



NSDL/NSTA Web Seminar: Chemistry Comes Alive IV: Oxidation/Reduction



Thursday, October 15, 2009

Resources from this web seminar are listed at:

<http://www.diigo.com/list/nsdlworkshops/web-seminar-chemistry-redox>



Today's NSDL Experts



Dr. John Moore, W. T. Lippincott Professor,
University of Wisconsin-Madison and
Director of the Institute for Chemical Education



Dr. Lynn Diener, Assistant Professor,
Mount Mary College, Milwaukee, Wisconsin



Dr. Shannon Stahl, Professor,
University of Wisconsin-Madison



<http://nsdl.org>



Today we will explore oxidation/reduction using selected ChemEd DL and JCE resources



- A JCE Classroom Activity—hands on
- Netorials—interactive online tutorials
- What's this? Videos
- Multimedia Problems
- Living Textbook—online and interactive
- Periodic Table Live!—comprehensive and free!



<http://nsdl.org>





A Hands-On Redox Activity

To participate, you need:



- Unsweetened powdered drink mix
- Steel wool (fine works best, #0000)
- Container of water
- 2 clear, colorless cups (beakers, glasses, clear plastic)
- Measuring cup
- Something to stir the water



(participation is not required)



Redox Activity: What to do



- Use a cup of water and about 1/4 of the drink mix, stir them together (you can save the rest of the dry mix to drink later)
- Pour the solution into two clear cups
- Wash the steel wool with hot water (to remove protective oils)
- Put steel wool into one of the cups; set both aside
- Observe the cups later





Oxidation is...

- A. Gaining oxygen atom(s)
- B. Gaining electron(s)
- C. Losing electron(s)
- D. Losing hydrogen atom(s)



Oxidation/Reduction



- When something is **oxidized**, it **loses** one or more electrons.
- When something is **reduced**, it **receives** one or more electrons.
- Oxidation and reduction *always* occur together.
- When oxidation occurs in one place and reduction in another, **electrons flow from the one place to the other.**

Why is redox important?



- Moving electrons can be useful.
- Electrons can do useful work.
 - A flashlight comes on thanks to the miracle of moving electrons.
 - An electric motor turns thanks to the miracle of moving electrons.

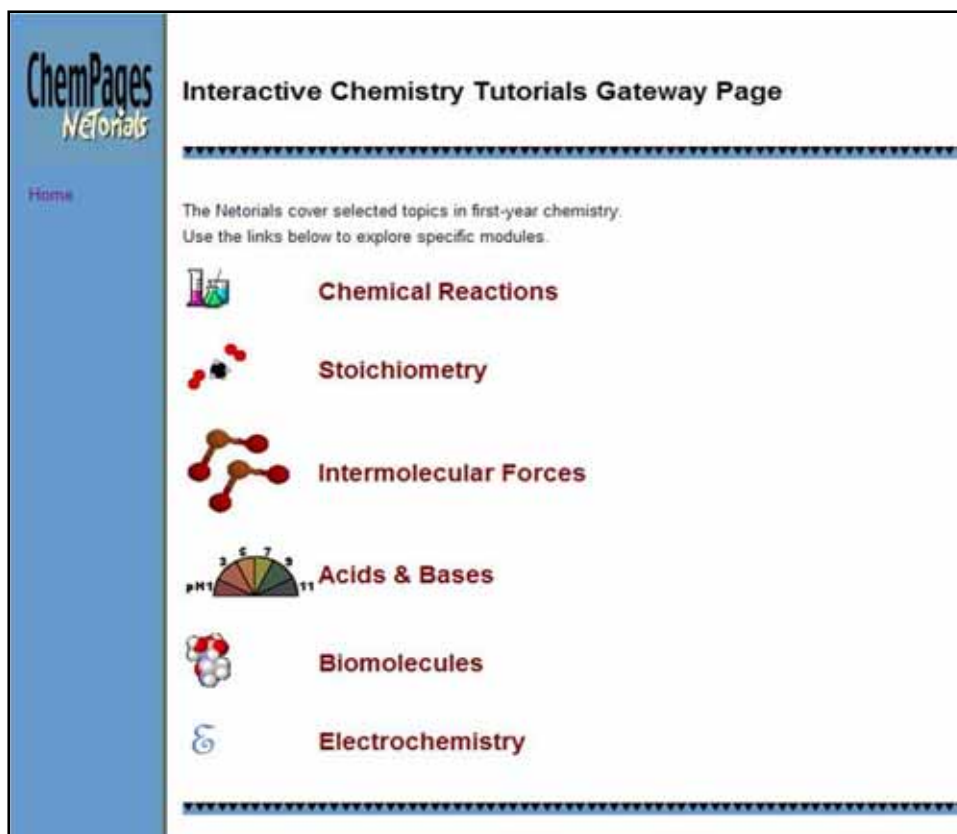


Basics:

Netorials can help your students learn



- More than 30 interactive, online tutorials cover many introductory topics: chemical reactions, stoichiometry, biomolecules, acids and bases, **electrochemistry**.







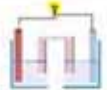




<http://nsdl.org>



Netorials: Redox Chemistry



Within the topic of Electrochemistry, there are seven different tutorials to help your students understand everything from oxidation/reduction to electrolytic cells.

Gateway to  lectrochemistry		
Link	Name	Brief Summary
	Introduction and Legend	The basic premise of the NeTorial application is explained along with a description of the various icons used.
	Oxidation and Reduction	Oxidizing and reducing agents are defined. Common agents are described. Changes in oxidation states are used to follow simple chemical reactions.
	Half-Reactions	Solving net equations by manipulating half-reactions.
	Voltaic Cells	The construction and operation of a voltaic cell.
	Cell Voltage	A description of how a voltaic cell generates a potential with a spontaneous redox reaction.
	Standard Cell Potentials	Using the table of standard potentials to relate oxidation / reduction strength and to calculate cell potentials.
	Batteries	The construction and function of some common primary and secondary batteries.
	Electrolytic Cells	Cells that require an external power source to drive non-spontaneous reactions.

Oxidation and Reduction Netorial

Here is a sample of what you will find.

Electrochemistry: Oxidation and Reduction

Goal: to identify common agents of oxidation or reduction

Working Definitions:

Oxidizing agents cause the oxidation state of other substances to become more positive by accepting their electrons. **Oxidizing agents are themselves reduced.** Common oxidizing agents are listed in Figure 1.

Reducing agents cause the oxidation state of other substances to become more negative by releasing electrons to them. **Reducing agents are themselves oxidized.** Common reducing agents are listed in Figure 1.

Click on the buttons to see common oxidizing and reducing agents.

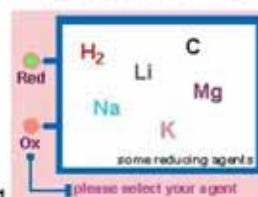


Figure 1

Notice that the reducing agents listed in Figure 1 are mostly alkali and alkaline earth metals, Groups 1a and 2a respectively. Why is it easy for these metals to give up their electrons? Notice also that the oxidizing agents are mostly halogens. Why do Groups 7a and 6a nonmetals find it relatively easy to accept electrons? Atoms in both groups are trying to achieve an octet of valence electrons! It is chemically 'easier' for Groups 1a and 2a to lose 1 or 2 electrons than to gain 6 or 7. The exact opposite holds true for Groups 6a and 7a (it is easier for these atoms to gain 1 or 2 electrons than to lose 6 or 7).

Oxidation occurs when the oxidation state of an atom, molecule, or ion becomes more positive.



Reduction occurs when the oxidation state of an atom, molecule, or ion becomes more negative.



Note: The above example sets (1, 2) illustrate the point that the opposite of reduction is oxidation, the opposite of oxidation is reduction.

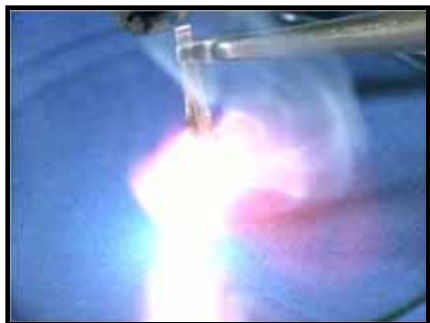
? Based on the previous definitions, identify the oxidizing agents in the following equations by clicking on them. (Clicking the question mark will reset the problem.)



Right! Fluorine is a common oxidizing agent.



What's This? Videos



Which would be most effective to put out a magnesium fire?
(Stamp your answer)



Want to teach redox chemistry graphically? Try What's This?



What's this?
is a series of free
videos donated by
the *JCE* to the
ChemEd DL

- Nitrogen triiodide detonation
- Copper penny with nitric acid
- Magnesium with carbon dioxide

ChemEd DL
Chemical Education Digital Library

Collections Communities Online Services About

What's this?

Click to Play

Video
QuickTime? Required
Duration: 58 s
Size: 4 MB
Viewing Options

Copper Penny with Nitric Acid
The reaction of a copper penny and concentrated nitric acid is shown. Red-brown nitrogen dioxide is generated and some of the copper dissolves to form a blue solution of copper(II) nitrate, $\text{Cu}(\text{NO}_3)_2$.

$$\text{Cu(s)} + 4 \text{H}^+(\text{aq}) + 4 \text{NO}_3^-(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2 \text{NO}_3^- + 2 \text{NO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l})$$

What's This? ChemEd DL Collection?
Like many of us, chemists are curious about some of the things they see. However, a chemist is less likely to go off with a shrug. Chemists are likely to want to understand and explain the things they see. This collection of interesting images uses video in an attempt to give you a chemist's explanation of what is occurring.

What's This? Archive
Click an image below to learn about its chemistry.

© 2007 Chemical Education Digital Library | Contact | Privacy | Terms of Use



Let's pause for
questions from
the audience....



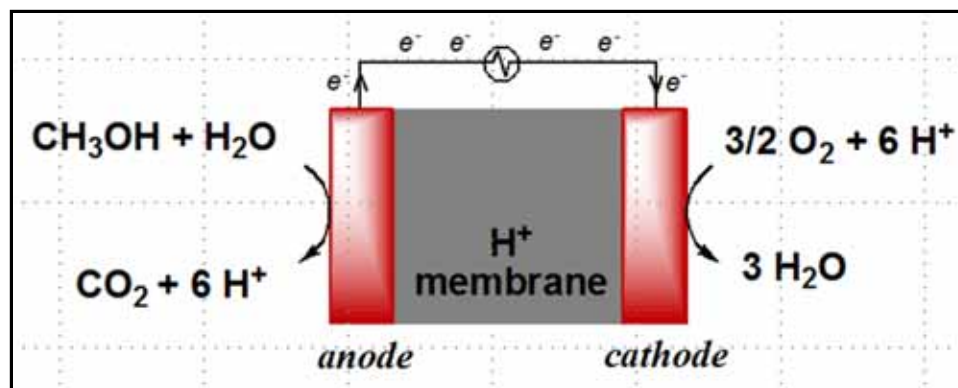
<http://nsdl.org>



Practical Redox Chemistry: Hydrogen fuel cells



- “Clean” energy!
$$2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{l})$$
- No harmful byproducts produced, only water and electricity.



Are hydrogen fuel cells a viable solution to the energy crisis?
(Stamp your answer)



Absolutely!	Nope!

Where might we get the hydrogen? How about electrolysis of water?



- Water can be split into oxygen and hydrogen gas by an electric current.
- At present most electricity is generated by burning fossil fuels.
- But maybe it could come from solar panels.



Some of the more than 30 General Chemistry Multimedia Problems tackle electrolysis of water



In a typical multimedia problem students watch videos and answer questions about the videos. Regarding electrolysis, they:

- Think about half reactions
- Compare electrolysis with boiling
- View nanoscale diagrams showing molecules
- Think about interparticle forces
- Are aided in avoiding misconceptions



<http://nsdl.org>



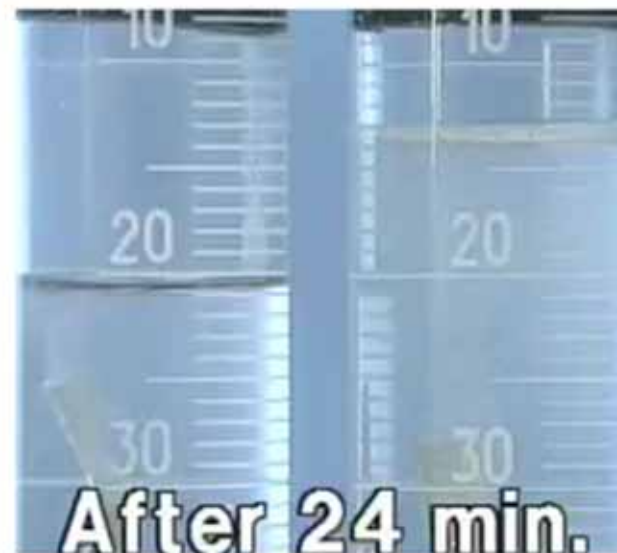
Observe the video and answer the poll question:



Which gas is in the collection tube at the right?

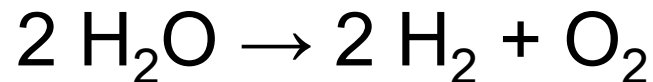
- A. Water vapor
- B. Oxygen gas
- C. Hydrogen gas

(assume that the liquid was initially at the mark just above 10 mL)



Water containing H_2SO_4 is decomposed by electrolysis. The two product gases are tested with a flame and a glowing splint.

HINT: Think about the properties of gases and the stoichiometry of the reaction



<http://nsdl.org>

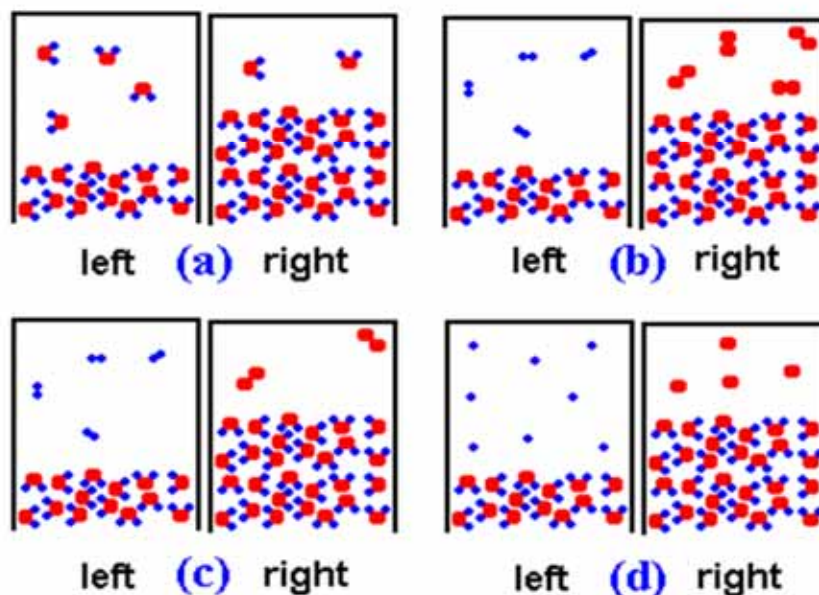


Questions from Electrolysis of Water Multimedia Problem



Poll Question:

Which of the following is the best representation of what happens during the [electrolysis of water](#)?



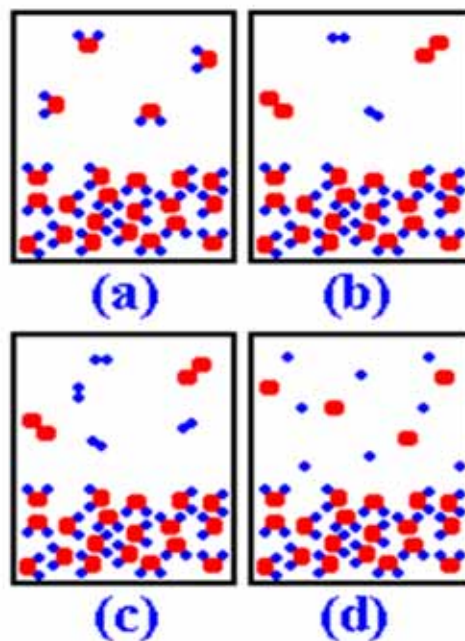
This question and the one on the next slide address a common misconception.

Questions from Electrolysis of Water Multimedia Problem



Poll Question:

Which of the following is the best representation of what happens during the boiling of water ?



This question and the one from the previous slide address a common misconception.

Hands-On Redox Activity: What happened?



Take another look at the experiment you set aside
at the beginning of this Web seminar

- Steel wool is made of iron, a reducing agent
- Fe reduces the azo dyes that color many drink mixes, turning them from colored to colorless
- Coarse steel wool takes longer than fine steel wool (less surface area)



Red drink mix (right) has become colorless after reacting with steel wool (left).

More JCE Classroom Activities that teach redox chemistry



- **Aluminum-Air Battery.** Construct and use a battery that runs on air.
- **Silver to Black – and Back.** Remove silver tarnish electrochemically.
- **Calories – Who's Counting?** Determine the energy content of foods by burning them.
- **Trusty or Rusty? Oxidation Rate of Nails**



JCE HS CLIC: <http://www.jce.divched.org/HS/index.html>



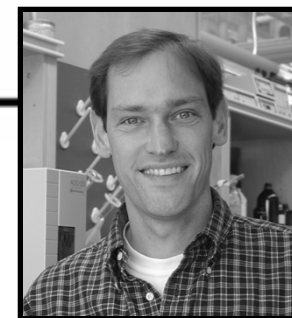
Let's pause for
questions from
the audience....



<http://nsdl.org>

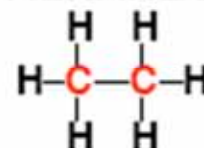
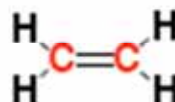


Oxidation in the Chemical Industry



Chemical Feedstocks

ACETYLENE \longleftrightarrow OLEFINS \longleftrightarrow ALKANES

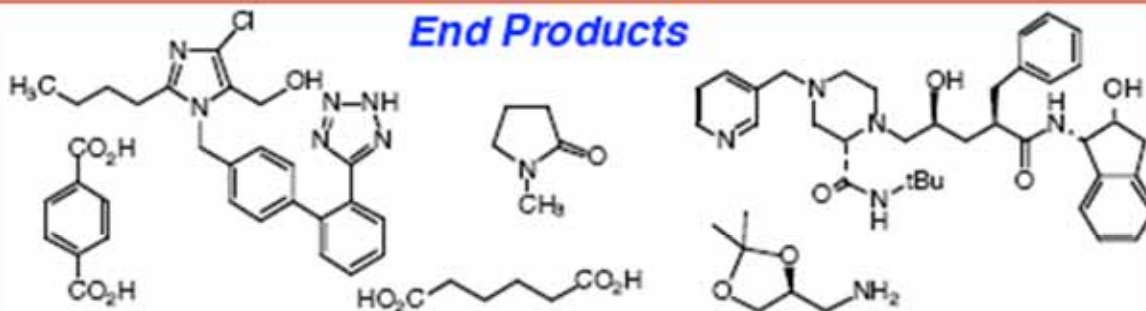


_____ decreasing cost \longrightarrow
_____ availability \longrightarrow



*Selective Chemical
Oxidation*

End Products



>95% of organic chemicals are derived from petroleum feedstocks,
a resource that largely consists of reduced hydrocarbons

Oxidation of Organic Chemicals: Energy Production



Energy Production

Heat/thermal energy



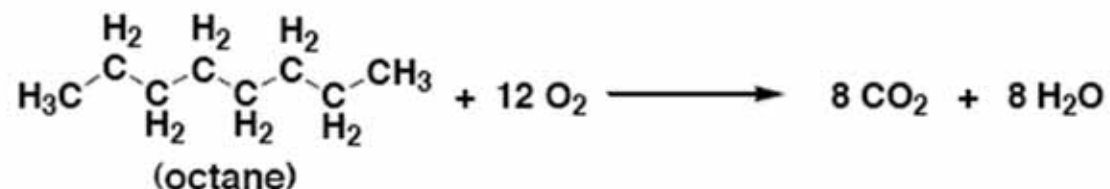
Electricity Generation



(electricity via thermal energy,
e.g., power plants)



Internal Combustion Engine (Mechanical energy)

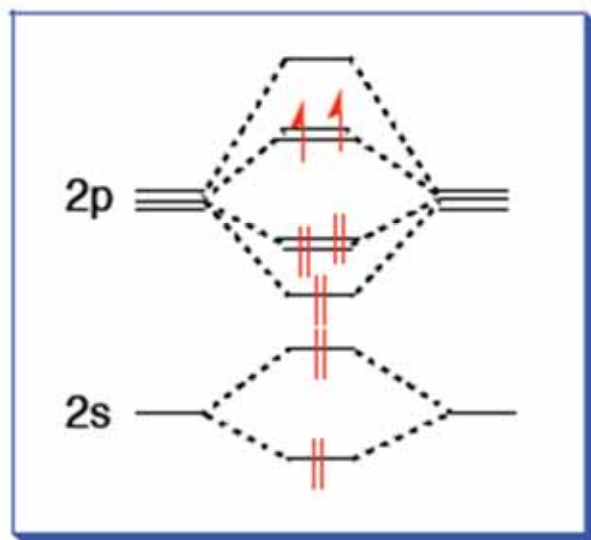


Molecular Oxygen as a Chemical Oxidant



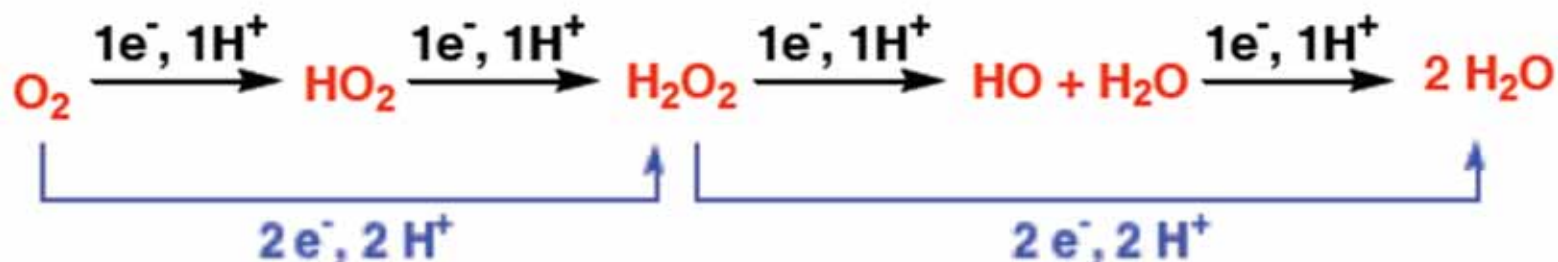
Advantages

- Inexpensive
- Strong Oxidant
- Environmentally Benign



Challenges

- Kinetically inert, ground-state triplet
- Difficult to avoid over-oxidation
- Side reactions often generate radicals
- O₂ is a 4-electron oxidant

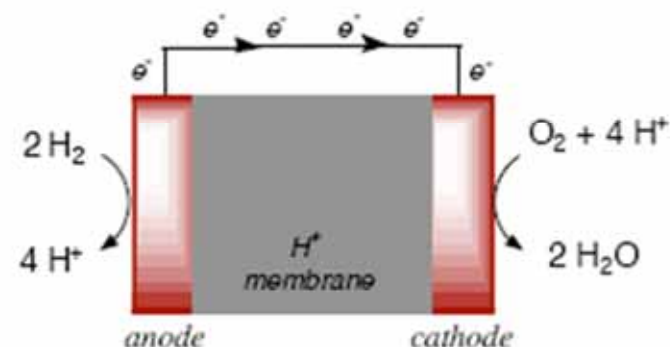


Strategies for Aerobic Oxidation: Oxidase Catalysis

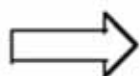
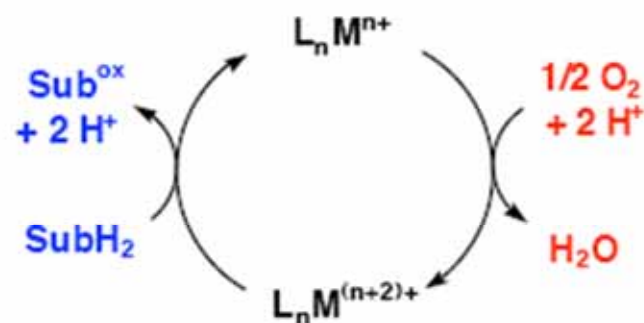
Metalloenzymes: *Oxidases*



Fuel Cells



Chemical Oxidase Catalysis



An **oxidase** mechanism is compatible with the entire scope of target oxidation reactions



Let's pause for
questions from
the audience....



<http://nsdl.org>



Let's consider some redox chemistry of the elements.



Which statement about the alkali metals is true?

- A. They are neither oxidizing agents nor reducing agents.
- B. They usually act as reducing agents.
- C. They usually act as oxidizing agents.



Li



Na



K



Rb



Cs

Learning about redox from an online, interactive textbook



Font size: [bigger](#) [smaller](#) [reset](#)

ChemPaths
Learning to Meander

Student Resources for General Chemistry

Home | Periodic Table Live! | GenChem Textbook | Quick Resources | Tools

Username: Password: [Login](#) [Google™ Custom Search](#) [Search](#)

Home
GenChem Text
Course Modules:
Wave Tutorial
From Waves to Orbitals

WELCOME TO CHEMPATHS!

Last Updated (Friday, 03 April 2009 00:05)
Written by Administrator

This site is the Student Access Portal of many of the Chemistry Education Digital Library collections! Some things you can see while you look around:

To the left are **Course Modules** which you can use to go over various topics in General Chemistry. If your instructor has sent you here, those are likely where you were told to go. The first tutorial, *Wave Tutorial*, uses Chemistry Comes Alive! videos to demonstrate wave mechanics. The second tutorial is the **Prototype Module** *From Waves to Orbitals* which demonstrates the usage of ChemPaths using many of the various interactive tools which are easily embedded into tutorials. In addition to being a prototype, it is also very useful if you're looking to understand how wave mechanics relates to molecular orbitals!

Across the top you will find links to the Periodic Table Live! (wiki-version) and our General Chemistry Textbook. The General Chemistry Textbook is freely available and you may use it to look up anything! The textbook itself is considered one pathway, albeit a fairly long one! But the navigation is the same as for pathways.

Throughout the site there are options to explore various resources throughout the National Science Digital Library (NSDL) as well as our ChemEd Digital Library. Use these to expand your knowledge and gain perspectives!

Instructors: Please log in in order to access course material and teaching resources. It's free to join our community of educators! There are also additional links to NSDL resources after registering.

[Add this page to Digg!](#)

Who's Online
We have 67 guests online

Latest News
[Multi-Atom Molecules](#)
[Electron Orbitals](#)
[From Waves to Orbitals](#)

Mouse Over Terms for Definition:

Popular
[Wave Tutorial Intro](#)
[Welcome to ChemPaths!](#)
[From Waves to Orbitals](#)
[Standing Waves in a Circular Boundary](#)
[Standing Waves](#)

Can you find your course easily?
☐ Yes, no problems.
☐ Yes, but it was a little hard to find.
☐ I'm still looking...

[Vote](#) [Results](#)

[Feed Entries](#)

A project of the ChemEd DL Powered by [Joomla!](#)



<http://nsdl.org>



Typical textbook chapters, plus many new, exciting features

ChemPaths

Student Resources for General Chemistry

Font-size: [bigger](#) [smaller](#) [reset](#)

Home | Periodic Table Live! | **GenChem Textbook** | Quick Resources | Tools

Username: Password:

GenChem Textbook

Chemistry

Introduction

- What Chemists Do
- Measurement
- Numbers, Units, Quantities
- Handling Large and Small Numbers with Units
- SI Units
- SI Prefixes
- Volume
- Density
- Ions in Solution
- Acid-Base Reactions
- Acid and Base Strength
- Lewis Acids and Bases
- Redox Reactions
- Common Oxidizing Agents
- Common Reducing Agents
- Substances Which Are Both Oxidizing and Reducing Agents
- Redox Couples

Chemistry

- Introduction (Units, Measurement)
- Atoms, Molecules, and Chemical Reactions
- Using Chemical Equations in Calculations
- The Structure of Atoms
- The Electronic Structure of Atoms
- Chemical Bonding: Electron Pairs and Octets
- Further Aspects of Covalent Bonding
- Properties of Organic Compounds and Other Covalent Substances
- Gases
- Solids, Liquids, and Solutions
- Reactions in Aqueous Solutions
- Chemistry of the Representative Elements
- Chemical Equilibrium
- Ionic Equilibria in Aqueous Solutions
- Thermodynamics: Atoms, Molecules, and Energy
- Entropy and Spontaneous Reactions
- Electrochemical Cells
- Chemical Kinetics
- Nuclear Chemistry

[Add this page to Diigo!](#)

Other ChemPath Resources

From your textbook:

From elsewhere:

Mouse Over Terms for Definition:

[What Chemists Do](#) →

the slow decay of living organisms into fossil fuels

everyday life have many properties that would have been conceived as magic only a few centuries ago. Could you imagine describing in precise generations electricity from batteries? Could you imagine what they would be doing the decomposition of nitrogen triiodide?

Molecules in Living Systems

Spectra and Structure of Atoms and Molecules

Metals

Consider Chapter 4: The Structure of Atoms



- Groups of Related Elements teaches your students about alkali metals and halogens
- Words tell the story
- Videos bring the message home

Because of their similarities, lithium, sodium, potassium, rubidium, and cesium are grouped together and called the **alkali metals**. What do we mean when we say these elements are similar? The following video of lithium, sodium, and potassium reacting in water demonstrates the similarities quite well. In the video, lithium is at the top, sodium the bottom left, and potassium the bottom right.



A small section from online appears above.



<http://nsdl.org>





Periodic Table Live!

Enables students to explore properties of alkali metals, halogens, and other elements

Periodic Table Live!

Chart/Sort... Glossary...

Sodium

11
Na
22.989770


[Ne] 3s¹

Description Physical Atomic

Characteristics | Discovery | Name | Preparation | Reactions | Uses

Na Sodium Media

Crystal
Images
Video



Use the menu on the left to browse media for sodium.

Sodium, an alkali metal, is the first element of the [3rd period](#) and so is in [Group 1A](#). Other members of the group are lithium (Li), potassium (K), rubidium (Rb), cesium (Cs), and francium (Fr).

Sodium was first prepared by electrolysis of caustic soda, sodium hydroxide, in 1807 by [Davy](#). The name is derived from soda, the substance from which the element was first obtained. The symbol Na is an abbreviation of *natrum*, Latin for sodium.

Sodium is present in fair [abundance in the sun and stars](#). Sodium is the sixth most abundant element on earth, comprising about 2.6% of the [earth's crust](#); it is the most abundant of the alkali group of metals of which it is a member.

Sodium metal has a [body centered cubic](#) structure.

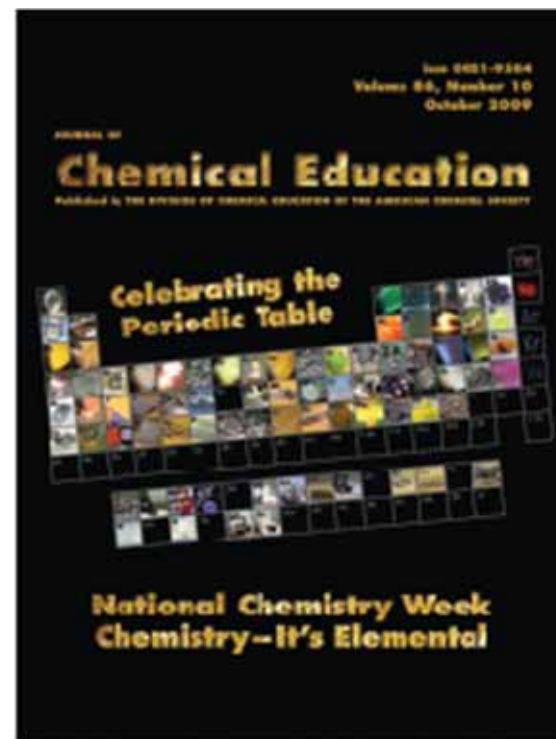
Sodium is now obtained commercially by the electrolysis of absolutely dry fused sodium chloride (the Downs process).

Periodic Table Live!



is a great resource for exploring the National Chemistry Week theme: Chemistry—It's Elemental

- NCW is the week of October 18-24 and includes Mole Day (Oct. 23)
- Chemistry—It's Elemental celebrates the 140th anniversary of Mendeleev's creation of a periodic table
- The October issue of the *JCE* is full of good ideas and great activities



<http://nsdl.org>



Will you and your students participate in National Chemistry Week this year?



YES	NO



<http://nsdl.org>



Chemical Education Digital Library

<http://www.chemeddl.org/>



is ***the*** place on the Web to find chemistry resources. It is a collaboration of the *JCE*, the ACS Education Division, and the ChemCollective project. We have demonstrated only a fraction of what is there.

Explore!





Everything we shared today—and much, much more—can be found in the ChemEd DL, the JCE Dlib, or NSDL.



<http://nsdl.org>

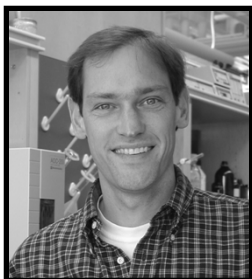




Dr. John Moore
jwmoore@chem.wisc.edu



Dr. Lynn Diener
Imdiener@wisc.edu



Dr. Shannon Stahl
stahl@chem.wisc.edu

**THANK
YOU!**



<http://nsdl.org>



Resources from this web seminar are listed at:

<http://www.diigo.com/list/nsdlworkshops/web-seminar-chemistry-redox>

Learn about new tools and resources, discuss issues related to science education, find out about ways to enhance your teaching at:

<http://expertvoices.nsdl.org/learningdigitalK12>



<http://nsdl.org>



[Back to NSTA.org](#)
[Contact Us](#)
[Help](#)
[Feedback](#)




[Home](#)
[My Account](#)
[Subjects](#)
[Learning Resources & Opportunities](#)
[Professional Development Tools](#)
[Education Administrator](#)

Welcome to Your Professional Development

The Learning Center is NSTA's e-professional development portal to help you address your classroom needs and busy schedule. You can gain access to more than 3,300 different resources that cater to your preference for learning. Over 925 resources, such as journal articles, science objects and web seminars are available [for free](#). A suite of practical tools such as My Library, My Transcript, and My Professional Development Plan and Portfolio tool help you organize, personalize, and document your growth over time. If desired, you may review an [archived Web Seminar](#) overview of the NSTA Learning Center, or download the ["How to Guide"](#) PDF (2.7 MB).



[Login](#)
[\[Click Here to Log In Now \]](#)
[RSS](#) [SHARE](#) 

Most Popular Science Objects

Viewed **Emailed**

1. Energy: Different Kinds of Energy
2. Plate Tectonics: Layered Earth
3. Energy: Thermal Energy, Heat, and Temperature
4. Universe: The Sun as a Star

[More Popular Resources...](#)

Explore Learning Opportunities

[See all FREE Resources](#) [Advanced Search](#)

By Subject	By Grade Level	By State Standards
<ul style="list-style-type: none"> Earth & Space Science Life Science Physical Science 	<ul style="list-style-type: none"> Elementary Middle School High School College 	Select your state to begin: <input type="text" value="Choose a state"/>


Do-It-Yourself Learning
 Learn at your own pace online with these 1-2 or 6-10 hour interactive activities.


Live Online Seminars & Classes
 Learn online from certified instructors with your colleagues. 1-2 hour seminars, week and month long courses are available. Earn state

Multimedia Overview




Flash Player Required

Free Learning Resources


[Solar System: A Look at the](#)

<http://learningcenter.nsta.org>



<http://www.elluminate.com>

National Science Teachers Association

Dr. Francis Q. Eberle, Executive Director

Zipporah Miller, Associate Executive Director
Conferences and Programs

Al Byers, Assistant Executive Director e-Learning

NSTA Web Seminars

Paul Tingler, Director

Jeff Layman, Technical Coordinator

