M, Fig. 4-18, this proton condition is met at pH 8.3 where $[H_2CO_3^*] = [CO_3^{2-}]$, $[H_2CO_3^*] \gg [H^+]$, and $[CO_3^{2-}] \gg [OH^-]$. The solution composition is

$$[H^+] = 10^{-8.3},\ [OH^-] = 10^{-5.7},\ [H_2CO_3^*] = 10^{-5},$$
$$[HCO_3^-] = 10^{-3},\ [CO_3^{2-}] = 10^{-5}$$

2. The equivalent fraction is calculated as

$$f = \frac{\text{number of equivalents of } HNO_3 \text{ added/liter}}{C_{T,CO_3}} = \frac{2 \times 10^{-3}}{1 \times 10^{-3}} = 2$$

We determine the solution composition as in part (1).

Mass Balances

$$C_{T,Na} = [Na^+] = 2 \times 10^{-3}$$
$$C_{T,NO_3} = 2 \times 10^{-3}$$
$$C_{T,CO_3} = [H_2CO_3^*] + [HCO_3^-] + [CO_3^{2-}]$$

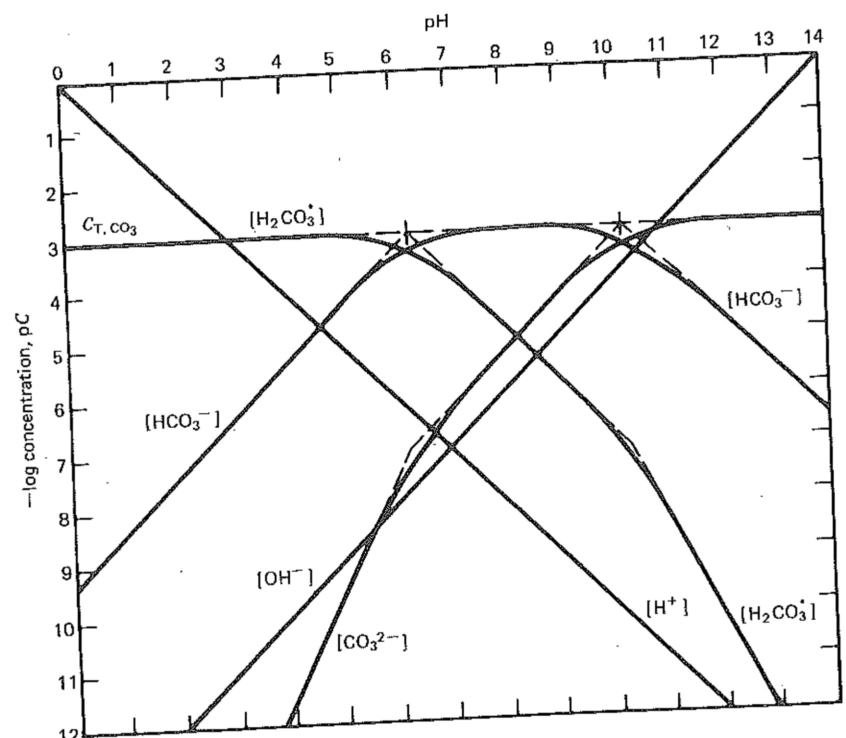

Fig. 4-18. The pC-pH diagram for a carbonate solution, $C_{T,CO_3} = {}^{-3}\ M$ at 25°C.