Uva Wellassa University, Sri Lanka
End Semester Examination – February 2012
MRT 453-1 Water Quality Data Management

Time: One (01) hour

Uva Wellassa University

Answer all questions
All symbols carry standard meanings
Use of standard symbols without a definition is allowed

1. Routine analysis of a water sample provides the following concentrations (in mg L^{-1}): Ca, 93.9; Mg, 22.9; Na, 19.1; bicarbonate, 344; sulfate, 85.0; chloride, 9.0; pH: 7.20.

   a) Express each concentration in terms of molarity, molality, and normality.

   b) Determine the hardness of the water in mg L^{-1} as $CaCO_3$

   c) If this data is fed to a computer code such as VMINTEQ, list all components that you enter as input values for a calculation of chemical speciation.

   d) List three activity models commonly used in this code to correct activities of ionic species (no mathematical equations are required). How do you calculate the activity of a neutral species in solution?

2. The analysis of a water sample provides the following concentrations (as mg L^{-1}): Ca^{2+} - 93.9; Mg^{2+} - 22.9; Na^{+} - 19.1; HCO_3^{-} - 344; SO_4^{2-} - 85.0; Cl^{-} - 9.0; and a pH of 7.20.

   a) What is the ionic strength of the water?

   b) Determine the saturation index for calcite at 25 °C given that $a_{CO_3^{2-}} = 0.34\times10^{-5}$ and that the equilibrium constant for calcite dissolution is 4.27×10^{-9}.

   c) What does the saturation index indicate about the state of saturation with respect to calcite?

   d) If water is in equilibrium with calcite at 25 °C, what is the calcium concentration in mg L^{-1} if the CO_3^{2-} is 5 mg L^{-1}? Assume activity equals molality.

3. a) State the Henry's Law. Define all terms.

   b) Calculate the solubility product for the dissolution of carbon dioxide in water at 25 °C.

c) If the dissolved CO_2 concentration in a lake at the same temperature is 2.2 mg L^{-1}, is the lake in equilibrium with atmospheric CO_2 (partial pressure = $10^{-3.5}$)? If not, is the gas volatilizing from the lake or dissolving into it?

d) When solving the problem given in Section c using a computer, determine components.

Following data are given:

$$\log \gamma_i = \frac{-Az_i^2\sqrt{I}}{1+Ba_0\sqrt{I}} \qquad \log K = \frac{-\Delta_r G^o}{2.303RT}$$

$A = 0.5085$ and $B = 0.3281\times10^8$ For Ca^{2+} $a_0 = 5.0\times10^{-8}$, $z_{Ca2+} = 2$
(Na = 22.9; Mg =24.2; Ca = 40.1; HCO_3 = 61.0; SO_4^{2-} = 96.0; Cl^- = 35.4; H 1.00)
$\Delta_f G°(H_2CO_3^0)$ = -623.2; $\Delta_f G°(CO_2)$ = -394.4; $\Delta_f G°(H_2O)$ = -394.4 kJ.mol^{-1}