

NATIONAL EXAMS December 2008

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 assumption made.
2. This is a **CLOSED BOOK EXAM**.
A calculator is permitted.
3. The exam has two sections: *CHEMISTRY* and *MICROBIOLOGY*. The chemistry portion of the exam has **ten (10)** questions and the microbiology section has **ten (10)** questions. The **twenty (20)** questions constitute a complete exam paper.
4. Each question is of the value indicated. There are **60** marks for the *chemistry* portion and **60** marks for the *microbiology* portion of this exam. The total examination mark is **120**.
5. Clarity and organization of the answers are important.
6. One aid sheet written on both sides is permitted.

SECTION 1: CHEMISTRY (10 questions, 60 marks)

- 10 1. DEFINE:
- 1.1 mole
 - 1.2 Oxidation-Reduction reaction
 - 1.3 equivalent weight
 - 1.4 ORP
 - 1.5 molarity
 - 1.6 Fick's Law
 - 1.7 alkalinity
 - 1.8 gram-molecular weight
 - 1.9 chemical coagulation
 - 1.10 electrolyte
- 5 2. Briefly state in point form, how and when you use the following parameters:
- 2.1 BOD₅
 - 2.2 BOD_u
 - 2.3 BOD₂₀
 - 2.4 ThOD
 - 2.5 COD
- 5 3. Name and briefly state the role of 5 chemical unit processes used in water/wastewater treatment engineering.
- 5 4. Name 5 factors affecting the choice of chemical for phosphorous removal. Also state why these factors are important.
- 4 5. Name 4 alternative disinfection technologies.
- 6 6. Name 6 advantages and 6 disadvantages of UV technology for disinfection.
- 5 7. Determine the suspended solids and the percent volatile matter in a solids sample based on the following data:
- sample size = 25 mL
 - tare mass of filter = 1.5325 g
 - tare mass of filter plus retained solids = 1.5415 g
 - tare mass of filter plus retained ash = 1.5378 g

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CHEMISTRY continued:

- 5 8. Sketch and label a process flow diagram that shows a process sequence for water reclamation to drinking water standards.
- 5 9. Determine the COD of $C_5H_7NO_2$
- 10 10. An existing 12,000 m³/d (ave. flow) wastewater treatment facility now is required to discharge an effluent with a TP concentration of 1.0 mg/L. The 50 percentile influent TP is 8.0 mg/L. You determined that chemical precipitation using alum is the most cost effective phosphorous removal solution.

The theoretical phosphate precipitation with alum:



Based on your laboratory testing 1.5 mole of Al will be required per mole of P. The molecular weight of Al and P are 27 and 31. The following data are for the liquid alum supply:

- formula for liquid alum $Al_2(SO_4)_3 \cdot 18 H_2O$
- molecular weight of alum = 666.5
- Alum strength = 48 %
- density of liquid alum solution = 1.2 kg/L
atomic weight of Al = 27
atomic weight of P = 31

10.1 Determine the amount of liquid alum required per day.

60 CHEMISTRY TOTAL

next page starts the MICROBIOLOGY section of examination

SECTION 2: MICROBIOLOGY (10) questions, 60 marks)

- 10 **1. DEFINE:**
 1.1 DNA
 1.2 autotroph
 1.3 enzyme
 1.4 pathogenicity
 1.5 flagellates
 1.6 virus
 1.7 synthesis
 1.8 binary fission
 1.9 thermophilic
 1.10 metabolism
- 5 **2.** Sketch and identify the growth phases based on mass of organisms.
- 5 **3.** Sketch and label the rate of growth for mesophilic bacteria with increasing temperature.
- 5 **4.** Sketch and label all components of a typical bacterial cell.
- 4 **5.** Explain the difference between sterilization and disinfection.
- 4 **6.** Name 4 diseases which are transmitted by water.
- 4 **7.** Describe and compare the nutritional requirements of autotrophic and heterotrophic bacteria.
- 3 **8.** How is the F/M ratio used in wastewater engineering?
- 5 **9.** Bacterial cells are often represented by the empirical formula $C_5H_7NO_2$. Determine the potential carbonaceous BOD_u of 1 g of cells.
10. An aerobic, complete-mix biological treatment process without recycle receives wastewater with a biodegradable soluble COD of 700 g/m^3 . The flowrate is $10,000 \text{ m}^3/\text{d}$ and the reactor effluent soluble COD and VSS concentrations are 50 and 200 g/m^3 , respectively.
- 5 **10.1** What is the observed yield in gVSS/gCOD removed?
- 10 **10.2** What is the amount of oxygen used in $\text{kgO}_2/\text{kg COD removed}$ and in kg/d ?
 Assume the following general reaction is applicable:
 Organic matter + O_2 + nutrients $\rightarrow C_5H_7NO_2 + \text{CO}_2 + \text{H}_2\text{O}$

60 MICROBIOLOGY TOTAL

120 TOTAL EXAMINATION MARK