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

B.Sc. Degree in Environmental Health Science

MAIN EXAMINATION PAPER MAY 2014

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%

Question One (25 Marks)

(Note: Each question below carries 5 marks)

A. What is the dominant mechanism by which solids are removed in i) rapid sand filters and ii) slow sand filters?

B. Discuss in the context of slow sand filtration the impact of choice of filter media that is i) too fine ii) too coarse

C. What are the advantages of maintaining the outlet weir levels above the top level of sand in the filter?

D. Discuss the operational features of declining rate filters including their advantages and disadvantages.

E. List the major possible problems that may be encountered in the course of operating a rapid sand filter.

Question Two (25 Marks)

(Note: Each question below carries 5 marks)

A. Discuss the importance of the ratio Cl_2/NH_3 in the chloramination process for the disinfection of water. Indicate the optimum ratio Cl_2/NH_3 and give reasons for your choice.

B. Discuss the advantages and disadvantages of excess chlorination beyond the break point.

C. Develop a break point chlorination curve for a water sample that contains 1.5 mol/L of ammonia in addition to organic matter that has a chlorine demand of 1 mol/L.

D. A treated water after disinfection has 40% OCl^- and 60% HOCl. The concentration versus contact time for 99% inactivation of *E.coli* is given in Figure Q2-1 below. For a contact time of 5 minutes, determine the total amount of chlorine that will have to be added to water to achieve the desired inactivation, i.e., 99% inactivation of *E.coli*.

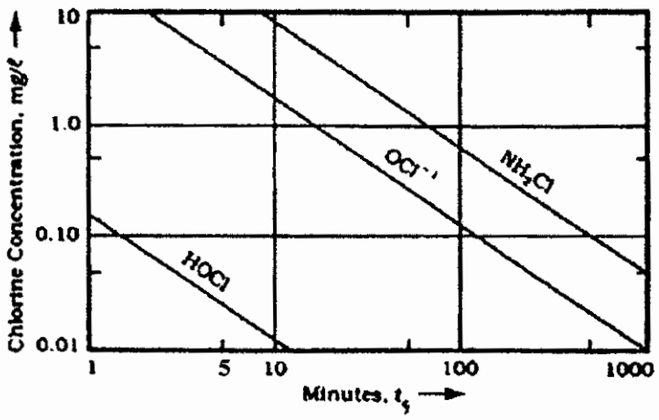

Figure Q2-1

E. Compare the advantages of and disadvantages of ozone as a disinfectant with that of chlorine.

Question Three (25 Marks)

The table below shows the results of water quality analysis of a sample of raw water intended for potable water treatment. Determine:

i. The bicarbonate and permanent hardness in mg/L of $CaCO_3$ ..... [12 Marks]

ii. The lime and soda ash required to soften this water. .....[13 Marks]

Parameter	TDS	Ca	Mg	Na	K	HCO_3	SO_4	Cl	$H_2CO_3^*$	pH
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH units
Concentration	300	65	20	15	5	200	120	25	20	7.2

Question Four (25 Marks)

(Note: Each question below carries 5 marks)

A. Define the following terms: i) Permeate ii) retentate iii) permeator iv) concentration polarization v) solute rejection.

B. Give reasons as to why the dead end operating mode of membrane processes is preferred for water treatment applications in general over the cross flow mode of operation.

C. Describe with the help of a diagram the voltage driven electro dialysis process.

D. Describe the protection measures that can be taken to protect membranes from fouling caused by i) iron and manganese ii) organic matter.

E. A membrane module contains 6000 fibers. The fibers are 1.2 m long with an outside diameter of 1.8 mm and 0.8 mm. Calculate the flux necessary to produce a flow of 2500 liter/hour if flow is:

i. outside in

ii. Inside out

Question Five (25 marks)

(Note: Each question below carries 5 marks)

A. Describe the chemicals attached as functional groups to i) strong acid cation exchangers and ii) weak acid cation exchangers. Also state the capabilities of the exchangers and their disadvantages.

B. Describe the functional advantages of highly cross-linked macro porous ion exchange resins.

C. The selectivity quotient diagram of three types of ion exchangers towards a specific ion is shown in Figure Q5-1 shown below. Describe the characteristics of each resin with respect to the intended ion to be removed.

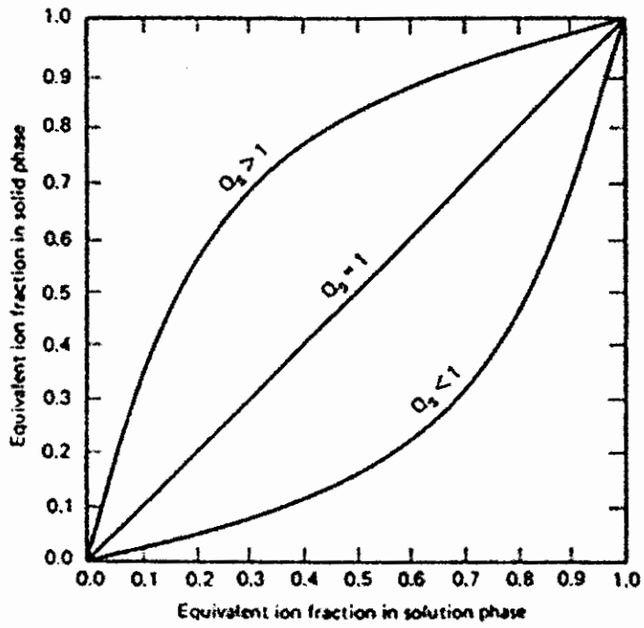

Figure Q5-1

D. List the basic factors that influence the adsorption processes on activated carbon adsorbent. Indicate also how they affect the adsorption process.

E. State the procedure for the development of adsorption isotherm of activated carbon.