

My Chemistry Olympiad Journey

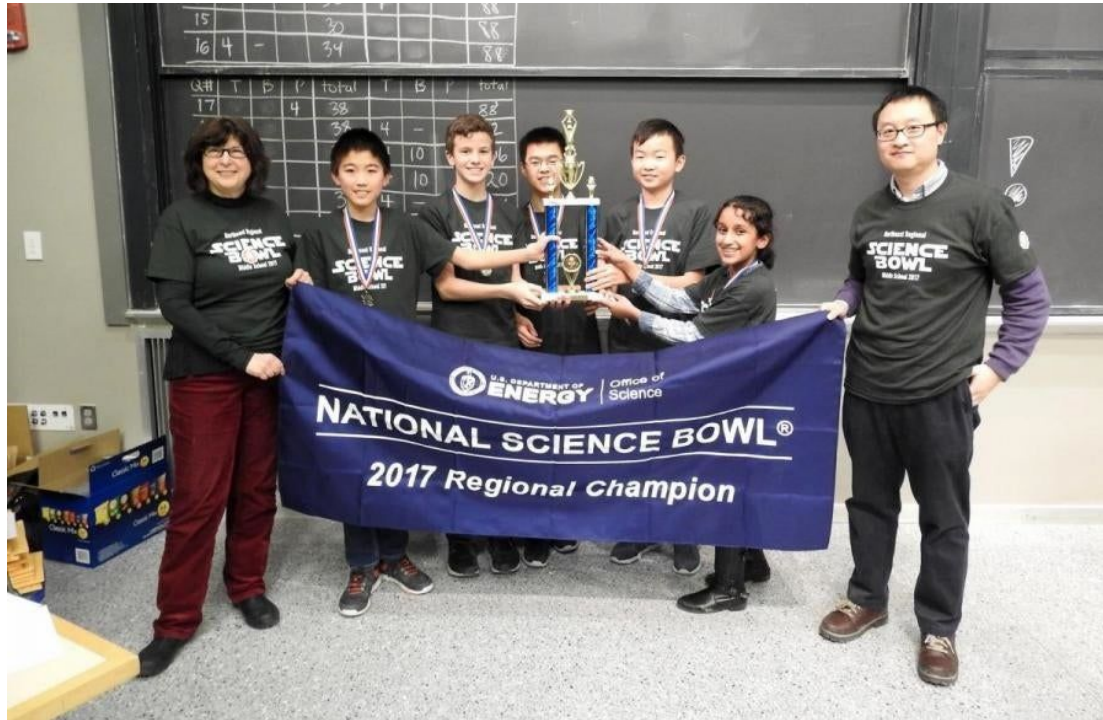
Alex Li

A dark blue diagonal graphic that starts from the bottom left corner and extends towards the top right corner, creating a triangular shape in the bottom right of the slide.

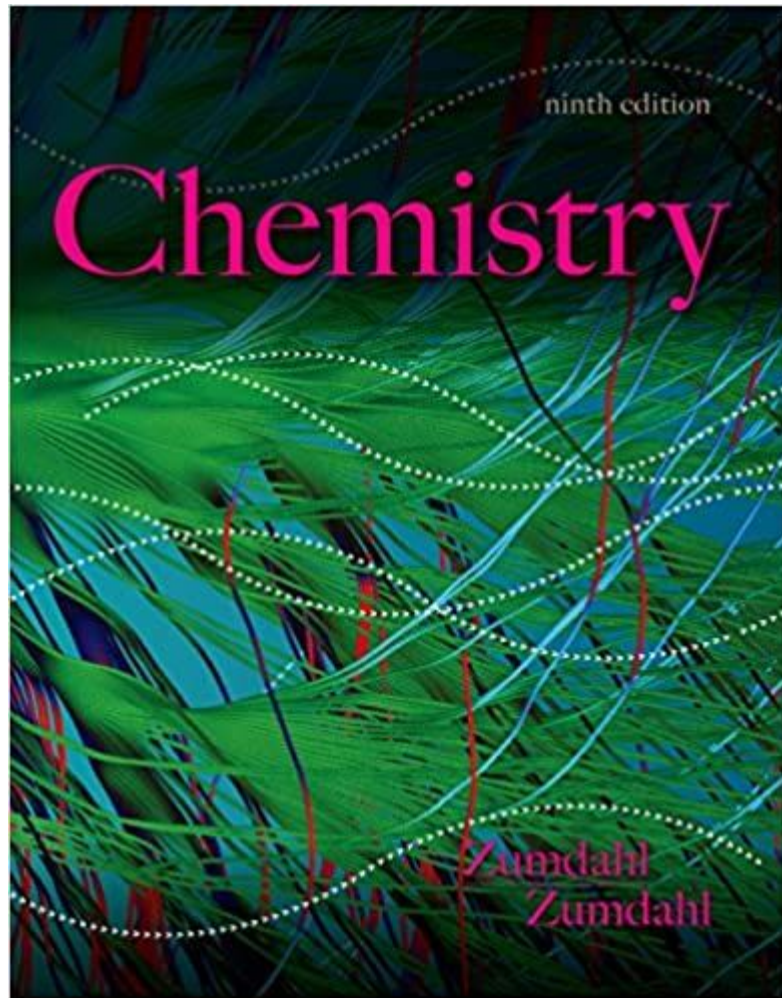
How did I get to where I am today?

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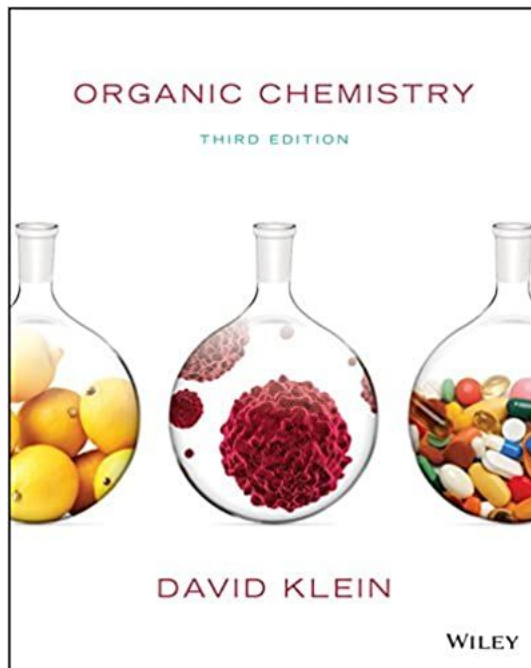
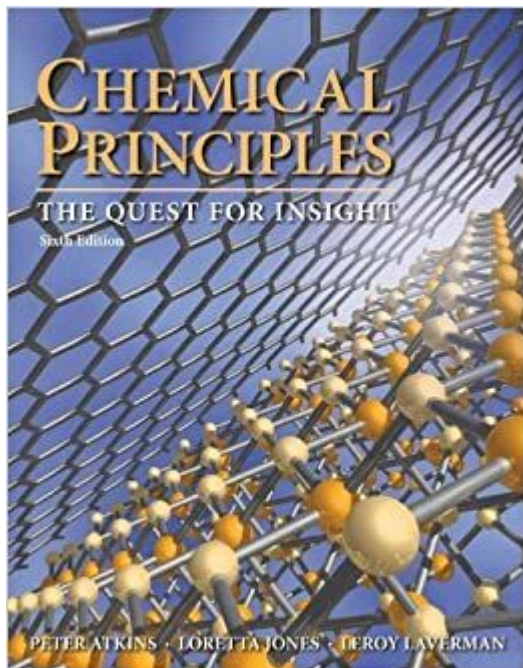
Middle School Science Bowl



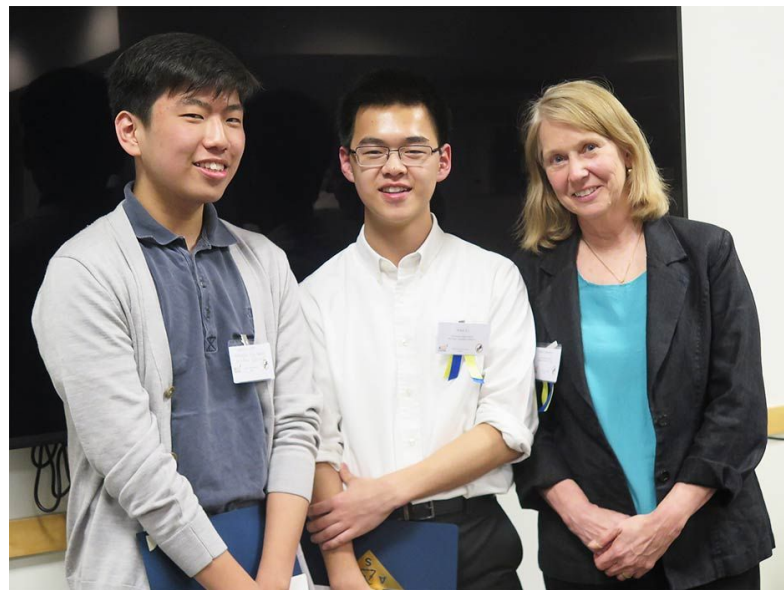
Going into High School



Studying my Freshman Year



Avery Ashdown Exam



ACS
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The National Exam



ACS USNCO
U.S. National Chemistry Olympiad



2018 U. S. NATIONAL CHEMISTRY OLYMPIAD NATIONAL EXAM PART I

Prepared by the American Chemical Society Chemistry Olympiad Examinations Task Force

OLYMPIAD EXAMINATIONS TASK FORCE

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DIRECTIONS TO THE EXAMINER – PART I

The USNCO Subcommittee continues conducting a survey in an effort to determine the impact of the Olympiad program on students. At the end of the exam there are four questions, which should be answered on the same Scantron sheet students use for the exam. These questions may be administered after the 90 minutes allotted for the exam, each student should be encouraged to answer these questions.

Part I of this test is designed to be taken with a Scantron answer sheet on which the student records his or her responses. Only this Scantron sheet is graded for a score on Part I. Testing materials, scratch paper, and the Scantron sheet should be made available to the student only during the examination period. All testing materials including scratch paper should be turned in and kept secure until April 23, 2018, after which tests can be returned to students and their teachers for further study.

Allow time for students to read the directions, ask questions, and fill in the requested information on the Scantron sheet. The answer sheet must be completed using a pencil, not pen. When the student has completed Part I, or after one hour and thirty minutes has elapsed, the student must turn in the Scantron sheet, Part I of the testing materials, and all scratch paper.

There are three parts to the National Chemistry Olympiad Examination. You have the option of administering the three parts in any order, and you are free to schedule rest breaks between parts.

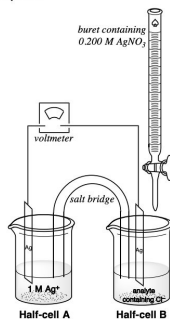
Part I	60 questions	single answer, multiple-choice	1 hour, 30 minutes
Part II	8 questions	problem-solving, explanations	1 hour, 45 minutes
Part III	2 lab problems	laboratory practical	1 hour, 30 minutes

A periodic table and other useful information are provided on page 2 for student reference.

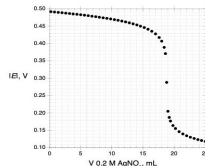
Students should be permitted to use non-programmable calculators. The use of a programmable calculator, cell phone, watch, or any other device that can access the internet or make copies or photographs during the exam is grounds for disqualification.

DIRECTIONS TO THE EXAMINEE – DO NOT TURN THE PAGE UNTIL DIRECTED TO DO SO. Answers to questions in Part I must be entered on a Scantron answer sheet to be scored. Be sure to write your name on the answer sheet, an ID number is already entered for you. Make a record of this ID number because you will use the same number on Parts II and III. Each item in Part I consists of a question or an incomplete statement that is followed by four possible choices. Select the single choice that best answers the question or completes the statement. Then use a pencil to blacken the space on your answer sheet next to the same letter as your choice. You may write on the examination, but the test booklet will not be used for grading. Scores are based on the number of correct responses. When you complete Part I (or at the end of one hour and 30 minutes), you must turn in all testing materials, scratch paper, and your Scantron answer sheet. Do not forget to turn in your U.S. citizenship/Green Card Holder statement before leaving the testing site today.

3. [12%] The amount of chloride in an unknown sample can be determined by potentiometric titration, which uses an electrochemical cell shown schematically below:



- a. During the titration, when some of the 0.200 M AgNO₃ solution has been added to the analyte, which half-cell (A or B) contains the anode of the electrochemical cell? Explain your reasoning.
A saline solution, consisting of NaCl dissolved in 5% dextrose solution, is analyzed using this technique. 100.0 g of the saline solution is placed in half-cell B and the voltage from the voltmeter is recorded as a function of the volume of added 0.200 M AgNO₃:

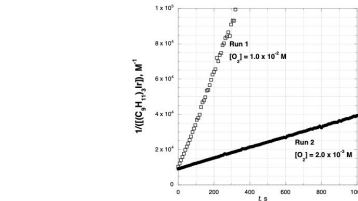
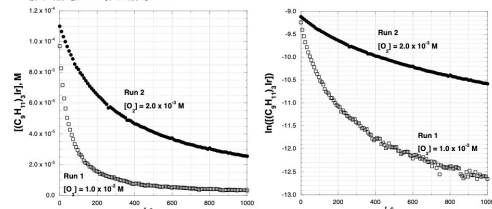


- b. Calculate the mass percentage of NaCl in the saline solution.
c. Calculate the concentration of free silver ion in half-cell B when 10.00 mL of titrant has been added.
d. Calculate the K_{sp} of AgCl(s).

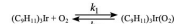
4. [12%] The air oxidation of an organoiodium compound (C₂H₃)₂I₂ takes place according to the following equation:



The reaction was studied with the initial [(C₂H₃)₂I₂] = 1.3 × 10⁻⁶ M under two different O₂ concentrations (run 1, [O₂] = 1.0 × 10⁻³ M; run 2, [O₂] = 2.0 × 10⁻³ M). The concentration of (C₂H₃)₂I₂ was measured as a function of time; below are plotted [(C₂H₃)₂I₂], ln[(C₂H₃)₂I₂], and 1/[(C₂H₃)₂I₂] vs. time.



- a. Is the order of the reaction in (C₂H₃)₂I₂ 0, 1, or 2? Justify your answer. (Even if the data are not exactly consistent with an integer order, pick the closest integer order.)
b. Is the order of the reaction in O₂ 0, 1, or 2? Justify your answer. (Even if the data are not exactly consistent with an integer order, pick the closest integer order.)
c. Calculate the rate constant for the reaction.
d. The following mechanism has been proposed. Is the mechanism consistent with the observed rate law? Explain your reasoning.



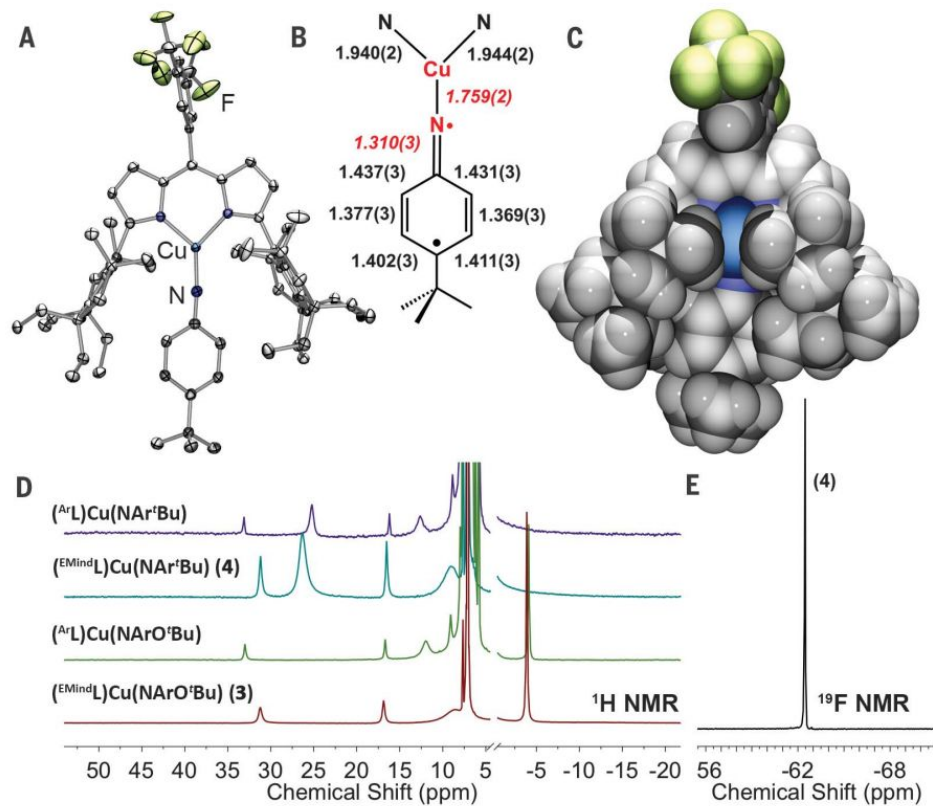
USNCO Study Camp 2018



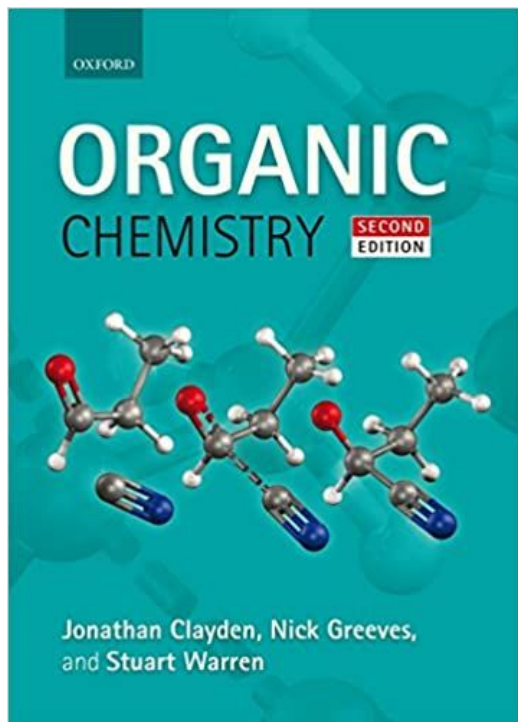


2018 Team USA earning 4 gold medals in Slovakia/Czech Republic.

Research at the Betley Lab



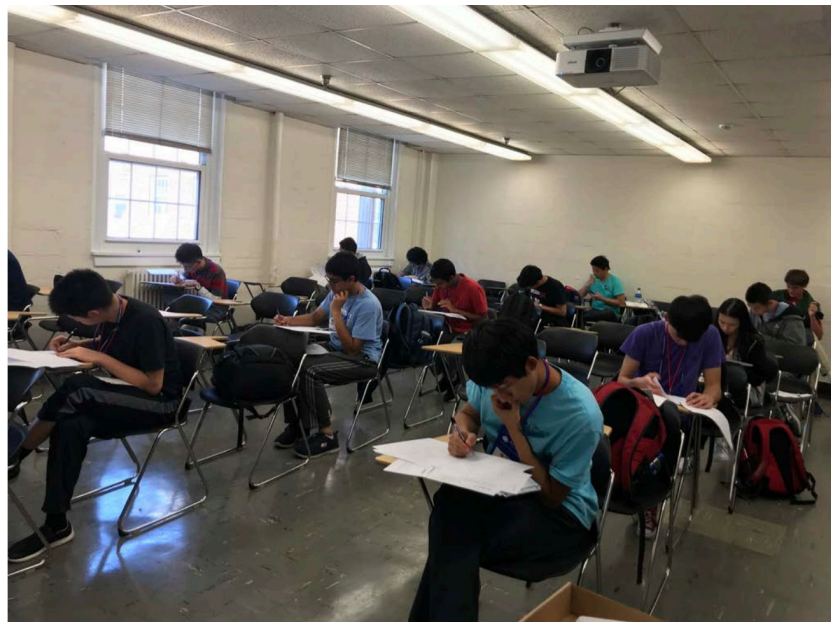
Studying my Sophomore Year



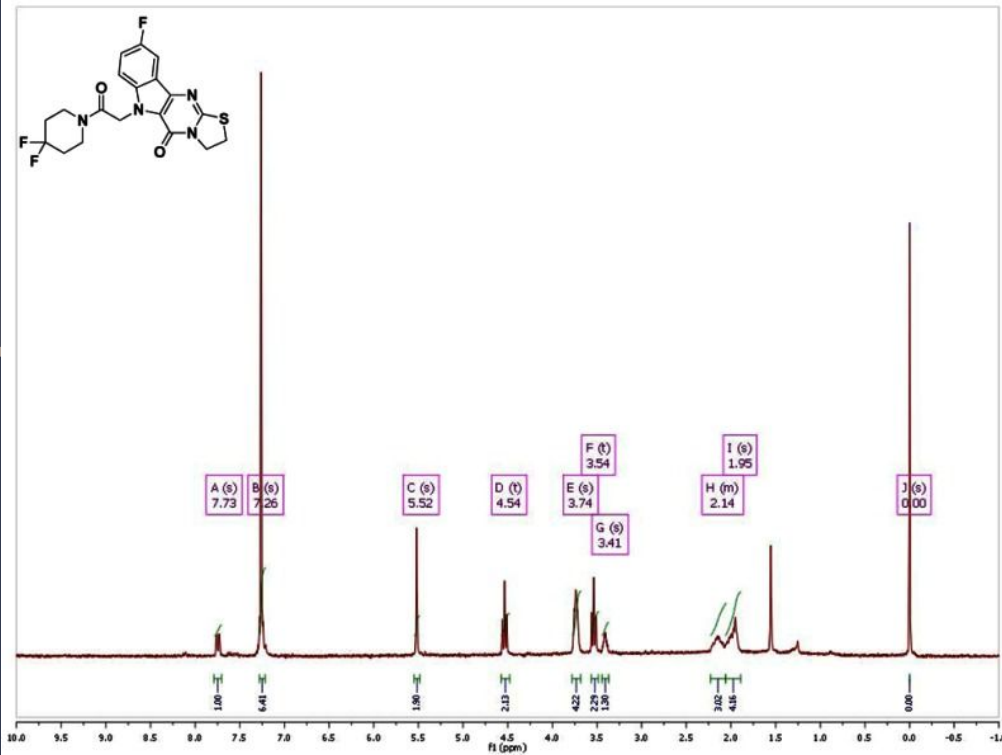
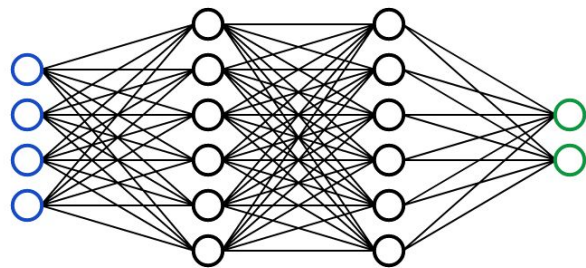
Washington, D.C. • USA



USNCO Study Camp 2019

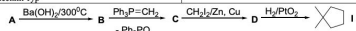


Research with the Jensen Group



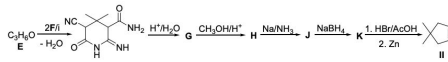
Studying my Junior Year

53-я Международная Менделеевская Олимпиада, 2019
 II теоретический тур Санкт-Петербург Задания



1. Расшифруйте соединения A, B, C, D, если A имеет простейшую формулу $C_8H_{10}O$, $w(H) = 6.85\%$ и титруется двумя эквивалентами щелочи; B и C – моноцикла, а D – спiroцикл, который в 1H ЯМР спектре имеет три сигнала одинаковой интенсивности.

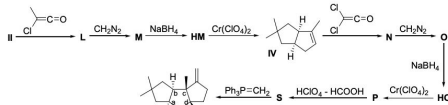
Для проведения каскадной полициклизации используйте α -диметилциклопропены. Синтез 3,3-диметилциклопентена (II) проведен в несколько стадий:



2. Расшифруйте соединения E, F, G, H, J, K, если G – гомолог A и содержит в спектре 1H ЯМР три сигнала (3 : 2 : 1); J и K – циклические структуры.

3. Выберите условие (i) проведения реакции E + 2F: а) $LiN(CH_3)_2$; б) $LiN(CH_3)Pr_2$.

Синтез природного полицикла хиреустана (X), включающий тащидую циклизацию, проведен из α -диметилциклопентена II:



4. Расшифруйте соединения L, M, NM, N, O, HO, P и S, если стадии L→M и N→O проходят с расширением цикла через образование неустойчивых дивинтер-ионов L' и N'; M, N, O, S в ИК-спектре имеют полосу – 1750 cm^{-1} .

5. Предложите структуру интермедиата L', образующегося как продукт нуклеофильного присоединения CH_2N_2 к L.

6. Установите, из каких исходных веществ получены кетены для реакций: II→L и IV→N: 1) $CH_3CHClCOCl$; 2) CH_3COCl ; 3) Zn/Cu ; 4) $(C_2H_5)_2N$.

7. Укажите конфигурацию атомов a, b, c, d в хиреустане X.

53-я Международная Менделеевская Олимпиада, 2019
 II теоретический тур Санкт-Петербург Задания

Задача 3

Распространённым топливом для зимнего обогрева загородных домов в России является сжиженный газ в баллонах, обычно представляющий собой смесь пропана и бутана.

Хозяин, приехавший к себе зимой, обнаружил, что температура в комнате и снаружи равна –10°C и зажёг печь. Баллон с жидким пропаном находится снаружи. Барометр на стене показал, что атмосферное давление было равно 760 мм Hg. Размер отапливаемой комнаты 20 м²×2.5 м.

- Запишите термохимическую реакцию сгорания пропана.
- Оцените молярную теплоёмкость C_V (Дж/моль·К) воздуха в комнате, считая, что он состоит только из азота и кислорода.
- Определите удельную тепловорную способность q_v пропана (Дж/г), используя подходящие данные из таблицы.

	$C_2H_6(g)$	$C_3H_8(g)$	$O_2(g)$	$CO_2(g)$	$H_2O(g)$	$H_2O(l)$
$\Delta_f H^\circ$ (298 K), кДж/моль	–120.9	–103.9	—	–393.5	–285.8	–241.8
S° (298 K), Дж/моль·К	195.2	269.9	205.0	213.7	70.0	188.7

- Какое количество пропана (г) потребуется для нагрева воздуха в комнате до температуры 20°C? Изменением теплоёмкости воздуха с температурой пренебрегите. Теплопроводность стены дома, нагрев стен и других предметов не учитывать. Все газы считайте идеальными.
- Вычислите давление (атм) насыщенного пара пропана по табличным данным.

Число ударов молекула газа об единицу поверхности стенки сосуда выражается формулой (P – давление газа, m – масса молекулы)

$$v = \frac{P}{\sqrt{2\pi m k_B T}} \quad (1)$$

- Обычно газ из баллона в горелку подается через редуктор для снижения потока газа.
- Какова максимальная (теоретически возможная, без редуктора) интенсивность I подачи ($г/с$) пропана, когда газ поступает к месту сгорания по широкой трубе, причём покинувшие баллон молекулы не возвращаются в него. Внутренний диаметр вертикально стоящего баллона с жидким газом $d = 20$ см.

После достижения нужной температуры в комнате барометр по-прежнему показывал давление 760 мм Hg.

- Как изменилась внутренняя энергия U воздуха в объёме комнаты (Дж) после достижения температуры 20°C?

Некоторые данные: 1 атм = 101325 Па, $R = 8.314$ Дж/моль·К, $k_B = 1.38 \cdot 10^{-23}$ Дж/К, а.е.м. = $1.66 \cdot 10^{-27}$ кг.

No. 3

doi: 10.18666/PKU.DXHX201910066

137

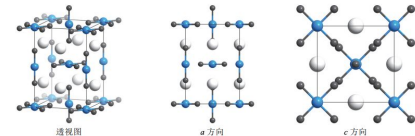


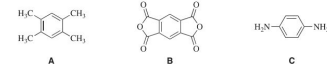
图1 $CsAuCl_4$ 的晶体结构

大球为 Cs, 小球为 Cl, 蓝色球为 Au. 电子能为 0

有同学在看到晶体结构后认为, Au(III)应为拉长的八面体六配位结构, 这种说法是不正确的. 其一, 若要将 Au(III)轴两个离子也算作配体, 那么离子的配位数也会上升为 $(6 \times 2 + 5 \times 4) = 5.33 > 5$, 与题意不符. 另外从科学性角度上讲, Au(III)的 $5d$ 电子构型处于平面四方配位场中时已为能量最低 ($d_{xy}^2, d_{xz}^2, d_{yz}^2$), 若此完全平面四方场向八面体场 (d_{xy}^2, d_{xz}^2) 过渡, 势必会导致轨道能量上升并导致整个体系能量上升, 因而不能认为晶体中的 Au(III)为六配位变形八面体结构. 事实上, 大多数的简单 d 配合物一般情况下通常为四配位平面四方形结构或四面体结构, 稳定的六配位八面体 d 配合物要少得多.

当然, 我们也可以从 Jahn-Teller 畸变的根本形式化地“理解”这个配合物的结构. 如果强行认为 Au 为 2 氧化态, d^8 电子构型, 那么根据 Jahn-Teller 效应 (Jahn-Teller effect): “在配合物的基态电子组态中, 且电子在轨道中占据不对称时, 配合物发生畸变以消除简并性并使得体系能量降低”, 配合物中电子构型的 Au(II)中应有一半发生拉长八面体畸变 (d_{xy} 核心和 ab 面心的 Au 原子), 一半发生压缩八面体畸变 (d_{xy} 面心和体心的 Au 原子). 到极限时, 即可分别得到直线型配位的 Au^+Cl_2 和平面正方形配位的 $Au^+Cl_4^-$, 并发生单电子转移到 Au^+Cl_2 和 $Au^+Cl_4^-$. 当然, 在答案中写“拉长八面体”依然是错误的, 这里仅作一种补充讨论.

1.3 这是一组以聚合物为背景的综合题, 较为简单, 重点在于提升解题速度. 培养“看到产物的一组数据将其切碎的”综合成题感. 非常需要. 下面与详细分析: C_8H_8 的不饱和度为: $11 - 14/2 = 4$. 结合产物顺旋二烯结构可推测 A 中含有双键. 根据数据 ($n=10$) 可推测产物聚合物结构中的 1,2,4,5-苯二胺片段是由 A 提供的, 因此根据碳原子分布 A 只能为 1,2,4,5-四甲基苯. 同时也很容易推出 C 为对苯二胺. 然而在推导 B 的结构式时要小心, 这里可能出错: 从 B 的生成条件与最终聚合物的结构来看, B 应为某种羧酸或羧酸衍生物. 那么同学们看到这里, 想当然地就写出“1,2,4,5-苯四甲酸”. 然而若 B 为四羧酸, 那么在聚合过程中, n mol B 与 n mol C 就应生成 $4n$ mol 水分子, 而非 $2n$ mol! 根据原子守恒, 真实的 B 应在苯四甲酸的基团上“去掉 2 分子水”, 容易看出它就是均苯四甲酸二酐 (pyromellitic dianhydride, PMDA). A, B, C 的结构简式如下图所示:

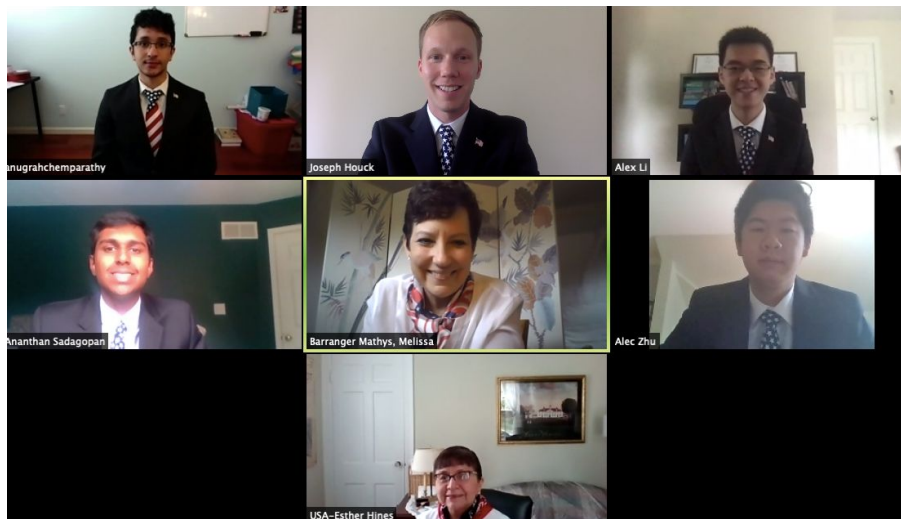
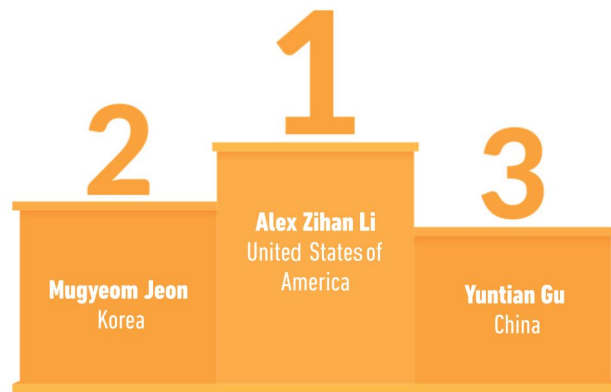


USNCO Study Camp 2020

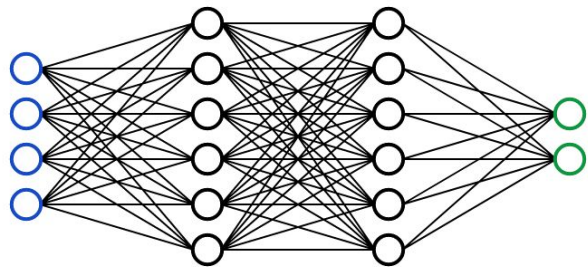


2020 International Olympiad

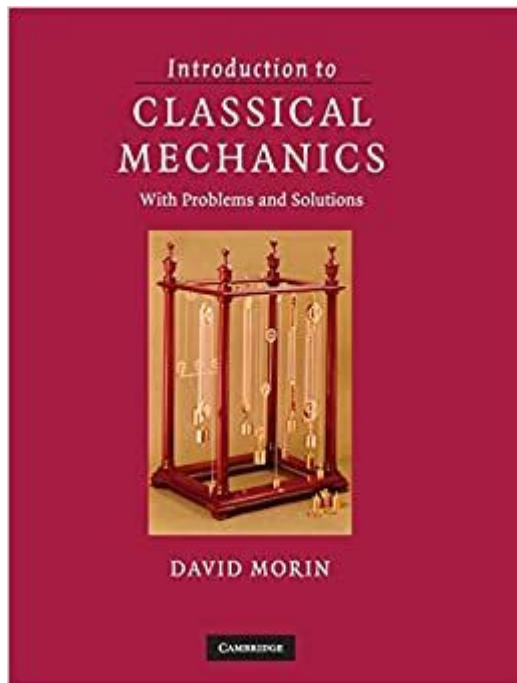
Best Of IChO 2020



What I am doing today



common
app 



Q&A Session



From what grade did you
start to prepare?

Do you need to study college chemistry, such as inorganic chemistry, organic chemistry and physical chemistry?

Does the competition
involve doing
experiments?

Is it true that it is more difficult to get into the finals in Massachusetts?

How can I safely run
chemistry experiments at
home?

How did you find your interest and how did you stick with it? Have you ever thought to give up?

How do you see your interest in chemistry and math align with your future career development? Any advice for those kids who haven't found their interest in any career path?

Any other questions?