FORENSICS

1. **DESCRIPTION**: Given a scenario and some possible suspects, students will perform a series of tests which, along with other evidence or test results will be used to solve a crime

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 minutes

2. **EVENT PARAMETERS:**
   a. **Students** may bring only these items:
      i. Test tubes and test tube holders or any devices in which they can perform the tests, droppers, funnel (s), filter paper, pH or litmus paper, spatulas, plastic spoons or stirring rods, 9-volt conductivity tester (no testers will be allowed that run on AC current), thermometer, flame test equipment (nichrome wire, cobalt blue glass, etc.), slides, ruler, hand lens, writing instruments, a pencil (for chromatograms), paper towels, and metal tongs. (Students not bringing these items will be at a disadvantage. The event supervisor will not provide them.)
      ii. Each team member may bring one 8.5 X 11 sheet of paper with hand written notes on either or both sides, and a non-programmable calculator.
   b. **Supervisor** will provide: Iodine reagent (Iodine dissolved in KI solution), 2M HCl, 2M NaOH, Benedict's solution, (no more than 50 mL of each of the solutions) a hot water bath, **a Bunsen burner or equivalent BTU** heat source to perform flame tests, a method that may be used for differential density tests on plastics, a waste container, chromatography materials, and a wash bottle with distilled water (no more than 250 mL). The supervisor will provide a candle and matches for burn tests on the fiber samples. Flame tests may not be done on the polymers. The supervisor may provide other equipment (such as a microscope) or reagents to perform additional tests.
   c. **Safety Requirements**:
      Students must wear pants or skirts that cover the legs to the ankles. In addition, students must bring and wear a lab coat or apron that reaches below the knees. Students must wear closed toed shoes and OSHA approved non-vented or indirect vented chemical splash goggles. Students who fail to meet any of the above safety requirements will not be allowed to participate. Tasting or touching the chemicals will result in disqualification. Gloves are optional. Students who unsafely remove their safety clothing/glasses will be disqualified from the event. Anyone observed handling any of the material or equipment in a hazardous manner will be disqualified.
3. **THE COMPETITION:** There will be 4 parts and then the Analysis of the Crime. The event will consist of evidence from the first three parts and up to 2 parts from Crime Scene Physical Evidence at Regional, 3 parts from Crime Scene Physical Evidence at State and 4 parts of Crime Scene Physical Evidence at National.
   a. **Qualitative Analysis**: Substances to identify: sodium acetate, sodium chloride, sodium hydrogen carbonate, sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid, and ammonium chloride (there will be no mixtures). The team will be provided with 3-5 powders at Regional (4-8 at State and 6-8 at National) of the 15 substances listed above. All teams will have the same set of solids to identify. No more than 15 g of each substance will be given to the team.
   b. **Polymer Testing/Natural & Man-made Substances to identify:** PETE, HDPE, non-expanded (slide 7) PS, LDPE, PP, PVC, PMMA, PC, cotton, wool, silk, linen, nylon, spandex, polyester, human hair, dog hair, and cat hair. Students may not perform any burn tests on the PETE, HDPE, PS, LDPE, PP, PVC, PMMA or PC (burn test results on these plastics may be provided by the event supervisor). Burn tests will be permitted on the fibers. Students may use density tests, their senses, or other characterizations of the samples to identify them. Students will be given 4-7 samples at Regional, 7-10 at State, and 10-13 at National competitions.
   c. **Chromatography/Spectroscopy**: Students may be expected to separate components using chromatography and/or analyze mass spectra. Students may be expected to do paper or thin layer chromatography and measure R_fs (rate of flow). Students will be expected to do chromatograms on 1 type of material at Regional, 1-2 at State, and 2-3 at National.
   d. **Crime Scene Physical Evidence**:
      i. **Fingerprint Analysis**: Students will be expected to know the **8 NCIC classifications (arch, tented arch, radial loop, ulnar loop, plain whorl, central pocket whorl, accidental, and double loop). Students should also be familiar with the common fingerprint development techniques of dusting, iodine fuming, ninhydrin, and cyanoacrylate fuming.** Students should understand terminology such as bifurcation, ridges, island, enclosure, loop, whorl, and arch. Students should be able to answer questions about skin layers and how fingerprints are formed.

Students may be asked questions on the different methods of detecting fingerprints and the chemistry behind each of these methods.

ii. **DNA**: Students may be asked to compare DNA chromatograms/electropherograms from materials found at the scene to those of the suspects. Students will be expected to know how DNA is copied. See http://nobelprize.org/educational_games/chemistry/pcr/index.html

iii. **Glass analysis**: Students may be asked to use index of refraction to determine the type of a glass found broken at a crime scene. They may be asked to analyze which hole or fractures occurred before others based on a piece of glass available for examination or a picture of a piece of glass.

iv. **Entomology**: Students may be asked to identify how long an animal has been dead based on the type of insects found on the body at the scene.

v. **Spatters**: Students may be asked to analyze actual spatters or photographs of spatters to determine the angle and velocity with which the liquid approached the solid object bearing the spatter.

vi. **Seeds and Pollen**: Students may be asked to compare pictures of seeds or pollen found at the scene with either seeds or pollen found on the suspects or seeds or pollen from different regions of the country.

vii. **Tracks and Soil**: Students may be asked to match tire tracks or footprints found at the scene to tires or shoes of the suspects. Students may be given the composition of soil found at the scene or on the suspects and asked to determine if this implicates any of the suspects.

viii. **Blood:** Students may be asked to identify the ABO blood type using artificial blood (event supervisor required to provide instructions on how the typing system works) or students may be asked to identify if blood sample, either prepared microscope slide or pictures of microscope slide is human, avian, mammalian, or reptilian/amphibian.

ix. **Bullet striations:** Students may be asked to match the striations on bullets or casings found at the crime scene and fired from a given gun.

e. **Analysis of the Crime:** Students will be asked to write an analysis of the crime scene explaining not only which pieces of evidence implicate which suspect and why the suspect(s) was (were) chosen as the culprit(s), but also why the other suspects were not chosen. They will also answer any other crime scene analysis questions posed by the event supervisor.

4. **SAMPLE QUESTIONS:** The Collected Evidence And Other Data Given could be used in a mock crime scene analysis to solve a crime problem. A scenario will be developed such as the following: a bank robber enters the bank and hands the teller a note, which says, "Give me all your money." The robber escapes with the money, but a white powder remains. Later, suspects are brought in. Chromatographic analysis of the ink from their pens is performed in order to identify the robber. Each suspect's white powder is then compared with the powder found at the scene of the crime and so on.

5. **SCORING**: Team with the highest score wins. Time will not be used for scoring. The score will be composed of the following elements **(percentages given are approximate):**
   a. Part 3a 20%, Part 3b 20%, Part 3c 15%, Part 3d 15%, and 3e Analysis of the Crime 30%.
   b. Tiebreaker: Ties will be broken by the highest score on the analysis of the crime scene, which includes the reasons why certain suspects have been eliminated or others remain in the pool of possible criminals.
   c. A 10% penalty may be given if the area is not cleaned up as designated by the event supervisor.

Resources: Science Olympiad Website www.soinc.org, www.nobelprize.org, www.handsonplastics.com

National Science Education Standards:

- Carbon atoms can be bonded to one another in chains, rings, and branching networks to form a variety of structures including synthetic polymers, oils, and the large molecules essential to life.
- Chemical reactions may release or consume energy.
- 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 from 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
- Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles.
- In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A<G<C< and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome.

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