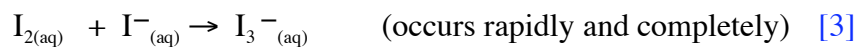
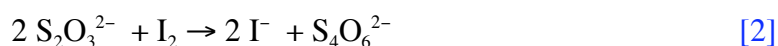
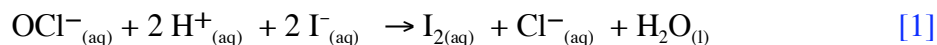


## Analysis of Hypochlorite in Bleach (Redox titrations are cool!)

This experiment allows you to determine the percentage (w/v) of active ingredient, **sodium hypochlorite (NaOCl)** in common commercial bleaches. We won't do it directly, but we will use some cool chemistry and we will be able (or should be able) to determine percentages pretty accurately.

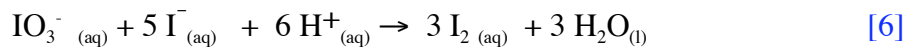
**THE CHEMISTRY:** (for more a more detailed description see your lab manual)



So when  $\text{I}^-$  is in excess:



**Our problem:** The analysis of  $\text{OCl}^-$  by titration with  $\text{S}_2\text{O}_3^{2-}$  requires that we know the concentration of the  $\text{S}_2\text{O}_3^{2-}$  solution. Unfortunately, **sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ )** is not a primary standard, so we must standardize the sodium thiosulfate solution. A similar series of reactions is used for the standardization, only **potassium iodate ( $\text{KIO}_3$ )** is used to oxidize **iodide ( $\text{I}^-$ )** to **iodine ( $\text{I}_2$ )**:

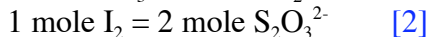
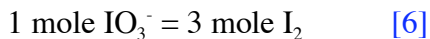


So we'll titrate a known amount of  $\text{KIO}_3$  (**the limiting reagent**), in the presence of excess of  $\text{I}^-$ , with our  $\text{Na}_2\text{S}_2\text{O}_3$  solution. Using the stoichiometry of reaction 6, we can calculate the  $\text{I}_2$  generated (theoretically) and then using the stoichiometry of reaction 2 (this gives us moles  $\text{Na}_2\text{S}_2\text{O}_3$  used in each titration) and the titration volumes we can calculate  $[\text{Na}_2\text{S}_2\text{O}_3]$ .

## THE EXPERIMENT:

- 1) Standardize  $\text{S}_2\text{O}_3^{2-}$  (aq)  $\Rightarrow$  Solves problem.

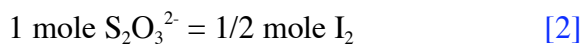
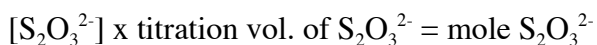
The stoichiometry is important:



So after titrations are completed (volumes), you can find  $[\text{S}_2\text{O}_3^{2-}]$ .  
You need at least 3 titration volumes within 0.05 mL.

- 2) Determine % NaOCl in bleach (w/v)

You need at least 3 titrations within 0.05 mL.



Convert to mass NaOCl (g) (MW NaOCl = 74.44 g/mole)

Find (g/sample vol.)  $\times$  100%

sample vol. = 0.10 mL  $\Rightarrow$  5.00 mL of original bleach solution/250.0 mL, so, stock bleach solution is 0.02 ( or 1/50) of original bleach solution.

For each titration  $\Rightarrow$  5.00 mL  $\times$  0.02 (or 5.00 mL/50) = 0.10 mL

## SAMPLE CALCULATIONS:

- 1) Standardization of  $\text{Na}_2\text{S}_2\text{O}_3$ :

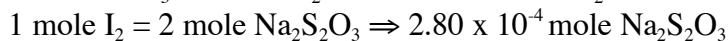
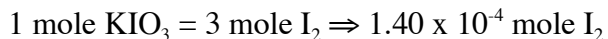
$$(0.2000 \text{ g KIO}_3)(1 \text{ mole KIO}_3/214.00 \text{ g/mole}) = 9.346 \times 10^{-4} \text{ mole KIO}_3$$

You made up  $\text{KIO}_3$  stock solution in a 100.0 mL volumetric flask and for each titration you used 5.00 mL of your stock solution

So.... for each titration you used 1/20 of your stock solution:

$$\text{KIO}_3 \text{ used in each titration} = 9.346 \times 10^{-4} \text{ mole KIO}_3/20$$

$$\text{KIO}_3 \text{ used in each titration} = 4.67 \times 10^{-5} \text{ mole KIO}_3$$



e.g. For a titration volume = 5.61 mL (from experimental data):

$$2.80 \times 10^{-4} \text{ mole Na}_2\text{S}_2\text{O}_3 / 0.00561 \text{ L} = 0.0500 \text{ M Na}_2\text{S}_2\text{O}_3$$

## 2) Analysis of Bleach (Clorox)

e.g. For a titration volume = 3.44 mL (from experimental data)

$$(0.00344 \text{ L Na}_2\text{S}_2\text{O}_3)(0.0500 \text{ mole/L Na}_2\text{S}_2\text{O}_3) = 1.72 \times 10^{-4} \text{ mole Na}_2\text{S}_2\text{O}_3$$

$$1 \text{ mole Na}_2\text{S}_2\text{O}_3 = 1/2 \text{ mole I}_2 \Rightarrow 8.68 \times 10^{-5} \text{ mole I}_2$$

$$1 \text{ mole I}_2 = 1 \text{ mole NaOCl} \Rightarrow 8.68 \times 10^{-5} \text{ mole NaOCl}$$

$$\text{mass NaOCl} = (8.68 \times 10^{-5} \text{ mole NaOCl})(74.44 \text{ g/mole}) = 0.00640 \text{ g NaOCl}$$

$$\% \text{ NaOCl (w/v)} = (0.00640 \text{ g NaOCl} / 0.10 \text{ mL bleach}) \times 100\% = 6.40 \% \text{ NaOCl}$$

$$\text{RMD (ppt)} = (\text{mean deviation/mean}) \times 1000$$