

- Ethylenediamine tetraacetate (EDTA^{4-}) is a ligand that forms complexes with many metal ions and consequently may be used to treat heavy metal toxicity in the body. The reaction with lead ions is represented by the following equilibrium:



If a solution had an initial concentration of $1 \times 10^{-4} \text{ M Pb}^{2+}$ and 0.05 M EDTA , what will be the concentration of uncomplexed lead ions once equilibrium is established? K_{stab} for $[\text{PbEDTA}]^{2-}$ is $1 \times 10^{18} \text{ M}^{-1}$.

K_{stab} is very large so the amount of uncomplexed Pb^{2+} will be tiny.

If $[\text{Pb}^{2+}] = x \text{ M}$,

$$[[\text{PbEDTA}]^{2-}] = (1 \times 10^{-4} - x) \text{ M} \sim 1 \times 10^{-4} \text{ M as } x \text{ is so small.}$$

$$[\text{EDTA}^{4-}] = 0.05 - (1 \times 10^{-4} - x) \text{ M} \sim 0.05 - (1 \times 10^{-4}) \text{ M} = 0.0499 \text{ M}$$

Hence,

$$K_{\text{stab}} = \frac{[[\text{PbEDTA}]^{2-}]}{[\text{Pb}^{2+}][\text{EDTA}^{4-}]} = \frac{(1 \times 10^{-4})}{x(0.0499)} = 1 \times 10^{18}$$

$$x = [\text{Pb}^{2+}] \text{ M} = 2 \times 10^{-21} \text{ M}$$

Answer: $[\text{Pb}^{2+}] = 2 \times 10^{-21} \text{ M}$