

NATIONAL EXAMS May 2016

*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 Aid Sheet 8.5 x11 “ permitted on both sides.  
Any non-communicating calculator is permitted.
3. The exam has two sections: **CHEMISTRY** and **MICROBIOLOGY**. The chemistry portion of the exam has **eight (8)** questions and the microbiology section has **twelve (12)** questions. The **twenty (20)** 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 (8 questions, 50 marks)**

- 5 1. Define:
- 1.1 mole
  - 1.2 Solubility Product
  - 1.3 ORP
  - 1.4 Temporary hardness
  - 1.5 Equivalent weight
- 2 2. How many moles of  $\text{Na}_2\text{SO}_4$  are there in 240 g of  $\text{Na}_2\text{SO}_4$ ?  
Atomic weights: Na=23; S=32; O=16
- 3 3. Determine the COD of  $\text{C}_5\text{H}_7\text{NO}_2$   
C=12; H=1; N=14; O=16
- 10 4. Name and briefly state the role of 5 chemical unit processes used in water/wastewater treatment engineering.
- 5 5. You have determined that the composition of digester gas from the anaerobic digestion of wastewater sludge is: 68%  $\text{CH}_4$ , 30%  $\text{CO}_2$  and 2%  $\text{H}_2\text{S}$ . If 1,000 kg of the gas mixture is stored in a gas tank at a pressure of 300 kPa, calculate the partial pressure of each component present. C=12; H=1; O=16; S=32.
- 10 6. 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 = 24.78 % dry weight | O=16 |
| N = 15.2% dry weight   | N=14 |
- How many kg of oxygen are required for the complete oxidation of 50 kg of this organic material?
- 10 7. Determine the quantity of liquid alum required to precipitate phosphorous in a wastewater that contains 8 mg P/L. Also determine the required storage capacity if a 30 day supply is to be stored at the treatment plant facility. Based on laboratory testing, 1.5 moles of Al will be required per mole of P. The average plant flow rate is 10,500  $\text{m}^3/\text{d}$ . The regulatory allowable effluent P is 0.2 mg/L.  
The following data are for the liquid alum supply:  
Formula for the liquid alum supply is  $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ :  
Alum strength = 48%  
Density of liquid alum solution = 1,280  $\text{kg}/\text{m}^3$
- 5 8. Sketch a process flow diagram that shows a feasible process sequence to produce drinking water from wastewater. Identify each step and state its purpose.

**50 sub-total**

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**SECTION 2: MICROBIOLOGY (12 questions, 50 marks)**

- 10 1. DEFINE:
- 1.1 what is a heterotroph?
  - 1.2 what is the function of an enzyme?
  - 1.3 what is an autotroph?
  - 1.4 what is binary fission?
  - 1.5 what does DNA do?
  - 1.6 what is pathogenicity?
  - 1.7 what do we mean by synthesis?
  - 1.8 what is Brownian movement?
  - 1.9 what is the function of ATP?
  - 1.10 what does MPN mean?
- 4 2. TRUE OR FALSE
- 2.1 fungi are anaerobic organisms.
  - 2.2 algae are heterotrophic organisms.
  - 2.3 aerobic bacteria can metabolize organic matter at a faster rate than anaerobic bacteria.
  - 2.4 procaryotic cells contain a nucleus enclosed within a well defined nuclear membrane.
- 3 3. Sketch and label a diagram showing the effect of nitrification on the BOD test.
- 4 4. Sketch and identify the phases of growth pattern for viable microorganisms.
- 3 5. Name three diseases transmitted by water.
- 5 6. Explain the interaction of UV light and microorganisms. What happens?
- 4 7. How is the F/M ratio used in biological wastewater treatment?
- 5 8. What is SRT? Why is it used? and how is it used in wastewater treatment?
- 4 9. Why do we use the BOD test? How is test conducted?
- 3 10. Identify 3 causes of sludge bulking.
- 3 11. Name 5 reasons why environmental engineers should have a basic knowledge of microbiology.
- 2 12. Name 3 common diseases which have been found to be spread through the air.

**50 sub-total**

**100 TOTAL MARK**

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