BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
M.E. (Civil) 1st SEMESTER EXAMINATIONS, 2011
Environmental Engineering Chemistry (CE 913)

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

PART – I

Answer any 3 (THREE) questions.

1. Define the terms 'normality', 'molarity' and 'molality' in respect of a solution. Determine 'molarity' of the water itself. How can you use the 'half reaction' for balancing oxidation-reduction reactions? Balance the chemical reaction when $KH(IO_3)_2$ reacts with KI under strong H_2SO_4 medium.

(3+3+3+5 = 14)

2. Write the practical significance of 'ionic strength' of a solution.
Calculate the activity co-efficients and activities of each ion in a solution containing 0.1 M $MgCO_3$, 0.04 M NaCl and 0.2 M Na_2CO_3.
Define 'chemical equilibria' with suitable examples. Illustrate the dissociation of a weak acid and a weak base in respect of 'acid-base equilibria'.

(2+5+4+3=14)

3. If 0.6 gms of Benzoic acid (C_6H_5COOH) is added to enough distilled water to make 1 liter of solution, what will be the percent ionization and pH of the solution?
K_a of Benzoic acid = 6×10^{-5}
Define a Di-protic weak acid and briefly discuss the method to find out the percent ionization for each relevant species at a given pH.
Evaluate the percent ionization of the relevant species in a H_2S solution at the pH levels 6 and 7. [Ionization constant for H_2S and HS^- is 1×10^{-7} and 1.2×10^{-13} at 25°C respectively]

(5+4+5=14)

4. Calculate the Ag^{+1} and CrO_4^{-2} concentration and solubility of Ag_2CrO_4 solution prepared by adding of excess Ag_2CrO_4 and 0.2 moles of Na_2CrO_4(s) up to a volume 1 litre. K_{sp} of Ag_2CrO_4 may be taken as 8.55×10^{-13}. [Ag = 108 and Cr = 52]
How would you separate various metallic ions in a solution by 'Fractional precipitation'? Establish that solubility of a 'slightly soluble substance' gets enhanced in the solution of salts.

(5+4+5=14)

5. Write the steps involved to determine the 'saturation pH' of a water sample of given relevant characteristics. Examine whether the water with following composition is corrosive.

pH	7.60
Calcium Hardness	180
Total Hardness	270
Total Alkalinity	195

Note : All the parameters are expressed in mg/L as $CaCO_3$ except pH.
The temperature of water is 10°, at which pK_s and pk_2 values are 8.15 and 10.49 respectively.

(5+3+6=14)

P.T.O.

PART – II

Answer any 2 (TWO) questions

6. What is the utility of 'kinetic constant'? How would you determine 'kinetic constant' in case of a 'third order' reaction. Show that the 'Pseudo-first order reaction' is a special type of first order reaction.
COD concentration of the effluent sample, collected from a biological reactor after 2 hrs from start-up is measured to be 160 mg/L. The COD concentration of the influent wastewater is already estimated as 360 mg/L. Find out the rate of COD conversion assuming 1^{st} order kinetics. Also determine the total time required to lower the COD concentration to 100 mg/L.

(2+3+3+6=14)

7. Establish that there is no change in total mass of the reactants in the 'Consecutive reaction'. Explain the consequence of DO depletion and reaeration in terms of consecutive reactions. How does the 'DO sag curve' originate?
A wastewater sample containing NH_4^+-N, NO_2^-N and NO_3^--N concentration of 45 mg/L (as N), 14 mg/L (as N) and 12 mg/L (as N) respectively is subjected to nitrification. If the rate of NH_4^+-N conversion and NO_3^- production are 0.06/hr and 0.08/hr respectively, then determine the concentration of nitrogenous species after 6 and 8 hrs.

(3+4+3+4)

8. Write the mechanism of 'Energy Substrate reaction'. Justify the statement "The overall reaction rate is independent of substrate in case of abandoned substrate condition".
The rate of BOD removal is observed as 0.10/day and 0.12/day at a temperature of 20°C and 25°C respectively. What would be the expected rate of BOD removal at a temperature of 30°C?
Develop the kinetic expression to predict the effluent substrate concentration for a batch reactor 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. Differentiate between a 'plug-flow' and a 'completely mixed' reactor.
A CFSTR for BOD removal is operated with a wastewater flow rate of 3 m^3/hr and volume of 9 m^3. The removal rate constant is estimated to be 0.12 hr^{-1}. Find out the BOD removal efficiency at steady state. What will be the change in the BOD removal efficiency if the flow rate is adjusted to 4.5 m^3/hr?
How can you determine the efficiency of a completely mixed reactor, divided into a few compartments?
A completely mixed reactor of volume 10 m^3 is operated with a hydraulic retention period of 2.5 hrs. and is fed with influent COD concentration of 500 mg/L. The removal rate constant is already measured as 0.15 /day at steady state condition. If the reactor were divided into 4 numbers of cell of equal volume then what would be the improvement in the overall efficiency?

(3+5+3+3=14)