



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

B.Sc. DEGREE IN ENVIRONMENTAL HEALTH SCIENCE

MAIN EXAMINATION PAPER 2017

TITLE OF PAPER	URBAN WATER TREATMENT
COURSE CODE	EHS 222
DURATION	2 HOURS
MARKS	100
INSTRUCTIONS	READ THE QUESTIONS & INSTRUCTIONS CAREFULLY ANSWER <u>ANY FOUR</u> QUESTIONS EACH QUESTION <u>CARRIES 25</u> 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. Multiple barrier system is a term that is commonly used in water treatment. Explain what this term means and state its importance in modern water treatment processes.[5 marks]

1B. List and describe the factors that influence the location of intakes to water treatment plants. [5 marks]

1C. Figure Q1-1 below shows a multiple intake reservoir system. Describe the advantages of this multiple intake system and the reason for providing a siphon intake at each intake level.[5 marks]

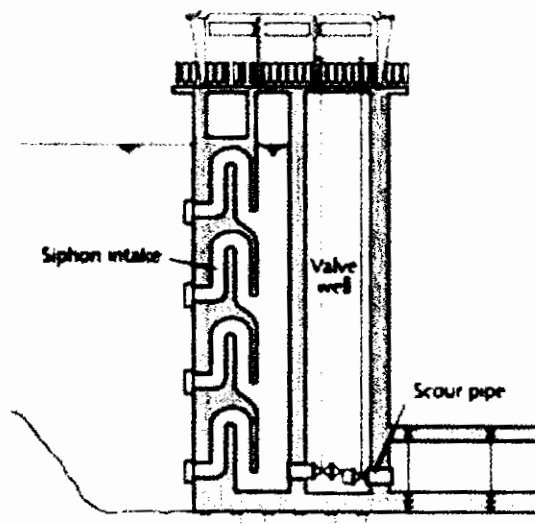


Figure Q1-1 Multiple level intake system with siphon intake

1D. Draw a sketch of a possible intake structure located in upstream mountainous streams.[5 marks]

1E. Name the structure provided in water shown in Figure Q1-2 below and indicate the purpose for which it is provided.[5 marks]



Figure Q1-2 A structure (appearing white) provided inside a water body

QUESTION TWO

2A. Discuss the appropriateness of plain sedimentation tanks for the following cases.

- i. The raw water contains mostly sand and silt.[1 mark]
- ii. The raw water contains mostly colloidal suspensions....[1 mark]
- iii. The raw water contains mostly a mixture of sand, silt and colloidal suspensions.[1 mark]
- iv. The raw water contains largely suspended algal material....[1 mark]
- v. The raw water has passed through infiltration gallery.[1 mark]

2B. Looking at the stability diagram of copper metal shown in Figure Q2-1 below, discuss in detail the potential for corrosion of copper.[5 marks]

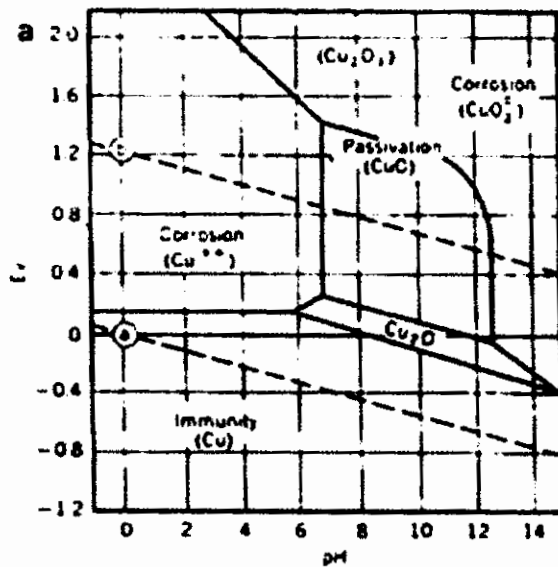


Figure Q2-1 Stability diagram of copper metal

2C. List measures that can be taken to reduce short-circuiting and the adverse effect of wind in plain sedimentation tanks.[5 marks]

2D. For each of the following cases listed below, discuss the change in the stability of water and what will happen as a result.

- i. The pH of the water decreased[1 mark]
- ii. The alkalinity of the water increased.[1 mark]
- iii. The calcium content of the water increased.[1 mark]
- iv. The temperature of water increased.[1 mark]
- v. The sodium content of the water increased.[1 mark]

2E. List seven objectives of aeration treatment of water.[5 marks]

QUESTION THREE

- 3A.** Define the following terms: i) suspension ii) colloid iii) floc iv) coagulation v) flocculation.[5 marks]
- 3B.** Describe the roles of i) electro static forces and ii) Van der Waal forces in the formation of stable colloids in water[5 marks]
- 3C.** Describe i) Ortho-kinetic flocculation ii) Peri-kinetic flocculation. Indicate the instances in which each of these types of flocculation arise in water treatment. Indicate the factors that affect the extent of flocculation for each type. ...[5 marks]
- 3D.** Compare mechanical flocculators with that of baffle channel flocculators indicating the advantages and disadvantages in each case.[5 marks]
- 3E.** As a demonstration of the efficiency of tube settlers, calculate the change in design settling velocity V_s of a particle for a given rectangular sedimentation tank of plan area $A \text{ m}^2$ carrying a water flow of $Q \text{ m}^3/\text{sec}$ in which an extra bottom is provided at the middle as shown in Figure Q3-1 below.[5 marks]

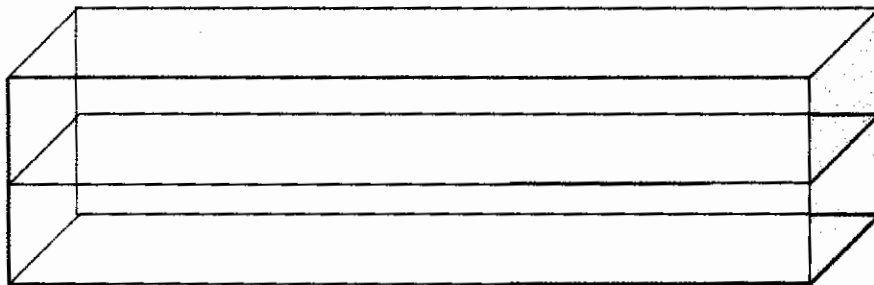


Figure Q3-1: Rectangular sedimentation tank in which extra bottom is provided in the middle of the tank.

QUESTION FOUR

- 4A. Draw a possible layout of under drain system for rapid sand filter system indicating the important components.[5 marks]
- 4B. Describe declining rate filtration, indicating the setup mechanism, advantages and limitations of this system of filtration.[5 marks]
- 4C. You are required to design a dual media filtration system for a given water treatment system. Explain in detail as to why you may need dual media filter, what filter materials can be used, what will be the relative sizes of the media and how the different media would be arranged.[5 marks]
- 4D. Figure Q4-1 below shows the cross section of different layers existing in slow sand filter just before the time for re-sanding is reached. Draw the cross section of the different layers in the slow sand filter immediately after sanding.[5 marks]

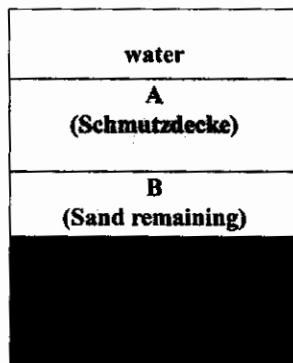


Figure Q4-1 Layers of slow sand filter just before re-sanding

- 4E. List possible operational faults of slow sand filter.[5 marks]

QUESTION FIVE

5A. Describe how disinfection byproducts are formed and the measures that can be taken to minimize the formation of disinfection byproducts in water treatment.[5 marks]

5B. Discuss the advantages and limitations of the following two disinfectants when used in water treatment:

- i. Ultra violet ray[2 marks]
- ii. Chloramine[3 marks]

5C. Figure Q5-1 shows the chlorine residual curve for a given water treatment application. Explain the stages labeled A-E in the curve.[5 marks]

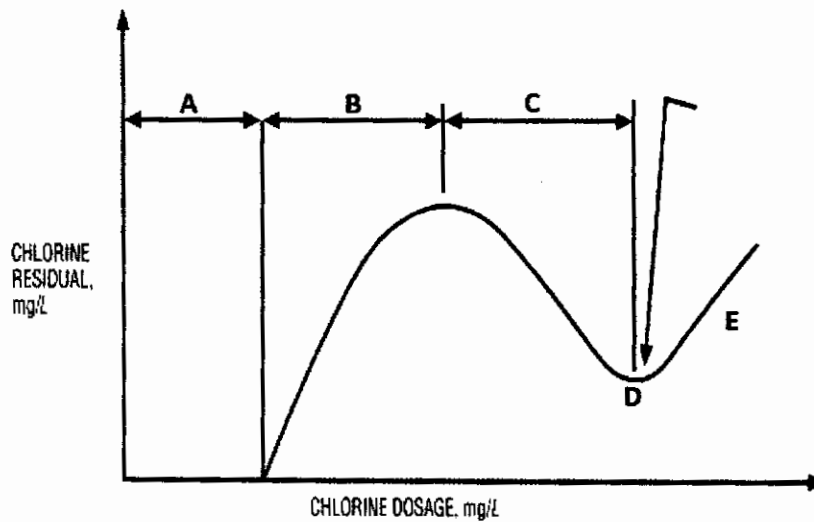


Figure Q5-1 Chlorine residual curve

5D. You are required to design a chlorine dosing system using calcium hypochlorite as a disinfectant. The water to be disinfected has passed through a filtration system and is led by gravity into to a chlorine tank. Outline with the help of a sketch how you would achieve this design.[5 marks]

5E. Explain the variation of the effectiveness of chlorine disinfection with water temperature in terms of activation energy.[5 marks]