

NATIONAL EXAMS May 2013

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**.
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 **Eleven**(11) questions and the microbiology section has **Fourteen** (14) questions. The **Twentyfive** (25) questions constitute a complete exam paper.
4. Each question is of the value indicated. There are **50** marks for the **chemistry** portion and **50** marks for the **microbiology** portion of this exam. The total examination mark is **100**.
5. Clarity and organization of the answers are important.

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SECTION 1: CHEMISTRY (11 questions, 50 marks)

- 2 1. A reaction has the stoichiometric equation $A \rightleftharpoons C + D$. What is the order of reaction?
- 5 2. A water treatment plant serves a city of 100,000 people. Calculate:
2.1 the number of kg chlorine needed per day and
2.2 the capacity of the chlorine contact tank required.
The chlorine demand is 1 mg/L. **State all assumptions made.**
- 10 3. **DEFINE:**
3.1 ionization
3.2 solubility product
3.3 specific heat
3.4 specific gravity
3.5 generalized gas law
3.6 Charles s Law
3.7 equivalent weight
3.8 solute
3.9 normality
3.10 molecular weight
- 3 4. Name 3 alternative disinfection technologies.
- 4 5. Name 4 advantages and 4 disadvantages of UV technology for disinfection.
- 3 6. Name the factors influencing the action of disinfectants.
- 4 7. 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
Determine:
7.1 the suspended solids and
7.2 the percent volatile matter

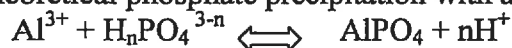
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5 8. Name and briefly state the role of 5 chemical unit processes used in water/wastewater treatment engineering.

7 9. An existing 12,000 m³/d 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 6.0 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 $\text{Al}_2(\text{SO}_4)_3 \cdot 18 \text{H}_2\text{O}$
- 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

9.1 Determine the amount of liquid alum required per day.

9.2 Determine the required alum storage capacity if a 30-day supply is to be stored at the treatment plant site

3 10. Sketch and label a process flow diagram that shows a process sequence for water reclamation to drinking water standards.

4 11. Determine the COD of $\text{C}_5\text{H}_7\text{NO}_2$
C = 12; H = 1; N = 14; O = 16

50 sub-total

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SECTION 2: MICROBIOLOGY (14) questions, 50 marks)

- 10 **1. DEFINE:**
- 1.1 RNA
 - 1.2 infection
 - 1.3 toxin
 - 1.4 pathogen
 - 1.5 virulence
 - 1.6 saprophytes
 - 1.7 obligate parasites
 - 1.8 endotoxins
 - 1.9 thermophilic
 - 1.10 metabolism
- 3 **2.** Why and how is UV technology used in water and wastewater treatment?
- 4 **3.** Sketch and identify the growth phases based on mass of organisms.
- 2 **4.** Sketch and label the rate of growth for mesophilic bacteria with increasing temperature.
- 3 **5.** Explain the difference between sterilization and disinfection.
- 4 **6.** Name 4 waterborne diseases.
- 4 **7.** Describe and compare the nutritional requirements of autotrophic and heterotrophic bacteria.
- 3 **8.** What are trihalomethanes and where do they come from?
- 3 **9.** How is the F/M ratio used in wastewater engineering?
- 4 **10.** Bacterial cells are often represented by the empirical formula $C_5H_7NO_2$.
C = 12; H = 1; N = 14; O = 16
Determine the potential carbonaceous BOD_u of 1 g of cells.

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- 3 11. What are the requirements for an organism to be an indicator organism?
- 3 12. Why is filtration of water without chlorination partially effective in controlling pathogenic bacteria?
- 2 13. Why are you less likely to contact an airborne infection outdoors than indoors?
- 2 14. How do account for the increase in deaths due to non-infectious diseases in North America over the past century?

50 sub-total

100 TOTAL MARK