SALS Activity 2
Balancing redox reactions

Introduction

In redox reactions one or more reactants are oxidized (loses electrons) and one or more reactants are reduced (gain electrons). The reducing agent is oxidized since oxidation causes reduction and the oxidizing agent is reduced since reduction causes oxidation. The most common example of this is a battery in which electrons flow from an electron dense end to an electron deficient end; the battery loses charge (dies) once the reaction reaches equilibrium. In redox reactions, both the charges on the atoms and the number of atoms on either side of the reaction need to be balanced; this is referred to as charge and mass balance. Redox reactions are divided into half-reactions to show each process in the reaction. An example of this is shown below:

Original Reaction:
$Cl_2 + Fe^{2+} \longrightarrow Cl^- + Fe^{3+}$

Half Reactions:
$Cl_2 \longrightarrow Cl^-$
$Fe^{2+} \longrightarrow Fe^{3+}$

Atom Balanced Half Reactions:
$Cl_2 \longrightarrow 2Cl^-$
$Fe^{2+} \longrightarrow Fe^{3+}$

Atom and Charged Balanced Half Reactions:
$Cl_2 + 2e^- \longrightarrow 2Cl^-$ **Reduction**
$Fe^{2+} \longrightarrow Fe^{3+} + e^-$ **Oxidation**

In order to completely balance this reaction and cancel out the electrons (since the number of electrons lost is equal to the number of electrons gained), the oxidation reaction must be multiplied by two, giving the final balanced reaction:

$Cl_2 + 2Fe^{2+} \longrightarrow 2Cl^- + 2Fe^{3+}$

Materials

- SALS app downloaded onto iPhone or iPad
- SALS probe
- 250 mL Pyrex (glass) beaker
- Granulated Zinc (Zn)
- Sodium Hydroxide (NaOH) pellets
- 200 mL water (measure with notched syringe or other device)
- Metal tongs or long metal forceps or tweezers
- Pennies

- Stirring rod
- Latex or rubber gloves
- Safety goggles
- Laboratory fume hood
- Cookie sheet with a raised edge or rim
- Hot plate
- Paper towels
- Bunsen burner or candle
- Timer

Caution
Sodium Hydroxide (NaOH) is corrosive and decomposes lipids and proteins. Accidental exposure to the skin or splashing of this chemical in the eyes can cause chemical burns and blindness. **All students must wear gloves and safety goggles when doing this activity which should only be performed in a laboratory fume hood with the exhaust fan operating**.

Directions

1. Place the cookie sheet and the hot plate in the fume hood and turn the exhaust fan on.
2. Place the 250 mL beaker on the tray in the hood and cover the bottom of the beaker with a layer of granulated zinc. Place a small beaker filled with at least 250 mL of water to the side in the hood.
3. To the reaction beaker add 6 NaOH pellets with the tongs and 200mL of water measured with the notched syringe and mix with the stirring rod to get an even mixture.
4. Using the SALS probe, get an initial Hertz/tone reading on the color of the penny, and save the Hertz/tone for later comparison.
5. Place the beaker on the hot plate on a low setting and close the hood enough to prevent fumes from exiting the hood, yet allow comfortable work with your arms and hands. Seek help from the instructor for this if necessary.
6. Grasp a penny with the tongs or long forceps and hold it in the warmed mixture for 5 minutes (with the tongs).
7. Using the tongs, place the penny in the beaker of water and let it sit for 3 minutes. Turn off the hot plate.
8. With the tongs and gloved hands, remove the penny from the beaker of water, dry it off, and then take another reading with the SALS probe (make sure the ambient lighting is the same as for the initial reading of the penny); save the tone.
9. Hold the penny with the tongs in or over the flame of a Bunsen burner or candle for approximately 10 – 15 seconds. Remove the penny from the flame, place it on a paper towel, and extinguish the flame.

10. Take a final reading of the penny with the SALS probe and save the tone, making sure the ambient lighting is the same as in the previous two measurements.
11. Compare the three tones from SALS and record the results in a notebook.
12. After cooling for several minutes, the penny is safe to touch with your bare hands; keep it if you wish.

Questions to answer

1. What physically changed about the penny?

2. Suppose one of the half reactions for this is
$Zn_{(s)} + OH^{-}_{(aq)} \rightarrow ZnO_2^{2-}{}_{(aq)} + H_{2\,(g)}$.
Is the zinc oxidized or reduced? Is the zinc the oxidizing agent or the reducing agent?

3. Why do you think the penny is now a different color?

Resource

Rogers, Casey. "Gold and Silver Pennies."*Chemistry Demonstrations*. James Madison University, 14 June 2011. Web. 9 Feb. 2015. <http://sites.jmu.edu/chemdemo/2011/06/14/gold-and-silver-pennies/>.