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आविष्कार

फरवरी 2020, वर्ष 50, अंक 2 ISSN 0970-6607

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वैज्ञानिक और औद्योगिक अनुसंधान विभाग,
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लेख

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टेक्नोलॉजी एंड रिसर्च, कोनेरु लक्ष्मीबा कॉलेज ऑफ इंजीनियरिंग, स्कूल ऑफ
प्सालिज एंड आर्टिफैक्ट्स, विज्ञान फर्मेसी कॉलेज, और कुमाऊ विश्वविद्यालय के
साथ समझौता ज्ञानियों पर हस्ताक्षर किए।
आवरण : पारुल सिन्हा

● आविष्कार नेशनल रिसर्च डिवेलपमेंट कारपोरेशन (एनआरडीसी) द्वारा प्रकाशित विज्ञान और प्रौद्योगिकी की लोकप्रिय विज्ञान मासिक पत्रिका है। ● आविष्कार में किसी लेख के प्रकाशन हेतु लेखन के सदर्भ में संपादक का निर्णय अंतिम होगा। प्रकाशित लेखों और लेखकों द्वारा भेजे गए चित्रों की मौलिकता के संबंध में लेखक स्वयं उत्तरदायी होंगे। ● आविष्कार में प्रकाशित सामग्री का किसी भी रूप में उपयोग करने से पूर्व संपादक की अनुमति लेना आवश्यक है। ● आविष्कार में प्रकाशित किसी व्यक्ति, वैज्ञानिक, इलेक्ट्रॉनिक आदि व्यक्ति के नाम में करने की स्थिति में पत्रिका/ एनआरडीसी उसके लिए उत्तरदायी नहीं होगी। ● आविष्कार में प्रकाशित विज्ञापनों में किए गए दावों के लिए पत्रिका और एनआरडीसी उत्तरदायी नहीं होगी।
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समानो मन्त्रः समितिः समानो समानं मनः सहचिन्तयेत्।
समानं मन्त्रमभिमतव्ये वः समानं चो हविषा जुहोमि।।
समानो व आकृतिः समाना हृदयानि वः।
समानयन्तु को मनो वथा वः सुसहासति।। कन्देद

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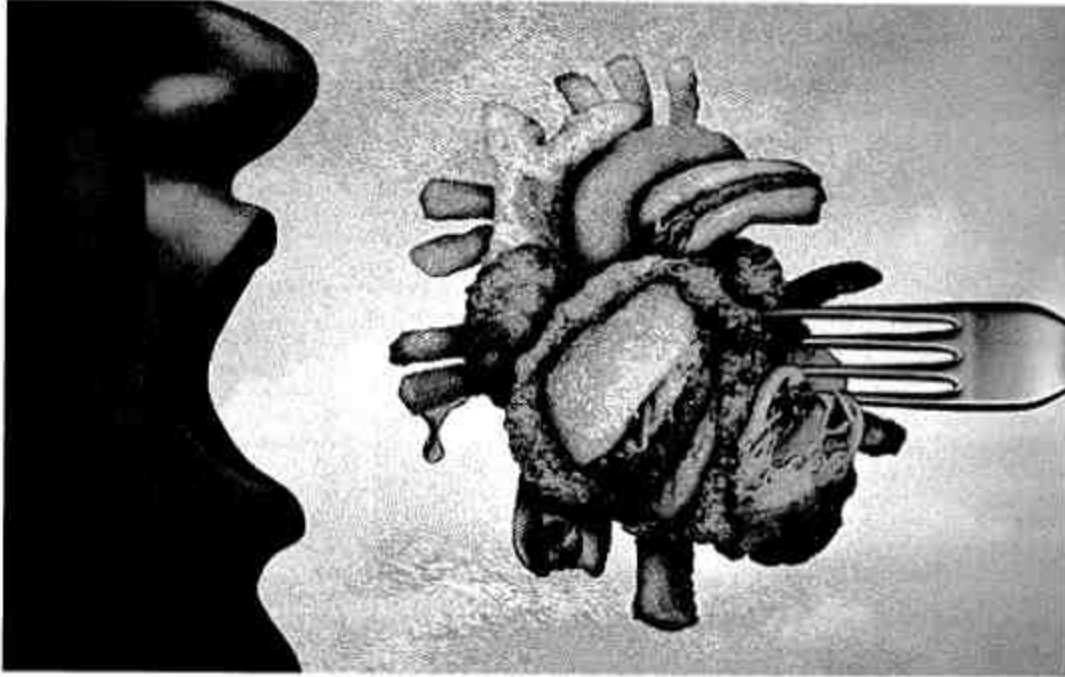
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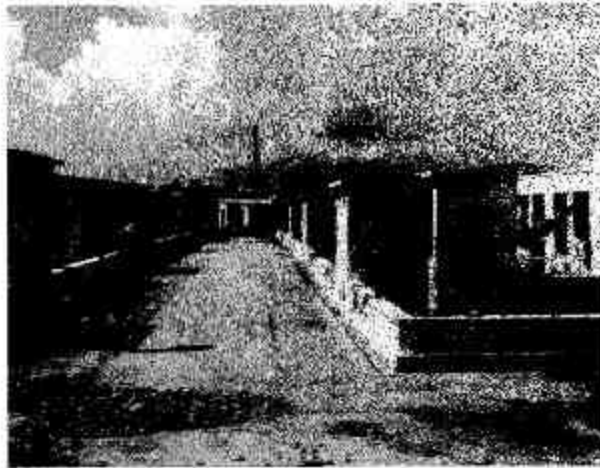
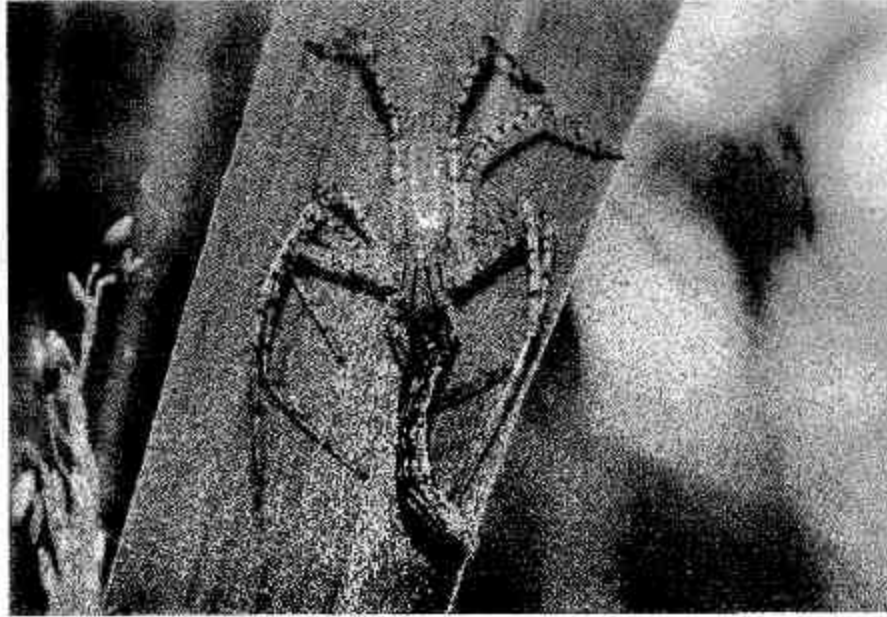
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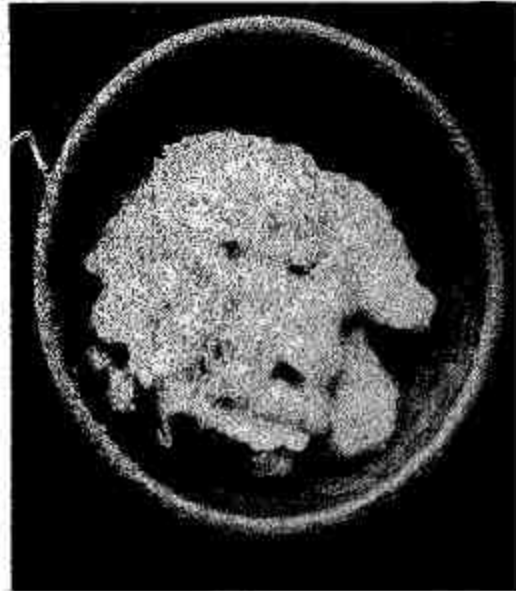
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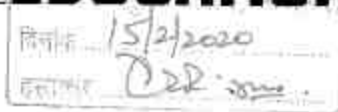
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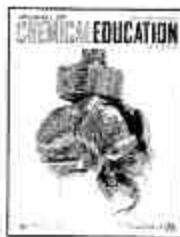
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ON THE COVER: National Chemistry Week, a community-based annual event uniting ACS local sections, businesses, schools, and individuals in communicating the value of chemistry in our everyday life, is being celebrated October 20–26, 2019 with the theme “Marvelous Metals”. Articles featuring metals in this and past issues of the *Journal of Chemical Education* can help you make the most of this ACS annual celebration, including “Electroless Deposition on Three Substrates: Brass Washers, Cicada Exoskeletons, and Beetles” (DOI: 10.1021/acs.jchemed.9b00055). In this laboratory experiment, Craig J. Donahue, Amina Mazini, Codruta Savu, and Hanan Yehya showcase electroless deposition, an autocatalytic reduction process performed in aqueous solution containing a metal ion in the presence of a reducing agent, yielding a coherent metal film. The cover shows a nickel-plated cicada exoskeleton being held by a neodymium magnet.

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2308  DOI: 10.1021/acs.jchemed.9b00485
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2315  DOI: 10.1021/acs.jchemed.8b01037
Using a Flatbed Scanner and Automated Digital Image Analysis To Determine the Total Phenolic Content in Beer
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2322  DOI: 10.1021/acs.jchemed.9b00446
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2326  DOI: 10.1021/acs.jchemed.9b00359
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2333  DOI: 10.1021/acs.jchemed.9b00450
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2339 DOI: 10.1021/acs.jchemed.8b00976
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2345  DOI: 10.1021/acs.jchemed.8b01008
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2348  DOI: 10.1021/acs.jchemed.9b00007
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2352 DOI: 10.1021/acs.jchemed.8b01057
Benchmark Global-Warming Demonstrations Do Not Exemplify the Atmospheric Greenhouse Effect, but Alternatives Are Available
Jerry A. Bell*

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2355

DOI: 10.1021/acs.jchemed.9b00711

Reply to "Benchmark Global Warming Demonstrations Do Not Exemplify the Atmospheric Greenhouse Effect, but Alternatives Are Available"

Jessica C. Deon,* Jennifer A. Faust, C. Scott Browning, and Kristine B. Quinlan

Additions and Corrections

2357

DOI: 10.1021/acs.jchemed.9b00710

Correction to "Exploring the Phases of Carbon Dioxide and the Greenhouse Effect in an Introductory Chemistry Laboratory"

Jessica C. Deon,* Jennifer A. Faust, C. Scott Browning, and Kristine B. Quinlan

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ON THE COVER: Virtual reality (VR) is an affordable, high-quality commodity hardware that can offer new ways to teach, communicate, and engage with complex molecular topics while enabling students to become comfortable with emerging simulation and visualization approaches. In "Teaching Enzyme Catalysis Using Interactive Molecular Dynamics in Virtual Reality" (DOI: 10.1021/acs.jchemed.9b00181), Simon J. Dennis, Kara E. Ranaghan, Helen Deeks, Heather E. Goldsmith, Michael B. O'Connor, Adrian J. Mulholland, and David R. Glowacki describe a traditional computational chemistry class complemented by an additional component using real-time interactive molecular dynamics simulations in VR (IMD-VR) and show that IMD-VR is an effective and practical tool for demonstrating biochemical processes to undergraduate students. On the cover, an image of chorismate mutase in a van der Waals "rainbow" rendering shows from the user's perspective how with VR it is possible to reach into an enzyme and interact with the molecular world. The active site of the enzyme is highlighted in a ball and stick representation showing the enzyme substrate, chorismate, and key amino acid residues.

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2359

DOI: 10.1021/acs.jchemed.9b00982

Reproducibility, Replication, and Generalization in Research about Teaching Innovation
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DOI: 10.1021/acs.jchemed.9b00594

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DOI: 10.1021/acs.jchemed.9b00516

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DOI: 10.1021/acs.jchemed.9b00392

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DOI: 10.1021/acs.jchemed.9b00239

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- 2403  DOI: 10.1021/acs.jchemed.9b00160
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- 2410  DOI: 10.1021/acs.jchemed.9b00277
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- 2420  DOI: 10.1021/acs.jchemed.9b00375
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- 2426  DOI: 10.1021/acs.jchemed.9b00370
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- 2432  DOI: 10.1021/acs.jchemed.9b00289
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- 2441  DOI: 10.1021/acs.jchemed.9b00146
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- 2450  DOI: 10.1021/acs.jchemed.9b00489
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- 2467  DOI: 10.1021/acs.jchemed.9b00750
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- 2476  DOI: 10.1021/acs.jchemed.9b00399
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2488  DOI: 10.1021/acs.jchemed.9b00181

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2497  DOI: 10.1021/acs.jchemed.8b00965

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2503  DOI: 10.1021/acs.jchemed.8b00819

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2510  DOI: 10.1021/acs.jchemed.9b00194

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2518  DOI: 10.1021/acs.jchemed.9b00142

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2528  DOI: 10.1021/acs.jchemed.9b00420

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2532  DOI: 10.1021/acs.jchemed.8b00732

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2535  DOI: 10.1021/acs.jchemed.9b00486


CHEMCompete-It: An Organic Chemistry Card Game To Differentiate between Substitution and Elimination Reactions of Alcohols
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2545  DOI: 10.1021/acs.jchemed.9b00131
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2553  DOI: 10.1021/acs.jchemed.9b00479
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2560  DOI: 10.1021/acs.jchemed.9b00638
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2565  DOI: 10.1021/acs.jchemed.9b00461
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2574  DOI: 10.1021/acs.jchemed.9b00429
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2578  DOI: 10.1021/acs.jchemed.9b00197
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2584  DOI: 10.1021/acs.jchemed.9b00559
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2590  DOI: 10.1021/acs.jchemed.9b00046
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2597  DOI: 10.1021/acs.jchemed.9b00630
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2600  DOI: 10.1021/acs.jchemed.8b00687
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2606  DOI: 10.1021/acs.jchemed.8b00674
Implementing a Hybrid Expression Method That Allows Upper-Division Biochemistry Lab Students To Engage in a Full Protein Production Experience While Allowing Ample Time for Characterization Experiments
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2611  DOI: 10.1021/acs.jchemed.9b00066
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2617  DOI: 10.1021/acs.jchemed.9b00350
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2622  DOI: 10.1021/acs.jchemed.8b00636
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2628  DOI: 10.1021/acs.jchemed.9b00607
A Simple and Practical Method for Incorporating Augmented Reality into the Classroom and Laboratory
Kyle N. Plunkett*

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2632  DOI: 10.1021/acs.jchemed.9b00234

Maximizing Student Engagement Outside the Classroom with Organic Synthesis Videos

John Rose, Richard Pennington, Derek Behmke, David Kervan, Robert Lutz, and Julia E. Barker Paredes*

2638  DOI: 10.1021/acs.jchemed.9b00010

Incorporating Chemical Structure Drawing Software throughout the Organic Laboratory Curriculum

Noel M. Paul,^a Ryan J. Yoder,^a and Christopher S. Callam*

2643  DOI: 10.1021/acs.jchemed.8b00723

"Sugar Mapping", an Easy-To-Use Visual Tool To Help the Synthetic Chemist identify Carbohydrate Stereochemical Relationships

Marie-Charlotte Belhomme, Stéphanie Costex, and Amauc Haudrechy*

2649  DOI: 10.1021/acs.jchemed.9b00252

Low-Cost Turbidimeter, Colorimeter, and Nephelometer for the Student Laboratory

Marin Kovačić* and Danijela Ašperger*

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2655  DOI: 10.1021/acs.jchemed.9b00196

Celebrating 27 Years of a Chemistry Contest for High School Students at a University in Poland That Promotes Chemistry for Future Study and Career Choices

Mariusz Zalewski and Tomasz Krwaczyk*

2661  DOI: 10.1021/acs.jchemed.9b00082

Mass-Based Approach to the Determination of the Henry's Law Constant for CO₂(g) Using a Diet Carbonated Beverage

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2665  DOI: 10.1021/acs.jchemed.8b01022

Microwave-Assisted Isolation of Eugenol from Cloves

Kenneth R. Overly*

2668  DOI: 10.1021/acs.jchemed.9b00310

Discovery-Based S_NAr Experiment in Water Using Micellar Catalysis

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2672  DOI: 10.1021/acs.jchemed.9b00191

Experimenting with a Suzuki–Miyaura Cross-Coupling Reaction That Demonstrates Tolerance toward Aldehyde Groups To Teach Undergraduate Students the Fundamentals of Transition-Metal-Catalyzed Reactions

Jie Dai, Dadong Lu, Tao Ye, Shouyun Yu,^a and Xu Cheng*

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DOI: 10.1021/acs.jchemed.9b00899

Correction to "Learning Nuclear Chemistry through Practice: A High School Student Project Using PET in a Clinical Setting"

Lucia Liguori* and Tom Christian Holm-Adamsen

2677

DOI: 10.1021/acs.jchemed.9b00973

Correction to "A Reverse Science Fair that Connects High School Students with University Researchers"

Brian Mernoff, Amanda R. Aldous, Natalie A. Wasio, Joshua A. Kritzer, E. Charles H. Sykes,* and Karen O'Hagan*

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ON THE COVER: In response to a call for papers, chemistry educators from around the world have contributed articles to the *Journal of Chemical Education* now collected in a special issue on systems thinking and green and sustainable chemistry. This special issue topic was proposed by the IUPAC task force on Systems Thinking in Chemistry Education. Papers in the issue are intended to be the inaugural global reference point for literature on systems thinking in chemistry education that will lead to further understanding about the interdependence of the components of systems at work for chemistry learners, and the application of systems thinking to green and sustainable chemistry education. Contributions to the "Reimagining Chemistry Education: Systems Thinking, and Green and Sustainable Chemistry" special issue have a designation that they are part of the collection published in this issue.

SPECIAL ISSUE: REIMAGINING CHEMISTRY EDUCATION: SYSTEMS THINKING, AND GREEN AND SUSTAINABLE CHEMISTRY

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Can Chemistry Be a Central Science without Systems Thinking?
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DOI: 10.1021/acs.jchemed.9b00991

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Reimagining the Materials Tetrahedron
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DOI: 10.1021/acs.jchemed.9b00016

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Navigating Complexity Using Systems Thinking in Chemistry, with Implications for Chemistry Education
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DOI: 10.1021/acs.jchemed.9b00358

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Integrating the Human Element in the Responsible Research and Innovation Framework into Systems Thinking Approaches for Teachers' Professional Development
Ron Blonder[†] and Sherman Rosenfeld

DOI: 10.1021/acs.jchemed.9b00387

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2704  DOI: 10.1021/acs.jchemed.9b00027
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2710 DOI: 10.1021/acs.jchemed.9b00344
Connecting Systems Thinking and Service Learning in the Chemistry Classroom
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2715  DOI: 10.1021/acs.jchemed.9b00346
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2720 DOI: 10.1021/acs.jchemed.9b00169
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2730 DOI: 10.1021/acs.jchemed.9b00390
Integrating the Molecular Basis of Sustainability Into General Chemistry through Systems Thinking
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2742  DOI: 10.1021/acs.jchemed.9b00261
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2752 DOI: 10.1021/acs.jchemed.9b00416
Systems Thinking in Chemistry Education: Theoretical Challenges and Opportunities
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2764 DOI: 10.1021/acs.jchemed.9b00309
Turning Challenges into Opportunities for Promoting Systems Thinking through Chemistry Education
Felix M. Ho*

2777 DOI: 10.1021/acs.jchemed.9b00334
Systems Thinking and Green Chemistry: Powerful Levers for Curricular Change and Adoption
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2784  DOI: 10.1021/acs.jchemed.9b00377

Systems Thinking: Adopting an Emergy Perspective as a Tool for Teaching Green Chemistry
Alvise Perosa,* Francesco Gonella,* and Sofia Spagnolo

2794 DOI: 10.1021/acs.jchemed.9b00341

International Perspectives on Green and Sustainable Chemistry Education via Systems Thinking
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2805  DOI: 10.1021/acs.jchemed.9b00280

Integrating Systems Thinking into Teaching Emerging Technologies
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2814 DOI: 10.1021/acs.jchemed.9b00298

Identifying Systems Thinking Components in the School Science Curricular Standards of Four Countries
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2825 DOI: 10.1021/acs.jchemed.9b00270

The End of Simple Problems: Repositioning Chemistry in Higher Education and Society Using a Systems Thinking Approach and the United Nations' Sustainable Development Goals as a Framework
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2836  DOI: 10.1021/acs.jchemed.9b00287

A Systems Thinking Department: Fostering a Culture of Green Chemistry Practice among Students
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2845  DOI: 10.1021/acs.jchemed.9b00307

United Nations Sustainable Development Goals as a Thematic Framework for an Introductory Chemistry Curriculum
Riley J. Petillion, Tamara K. Freeman, and W. Stephen McNeil†

2852  DOI: 10.1021/acs.jchemed.9b00318

Systems Thinking in Science Education and Outreach toward a Sustainable Future
Jillian L. Blatti,* John Garcia, Danyal Cave, Felix Monge, Anthony Cuccinello, Jennifer Portillo, Betsy Juarez, Ellen Chan, and Frieda Schwebel

2863  DOI: 10.1021/acs.jchemed.9b00336

Experiential Learning To Promote Systems Thinking in Chemistry: Evaluating and Designing Sustainable Products in a Polymer Immersion Lab
Aurora L. Ginzburg, Casey E. Check, Demetri P. Hovekamp, Alyson N. Sillin, Jack Brett, Hannah Eshelman, and James E. Hutchison†

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2872 DOI: 10.1021/acs.jchemed.9b00354
Integrating Green Chemistry in the Curriculum: Building Student Skills in Systems Thinking, Safety, and Sustainability
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2881 DOI: 10.1021/acs.jchemed.9b00302
Roles of Systems Thinking within Green Chemistry Education: Reflections from Identified Challenges in a Disadvantaged Context
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2888 DOI: 10.1021/acs.jchemed.9b00314
Graphical Tools for Conceptualizing Systems Thinking in Chemistry Education
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2901 DOI: 10.1021/acs.jchemed.9b00358
Promoting Systems Thinking Using Project- and Problem-Based Learning
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2910 DOI: 10.1021/acs.jchemed.9b00263
Introducing Chemistry through the Lens of Earth's Systems: What Role Can Systems Thinking Play in Developing Chemically and Environmentally Literate Citizens?
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2918 DOI: 10.1021/acs.jchemed.9b00218
Some Insights into Assessing Chemical Systems Thinking
Vicente Talanquer*


2926 DOI: 10.1021/acs.jchemed.9b00210
Using a Systems Thinking Approach and a Scratch Computer Program To Improve Students' Understanding of the Bronsted-Lowry Acid-Base Model
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2937 DOI: 10.1021/acs.jchemed.9b00288
Redox Aluminophosphates: Applying Fundamental Undergraduate Theory To Solve Global Challenges in the Chemical Industry
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2947 DOI: 10.1021/acs.jchemed.9b00405
Total Chemical Footprint of an Experiment: A Systems Thinking Approach to Teaching Rovibrational Spectroscopy
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2959  DOI: 10.1021/acs.jchemed.9b00257
Industry-Informed Workshops to Develop Graduate Skill Sets in the Circular Economy Using Systems Thinking
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2968  DOI: 10.1021/acs.jchemed.9b00266
Situating Sustainable Development within Secondary Chemistry Education via Systems Thinking: A Depth Study Approach
Andrew C. Eaton, Seamus Delaney, and Madeleine Schultz*


2975  DOI: 10.1021/acs.jchemed.9b00286
Integrating Green and Sustainable Chemistry into Undergraduate Teaching Laboratories: Closing and Assessing the Loop on the Basis of a Citrus Biorefinery Approach for the Biocircular Economy in Brazil
Vânia G. Zuin,* Mateus L. Segatto, Dorai P. Zandonal, Guilherme M. Grossell, Aylon Stahl, Karne Zanotti, and Rosivania S. Andrade

2984  DOI: 10.1021/acs.jchemed.9b00345
Not Just an Academic Exercise: Systems Thinking Applied to Designing Safer Alternatives
Megan R. Schwarzman* and Heather L. Buckley

2993  DOI: 10.1021/acs.jchemed.9b00400
Sustainable Consumer Choices: An Outreach Program Exploring the Environmental Impact of Our Consumer Choices Using a Systems Thinking Model and Laboratory Activities
Kathleen C. Murphy,* Meghna Dilip, Joseph G. Quattrucci, Susan M. Mitroka, and Jeremy R. Andreatta

3000 DOI: 10.1021/acs.jchemed.9b00637
Future Directions for Systems Thinking in Chemistry Education: Putting the Pieces Together
Alison B. Flynn, MaryKay Orgill, Felix M. Ho, Sarah York, Stephen A. Matlin, David J. C. Constable, and Peter G. Mahaffy*

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Jonathan L. Miller, Michael T. Wentzel, James H. Clark, and Glenn A. Hurst*

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Exploring Real-World Applications of Electrochemistry by Constructing a Rechargeable Lithium-Ion Battery
Franklin D. R. Mahara,[†] Wanxin Wu, Yiwei Zhou, Logan T. Schwanz, and Michael P. Marshak*

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Microwave Synthesis of a Prominent LED Phosphor for School Students: Chemistry's Contribution to Sustainable Lighting
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DOI: 10.1021/acs.jchemed.8b01009

Valorization of Waste Orange Peel to Produce Shear-Thinning Gels
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The Dark Side of Biomass Valorization: A Laboratory Experiment To Understand Humin Formation, Catalysis, and Green Chemistry
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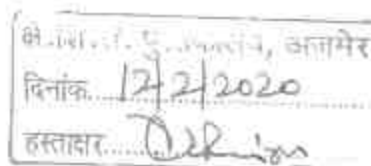
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Synthesis of Magnetic Nanoparticles Using Potato Extract for Dye Degradation: A Green Chemistry Experiment
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Supporting Information available via online article



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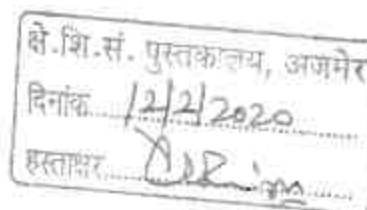
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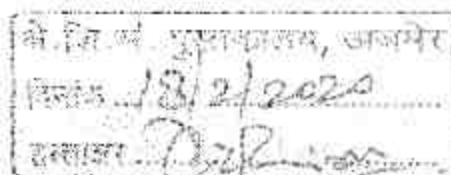
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एन सी ई आर टी ई
NCERT

**द्या से अमरत्व
प्राप्त होता है।**

परस्पर आबंधित इस राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद् (एन.सी.ई.आर.टी.) के कार्य के तीनों पक्षों के एकीकरण के प्रतीक हैं—

(i) अनुसंधान और विकास,
(ii) प्रशिक्षण, तथा (iii) विस्तार।

यह डिजाइन कर्नाटक राज्य के रायचूर जिले में मस्क के निकट हुई खुशियों से प्राप्त ईसा पूर्व

तीसरी शताब्दी के अशोकयुगीन भग्नावशेष के आधार पर बनाया गया है। उपर्युक्त आदर्श वाक्य ईसायास्य उपनिषद् में लिया गया है जिसका अर्थ है— विद्या से अमरत्व प्राप्त होता है।

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संपादक अपना प्रकाशक को जर्मन सहमत होने आवश्यक नहीं है।



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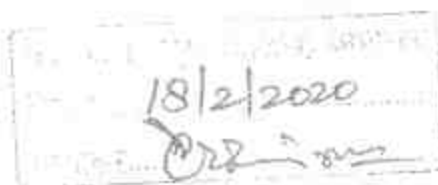
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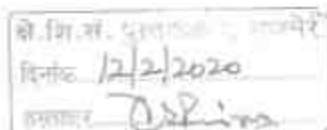
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Elements from the periodic table that are noteworthy for their dangerous characteristics
- 77 Recognising the long table and using it to make a folding (or 'concertina') periodic table**
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An activity designed to enable students to see how the periodic table was first envisaged after finding similarities in the properties of elements, and how it had to be extended as more elements were discovered
- 80 An Elemental Spectacle: A Guided Tour of the Darker Reaches of the Periodic Table**
Michael Hal Sosabowski, Theodore Gray, Max Whitby, Fiona Barclay and David Campbell
Descriptions of demonstrations that can be done to show the properties of most of the elements
- 87 Reviews; 93 Science websearch; 96 SSR special issues; 96 Advertisers index**

Health & Safety

For all practical procedures described in SSR, we have attempted to ensure that:

- all recognised hazards have been identified;
- appropriate precautions are suggested;
- where possible procedures are in accordance with commonly adopted model risk assessments;
- if a special risk assessment is likely to be necessary this is highlighted.

However errors and omissions can be made, and employers may have adopted different standards. Therefore, before any practical activity, teachers should always check their employer's assessment. Any local rules issued by their employer must be obeyed, whatever is recommended in SSR.

Unless the context dictates otherwise it is assumed that:

- practical work is conducted in a properly equipped laboratory;
- any mains-operated and other equipment is properly maintained;
- any fume cupboard operates at least to the standard of CLEAPSS Guide G9;
- care is taken with normal laboratory operations such as heating substances or handling heavy objects;
- good laboratory practice is observed when chemicals or living organisms are handled;
- eye protection is worn whenever there is any recognised risk to the eyes;
- fieldwork takes account of any guidelines issued by the employer;
- pupils are taught safe techniques for such activities as heating chemicals or smelling them, and for handling microorganisms.

Readers requiring further guidance are referred to:

Hazards (CLEAPSS, 2016 and updates)

Topics in Safety, 3rd edn (ASE, 2001; updates available at www.ase.org.uk/resources/topics-in-safety)

Safeguards in the School Laboratory, 11th edn (ASE, 2006)

Preparing COSHH Risk Assessments for Project Work in Schools (SSERC, 1991)

SSERC hazardous chemicals database (www.sserc.org.uk/health-safety/chemistry-health-safety/hazchem_database-2/)

Be Safe! Health and Safety in School Science and Technology for Teachers of 3- to 12-Year-olds, 4th edn (ASE, 2011)

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