Answer to the Question 63493

How many moles of HF ($K_a = 6.8 \times 10^{-4}$) must be added to water to form 0.250 L of solution with a pH of 3.20?

$$HF \rightarrow H^+ + F^-$$

$$K_a = \frac{[H^+] \cdot [F^-]}{[HF]}$$

$$K_a = \frac{\alpha^2 \cdot C_m}{(1-\alpha)}$$

$$[H^+] = \alpha \cdot C_m$$

$$K_a = \frac{\alpha \cdot [H^+]}{(1-\alpha)}$$

$$C_m = \frac{n(HF)}{V} = \frac{n(HF)}{0.25} = 4 \cdot n(HF)$$

$$pH = -\lg[H^+]$$

$$[H^+] = 10^{-pH} = 10^{-3.2} = 6.31 \cdot 10^{-4}$$

$$K_a = \frac{\alpha \cdot [H^+]}{(1-\alpha)} = \frac{\alpha \cdot 6.31 \cdot 10^{-4}}{(1-\alpha)} = 6.8 \times 10^{-4}$$

$$\alpha \cdot 6.31 \cdot 10^{-4} = 6.8 \times 10^{-4}(1-\alpha)$$

$$\alpha = 0.5187$$

$$[H^+] = \alpha \cdot C_m = 4 \cdot n(HF) \cdot \alpha = 6.31 \cdot 10^{-4}$$

$$n(HF) = \frac{6.31 \cdot 10^{-4}}{4 \cdot \alpha} = 3 \cdot 10^{-4} mol$$