Questions relating to the Oxidizing Power Lab are related to the characteristics and stoichiometry of oxidation-reduction reactions. You are asked to identify oxidizing and reducing agents and determine which substances in a redox reaction are reduced and which are oxidized. You use the lab results and stoichiometric relationships to determine the concentration of the sodium thiosulfate standard and to calculate the percent Na0Cl or H_2O_2 in commercial bleaches.

1. **Oxidation and Reduction**
   Oxidation-reduction reactions are paired reactions in which reactants undergo a change in oxidation number, either losing electrons (oxidation) or gaining electrons (reduction). Electrons are not, of course, lost or destroyed during chemical reactions, so when an electron is lost by one substance it is gained by another substance; thus oxidation and reduction occur simultaneously.
   The substance that loses an electron is called the reducing agent, and the substance that gains an electron is called the oxidizing agent. The reducing agent is oxidized, and the oxidizing agent is reduced in the redox reaction.
2. **Stoichiometry**
   Stoichiometry, or mass relationships of substances involved in chemical reactions, involves correctly balanced chemical reactions, from which you obtain the mole ratios of reactants and products. The Oxidizing Power of Bleach lab involves several redox reactions, and it is important to understand the interrelationships of these reactions.

   The net ionic reaction of sodium hypochlorite with potassium iodide:

   $$ClO^- + 2I^- + 2H^+ \rightarrow I_2 + Cl^- + H_2O$$

   The net ionic reaction of hydrogen peroxide with potassium iodide:

   $$2H_2O_2 + 2I^- \rightarrow I_2 + 2H_2O + O_2$$

   The net ionic reaction of iodine with sodium thiosulfate:

   $$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

   The net ionic reaction of iodate with iodine:

   $$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$$

   The net ionic reaction of sodium thiosulfate with potassium iodate (Standardization Reaction):

   $$IO_3^- + 6S_2O_3^{2-} + 6H^+ \rightarrow I^- + 3S_4O_6^{2-} + 3H2O$$

3. **Sample Calculations**
   Standardization of Sodium Thiosulfate

   Determine the concentration of $Na_2S_2O_3$ solution if 23.55 mL are required to titrate the iodine formed from the reaction of a 20.00 mL of a 0.0100 M solution of KClO with excess KI.$_3$

   - First, determine the number of moles that react:

     moles $KClO_3$ = (0.02000 L)(0.010 mol $KCL0_3$/L) = 2.00 x 10^{-4} mol $KClO_3$

   - Then use the mole ratio of NaOCl to sodium thiosulfate to KClO to determine the number of moles of $Na_2S_2O_3$ that react:

     (2.00 x 10^{-4} mol KIO_3) x (6 mol $Na_2S_2O_3$ / 1 mol KIO_3) = 1.20 x 10^{-3} moles $Na_2S_2O_3$

   - Finally, use the volume of Na_2S_23 titrated to determine the molarity:

     1.20 x 10^{-3} mol / 0.02335 L = 0.0520 M $Na_2S_2O_3$

Percent Sodium Hypochlorite in Bleach

A 0.415 g sample of bleach is treated with an excess of KI and, after the reaction is completed, 8.73 mL of a 0.0.0736 M solution of $Na_2S_2O_3$ is required to titrate the iodine liberated in the reaction. Determine the percent NaOCl in the bleach sample.

- First, determine the number of moles of $Na_2S_2O_3$ that react:

  moles $Na_2S_2O_3$ = (0.00873 L) x (0.0736 mol $Na_2S_2O_3$/L) = 6.43 x 10^{-3} moles $Na_2S_2O_3$

- Then, use the mole ratio of NaOCl to $Na_2S_2O_3$ to determine the number of moles NaOCl in the sample:

  (6.43 x 10^{-3} mol $Na_2S_2O_3$) x (1 mol NaOCl / 2 mol $Na_2S_2O_3$) = 3.21 x 10^{-3} moles NaOCl

- Next, convert the moles NaOCL to grams NaOCl:

  (3.21 x 10^{-3} mol NaOCl) x (74.5 g NaOCl/mol NaOCL) = 0.0239 g NaOCl

- Finally, calculate the percent NaOCl in the sample:

  0.0239 g NaOCl / 0.415 g bleach x 100 = 5.76% NaOCl