

Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 Level 1st Semester Examination – July/August 2016



MRT 321-3 Water Chemistry



Part II: Answer in separate sheets provided

Question 1

- (a) State two unique properties of water and comment on their role for the evolution of life.
- (b) Comment on the distribution of freshwater resources in the world.
- (c) 250 ml of well mixed water sample was transferred to a crucible weighing 50 g and heated to dryness. The final weight of the crucible was 50.155 g. 250 ml of the filtered sample, where dried under identical conditions deposited residues weighing 0.151 g. Calculate total solids and TDS
- (d) Why rainwater is not good for human consumption? Explain.

Question 2

The following ground water analyses are expressed in mg/L.

Sample Location	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	HCO ₃ ⁻	SO ₄ ²⁻	Cl ⁻	NO ₃ ⁻	pH
A	3.0	7.4	857	2.4	2080	1.6	71	0.2	8.3
B	40	50	699	16	456	1320	17	0.9	8.2

(Ca = 40; Mg = 24; Na = 23; K = 39; HCO₃ = 61; SO₄ = 96; Cl = 35)

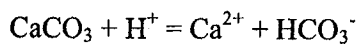
- (a) Calculate charge balance error of the analyses. Plot the data in a Piper diagram. Identify water types of the locations A and B.
- (b) Calculate the TDS (in mg/L) and total hardness (in mg/L CaCO₃) of water in Location A.
- (c) What are primary water quality standards? How they differ from secondary standards. Name one primary and one secondary parameter from the results shown.
- (d) A 100 ml of a water sample is titrated against N/50 HCl in the presence of phenolphthalein consumed 17.5 ml of the acid for the disappearance of pink color. Determine the type and the amount of alkalinity?

Question 3

- (a) State the differences between pe and Eh.
- (b) Calculate the pe and Eh of the following half reaction at the standard state.
- $$\text{H}^+ + \text{e} = \frac{1}{2} \text{H}_2$$
- (c) State different water types in nature identifying corresponding redox couples whenever possible.
- (d) What is meant by acid mine drainage? How does it occur? Comment on its occurrence giving relevant chemical reactions

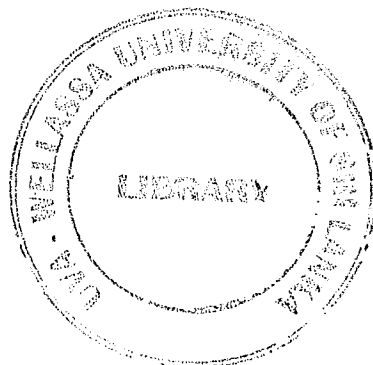
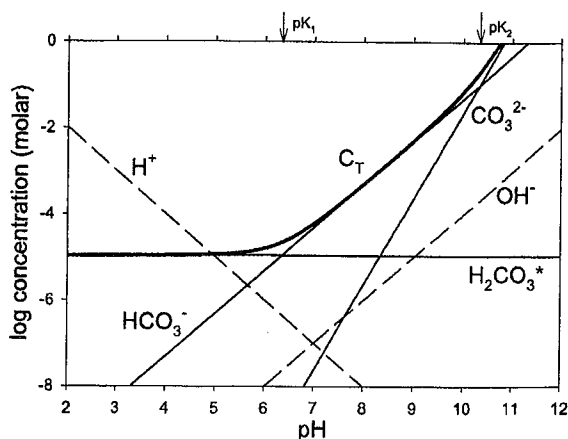
Question 4

- (a) The ionization product of $\text{H}_2\text{O} = \text{H}^+ + \text{OH}^-$ $K_w = 10^{-14} \text{ mol}^2 \cdot \text{L}^{-2}$ at 298 K. State concentration scales used. Re-calculate K_w in molar scale.
- (b) Comment on the meaning of the activity and the concentration of a given chemical species. Calculate the ionic strength of 0.01 M CaCl_2 solution. State the names of two activity correction models commonly used in water chemistry.
- (c) The acid-mediated dissolution of calcite is given below:



Calculate mass action constant of the reaction (the standard state free energy values are Ca^{2+} -553.54 kJ/mol, HCO_3^- -586.8 kJ/mol, CaCO_3 -1128.8 kJ/mol).

- (d) A CO_2 water speciation diagram is shown below. Indicate all assumptions made in the construction of this diagram. Calculate the pH of rainwater droplet that passes through the atmosphere.



Question 5

- (a) State the formation of a surface hydroxyl site in a mineral.
- (b) Identify the differences between variable and fixed charge surfaces.
- (c) State Langmuir isotherm in linearized form.
- (d) An adsorption study was conducted by adding varying amounts of activated carbon to a series of five flasks containing 500 mL of feed water used in soft drink preparation having an initial TOC of 2.0 mg/L. The flasks were agitated for 14h, and the residual, steady-state TOC concentrations were determined. Plot the Langmuir isotherm for the data presented below and determine the values of the appropriate constants.

<i>Flask No.</i>	<i>Carbon Dosage (mg)</i>	<i>Final TOC (mg/L)</i>
1	0	2.0
2	4.4	1.7
3	9.7	1.4
4	14	1.2
5	28	1.0

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Use this template to answer question (2)

