

National Exams May 2017

04-Env-B9, Environmental Chemistry & Microbiology

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a **CLOSED BOOK EXAM**.
One of two calculators is permitted any Casio or Sharp approved models.
3. The exam has two sections: **CHEMISTRY** and **MICROBIOLOGY**. The chemistry portion of the exam has **SIX** (6) questions and the microbiology section has **TWELVE** (12) questions. The **EIGHTEEN** (18) questions constitute a complete exam paper.
4. Each question is of the value indicated.
5. Clarity and organization of the answer are important.

SECTION 1: CHEMISTRY (6 questions, 50 marks)

Page 2 of 5

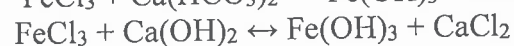
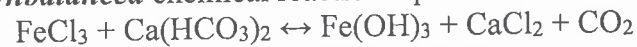
- 10 1. DEFINE
- 1.1 saturated solution
 - 1.2 mole fraction
 - 1.3 chelating agent
 - 1.4 ORP
 - 1.5 Fick's Law
 - 1.6 NTU
 - 1.7 equilibrium constant
 - 1.8 normality
 - 1.9 temporary hardness
 - 1.10 C_{Rt} concept
- 5 2. Name 4 Chemical Unit Processes and identify their application in wastewater treatment.
- 10 3. Determine the amount of liquid alum required to precipitate phosphorous in a wastewater which contains 8 mg P/L. The discharge TP concentration target is 1.0 mg/L. Also determine the required storage capacity if a 30 day supply is to be stored at the treatment facility. Based on laboratory testing, 1.5 moles of Al will be required per mole of P. The flow rate is 10,000 m³/d.
- The following data are for the liquid alum supply:
- Formula for the liquid alum $Al_2(SO_4)_3 \cdot 18 H_2O$
 - Alum strength = 48 percent
 - Density of liquid alum solution = 1,280 kg/m³
- 5 4. The elemental composition of an organic material was determined to be:
- | | |
|------------------------|--------|
| C = 52.85 % dry weight | C = 12 |
| H = 6.48 % dry weight | H = 1 |
| O = 24.76 % dry weight | O = 16 |
| N = 15.12 % dry weight | N = 14 |
- How many kg of oxygen are required for the complete oxidation of 30 kg of this material?

- 15 5. Estimate the mass and volume of sludge produced from untreated wastewater without and with the use of ferric chloride for the enhanced removal of TSS. Also estimate the amount of lime required for the specific ferric chloride dose. Assume that 60 % of the TSS is removed by primary sedimentation without the addition of chemicals, and that the addition of ferric chloride results in an increased removal of TSS to 85 %.

Also assume that the following data apply:

1. wastewater flow rate, m ³ /d	1,000
2. wastewater TSS, mg/L	220
3. wastewater alkalinity as CaCO ₃ , mg/L	136
4. Ferric chloride (FeCl ₃) added, kg/1,000 m ³	40
5. Raw sludge properties	
Specific gravity	1.03
Moisture content, %	94
6. Chemical sludge properties	
Specific gravity	1.05
Moisture content, %	92.5

Unbalanced chemical reaction equations:



- 5 6. Sketch and label a process flow diagram that shows a sequence of unit processes for the reclamation of drinkable water from raw municipal wastewater.

50 Chemistry sub-total

SECTION 2: MICROBIOLOGY (12 questions, 50 marks)

- 4 1. Draw a schematic of a bacterium, label its parts and identify the role of each part.
- 4 2. Sketch the growth pattern based on number of organisms and identify and note the various phases.
- 10 3. DEFINE
- 3.1 Endemic
 - 3.2 Virus
 - 3.3 Virulence
 - 3.4 Enzyme
 - 3.5 Binary fission
 - 3.6 pH
 - 3.7 Thermophilic
 - 3.8 MPN
 - 3.9 F/M ratio
 - 3.10 OUR
- 2 4. Why do we use the BOD test?
- 3 5. What is SRT, and how is it used in wastewater engineering?
- 8 6. An aerobic, complete-mix biological treatment process without recycle receives wastewater with a biodegradable soluble COD of 500 g/m^3 . The flowrate is $1,000 \text{ m}^3/\text{d}$ and the reactor soluble COD and VSS concentrations are 10 and 200 g/m^3 , respectively.
- Assume that the following general reaction is applicable:
 $\text{Organic matter} + \text{O}_2 + \text{nutrients} \longrightarrow \text{C}_5\text{H}_7\text{NO}_2 + \text{CO}_2 + \text{H}_2\text{O}$
- What is the amount of oxygen used in $\text{g VSS/g COD removed}$ and g/d ?
- 3 7. Name 3 diseases which are transmitted by water,

04-Env-B9 Environmental Chemistry/Microbiology May 2017

Page 5 of 5

- 4 8. What role do fungi, bacteria, algae and viruses play in environmental engineering?
- 3 9. What are indicator organisms, and what is their role in sanitary microbiology?
- 3 10. What is SRT? And how is it used in environmental engineering?
- 2 11. How do pathogens survive?
- 4 12. What is meant by food to microorganism ratio? Identify how it is used in environmental engineering.

50 Microbiological Total

100 TOTAL EXAMINATION MARK