Precipitation Titrations
A precipitation titration is simply one where one of the products of the reaction is a precipitate. For example, the concentration of chloride ions in seawater may be determined by titration with silver ions. As this titration proceeds, a precipitation reaction occurs:

\[ \text{Ag}^+(\text{aq}) + \text{Cl}^-\text{(aq)} \rightarrow \text{AgCl(s)} \]

The equivalence point for this particular titration is when an amount of silver ions equal to the amount of chloride ions in the sample has been added. The chromate ion, $\text{[CrO}_4\text{]}^{2-}$, is a suitable indicator for this reaction as, while both silver chloride and silver chromate are insoluble, the precipitates are of differing colour, white and red respectively. Moreover, under the starting conditions, silver chloride will precipitate out of the reaction mixture first. Silver chromate will only start precipitating when there appears an excess of silver ions in comparison to chloride ions.

Complexometric Titrations
Many metals react to form 1:1 complexes with the ion 1,2-diaminoethane-$N,N',N',N''$-tetraacetate:

![Complexometric Titrations Diagram](image)

This is derived from 1,2-diaminoethane-$N,N',N',N''$-tetraacetic acid (EDTA) by loss of four protons. In its complexation of metals, EDTA acts as a hexadentate ligand, binding at the 4 carboxylate sites and the two nitrogen atoms, effectively "wrapping up" the metal.

Natural water contains many metal ions; that which contains significant amounts of Ca$^{2+}$, Mg$^{2+}$, or both is known as "hard" water. EDTA can be used in a titration to determine the aggregate concentration of these ions in hard water. The indicator used in such a titration is Eriochrome-Black-T, which forms a red colour in the presence of excess Ca$^{2+}$ and Mg$^{2+}$ but gives a blue solution in their absence. This change in colour comes about because the indicator itself is a weak ligand, much weaker than EDTA. Thus, the EDTA ligand effectively competes for the metal ions with the indicator, with the end point marked by the change in colour from red to blue.

However, metallic ions other than Ca$^{2+}$ and Mg$^{2+}$ interfere with this titration and traces of heavy metal ions (e.g. Cu$^{2+}$, Fe$^{3+}$, Zn$^{2+}$) can be found in most natural waters. These trace metals are prevented from interfering by the addition of a small quantity of the strong ligand CN$, which preferentially binds to these trace metals. Cyanide, being a strong ligand, is not displaced by EDTA during the titration, effectively preventing reaction between EDTA and these metals. This procedure is known as masking.