

Experiment 6

Redox Titration

Iodine Titrations

Objective:

Determination the concentration of Sn^{2+}
in an unknown sample using
back titration

****An oxidation-reduction (redox) reaction**
is a type of chemical reaction that involves a transfer of **electrons** between two species.

****An oxidation-reduction reaction** is any chemical reaction in which the oxidation number of a molecule, atom, or ion changes by gaining or losing an electron.

I^- : Iodide ion

IO_3^- : Iodate ion

I_3^- : triiodide ion



- The reaction is reversible
- I_2 is the oxidizing agent and I^- is the reducing agent
- Analyte in iodine titration can be
 - oxidizing agent: example $\text{Fe}^{3+} + 2\text{I}^- \longrightarrow \text{I}_2 + \text{Fe}^{2+}$
 $\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \longrightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$
 - reducing agent: example $\text{S}^{2-} + \text{I}_2 \longrightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$

a) Standardization of $\text{S}_2\text{O}_3^{2-}$ using KIO_3 as primary standard

Reduction equation: $6 \text{H}^+ + \text{IO}_3^- + 5\text{e}^- \longrightarrow 1/2 \text{I}_2 + 3 \text{H}_2\text{O}$

Oxidation equation: $5 \text{I}^- \longrightarrow 5/2 \text{I}_2 + 5\text{e}^-$

Net equation: $6 \text{H}^+ + \text{IO}_3^- + 5 \text{I}^- \longrightarrow 3 \text{I}_2 + 3 \text{H}_2\text{O}$

Reduction equation: $\text{I}_2 + 2\text{e}^- \longrightarrow 2\text{I}^-$




Oxidation equation: $2\text{S}_2\text{O}_3^{2-} \longrightarrow \text{S}_4\text{O}_6^{2-} + 2\text{e}^-$

Net equation $\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \longrightarrow \text{S}_4\text{O}_6^{2-} + 2 \text{I}^-$

$$M_{\text{KIO}_3} = \frac{\frac{m}{M_w}}{v}, \quad v = 0.1 \text{ L}$$

Number of moles $\text{I}_2 = (M \times V)_{\text{KIO}_3} \times 3$

Number of moles $\text{I}_2 \times 2 = (M \times V)_{\text{S}_2\text{O}_3^{2-}}$

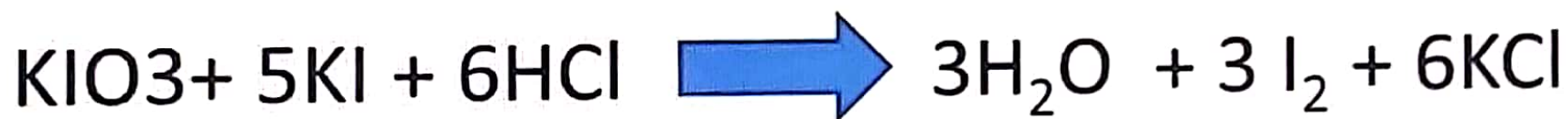
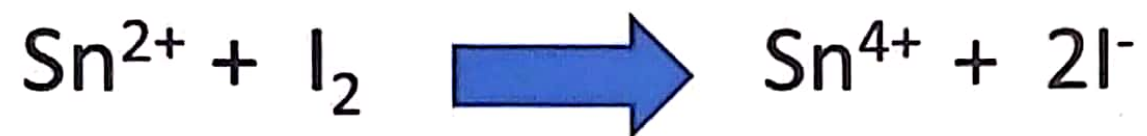
- Standard Solution: KIO_3
- Analyte: Sn^{2+}
- Excess reactant: Iodine
- Titrant: $\text{Na}_2\text{S}_2\text{O}_3$
- Indicator: Iodine (self indicator) through the appearance or disappearance of color (deep brown  orange  yellow  colorless)
- If $[\text{I}_2]$ less than $4 \times 10^{-5} \text{ M}$ add starch to give dark blue color with iodine

❖ End point detection:

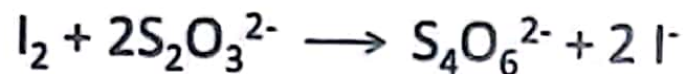
Red-brown color due to I_3^- titration with $S_2O_3^{2-}$ yellow adding starch
blue titration with $S_2O_3^{2-}$ colorless

❖ Starch is used to detect iodine concentration down to $2 \times 10^{-5} \text{ mol/L}$

Reactions:

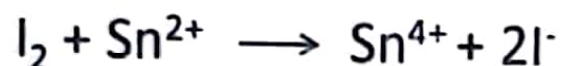


b) Standardization of iodine using $S_2O_3^{2-}$:



$$(M \times V) I_2 \times 2 = (M \times V) S_2O_3^{2-}$$

c) Determination of tin in an unknown sample (back titration):



Total number of moles iodine = number of moles iodine react Sn^{2+} +
number of moles iodine react $S_2O_3^{2-}$

$$(M \times V) I_2 = (M \times V) Sn^{2+} + (M \times V) S_2O_3^{2-}/2$$

❖ Back titration is used instead of direct titration because the reaction between I_2 and Sn^{2+} is slow