Redox Reactions

As there is already a reasonably good representation for redox reactions already on my website, I'm dispensing with most of the introductory material and cutting to the chase.

The experiment undertaken this day takes advantage of two things:

1. you already know how to titrate and
2. iodine is an adequate oxidizing agent with thiosulfate

The net ionic reaction, below, reflects what happens during the overall reaction:

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

$S_2O_3^{2-}$ is the thiosulfate ion and $S_4O_6^{2-}$ is the tetrathionate ion; the oxidation state of the S in the former is +2; in the latter is +2.5.

This reaction is not an easy reaction to observe with the naked eye. An indicator is required. The indicator for this reaction is a solution of starch. Starch reacts with the iodine to form an inclusion compound (I_2 "crawls" into the spaces in the secondary structure of the starch) that is blue/black in color. As the iodine is reduced to iodide ion, the color changes to clear/colorless. The change to colorless is the endpoint of the titration. In other words, the iodine has been completely reduced and no longer forms an inclusion compound with the starch. The trick to this, though, is to titrate the iodine solution until the dark amber color of the iodine solution is about the color of concentrated urine. At that time, ADD the starch to the reaction mixture. The endpoint is very near at that time, so add thiosulfate from your buret a drop at a time so as to not go over the endpoint.

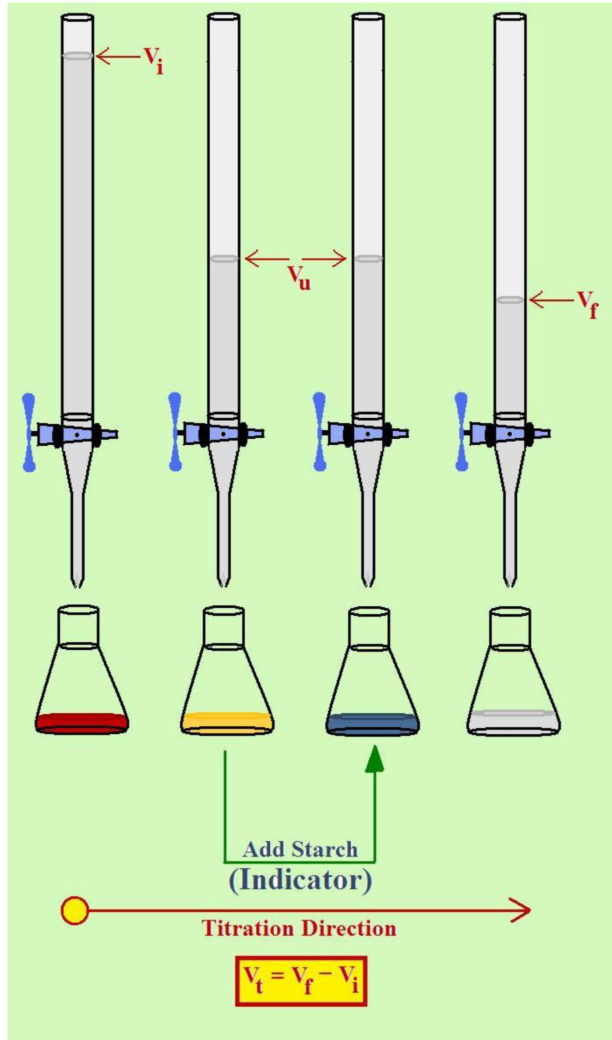
Solution Preparation

Potato Starch: Dissolve 0.5 g potato starch in 250 mL boiling water. Let boil until the solution is clear. Let cool, then add enough water to bring the solution back to 250 mL.	Iodine solution: Dissolve 30 g KI in 15 mL water. Add 9.49 g iodine crystals and stir. Add another 30 mL of water with mixing. Without pouring the solid iodine granules with the solution, pour this solution into 750 mL of water. Mix and store in a brown bottle -- store in refrigerator between labs.
0.1 N Sodium thiosulfate: boil distilled water for 5 minutes. Let cool, then add 9.31 g of the pentahydrate with 0.075 g sodium carbonate to 750 mL of the water. Stir and store in a brown bottle in the dark.	

Experimental

Pour 10 mL of the iodine solution into each of 2 Erlenmeyer flasks (2-125 mL flasks). Prepare your burets as you have in the past, I.e., rinse with the thiosulfate solution, then fill it with that solution.

Titrate 1 sample at a time with the sodium thiosulfate solution. As the solution takes on the color of concentrated urine, add 2 mL of starch solution to the flask. (See graphic at right.) Complete the titration, recording the initial volume (V_i) of thiosulfate in the buret and the final volume (V_f)of thiosulfate on the buret at the end point -- <u>record no other thiosulfate volumes</u>! Repeat with the second sample. Your data sheet is below:



	TRIAL 1	TRIAL 2
Final volume (V_f) of thiosulfate (mL)		
Initial volume (V_i) of thiosulfate (mL)		
Volume (V_t) of thiosulfate used (mL)		
Normality of thiosulfate (from instructor) (N)		
Volume of iodine solution used (mL)		
Normality of the iodine solution (CALCULATED!)		

Questions

Complete these questions on a separate piece of paper and attach to the lab for turn in.

1. If the normality of the thiosulfate is 0.1 N, what is the normality of the iodine solution?
2. Which reagent is the oxidizing agent?
3. Which reagent is the reducing agent?
4. What was the blue color?
5. Why did the blue color change to clear?
6. Which reagent was oxidized?
7. Which reagent was reduced?

   Balance the following chemical reactions by one of the three methods discussed in the lecture on redox reactions:

8. $H_2SO_4 + HBr \rightarrow SO_2 + Br_2 + H_2O$
9. $MnO_4^- + H_2S + H_3O^+ \rightarrow Mn^{2+} + S + H_2O$
10. $H_2S + H_2O_2 \rightarrow H_2O + S$
11. $Zn + NO_3^- \rightarrow Zn^{2+} + N_2$ (in acid)
12. $H_2O_2 + MnO_4^- \rightarrow Mn^{2+} + O_2$ (in acid)

References

1. Holtzclaw, Robinson and Odom: General Chemistry with Qualitative Analysis, 9th Ed. (D.C. Heath and Co: Lexington, MA) © 1991, p. 684.
2. Russell: General Chemistry, 2d Edition. (McGraw-Hill: NY) © 1992, pp. 451, 454, 457.
3. Skoog and West: Fundamental Analytical Chemistry, 4th Ed. (Saunders College Publishing: Philadelphia) © 1982, pp. 374-377, 386, 764, 767.

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