(22.6) What will be the ratio of [Pu(III)]/Pu[(IV)] in a groundwater containing small concentrations of iron in the relation Fe(II) 99% and Fe(III) 1%? E° for Fe(II)/Fe(III) = 0.743 V. Neglect hydrolysis.

Assume that data for Pu(III)/Pu(IV) from Fig. 22.3 at pH 8 are valid and that water temperature is 10ºC.

$E0_{Fe} := 0.743 \cdot volt$

$E0_{Pu} := -0.39 \cdot volt$

$T := (273.15 + 10) \cdot K$

$R := 8.31451 \cdot \frac{joule}{mole \cdot K}$

$n := 1$ for both Fe and Pu in this example.

$N_A := 6.022137 \cdot 10^{23} \cdot mole^{-1}$

$q_e := 1.6021773 \cdot 10^{-19} \cdot coul$

$F := q_e \cdot N_A$

$x_{Fe2} := 99 \cdot \%$

$x_{Fe3} := 1 \cdot \%$

$E_{Fe} := E0_{Fe} + \frac{R \cdot T}{n \cdot F} \cdot ln\left(\frac{x_{Fe3}}{x_{Fe2}}\right)$

$E_{Pu} = E0_{Pu} + \frac{R \cdot T}{n \cdot F} \cdot ln\left(r_{Pu}\right)$

$E_{Fe} = 0.631 \cdot volt$

$E_{Pu} := E_{Fe}$

$r_{Pu} := exp\left[\frac{\left(E_{Pu} \cdot n \cdot F - E0_{Pu} \cdot n \cdot F\right)}{(R \cdot T)}\right]$

$r_{Pu} = 1.481 \cdot 10^{18}$ and $\frac{1}{r_{Pu}} = 6.753 \cdot 10^{-19}$ $log\left(\frac{1}{r_{Pu}}\right) = -18.2$

Thus, the ratio Pu(IV)/Pu(III) will be 1.481*10^{18}, and the inverse is 6.75*10^{-19} or 10$^{-18.2}$.