# 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 $A \Rightarrow C + D$. 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

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 $m^3$/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:

$$Al^{3+} + H_nPO_4^{3-n} \rightleftharpoons AlPO_4 + nH^+$$
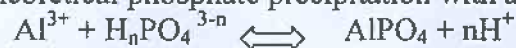
Based on your laboratory testing 1.5 mole of Al will be required per mole of P. The molecular weight of Al and P are 27 and 31. The following data are for the liquid alum supply:

- formula for liquid alum $Al_2(SO_4)_3.18\ H_2O$
- 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*

*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 $C_5H_7NO_2$

$$C = 12;\ H = 1;\ N = 14;\ O = 16$$

**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.

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*