DYNAMIC PLANET

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

1. **DESCRIPTION:** Students will use process skills to complete tasks related to Earth's fresh waters.
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. 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, & using number relationships) to answer questions on the following topics:
      i. Interpretation of fresh water features shown on USGS topographic maps
      ii. Stream drainage systems: stream order, drainage patterns, main channel, tributaries and watersheds
      iii. Channel types: braided, meandering, straight and calculations of sinuosity
      iv. Sediment: weathering, erosion, clast forms & sizes, transportation, capacity & competence, deposition
      v. River valley forms and processes: geology, gradient, base level, floodplain features, dynamic equilibrium, nick points, waterfalls, stream capture, deltas and fans
      vi. Perennial and intermittent stream flow, stream gauging and monitoring, stream flow calculations, discharge, load, floods, recurrence intervals
      vii. Groundwater: zone of aeration, zone of saturation, water table, porosity, permeability, aquifers, confining beds, hydraulic gradient, water table contour lines, flow lines, capillarity, recharge and discharge, saltwater intrusion, and interactions between surface and groundwater
      viii. Karst features: sinkholes, solution valleys, springs, disappearing streams, caves
      ix. Lake formation & types: faulting, rifting, volcanic action, glaciation, damming of rivers, changes over time
      x. Lake features: inflow & outflow, physical & chemical properties, stratification, shorelines, waves
      xi. Wetlands: interactions between surface and groundwater in the evolution of bogs and marshes
      xii. Destruction/Effects of land use changes, dams and levees: sedimentation, down-cutting, diversion of water, flooding, ecological changes
      xiii. Hydrologic cycle and water budgets: precipitation, runoff, evaporation
      xiv. Pollution: types, sources, transport
      xv. Critical zone hydrology: infiltration, evapotranspiration, soil moisture, permafrost, pingos
      xvi. Division C Only:
         (1) Chezy and Manning equations
         (2) Darcy's Law
4. **REPRESENTATIVE ACTIVITIES:**
   a. Analyze and interpret features and actions of a stream or river appearing on a topographic map including watershed boundaries, elevation, gradient, direction of flow, drainage pattern, valley shapes, erosional landscapes, and depositional features.
   b. Construct a water table contour map and indicate the direction of groundwater movement.
   c. Analyze data on the thermal structure of a lake and determine how the stratification changes seasonally.
   d. Given a geologic map, cross section, or lithologic sequence, determine pattern of water flow and storage, optimal reservoir sitting.
5. **SCORING:**
   a. All questions will have been assigned a predetermined number of points.
   b. The highest score wins.
   c. Selected questions will be used to break ties.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org

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METEOROLOGY

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

1. **DESCRIPTION:** Participants will use scientific process skills as well as qualitative and quantitative analyses to demonstrate an understanding of the factors that influence **Everyday Weather.**

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

2. **EVENT PARAMETERS:**
   a. **Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. 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.**
   c. Teams will not be required to bring additional supplies or materials for any hands-on task, demonstration or lab exercise.
3. **THE COMPETITION:**
   a. **The event may be either in a written exam format or teams may 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 answers while at other stations.**
   b. **Emphasis will be placed upon interpretation of weather data displayed in maps, graphs, images, photographs, charts, and/or tables to analyze Everyday Weather.** The questions will address the following **Everyday Weather** topics:
      i. The atmosphere: structure including temperature profiles **of the troposphere and stratosphere, including inversions,** thickness, composition and atmospheric pollutants
      ii. Solar radiation & seasons: atmospheric influences on insolation, diurnal & seasonal temperature patterns, Earth's revolution, rotation and axial tilt
      iii. Properties of Water: specific heat, density, sensible and latent heat along **effects on weather**
      iv. Atmospheric moisture: humidity, water vapor, **atmospheric rivers, virga**, clouds, **dew, frost & fog**
      v. **Clouds: formation of high, middle, & low clouds with vertical development; limited to the following: cirrocumulus, cirrus, and cirrostratus, altocumulus, altostratus, and nimbostratus, and stratus, cumulus, stratocumulus and cumulonimbus as well as lenticular/cap, orographic and pyrocumulonimbus clouds**
      vi. **Fog types and formation: advection, freezing, precipitation, radiation, steam & valley fog**
      vii. **Precipitation:**
         (1) **types and formation:** snow, snow grains, rain, drizzle, ice pellets (sleet), hail, graupel, freezing rain, freezing drizzle
         (2) **hazards:** training thunderstorms, flash and river flooding and snow and ice storms
      viii. **Atmospheric optical effects**: sundogs, rainbows, **halos, and mirages**
      ix. **Atmospheric pressure**: horizontal & vertical gradients, **troughs & ridges**, cyclones **(lows)** & anticyclones (highs) and their circulations, including Coriolis Effect & friction
      x. **Origin and characteristics of air masses:** temperature, density, moisture & atmospheric stability
      xi. **Characteristics of fronts and boundaries**: warm, cold, occluded (complex) and stationary fronts, dry lines
      xii. **Local winds:** Chinook and Santa Ana winds, sea, **lake** & land breezes, valley & mountain breezes
      xiii. **Effects of topography on winds & precipitation patterns**
      xiv. **Storms and other hazardous weather**: cyclogenesis **& cyclolysis**, Alberta Clippers, panhandle hook, nor'easters, **Lake Effect snowstorms**, ice storms, winter storms, **blizzards**, thunderstorms (not severe), fire weather, **heat waves, drought, dust storms, dust devils; Questions will not address the following types of severe storms: tropical storms, hurricanes, severe thunderstorms and/or tornadoes.**
      xv. Weather instrumentation & technology: thermometers, anemometers, barometers, satellite imagery (visible, infrared & water vapor), radiosondes, rawinsondes, Doppler radar, wind profilers, rain gauges, snow boards
      xvi. **Weather data: meteograms, radiosonde soundings, station models and METAR observations**

xvii. **Surface weather maps**: **highs, lows, fronts, dry lines, station model**, isobars, isotherms, **isohyets, areas of precipitation, and interpretation to understand and predict weather events**
xviii. Upper air charts: 850, 700, 500 & 300 mb, jet streams, ridges, & troughs
xix. **Weather forecasting**:
  (1) weather **forecast** maps, meteograms, **isolines**/isopleths, fronts, Doppler radar images, model predictions, **radiosonde soundings**, Stüve diagrams
  (2) National Weather Service non-severe forecast products: **Zone forecasts, Public Information Statements**
  (3) hazard map advisories, **watches and warnings** (e.g., dense fog, flooding, high winds, associated with non-severe weather)
xx. Temperature indices: wind chill, heat index, and heating & cooling degree days

4. **SAMPLE QUESTIONS/TASKS:**
   i. Interpret station models.
   ii. **Analyze isobars to determine areas of highest wind speeds.**
   iii. **Analyze a meteogram to determine whether a cold, warm or stationary front passed and at what time.**
   iv. **Examine a surface weather map and interpret the weather conditions at different locations.**
   v. Use upper-air charts with surface maps to predict the trajectories of high- and low-pressure systems.
   vi. Interpret local weather conditions using satellite imagery.
   vii. **Decode & interpret METAR observations.**
   viii. **Determine if and the type of precipitation that would be observed at the surface based on a radiosonde sounding.**
   ix. Given stations with temperatures and dew points, which one has the highest relative humidity?

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org

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SOLAR SYSTEM

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

1. **DESCRIPTION:** Participants will demonstrate an understanding and knowledge of **habitability within and beyond the Solar System.**

   A TEAM OF UP TO: 2 **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.
3. **THE COMPETITION:**
   a. **Participants will be asked to identify the following objects/systems and, if applicable, surface/atmospheric/spectroscopic features associated with these objects/systems as they appear on diagrams, plots, maps, or images. They must also be knowledgeable about the structures and properties of these objects/systems, with particular emphasis on how these objects/systems may satisfy the criteria thought to be required for originating and/or sustaining extraterrestrial life. Exams should not contain detailed questions about other objects/systems unless sufficient background information is provided.**
      i. **Solar System Objects: Venus, Mars, Europa, Enceladus, Titan, 101955 Bennu, & 67P/Churyumov-Gerasimenko**
      ii. **Extrasolar Systems: TRAPPIST-1, Kepler-186, TOI-700, and Proxima Centauri**
   b. Participants may also be tested on the following topics:
      i. **Techniques used to assess an object's habitability, including, but not limited to: using spectroscopy to detect specific compounds in atmospheres, analyzing images of surface features to study geologic activity, and estimating objects' surface conditions.**
      ii. **Engineering design principles and science objectives/discoveries associated with the following: DAVINCI+, VERITAS, Spirit/Opportunity, Phoenix, Curiosity, Perseverance/Ingenuity, Mars Reconnaissance Orbiter, MAVEN, Galileo, Europa Clipper, Cassini, Dragonfly, OSIRIS-REx, Rosetta, Spitzer, Kepler, JWST, and TESS.**
      iii. **Basic understanding of mathematical concepts in the context of habitability, including, but not limited to: Kepler's Laws, equilibrium temperature and energy budgets, and tidal forces. Exams should not contain any questions that require a calculator.**
      iv. **Exoplanet detection and characterization techniques limited to transits, radial velocity, and direct imaging.**
      v. **Basic biology and chemistry in the context of habitability, including, but not limited to: extremophiles, building blocks of life on Earth (e.g., proteins, nucleic acids, etc.), spectroscopy, atmospheric chemistry, and different forms of water.**
      vi. **General characteristics of asteroids and comets in the Solar System.**
4. **SAMPLE PERFORMANCE TASKS:**
   a. **Given an image of a surface feature, identify the surface feature, estimate its age, and explain how that feature is thought to have been formed.**
   b. **Describe how data from a magnetometer could be used to infer the presence of a subsurface ocean on an icy moon.**
   c. **Explain the difference between detecting *evidence of life* and detecting *areas of habitability*. Do you think that an instrument that measures chemical signatures is a better tool for detecting *evidence of life* or *areas of habitability*? Why?**
   d. **When the Sun becomes a red giant, its radius will become about 100 times larger, but its temperature will be halved. By what factor would we expect the equilibrium temperature of Europa to change? Assume all other variables (e.g., Europa's albedo) to stay the same.**
5. **SCORING:**
   a. High score wins.
   b. Each task or question will be assigned a predetermined number of points.
   c. Selected questions will be used to break ties.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org

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

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