

MATERIALS SCIENCE

- 1 **DESCRIPTION:** Teams will answer a series of questions or complete a task involving the science processes of chemistry focused in the areas of **Materials Science**.

TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

2 **EVENT PARAMETERS:**

- a. **Students** must bring
- A handheld calculator
 - A pencil
 - one 5 x 7 notecard with notes written in pencil only
 - protractor and handheld magnifying lens
- b. **Event Supervisors** must provide
- Periodic table
 - Any materials needed for modeling
 - Any constants needed

- c. **Safety Requirements:** Students must wear the following or they will not be allowed to participate: close-toed shoes, OSHA approved chemical splash goggles with indirect vents, pants or skirts that cover the legs to the ankles and a lab coat or apron that reaches below the knees. Gloves are optional. Students who unsafely remove their safety clothing/goggles or are observed handling any of the material or equipment in a hazardous/unsafe manner (e.g., tasting or touching chemicals or flushing solids down a drain and not rinsing them into a designated waste container provided by the supervisor) will be disqualified from the event.



3 **THE COMPETITION:**

- The competition will consist of a series of stations. These stations could include hands-on activities, questions about each topic, interpretation of experimental data (graphs, diagrams, models, etc.), and/or observation of an experiment set up and running. Supervisors are encouraged to use computer or calculators with sensors/probes wherever possible. Students may be asked to collect data using probeware that has been set-up and demonstrated by the Supervisor. Or the supervisor may provide students with data sets collected by such sensors/probes following demonstration of the data collection. Digital microscopes connected to computers are encouraged. Data will be presented in a tabular and/or graphic format and students will be expected to interpret the data. Students should be aware that nomenclature, formula writing, and stoichiometry are essential tools of chemistry and may be included in the event at any time. Stoichiometry includes, for example, such abilities as mole conversions and percentage yield. For purposes of nomenclature and formula writing, students are expected to know the symbols and charges for the following ions by memory: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate, and hydroxide. Students should know how to use the “ite” form of an ion, which is one less oxygen than the “ate” form. Students should be able to use the periodic table to obtain the charge for monatomic ions (e.g., Na^+ , S^{2-} , etc.).
- The lab portion may be run in microscale.
- Cleanup should occur after all materials have been returned or a penalty may be given.
- Students may be expected to prepare data tables and/or construct graphs of the data. Completeness, accuracy and quality of data tables and graphs will be taken into account.
- All measurements must be recorded with correct significant figures and units. All calculations must also include correct significant figures and units.

A. Surface Tension/Contact Angle

Students will be provided materials to evaluate provided surfaces and/or design a droplet/surface system that is described by the event supervisor on the day of competition. Possible materials provided by the Event Supervisor are: water, ethanol, methanol, isopropyl alcohol, mineral oil, liquid dish detergent, canning wax, anti-fog, salt water, bar soap

B. Solid State Chemistry

Student will be provided models or images to evaluate and/or create solid-state crystal structures. Students will then be asked solid-state chemistry questions related to these models and/or images.

C. SAMPLE QUESTIONS:

a. Surface Tension/Contact Angle:

1. Based on droplet characteristics, characterize the hydrophobicity/hydrophilicity of the provided surfaces. For example, students may be asked to identify unknown surfaces or rank the hydrophobicity of the provided surfaces.
2. At the Regional and State Level: Students will be provided images to measure contact angles and will answer question related to these contact angle measurements.
3. At the National Level: Students will be asked to create a droplet/surface to meet the contact angle designated by the Event Supervisor.

b. Solid State Chemistry: Students will complete experimental or modeling tasks and/or answer questions related to Solid State Chemistry. Students may be expected to complete labs/activities such as:

1. Using materials supplied by the event supervisor model packing for cubic crystal structures.
2. Answer questions related to unit cell characteristics and properties such as formula, density, and dimensions. Miller Indices will be utilized in questions and answers.
3. At the State and National levels, students will be asked to calculate unit cell dimensions from x-ray diffraction data.

D. **SCORING: Surface Tension 50% and Solid State Chemistry 50%.** All ties will be broken by selected questions chosen by the supervisor. These questions may or may not be identified to the students.

RECOMMENDED RESOURCES:

NATIONAL SCIENCE EDUCATION STANDARDS:

- a. Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methodology to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.
- b. A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gasses in the atmosphere, burning and processes of fossil fuels, the formation of polymers and explosions. Knowledge of the structure of matter is necessary to understand materials properties.
- c. Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles.