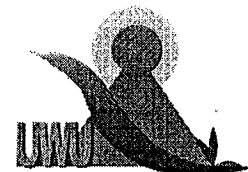




Uva Wellassa University, Sri Lanka
End Semester Examination – February 2012
MRT 453-1 Water Quality Data Management



**Uva Wellassa
University**

Time: One (01) hour

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 $a_{\text{CO}_3^{2-}} = 0.34 \times 10^{-5}$ 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:

$$\log \gamma_i = \frac{-Az_i^2 \sqrt{I}}{1 + Ba_0 \sqrt{I}}$$

$$\log K = \frac{-\Delta_r G^\circ}{2.303RT}$$

$A = 0.5085$ and $B = 0.3281 \times 10^8$ For Ca^{2+} $a_0 = 5.0 \times 10^{-8}$, $z_{\text{Ca}^{2+}} = 2$
 (Na = 22.9; Mg = 24.2; Ca = 40.1; $\text{HCO}_3^- = 61.0$; $\text{SO}_4^{2-} = 96.0$; $\text{Cl}^- = 35.4$; H 1.00)
 $\Delta_f G^\circ(\text{H}_2\text{CO}_3^0) = -623.2$; $\Delta_f G^\circ(\text{CO}_2) = -394.4$; $\Delta_f G^\circ(\text{H}_2\text{O}) = -394.4 \text{ kJ.mol}^{-1}$