Using a guided-inquiry lab to engage and create student understanding of oxidation states.

Debbie Johnson
North Muskegon High School
Grand Valley State University
Target Inquiry Program

My purpose for using an inquiry lab in instruction of oxidation states

- Meet a content standard (NSES, 1996) that all students should develop an understanding of chemical reactions that involve the transfer of electrons (oxidation/reduction)
- Create an experience for students to build on
- Make the invisible visible
- Link seemingly arbitrary rules to a meaningful real-world context

My chemistry course

Students have lab notebooks and will have performed and written 2 or 3 (inquiry-based) labs already

Students already know about the structure of the atom and that electrons can be exchanged or shared to form new compounds.

My friend has restless leg syndrome. Her doctor says she should take more Vitamin C.

Why might the doctor recommend Vitamin C?

Her doctor says she needs the Vitamin C to increase her iron absorption, which will decrease her restless leg syndrome. What other problems can happen if iron absorption is low?

What effect might the Vitamin C be having on iron?

Lets back up

Your body is a salt-water solution. What usually happens to iron exposed to salt-water?

What is the formula for this “new iron compound”?

Now what do you predict will happen to iron exposed to an antioxidant like vitamin C?

What about an oxidant like hydrogen peroxide?

To investigate a reaction between vitamin C and iron what materials do we need?

‘body’ solution
iron (nails)
well plate (or test tubes)
vitamin C pellets
mortar and pestle
spatulas
‘indicator’ solution

tweezers
50 mL beakers
hydrogen peroxide
stirrers or toothpicks
colored pencils

Safety

Work with your partner to decide how to set up and observe reactions of iron.

Example

1. Label the wells H_2O_2 , Vitamin C, and control.
2. Add a nail to each well.
3. Pour 'body' solution in each well, about halfway.
4. Add some H_2O_2 to its well.
5. Crush vitamin C with the mortar and pestle.
6. Add some crushed vitamin C to its well

Results/Observations

Part I.

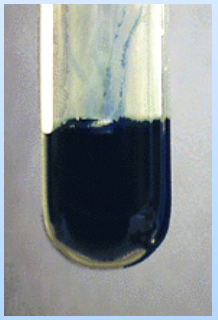
Nail Samples	*Immediate*	*after 10 minutes*	*after 25 mins*
only salt water -	*yellow forming around nail*	*a few spots on nail slight yellow color*	*solution green color*
salt water - vitamin C.	*slightly yellow*	*cloudy some blue color*	*true blue color cloudy*
salt water - hydrogen peroxide	*lots of bubbling slight orange forming*	*still bubbling more orange color*	*few bubbles, spots on nail, orange precipitate*

Part II.

Observations of known Fe^{2+} and Fe^{3+}solutions

Fe^{2+} solution is blue and Fe^{3+} solution is orange

Orange (*Fe^{3+}*)



Blue (*Fe^{2+}*)

What do the known solutions and indicator tell you about the effect Vitamin C and hydrogen peroxide have on iron? Restate evidence!

The Submicroscopic Drama (Or Chemistry)

We need some background to describe what was happening in our experiment.

Oxidation **numbers**

- **Pure elements are zero. Like solid iron. We write Fe^0**
- **The oxidation number represents what has happened to the electrons.**

Rust is really a mixture of Fe^{2+} and Fe^{3+}.

Oxidation **reactions**

As pure solid iron became rust in the presence of Vitamin C, the iron formed the +2 ion, Fe^{2+}. We can write the reaction,

$$\overset{0}{Fe} \rightarrow \overset{2+}{Fe} + 2 \text{ electrons}$$

This is called an **oxidation half-reaction** for two reasons

1. Describe what happened to the electrons of the element (iron, Fe^0).

   Iron loses electrons.

2. Describe what happened to the oxidation number of the element (iron, Fe^0).

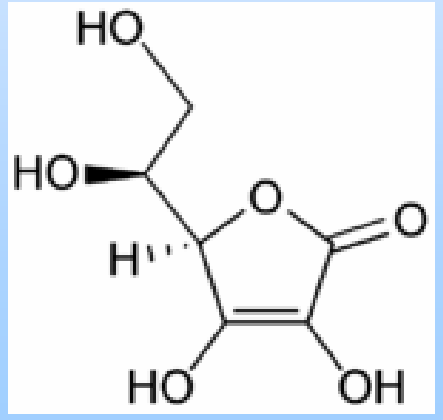
   It increased.

3. Write a definition of oxidation half-reactions

Now guess what happens in a reduction half-reaction?

My friend’s doctor said that restless leg syndrome can be aggravated by low iron and our bodies absorb iron more easily in its "reduced form”.

Now you can explain what the doctor means by “reduced form” and how Vitamin C can help my friend.



Vitamin C

Students then summarize the lab

The Inquiry of the Lab

- Students introduced to a new concept
- Students designed and evaluated their own procedures
- Students used their observations to construct new knowledge
- Students also used their observations to answer a real-world chemistry question

Acknowledgments

Dr. Deborah Herrington, Dr. Ellen Yezierski and Dr. Julie Henderleiter of

Grand Valley State University
Department of Chemistry

The Camille and Henry Dreyfus Foundation:
2005 Special Grant Program in the Chemical Sciences

National Science Foundation (ESI-0553215)

Flinn Scientific, Inc

Flinn Chemtopic Labs: Oxidation and Reduction Volume 16

The chemistry students of

North Muskegon Public Schools

Questions?

- Email Debbie Johnson at

johnsode@nmps.k12.mi.us

- Download student and teacher guide at

http://www.gvsu.edu/targetinquiry/