

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

B.Sc. Degree Programs in Environmental Health

MAIN EXAMINATION PAPER MAY 2013

TITLE OF PAPER : URBAN WATER TREATMENT

COURSE CODE : EHM 208

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) The following analysis has been completed on filtered water from a surface water treatment plant. Check the accuracy of the analysis to determine if it is sufficiently accurate.

| Cation | Concentration, mg/L | Anion | Concentration, mg/L |
|------------------|---------------------|-------------------------------|---------------------|
| Ca ²⁺ | 54.6 | HCO ₃ ⁻ | 172.5 |
| Mg ²⁺ | 11.2 | SO ₄ ²⁻ | 37.7 |
| Na ⁺ | 13 | Cl ⁻ | 33.8 |
| K ⁺ | 10 | NO ₃ ⁻ | 2 |

..... [10 Marks]

B) Given the following unit treatment processes, arrange them in the proper sequence in which they are provided in water treatment; i) super chlorination, ii) flash mixing iii) settling iii) plain sedimentation iv) pre-chlorination v) activated carbon vi) de-chlorination viii) coagulation ix) filtration.

..... [5 Marks]

C) What are the problems that can be caused by the presence of algae in water treatment and supply?

..... [5 Marks]

D) Suppose you are given a sample of water from a certain source. The water sample appears to be coloured. Describe the procedure for determining if the observed colour is a true colour or an apparent colour.[5 Marks]

Question Two (25 Marks)

- A. Discuss the factors that influence the location of intakes to water treatment plants.
..... [5 Marks]
- B. Compare horizontal flow roughing filtration with vertical flow roughing filtration for the pretreatment of water.[5 Marks]
- C. Discuss the advantages and disadvantages of abstracting intake i) from the top depth of a lake and ii) from the lower depths of a lake intake.[5 Marks]
- D. List seven reasons for which aeration may be provided in water treatment facilities.
..... [5 Marks]
- E. Draw a sketch of an infiltration gallery that abstracts water from a river indicating the necessary provisions. [5 Marks]

Question Three (25 Marks)

- A. List the advantages and disadvantages of hydraulic flocculators over mechanical flocculators. [5 Marks].
- B. List the advantages of ferrous salts over aluminium sulphate for the coagulation of water. What may be the disadvantage of using iron salts for coagulation..?[5 Marks]
- C. Answer each of the following related to flocculation;
- i. How do you compare the density of flocs with that of individual particles of clay from which flocs are formed? [2 Marks]
 - ii. What will happen to the density of flocs when the floc radius is increased? [1 Mark]
 - iii. Is the rate of settlement of flocs dependent on the depth of tank? Give reasons for your answer. [2 Marks]
- D.
- i. Differentiate between perikinetic flocculation and orthokinetic flocculation.
 - ii. What are the factors that influence the rate of perikinetic flocculation?
 - iii. What are the factors that influence the rate of orthokinetic flocculation?
..... [5 Marks]
- E. Describe the four mechanisms of destabilisation of colloidal suspension in water.
..... [5 Marks]

Question Four (25 Marks)

- A. List the advantages of slow sand filters the three principal mechanisms of flocculation and the effects of particle number, velocity gradient and time of flocculation. [5 Marks]
- B. Describe diatomaceous filtration and explain the working principle of diatomaceous filtration..[5 Marks]
- C.
- i. Discuss the operational problem that occurs because of using non-uniform filter media for a rapid sand filter.[2.5 Marks]
 - ii. Explain what a multi-media filter is and state the advantages of using dual media filtration.[2.5 Marks]
- D. Define the following terms:
- i. Schmutzdecke[1 Mark]
 - ii. Filter run[1 Mark]
 - iii. Media segregation.....[1 Mark]
 - iv. Filter break through[1 Mark]
 - v. Uniformity coefficient.[1 Mark]
- E. Compare rapid sand filter with slow sand filter in terms of: ii) Filter run length iii) Filtration rate and iv) Filter media[5 Marks]

Question Five (25 marks)

A. How do you evaluate ozone (O₃) as a disinfection agent with respect to the following criteria?

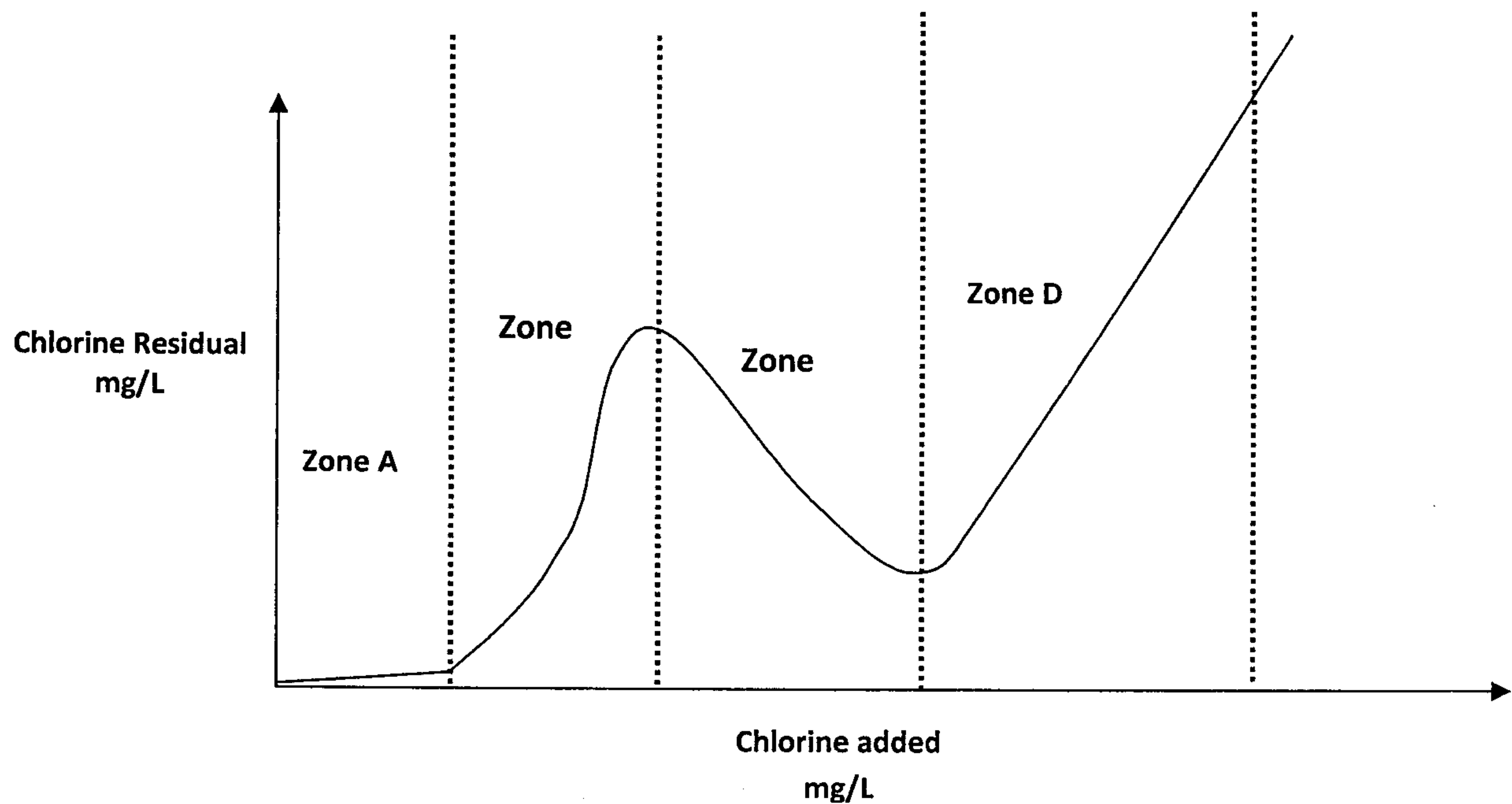
- i) Effectiveness in comparison with chlorine
- ii) Ability to leave a residual
- iii) Solubility in water compared with oxygen
- iv) Material of container used for generation of ozone
- v) Means of disposal of excess ozone after disinfection and the danger it poses if such excess ozone is allowed to escape into the open air.

..... [5 Marks]

B. Match the items in B against the items in A. Items in A can have more than one matches from items of B. Marks will be deducted for wrong matches.[5 Marks]

| Item A | Item B |
|-------------------|--|
| 1. Heat Treatment | a) Requires pretreatment for turbidity removal and very clear water. |
| 2. Irradiation | b) Effective for low organism concentrations |
| 3. Metal ions | c) Harmful residual byproducts may be formed |
| 4. Ozonation | d) Limited to emergency situations and individual supplies |
| 5. Chlorination | e) Require low disinfectant concentrations |
| | f) Not effective against cysts, spores and viruses |
| | g) Long contact times are required |
| | h) Improves the dissolved oxygen content of the water. |

- C. Given below is a chlorine dosage-residual response curve for a break point chlorination system. Explain what happens in each of the zones labeled from A to D in the figure below. [5 Marks]



- D. For each of the following states/provisions related to ammonia in water, state what will happen as a result or the reason behind such provision.[5 Marks]

- Chlorine is added in water that contains high concentration of ammonia.
- Ammonia is added before chlorination to water that contains dissolved organic Compounds.
- Ammonia is added together with chlorine for the disinfection of water to be supplied through along distribution line.
- An excess of chlorine is added to water containing ammonia to reach the break point.

- E. Write the reaction takes place when each of the following disinfecting compounds are added to water:[5 Marks]

- Chlorine gas, Cl_2
- Sodium Hypochlorite, NaOCl .
- Calcium Hypochlorite, $\text{Ca}(\text{OCl})_2$