

1. **DESCRIPTION:** Teams will answer a series of questions or complete a task involving the science processes of chemistry focused in the areas of **Acids & Bases and Titration Race**.

**A TEAM OF UP TO: 2**

**APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**

- a. **Students must bring:** A non-programmable/non-graphing calculator and chemical splash goggles. No reference materials are allowed, but bring something to write with.
- b. **Event Supervisors must provide:** An acid of up to 0.2 M (up to 100 mL/team); A standardized base of up to 0.2M (up to 100 mL/team); Phenolphthalein indicator &/or pH probes; 2 funnels & a wash bottle containing < 250 mL DI or RO; Two burettes (or pipettes, etc.), one for acid and one for base, and an appropriate container for a titration given the size of the burettes provided; A card for students to report the concentration and Stan. Dev. of the acid for the titration race; Whatever other reagents/glassware are appropriate for the tasks students are asked to do in the acids and bases part; Any polyatomic ions not included in the group to be memorized below; Periodic Table; 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:**

- a. **Acid-Base:** Stations (similar to those in a first year chemistry class) could include hands-on activities, questions about each topic, interpretation of experimental data (graphs, diagrams, etc.), and/or observation of an experiment set up and running. Supervisors are encouraged to use computers 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. 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.,  $\text{Na}^+$ ,  $\text{S}^{2-}$ , etc.).
  - i. The lab portion may be run in microscale.
  - ii. Cleanup should occur after all materials have been returned or a penalty may be given.
  - iii. 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.
  - iv. All measurements must be recorded with correct significant figures and units. All calculations must also include correct significant figures and units.
- b. **Titration Race:** Students will complete an acid-base titration using a burette and phenolphthalein or a pH sensor, or a combination of the two, to determine the concentration of an acid and the standard deviation. See [www.soinc.org](http://www.soinc.org) for sample titration procedures.

4. **SAMPLE QUESTIONS: Acid-Base Chemistry:** Students will complete experimental tasks and answer questions related to acid-base chemistry. Students may be expected to complete labs/activities such as:

- a. Properties & Uses of Common Acids ( $\text{HCl}$ ,  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{H}_2\text{CO}_3$ , acetic and ascorbic acid) and Bases ( $\text{NaOH}$ ,  $\text{KOH}$ ,  $\text{Ca}(\text{OH})_2$ ,  $\text{Mg}(\text{OH})_2$ , and  $\text{NH}_3(\text{aq})$ ).
- b. Acid/Base indicators (pH ranges and color changes will be provided). Use of indicators, NOT theory of how they work, is the emphasis. Reactions of acids and bases will be limited to metals, carbonates, bicarbonates, sulfites, bisulfites, oxides, and neutralization reactions.
- c. Titrations to determine percent composition, molarity, and/or molecular mass.
- d. Additional calculations will be limited to  $K_a$ ,  $K_b$ , pH, pOH, and dilution. NO calculations or questions about buffers will be included.

5. **SCORING: Acids & Bases: 50%** (points will be awarded for correct answers/proper technique. Ties will be broken by selected questions chosen by the supervisor. These questions may or may not be identified. **Titration Race: 50%** (students will be ranked by accuracy/precision and ties will be broken by time).