

Uva Wellassa University, Sri Lanka
Faculty of Science and Technology
Mineral Resources and Technology Degree Programme
1st Semester Examination – March/April 2013



MRT422-3 Advanced Water Chemistry

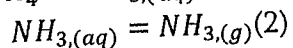
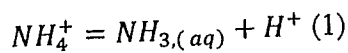
PART II:

1. a. The Gibbs free energy of a reaction, equilibrium constant and reaction quotient are related as

$$\overline{\Delta G}_r = RT \ln \left(\frac{Q}{K} \right)$$

Based on this relationship prove that $-\overline{\Delta G}_r^0 = -RT \ln K$. (20 marks)

- b. The odor of solutions containing ammonia is generated by volatilization. The equilibrium constant for reaction (1) is $10^{-9.25}$ and the standard Gibbs energy of the volatilization reaction (2) is $+10.09 \text{ kJ} \cdot \text{mol}^{-1}$.



A solution containing 10^{-2} M total dissolved ammonia species is at pH 7.25 and 298 K. This is in contact with a gas phase containing a partial pressure of 10^{-6} bar NH_3 .

- i. Calculate the equilibrium constant of reaction (2). (20 marks)
- ii. Calculate the reaction quotient of reaction (2) for the conditions shown. (20 marks)
- iii. Deduce whether the chemical driving force favor dissolution of ammonia, volatilization of ammonia, or is the system at equilibrium? (20 marks)
- iv. Calculate the molar Gibbs free energy of reaction (2) for the conditions stated in the problem. How much and in what direction (increase or decrease) would the total Gibbs free energy of the system change of 10^{-6} mol of NH_3 was transferred from the gas to solution? (20 marks)

2.

a.

- i. The mathematical definition of buffer capacity is $\beta = \frac{d(C_B - C_A)}{dpH}$ where

C_B and C_A are the base and acid concentrations, respectively. Based on this definition plus your intuitive understanding of aqueous solutions, explain why the value of β can never be zero for any solution. (50 marks)