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

BACHELOR OF SCIENCE IN ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

MAIN EXAMINATION PAPER 2017

TITLE OF PAPER	:	WATER TREATMENT
COURSE CODE	:	EHM 423
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 (5 Marks each)

1A. The rate of transfer of gas such as oxygen to water is expressed by the following equation:

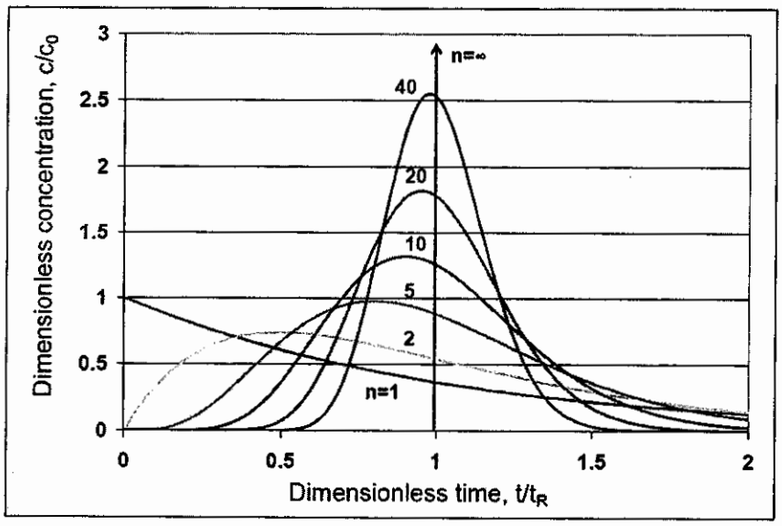
$$\frac{dc_w}{dt} = k_2 \cdot (c_s - c_w)$$

What kind of reaction does the above equation represent?

a. First order reaction
b. Zero order reaction
c. Saturation or mixed order reaction
d. First order retarded reaction

1B. The diagram below represents the response of outlet concentration in a tracer test to different tank configurations:

i. What kind of flow does n=1 represent ?
ii. What kind of flow does n=40 represent and how do you evaluate the performance of such reactor compared to that of n=1
iii. If the standard deviation from the mean is taken as the measure of dispersion, which of the reactors have the lowest standard deviation and which one has the highest standard deviation
iv. What will be the profile of the tracer curve if the index n= ∞. What will be the standard deviation?



1C. Describe the chemical method for the removal of chromium from water.

1D. List water treatment methods for the deactivation of chelating agents

1E. List the sequence of steps required in heterogeneous reactions.

QUESTION TWO

2A. How do you describe the variation of the selectivity of ion exchange resins among ions of the same valancy?

2B. What are the advantages and disadvantages of resins with high degree of cross linking?

2C. List the factors that decrease the rate of film diffusion in ion exchangers.

2D. Describe with the help of a diagram counter current operation and state the advantage of counter current operation of ion exchangers?

2E. What are the objectives of backwashing of ion exchangers?

QUESTION THREE (5 Marks)

3A. Define the following terms:

i) Adsorbate ii) Adsorbent iii) Adsorption isotherms

3B. Describe the characteristics of adsorption of i) hydrophilic molecules ii) hydrophobic molecules on activated carbon.

3C. How do you characterize the adsorption molecules on activated carbon when the solution contains salts compare to the adsorption of the same molecules on activated carbon when the solution does not contain salt.

3D. Differentiate between the following three types of adsorption

i. Physical adsorption
ii. Chemical adsorption
iii. Exchange adsorption

3E. State the size boundaries of the micro, meso and macro sizes. Which of these sizes are dominant in activated carbon?

QUESTION FOUR (25 Marks)

The removal of iron by oxidation using oxygen can be modeled as a first order reaction (assuming that the concentration of oxygen in the aerator supply remains constant). The first order apparent reaction rate constant, K_{app}, for the removal of iron by precipitation through oxidation is then given by the formula:

$$K_{app} = \frac{1.68 * 10^{-15}}{[H^+]^2} \quad min^{-1}$$

Where:

K = The apparent reaction rate constant for the oxidation of iron by aeration in min^{-1} $[H^+]$ = The hydrogen ion concentration in moles/L.

Determine the detention time (in minutes) of the reactor tank required to achieve 99% removal of dissolved iron by aeration.