



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

DEGREE IN ENVIRONMENTAL HEALTH SCIENCE
FINAL EXAMINATION PAPER 2016

TITLE OF PAPER : URBAN WATER TREATMENT

COURSE CODE : EHM 208

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. Choose the correct sequence of water treatment unit process from among the following

- i. Coagulation-microstraining-filtration-sedimentation-flocculation-disinfectio
- ii. Disinfection-microstraining-filtration-coagulation-sedimentation-flocculation
- iii. Microstraining-coagulation-flocculation-sedimentation-filtration-disinfection
- iv. Sedimentation-microstraining-coagulation-flocculation-filtration-disinfection

1B. Which of the following statements is/are FALSE?

- i. Operating water treatment plant beyond its capacity can lead to deterioration of the quality of the treated water.
- ii. Water quality can be improved by intermittent supplies
- iii. The World health organization has prepared an International Standard for drinking water quality.
- iv. Sanitary protection is essential in water sources that are not continuously chlorinated such as springs and wells.

1C. One or more of the following statements is TRUE about the effect of temperature.

- i. Temperature has an effect on the rate at which chemicals dissolve in water
- ii. When water is cold less chemicals are required for coagulation to take place
- iii. High water temperatures often lead to high chlorine demand
- iv. The rate of sedimentation increases when temperature of water increases
- v. The solubility of gases increases with increase in water temperature

1D. Match the items in (II) against the items in (I)

Item (I)	Item (II)
1. Anaerobic	A. Organisms that use CO ₂ as a carbon source.
2. Anoxic	B. Metabolic processes carried out in a reduced environment in the absence of free oxygen where compounds such as SO ₄ ²⁻ and CO ₂ serve as terminal electron acceptor.
3. Chemoautotrophs	C. Organisms that have metabolic processes that allows them to operate under anaerobic, anoxic and aerobic conditions.
4. Autotrophs	D. Organisms that use organic chemicals as a carbon source: can be aerobic, facultative or anaerobic.
5. Facultative	E. Organisms that in addition to deriving energy from chemical reactions, synthesize all necessary organic compounds from carbon dioxide.
6. Heterotrophs	F. Metabolic process carried out in a reduced environment in the absence of free oxygen where compounds such as NO ₃ ⁻ and NO ₂ ⁻ and Fe (III) serve as terminal electron acceptors.

1E. List the methods available for algal control in reservoir feeding water to a water treatment plant.

QUESTION TWO (5 Marks each)

2A. Discuss the importance of the following factors on intake and their design

- i. Heavy currents
- ii. Water demand
- iii. Water rights
- iv. Climatic conditions

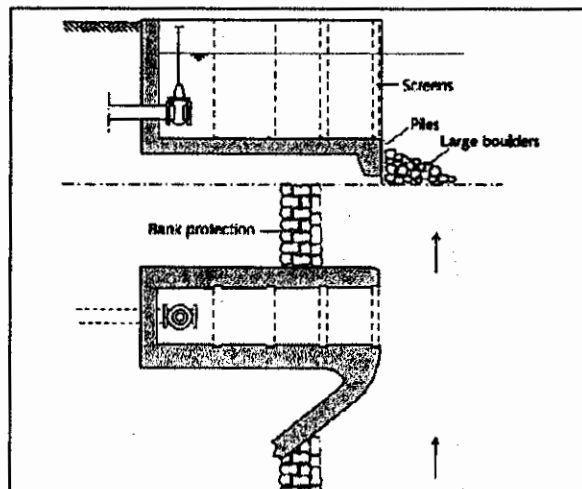
2B. Draw a sketch of an infiltration gallery to draw water from a river whereby the top of the river bank is about 6 m from the lowest water level. Indicate all the necessary components.

2C. List the advantages and limitations of providing micro-strainers for water treatment.

2D. The plan and vertical section of a river side intake is shown in the figure below.

Discuss the importance of the following design components showing the figure:

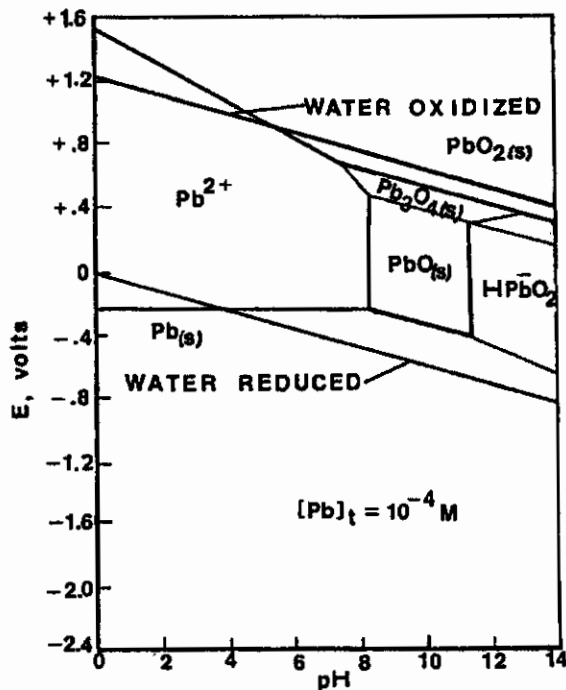
- i. Provision of multiple intake screens
- ii. Provision of piles and boulders
- iii. Bending of the approach wall to the side screen



2E. Discuss the advantages and disadvantages of horizontal flow roughing filters over vertical flow roughing filters.

QUESTION THREE

- 3A. List seven objectives for providing aeration in water treatment[5 Marks]
- 3B. For the E-pH diagram of Lead shown below, indicate the areas of corrosion, passivation and immunity. Comment also on the thermodynamic stability of lead in water.[5 Marks]



- 3C. List the different methods of control of corrosion in water pipes and state the advantages and limitation so each method.[5 Marks]

- 3D. Calculate the Langelier saturation index and the Ryzner stability index of a water having the following characteristics: pH = 6.5, Calcium 300 mg/L as CaCO₃, alkalinity= 250 mg/L as CaCO₃. Use the formula given below and assume that $\gamma_m = 0.89$ and that $Pk_2 - Pk_s = 2.4$

$$pH_s = pK_2 + pCa^{2+} - Pk_s - \text{Log}(2[\text{Alk}]) - \text{Log}(\gamma_m)$$

.....[10 Marks]

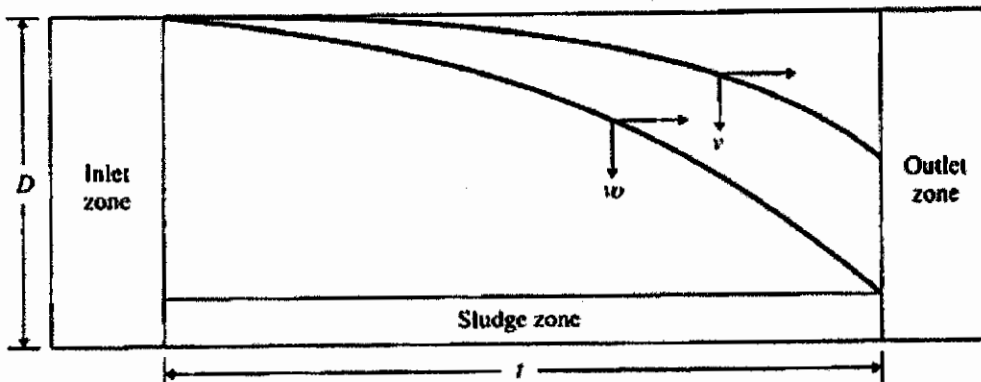
QUESTION FOUR (5 Marks each)

4A. Describe the following mechanisms of destabilization of colloidal suspensions in water:

- i. Compression of the double layer[2 Marks]
- ii. Adsorption for neutralization of charges.[1 Mark]
- iii. Entrapment in a precipitate.[1 Mark]
- iv. Adsorption for inter-particle bridging.[1 Mark]

4B. Derive the formula for the average velocity gradient in baffle channel flocculators and discuss how each variable in the formula affects the formation of velocity gradient.

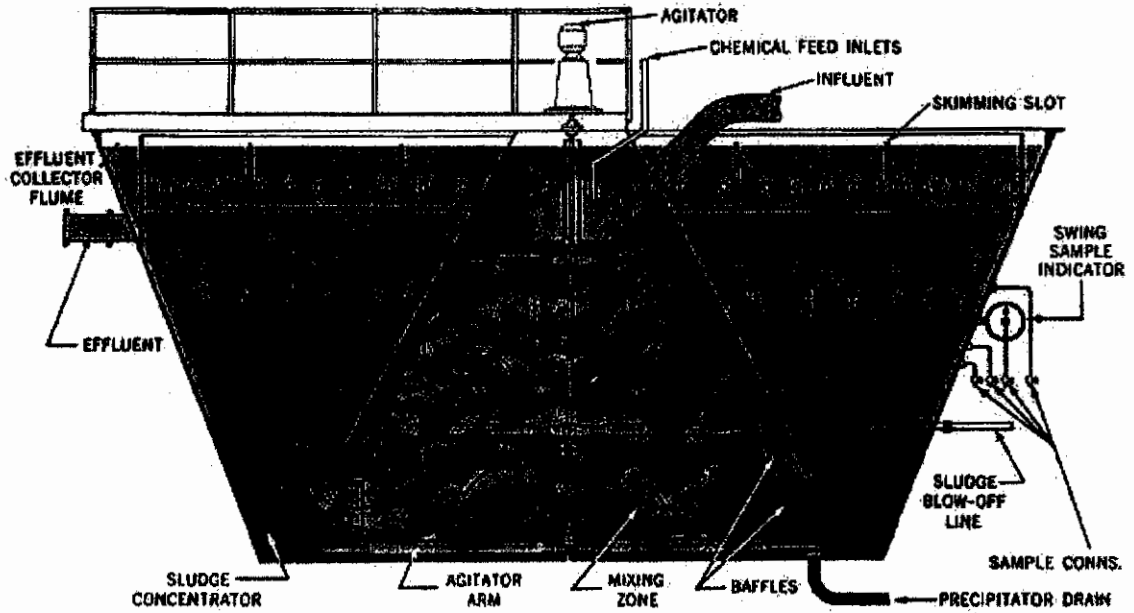
4C. The figure below shows the trajectory of solids in a given sedimentation tank. State the nature of sedimentation and indicate the effect of depth of the rate of sedimentation.



4D. The manager of a water treatment plant is concerned about deterioration of the quality of water coming out of a sedimentation tank because of the following listed reasons: Discuss the solutions that he can provide to alleviate some of the problems.

- i. The flow has increased in recent times due to increased times.
- ii. Wind blows over the sedimentation tank
- iii. There is a hot still condition in summer
- iv. There is problem of resuspension of settled solids (scouring).

- 4E. The diagram below shows a treatment unit common in conventional water treatment setup of small cities. Indicate the type of treatment that is taking place and the advantage of this particular unit of treatment over other units designed for the same objective.



QUESTION FIVE

5A. Discuss the role of the following factors in rapid sand filtration

- i. Media size[2 Marks]
- ii. Uniformity coefficient[1 Mark]
- iii. Media depth[2 Marks]

5B. Discuss the effect of positioning of the wash water trough in rapid sand filter. In other words state what will happen:

- i. If the wash water trough is located too high relative to the sand bed level.[2.5 marks]
- ii. The wash water trough is located too low relative to the sand bed level.
.....[2.5 marks]

5C. For the slow sand filter shown in the diagram below, state the function of the components labeled A, B, C, D, E, F, G, H, and J below.
.....[15 Marks]

