Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 Level 1st Semester Examination – Sep./Oct. 2015
MRT 321-3 Water Chemistry

Uva Wellassa University

Instructions to candidates
Duration: 03 hours
Number of questions: 06
Answer all questions
Mark allocation: 600
Use standard symbols/ abbreviations without a definition

1.

a. How does water function in heat transfer of the atmosphere? What property of the water molecule makes it especially effective for heat transfer? (25 mark)

b. How has the troposphere of the atmosphere prevented loss of Earth's water? (25 mark)

c. Why is rainwater not recommended for drinking purposes? How can "Rainwater Harvesting" project in Sri Lanka be better implemented as a substitute for drinking water? (25 mark)

d. Why does pH of distilled water opened to atmosphere become less than 7? Explain with relevant chemical reactions. (25 mark)

2. The major ion concentration of "global average" river water are given below in mg/L along with their respective formula weights, FW (in g/mol).

Ion	Na^{+}	K^{+}	Mg^{2+}	Ca^{2+}	HCO^{-}_{3}	SO^{2-}_{4}	Cl^{-}
Concentration (mg/L)	9.0	1.4	5.0	21	68	20	8
FW	22.99	39.10	24.30	40.08	61.02	96.07	35.45

a. Calculate charge balance error. Comment on the results. What is the SO_4^{2-} - S (in mg/L) of the water sample? (25 mark)

b. Calculate the TDS of the river water. Indicate assumptions made. How is TDS experimentally determined? (25 mark)

c. Calculate total and temporary hardness of water in mg/L, $CaCO_3$ (H=1.00). (25 mark)

d. What is the ionic strength of global average water? Can γ value in this water be approximated as 1? Give reasons for your answer. (25 mark)

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3.

a. Part I

i. $CaCO_{3(s)} + H^+ = Ca^{2+} + HCO_3^-$ $\Delta G^0 = -11.54$ kJ/mol.
Calculate K_{eq} for the reaction. (25 mark)

ii. If both Ca^{2+} and HCO_3^- activities are 1 mmol/L, what concentration of proton is required to dissolve $CaCO_3$? (25 mark)

b. Part II

A water chemist has found a sample of celesitite ($SrSO_4$). He decides to clean it in a solution containing 10^{-3}M CO_3^{2-} and 10^{-7}M SO_4^{2-}. Consider following reaction,

$$SrSO_{4(s)} + CO_3^{2-} = SrCO_{3(s)} + SO_4^{2-}$$

i. Calculate ΔG and deduce the progress direction of the reaction. (25 mark)

ii. Assume the concentration of CO_3^{2-} can be held constant at 10^{-3} M. What concentration of SO_4^{2-} must be added to solution to reverse the direction of the reaction ($SrCO_{3(s)}$ -1137.6 kJ/mol; $SrSO_{4(s)}$ -1341.0 kJ/mol)? (25 mark)

4.

a. Differentiate between Eh and pe. (25 mark)

b. Plot an Eh-pH diagram of natural water demarcating ground water, swamp water, rain water, and rainwater regions. (25 mark)

c. How is acid mine drainage generated? Your answer requires relevant chemical reactions. (25 mark)

d. Draw the essential components of combined Eh electrode and indicate steps taken when measuring Eh of a water sample. How is Eh value calculated from the reading obtained by a commercial Eh electrode? (25mark)

5.

a. Part I

i. State the meaning of alkalinity of a water sample. How is the alkalinity of a water sample measured? (25 mark)

ii. Calculate the total alkalinity of following solutions: (i) 10^{-3}M $NaHCO_3$ (ii) H_2O (iii) 10^{-4} M Na_2CO_3 (25 mark)

b. Part II

i. Draw breakpoint chlorination graph identifying all regions. (25 mark)

ii. Discuss advantages and disadvantages of water chlorination. State alternative disinfectants used today highlighting their beneficial uses over chlorine. (25 mark)

6.

a. Define following terms: (25 mark)

   i. Adsorption
   ii. Inner sphere surface complex
   iii. Ion pair
   iv. pH_{zpc}

b. Differentiate between variable and fixed charge surfaces. (25 mark)

c. State a mathematical expression for Langmuir isotherm defining all terms therein. (25 mark)

d. How does Langmuir adsorption isotherm differ from Freundlich isotherm? (25 mark)

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