

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

**B.Sc. Degree in Environmental Health Science**

**MAIN EXAMINATION PAPER MAY 2013**

**TITLE OF PAPER** : WATER TREATMENT II

**COURSE CODE** : EHS:585

**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%  
: NO PAPER SHOULD BE BROUGHT INTO OR OUT OF THE  
EXAMINATION ROOM

**Question One (25 Marks)**

- A. Compare the slow sand filter with the rapid sand filter in terms of: i) filtration rate ii) media diameter iii) filter run length and iv) regeneration method. .... [5Marks].
- B. Describe the problem of media segregation in a rapid sand filter. What are the causes and effects of media segregation and how can this problem be overcome? ....[5 Marks].
- C. Describe the advantages of employing pre-coat filtration such as diatomaceous earth over granular media filtration. State how regeneration of pre-coat media is achieved. .... [5Marks].
- D. State the procedure for resanding of a slow sand filter when the minimum allowable depth of the filter is reached. .... [5Marks].
- E. List the principles of good management of slow sand filtration. ....[5Marks].

**Question Two (25 Marks)**

- A. Evaluate the disinfection potential of the disinfectants listed in table Q1 below against the pathogens listed in the same table. Rate the potentials in terms of : Excellent, Good, Fair and Poor. ....[ 9 Marks]

Table Q1: Disinfection potential of disinfectants against pathogens.

	Free chlorine	Combined chlorine	Chlorine dioxide	Ozone	Ultraviolet light
Bacteria					
Virus					
Protozoa					
Endospore					

- B. The chlorine residuals measured when various dosages of chlorine were added to a sample of water are given in Table Q2 below. Determine:

- i. The breakpoint dosage .....[8 Marks]
- ii. The design dosage to obtain a residual of 0.75 mg/lit free available chlorine.  
.....[ 8 Marks]

Table Q2; Chlorine residual in mg/L against chlorine added in sample of water.

Dosage (mg/L)	0.1	0.5	1	1.5	2	2.5	3
Residual (mg/L)	0.0	0.3	0.6	0.35	0.35	0.8	1.3

**Question Three (25 Marks)**

- A. Arrange the following cations in the order of decreasing preference for absorption on to a cation exchanger:  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Hg}^+$ ,  $\text{Li}^+$ ,  $\text{Fe}^{2+}$  .....[5 Marks]
- B. List the advantages of choosing an ion exchange resin with a high affinity for the ion to be exchanged. ....[5 Marks]
- C. Write the equations for the removal  $\text{NaCl}$  from water using strong anion and strong cation exchangers. Write also the chemical reactions for the regeneration of the ion exchangers. ....[5 Marks]
- D. Compare the use of weak ion exchangers and strong ion exchangers in terms of exchange capacity, preference for adsorption and regeneration potential. ....[5 Marks]
- E. List five mechanisms by which the rate of film diffusion is increased in an ion exchange process. ....[5 Marks]

**Question Four (25 Marks)**

- A. List five mechanisms by which odour problems can be eliminated from drinking water.  
 .....[5 Marks]
- B. An observer participating in a threshold odour test was given a sequence of samples dilutions for testing which are listed in Table Q4.1 below. The responses obtained from the observer against each of the sample dilutions are also listed in the same table.
- i. Comment on the responses obtained from this particular observer and evaluate the suitability of this observer for the odour test. ....[3 Marks]
  - ii. Calculate the threshold odour number (TON) according to this test result.  
 .....[2 Marks]

Table Q4.1 Responses obtained from an observer in an odour test.

mL of sample diluted to 200 mL	12	0	17	25	0	35	50
Response	-	-	-	+	-	+	+

- C. For an odour taste of a given sample of water, a 25:175 dilution was made 4 times after which 25 mL of the diluted sample was transferred to the 200 mL odour flask to achieve the just detectable odour. Determine
- i. The Threshold odour number (TON).....[2.5 Marks]
  - ii. The odour intensity index (OII).....[2.5 Marks]
- D. List five methods employed for the removal of iron and manganese from water  
 .....[5 Marks]
- E. Discuss the influence of the presence of organic matter in water on the efficiency of removal of iron and manganese from water. ....[5 Marks]

**Question Five (25 marks)**

A. Describe the following water treatment processes in terms of: the method of removal of targeted constituents, the membrane type used the pressure requirement and the rate of recovery.

- i. Micro membrane filtration
- ii. Ultra membrane filtration
- iii. Nano membrane filtration
- iv. Reverse osmosis

.....[5 Marks]

B. Compare the following three types of membrane filtration processes:

- i. Submerged filtration. ....[2 Marks]
- ii. Cross flow filtration. ....[2 Marks]
- iii. Dead end (transverse) filtration. ....[1 Mark]

C. List the factors that contribute to membrane fouling by dissolved organic matter.

.....[5 Marks]

D. Discuss the merits of combining membrane filtration treatment with i) coagulation ii) activated carbon .....[5 Marks]

E. A membrane module contains 8000 fibers. The fibers are 1 m long with an outside diameter of 2 mm and 0.9 mm. Calculate the flux necessary to produce a flow of 2500 liter/hour if flow is outside in. ....[5 Marks]