Potions & Poisons

Division B

Georgia Tech Event Workshop Series
2024-25

Science Olympiad at Georgia Tech®

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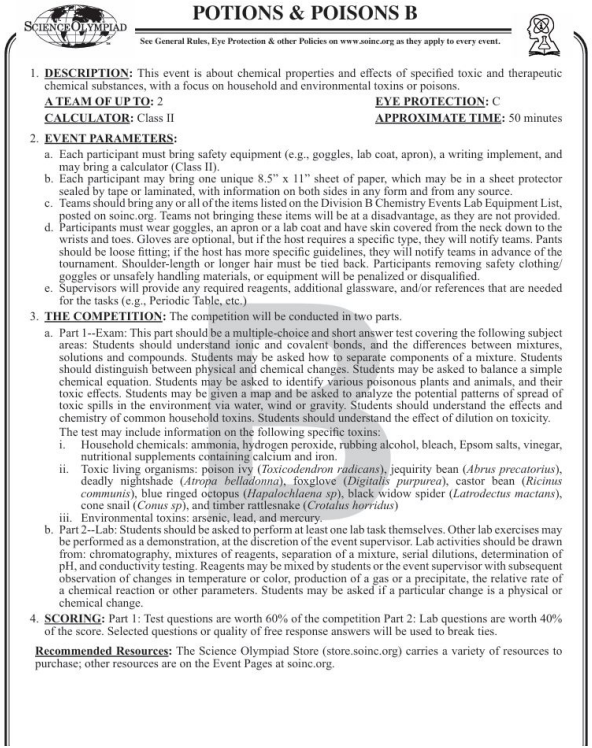
About Me

(Why you should trust me)

The Rules Sheet

- Basic chemistry (bonds, mixtures vs. solutions, physical vs. chemical changes)
- Lab skills (chromatography, pH testing, dilutions)
- Environmental spread of toxins
- Specific toxic organisms and household chemicals
- Written Test: 60%
- Lab Component: 40%
- **Safety**



POTIONS & POISONS B

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

1. **DESCRIPTION:** This event is about chemical properties and effects of specified toxic and therapeutic chemical substances, with a focus on household and environmental toxins or poisons.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C
   CALCULATOR: Class II **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each participant must bring safety equipment (e.g., goggles, lab coat, apron), a writing implement, and may bring a calculator (Class II).
   b. Each participant may bring one unique 8.5" x 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, with information on both sides in any form and from any source.
   c. Teams should bring any or all of the items listed on the Division B Chemistry Events Lab Equipment List, posted on soinc.org. Teams not bringing these items will be at a disadvantage, as they are not provided.
   d. Participants must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrists and toes. Gloves are optional, but if the host requires a specific type, they will notify teams. Pants should be loose fitting; if the host has more specific guidelines, they will notify teams in advance of the tournament. Shoulder-length or longer hair must be tied back. Participants removing safety clothing/goggles or unsafely handling materials, or equipment will be penalized or disqualified.
   e. Supervisors will provide any required reagents, additional glassware, and/or references that are needed for the tasks (e.g., Periodic Table, etc.)
3. **THE COMPETITION:** The competition will be conducted in two parts.
   a. Part 1--Exam: This part should be a multiple-choice and short answer test covering the following subject areas: Students should understand ionic and covalent bonds, and the differences between mixtures, solutions and compounds. Students may be asked how to separate components of a mixture. Students should distinguish between physical and chemical changes. Students may be asked to balance a simple chemical equation. Students may be asked to identify various poisonous plants and animals, and their toxic effects. Students may be given a map and be asked to analyze the potential patterns of spread of toxic spills in the environment via water, wind or gravity. Students should understand the effects and chemistry of common household toxins. Students should understand the effect of dilution on toxicity.
      The test may include information on the following specific toxins:
      i. Household chemicals: ammonia, hydrogen peroxide, rubbing alcohol, bleach, Epsom salts, vinegar, nutritional supplements containing calcium and iron.
      ii. Toxic living organisms: poison ivy (*Toxicodendron radicans*), jequirity bean (*Abrus precatorius*), deadly nightshade (*Atropa belladonna*), foxglove (*Digitalis purpurea*), castor bean (*Ricinus communis*), blue ringed octopus (*Hapalochlaena sp*), black widow spider (*Latrodectus mactans*), cone snail (*Conus sp*), and timber rattlesnake (*Crotalus horridus*)
      iii. Environmental toxins: arsenic, lead, and mercury.
   b. Part 2--Lab: Students should be asked to perform at least one lab task themselves. Other lab exercises may be performed as a demonstration, at the discretion of the event supervisor. Lab activities should be drawn from: chromatography, mixtures of reagents, separation of a mixture, serial dilutions, determination of pH, and conductivity testing. Reagents may be mixed by students or the event supervisor with subsequent observation of changes in temperature or color, production of a gas or a precipitate, the relative rate of a chemical reaction or other parameters. Students may be asked if a particular change is a physical or chemical change.
4. **SCORING:** Part 1: Test questions are worth 60% of the competition Part 2: Lab questions are worth 40% of the score. Selected questions or quality of free response answers will be used to break ties.

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

Annotate Your Sheet!

b. In addition, each team may bring writing utensils, two calculators of any type dedicated to computation, and five 8.5" x 11" sheets of paper that may contain information on both sides in any form and from any source. Other items not listed are prohibited. The event supervisors will check each team's kit, confiscate non-allowed items, and have the right to penalize a team up to 10% if additional items are in the kit.

c. Participants must bring and wear goggles, an apron or a lab coat, and have skin covered from the neck down to the wrist and toes. Gloves are optional; but if a host requires a specific type they must notify teams. Shoulder length or longer hair must be tied back. Participants who unsafely remove their safety clothing/goggles or are observed handling any mate
rial or equipment in an unsafe manner will be penalized or disqualified.

d. Event supervisors will provide each team with all required reagents and test solutions, any needed probes or other instrumentation, chromatography materials, and the answer sheet. The event supervisor may provide any other items or instructions deemed necessary.

THE COMPETITION:

PART I: Written Exam

a. This part will be a multiple-choice and short answer test covering the following topics/areas: ionic and covalent bonds; the difference between mixtures, solutions, and compounds; how to separate components of a mixture; distinguishing between physical and chemical changes; balancing a simple chemical equation; identifying various poisonous plants and animals, and their toxic effects; using a map analyze the potential patterns of spread of toxic spills in the environment via water, wind, or gravity; the effects and chemistry of common household toxins; the effect of dilution on toxicity. The test is limited to information on the following specific toxins:

i. Household chemicals: ammonia, hydrogen peroxide, rubbing alcohol, bleach, Epsom salts, vinegar, nutritional supplements containing calcium and iron.

ii. Toxic living organisms: Poison Ivy (*Toxicodendron radicans*), Poison Oak (*Toxicodendron diversilobum*), Death-cap mushroom *(Amanita phalloides)*, Jimson weed *(Datura sp)*, Mayapple *(Podophyllum peltatum)*, Ongaonga *(Urtica ferox)*, Cane toad (*Rhinella marina*), Pacific newt *(Taricha sp)*, Brown recluse spider *(Loxosceles recluse)*, and Fattail scorpion (*Androctonus australis*).

iii. Environmental toxins: iron, arsenic, and lead.

PART II: Lab

b. Participants will perform at least one lab activity by themselves. Other lab activities may be performed as a demonstration, at the discretion of the event supervisor. Lab activities may include: chromatography; mixtures of reagents; separation of a mixture; serial dilutions; determination of pH; conductivity testing; observation of changes in temperature, color, production of a gas or a precipitate after reagents have been mixed together by either themselves or the supervisor; calculation of the rate of a chemical reaction or other parameters; and identification of a particular change as either a physical or chemical change.

SAMPLE EXAM QUESTIONS/ACTIVITIES:


DIFFICULT
TOPICS

Potions (Chemistry)

- Need an extensive understanding of basic chemistry (HS level intro chem)
  - Ionic and covalent bonds
  - Mixtures, solutions, and compounds
  - Separation techniques
  - Physical vs. chemical changes
  - Basic equation balancing
- Requires **lots of practice**
  - Great to be **fast**

Potions (Chem Lab)

- Lab Safety is **the most important part**
  - Seen multiple teams DQ'd across **all levels** of competition.
- Common Lab Topics
  - Chromatography
  - Working with reagent mixtures
  - Mixture separation
  - pH determination
  - Observation of chemical reactions:
    - Temperature changes
    - Color changes
    - Gas production
    - Precipitate formation
    - Reaction rate analysis

Poisons (Toxins)

- Extensive knowledge required here
- Household Chemicals
  - Ammonia
  - Hydrogen peroxide
  - Rubbing alcohol
  - Bleach
  - Epsom salts
  - Vinegar
  - Calcium/iron supplements
- Toxic Organisms
- Environmental Toxins (and Cleanup)
  - Arsenic
  - Lead
  - Mercury

COMMON QUESTIONS

All of the following questions have been pulled from past YJI exams (which can be found on our website) or the Text Exchange on SciOly Wiki

Question 1: Equation balancing

23. What are 4 types of chemical reactions? How do you identify each?

Decomposition,Synthesis

24. Balance the following equations:

(a) $Fe + Cl_2 \longrightarrow FeCl_3$: **$2Fe + 3Cl_2 \rightarrow 2FeCl_3$**

(b) $Fe + O_2 \longrightarrow Fe_2O_3$: **4Fe+3O2 → 2Fe2O3**

(c) $FeBr_3 + H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + HBr$: **2FeBr3 + 3H2 SO4 → Fe2 (SO4) 3 + 6HBr**

Question 1: Equation balancing

6. The concentration of common household hydrogen peroxide is usually _3_ percent. (2 pts)

    a. You are given a 250 mL solution of 75 percent hydrogen peroxide. How much water do you need to add to dilute the solution to normal household levels? (2 pts)

$C_1V_1=C_2V_2$ $(.75)(250) = (.03)V_2$ $V_2 = 6250$ mL

Question 2: Changes

Physical and Chemical Changes

15. What is the difference between a physical change and a chemical change?

A physical change can be reversible and is a change in appearance, state of matter, shape, size, and in a chemical change cannot be reversible, as it is changing the chemical identity of the substance.

16. List 5 ways that something can change physically.

State of matter, size, shape, texture, color (not chemically, but for example if you colored a piece of paper)

17. List 6 indicators of a chemical reaction

Precipitate, change in color, formation of a gas, Change in temperature, change in chemical identity, new compound/chemical is formed.

For the next several questions, identify if each is a chemical or physical change and explain how you know.

18. Baking a cake-**chemical because it is irreversible and changes the chemical identity of the ingredients.**

19. Sublimating- **Physical because it is a change in state of matter.**

20. Dissolving salt into water- **Physical because it is reversible by evaporation (explained earlier)**

21. Nail rusting- chemical; **change in color**

Question 3: Poisons

25.

a. Common and scientific name **Poison Ivy Toxicodendron Radicans**
b. What is the toxin associated with the above picture? **Urushiol**
c. How does the toxin harm people? **Causes redness, swelling, Papules and Vesicles.**
d. What are some treatments? **Ointment and Antibiotic can help reduce swelling and itching.**
e. Is everyone affected by this toxin? **About 15-20% if the human population does not experience a reaction to urushiol.**

8. The toxin of *Amanita phalloides* is thermostable. Why is this significant? (2 pts)

   Cooking does not reduce the effect of its toxin

9. What is the difference between a poison and venom? (2 pts)

   Venom has to be injected while poison can be delivered through touch or ingestion

10. What's an easy way to lessen the effects of a toxic agent? (2 pts)

    Dilution

11. the common name with their scientific names (5 pts)

a. Cane toad - III	I. *Androctonis australis*
b. Mayapple - II	II. *Podophyllum peltatum*
c. Poison Oak - V	III. *Rhinella marina*
d. Brown Recluse Spider - IV	IV. *Lococseles recluse*
e. Fattail Scorpion - I	V. *Toxicodendron diversilobum*

Question 4: Labs

Lab Questions:

1. Label each solution as either strong acid, acid, neutral, base, or strong base (20 pts)
    a. pH 4 SA

    b. pH 4.6 A

    c. pH 10 Base

    d. pH 7 Neutral

2. How does pH paper work? (10 pts)

    The paper is coated with different pH indicators that change color depending on the pH of the solution for which it is used.

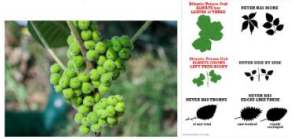
3. How does paper chromatography work? (10 pts)

    A mobile phase moves up the stationary phase and the compounds are separated based on the affinity it has to the mobile phase vs the stationary phase.

Tips from a Veteran

- Come up with a cheat-sheet divide ASAP
  - Create quick guides for common labs
  - In-depth information on toxins and organisms
  - Understand organizational involvement
  - Avoid having common chemistry things
- Don't depend on "provided reference materials"
- Practice labs, many of the labs are easily accessible and can be practiced fairly easily at a school
- Work well with your partner
  - Should one specialize in toxins vs chemistry?
  - How are y'all going to synchronize for labs?
  - **Time Management**

Cheat Sheet Tips

Specimen	Location/Origin	Form of Toxicity	Effect on Humans	Description
Common Name: Poison Ivy Genus: Toxicodendron Radicans Class: Magnoliopsida Order: Sapindales Family: Anacardiaceae	Asia and North America (throughout Eastern North  America)	Sap -Urushiol **The oxidation and polymerization of urushiol in the tree's sap in the presence of moisture allows it to form a hard lacquer, which is used to produce traditional Chinese, Korean and Japanese lacquerware.**	Causes Redness, Swelling, Papules, Vesicles,etc. Sensitivity depends on person. Ingestion - Causes irritation of the lips, tongue, mouth and GI tract, Very dangerous can cause death. **Essentially causes Dermatitis** 	Highly Variable trailing vine,or climbing by aerial rootlets. Its hairy trunk resembling a "hairy rope", hugs trees as it climbs. Leaves are alternate, with three leaflets, outermost leaf on longer stalk , irregularly toothed, smooth above, hairy beneath.When it grows near salt water, poison ivy very often takes on this waxy, curly look. But it grows well near the beach and is VERY common along East Coast beaches. When fall comes, the plant oil that causes the rash withdraws from the leaves into the stems and roots, which means the leaves might be somewhat less dangerous in the fall. 
Common Oak: Poison Oak Genus: Toxicodendron diversilobum Class: Magnoliopsida Order: Sapindales Family: Anacardiaceae	Western North America 	Surface oil on leaves and twigs -Urushiol **The oxidation and polymerization of urushiol in the tree's sap in the presence of moisture allows it to form a hard lacquer, which is used to produce traditional Chinese, Korean and Japanese lacquerware.**	Will cause a rash on anyone is allergic to it. Only 15-20% of the human population isn't allergic to Poison Oak. During an extreme reaction, you may experience difficulty breathing and feel your eyes swelling, be cautioned. 	An upright, bushy shrub, but sometimes sprawling, producing a vine-like appearance,; 3-6 ft. with stiff smooth branches. Compound leaves with 3 leaflets, round or even lobed, shiny, paler beneath. 
Common Name: Death-Cap Mushroom Genus: Amanita phalloides Class: Agaricomycetes Order: Agaricales Family: Amanitaceae	Europe, some parts of Western Asia, and Northern Africa 	Generally Poisonous (eaten), **Amatoxin, Phallotoxin, and Phallolysin. Deathcap can be used as therapy for brain tumors and lymphatic leukemia.**	30 grams can kill a person, extremely damaging to the liver and kidney. Accounts for 90% of mushroom fatalities in Europe. 	Solitary or clustered, medium to large mushroom. variable in all aspects. Cap is greenish and smooth, as well as somewhat sticky, roundish of flat, darker in the center, often with radiating streaks 2 1/2- 6 in. Stalks are smooth with occasional bands of, white to greenish yellow, tapering to bulbous base, 3-5 in. Gills white, close, free. Volvo cuplike, white to green, usually with projection on one side. Ring persistent, membranous, pendent, near top of stalk.
Common Name: Jimsonweed Genus: Datura stramonium Class: Magnoliopsida Order: Solanales Family: Solanaceae	North  America, Europe	Whole Plant - **Tropane Alkaloids, Atropine, Hyoscyamine Scopolamine, Tropane alkaleids are used as Anticholinergics. Which are used to treat dizziness. They work by inhibiting parasympathetic nervous responses. Hyoscyamine is also used to as an antispasmodic, anti tremor and to treat GI tract issues. Ulsers, pain, etc.**	Causes convulsions, hallucinations, and even death, if ingested. Climate change only increases the toxicity of plants like jimson weed. **It is used as medicine and ritual as well as prayers has also place this. Even being a poisonous plant, datura has been using since the ancient times by ayurveda physicians, spiritual purposes, holy men and its use in modern medicine drugs.** 	This plant is a summer annual which is 3-5 feet tall with branches that are dichotomous (meaning they split into two). The roots are long, thick, white, and fibrous. Its leaves are about 8-20 cm long. The upper surface is a darker green than the bottom. The flowers open at night, emitting a pleasant fragrance, and are fed upon by nocturnal moths.
Common Name: Mayapple Genus: Podophyllum peltatum Class: Magnoliopsida	Eastern US and Southeastern Canada	Unripe Fruit, Foliage, and Roots - **Podophyllotoxin has a variety of medical uses including Antiviral, Anti**	Podophyllotoxin - mostly safe. Podophyllin- Enteritis CNS Depression	It is unique as it only has 2 leaves and one flower. The large, umbrella-like leaves are showy and conspicuous. They remain closed as the stem lengthens, unfolding 6-8 inches across when the plant has reached its 1-1 1/2 ft. height. The solitary, nodding, white to rose-colored flower grows in the axil of the leaves and has 6-9 waxy white petals, with many stamens. The nodding fruit is a large, fleshy.

Name	Acid Color	pH Range of Color Change	Base Color	Name	Acid Color	pH Range of Color Change	Base Color
Methyl violet	Yellow	0.0 - 1.6	Blue	Phenolphthalein	Colorless	8.2 - 10.0	Pink
Thymol blue	Red	1.2 - 2.8	Yellow	Thymolphthalein	Colorless	9.4 - 10.6	Blue
Methyl orange	Red	3.2 - 4.4	Yellow	Alizarin yellow R	Yellow	10.1 - 12.0	Red
Bromocresol green	Yellow	3.8 - 5.4	Blue	Litmus	Red	5.0 - 8.0	Blue
Methyl red	Red	4.8 - 6.0	Yellow	Bromothymol blue	Yellow	6.0 - 7.6	Blue
Litmus	Red	5.0 - 8.0	Blue	Thymol blue	Yellow	8.0 - 9.6	Blue

Reagents

Reagents are "substances or compounds that are added to a system in order to bring about a chemical reaction or are added to see if a reaction occurs."[2] Some reagents are just a single element. However, most processes require reagents made of chemical compounds. Some of the most common ones are listed below.

Name	General Description	Name	General Description
Acetic acid	an organic acid; is one of the simplest carboxylic acids	Lime	used in Flue Gas Desulphurisation Power Plants
Acetone	an organic compound; simplest example of the ketones	Limestone	used in Flue Gas Desulphurisation Power Plants
Acetylene	a hydrocarbon and the simplest alkyne; widely used as a fuel and chemical building block	Lithium aluminium hydride	a reducing agent in organic synthesis; used to prepare main group and transition metal hydrides from the corresponding metal halides
Ammonia	inorganic; the precursor to most nitrogen-containing compounds; used to make fertilizer	Lithium diisopropylamide	strong base used in organic chemistry for the deprotonation of weakly acidic compounds
Ammonium hydroxide	aqueous ammonia; used in traditional qualitative inorganic analysis	Manganese dioxide	used as a pigment and as a precursor to other manganese compounds; used as a reagent in organic synthesis for the oxidation of allylic alcohols
Azobisisobutyronitrile	organic compound; often used as a foamer in plastics and rubber and as a radical initiator	Meta-Chloroperoxybenzoic acid	used as an oxidant in organic synthesis
Beeyer's reagent	is an alkaline solution of potassium permanganate; used in organic chemistry as a qualitative test for the presence of unsaturation, such as double bonds;	Methyl tert-butyl ether	a gasoline additive; also used in organic chemistry as a relatively inexpensive solvent
N-Bromosuccinimide	used in radical substitution and electrophilic addition reactions in organic chemistry	Millon's reagent	an analytical reagent used to detect the presence of soluble proteins
Butanone(methyl ethyl ketone)	organic compound; similar solvent properties to acetone but has a significantly slower evaporation rate	Nitric acid	highly corrosive and toxic strong acid; used for the production of fertilizers, production of explosives, and as a component of aqua regia
Butylated hydroxytoluene	a fat-soluble organic compound that is primarily used as an antioxidant food additive	Osmium tetroxide	in organic synthesis, is widely used to oxidize alkenes to the vicinal diols
n-Butyllithium	[organometallic] reagent; used as acopolymerizationinitiator in the production ofelastomericpoly(styrene-butadiene-styrene) (SBS)	Oxalyl chloride	used in organic synthesis for the preparation of acid chlorides from the corresponding carboxylic acids
Carbon disulfide	a non-polar solvent; used frequently as a building block in organic chemistry	Palladium(II) acetate	a catalyst for many organic reactions by combining with many common classes of organic compounds to form reactive adduct
Carbon tetrachloride	toxic, and its dissolving power is low; consequently, it has been largely superseded by deuterated solvents	Perchloric acid	a powerful oxidizing agent; readily forms explosive mixtures, mainly used in the production of rocket fuel
Carbonyldiimidazole	often used for the coupling of amino acids for peptide synthesis and as a reagent in organic synthesis	Phosphoric acid	a mineral acid with many industrial uses; commonly used in the laboratory preparation of hydrogen halides
Ceric ammonium nitrate	an inorganic compound; used as an oxidizing agent in organic synthesis and as a standard oxidant in quantitative analysis	Phosphorus pentachloride	one of the most important phosphorus chlorides; a chlorinating reagent. Also used as a dehydrating agent for oximes which turn them into nitriles.
Chloroform	organic compound; often used as CHCl3 (deuterated chloroform) as a solvent for NMR spectroscopy and as a general solvent;	Phosphorus tribromide	used for the conversion of alcohols to alkyl bromides
Chromic acid	a strong and corrosive oxidizing agent; an intermediate in chromium plating	Phosphorus trichloride	most important of the three phosphorus chlorides; used to manufacture organophosphorus compounds; used to convert primary and secondary alcohols into alkyl chlorides, or carboxylic acids into acyl chlorides
Chromium trioxide	the acidic anhydride of chromic acid, mainly used in chrome-plating	Phosphonyl chloride	used to make phosphate esters such as trixresyl phosphate
Collins reagent	used to selectively oxidize primary alcohols to aldehyde	Potassium dichromate	a common inorganic chemical reagent, most commonly used as an oxidizing agent in various laboratory and industrial applications
Copper(I) iodide	useful in a variety of applications ranging from organic synthesis to cloud seeding	Potassium hydroxide	a strong base; precursor to most soft and liquid soaps as well as numerous potassium-containing chemicals
Dess–Martin periodinane	chemical reagent used to oxidize primary alcohols to aldehydes and secondary alcohols to ketones	Potassium permanganate	a strong oxidizing agent; can be used to quantitatively determine the total oxidisable organic material in an aqueous sample; a reagent for the synthesis of organic compounds
Diborane	the central organic synthesis reagent for hydroboration	Pyridinium chlorochromate	used to oxidize primary alcohols to aldehydes and secondary alcohols to ketones

Additional Resources

Government Agencies (EPA, CDC, NOAA, USDA ARS)

Khan Academy for basic Chem

PubChem / Toxnet

MIT OCW: Toxicology and Environmental Health

THANKS!