CIVE 3331 - ENVIRONMENTAL ENGINEERING
Spring 2003

Document Name: CIVE3331_Exercises_010.doc

Purpose: Exercises related to Lecture # 10. These exercises develop skills in selected environmental water quality problems. Direct relationships to various accreditation objectives are highlighted in **Bold** type in the following sections. The exercises start on the next page.

Relevant ABET EC 2000 Criteria: Criterion 3 Program Outcomes and Assessment

(3-a) an ability to **apply knowledge of mathematics, science,** and engineering.
(3-e) an ability to identify, **formulate**, and **solve engineering** problems.
(3-k) **an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.**

Relevant CEE Educational Objectives:

(3) Emphasize problem-identification, problem-formulation and communication skills, **problem-solving techniques** and the many facets of engineering design throughout the curriculum.

(5) Prepare every student to develop the skills for critical thinking and lifelong learning.

Relevant CEE Program Outcomes:

ii. **Students should acquire the ability to solve practical civil engineering problems by applying the knowledge of mathematics, science**, **engineering, modern techniques**, **skills and practical tools they gained in their courses.**

CIVE 3331 Environmental Engineering

Exercise_010-1

A sample of groundwater has 150 mg/L of Ca^{2+} and 60 mg/L of Mg^{2+}. Find the total hardness in meq/L and mg/L as $CaCO_3$. Using Table 6.3 in the text classify the water (e.g. hard, soft, etc.).

CIVE 3331 Environmental Engineering

Exercise_010-2

For a solution with pH=9.0 express the concentrations of $[H^+]$ and $[OH^-]$ in meq/L and mg/L as $CaCO_3$

CIVE 3331 Environmental Engineering

Exercise_010-3

A sample of water at pH=10.5 has 39.0 mg/L of $CO3_2^-$ and 24.5 mg/L of HCO_3^-.

a) Ignoring the contribution of $[H^+]$ and$[OH^-]$ to alkalinity, what is the alkalinity of the sample as CaCO3?
b) Including the contribution of $[H^+]$ and$[OH^-]$, find the alkalinity of the sample.

CIVE 3331 Environmental Engineering

Exercise_010-4

A sample of water has the following constituents of ions and the pH is near neutral.

Cations	mg/L	Anions	mg/L
Ca^{2+}	95.0	HCO_3^-	160.0
Mg^{2+}	26.0	SO_4^{2-}	135.0
Na^+	15.0	Cl^-	73.0

a) What is the total hardness (TH)?
b) What is the carbonate hardness (CH)?
c) What is the noncarbonate hardness (NCH)?
d) What is the alkalinity?
e) What is the total dissolved solids concentration?
f) Draw an ion concentration bar chart.

CIVE 3331 Environmental Engineering

Document History:

Author	**Action**	**Date**	**Archive File Name**
Theodore G. Cleveland	Created	January 23, 2003	CIVE3331_Exercises_008.PDF