Answer on Question #66937, Chemistry - General Chemistry

$EDTA^{4-}$ binds metal ions to form complexes, thus can be used to determine concentrations of metal ions. Calculate the concentration of $[Co^{2+}]$ in solution after the addition of 48.0mL of 0.05M EDTA $^{4-}$ to a 50mL sample of 0.048M $[Co^{2+}]$.

$$Co^{2+} + EDTA^{4-} \Rightarrow [Co(EDTA)]^{2-}$$

$K_f = 2.04 \times 10^{16}$

Solution:

1. $c\,(Co^{2+}) = [Co^{2+}] + [[Co(EDTA)]^{2-}] = \frac{50*0.048}{98} = 2.45 * 10^{-2}$ M

2. $c\,(EDTA^{4-}) = [EDTA^{4-}] + [[Co(EDTA)]^{2-}] = \frac{48*0.05}{98} = 2.45 * 10^{-2}$ M

3. $[[Co(EDTA)]^{2-}] = c\,(Co^{2+}) - [Co^{2+}]$

4. $[EDTA^{4-}] = c\,(EDTA^{4-}) - [[Co(EDTA)]^{2-}] = c\,(EDTA^{4-}) - c\,(Co^{2+}) + [Co^{2+}] = 2.45 * 10^{-2} - 2.45 * 10^{-2} + [Co^{2+}] = [Co^{2+}]$

5. $K_f = \frac{[[Co(EDTA)]^{2-}]}{[Co^{2+}]*[EDTA^{4-}]}$

$$2.04 * 10^{16} = \frac{[[Co(EDTA)]^{2-}]}{[Co^{2+}] * [EDTA^{4-}]} = \frac{2.45 * 10^{-2} - [Co^{2+}]}{[Co^{2+}] * [Co^{2+}]}$$

$$2.04 * 10^{16} = \frac{2.45 * 10^{-2}}{[Co^{2+}] * [Co^{2+}]} = \frac{2.45 * 10^{-2}}{[Co^{2+}]^2} \Rightarrow [Co^{2+}]^2 = \frac{2.45 * 10^{-2}}{2.04 * 10^{16}}$$

$$[Co^{2+}]^2 = 1.2 * 10^{-18}$$

$$[Co^{2+}] = 1.1 * 10^{-9} \text{ M}$$

Answer: the concentration of $[Co^{2+}]$ in solution is $1.1*10^{-9}$ M.