

UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

**B.Sc. Degree in Environmental Management and Occupational Safety
and Health**

MAIN EXAMINATION PAPER MAY 2015

- TITLE OF PAPER** : Wastewater Management
- COURSE CODE** : EHM418
- DURATION** : 2 HOURS
- MARKS** : 100
- INSTRUCTIONS** : THERE ARE FIVE QUESTIONS IN THIS EXAM
- : ANSWER ANY FOUR OUT OF THE FIVE QUESTIONS
- : EACH QUESTION CARRIES A MAXIMUM MARK OF 25

FINAL EXAM

EHM 418 May 2015

Question One (25 Marks)

In a BOD determination, 6 mL of wastewater are mixed with 294 mL (total volume of BOD bottle is 300 mL) of diluting water containing 8.5 mg/L of dissolved oxygen. After a 5 day incubation period at 20 °C, the dissolved oxygen content of the mixture is 2.0 mg/L. Assume that the initial dissolved oxygen concentration in the wastewater is zero and that the following equation applies:

$$BOD, \frac{mg}{L} = \frac{D_1 - D_2}{P}$$

Where: D_1 = Dissolved oxygen of diluted sample immediately after preparation, mg/L

D_2 = Dissolved oxygen of diluted sample after 5 day incubation period at 20 °C, mg/L

P = Fraction of wastewater sample volume to total combined volume.

- i) Calculate the BOD of the wastewater.[13 Marks]

- ii) Estimate the ultimate BOD (UBOD) of the wastewater sample if the first order rate constant for BOD removal was , $k = 0.23 \text{ day}^{-1}$[12 Marks]

Question Two (25 Marks)

(Each question below carries 5 marks)

- 2A.** Describe the following types of settlement of solids in wastewater treatment processes:
- i) Discrete particle settling (2 marks)
 - ii) Flocculent settling (2 marks)
 - iii) Hindered (zone) settling (1 mark)
- 2B.** For each of the particle settlement processes listed in question 2A above, give an example of unit operations in wastewater treatment plants in which such settlement process may take place.
- 2C.** List possible physical unit operations for the removal of each of the following waste water constituents; (1 mark each)
- i) Removal of ammonia, hydrogen sulphide and other gases
 - ii) Removal of volatile and semi volatile organic compounds
 - iii) Removal of colloidal solids
 - iv) Removal of dissolved organic and inorganic matter
 - v) Removal of sand and grit
- 2D.** Describe possible methods for breaking up chemically emulsified fat, oil and grease and second stage treatment techniques for their removal.
- 2E.** Describe commonly used dewatering technics for solids collected from wastewater treatment processes.

Question Three (25 Marks)

3A. Define the following terms in relation to chemical methods of wastewater treatment

- i) Advanced oxidation (2 marks)
- ii) Isotherm (2 marks)
- iii) Regeneration (1 mark)

..... [5 Marks]

3B. State the capabilities and limitations of advanced oxidation process for disinfection of wastewater.[5 Marks]

3C. List the chemical methods that are available for the removal of phosphorous from wastewater. [5 Marks]

3D. Indicate the designated zone of coagulation each of the following combination of turbidity and coagulant doses. State also the mechanism of coagulation in each case.

(2.5 marks each)

- i) Low turbidity of raw waste water and low concentration of coagulant
- ii) High turbidity of raw waste water and moderate concentration of coagulant
- iii) High turbidity of raw waste water and high concentration of coagulant
- iv) High turbidity of raw waste water and very high concentration of coagulant

..... [10 Marks]

Question Four (25 Marks) (Note: each question below carries 5 marks)

- 4A. Describe two mechanisms by which nitrification may be achieved in activated sludge processes.
- 4B. Draw a diagram of
- i. The post anoxic nitrification process(3 marks)
 - ii. The pre anoxic denitrification process(2 marks)
- 4C. State for aerobic autotrophic waste assimilation processes involving nitrification:
- i. The input ingredients(3 marks)
 - ii. The outputs(2 marks)
- 4D. Describe process control mechanisms for activated sludge processes.
- 4E. Describe methods for controlling bulking in activated sludge

Question Five (25 marks) (Note: each question below carries 5 marks)

- 5A. What is the purpose of recirculation of recycled effluent to trickling filters?
- 5B. What factors should be considered when selecting rocks for percolating filters?
- 5C. Draw a diagram of submerged attached growth process labelling the essential components.
- 5D. How do you evaluate the suitability of anaerobic processes under the following conditions: (1 mark each)
- i. Low temperature environments
 - ii. Seasonal wastewater generation
 - iii. Provision of adequate treatment to satisfy effluent discharge requirements
 - iv. Energy saving
 - v. Nutrient removal
- 5E. Give examples of waste water characteristics in which pH adjustment may become necessary in anaerobic treatment of wastewater.