

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT
MID-SEMESTER EXAMINATION (March- 2015)
M. Tech. (II- SEM.)

COURSE CODE: 14M31CE212
COURSE NAME: Contaminant Transport
COURSE CREDIT: 3

MAX. MARKS: 30

MAX. TIME: 2 HRS

Note: Attempt all Questions. Assume suitable data if required.

Section A – (6 x 1 = 6 Marks)

1. Answer the following
 - a) What is the ratio of acetate ion concentration (CH_3COO^-) to the acetate molecule concentration (CH_3COOH) in water if pH is 10? ($\log K = 4.8$)
 - b) Mention the application of metal –containing catalysts in control of pollution from automobile exhaust
 - c) Express vapor pressure of 0.12 atm of carbon tetrachloride (Mol. Wt. 153.82) in terms of mm Hg of CCl_4 at 20°C .
 - d) How **Gibbs free energy** helps in providing information about a chemical reaction or the distribution of a chemical among phases. What are the factors on which Gibbs free energy depends upon?
 - e) What does octanol-water partition coefficient signify and how this index is helpful in pharmaceutical industry.
 - f) What do you mean by “Polar” and “Non-Polar” chemicals? What are the characteristics which distinguish between a polar and non-polar chemical.

Section B – (3 x 3 = 9 Marks)

2. Distinguish between “Kinetics” and “Equilibrium”. How do you relate chemical kinetics with order of a reaction? Explain each order of reaction with neat figures. [03 Marks]
3. What are the necessary and sufficient equations (based on key principles) required to determine the equilibrium chemical composition of a system. Discuss any one principle. [03 marks]
4. Distinguish between “Adsorption” and “Absorption”. What are the mechanisms by which sorption can occur in the environment. Mention the relationship between the concentration of a sorbed and dissolved chemical and the significance of the exponent used. [03 Marks]

Section C – (3 x 5 = 15 Marks)

5. a) What are the factors which influence the partitioning of a chemical between aqueous and gas phases and how do these factors influence Henry's law constant. [03 Marks]
- b) How do you convert a dimensionless Henry's law constant to Henry's law constant with units? [02 Marks]
6. a) Define "fugacity". How the concept of fugacity does help in determination of the relative concentrations of a chemical in different phases of environment at equilibrium. [02 Marks]
- b) 10 kg of toluene (C_7H_8) are added to an artificial ecosystem consisting of $5 \times 10^6 \text{ m}^3$ of water, 10^7 m^3 of air and 5.0 m^3 of fish. Using the fugacity concept, predict the equilibrium partitioning of toluene into each phase. Assume a BCF of of 3.1 liter/kg, a fish density of 1 g/cm^3 , and a temperature of 25°C . Properties of toluene are given below: [03 Marks]

Chemical	Mol. Wt.(g/mol)	Density (g/cm^3)	Solubility (mg/L)	Vapour Pressure (atm.)	Henry's law constant ($\text{atm. m}^3/\text{mol}$)
Toluene	92.14	0.87	515	3.7×10^{-2}	6.6×10^{-3}

7. a) Relate "Volatility" with "Vapour Pressure". How the chemicals are classified based on their volatility and discuss their characteristics. [02 Marks]
- b) A fuel tank in a pick-up truck has a filler pipe 2 ft in length with a diameter of 1.5 in. Estimate the amount of fuel lost a) by molecular diffusion (if the gas cap is left off for a day) and b) by advective "pumping" through a tank vent, when atmospheric pressure decreases from 30.0 to 29.0 inches of mercury (in Hg). Use an appropriate diffusion coefficient of $0.115 \text{ cm}^2/\text{sec}$. Assume the fuel is ethanol (C_2H_6O) with a vapour pressure of 0.08 atm at the ambient temperature of 21°C . The fuel tank capacity is 90 L and the tank is $1/3$ full. What would be the percentage loss of fuel if the tank would have been $1/4^{\text{th}}$ full? [03 Marks]