BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
M.E. (Civil) 1st SEMESTER EXAMINATIONS, 2013
Environmental Engineering Chemistry (CE 913)

Full Marks: 70 **Time: 3 hrs**

PART – I

Answer any 3 (THREE) questions.

1. Define the terms 'equivalent weight', 'co-valent bond' and 'molality'. Calculate the normality of a 98.6% HCl solution whose specific gravity is 1.18. How can you apply the concept of 'electron balance' in developing the stoichiometry of a chemical reaction? Balance the chemical reaction when Potassium Iodide (KI) gets oxidized by HNO_2 under strong H_2SO_4 medium.

(3+3+3+5 = 14)

2. What is the 'ionic strength' of a solution?
Calculate the activity co-efficients and activities of each ion in a solution containing 0.3 M NaCl, 0.06 M Na_2SO_4 and 0.85 N $MgSO_4$.
Briefly highlight on various forms of 'chemical equilibria' observed in the environmental engineering system. Write the general methodology for solving the problems on 'Acid-base equilibria'.

(2+5+3+4=14)

3. 1.6 gms of Acetic acid (CH_3COOH) and 1.2 gms Formic acid (HCOOH) are added to enough distilled water to make 1.5 liter of solution, what will be the percent ionization of each species and pH of the solution?
K_a of Acetic acid = 1.8×10^{-5} and K_a of Formic acid = 1.7×10^{-4}.
Develop a relationship to find out the pH of a strong acid solution under equilibrium, considering the dissociation of water.
Calculate pH of a 0.05 M CH_3COOH solution considering the dissociation of water. Also determine the change in pH, if the concentration is reduced to 0.1% of the present one.

(5+4+5=14)

4. Classify the solutions in respect of 'solubility product'.
Calculate the actual solubility of AgCl solution having strength 0.003 M in presence of 0.1 N Na_2SO_4 and 0.05 M $MgNO_3$. Also determine the apparent solubility product of AgCl considering activity of all the solutes. What will be percentage increase in solubility due to addition of those impurities?
Write the mechanism of 'Fractional precipitation' in reference to solubility of a metal.

(3+6+5=14)

5. Write the physical significance of 'saturation pH' of a water sample with a given characteristics. What is 'salinity correction'? Determine the 'saturation index' of a water sample with following composition and comment on its quality.

pH	7.80
Calcium Hardness	300
Total Hardness	410
Total Alkalinity	275

Note : All the parameters are expressed in mg/L as $CaCO_3$ except pH.
Consider pK_s and pk_2 values as 8.15 and 10.49 respectively at the given temperature.

(6+2+6=14)

P.T.O.

PART – II

Answer any 2 (TWO) questions

6. How can you anticipate the fastness of a reaction from 'order'? How would you determine 'kinetic constant' in case of a 'zero order' reaction? What is a 'Pseudo-first order reaction'?

NH_4^+-N concentration of the effluent sample, collected from a biological reactor after 4 hrs from start-up is measured to be 45 mg/L as N. The NH_4^+-N concentration of the effluent wastewater is also estimated as 25 mg/L as N after 2 hrs from the previous sampling. Find out the rate of NH_4^+-N conversion. Also determine the total time required to lower the NH_4^+-N concentration to 10 mg/L as N.

(2+3+3+6=14)

7. Establish that the sum of concentration of all the reactants in a two-stage 'consecutive reaction' always remain same. Explain how the maximum DO deficit on account of disposal of organic matter can be measured from the concept of consecutive reaction.

An anaerobic reactor system contains hydrolysis product, fatty acids and methane concentration of 2275 mg/L (as COD), 1480 mg/L (as COD) and 116 mg/L (as COD) respectively and is subjected to digestion. If the rate of hydrolysis product conversion to fatty acids and methane production are 0.13/hr and 0.16/hr respectively, then determine the time required for 99% conversion of hydrolysis product and the respective concentrations of all the constituents.

(3+6+5=14)

8. Write the principle of 'Energy Substrate reaction' reaction. How can you find out the maximum specific rate of such a reaction?

The rate of COD removal is observed as 0.16/day and 0.13/day at a temperature of 25°C and 22°C respectively. What would be the expected rate of COD removal at a temperature of 35°C?

Develop the kinetic expression to predict the steady state effluent substrate concentration for a CFSTR of volume V and operating with a reaction period of T. The influent substrate concentration and the rate of reaction can be considered as C_o and k respectively.

(3+4+4+3=14)

9. What is the basic advantage of a 'plug-flow' reactor over a 'completely mixed' one?

A Plug-flow reactor for BOD removal is operated with a wastewater flow rate of 1.6 m^3/hr and volume of 7.2 m^3 (0.6 m x 1.2 m x 10 m. The removal rate constant is estimated to be 0.13 hr^{-1}. Find out the BOD removal efficiency of this reactor. What will be the BOD concentration at the middle length of the reactor?

Establish that the efficiency of a completely mixed reactor would be enhanced further, if it is divided into three compartments from the existing two.

A completely mixed reactor of volume 15 m^3 is operated with a hydraulic retention period of 7.5 hrs and is fed with influent BOD concentration of 250 mg/L. The removal rate constant is already measured as 0.15 /day at steady state condition. If the reactor were divided into 3 numbers of cell of volume fraction 0.40, 0.25 and 0.35 then what would be the improvement in the overall efficiency?

(3+5+3+3=14)