ROCKS AND MINERALS C

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

1. **DESCRIPTION:** Teams will identify and classify rocks and minerals and demonstrate knowledge of how rocks and minerals help to understand geologic processes, interpretation of earth's history, the development of natural resources, and use by society.

   A TEAM OF UP TO: 2

   APPROXIMATE TIME: 50 minutes

   CALCULATOR: Class II

2. **EVENT PARAMETERS:**
   a. Each team may bring writing utensils.
   b. Each team may bring one Class II calculator.
   c. Each team may bring one magnifying glass
   d. 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.
   e. Each team may also have one commercially produced field guide which may be tabbed and annotated.
   f. In addition to a binder and a field guide, each team may bring one copy of the **2027** National Rocks and Minerals List which does not have to be secured in the binder and may be annotated.
   g. Teams are not permitted to bring samples or specimens to the event.
   h. 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, except for the **2027** National Rocks and Minerals List.

3. **THE COMPETITION:**
   a. Emphasis will be placed upon task-oriented activities such as identification of rocks and minerals based on observations of properties and characteristics, interpretation of graphs and charts, and analyzing data.
   b. Where possible, participants will move from station to station, with the length of time at each station predetermined and announced by the Event Supervisor. Participants may not return to stations but may change or add information to their original responses while at other stations.
   c. Identification will be limited to specimens appearing on the Official Science Olympiad **2027** National Rocks and Minerals List, but other rocks or minerals may be used to illustrate key concepts.
   d. If identification of a specimen is not possible through observation, key characteristics/properties of the specimen will be provided.
   e. Identification of rocks and minerals should be at least 30% but not more than 50% of available points.
   f. Questions/tasks should be balanced between rock and mineral topics.
   g. Written descriptions of how a specimen might react if tested with hydrochloric acid (HCl) may be given. However, HCl will not be used or provided. Participants will not be allowed to do a taste test.
   h. **Mineral Topics**
      i. **Definition of a mineral: naturally occurring inorganic solid with definite composition and crystalline structure.**
      ii. Identification - specimens or images used should show observable properties. **Where observable properties are insufficient to identify a specimen, other diagnostic characteristics will be provided**
      iii. Physical Properties - color, hardness, luster, streak, cleavage/fracture, density/specific gravity/ heft, diaphaneity, and tenacity
      iv. Other properties - limited to reaction with acid, fluorescence, magnetism, smell, taste, double refraction, piezoelectricity, and radioactivity.
      v. Mineral habit - limited to acicular (needlelike), bladed, botryoidal, cubic, dendritic, dodecahedral, doubly terminated, druzy, geodic, hexagonal, hopper, massive, micaceous, octahedral, pisolitic, prismatic, radiating, rosette, stalactitic, twinning, and tabular
      vi. Chemical composition – chemical formulas, relationships between chemistry and properties (e.g., effect of trace elements on mineral color)
         (1) Solid solution series: **limited to: plagioclase and alkali feldspars** (e.g., feldspar ternary diagrams); **olivine group (magnesium-rich forsterite and iron-rich fayalite); carbonate group (calcite, siderite and rhodochrosite); amphibole group (actinolite and tremolite); and sulfate group (barite and celestite)**
         (2) Phase diagram interpretation: temperature/pressure, temperature/composition (limited to two component systems)

vii. Polymorphs (e.g., aragonite/calcite; diamond/graphite, orthoclase/microcline; sillimanite/andalusite/kyanite**)**
viii. Classification - mineral families based on composition (see 2027 National Rocks and Minerals List)
  (1) Mineral groups (e.g., feldspar, garnet, tourmaline) - similarities of chemical composition and shared properties
  (2) Silicate tetrahedra and their structures: isolated tetrahedra (nesosilicates), island (sorosilicates), chain (inosilicates), ring (cyclosilicates), sheet (phyllosilicates), and framework (tectosilicates)
  (3) Crystal Systems – cubic, tetragonal, orthorhombic, monoclinic, triclinic, trigonal, and hexagonal; emphasis on how crystalline structures result in certain physical properties (e.g., cleavage planes, crystal shape)
ix. Methods of formation and environments (e.g., hydrothermal, chemical weathering, crystallization from magma, evaporites, chemical precipitation, alteration under heat & pressure)
x. Minerals associated with rock-forming environments (e.g., evaporite minerals in sedimentary settings; mafic minerals in oceanic crust; minerals that form under metamorphic conditions)
xi. Bowen's Reaction Series – relationship between mineral crystallization and temperature in magma
xii. Uses of minerals
  (1) Ores, industry, jewelry, geochronology, medicine, manufacturing, construction, electronics, etc**.**
  (2) Precious and semi-precious gemstone minerals on the **2027** Rocks and Minerals List as well as the following **varieties,** limited to: emerald, aquamarine~~,~~ **and** morganite **(beryl); kunzite and hiddenite (spodumene)**, peridot **(olivine)**; ruby **and** sapphire **(corundum)**; pearl; and amber

i. **Rock Topics**
  i. **Definition of a rock: naturally occurring solid mass composed of one or more minerals or mineraloid matter; rocks can be an aggregate (mixture) of one (monomineralic) or more minerals (polymineralic); unlike minerals, rocks can be made of organic matter.**
  ii. Identification - specimens or images used should show observable characteristics. **Where observable characteristics are insufficient to identify a specimen, other diagnostic characteristics will be provided (e.g., mineral composition of fine-grained igneous rocks, reaction to acid of chalk or diatomite)**
  iii. Classification - igneous, sedimentary, and metamorphic including observable diagnostic characteristics that facilitate classification (e.g., glassy or vesicular texture in igneous; rounded grains, fossils, or layers in sedimentary; and foliation or banding in metamorphic)
  iv. Igneous Rocks:
    (1) Textures - including aphanitic (fine-grained), glassy, vesicular, porphyritic, pyroclastic, phaneritic (coarse-grained), and pegmatitic
    (2) Composition and essential minerals - felsic, intermediate, mafic, and ultramafic
    (3) Intrusive (plutonic) and extrusive (volcanic) environments; and igneous formations limited to batholith, lava flow, and pyroclastic deposits
    (4) Relationship between textures and environments of formation (e.g., intrusive/plutonic, extrusive/volcanic and relative rates of solidification.)
    (5) Types of igneous rocks and constituent minerals at various types of plate boundaries (e.g., basalt at mid-ocean ridge; andesite/diorite at subduction zones; granite at convergent boundaries)
    (6) **Evolution of Igneous Melts**
      (a) **Magmatic differentiation: limited to fractional crystallization governed by Bowen's Reaction Series; assimilation (rising magma melts and incorporates country rock); and magma mixing.**
      (b) **State and Nationals only: Basic understanding of incompatible elements (trace elements with atomic sizes or charges that make them unable to fit into crystal structures of common minerals and are concentrated in the liquid phase of magma) and their significance in pegmatites (large crystals, exotic minerals, gemstones, and economically valuable elements).**
  v. Sedimentary Rocks:
    (1) Textures - limited to clastic (detrital or terrigenous), chemical (crystalline), and biochemical **(**organic/bioclastic)

(2) Composition and essential minerals
(3) Grain sizes (e.g., clay, silt, sand, pebble, cobble, boulder) **and their relationship to water velocity in rivers and streams**; sorting, and shape (round vs angular) and their implications for energy and conditions of environments of deposition (e.g., fine grained-low energy; coarse-grained-high energy)
(4) Relationship between textures and composition to environments of deposition
(5) Environments of deposition - including, but not limited to alluvial fan, delta, river/stream (fluvial), lake (lacustrine), swamp, wind (aeolian), floodplain, beach, shallow marine/shelf, and deep marine **(abyssal)**
(6) Primary sedimentary structures and their implications about depositional processes and environments (e.g., plane bedding, crossbedding, ripple marks, mud cracks, graded bedding, and fossil tracks & trails)

vi. Metamorphic Rocks:
(1) Textures - foliated **(**e.g., slaty cleavage, schistose, banding) and non-foliated
(2) Mineral composition
(3) Metamorphic minerals that form in existing rocks due to heat and pressure (e.g., garnet, corundum, kyanite, staurolite, epidote, andalusite, sillimanite, chlorite)
(4) Protoliths (parent rocks); e.g. shale for slate, limestone for marble, sandstone for quartzite, **peridotite for serpentinite, basalt or gabbro for amphibolite**.
(5) Regional and contact metamorphism
(6) Grade (intensity) of metamorphism (low, medium, high) and index minerals (**limited to** chlorite, **muscovite, biotite,** garnet, staurolite, kyanite, and sillimanite) that indicate the degree of metamorphism
(7) Relationship of temperature, pressure, depth to types of metamorphism and metamorphic facies (hornfels, zeolite, greenschist, amphibolite, granulite, blueschist, and eclogite) based on interpretation of graphs and charts
(8) Environments of metamorphism in the context of plate tectonics - regional metamorphism and mountain building at convergent continental-continental boundary; blueschist and eclogite formation in subduction zones; greenstone/greenschist formation from basalt or gabbro at ocean crust divergent boundaries

vii. Rock Cycle – emphasis on the geologic processes that form rocks (e.g., melting & solidification; uplift, erosion & deposition; burial, compaction & cementation; heat & pressure resulting in recrystallization & deformation)
viii. Economic importance and uses of rocks (e.g., building stone, ores, ornamental, agriculture, fossil fuels)
ix. **States and National Only** - Thin Sections of Rocks; using photographs taken through a microscope (photomicrographs)
(1) Identify minerals using their optical properties and features in polarized light (twinning, extinction, cleavage planes, birefringence); limited to microcline, plagioclase, calcite, augite, and garnet.
(2) Distinguish rock types and characteristics of igneous, sedimentary, metamorphic rocks by their microscopic textures limited to:
(a) Igneous - fine grained crystalline (holocrystalline), vesicular, glassy, porphyritic (e.g., basalt vs. pumice)
(b) Sedimentary – rounded, angular, well sorted vs. poorly sorted, skeletal fragments (e.g., oolites, sandstone vs. arkose)

4. **SCORING:**
a. High Score wins.
b. Point values of each question or section may be specified.
c. Preselected questions/sections will be used as tiebreakers.

MINERALS

BORATES
- Ulexite

CARBONATES
- Aragonite
- Azurite
- Calcite
- Dolomite
- Malachite
- Magnesite*[1]
- Rhodochrosite*
- Siderite*

NATIVE ELEMENTS
- Copper
- Diamond
- Gold
- Graphite
- Silver
- Sulfur

HALIDES
- Fluorite
- Halite[5]

OXIDE/HYDROXIDES
- Corundum
- Goethite/Limonite
- Hematite
- Magnetite
- Pyrolusite*
- Rutile*
- Zincite*

PHOSPHATES
- Turquoise*
- *Apatite Group*
  - Fluorapatite
  - Pyromorphite*
  - Vanadinite*

SULFATES
- Barite
- Celestite/**Celestine**
- *Gypsum[5] varieties:*
  - Alabaster (massive)
  - Satin Spar (fibrous)
  - Selenite (crystalline)

SULFIDES
- Bornite*[1]
- Chalcopyrite
- Galena
- Pyrite
- Sphalerite
- Stibnite*

SILICATES
- *Amphibole Group*
  - Actinolite*
  - Hornblende
  - Tremolite*
- Apophyllite*
- Beryl
- Chrysocolla*
- Dioptase*
- Epidote
- *Feldspar Group*
  - Plagioclase feldspars
    - Albite
    - Labradorite
  - Potassium feldspars
    - Amazonite
    - Orthoclase/Microcline[2] (tan/pink variety)
- *Garnet Group*
  - Almandine
  - Grossular (green variety)

SILICATES (cont.)
- Kaolinite
- Kyanite
- *Mica Group*
  - Biotite
  - Lepidolite*
  - Muscovite
- Olivine
- Prehnite*
- *Pyroxene Group*
  - Augite
  - Rhodonite*
  - Spodumene*
- *Quartz varieties:*
  - Aventurine
  - Agate/Chalcedony
  - Amethyst
  - Citrine
  - Jasper*
  - Milky Quartz
  - Opal
  - Rock Crystal
  - Rose Quartz
  - Smoky Quartz*
  - Tiger's Eye*
- Sodalite
- Staurolite
- Stilbite*
- Talc
- Topaz
- Tourmaline[3]
- Willemite*[1]
- Wollastonite*
- Zircon*

ROCKS

IGNEOUS

- Andesite
- Basalt
- Diorite
- Gabbro
- Granite
- Obsidian
- Pegmatite
- Peridotite
- Pumice
- Rhyolite
- Scoria
- Syenite*[1]
- Tuff*[1]
- Tuff Breccia[1]*

SEDIMENTARY

- Banded Iron Formation
- Bauxite[4]
- Breccia
- Chert/Flint
- Conglomerate
- Diatomite*[1]
- Dolostone
- Rock Salt (Halite)[5]
- Rock Gypsum[5]
- Shale
- *Coal varieties:*
  - Anthracite
  - Bituminous
  - Lignite
- *Limestone varieties:*
  - Chalk
  - Coquina
  - Fossil Limestone
  - Oolitic Limestone
  - Travertine
- *Sandstone varieties:*
  - Arkose
  - Greywacke*
  - Quartz Sandstone

METAMORPHIC

- Amphibolite*
- Gneiss
- Marble
- Phyllite
- Quartzite
- *Schist varieties:*
  - Garnet Schist
  - Mica Schist
  - Talc Schist (Soapstone)*
- Serpentinite*
- Slate

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

1. **For identification purposes, information will be provided such as diagnostic properties, chemical formulas, grain size, or composition.**
2. The pink/tan variety of feldspar should be identified as **Orthoclase/Microcline** or Potassium feldspar. **White or pink/tan Orthoclase/Microcline can be found in granite.**
3. Although Tourmaline is the generic name for a group of related mineral species, for identification purposes, tourmaline will be accepted.
4. Bauxite has been reclassified as a sedimentary rock.
5. Rock Salt and Rock Gypsum for identification purposes are considered the same, respectively, as the minerals Halite and Gypsum and do not need to be distinguished