **Division C Only:** Ekman and geostrophic balances
      xi. Coastal currents: longshore currents, rip currents, and upwelling
      xii. Deep ocean circulation, ocean overturning, and water masses
      xiii. High and low tides, spring and neap tides, tidal currents, and tidal resonance
      xiv. Coastal features and processes, uplift and subsidence, and influence on sea level rise
      xv. Oceanic tools used for research (e.g., collection of water samples, sediments, cores, and tracking water movement)
      xvi. Relationships between fisheries and ocean circulation (e.g., upwelling, El Niño, Pacific Decadal Oscillation)
4. **REPRESENTATIVE ACTIVITIES**:
   a. Given the water temperatures at various depths in a column of seawater, teams will construct graphs to identify and label the thermocline.
   b. Use a downloaded dataset of oxygen to identify water masses and pathways of circulation.
   c. Identify topographic features of ocean regions using seafloor maps.
   d. Write a hypothesis to explain changes in water salinity in high latitude ocean regions.
   e. Analyze and interpret water pH data from selected regions where barrier reef formation is changing.
   f. Given a set of vertical profiles of salinity in an estuary, identify the type of estuary (e.g., fjord, salt wedge, well-mixed, partially-mixed) and discuss implications for bottom water hypoxia.
   g. Relate trends in coastal flooding at specific locations to global sea level rise and local subsidence.
5. **SCORING**: Points will be awarded for the quality and accuracy of responses. High score wins. Ties will be broken by the accuracy and/or quality of 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.

This event is sponsored by National Oceanic and Atmospheric Administration (NOAA)

EXPERIMENTAL DESIGN

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

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

4. **SCORING:**
   a. High score wins. Scoring will be done using the Experimental Design Checklist found on the Science Olympiad website (soinc.org).
   b. Points will be awarded depending upon the completeness of the response. Zero points will be given for no responses as well as illegible or inappropriate responses.
   c. Ties will be broken by comparing the point totals in the scoring areas **of the checklist** in the following order:
      i. **L. Analysis of Claim/Evidence/Reasoning**
      ii. **F. Procedure and Set-Up Diagrams**
      iii. **C. Variables**
      iv. **H. Data Table**
      v. **I. Graph**
   d. Any participant not following proper safety procedures will be asked to leave the room and will be disqualified from the event.
   e. Any team not following clean-up procedures will have their final score multiplied by 0.95.
   f. Any team not addressing the assigned question/topic area will have their final score multiplied by 0.75.
   g. **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.

2020 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)**

② ① ⓪ **Statement addresses the experiment including variables (Not a yes/no question)**

B. Hypothesis (6 pts)

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

C. Variables (20 pts)

a. Independent (IV) & Dependent (DV) Variable (12 pts)
④ ③ ② ① ⓪ **IV Correctly identified and defined**
④ ③ ② ① ⓪ Levels of IV given
④ ③ ② ① ⓪ **DV Correctly identified and defined**

b. **Controlled Variables (CV) & Constants (8 pts)**
② ① ⓪ **First** CV correctly identified
② ① ⓪ **Second** CV correctly identified
② ① ⓪ **First Constant correctly identified**
② ① ⓪ **Second Constant correctly identified**

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

② ① ⓪ SOC logically identified for the experiment
② ① ⓪ Reason given for selection of SOC

E. Materials (4 pts)

② ① ⓪ **All materials are listed and quantified**
② ① ⓪ No extra materials are **listed**

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

② ① ⓪ Procedure **is presented in list form**
② ① ⓪ Procedure is in a logical sequence
② ① ⓪ Steps for repeated trials are included
② ① ⓪ **Multiple diagrams** of setup are provided
② ① ⓪ **All diagrams are appropriately labeled**
④ ③ ② ① ⓪ Procedure detailed enough to repeat experiment accurately

G. Qualitative Observations (**6 pts**)

② ① ⓪ Observations about procedure provided
② ① ⓪ Observations about the results provided
② ① ⓪ Observations given throughout the course of the experiment

H. Quantitative Data - Data Table (1**0 pts**)

② ① ⓪ All raw data is **provided**
② ① ⓪ **Condensed data table with only the data to be graphed is provided**
② ① ⓪ Tables **and columns** labeled properly
② ① ⓪ All data has units
② ① ⓪ **Example calculations for derived variables are given**

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

I. Graph (1**2 pts**)

④ ③ ② ① ⓪ Appropriate **Graph is provided**
④ ③ ② ① ⓪ Graph properly titled and labeled
④ ③ ② ① ⓪ Appropriate scale and units included

J. Statistics (**14 pts**)

④ ③ ② ① ⓪ Statistics of Central Tendency used (i.e., best fit, median, mode, mean)
④ ③ ② ① ⓪ **One example calculation is given for each statistic with units**
④ ③ ② ① ⓪ **Statistics of variation are included (i.e., minimum, maximum, range, standard deviation)**
② ① ⓪ Calculations are accurate

K. **Significant Figures** (**12 pts**)

④ ③ ② ① ⓪ **Data is reported using correct significant figures**
④ ③ ② ① ⓪ **Graph completed using correct significant figures**
④ ③ ② ① ⓪ **Statistics are reported using correct significant figures**

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

② ① ⓪ **Statistics Claim completed logically**
② ① ⓪ **Statistics Evidence completed logically**
② ① ⓪ **Statistics Reasoning completed logically**
② ① ⓪ **Outliers Claim completed logically**
② ① ⓪ **Outliers Evidence completed logically**
② ① ⓪ **Outliers Reasoning completed logically**
② ① ⓪ **Data Trend Claim completed logically**
② ① ⓪ **Data Trend Evidence completed logically**
② ① ⓪ **Data Trend Reasoning completed logically**

M. Possible Experimental Errors (8 pts)

④ ③ ② ① ⓪ **One specific error is identified and effect on results discussed.**
④ ③ ② ① ⓪ **Second specific error is identified and effect on results discussed.**

N. Conclusion (8 pts)

② ① ⓪ Hypothesis is re-stated
② ① ⓪ **Hypothesis Claim completed logically**
② ① ⓪ **Hypothesis Evidence completed logically**
② ① ⓪ **Hypothesis Reasoning completed logically**

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

② ① ⓪ Suggestions to improve the experiment given
② ① ⓪ Suggestions for practical applications of experiment are given
② ① ⓪ Suggestions for future experiments are given

*****Continued on back *****

EXPERIMENTAL DESIGN CHECKLIST (CONT.)

P. **Abstract** (16 **pts**)

- ④ ③ ② ① ⓪ **Brief and well-organized**
- ④ ③ ② ① ⓪ **Contains the Statement of the Problem and Hypothesis**
- ④ ③ ② ① ⓪ **Describes the research procedure**
- ④ ③ ② ① ⓪ **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)

FORENSICS

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

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

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

2. **EVENT PARAMETERS**:
   a. Each team may bring any or all of the items listed as Recommended Lab Equipment for Division C Chemistry Events, posted on soinc.org, to use during this event and two stand-alone calculators **of any type**. Teams not bringing these items will be at a disadvantage. The Supervisor will not provide them.
   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, that may contain information on both sides in any form and from any source without any annotations or labels affixed.
   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 hair - participants will need to know hair structure

including medulla, cortex, cuticle, and root.

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

f. **Crime Scene Physical Evidence:**

   i. **Fingerprint Analysis:** Participants will be expected to know the 8 specific fingerprint patterns (plain arch, tented arch, radial loop, ulnar loop, plain whorl, central pocket whorl, accidental whorl, and double loop whorl). Participants should also be familiar with the common fingerprint development techniques of dusting, iodine fuming, ninhydrin, and cyanoacrylate fuming. Participants should understand terminology such as bifurcation, ridges, island, enclosure, loop, whorl, and arch. Participants should be able to answer questions about skin layers and how fingerprints are formed. 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://nobelprize.org/educational_games/chemistry/pcr/index.html

   iii. **Glass analysis:** Participants may be asked to use index of refraction to determine the type of a glass found broken at a crime scene. They may be asked to analyze which hole or fractures occurred before others based on a piece of glass available for examination or a picture of a piece of glass.

   iv. **Entomology:** Participants may be asked to identify how long an animal has been dead based on the type of insects found on the body at the scene.

   v. **Spatters:** Participants may be asked to analyze actual spatters or photographs of spatters to determine the angle and velocity with which the liquid approached the solid object bearing the spatter & the spatter origin direction.

   vi. **Seeds and Pollen:** Participants may be asked to compare pictures of seeds/pollen found at the scene with either seeds/pollen found on the suspects or seeds/pollen from different country regions.

   vii. **Tracks and Soil:** Participants may be asked to match tire tracks or footprints found at the scene to tires or shoes of the suspects. Participants may be given the composition of soil found at the scene or on the suspects and asked to determine if this implicates any of the suspects.

   viii. **Blood:** Participants may be asked to identify the ABO blood type using artificial blood (Event Supervisor required to provide instructions on how the typing system works) or participants may be asked to identify if a blood sample, either prepared microscope slide or pictures of microscope slide, is human, avian, mammalian, or reptilian/amphibian.

   ix. **Bullet striations:** Participants may be asked to match the striations on bullets or casings found at the crime scene and fired from a given gun.

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

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

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

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

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

FOSSILS

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

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

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one magnifying glass, the *Science Olympiad Official Fossil List* and **one 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. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder.

3. **THE COMPETITION:**
   a. Participants will move from station to station, with the length of time at each station predetermined and announced by the Event Supervisor.
   b. Participants may not return to stations but may continue to work on their responses throughout.
   c. **Stations will feature task-oriented activities emphasizing application of paleontological concepts.**
   d. Identification will be limited to specimens on the *Science Olympiad Official Fossil List*, but other samples may be used to illustrate key concepts.
   e. Questions will be chosen from the following topics:
      i. Identification of all fossil specimens on the *Science Olympiad Official Fossil List*
      ii. Taxonomic classification restricted to the hierarchy on the *Science Olympiad Official Fossil List*
      iii. Conditions required for a plant or an animal to become fossilized
      iv. Common modes of preservation: petrification/petrifaction (e.g., permineralization & mineral replacement including silicification and pyritization), cast, **external vs. internal molds (steinkerns),** imprints, carbonization, unaltered remains
      v. Uncommon modes of preservation: encasement in amber, mummification, freezing, tar
      vi. Relative dating: law of superposition, original horizontality, cross-cutting relationships, unconformities
      vii. Absolute dating: radiometric dating (i.e., **Carbon 14 dating)**, including half-life, **radioactive isotopes used**, and **use of igneous rocks and** volcanic ash layers **in absolute dating**
      viii. The Geologic Time Scale, its organization, major events, the 5 major mass extinctions, and the Pleistocene-Holocene extinction of megafauna. An official *Science Olympiad Geologic Time Scale* is posted at soinc.org & should be used for all competitions
      ix. Index Fossils: characteristics and use in determining the age of rocks & geologic formations
      x. Fossil-bearing sedimentary rocks: limestone, shale, sandstone, coquina, **chert**
      xi. Modes of life: filter feeder, predator, scavenger, deposit feeder, benthic, pelagic
      xii. Environments: shallow marine, **reef, lagoon**, deep marine, terrestrial, fresh water
      xiii. Mineral and organic components of exoskeletons, shells, and bones/teeth (e.g., calcite, aragonite, silica, chitin, biological apatite)
      xiv. Adaptations and morphologic features of major fossil groups
      xv. Important paleontological discoveries (i.e., non-avian dinosaurs with feathers; transitional species such as *Tiktaalik* and *Archaeopteryx*)
      xvi. *Lagerstätten* (conservation and concentration) and their significance, limited to: Burgess Shale, Beecher's Trilobite Bed, Mazon Creek, Ghost Ranch, Solnhofen Limestone, Yixian Formation (Liaoning), Green River Formation, and La Brea Tar Pits
      xvii. Fossils as evidence for evolutionary trends and patterns such as morphological adaptations within groups, major evolutionary events **and transitions** (e.g., Cambrian Explosion, **Mesozoic Marine Revolution**, fish to tetrapods, dinosaurs to birds, whales, horses)
      xviii. **Trace fossils (ichnofossils) including, but not limited to trails, trackways, borings, burrows, tubes, predation marks, repair scars, and coprolites**
      xix. **Stromatolites, how they form, and their role in the history of life and development of Earth's atmosphere**

4. **SAMPLE QUESTIONS/TASKS:**
   a. Identify each fossil, record its mode of preservation, the type of rock the sample is embedded in, and the geologic period it represents.
   b. List samples in order from oldest to most recent.
   c. Based on the fossil and rock associations, determine the environment in which the organism lived.
   d. **The fossils illustrated were discovered in the Solnhofen Limestone, a unique Lagerstätten in Germany. What geological period is indicated based on the specimens in this limestone?**
   e. **How can the occurrence of both marine and terrestrial animals in the Solnhofen Limestone be explained?**
   f. **Describe the evolutionary relationships between the organisms illustrated on the family tree (cladogram/phylogenetic tree).**
   g. Construct a range chart and determine the age of the fossil assemblage.
5. **SCORING:**
   a. High score wins. Points will be awarded for the quality and accuracy of responses.
   b. Ties will be broken by the accuracy and/or quality of responses to several pre-identified questions.

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

FOSSIL LIST

SCIENCE OLYMPIAD

KINGDOM PROTOZOA

Phylum Foraminifera (Forams) *
- Order Fusulinida (Fusulinids)*
- **Order Rotaliida***
  - Genus *Nummulites**

KINGDOM ANIMALIA

SPONGES (Phylum Porifera)
- Genus *Astraeospongia* (calcareous sponge)
- Genus *Hydnoceras* (glass sponge)*

BRYOZOANS (Phylum Bryozoa)

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

GRAPTOLITES (Phylum Hemichordata)*
- **Order Dendroidea (benthic graptolites)**
- **Order Graptoloidea (planktic graptolites)**

CORALS (Phylum Cnidaria)
- **Order Tabulata (tabulate corals)**
  - Genus *Favosites*
  - Genus *Halysites**
- **Order Rugosa (rugose corals)**
  - Genus *Heliophyllum* (horn coral)
  - Genus *Hexagonaria*
- **Order Scleratinia (stony corals)**
  - Genus *Septastrea*

ARTHROPODS (Phylum Arthropoda)
- Subphylum Crustacea (shrimp, lobster, crabs, barnacles, ostracods)*
- **Subphylum Chelicerata**
  - Order Eurypterida (Eurypterids)
- Class Insecta (Insects)
- Class Trilobita (Trilobites)
  - Genus *Cryptolithus*
  - Genus *Calymene*
  - Genus *Elrathia*
  - Genus *Isotelus**
  - Genus *Eldredgeops* (formerly *Phacops*)

BRACHIOPODS (Phylum Brachiopoda)
- Class Inarticulata
  - Genus *Lingula*
- Class Articulata
  - Genus *Atrypa*
  - Genus *Composita*
  - Genus *Juresania**
  - Genus *Leptaena*
  - Genus *Mucrospirifer*
  - Genus *Platystrophia*
  - Genus *Rafinesquina*
  - Order Rhynchonellida

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

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

VERTEBRATES (Phylum Chordata)
- **Superclass Agnatha (Jawless Fish) (Ostracoderms)***
- Class Placodermi (Armored Jawed Fish)
  - Genus *Bothriolepis*
  - Genus *Dunkleosteus*
- Class Chondrichthyes (Cartilaginous Fish)
  - Superorder Selachimorpha (Sharks)
    - Genus ***Otodus***
    - Genus *Carcharocles* (formerly *Carcharodon)*
      - Species *C. megalodon*
  - Superorder Batoidea (Rays)*
- Superclass Osteichthyes (Bony Fish)
  - Class Actinopterygii (ray-finned)
    - **Genus *Knightia***
    - **Genus *Xiphactinus****
  - Class Sarcopterygii (lobe-finned)
    - **Genus *Eusthenopteron***
    - **Genus *Latimeria* (Coelacanth)**
    - Genus *Tiktaalik*

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

FOSSIL LIST (CONT.)

Class Amphibia (**Amphibians**)
- Genus *Acanthostega*
- Genus *Eryops*
- Genus *Diplocaulus*

Class Reptilia (**Reptiles**)
- **Order Crocodilia (crocodiles)***
- **Order Testudines (turtles)***
- Order Ichthyosauria (Ichthyosaurs)
- **Order Squamata**
  - Family Mosasauridae (Mosasaurs)
- Order Plesiosauria (Plesiosaurs & Pliosaurs)
- Order Pterosauria (Pterosaurs)

Clade Dinosauria (Dinosaurs)
- Order Saurischia (lizard-hipped)
  - **Suborder Theropoda**
    - Genus *Allosaurus*
    - Genus *Coelophysis*
    - Genus *Dilophosaurus*
    - **Genus *Spinosaurus****
    - Genus *Tyrannosaurus*
    - Genus *Velociraptor*
  - **Suborder Sauropodomorpha**
    - **Genus *Brachiosaurus***
    - Genus *Diplodocus*
    - **Genus *Patagotitan****
    - Genus *Plateosaurus*
- Order Ornithischia (bird-hipped)
  - **Infraorder Ankylosauria**
    - Genus *Ankylosaurus*
  - **Infraorder Ceratopsia**
    - Genus *Triceratops*
    - **Genus *Protoceratops****
  - **Infraorder Ornithopoda**
    - Genus *Iguanodon*
    - Genus *Parasaurolophus*
    - **Genus *Maiasaura***
  - **Infraorder Pachycephalosauria**
    - Genus *Dracorex*
  - **Infraorder Stegosauria**
    - Genus *Stegosaurus*

Class Aves (Birds)
- Genus *Archaeopteryx*
- Genus *Titanis* (Terror Bird)
- **Genus *Ichthyornis****

Clade Synapsida
- Mammal-like Reptiles
  - Genus *Dimetrodon* (pelycosaurs)
  - Genus *Lystrosaurus* (therapsids)

Class Mammalia (Mammals)
- Genus *Basilosaurus* (prehistoric whale)
- Genus *Equus* (modern horse)
- **Genus *Australopithecus* (hominin)***
- Genus *Homo* **(hominin)**
  - Species *H. neanderthalensis*
  - **Species *H. erectus****
  - **Species *H. sapien***
- Genus *Mammut* (Mastodon)
- Genus *Mammuthus* (Mammoth)
  - **Species *M. primigenius* (Wooly Mammoth)**
- Genus *Megacerops* **(**Brontothere)
- Genus *Mesohippus* (three-toed horse)
- Genus *Smilodon* (saber-toothed cat)

KINGDOM PLANTAE

FLOWERING PLANTS (Phylum Anthophyta)
- Genus *Acer* (Maple)
- Genus *Populus* (Aspen & Poplar)
- Genus *Platanus* (Sycamore)

GINKGOS (Phylum Ginkgophyta)
- Genus *Ginkgo*

CLUB MOSSES (Phylum Lycopodiophyta)
- Genus *Lepidodendron* (scale tree)

CONIFERS (Phylum Pinophyta)
- Genus *Metasequoia*

HORSETAILS (Phylum Sphenophyta)
- Genus *Calamites* **(form leaf genus**: *Annularia)*

SEED FERNS (Phylum Pteridospermatophyta
- Genus *Glossopteris*

TRUE FERNS (Phylum Pteridophyta)
- **Genus *Psaronius* (form leaf genus:** *Pecopteris)*

ADDITIONAL EARTH MATERIALS

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

Stromatolites

Amber/copal

Petrified wood

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

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

GEOLOGIC MAPPING

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

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

2. **EVENT PARAMETERS:**
   a. Each team may bring **one 2" or smaller** three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder throughout the event.
   b. Each **participant may** bring **one** protractor, **one** ruler, **one set of** colored pencils, and a stand-alone non-programmable, non-graphing calculator.
   c. **State and National participants may also have one geologic compass per team.**

3. **THE COMPETITION:**
   The event may be composed of a test, stations, or a combination of both that will require the use of knowledge and relevant skills including observing, classifying, measuring, inferring, predicting and using relationships from the following topics:
   a. Topographic and geologic maps
   b. Plate tectonics, rock formation, Earth's structure, Earth's history, lithologies, and geological principles;
   c. Major structural elements, fold geometries, fault types, erosional patterns, intrusion types, subsurface geometries, and depositional and deformation sequences
   d. Cross-sections topographic profiles, projections of mapped features, **and drill cores (physical or representations of)**
   e. Bed thicknesses, orientations of planes from points, and map projection types
   f. **Key features used for differentiating between and within types of continental, marine, and transitional depositional environments (alluvial, tidal, deep marine, etc.)**
   g. **Changes in depositional environments over time and space (transgressions, regressions, uplift, etc.)**

4. **SAMPLE QUESTIONS/TASKS:**
   a. Use a topographic map to construct a topographic profile.
   b. Use stratigraphic column, geologic map, topographic profile, strike and dip, and bed thickness measurement to construct a cross-section of sub-surface structures.
   c. Determine the order of events based on geological principles.
   d. **Interpret the changes over time of paleodepositional environments for a particular location based on lithologies, fossil assemblage, and sedimentary structures in the underlying bedrock.**
   e. **Reconstruct the depositional systems across a geographic region, based on lithologies, fossil assemblage, and sedimentary structures in a mapped area.**

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

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

GRAVITY VEHICLE

SCIENCE OLYMPIAD

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 quickly and accurately as possible.

   A TEAM OF UP TO: 2 **IMPOUND:** Yes

   EYE PROTECTION: None **APPROXIMATE TIME:** 8 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.
   b. Teams may bring data and a stand-alone calculator of any type along with non-electric 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. An approximately ¼" round wooden dowel must be attached to the front of the Vehicle. When the Vehicle is placed flat on the floor, the dowel must be approximately perpendicular to the floor, extend to within 1.0 cm of the floor, and extend at least 20.0 cm above the floor. The dowel must be easily accessible by the Event Supervisor - no part of the Vehicle, except the wheels, may extend more than 0.5 cm beyond the front of the dowel. The dowel's front bottom edge will be the Vehicle's Measurement Point for distance measurements.
   f. The Vehicle and the Ramp, together, in the ready-to-run configuration, must fit within a rectangular box with a 50.0 cm x 50.0 cm base and a height of 100.0 cm.
   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 during the run constitutes a construction violation.

4. **PRACTICE LOG:**
   a. The Practice Log must include 4 or more parameters (3 required and at least 1 additional) for 10 or more practice runs. The required parameters are: Target Distance, Vehicle Distance from Target, and Run Time. Each team must choose an additional 4th parameter beyond those required (e.g.; # of axle turns for braking, alignment angle) to test.
   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 8 minutes of Event Time to set up and start up to 2 runs. Vehicles in the ready-to-run configuration before the end of the Event Time will be allowed to complete a run.
   c. Electric 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.

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-electric measuring devices to verify the Track dimensions during their Event Time.

f. Only non-electric sighting/aiming devices are permitted. If placed on the Track, they must be removed before each run. If placed on the Vehicle 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. They may not touch/push the Vehicle, or the Ramp, to start it or hold it while actuating the release mechanism. 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. A Failed Run occurs for any run that does not occur in the 8 minutes, or if the time and/or distance cannot be measured for a Vehicle (e.g.; it starts before the Event Supervisor is ready, if it moves but does not cross the 0.5 m Line, or the participants pick it up before it is measured).

k. If the Vehicle does not move upon actuation of the release mechanism, it does not count as a run and the team may set up for another run but will not receive extra Event Time.

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 9.00 m and 12.00 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. Two timing lines are marked with pieces of tape approximately 2.5 cm wide and at least 1.50 m long, at distances of 0.50 m and 8.50 m from the Start Point, centered on and perpendicular to the imaginary center line. The edges of the tape closest to the Start Point defines these lines.

e. A photogate timing system is highly recommended. See www.soinc.org for information. If used, the system will be installed at the 0.50 m Line and the 8.50 m Line with the beams at a height of 17.0 ± 2.0 cm. At least one manual timer should be used as a backup.

f. If no photogate system is available, 3 timers should be used along with a laser system (if available), with the middle time recorded as the official Run Time in seconds to the precision of the timing devices.

g. At the Event Supervisor's discretion, more than one Track may be used. If so, the team may choose which Track they use, but must use the same Track for both runs.

7. **SCORING**:

a. The team with the lowest Final Score in the lowest number Tier wins. Each team's Final Score is their lower Run Score with the lower number Tier.

b. The Run Score for each run = 2 pts./cm x Vehicle Distance + 1 pt./sec x Run Time + Penalties.

c. 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.

d. The Run Time is the time it takes for the Vehicle to travel between the 0.50 m and 8.50 m Lines; it starts when the Vehicle's dowel reaches the 0.50 m Line and ends when it passes the 8.50 m Line. The Run Time is recorded in seconds to the precision of the timing device used. If the Vehicle passes the 0.50 m Line but stops before the 8.50 m Line, the Run Time will be recorded as 60.00 sec.

e. Teams with incomplete Practice Logs will incur a Penalty of 250 points. Teams without impounded Practice Logs will incur a Penalty of 500 points. Practice Log Penalties do not affect Tier placement.

f. Tiers: The highest number Tier will be applied when more than one is applicable:
   i. Tier 1: Runs with no violations.
   ii. Tier 2: Runs with any competition violations.
   iii. Tier 3: Runs with any construction violations.
   iv. Tier 4: Teams with 2 Failed Runs.
   v. Tier 5: Teams that did not impound their Vehicle during the impound period.

g. Tiebreakers in order: 1. Better non-scored run; 2. Faster time - scored run. 3. Lower Vehicle Distance - scored run.

SCORING EXAMPLE: A team's Vehicle stopped 28.6 cm from the Target Point. It made the run in 4.79 s without any penalties (Tier 1).

	Vehicle Distance	28.6 cm x 2 pts./cm =	57.2 points
	Run Time	4.79 s x 1 pt./sec =	4.79 points
+	Penalties	0 pts. =	0 points
	Run Score		61.99 points

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.

This event is sponsored by Lockheed Martin

MACHINES

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

1. **DESCRIPTION:** Teams will complete a written test on simple, **Division B**, and compound, **Division C**, machine concepts and construct a lever-based measuring device prior to the tournament to determine the ratio between two masses.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** B **IMPOUND:** Yes **EVENT 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 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.
   d. All participants must properly wear eye protection **during Part II – Device Testing**. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without proper eye protection will not be allowed to compete in **Part II – Device Testing**.
   e. Event Supervisors will supply three masses labeled A, B, and C. A flexible loop, large enough to pass a standard golf ball through, must be tied to the top of each mass. The loops may be made from fishing line, zip ties, string, etc. The masses, including the fully stretched out flexible loop, must be able to fit inside a 15.0 cm x 15.0 cm x 20.0 cm box. Masses A, B, and C must be between 20.0 and 800.0 g. The ratio of the largest mass to the smallest must not exceed the following limit:

	Regionals	States	Nationals
Division B	4:1	5.5:1	7:1
Division C	8:1	10:1	12:1

   f. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. **CONSTRUCTION PARAMETERS:**
   a. The device must fit inside a box no larger than 100.0 cm x 100.0 cm x 50.0 cm (at impound).
   b. **Division B:** The device must be a class 1 lever with a single beam no longer than 80.0 cm. **Division C:** The device must be a class 1 lever connected directly in series to a class 2 or 3 lever, each with a single beam of length less than or equal to 40.0 cm.
   c. The device may be made out of any materials. Electric or electronic components are prohibited.
   d. The device must be constructed to accommodate the masses, and must not include springs.
   e. Participants must not bring masses or include them in devices except when fixed in place prior to impound to obtain static equilibrium. Lightweight adjustable sliding hooks used solely to accommodate the masses are allowed and need not be fixed in place.
   f. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between masses 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.

4. **THE COMPETITION:**

   Part I: Written Test
   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.

c. The test will consist of at least three questions from each of the following areas:

	Division B	Division C
Concepts, e.g., types and terminology	Simple machines only	Simple and compound machines
Calculations	Ideal and actual mechanical advantage, efficiency, load, and effort as applied to simple machines	Division B topics extended to include compound machines, plus potential and kinetic energy and coefficient of friction

d. Questions are limited to the following simple machines (or, in Division C, combinations thereof) in static equilibrium and must include at least five of the following topics:
   i. Lever (all three classes)
   ii. Inclined plane
   iii. Wedge
   iv. Wheel and axle (including gears)
   v. Pulleys
   vi. Division C Only: Screw

e. Topics prohibited in either division: Dynamic calculations, material strength, and angle of repose.

Part II: Device Testing

a. The objective is to quickly determine the ratios of three unknown masses using a simple lever in Division B or compound lever in Division C.
b. At the start of the competition block, teams will be given 5 minutes to set up or modify their devices and use their graphs and/or tables to calibrate them. Devices that do not meet the construction specs will not be allowed to be tested until brought into specification.
c. 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, but all teams will use identical masses.
d. Part II timing (not to exceed 4 minutes) begins when the Event Supervisor provides the masses to the team. The Supervisor must ensure that the mass values are not revealed to any teams. Teams must not touch the masses until time begins.
e. Using the basic physical principles of a lever and adjusting only the relative positions of the masses and/or fulcrum(s) along the lever beam(s), teams must calculate the ratios of the masses. Teams may work with either two or three masses at a time. Teams may use their resources, calculators, and tools to determine mass ratios.
f. Teams must not mark on, attach anything to, or modify the masses.
g. Part II timing stops when the team provides the Supervisor with the calculated mass ratios A/B and B/C or 4 minutes has elapsed. Event Supervisors must record the elapsed time in seconds to the precision of the timing device. No changes are allowed to the calculated values once timing stops.
h. The Supervisor will review with the team the Part II data recorded on their scoresheet.
i. Teams filing an appeal regarding Part II must leave their device in the competition area.

5. **SCORING**:

a. High score wins; Final Score (FS) = ES + R1 + R2 + TS + CS. The maximum possible FS score 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. Time Score (TS) = ((240 - team's part II time in seconds) / 240) x 15 points.
d. Ratio Scores (R1 and R2) = (1 - (abs(AR - MR) / AR)) x 15 points. The smallest possible R1 and R2 is 0. AR is the actual ratio of two of the masses (measured to the best precision of the equipment available to the Event Supervisor) and MR is the measured value of the ratio as submitted by the team. R1 uses mass ratio A/B, R2 uses mass ratio B/C.

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 mass 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)
   v. 2 points for including a labeled device diagram
f. If a team violates a COMPETITION rule, their TS, R1, and R2 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 TS, R1, and R2 will be multiplied by 0.7.
h. Teams with no device, no ratio estimates, or that do not make an honest attempt to utilize a device of the prescribed type to determine the mass ratios receive R1, R2, and TS of 0. Such teams will be allowed to compete in Part I (the written test).
i. Tie Breakers: 1st - Best ES; 2nd - Best TS; 3rd - Best R1; 4th - Best R2.

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

ORNITHOLOGY

SCIENCE OLYMPIAD

1. **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:**
   a. Each team may bring one 2" or smaller three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source 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.
   b. 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.
   c. In addition to a binder, each team may bring one unmodified and unannotated copy of either the 2020 National Bird List or a 2020 Official State Bird List which does not have to be secured in the binder.
3. **THE COMPETITION:**
   a. The competition may be run as timed stations and/or as a timed slides/PowerPoint presentation.
   b. 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.
   c. Each team will be given an answer sheet on which they will record answers to each question.
   d. No more than 50% of the competition will require giving common or scientific names.
   e. 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.
   f. States may have a modified state or regional list which will be posted on the state website no later than November 1st.
   g. The National competition will be based on the 2020 National Bird List.
   h. 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.
   i. 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 (i.e., rare, common, special concern, endangered).
4. **SAMPLE ACTIVITIES:**
   a. Identify the order, family, and/or genus of the provided sample.
   b. What conclusion can be drawn about the habitat(s) of the given specimens?
   c. Which of these animals does not fit within this taxon?
   d. What unique anatomical feature distinguishes the animal shown in the picture?
   e. Consider the potential impact of human activities on the survival of birds.
5. **SCORING:**
   a. High score wins.
   b. Selected questions may be used as tiebreakers.

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

SCIENCE OLYMPIAD

2020 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** [Scientific name is in italics]*

ORDER: Anseriformes

Ducks, Geese, and Swans (*Anatidae*)

Black-bellied Whistling-duck
Snow Goose
Canada Goose *Branta canadensis*
Trumpeter Swan ♪
Wood Duck *Aix sponsa*
Mallard *Anas platyrhynchos* ♪
Northern Shoveler
Green-winged Teal
Canvasback
Hooded Merganser

ORDER: Galliformes

Partridges, Grouse, Turkeys, and Old World Quail (*Phasianidae*)

*Ring-necked Pheasant
Ruffed Grouse *Bonasa umbellus* ♪
Wild Turkey *Meleagris gallopavo*

New World Quail (*Odontophoridae*)

Northern Bobwhite ♪

ORDER: Gaviiformes

Loons (*Gaviidae*)

Red-throated Loon
Common Loon *Gavia immer* ♪

ORDER: Podicipediformes

Grebes (*Podicipedidae*)

Pied-billed Grebe *Podilymbus podiceps*
Red-necked Grebe

ORDER: Procellariiformes

Albatrosses (*Diomedeidae*)

Laysan Albatross

Shearwaters and Petrels (*Procellariidae*)

Northern Fulmar *Fulmarus glacialis*

ORDER: Pelecaniformes

Pelicans (*Pelecanidae*)

American White Pelican *Pelecanus erythrorhynchos*

Bitterns, Herons, and Allies (*Ardeidae*)

American Bittern ♪
Great Blue Heron *Ardea herodias*
Snowy Egret *Egretta thula*
Green Heron
Black-crowned Night-heron

Ibises and Spoonbills (*Threskiornithidae*)

Roseate Spoonbill *Platalea ajaja*

ORDER: Suliformes

Cormorants (*Phalacrocoracidae*)

Double-crested Cormorant *Phalacrocorax auritus*

Darters (*Anhingidae*)

Anhinga *Anhinga 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 *Falco peregrinus*

ORDER: Accipitriformes

Osprey (*Pandionidae*)

Osprey *Pandion haliaetus*

Hawks, Kites, Eagles, and Allies (*Accipitridae*)

Bald Eagle *Haliaeetus leucocephalus* ♪
Northern Harrier
Cooper's Hawk *Accipiter cooperii*
Red-tailed Hawk *Buteo jamaicensis* ♪
Golden Eagle

ORDER: Cathartiformes

New World Vultures (Cathartidae)

Turkey Vulture Cathartes aura
California Condor

ORDER: Gruiformes

Rails, Gallinules, and Coots (*Rallidae*)

Clapper Rail *Rallus longirostris*
Sora ♪
Purple Gallinule
American Coot

Cranes (*Gruidae*)

Whooping Crane *Grus americana* ♪

ORDER: Charadriiformes

Lapwings and Plovers (*Charadriidae*)

American Golden-Plover
Killdeer *Charadrius vociferus* ♪

Oystercatchers (*Haematopodidae*)

American Oystercatcher

Stilts and Avocets (*Recurvirostridae*)

Black-necked Stilt
American Avocet *Recurvirostra americana*

Sandpipers, Phalaropes, and Allies (*Scolopacidae*)

Spotted Sandpiper
Ruddy Turnstone
Dunlin *Calidris alpina*
Wilson's Snipe
American Woodcock *Scolopax minor*

Gulls, Terns, and Skimmers (*Laridae*)

Laughing Gull ♪
Ring-billed Gull
Herring Gull *Larus argentatus*
Least Tern *Sternula antillarum*
Caspian Tern
Black Tern
Black Skimmer *Rynchops niger*

Auks, Murres, and Puffins *(Alcidae)*

Common Murre *Uria aalge*
Tufted Puffin

ORDER: Columbiformes

Pigeons and Doves (*Columbidae*)

Mourning Dove *Zenaida macroura* ♪
Common Ground-Dove
**Rock Pigeon Columba livia*

ORDER: Cuculiformes

Cuckoos, Roadrunners, and Anis (*Cuculidae*)

Black-billed Cuckoo ♪
Greater Roadrunner

ORDER: Strigiformes

Barn Owls (*Tytonidae*)

Barn Owl *Tyto alba*

Typical Owls (*Strigidae*)

Great Horned Owl *Bubo virginianus* ♪
Snowy Owl
Barred Owl *Strix varia* ♪
Screech Owl

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 2019 Cornell University Laboratory of Ornithology.

2020 NATIONAL BIRD LIST

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

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

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

ORDER: Coraciiformes
Kingfishers *(Alcedinidae)*
Belted Kingfisher *Megaceryle alcyon* ♪

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

ORDER: Passeriformes
Tyrant Flycatchers (*Tyrannidae*)
Olive-sided Flycatcher
Eastern Phoebe *Sayornis phoebe*
Vermilion Flycatcher
Great Crested Flycatcher ♪
Eastern Kingbird
Scissor-tailed Flycatcher
Shrikes (*Laniidae*)
Loggerhead Shrike
Vireos (*Vireonidae*)
Warbling Vireo
Red-eyed Vireo *Vireo olivaceus*
Jays and Crows (*Corvidae*)
Steller's Jay
Blue Jay *Cyanocitta cristata* ♪
Black-billed Magpie
American Crow ♪
Common Raven *Corvus corax*
Larks (*Alaudidae*)
Horned Lark
Swallows (*Hirundinidae*)
Purple Martin
Cliff Swallow
Barn Swallow *Hirundo rustica*
Chickadees and Titmice (*Paridae*)
Black-capped Chickadee ♪
Tufted Titmouse *Baeolophus bicolor* ♪
Nuthatches (*Sittidae*)
Red-breasted Nuthatch *Sitta canadensis* ♪
White-breasted Nuthatch
Creepers (*Certhiidae*)
Brown Creeper *Certhia americana*
Wrens (*Troglodytidae*)
Cactus Wren
Marsh Wren
Carolina Wren ♪
Dippers (*Cinclidae*)
American Dipper *Cinclus mexicanus*
Kinglets (*Regulidae*)
Golden-crowned Kinglet
Ruby-crowned Kinglet
Gnatcatchers (*Polioptilidae*)
Blue-gray Gnatcatcher
Thrushes (*Turdidae*)
Eastern Bluebird
Wood Thrush ♪
American Robin *Turdus migratorius* ♪
Mockingbirds and Thrashers (*Mimidae*)
Gray Catbird
Northern Mockingbird *Mimus polyglottos* ♪
Brown Thrasher *Toxostoma rufum*
Waxwings (*Bombycillidae*)
Cedar Waxwing *Bombycilla cedrorum*
Wood-Warblers (*Parulidae*)
Yellow Warbler
Magnolia Warbler *Dendroica magnolia*
Yellow-rumped Warbler
Black-throated Green Warbler
Black-and-white Warbler *Mniotilta varia*
American Redstart
Ovenbird
Kentucky Warbler
Common Yellowthroat ♪
New World Sparrow (Passerellidae)
Spotted Towhee *Pipilo maculatus* ♪
Black-chinned Sparrow
Lark Sparrow
Harris's Sparrow
White-crowned Sparrow
Chipping Sparrow
Dark-eyed Junco *Junco hyemalis*
Longspurs and Buntings *(Calcariidae)*
Lapland Longspur
Snow Bunting
Cardinals and Allies (*Cardinalidae*)
Northern Cardinal *Cardinalis cardinalis* ♪
Indigo Bunting
Painted Bunting *Passerina ciris*
Scarlet Tanager
Blackbirds (*Icteridae*)
Bobolink
Red-winged Blackbird ♪
Western Meadowlark ♪
Yellow-headed Blackbird
Common Grackle
Brown-headed Cowbird *Molothrus ater*
Baltimore Oriole *Icterus galbula* ♪
Fringillids and Allies (*Fringillidae*)
Red Crossbill *Loxia curvirostra*
American Goldfinch *Carduelis tristis*
Evening Grosbeak
House Finch
Pine Siskin
Old World Sparrows *(Passeridae)*
*House Sparrow *Passer domesticus*
Old World Starlings *(Sturnidae)*
*European Starling *Sternus vulgaris*

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 2019 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.

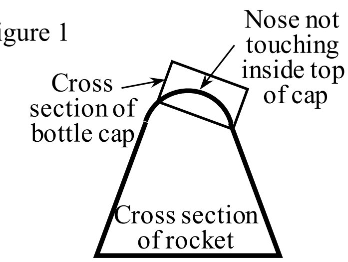
1. **DESCRIPTION:** Prior to the tournament, teams will design, build, and bring up to two bottle rockets to the tournament to launch a ping pong ball attached to a parachute to stay aloft for the greatest amount of time.

   A TEAM OF UP TO: 2 **IMPOUND:** No **EYE PROTECTION:** B **EVENT TIME:** 5 minutes

2. **EVENT PARAMETERS:**
   a. Teams must provide up to two rockets, two unaltered standard ping pong balls, and two 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.

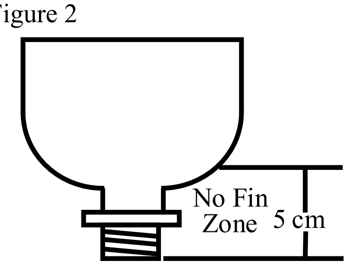
3. **CONSTRUCTION PARAMETERS:**
   a. Rocket pressure vessels must be made from a single 1-liter or less plastic carbonated beverage bottle with a nozzle opening internal diameter of approximately 2.2 cm (a 1/2-inch Schedule 40 PVC pipe must fit tightly inside the nozzle opening) and a standard neck height from flange to bottle's opening of under 1.6 cm. The bottle label must be presented.
   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).

Figure 1



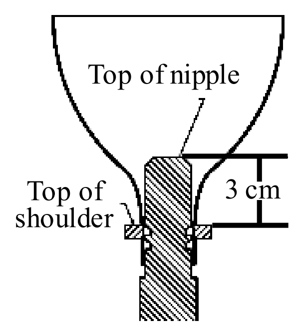
   d. Only tape must be used to attach fins and other components to the pressure vessel. No glues of any type may be used on the pressure vessel. Metal of any type is prohibited anywhere on the rocket or parachute payload system.
   e. Fins and other parts added to the bottle must be 5 cm or higher above the level of the bottle's opening, to ensure rockets fit on the launcher (see Figure 2).

Figure 2



   f. All energy imparted to the rocket/parachute payload system must originate from air pressure provided by the Supervisor; 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 cm +/- 0.5 cm) above the top side of the shoulder of the bottle (see Figure 3).

Figure 3



4. **PRACTICE LOG:**
   a. During inspection, each team must present a flight log of recorded data for each rocket. 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.).
   b. Teams must use their data to justify their pressure choice. Rockets without a flight log or an incomplete log will NOT be launched.

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 5 minutes to make a total of two launches using the same rocket or two 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. 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. The parachute payload system must separate from the rocket.
   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. This launch is placed in Tier 2.
   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. That launch is placed in Tier 3.
   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 greatest time aloft of a parachute payload system from a single launch within a tier.
   b. Rockets and/or parachute payload systems violating 2.c., 3.a.-f. and/or 4.a.-b. will NOT be launched. Teams unable to make any launches will receive participation points only.
   c. Ties will be broken by the best tier and/or greatest time aloft of the parachute payload system from each tied team's other launch.
   d. Tiers: The highest number Tier will be applied when more than one is applicable:
      i. Tier 1: A launch with no violations or problems
      ii. Tier 2: A launch where the parachute payload system did not separate from the rocket
      iii. Tier 3: A launch where the rocket or any part of the parachute payload system contacted the ceiling

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.

This event is sponsored by Lockheed Martin

PROTEIN MODELING

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

1. **DESCRIPTION:** Participants will use computer visualization and online resources to construct a physical model of a protein that is being used with CRISPR Cas9 to edit plant and animal genomes. This year's event will focus on **modifications to Cas9 that make it useful for base-editing**.

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

2. **EVENT PARAMETERS:**
   a. Each **participant** may bring one 8.5" x 11" sheet of paper, **which may be** in a sheet protector **sealed by tape** or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with writing utensils for each participant.
   b. Each team will impound a pre-built model of a **cytidine deaminase protein**.
   c. Event Supervisors will provide internet-connected computers, instructions for computer exploration of protein structure, and the written exams.

3. **THE COMPETITION:**

   Part I: The Pre-Built Model
   a. Participants will use the program Jmol/JSmol to visualize **cytidine deaminase (chain A, residues 214-310**) based on data found in the **5td5.pdb file**. The atomic coordinate data file can be downloaded for free from the RCSB Protein Data Bank (www.rcsb.org). A constructed model of this protein must be brought to all competitions; as the competition level increases, the scoring rubrics for the pre-built model will reflect higher expectations for model accuracy, detail and enhancements. (See SCORING for more details.) Jmol/JSmol can be accessed at http://cbm.msoe.edu/scienceOlympiad/designEnvironment/prebuild.html for free.
   b. The pre-built model must be based on the alpha carbon backbone display of the protein, using a scale of 2 cm per amino acid. Students may use Mini-Toobers®, or other comparable bendable material (e.g., Kwik Twists, 12-gauge dimensional house wire, etc.), to manually fold their pre-built model.
   c. Three Dimensional (3D) printed materials may NOT be used to build the protein backbone but may be used for functionally relevant features.
   d. Participants will use materials of their own choosing to add functionally relevant features to their model (e.g., selected amino acid sidechains, DNA or associated molecules). Additions to the model should highlight the significance of structure to the function of the protein.
   e. Participants must explain their functionally relevant features using clear and concise descriptions on a 4" x 6" notecard, in the form of a table with 3 columns, headed:
      i. What is displayed?
      ii. How is it displayed?
      iii. Why is it important?
   f. Teams may use both sides of the notecard, and information must be legible.
   g. All models, including all functionally relevant features, must fit within a 61.0 cm x 61.0 cm x 61.0 cm space.
   h. The model must be sufficiently sturdy that judges can pick it up and rotate it for judging.
   i. Teams must deliver their pre-built model and 4" x 6" notecard for impounding. They may pick up pre-built models after the competition.

   Part II: Computer Exploration of Protein Structure
   a. **Participants will explore a new protein structure onsite using Jmol/JSmol.**
   b. **The Event Supervisor will provide the computer and give the participants the PDB file of a new protein.**
   c. **Participants will use Jmol/JSmol to display the protein and answer questions related to its structure.**

   Part III: Written Exam
   a. Teams will complete a written exam consisting of multiple choice and short answer questions.
   b. Topics addressed include:
      i. the principles of chemistry that drive protein folding
      ii. **chemical principles underlying stability and interactions in biological macromolecules (e.g., proteins, and nucleic acids such as DNA and RNA)**
      iii. **mechanism whereby CRISPR functions as an adaptive immune system in bacteria**
      iv. **ways in which the Cas9 protein has been engineered to make it more useful as a base-editing tool**

4. **SCORING:**
   a. High Score wins. Final score will be derived from all three parts of the competition:
   b. The pre-built model (Part I) accounts for 40% of the final score.
      i. **The pre-built score is based on the accuracy and scale of the secondary structures, tertiary arrangement of these structures, as well as relevant functional features added.**
      ii. **Features that are not relevant or do not explain the structure/function relationship of the protein will not receive credit.**
      iii. **The scoring rubric for the pre-built model will change with the level of each competition.**
         (1) **For Regional competitions, scoring will be based primarily on the accuracy of the 3D folded structure of the alpha-carbon backbone of the protein (secondary and tertiary structures).**
         (2) **For State competitions, 30% of the score awarded to the pre-built model will be based on functionally relevant features, such as inclusion of key sidechains, substrates, nucleic acids and so forth, that have been added to the alpha-carbon backbone model to explain the protein's function.**
         (3) **For the National competition, in addition to the folding of the protein and creative additions, scoring will focus on how the structure modeled fits within the larger fusion protein of the BE4 expression plasmid displayed at https://www.addgene.org/browse/sequence/222010/. Note that it will be impossible to build the whole fusion protein to scale and fit within the space parameters. Teams are expected to include schematic representations of the other regions of the fusion protein and their connections to each other. Note that NO additional credit will be given to complete atomic models, but it is important that the additions are arranged in the correct linear order. This schematic fusion protein model will be worth 15% of the pre-built model score; the other 85% will come from the cytidine deaminase pre-built model. Both pre-built models must be impounded before the beginning of the event.**
   c. The computer-exploration of a protein structure (Part II) accounts for 30% of the event score.
   d. The written exam (Part III) accounts for 30% of the event score.
   e. Ties will be broken using identified questions from the written exam (Part III).

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

This event is sponsored by Milwaukee School of Engineering (MSOE)

SOUNDS OF MUSIC

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

1. **DESCRIPTION:** Teams must construct and tune one device prior to the tournament based on **a two-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 **EYE PROTECTION:** None

   IMPOUND: No **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. **Sheet protectors, lamination, tabs and labels are permitted.** Participants may remove information or pages for their use during the event.
   b. Each team may also bring writing utensils and two stand-alone calculators of any type for use during any part of the event.
   c. Teams may bring a personal tuner, which may be an app on their cell phone, for use during set up. Access to an electrical outlet is not guaranteed.
   d. If testing a string**ed device**, a team may bring rosin.
   e. Prior to the competition, teams must tune their device to play eight notes from a **two**-octave major scale of the team's choice. A log describing the process of tuning one pitch must be submitted.
   f. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. **CONSTRUCTION PARAMETERS:**
   a. The **device** may be constructed of and contain any materials except for the following: electric or electronic components, toys, professional instruments, or parts of such instruments (e.g., bells, whistles, mouthpieces, reeds or reed blocks, audio-oscillators, tuning pegs, etc.). The only exception is that strings (instrumental or otherwise) of any type are permitted.
   b. The device must be able to play an **ascending** major scale **beginning on any note between F2 and F3 (inclusive)**. (A4 = 440 Hz) **The scale must include an octave jump after the fourth note of the scale. For example, G2, A2, B2, C3, *octave jump*, D4, E4, F#4, G4**
   c. **The device must also be able to play additional pitches within the scale's skipped range in order to play the first four bars of "Twinkle, Twinkle". The song excerpt (attached at the end of the rules) must be played in 15 seconds and must be played within one octave.**
   d. **For a bonus, the device may have one additional pitch (outside of the two octave range) EITHER:**
      i. **At least one octave lower than the lowest note of the required scale in 3.b. (In the example above, G1 or lower),**
      ii. **At least one octave higher than the highest note of the required scale in 3.b. (In the example above, G5 or higher).**
   e. **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.
   f. Each device must fit within a 60.0 cm x 60.0 cm x 100.0 cm box when brought into the competition area and be moveable by the participants without outside assistance. Devices may become larger once set up.

4. **THE COMPETITION:**

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

   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 "Twinkle, Twinkle" song excerpt within 15 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.**
g. **Teams may also try to play a Bonus Pitch. This may be before or after the Song Score Test.**
    i. **No alterations of the device are allowed.**
    ii. **Participants will indicate what their Bonus Pitch is.**
    iii. Participants will play the pitch for 3 seconds **as required by 4.Part II.e.ii.-iii.**.
    iv. **Bonus points will be awarded based on the accuracy of the pitch.**
h. The Event Supervisor will review with the teams the Part II data recorded on their scoresheet.
i. **Teams filing an appeal regarding Part II must leave their device in the competition area.**

5. **<u>SCORING</u>:**
    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 + Bonus;
        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 x C**
                b. **States: If $C \leq 7$, IPS = 4.5; If $C > 7$, IPS = 5 - 0.1 x C**
                c. **Nationals: If $C \leq 3$, IPS = 4.5; If $C > 3$, IPS = 5 - 0.2 x 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 9 points
        v. Bonus – max of 5 points
    c. The log must track the iterations of calibrating one pitch on the device. The Log Score (LS) points will be assigned as follows:
        i. 2 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:**
- i. **3 points – Rhythmic accuracy**
- ii. **3 points – Pitch accuracy**
- iii. **3 points – Was the song played within 15 seconds from the start of playing**

e. **The Bonus will be assigned as indicated:**
- i. **Regional Level – 5 points, if the played pitch is within 10 cents of the selected pitch. Otherwise zero points**
- ii. **State Level – 5 points, if the played pitch is within 7 cents of the selected pitch. Otherwise zero points**
- iii. **National Level – 5 points, if the played pitch is within 3 cents of the selected pitch. Otherwise zero points**

f. If a team violates any COMPETITION rules, their IPS values will be multiplied by 0.9 when calculating the scores.

g. 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.

h. Teams that are disqualified for unsafe operation, do not bring a device, or whose device does not meet construction parameters at the end of their setup time receive zero points for their PS and SS scores. Teams will be allowed to compete in Part I.

i. 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

<u>"Twinkle, Twinkle" excerpt</u>:
Note that the excerpt may be transposed into an appropriate key. **The time signature for this piece should be 4/4.**

<u>Recommended Resources</u>: 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.

WATER QUALITY

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

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

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

2. **EVENT PARAMETERS:**
   a. Each team may bring one 8.5" x 11" sheet of paper, **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, two stand-alone non-programmable, non-graphing calculators, and one participant-built salinometer/hydrometer for testing.
   b. Participants must wear eye protection during Salinometer Testing (**3.Part IV**.). Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.

3. **THE COMPETITION:**

   Scenarios and tasks will be drawn from **marine and estuary locales** (e.g., oceans, coral reefs, Chesapeake Bay) and scenarios and may require analysis, interpretation or use of charts, graphs and sample data as well as equipment use, collecting and interpreting data, measuring, analyzing data, and making inferences to evaluate comparative macroinvertebrates and water quality data.

   Part I: Marine and Estuary Ecology – 30% of the total score
   a. This part will use multiple choice, matching, fill-in-the-blank and/or short answers to assess participants' knowledge in areas such as: aquatic ecology, water cycle, nutrient cycling, aquatic chemistry and its implications for life, potable water treatment, waste water treatment, aquatic food chains/webs, community interactions, population dynamics, watershed resource management issues, sedimentation pollution, harmful species **and recently killed coral.**
   b. **Division C - State and Nationals Only**: life history strategies (e.g., age, structure, survival curves, life tables, succession, R and K strategies).

   Part II: Coral Reef Macroflora and Fauna Identification – 30% of the total score
   a. This part will assess participants' knowledge of coral reefs and the ecological factors that have harmful effects on reef ecosystems. It will also include the identification (common name only) of Coral Reef organisms and their importance as indicators of reef health.
   b. Participants are also expected to know the general ecology, life cycles, and feeding habits of the following organisms (note: spp. is an abbreviation for multiple species):
      i. Organisms found around the globe: Banded coral shrimp (***Stenopus hispidus***), Butterfly fish (***Chaetodon*** **spp.),** Crown of thorns starfish (***Acanthaster planci***), Fleshy algae, Grouper >30 cm (Serranidae, Epinephelinae), Hard coral, Lobster, Long-spined black sea urchins (***Diadema*** **spp*.),*** Moray eel (Muraenidae), Parrotfish (>20 cm) (Scaridae or Scarinae), Pencil urchin, Snapper (Lutjanidae), Sponge, Sweetlips (Haemulidae ***Plectorhinchus*** **spp.**), and Triton ***(Charonia*** **spp.)**
      ii. Organisms found in the Indo-Pacific region only: Barramundi cod (***Cromileptes altivelis***), Bumphead parrotfish (***Bolbometopon muricatum***), Giant clams (***Tridacna*** **spp.),** Humphead wrasse ***(Cheilinus undulatus),*** and Sea Cucumber
      iii. Organisms found in the Atlantic region only: Flamingo Tongue Snail ***(Cyphoma gibbosum***), Gorgonia, and Nassau grouper ***(Epinephelus striatus)***

   Part III: Water Monitoring and Analysis – 30% of the total score
   a. Participants are expected to understand and interpret data related to testing procedures and purposes for collecting data related to salinity, pH, phosphates, turbidity, dissolved oxygen, temperature, nitrates, fecal coliform, total solids, biochemical oxygen demand and **aragonite saturation** and their relationships to one another.
   b. No **physical, laboratory** tests will be performed on these topics **by participants**.

Part IV: Salinometer Testing – 10% of the total score

a. Teams must build, calibrate, bring and demonstrate a salinometer/hydrometer capable of measuring saltwater (most likely NaCl) concentrations between 1-10% (mass/volume).

b. There are no restrictions on size except that the team must build the device to operate within a standard 400 – 600 mL beaker filled with **at least 400 mL of** the saltwater solution.

c. Teams will be expected to estimate the percent salinity measured by their device to the nearest tenth of a percent. Full credit will be given ±1% at Regionals and ±0.5% at State/Nationals. Calibration solutions may or may not be provided by the Event Supervisor.

4. **SCORING**:

a. High score wins.

   i. Points will be assigned to the various questions and problems **for Parts I, II, and III**.

   ii. **Points for bringing a salinometer for testing will be 5% of the total score.**

   iii. **Points for making an accurate salinity measurement per 3.Part IV.c will be 5% of the total score.**

b. Selected questions may be used as tiebreakers.

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

WRIGHT STUFF

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

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

   A TEAM OF UP TO: 2 **IMPOUND:** None **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 and/or a student's design. Kits must not contain any pre-glued joints or pre-covered surfaces.
   b. Any materials except Boron filaments may be used in construction of the airplane.
   c. Total mass of the airplane throughout the flight, excluding the rubber motor, must be 8.00 g or more.
   d. The wing(s) must not exceed **30.0** cm horizontally projected wingspan and must not exceed 8.0 cm chord (straight line distance from leading edge of wing to trailing edge, parallel to the fuselage). **The horizontal stabilizer must not exceed 12.0 cm horizontal projected span and must not exceed 6.0 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 8.0 cm**. Variable-pitch propellers that include mechanisms to actively change the blade diameter or angle must not be used.
   f. A rubber motor may be of any mass and must be the sole power for the airplanes.
   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/recorded peak flight height, the motor torque at landing, etc.).
   d. At the Event Supervisor's discretion:
      i. Multiple official flights may occur simultaneously according to the Event Supervisor's direction.
      ii. Test flights may occur throughout the contest but must yield to any official flight.
      iii. No test flights will occur in the final half-hour of the event's last period, except for teams that declare a trim flight during their 8-minute Flight Period.
   e. A self-check inspection station may be made available to participants for checking their 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.
   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 surface of the wing between at least 2 ribs of the leading and trailing edges or at least one of the wing tip fences completely marked with black marker or black tissue. If no ribs are present, the whole surface must be black.
d. **If the team uses the same airplane, meaning all airplane components except for the rubber band from the first flight must be reused on the second flight, for both official flights and on the first flight the airplane completes at least one orbit (360 degree horizontal turn) in either a clockwise or counterclockwise direction and the team makes adjustments to the airplane such that it completes at least one orbit in the opposite direction on the second flight, the flight times will be added together for their official score.**
e. Teams with incomplete flight logs will have 10% of their flight time deducted from each flight.
f. Teams without flight logs will have 30% of their flight time deducted from each flight.
g. Teams that violate a rule under "CONSTRUCTION" or "THE COMPETITION" that does not have a specific penalty 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

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

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

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

3. **THE COMPETITION:**
   a. One participant from each team is shown an object, which may be abstract but is the same for all teams, built from, but not limited to, such items as science materials, inexpensive materials (e.g., straws, push pins, Styrofoam balls, paper cups, Popsicle sticks, etc.) or commercial sets (e.g., K'nex, Tinker Toys, Lego, Lincoln Logs, etc.). This participant is not allowed to touch the object unless the Event Supervisor permits it.
   b. The participant viewing the object has twenty-five (25) minutes to write a description of the object and how to build it. There will be no advantage to finishing early.
   c. Drawings and diagrams of the model or subsections of the model are not allowed. Numerals, words and single letters that fit within the context of the written description are allowed. The participant may use abbreviations and do not have to define the abbreviation. Editing, punctuation, or scientific symbols that fit within the context of the written description are allowed.
   d. The Event Supervisor will pass the description to the second team member who will take the description and attempt to recreate (build) the original object in twenty (20) minutes.
   e. Supervisors will attempt to use different materials than the materials that were used last year.

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

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

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 GUIDE

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.

Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators can be used in the following events: Anatomy & Physiology, Astronomy, Chemistry Lab, Circuit Lab, Codebusters, Density Lab, Designer Genes, Disease Detectives, Dynamic Planet, Elastic Launched Glider, Experimental Design (Both Divisions), **Food Science**, Forensics, Geologic Mapping, **Gravity Vehicle,** Heredity, **Machines,** Meteorology, Mousetrap Vehicle, **Reach for the Stars,** Road Scholar, Sounds of Music, Water Quality, and Wright Stuff.

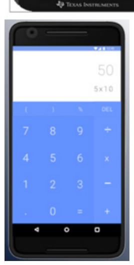
Stand-alone non-graphing, non-programmable, non-scientific 4-function or 5-function calculators are the most basic type of calculators and often look like the one shown to the right. These calculators are limited to the four basic mathematics functions and sometimes square roots. These calculators can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

Stand-alone non-programmable, non-graphing calculators, in addition to the above listed calculators, can be used in the following events: Anatomy & Physiology, Astronomy, Chemistry Lab, Circuit Lab, Density Lab, Designer Genes, Disease Detectives, Dynamic Planet, Elastic Launched Glider, Experimental Design (Both Divisions), **Food Science**, Forensics, Geologic Mapping, **Gravity Vehicle,** Heredity, **Machines,** Meteorology, Mousetrap Vehicle, **Reach for the Stars,** Road Scholar, Sounds of Music, Water Quality, and Wright Stuff.

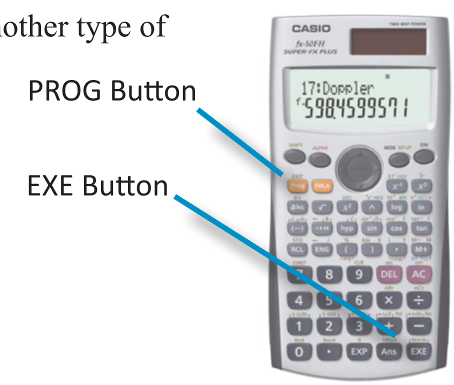
Stand-alone non-programmable, non-graphing calculators look like the calculator to the right or simpler. There are hundreds of calculators in this category but some common examples include: CASIO FX-260, Sharp EL-501, and TI-30X.

Stand-alone, programmable, graphing calculators and **stand-alone non-graphing, programmable calculators,** in addition to the above listed calculators, can be used in the following events: Astronomy, **Chemistry Lab**, Circuit Lab, Density Lab, Dynamic Planet, Elastic Launched Glider, Experimental Design (Division C), **Gravity Vehicle, Machines,** Mousetrap Vehicle, Sounds of Music, and Wright Stuff.

Stand-alone, programmable, graphing calculators often look like the calculator shown on the left. Some examples are: Casio 975 0/9850/9860, HP 40/50/PRIME, and TI 83/84/89/NSPIRE/VOYAGE.



Stand-alone non-graphing, programmable calculators are another type of calculator that can be used in the above listed events. To identify these calculators, 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.



Calculator applications on multipurpose devices (e.g., laptop, phone, tablet, watch) are not allowed unless expressly permitted in the event rule.

EYE PROTECTION GUIDE

SCIENCE OLYMPIAD

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

NOTES

2020 Division C National Tournament Schedule
at North Carolina State University; Raleigh, North Carolina
Saturday, May 16, 2020

Event	7:00 - 7:50 AM	8:00 - 9:00 AM	9:15 - 10:15 AM	10:30 - 11:30 AM	11:45 - 12:45 PM	1:00 - 2:00 PM	2:15 - 3:15 PM	7:00 – 9:00 PM
Anatomy & Physiology		1-10	11-20	21-30	31-40	41-50	51-60	Closing Ceremony
Astronomy		1-10	11-20	21-30	31-40	41-50	51-60	
Boomilever		Self-Schedule						
Chem Lab		41-50	51-60	1-10	11-20	21-30	31-40	
Circuit Lab		1-10	11-20	21-30	31-40	41-50	51-60	
Codebusters		31-40	41-50	51-60	1-10	11-20	21-30	
Designer Genes		41-50	51-60	1-10	11-20	21-30	31-40	
Detector Building		Self-Schedule						
Disease Detectives		31-40	41-50	51-60	1-10	11-20	21-30	
Dynamic Planet		41-50	51-60	1-10	11-20	21-30	31-40	
Experimental Design		21-30	31-40	41-50	51-60	1-10	11-20	
Forensics		51-60	1-10	11-20	21-30	31-40	41-50	
Fossils		51-60	1-10	11-20	21-30	31-40	41-50	
Geologic Mapping		21-30	31-40	41-50	51-60	1-10	11-20	
Gravity Vehicle	Impound	Self-Schedule						
Ornithology		31-40	41-50	51-60	1-10	11-20	21-30	
Machines	Impound	11-20	21-30	31-40	41-50	51-60	1-10	
Ping Pong Parachute		Self-Schedule						
Protein Modeling	Impound	11-20	21-30	31-40	41-50	51-60	1-10	
Sounds of Music		Self-Schedule						
Water Quality		11-20	21-30	31-40	41-50	51-60	1-10	
Wright Stuff		Self-Schedule						
Write It, Do It		51-60	1-10	11-20	21-30	31-40	41-50	

SCIENCE OLYMPIAD
2020 National Tournament Celebrating Wonder
Hosted by NC State University

SCIENCE OLYMPIAD™

Exploring the World of Science

Science Olympiad wishes to acknowledge the following business, government and education leaders for partnering with our organization. Working together, we can increase global competitiveness, improve science and technology literacy and prepare the STEM workforce of the future. Thanks to: North Carolina State University (2020 National Tournament Host), Cornell University (2019 National Tournament Host), ArcelorMittal, NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network, Ward's Science, Lockheed Martin, Combined Federal Campaign, Corteva Agriscience, NBC Universal Foundation, Google, ACE Hardware, Centers for Disease Control and Prevention (CDC), Discovery Education 3M Young Scientist Challenge, Double Good Foundation, Institute of Electrical and Electronics Engineers (IEEE), North American Association for Environmental Education (NAAEE), National Oceanic and Atmospheric Administration (NOAA), Potbelly Sandwich Works, Texas Instruments, VWR Foundation, Investing in Communities, SkyCiv and Yale Young Global Scholars. Strategic Partners: Code.org, MxD (The Digital Manufacturing Institute), Hardware Science, Japan Science and Technology Agency, Million Women Mentors (MWM) and Milwaukee School of Engineering (MSOE).

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

Science Olympiad

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Doing Good Together

- The Double Good Kids Foundation has provided Science Olympiad with a grant to create the first Science Olympiad program for kids with disabilities.

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