Chemistry - Laboratory #11: The Oxidation States of the Manganese Atom

ROUGH DRAFT pre-lab (goal through procedure) DUE THURSDAY 2/9/12
FINAL DRAFT of lab (title through procedure) in lab book DUE MONDAY, 2/13/12
LAB WILL BE ON MONDAY, FEBRUARY 13, 2012

Goal

The goal of this lab is to match the colors of four different manganese solutions to manganese's oxidation state in each.

Research Questions (* = must be done to get a correct conclusion)

1. In this lab, we will use four chemicals. What are the names and formulas of the four chemicals?
2. What is manganese's noble gas electron configuration shorthand? Looking at the configuration, why (and how) does manganese form more than one oxidation state?
3. What is an oxidation state? What are two other names for oxidation states?
4. Based on your answer to question 2, what would you predict would be the two most stable oxidation states for Mn? Why?

*5. Look at the three equations listed in the background section below. What are the four compounds that contain manganese? Calculate the oxidation numbers of manganese in each of the compounds. YOU MUST SHOW YOUR WORK!!
(Hint: Use the algebra method or the puzzle method!)

6. What do the little letters in parentheses stand for in the equations in the background section below? Based on the equations, which reaction (A, B, or C) should form a precipitate? How do you know?
7. Why are Erlenmeyer flasks such a good choice for this experiment? (two reasons)

Background

Many atoms can have different oxidation states depending on the compound they are part of. Manganese is one such atom. It can be found or prepared in four different oxidation states, each with its own properties (such as color!).

In this experiment, you will transform manganese into three oxidation states other than the one it starts out as in $KMnO_4$. You will perform each of the following reactions:

Reaction Equations

A) $4\ KMnO_4\ (aq) + H_2SO_4\ (aq) + 10\ NaHSO_3\ (aq) + H_2O\ (\ell) \longrightarrow$
$4\ MnSO_4\ (aq) + K_2SO_4\ (aq) + 2\ NaKSO_4\ (aq) + 4\ Na_2SO_4\ (aq) + 7\ H_2O\ (\ell)$

B) $2\ KMnO_4\ (aq) + 3\ NaHSO_3\ (aq) + 2\ H_2O\ (\ell) \longrightarrow$
$2\ MnO_2\ (s) + K_2SO_4\ (aq) + 2\ NaHSO_4\ (aq) + NaOH\ (aq) + 2\ H_2O\ (\ell)$

C) $2\ KMnO_4\ (aq) + 3\ NaOH\ (aq) + NaHSO_3\ (aq) \longrightarrow$
$2\ NaKMnO_4\ (aq) + Na_2SO_4\ (aq) + 2H_2O\ (\ell)$

Guidelines

1. You will need to use three different 125 mL Erlenmeyer flasks, one for each of the three reactions.
2. All chemicals in this lab will start in the aqueous state.
3. You will need to obtain each chemical in a different beaker and measure each in a different graduated cylinder. There is no need to measure the $NaHSO_3$ solution with a graduated cylinder; it is just added until the color changes.
4. **EVERYTHING** (from original color of the chemicals to what happens when the chemicals are dumped in the waste container) during the lab should be observed very carefully.
5. The color changes are easier to see when observed over white scrap paper.
6. Add the $NaHSO_3$ solution slowly while stirring! Swirling can be stirring! Swirl and add, swirl and add, swirl and add . . .
7. NOTE: For this lab ONLY, research will be worth 4 points (as it is longer), and data will be worth only 4 points. (The rest of the lab's sections will be the same as usual.)

First reaction (A) directions:

Add 5 mL of $KMnO_4$ to the flask. Next add 3 mL of H_2SO_4 to the flask. Finally, add $NaHSO_3$ solution to the flask until the color changes.

Second reaction (B) directions:

Put 5 mL of $KMnO_4$ in the flask. Add $NaHSO_3$ solution until the color changes.

Third reaction (C) directions:

Add 5 mL of $KMnO_4$ to the flask. Next add 4 mL of NaOH to the flask. Finally, add $NaHSO_3$ solution until the color changes.