



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

B.Sc. DEGREE IN: ENVIRONMENTAL MANAGEMENT &  
OCCUPATIONAL SAFETY AND HEALTH  
- ENVIRONMENTAL MANAGEMENT AND WATER  
RESOURCES

**MAIN EXAMINATION PAPER 2020**

- TITLE OF PAPER : WASTEWATER MANAGEMENT
- COURSE CODE : EHS 434
- DURATION : 2 HOURS
- MARKS : 100
- INSTRUCTIONS :
- : READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
  - : ANSWER ANY FOUR QUESTIONS
  - : EACH QUESTION CARRIES 25 MARKS.
  - : WRITE NEATLY & CLEARLY
  - : NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.
  - : BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

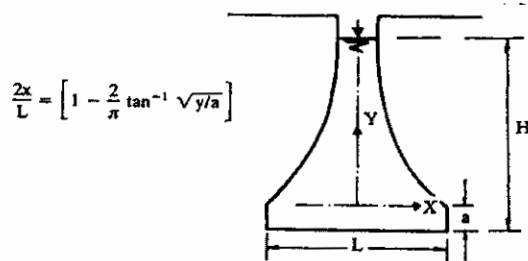
DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY  
THE INVIGILATOR.

**QUESTION ONE** (Each question below carries 5 marks)

**1A.** One of the flow control devices used at the outlet of grit channels in primary wastewater treatment installations is the Proportional (Sutro) weir shown in the figure below.

- i. What should be the shape of the approach channel if this weir is to be used for flow control
- ii. What is the importance of providing such weirs at grit channels in wastewater treatment installations?
- iii. Supposing that the wastewater flow suddenly increases three fold what will be the velocity in the grit channel and the effect that this surge in flow has on the settlement of grits in the channel?

PROPORTIONAL (SUTRO) WEIR

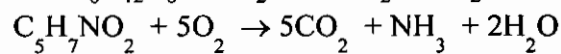
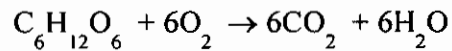
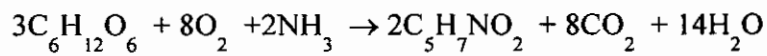


The discharge,  $Q = C_d L(2ga)^{1/2} (H - a/3)$

**1B.** If a given sample were diluted 4 times in a 1:1 dilution ratio after which 25 mL of the sample was taken and diluted eventually to 200 mL to give the just detectable odour, what will be the threshold Odour Number (TON).

1C. A wastewater effluent from a sugar processing industry has a theoretical COD of 3000 mg/L. using the chemical reactions provided below answer the following questions:

- i. What is the mass of glucose present ( $C_6H_{12}O_6$ ) in the waste in mg/L
- ii. What is the mass of sludge produced (MLVSS) in mg/L



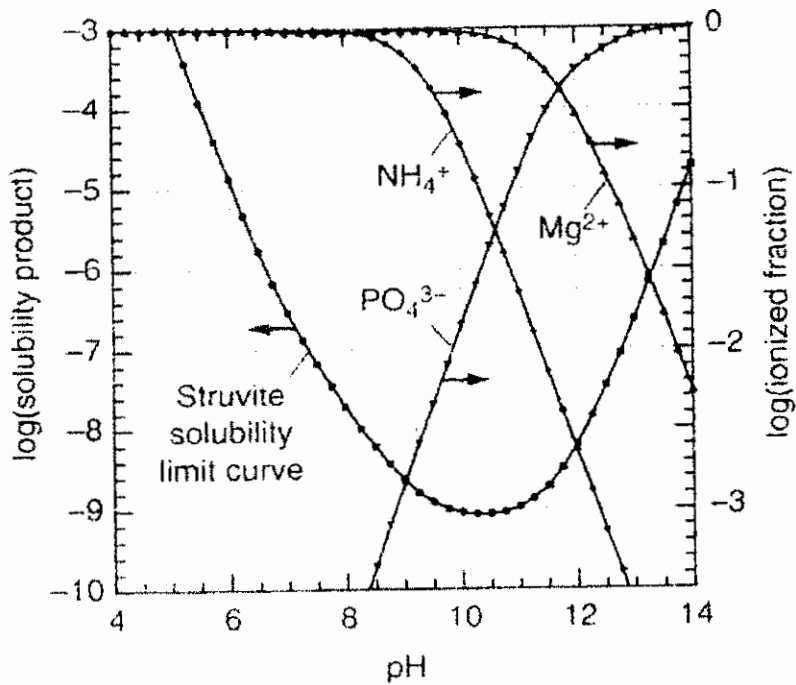
1D. List possible physical unit operations for the removal of each of the following waste water constituents;

- 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

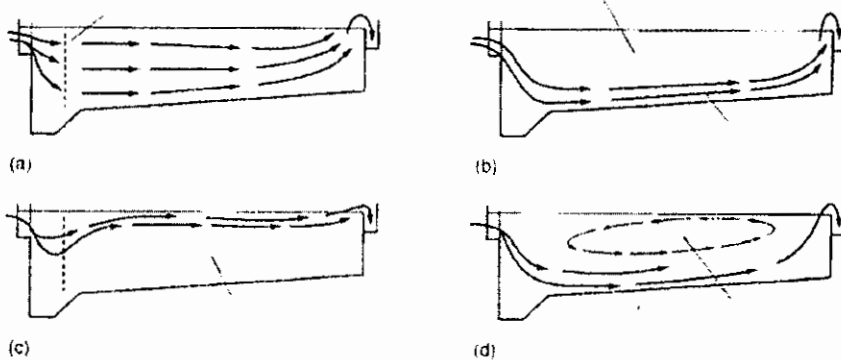
1E. An industry discharges wastewater to equalization tank uniformly at a flow rate of  $10 \text{ m}^3/\text{hr}$ . The industry operates for 12 hours from 6 A.M. until 6 P.M. If the outflow from the equalization tank is to be uniform throughout the 24 hour period, determine the volume of equalization tank required.

**QUESTION TWO** ( Each question below carries 5 marks)

**2A.** From the struvite solubility diagram shown in the figure below, state the inhibiting factor against precipitation of phosphorous i) at low pH and ii) at high pH



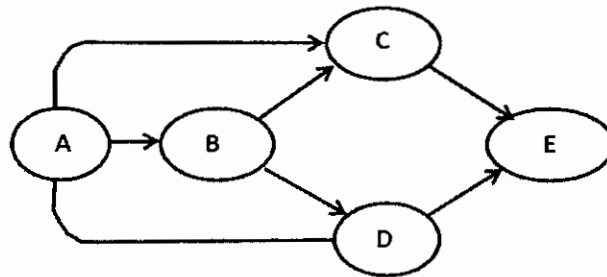
**2B.** The figures a,b,c and d below show flow pattern and extent of short circuiting in primary settlement tanks. Identify the possible causes of short circuiting in each case



- 2C. Show with the help of a diagram the pre-anoxic denitrification process indicating the important components
- 2D. What is the importance of providing grit chambers in waste water treatment?
- 2E. Compare the energy efficiency of ozone/UV advanced oxidation process with that of hydrogen peroxide/UV processes for the treatment of wastewaters.

**QUESTION THREE** (Each question below carries 5 marks)

- 3A. For the anaerobic process diagram shown in the figure below:
- List the substances that are involved in each of the process stages labeled A, B, C, D and E
  - Name the processes (step) taking place in the following steps: A-B, B-C, B-D, C-E, D-E.



- 3B. Describe the causes of rising sludge problem and indicate the mechanisms employed for the control of rising sludge.
- 3C. A process monitoring of the activated sludge process revealed that the MLSS concentration in the activated sludge reactor was excessively large. The manager of the wastewater treatment plant wanted to reduce this MLSS concentration in the activated sludge reactor. Explain how the manager is able to accomplish this modification.

- 3D.** List the advantages of anaerobic treatment processes.
- 3E.** What is the negative influence of the fermentation process (acidogenesis) on the operation of the subsequent process, namely, methanogenesis in anaerobic reaction? What are the types of wastewaters that can give rise to such negative influence?

**QUESTION FOUR** (Each question below carries 5 marks)

- 4A.** Draw a diagram of the A/O biological phosphorous removal indicating clearly the processes occurring in each of the steps involved.
- 4B.** A sludge settleability test indicated that the sludge volume index was 100 ml/mg. The initial MLSS concentration of the sludge before settlement was 3000 mg/L. Estimate the return sludge concentration in mg/L. Assume that all the solids occupy the settled position and that no solid is left in the supernatant water after settlement.
- 4C.** Draw a sketch of the dose vs. life time risk relationship curve for:
- i. Non-threshold risk substance ...( 1 mark)
  - ii. Threshold risk substance .....( 1 mark)
  - iii. Single hit modeled risk .....( 1 mark)
  - iv. Multi hit modeled risk .....( 2 marks)
- 4D.** Describe briefly the four discrete steps used in environmental risk analysis
- 4E.** Describe water pinch analysis and the benefits it provides.

**QUESTION FIVE** (Each question below carries 5 marks)

- 5A.** Describe the sources of odours in wastewater treatment plants and the mechanism that can be placed to minimize odours.
- 5B.** Describe with the help of a sketch contact stabilization activated sludge process and state their advantage in treating industrial wastewaters.
- 5C.** Describe the advantages of extended aeration units compared to the conventional activated sludge processes.
- 5D.** State the advantages of reducing the rotational speed of the distributor in percolating filters.
- 5E.** Describe with the help of a diagram the sequencing batch activated sludge reactor process. What type of wastewater is suitable for treatment with a sequencing batch reactor?