PROBLEM 1

Add x mg/l of Na_2CO_3 in distilled water and compute the various ionic species concentrations. Assume activity coefficients of unity, $K_w = 10^{-14}$, $K_1 = 4.31\times10^{-7}$, and $K_2 = 4.69\times10^{-11}$. Temperature T = 25 °C, x = 106 mg/l.

PROBLEM 2

If pH =10.0, Total Alkalinity = 100 mg/l as $CaCO_3$, temperature = 25 °C, ionic strength = 0.01, $K_1 = 4.31\times10^{-7}$, $K_2 = 4.69\times10^{-11}$, and $K_w = 10^{-14}$, calculate OH^-, CO_3^{-2}, HCO_3^- and $H_2CO_3^*$ in mg/l as $CaCO_3$.

PROBLEM 3

If Ca^{+2} = 30 mg/l as $CaCO_3$, total alkalinity TA = 20 mg/l as $CaCO_3$, pH = 6.6 temperature T = 25 °C and ionic strength $\mu = 0$, how much lime ($Ca(OH)_2$ must be added to make water a saturated solution of $CaCO_3$? Assume $K_1 = 4.31\times10^{-7}$, $K_2 = 4.69\times10^{-11}$ and $K_{sp} = 4.55\times10^{-9}$ ($CaCO_3$).

PROBLEM 4

For the water analysis data given below:

1. Express each ion concentration as ppm, meq/l, and mole/l;
2. Draw a meq/l bar graph and list the hypothetical compounds;
3. Check the ion balance;
4. Determine the various forms of hardness (total , Ca, and Mg);
5. Determine the various forms of alkalinity (carbonate and non-carbonate).

Ion	Concentration, mg/l
Ca^{+2}	42
Mg^{+2}	19
Na^+	8
K^+	3
HCO_3^-	190
SO_4^{-2}	28
Cl^-	14