X) Redox Titrations

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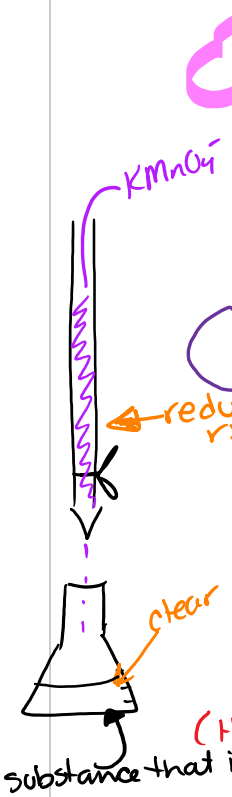

used to find [unknown] in a Redox Rxn.

X) Redox Titrations

Similar to acid-base titrations, redox titrations are also useful for determining the unknown concentration of a solution. However, the titration reaction is a redox reaction rather than an acid-base reaction.

A common solution used for titrations is acidified aqueous potassium permanganate, $KMnO_{4(aq)}$ (actually $K^+_{(aq)}$ and $MnO_4^-{}_{(aq)}$), because permanganate (MnO_4^-) is a strong oxidizing agent (top left of table) when in the presence of anacid, and there is a built in colour change as MnO_4^- is purple and reacts to become colourless $Mn^{2+}{}_{(aq)}$:

spectator ion

$$\underset{\text{purple}}{MnO_4^-} + 8H^+ + 5e^- \Rightarrow \underset{\text{colourless}}{Mn^{2+}} + 4H_2O$$

(near top of table)

acidic conditions

= clear

Purple MnO_4^- solution (from the buret) will spontaneously oxidize most reducing agents of unknown concentration (in the flask). How do you know this?

→ H_2O_2

As purple MnO_4^- ions drop into the flask, they will react with the reducing agent to produce Mn^{2+} ions, so the mixture in the flask will remain colourless. Once all of the reducing agent (H_2O_2) from the flask has reacted with MnO_4^-, the equivalence point has been reached, so the next drop of MnO_4^- solution added will …

(lightest)

→ Turn Flask purple

… because MnO_4^- no longer has a R.A (H_2O_2) to react with (used up) … so excess ↑ $[MnO_4^-]$ (purple)

= equivalence point

"equal" molar ratio (balanced rxn)

(H_2O_2) + an acid (H_2SO_4)

Practice Question: When 25.00mL of Cr^{3+} solution is titrated with 0.300M $KMnO_4$ solution, the titration takes 28.32mL of $KMnO_4$ solution to reach the endpoint according to the following equation:

$$6MnO_4^- + 10Cr^{3+} + 11H_2O \Rightarrow 6Mn^{2+} + 5Cr_2O_7^{2-} + 22H^+$$

Calculate the original $[Cr^{3+}]$.

The dichromate ion ($Cr_2O_7^{2-}$), which creates an orange solution, can be used as an oxidizing agent for many redox titrations if in an acidic environment, as it's high on the left side of the table, and it reacts to produce the Cr^{3+} ion, which forms a green solution.

Assignment 9: 1) Do Hebden p. 213-214 #26, 28, 29

XI) The Electrochemical Cell

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