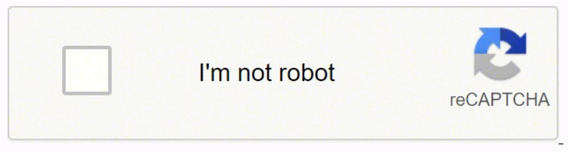

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Spectrometric identification of organic compounds 8th edition pdf download

Robert M. Silverstein’s Spectrometric Identification of Organic Compounds first appeared 50 years ago. Throughout these 50 years, this book has undergone many editions and remained one of the most popular textbooks on organic spectroscopy for chemistry undergraduates. The 8th edition, published in late 2014, is a revised and updated version of the 7th edition (1) that was published 10 years ago.The organization of the 8th edition is the same as that of 7th edition, and consists of seven chapters. Chapter 1 presents the technique of mass spectrometry. This chapter is virtually the same as that of the previous edition. The initial portion of the chapter is devoted to instrumental techniques such as ionization methods, mass analyzers, Fourier transform mass spectrometry, and tandem mass spectrometry. The remaining portion of the chapter gives an overview of fragmentation patterns of common organic homologous series. This portion of the chapter gives all the necessary background for understanding organic EI and CI mass spectrometry. For those students who want to go deeper into strategies of data interpretation and fragmentation patterns, J. T. Watson’s (2) and F. W. McLafferty’s books (3) are two valuable references. Surprisingly, there is hardly any discussion on isotopic patterns of poly-halogenated compounds.Except for the two additional sections on polymer and phosphorus compounds, Chapter 2 on infrared spectroscopy remains the same as that of the last edition. After initial presentation of the Michelson interferometer, sample handling, and coupled vibrations, the remaining portion of the chapter covers characteristic vibrations of various organic groups. The discussion on characteristic frequencies is extensive and useful in confirming the presence of organic functional groups in a given molecule.The next four chapters focus on NMR spectroscopy. Naturally, the first of these four chapters covers proton NMR spectroscopy. In this chapter, all the basic theories, concepts and terminologies such as free induction decay, relaxation, chemical shifts, scalar coupling, Pople notation, and chemical and magnetic equivalence are introduced. A few sections have been completely revised. The treatment of chemical equivalence has been shortened and revised. The exposition of this concept is better than that of the 7th edition. The section on the analysis of a complex first-order spectrum, although remaining largely the same as that of the previous edition, is well presented and provides a tool for analyzing this type of spectra methodically. In summary, this chapter covers proton NMR and all the necessary background for the subsequent three chapters.A few sections in the chapter on carbon-13 NMR have been revised. This chapter mainly covers all the topics such as chemical shifts (various functional groups), T1 relaxation, phase inversion recovery, broadband decoupling, gated-decoupling technique, nuclear Overhauser effect (NOE) and DEPT. NOE is only introduced in the context of signal enhancement or depletion. No discussion on the physics behind NOE is covered. Conceptually, this is the easiest among the four NMR chapters.Part of the chapter on two-dimensional NMR has been rewritten to make it much clearer and up-to-date. All current two-dimensional NMR techniques such as DQF-COSY, HETCOR, HMQC, HMBC, INADEQUATE, TOCSY (1-D and 2-D), and ROSEY are presented. HSQC, a variant of HMQC, is not covered. This is not a book for one trying to learn the principles behind pulse sequences. For those who want to have a better understanding of the principles behind pulse sequences, Friebolin’s (4) and Claridge’s (5) books should be consulted. The original section on pulse field gradient has been revised to include brief discussions on techniques such as ultrafast multidimensional NMR and single-scan NMR. Four compounds, namely, ipsenol, caryophyllene oxide, lactose, and the tetrapeptide VGSE (valine, glycine, serine, and glutamic acid) are used to illustrate the use of 2-D technique for structural elucidation. It starts with the easiest molecule, ipsenol, and ends with a more complicated one, VGSE. Each structure is derived from the given spectra in a systematic way. This part of the chapter remains largely the same as that of 7th edition. To understand how a structure is determined, one has to go back and forth between various spectra. For VGSE, there are a total of 8 spectra for amino acid identification and sequencing. For those students encountering multidimensional NMR for the first time, this can be confusing on the first read. With patience, one should have no problem understanding the power of multidimensional NMR. If these spectra could be downloaded from the Web and printed out and placed side by side, it would be easier to relate one spectrum to another.The chapter on multinuclear NMR is devoted to four 1/2-spin nuclei, namely, 15N, 29Si, 19F, and 31P that are commonly found in organic compounds. There are a few revisions. The IUPAC method of referencing chemical shifts for other nuclei is introduced. Simple molecules such as tetramethylsilane and triphenylphosphine are used to illustrate the principles of multinuclear NMR. This chapter provides an introduction to these nuclei. VGSE is used as an example to demonstrate the improved sensitivity of [(γ1H/γ15N)3/2] of inverse technique. While the 1H–15N HSQC spectrum shows three types of nitrogen, a 15-hour run of 1-D 15N detects no peaks at all.The final chapter presents six solved problems using all the common spectroscopic techniques and is virtually the same as that of 7th edition. The introduction gives a recommended set of guidelines on how to tackle a problem. Students are encouraged to explore their own systematic ways. Mass spectra are mainly used to establish molecular weights, and infrared spectra are used for the detection of functional groups such as carbonyl, hydroxyl, and acetylenic methine. NMR is the main workhorse used for structural elucidation. Like the previous chapter, it starts with the easiest molecule and ends with a more complicated one.As pointed out by the authors in the preface, the goal of Spectrometric Identification of Organic Compounds is to teach problem solving. There is hardly any doubt that this book has accomplished this goal. The exposition of the subject matter is clear. It covers all the necessary techniques for spectroscopic identification. The logic used in deducing a given structure from a set of spectra is well presented. Each chapter is packed with problems for students to practice spectrum interpretation. Many useful tables and charts on spectroscopic data are found at the end of each chapter. This book will continue to be a very useful reference for chemists.As this book is heavily NMR oriented, one should consider other good organic NMR books (6) available in the market before making a purchase of Silverstein’s book. This is especially true for those who currently own the 7th edition. This article references 6 other publications. 1Silverstein, R. M., Webster, F. X., and Kiemle, D. J. Spectrometric Identification of Organic Compounds, 7th ed.; John Wiley and Sons: Hoboken, NJ, 2005.2Watson, D. J. and Sparkman, O. D. Introduction to Mass Spectrometry, 4th ed.; John Wiley and Sons: West Sussex, England, 2007.3McLafferty, F. W. and Turecek, F. Interpretation of Mass Spectra, 4th ed.; University Science Books: Sausalito, CA, 1993.4Friebolin, H. Basic One- and Two-Dimensional NMR Spectroscopy, 5th ed.; John Wiley and Sons: Darmstadt, Germany, 2011.5Claridge, T. D. W. High Resolution NMR Techniques in Organic Chemistry, 2nd ed.; Elsevier Science: Amsterdam, The Netherlands, 2008.6Simpson, J. T. Organic Structural Determination Using 2-D NMR Spectroscopy, 2nd ed.; Academic Press: Waltham, MA, 2012.Spectrometric Identification of Organic Compounds, 7th edition by Robert M. Silverstein, Francis X. Webster, David J. Kiemle, and Robert L.Bryce. John Wiley and Sons: Hoboken, NJ, 2015. viii + 455 pp. ISBN 978-0-470-61637-6 (paperback). $190.42This article is cited by 4 publications.Antonina Filimonova, Andrey Chichirov, Natalya Chichirova, Aliya Batalova. Organic Substances in Process Waters of a Thermal Power Plant with a Combined Cycle Gas Turbine Plant and Methods for Their Detection. 2022,,, 247-256. Wang, Kaiyue Zhang, Feixiang Ji, Yurong Guo, Chao Wang, Shiping Wang, Ya Chu, Guangjiu Zhao. CDs/ZnO composite material with solid state fluorescence performance for quantitative determination of methyl red content and antibacterial properties. Journal of Industrial and Engineering Chemistry 2021, 104 , 179-185. Estrada–de la Vega, A H Bedoya–Calle, J Diabb, A L Villarreal–Rios, A Elías–Zuñiga, E M López–Cuellar, U Ortiz–Méndez. Preparation and characterization of lanthanum nitrate nanoparticles by a polyol method. Materials Research Express 2019, 6 (9) , 095030. Jeyaram, Krishnakumar Varadharajan, Boobas Singaram, Ranjith Rajendhran. Optical, photoconducting, thermal and anisotropic mechanical behaviours of Benzimidazolium salicylate single crystals. Journal of Science: Advanced Materials and Devices 2017, 2 (4) , 445-454. 2Figure 1. IPK (center) as it is stored in a vault at the BIPM with its six “official copies”. Photograph from BIPM and used with permission.Figure 2. Aluminum cube as manufactured by a combination of spark cutting and milling. The edge-length d is approximately 19.5 mm.Figure 3. Unit cell of a face-centered cubic crystal. Atoms are centered on each of the eight corners and on each of the six faces of the cube. The edge length is nominally 405 pm for an aluminum crystal.Figure 4. Near-perfect silicon crystal in the form of a near-perfect sphere, mounted for accurate determination of the sphere diameter (94 mm). Photograph from PTB/Stork and used with permission.Figure 5. Our aluminum cube is small enough to serve as a mass standard for the LEGO watt balance in addition to allowing the determination of the Planck constant by the aluminum XRCD method. The two methods agree within their uncertainties, just as the most accurate versions of these two methods agree. 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DOI: 10.1021/ed084p935 10Bouchendira, R.; Cladé, P.; Guellati-Khélifa, S.; Nez, F.; Biraben, F. State of the art determination of the fine structure constant: test of Quantum Electrodynamics and determination of h/mu Ann. Phys. (Berlin, Ger.) 2013, 525 (7) 484– 492 DOI: 10.1002/andp.201300044 12Bettin, H.; Fujii, K.; Man, J.; Mana, G.; Massa, E.; Picard, A. Accurate measurement of the Avogadro and Planck constants by counting silicon atoms Ann. Phys. (Berlin, Ger.) 2013, 525 (8–9) 680– 687 DOI: 10.1002/andp.201300038 13Azuma, Y.; Barat, P.; Bartl, G.; Bettin, H.; Borys, M.; Busch, I.; Cibik, L.; D’Agostino, G.; Fujii, K.; Fujimoto, H.; Hioki, A.; Krumrey, M.; Kuetgens, U.; Kuramoto, N.; Mana, G.; Massa, E.; Meeß, R.; Mizushima, S.; Narukawa, T.; Nicolaus, A.; Pramann, A.; Rabb, S. S.; Rienitz, O.; Sasso, C.; Stock, M.; Vocke, R. D.; Waseda, A.; Wundrack, S.; Zakel, S. 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See also (accessed Jun 2015) .19Pratt, J. R. How to Weigh Everything from Atoms to Apples Using the Revised SI NCSLI Measure 2014, 9 (1) 27– 3820For a brief, entertaining account of why Americans do not refer to the element Al as “aluminium”, see:Kearn, S. The Disappearing Spoon; Little, Brown, and Co.: New York, 2011.Page 3LEARN ABOUT THESE METRICSArticle Views are the COUNTER-compliant sum of full text article downloads since November 2008 (both PDF and HTML) across all institutions and individuals. These metrics are regularly updated to reflect usage leading up to the last few days.Citations are the number of other articles citing this article, calculated by Crossref and updated daily. Find more information about Crossref citation counts.The Altmetric Attention Score is a quantitative measure of the attention that a research article has received online. Clicking on the donut icon will load a page at altmetric.com with additional details about the score and the social media presence for the given article. Find more information on the Altmetric Attention Score and how the score is calculated.Page 4A 2011 report by the Department of Education states that understanding how teachers use results from formative assessments to guide their practice is necessary to improve instruction. Chemistry teachers have goals for items in their formative assessments, but the degree of alignment between what is assessed by these items and the teachers' goals has not previously been investigated. This understanding of teachers’ goal-setting will identify strengths and limitations in their formative assessment processes. In this qualitative project, we have characterized this alignment of assessment items with learning objectives with data collected from 19 high school chemistry teachers from 10 states. These teachers participated in semi-structured interviews describing their goals and use of a teacher-developed formative assessment they had administered to their classes. The teachers provided 41 items which were analyzed for this study. To evaluate the content knowledge and skills required for successful completion of each item, the items were evaluated by one researcher by listing statements and equations required to demonstrate an understanding and solve each individual problem. A different member of the team who conducted the interviews listed the assessment goals as stated by the teachers for each item to characterize the degree teacher’s goals are emulated by their items. The author team evaluated the alignment of teachers’ assessment goals to what is assessable by items. The results discussed show that teachers who address conceptual chemical phenomena in their goals, in line with the NGSS standards of using concepts to assess student understanding, are more likely to have a goal that is assessable by their assessment items than those who do not assess concepts. From findings and prior literature, we recommend that teachers use conceptual goals in conjunction with problem solving goals to assess student understanding, particularly with items that require computation.Page 5Students’ understanding about analogy was investigated after a CORE learning cycle general chemistry experiment. CORE (Chemical Observations, Representations, Experimentation) is a new three-phase learning cycle that involves (phase 1) guiding students through chemical observations while they consider a series of open-ended questions, (phase 2) developing representations using analogical thinking, and (phase 3) designing and conducting experiments in response to a scientific question. In the CORE experiment used in this study, Polymers and Cross Linking, an analogy was employed in phase 2 when students reflected on the similarities and limitations between objects used in the analogy (the analog) and the chemistry under observation (the target). Owing to the reliance on analogical reasoning in the CORE approach, we conducted a study at a single point in time at the very beginning of a lab course to investigate students’ understanding about analogy, the importance of considering the limitations of an analogy, and perceived benefits. Four online questions were asked approximately one week after lab work. Student responses (n = 501) across the four questions provided a rich data set of over 60 000 words (averaging >120 words/student). Results indicate that 75% of students have a basic or better understanding of the analogy, 61% of students connected the analogy with either chemical observations from lab and/or submicroscopic thinking, while 8% connected the analogy to both. A majority of students (57%) described the importance of appreciating the limitations of an analogical model and numerous students offered details about how analogy influenced their conceptual understanding. The data provide insight into student understanding about analogy and the degree to which students recognize the limitations of an analogy, as well as student perceptions of the benefits of the approach. This study informs those interested in developing curricula around the CORE approach and suggests design criteria for investigating student learning when analogies are used as part of lab work.Page 6There continues to be a persistent, widespread gender gap in multiple STEM disciplines at all educational and professional levels: from the self-reported interest of preschool aged students in scientific exploration to the percentages of tenured faculty in these disciplines, more men than women express an interest in science, a confidence in their scientific abilities, and ultimately decide to pursue scientific careers. Reported herein is an intensive outreach effort focused on addressing this gender gap: a full-time, week-long chemistry camp that was designed and implemented for middle school girls in the state of Rhode Island. The camp schedule included multiple hands-on experiments, field trips, and significant interactions with female scientists, all of which were designed to increase the participants’ interest in and enthusiasm for science. The success of the program in changing the participants’ attitudes toward science was measured through administration of a precamp and postcamp survey, and the survey results demonstrated a strong success in changing the participants’ attitudes toward the widespread applicability of science, their perceived level of support for scientific study, and their interest in pursuing STEM-related careers.Page 7The concept of oxidation state (or oxidation number) and related issues have always been difficult for students. In addition, there are misunderstandings and obscurities, which can cause improper balancing of the chemical equations (mostly in organic reactions). In particular, these problems are related to determination of the oxidation state of nitrogen and carbon atoms in organic compounds. In recent years, the Matura Exam in Poland (ending education in Upper Secondary School) puts special emphasis on verification of students’ skills of balancing of chemical equations on examples of organic compounds. In the absence of literature, methods and rules for establishing or assigning the oxidation state to nitrogen atoms in organic compounds, the authors decided to emphasize this undoubtedly important problem in this article. We present here, various approaches to determination of the oxidation state to nitrogen and carbon atoms in organic compounds. Additionally, we propose an alternative approach to determination of the oxidation state to nitrogen atoms in complicated situations (“nitrogen oxidation state trick”). Moreover, on the basis of results of our didactic studies, we indicate which method is the most popular and the best assimilable among Polish students from Upper Secondary School.Page 8An exercise in molecular modeling that demonstrates the distinctive features of Fischer and Schrock carbene complexes is presented. Semi-empirical calculations (PM3) demonstrate the singlet ground electronic state, restricted rotation about the C–Y bond, the positive charge on the carbon atom, and hence, the electrophilic nature of the Fischer carbene complex. Likewise, the triplet ground state of the Schrock carbene complex, along with the negative charge on the carbon atom and nucleophilic behavior, is also demonstrated.Page 9LEARN ABOUT THESE METRICSArticle Views are the COUNTER-compliant sum of full text article downloads since November 2008 (both PDF and HTML) across all institutions and individuals. These metrics are regularly updated to reflect usage leading up to the last few days.Citations are the number of other articles citing this article, calculated by Crossref and updated daily. Find more information about Crossref citation counts.The Altmetric Attention Score is a quantitative measure of the attention that a research article has received online. Clicking on the donut icon will load a page at altmetric.com with additional details about the score and the social media presence for the given article. Find more information on the Altmetric Attention Score and how the score is calculated.Page 10The expansion or compression of gas confined in a piston-and-cylinder device is a classic working example used for illustrating the First and Second Laws of Thermodynamics. The balance of energy and entropy enables the estimation of a number of thermodynamic properties. The entropy generation (also called entropy production) resulting from this process can also be used to determine the feasibility and reversibility of a process. In this work, we present an extended discussion involving quantitative analysis of the effects of friction between a piston and the interior wall of a cylinder. Our findings indicate that the friction force caused by the movement of the piston is a main source of entropy generation in this process. This explanation does not appear in most textbooks dealing with similar problems. We also discuss, from a quantitative perspective, the effects of friction on the dynamic physical and thermodynamic properties, including entropy generation. Our findings suggest that engaging students in a discussion related to piston-and-cylinder problems involving the effects of friction could provide valuable insight into entropy generation in practical applications.Page 11This paper presents a project about the chemical elements made by 15-year-old Spanish high school students of Chemistry. It focuses on contex-based teaching combined with the advantages of creating a large mural which subsequently is exposed in the school. The project consisted of researching the chemical elements in the different materials that make up a car, identifying the uses of some chemical elements in daily life, and remembering the names and symbols of the elements. Students’ response to the activity was evaluated through a survey in which progress can be seen in the pupils’ knowledge regarding the names, symbols, and uses of the chemical elements in daily life. An additional attitudes’ survey showed that students had enjoyed the project and the task had helped them understand how chemical elements are used to create materials.Page 12An educational card game, “Chemical Alias”, has been developed as an alternative method of reviewing students’ knowledge of nomenclature. In contrast to conventional tests, this highly competitive activity is a fun and effective way to examine and reinforce nomenclature. The students play in pairs, using Clark’s famous spiral arrangement of the elements as the board and cards with chemical formulas. One of the students names the chemical compounds and the other answers with their chemical formulas. The counters are moved through the elements according to the number of correct answers.Page 13A demonstration of the degradation of food coloring dyes by oxidation via the Fenton reaction can be substituted with a simpler demonstration using the oxidant oxone with iron(II) ions as an activator. The addition of small amounts of solid oxone and iron(II) sulfate to solutions containing mixtures of food coloring results in successive degradation of food dyes within minutes, also showing a kinetic separation of color. Because food dyes of different colors degrade at different rates, successive changes in color during degradation can be observed for various dye mixtures. Catalyst-like behavior is also demonstrated; in the absence of a transition metal such as iron to activate the oxone, negligible color degradation is observed within the time frame of the demonstration. The demonstration presents an opportunity to introduce topics such as structural characteristics of organic chromophores, the catalyst-like behavior of a transition metal, the practical importance of chemical kinetics, and challenges involved in finding eco-friendly methods of efficiently oxidizing pollutants, including not only waste dyes but also personal care products and excreted pharmaceuticals.Page 14LEARN ABOUT THESE METRICSArticle Views are the COUNTER-compliant sum of full text article downloads since November 2008 (both PDF and HTML) across all institutions and individuals. These metrics are regularly updated to reflect usage leading up to the last few days.Citations are the number of other articles citing this article, calculated by Crossref and updated daily. Find more information about Crossref citation counts.The Altmetric Attention Score is a quantitative measure of the attention that a research article has received online. Clicking on the donut icon will load a page at altmetric.com with additional details about the score and the social media presence for the given article. Find more information on the Altmetric Attention Score and how the score is calculated.Page 15Page 16LEARN ABOUT THESE METRICSArticle Views are the COUNTER-compliant sum of full text article downloads since November 2008 (both PDF and HTML) across all institutions and individuals. These metrics are regularly updated to reflect usage leading up to the last few days.Citations are the number of other articles citing this article, calculated by Crossref and updated daily. Find more information about Crossref citation counts.The Altmetric Attention Score is a quantitative measure of the attention that a research article has received online. Clicking on the donut icon will load a page at altmetric.com with additional details about the score and the social media presence for the given article. Find more information on the Altmetric Attention Score and how the score is calculated.Page 17This article proposes an indirect method to evaluate the corrosion rate of iron nail in simulated seawater. The official procedure is based on the direct measurement of the specimen’s weight loss over time; however, a highly precise scale is required and such equipment may not be easily available. On the other hand, mobile phones equipped with good built-in cameras have become an essential part of everyday lives of students and educators. With the built-in cameras, students followed the formation of the colored complex from the reaction between released iron ions and 1,10-phenanthroline. The images were then decomposed into the RGB channels that were converted into absorbance. Another point worth mentioning is that rather than providing students with a step-by-step procedure, the instructor used a problem-based approach that enabled students to develop the experimental procedure themselves. This project-driven interdisciplinary experiment engaged students into thinking and producing the experiment. Finally, bringing cell phones into science teaching was very helpful as it made learning more inviting and meaningful.Page 18The Electrochemical Pen (EChemPen) was developed as an attractive tool for learning electrochemistry. The fabrication, principle, and operation of the EChemPen are simple and can be easily performed by students in practical classes. It is based on a regular fountain pen principle, where the electrolytic solution is dispensed at a tip to locally modify a conductive surface by triggering a localized electrochemical reaction. Three simple model reactions were chosen to demonstrate the versatility of the EChemPen for teaching various electrochemical processes. We describe first the reversible writing/erasing of metal letters, then the electrodeposition of a black conducting polymer “ink”, and finally the colorful writings that can be generated by titanium anodization and that can be controlled by the applied potential. These entertaining and didactic experiments are adapted for teaching undergraduate students that start to study electrochemistry by means of surface modification reactions.Page 19A laboratory experiment was designed for upper-level students in a Chemical Analysis course to illustrate the theoretical and practical applications of 0.8% agarose gel electrophoresis and to reinforce an understanding of weak acids/bases using easy-to-visualize pH indicators. The careful choice of indicators included acid and base types with amphiprotic intermediates, species that become either singly or doubly deprotonated, and molecules with molecular weights that span from 269 to 670 g/mol. Students measure the rate of migration of the pH indicators relative to the rate of migration of a red dye standard. The relative rates are interpreted with respect to the indicators’ fractions of deprotonation (and resulting molecule charges), molecular weights, and shapes. This procedure occurs under acidic (pH 4.0) and basic (pH 7.5) conditions with lower and higher applied voltages to understand the impact of changing protonation/deprotonation. This experiment has been successfully completed by over 200 analytical chemistry students with consistent results. Overall, this procedure teaches students to evaluate the controls on molecule movement in an electrical field critically, while gaining insight into weak acid/base equilibria.Page 20A simple photometric assembly based in an LED as a light source and a photodiode as a detector is proposed in order to follow the absorbance changes as a function of the titrant volume added during the course of acid–base titrations in the presence of a suitable visual indicator. The simplicity and low cost of the electronic device allow the students to easily assemble the photometer and use it as a titration detector. The choice of the appropriate LED color should also demonstrate the principles of complementary colors. Concepts of data handling and relationship between the pH of the titration end point and indicator choice can be addressed. Errors associated with the use of wrong indicators can be demonstrated. The circuit assembly can highlight for the students the instrumentation and automation importance in modern chemical analysis. The discussion can be extended to relevant issues involved in this matter, such as light absorption, circuit analysis, and the hydrolysis concept, once they are involved and are closely related with the results obtained.Page 21The Paternò–Büchi photocycloaddition reaction is used as the basis for physical–organic final-year undergraduate laboratory experiments designed to emphasize the multidisciplinary approach to modern-day chemical practice. These reactions are performed using commercially available LED-based light sources, which offer a convenient and safe tool for teaching photochemistry. Using a series of substituted benzaldehydes and furan, experiments can be conducted to measure reaction rates and to isolate the products for structure determination. The experiments are deliberately broad in scope, covering mechanistic photochemistry, chemical kinetics, and photochemical organic synthesis in a holistic manner in order to demonstrate to students how topics usually taught separately are brought together. The reported experimental program also offers actinometry and quantum yield determinations, as well as NMR-based structural analysis, as potential routes for further elaboration of the experimental program.Page 22This work presents an approach that integrates the preparation of a coordination compound, potassium tris-(oxalato)ferrate(III), with its photochemical behavior and provides a possible application, the printing of a photograph using the cyanotype technique. Through this experiment, students can be taught several concepts that occur in a coordination chemistry course, including the thermodynamic aspects of forming a compound, its photochemistry, the detection of its photoproducts, and the observation of the formation of a new compound and the resulting intervalence band, which generates the blue print.Page 23LEARN ABOUT THESE METRICSArticle Views are the COUNTER-compliant sum of full text article downloads since November 2008 (both PDF and HTML) across all institutions and individuals. These metrics are regularly updated to reflect usage leading up to the last few days.Citations are the number of other articles citing this article, calculated by Crossref and updated daily. Find more information about Crossref citation counts.The Altmetric Attention Score is a quantitative measure of the attention that a research article has received online. Clicking on the donut icon will load a page at altmetric.com with additional details about the score and the social media presence for the given article. Find more information on the Altmetric Attention Score and how the score is calculated.Page 24An effective guided inquiry forensic case study (a pharmacy break-in) is described for first-year students. Four robust introductory forensic chemistry and biology experiments are used to analyze potential drug samples and determine the identity of a possible suspect. Students perform presumptive tests for blood on a “point of entry stain” sample; perform chemical presumptive tests on the “suspected drug” alongside known standards of codeine, morphine, and amphetamine; and carry out thin-layer chromatography analysis of the drug samples. They examine the specificity of the Kastle–Meyer and tetramethylbenzidine tests, prepare polymerase chain reaction samples from the suspects’ DNA samples, and perform gel electrophoresis to analyze the results. Students are required to analyze and integrate the results and to apply their acquired knowledge within the context of an engaging forensic case study. This first-year laboratory is part of a forensic case study vertically integrated into the curriculum.Page 25A simple, robust, and reproducible method was developed for the isolation of (−)-menthol from peppermint oil and to study the effect of different types of leaving groups, catalysts, solvents, and tertiary base on the extent of esterification of (−)-menthol to (−)-menthyl acetate. In this experiment, students compare leaving group properties of acetate and chloride ions from the acylating reagents acetic anhydride and acetyl chloride, respectively. The extent of conversion is compared when pyridine and 4-(dimethylamino)pyridine are used as catalysts, when N,N-diisopropylethylamine is used as tertiary base, and when the solvent is changed from dichloromethane to diethyl ether to N,N-dimethylformamide. Students are assessed on the chromatographic/spectroscopic purity and yield of (−)-menthol isolated and on their understanding of the factors that affect its extent of conversion to (−)-menthyl acetate. Full spectral characterization of both compounds is also conducted. They also complete a series of answers to questions based on lecture material presented on this topic, complete a crossword as a formative assessment tool, and are required to present a PowerPoint slide to their peers on a particular aspect of the bench to bedside development of peppermint oil for the treatment of irritable bowel syndrome.Page 26LEARN ABOUT THESE METRICSArticle Views are the COUNTER-compliant sum of full text article downloads since November 2008 (both PDF and HTML) across all institutions and individuals. These metrics are regularly updated to reflect usage leading up to the last few days.Citations are the number of other articles citing this article, calculated by Crossref and updated daily. Find more information about Crossref citation counts.The Altmetric Attention Score is a quantitative measure of the attention that a research article has received online. 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