Chemists Celebrate Earth Week

February 21, 2024
1:00 PM- 2:30 PM ET
Dr. Bill Doria
Chemistry Professor at Rockford University (Rockford, IL)
Agenda

• Welcome and Introductions
• What is CCEW?
• What is CCA and the Theme team?
• Why batteries and what do we want you to know?
• Let's Talk about batteries
• Resources (activities library, CCEW website, ACS Store, CCEW Coordinator)
• Questions
What is CCEW and CCA?
What is CCEW

• **Chemists Celebrate Earth Week (CCEW)** is a community-based program of the American Chemical Society (ACS). This annual program unites ACS local sections, student communities, technical divisions, businesses, schools, and individuals in communicating the positive role that chemistry plays in the world. Earth Day is observed on April 22 and CCEW is celebrated the week of Earth Day.

• Earth Day was first officially recognized on April 22, 1970, as a way to demonstrate support for a healthy environment, raise awareness about environmental issues, and remind people that we all need to contribute to a sustainable planet. ACS joined the Earth Day celebration in 2003. There have been annual CCEW events ever since.

• CCEW is administered by the ACS Office of Science Outreach, which is part of the Education Division.
What is CCA?

About CCA

The purpose of the Committee on Community Activities is to improve the public perception of chemistry by providing programs to connect chemists with their communities by:

• Providing guidance to the Society’s community outreach programs and activities, and developing and implementing new resources/technologies to support, evaluate, and sustain them;

• Encouraging participation in community outreach programs through recruitment, retention and recognition of volunteers; and

• Informing the Board, Council and other Society bodies of the Committee’s activities.

CCA's vision is promoting understanding and appreciation of chemistry, and CCA's mission is supporting the global chemistry community through engaging outreach, resources, training, and recognition. CCA works as an advisory group to the American Chemical Society’s Office of Science Outreach.

Who We Are

The CCA is organized into three subcommittees and theme teams for the purpose of achieving its goals in the areas of community programming and public outreach. The subcommittees are composed of members of CCA, while the theme teams consist of members from CCA and other groups associated with the specified program.
What is CCA?

- The CCA works alongside the ACS Office of Science Outreach to develop and support ACS-sponsored community outreach programs such as National Chemistry Week (NCW) and Chemists Celebrate Earth Week (CCEW). CCA authors the biannual children’s publication, Celebrating Chemistry, which features interviews from active chemists and hands-on activities that can be done at home.

- CCA reviews applications for international Chemistry Festival Grants and provides feedback for the Outreach Training Program.

- CCA also oversees the Volunteer of the Year program and the Salutes to Excellence program. The chair also writes annual comments in Chemical & Engineering News (C&EN).
2024 CCEW Theme Team

Lori Stepan, CCA Chair
Sara Delgado-Rivera (CCEW Theme team co-chair)
Bill Doria (CCEW Theme team co-chair)
Rick Rogers (PDP Co-Chair)
Weslene Tallmadge
Dave Heroux (PDP Co-Chair)
Tracy Hamilton
Gina Malczewski
Veronica Jaramillo
Susan Hershberger
Duy Le
Cheryl Trusty
Sherri Rukes
Neal Abrams
Juan C. Aponte-Santini
Dr. Neal Abrams  
Associate Professor of Chemistry –  
SUNY College of Environmental Science and Forestry (Syracuse, NY)
Build a Battery
Build a Battery

• Supplies: nails, a sports drink, and a few wires to light up an LED
Chemical Principle

- Zinc is oxidized in the presence of an ionic solution
- Theoretical voltage of +0.76 V
- Basis of cathodic protection

\[
\begin{align*}
\text{Zn}(s) & \rightarrow \text{Zn}^{2+}(aq) + 2e^- \\
2\text{H}^+(aq) + 2e^- & \rightarrow \text{H}_2(g) \\
\text{Zn}(s) + 2\text{H}^+(aq) & \rightarrow \text{Zn}^{2+}(aq) + \text{H}_2(g)
\end{align*}
\]
Why no copper?

- Consider what is in solution!

- For the Cu/Zn couple, the spontaneous reaction requires Cu$^{2+}$ ions in solution

- Still a battery – current flows from the dissolution of zinc.

\[
\begin{align*}
\text{Cu}^{2+} + 2 \text{e}^- & \rightarrow \text{Cu}(s) \quad 0.34 \text{ V} \\
2\text{H}^+ + 2 \text{e}^- & \rightarrow \text{H}_2(g) \quad 0.00 \text{ V} \\
\text{Zn}^{2+} + 2 \text{e}^- & \rightarrow \text{Zn}(s) \quad -0.76 \text{ V}
\end{align*}
\]
Materials

- Copper roofing nails
- Galvanized nails (electroplated)
- Alligator clips
- LEDs
- Paper cups or ice cube tray
Adaptations

• Replace the LED with an audible cue
  – Search for “low voltage toy buzzer”
• Use a multimeter to confirm the voltage

adafruit.com
amazon.com
Modifications and substitutions

• Substitute an ice cube tray for cups
• Replace a sports drink with other conductive solution
  – Sea water, salt water
• Try non-galvanized nails (*won’t work*)
Victoria Russell
Outreach Coordinator at NSF Center for Synthetic Organic Electrochemistry (CSOE) – University of Utah
More About Batteries!
The Basics

**Battery**: converts chemical energy into electrical energy.

Three main parts:

- **Anode** (-): gives up electrons (oxidation)
- **Cathode** (+): takes electrons (reduction)
- **Electrolyte**: helps energy flow through system

Two different metals and something salty or acidic will make a battery. But it might not be a “good” battery.

There are other types of batteries that use non-metals (e.g. graphite) or differences in concentration to produce electricity.
Battery Demonstrations

Copper and Zinc most common cathode and anode material in demonstrations.

If you have a source of copper ions (e.g. CuSO₄):

Oxidation: Zn → Zn²⁺ + 2e⁻
Reduction: Cu²⁺ + 2e⁻ → Cu

\[ E^0 = 1.10 \text{ V} \]

If you DON’T have a source of copper ions:

Oxidation: Zn → Zn²⁺ + 2e⁻
Reduction: 2H⁺ + 2e⁻ → H₂

\[ E^0 = 0.76 \text{ V} \]
The OG Battery: the Voltaic Pile (~1800)

Voltaic Pile: a controllable, continuous source of voltage.

Composed of alternating layers of:

• Copper (cathode, reduction)
• Zinc (anode, oxidation)
• Fabric soaked in sea water or acid (electrolyte)

Oxidation: Zn → Zn^{2+} + 2e^{-}

Reduction: 2H^{+} + 2e^{-} → H_{2}
What makes a frog twitch?

Observation:
Applying two different metals to a frog’s leg and to each other will cause that frog’s leg to “kick.”

Animal Electricity:
Nerve or tissue generates its own electricity

It’s the frog!

Luigi Galvani (1737-1798)

Giovanni Aldini (1762-1834)
What makes a frog twitch?

Animal Electricity: Nerve or tissue generates its own electricity

It’s the frog!

Externally applied electricity excites the tissue

Team Not Frog
Alessandro Volta (1745-1827)

Team Frog
Luigi Galvani (1737-1798)

Giovanni Aldini (1762-1834)
What makes a frog twitch?

Luigi Galvani (1737-1798)

Giovanni Aldini (1762-1834)

It’s the frog!

Alessandro Volta (1745-1827)

Team Not Frog

Mary Shelley

Team Frog

Frankenstein (1813)
Demo- Build a voltaic pile

**Cathode:** copper- penny, copper washer  
**Anode:** zinc- zinc/galvanized washer  
**Electrolyte:** vinegar, lemon juice, salt water
Lithium-ion Batteries

**Cathode (+)**
(Reduction, electrons gained during discharge)
Lithium Oxides: LiFePO₄, LiNiCoAlO₂

**Anode (-)**
(Oxidation, electrons are lost during discharge)
Often graphite

**Electrolyte**
Lithium salts: LiPF₆, LiBF₄, LiClO₄
Organic Solvent: ethylene carbonate, dimethyl carbonate, diethyl carbonate
Lithium-ion Battery Safety

Physical damage to a lithium battery can cause the flammable electrolyte to ignite. Don’t throw lithium-ion batteries in the trash! Check for lithium battery collections near you.

Thermal Runaway: An uncontrollable self-heating state. When a lithium-ion cell generates heat at a rate several times higher than the rate at which heat dissipates from the cell.
What do you want batteries to do better?

Can we make batteries:
• Safer
• Cheaper
• Less toxic/more environmentally friendly
• Charge faster
• Hold charge longer
• Store more energy
• Have a higher energy density (amount of energy in a given volume). Small, light, powerful battery.
• Last for more charge/discharge cycles
• Recyclable
Coming Next?

**Solid Electrolytes:**
Use solid electrolyte instead of liquid or gel. Less flammable, safer, faster charging. Lighter, thinner rechargeable battery!
- Inorganic solids
- Solid polymers
- Composite polymer

**Evolving lithium batteries**

**Lithium-Sulfur:**
- Sulfur: Cheaper and abundant
- Higher energy density than lithium-ion batteries

Li $\rightarrow$ Li$^+$ + e$^-$

$S_8 + 16Li^+ + 16e^- \rightarrow 8Li_2S$
Resources
During CCEW, ACS provides lots of resources to assist our local sections with their programs and events:

- We provide online resources for outreach programs and activities; and
- Encourage participation in community outreach programs through recruitment, retention and recognition of volunteers.
- Resources can be located on our website at www.acs.org/ccew
April 21-27, 2024

Chemists Celebrate Earth Week
Theme: Get a Charge out of Chemistry

To promote the positive role that chemistry plays in the world, ACS established the Chemists Celebrate Earth Week (CCEW) public awareness campaign. During CCEW, ACS members and chemistry enthusiasts celebrate by coordinating events and communicating the importance of chemistry. Read more about CCEW.

Celebrate batteries and their role in creating a more sustainable world during April 21-27, 2024, which is Chemists Celebrate Earth Week.

This year is all about batteries. Batteries have the power because they can accept energy from alternative energy sources such as solar, wind, and hydropower, then store it in chemical bonds. Anywhere and anytime we want, batteries release electrical energy. Today, batteries are an indispensable part of our world. We use them in devices, such as remote controls, wheelchairs, hearing aids, cars, mobile phones, laptops, bike lights, and more.

Did you know that by 2025, the global EV (electric vehicle) market is expected to be valued at $567 billion? Innovations in battery design and efficiency for the entire lifecycle of batteries will protect our environment even more. Get a Charge out of Chemistry as you learn about batteries and their impact on our everyday lives!
Resources - Design Toolkit

- PowerPoint slide
- Social media images
- Web banners
- Flyers
- Mole artwork

*www.acs.org/CCEW*
Resources

2024 Illustrated Poem Contest

- Local Section Winner Submission Deadline (students must submit to the local section by)
  - Sunday, April 28 by 11:59 p.m. ET

- Visit the Illustrated Poem Contest web page for more details

- To nominate your local winners, you must submit the online form located on the website

Ywts and Illustrate a poem using the CCEW theme “The Curious Chemistry of Amazing Algae.” Your poem must be no more than 40 words and in the following styles to be considered:

HAiku - LIMeRICk - Ode - abc Poem - Free Verse - end Rhyme - Blank verse

Possible topics related to the theme include:
- Seaweed
- Micro- or macro-algae
- Photosynthesis
- Bioluminescent algae
- Algae as food & habitat for animals
- Algae and consumer products from algae
- Oxygen from algae
- Ethanol from algae
- Entry must be written and illustrated by one student, who may work with others but must be the principal author of the work

Entries will be judged based on:
- Artistic Merit - use of color, quality of drawing, design, and layout
- Poem Message - fun, motivational, relating to poetry theme
- Originality, Creativity - unique, clever, and/or creative design
- Neatness - free of spelling and grammatical errors

Contest rules:
- All poems must be no more than 40 words and in one of the styles listed above
- Illustrations must be submitted electronically using a digital pen and paper or drawing tablet with the image saved to an electronic file format. Entries must be no larger than 300 dpi and saved as a JPEG, PDF, or PNG file
- All entries must be original works written by the student. Photographs may be submitted by hand or electronically
- All entries must be submitted electronically with an email
- The username field must contain the name of the student and the city of the local section
- All entries must be submitted to the local section by April 28, 11:59 p.m. ET
- Local winners selected from all entries will be announced in May

Winners of the Local Section’s Illustrated Poem Contest will advance to the National Illustrated Poem Contest for a chance to be featured on the ACS website and to win prizes.
Resources – ACS Store

www.acs.org/store
# Upcoming Themes

<table>
<thead>
<tr>
<th>Year</th>
<th>CCEW Theme</th>
<th>NCW Theme</th>
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<tbody>
<tr>
<td>2024</td>
<td><strong>Batteries</strong>&lt;br&gt;Theme: Get a Charge out of Chemistry&lt;br&gt;En Español: Recárgate con la Química</td>
<td><strong>Photography &amp; Imaging</strong>&lt;br&gt;Theme: Picture Perfect Chemistry&lt;br&gt;En Español: Fotografía Perfecta de la Química</td>
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<tr>
<td>2025</td>
<td><strong>Glaciers</strong>&lt;br&gt;Theme: Hot Topic, Cool Chemistry!&lt;br&gt;En Español: ¡Tema Candente, Química Refrescante!</td>
<td>TBD, Mar 2024</td>
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Contact

• Email: outreach@acs.org
• Facebook: @ACS_Outreach
Thank you!
Please take our quick survey
Registration Open

ACS Spring 2024: Many Flavors of Chemistry
March 17-21, 2024
New Orleans, LA
Next Month’s Webinar: Social Media in your Local Section

• What: How to utilize social media to communicate and engage within your local section

• When: *Hosted virtually* on Wednesday March 27\(^{\text{th}}\), 2024 at 1pm

• Future Webinar Schedule: [http://www.acs.org/localsectionwebinars](http://www.acs.org/localsectionwebinars)
THANK YOU!