Chemistry Lab-2019
Division C

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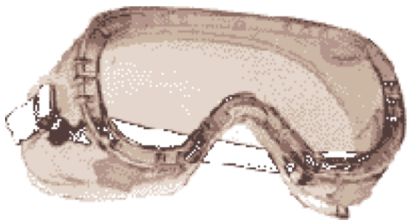
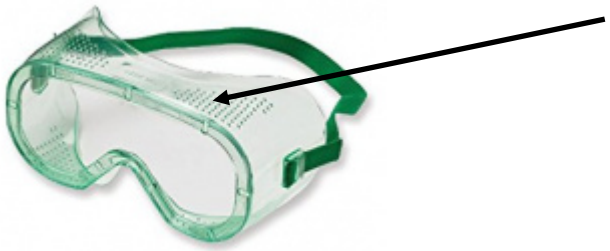
Required for the event:

- Category C Eye Protection: Safety goggles with Indirect Vent such as the two shown on above right but not the one below where there are direct vents
- Lab coat or chemical splash apron, closed-toed shoes, and long pants and sleeves
- Long haired tied back





Items to bring for the event:

- **1** page of double-sided, 8.5” by 11” sized papers of notes per team containing any information/source (recommended: sheet protector, easily readable, diagram, color)
- 2 stand-alone non-programmable, non-graphing, non-camera capable calculators per team
- Writing utensil

Team consideration

- Two students per team, communicate well with each other
- Test is long and include both written and hands-on components
- Both students need to work at different parts of the test concurrently in order to do well
- One student should be strong in answering written questions
- One student should be good in lab and able to think on his/her feet

Focus Areas for 2019: Physical Properties Acids and Bases

- Physical properties—50% and same focus area as last year
- Acids and bases—50% added to this year's rotation and continue to next year

- Physical property: Any property that can be measured or observed without changing the chemical composition of a substance
- Can include a wide variety of topics listed on the next slide

Physical properties continued

List: density, color, specific gravity, specific volume, thermal expansion, gases (velocity, volume, density), electrical resistance, elasticity/brittleness, magnetism, liquid (density measurement, viscosity, surface tension, solubility), solid (density measurement, refractive index, magnetism, conductivity, solubility, flexibility, elasticity), properties related to phase transition (phase diagram, boiling and melting point), polarity, heat capacity, energy associated with physical changes, separation method based on physical properties.

Physical properties continued

- Know the difference between intensive & extensive properties
- Know the common technique/instrument for measuring a variety of physical property
- Can include comparing/contrasting the physical properties of two substances
- Can include separation methods based on difference in physical properties of substances in a mixture
- Can include analysis of phase diagram
- Can include magnetic property, polarity, heat capacity, etc.

Physical properties continued

An example of question from last year's state test: 25 g of NaCl is added to 100 mL H_2O and dissolved. List 4 intensive physical properties of the resulting solution that are different from those of the pure solvent. For each intensive physical property, indicate whether the value for the solution is higher or lower compared to that of the pure solvent. 4 pairs of answer in the format of (property, higher/lower; property, higher/lower...).

Physical properties continued

More examples from last year's state test:

- Carbon steel is an example of interstitial alloy where carbon atoms occupy the interstitial positions created by the solvent iron atoms.

a. What physical property is enhanced in the alloy compared to pure iron?

b. What physical property is compromised in the alloy compared to the pure iron?

- List the following substances in order of decreasing melting temperature:

  Fe, CO_2, Xe, NaCl, and diamond.

Acids and Bases

- Definition: Arrhenius, Brønsted-Lowry, Lewis
- Nomenclature and formula of common acids and bases
- Properties & uses of common acids and bases
- Strong vs. weak acids/bases, Factors affecting acid strength
- Mono- and poly- protic acids, bases with 1 & >1 OH^- per formula unit
- Know pH, pOH, $[H_3O^+]$, $[OH^-]$, K_w, K_a, K_b, pK_a, pK_b
- Henderson-Hasselbach equation, ICE analysis
- Concentration and dilution calculation

List of Common Acids/Bases

- Common strong acids: HCl, HBr, HI, $HClO_4$, $HClO_3$, H_2SO_4, HNO_3
- Examples of common weak acids: HF, CH_3COOH
- Acid list from this year's rules: HCl, HNO_3, H_2SO_4, H_3PO_4, H_2CO_3, acetic acid, and ascorbic acid
- Base list from this year's rules: $NaOH$, KOH, $Ca(OH)_2$, $Mg(OH)_2$, and NH_3 *(aq)*

Acid base reaction scope (added from this year's rules)

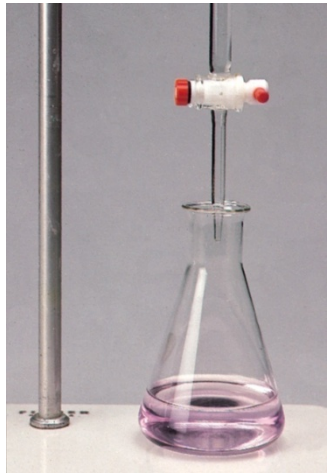
- Reactions involving metals
- Reactions involving carbonates & bicarbonates
- Reactions involving sulfites & bisulfites
- Reactions involving oxides
- Neutralization

Acids and Bases: Titration

- Lab activity likely involve titration, be sure to practice with titration
- Titration: A quantitative analysis where an acid and a base are mixed together until the combined solution reaches stoichiometric point. The concentration of one of the solution is accurately known and placed in a burette, this is known as titrant. The titrant is slowly added to a known volume of the other solution with unknown concentration placed in a flask. This is known as analyte. A color indicator is added to the analyte so that the endpoint of titration can be visualized.
- $M_a \times V_a = M_b \times V_b$ calculation

Acids and Bases: Titration

- A solution of accurately known concentration is added gradually added to another solution of unknown concentration until the chemical reaction between the two solutions is complete.
- Indicator – substance that changes color at (or near) the equivalence point
- Equivalence point – the stoichiometric point at which the reaction is complete
- Endpoint – The point at which the indicator changes color



Acids and Bases: Titration

- Write balanced chemical equation of acid base reaction (molecular and net ionic equation)
- Be familiar with common color indicators used in titration, an example of website on indicator: http://chemistry.bd.psu.edu/jircitano/abindic.html

  indicator color and pH ranges will be provided; no theory needed
- Buffers: what constitutes a buffer, its effect, buffering capacity, buffering range (state & national level)
- Features of a titration curve: equivalence pt, half-equivalence pt, pK_a, polyprotic acid vs. monoprotic acid
- Titration curves of strong acid-strong base, weak acid-strong base, strong acid-weak base

Acids and Bases continued (state level)

- There may also be questions related to environmental chemistry involving impact of industrial pollution and natural disaster like volcanic eruption on the pH of air, water, and soil

- Substances that affect the pH of air, water, and soil

Additional need to know topics

In addition, the test is written assuming that students also know:

- Formula Writing/Nomenclature
  - Symbol and Charge of Common Polyatomic Ions
  - Symbol of Common Elements
  - Formula of Common Compounds (Ionic, Molecular, Simple Organic compounds)
- Mole & Stoichiometry Calculations
  - Molar mass
  - Concentration Expression: molarity, molality, % m/m, % m/v, % v/v
  - Limiting Reactant
  - Theoretical & % yield

Clean up and follow the rules

- Tournament is run in tight schedule with multiple rotations of stations
- Timing is critical
- Students need to leave some time for cleaning up their area before moving on and may be penalized up to 10% if marked as not clean enough
- Up to 10% penalty may be assessed if a team brings disallowed items at the check-in to the event

Need to know topics

- Students are expected to be proficient at dimensional analysis and unit conversion
- Students need to report answers following the significant figure rules in calculation and answers for work problems need to include appropriate unit whenever applicable
- The test for state tournament will be more in depth compared to the test for regional tournament

Hands-on Activity

This is last year's state tournament activity on physical properties: Separation of the red and blue dye from grape flavored Kool-Aid solution using mini-column chromatography

References for this activity:
https://www.waters.com/webassets/cms/library/docs/sp79020.pdf

https://www.flinnsci.com/api/library/Download/f240c19c570e4596b65409131ac22db1