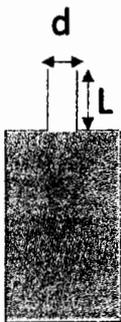


※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

- Describe in detail how seasonal variation affects lake stratification and its effect on the water quality of eutrophic lakes. (10 points)
- Describe "Biological oxygen demand (BOD)" and its use in environmental engineering. If 1-day BOD is 78 mg/L at 20°C, what is the 5-day BOD at the same temperature? Express your answer in terms of deoxygenation coefficient  $k_1$ . (10 points)
- Describe "Oxygen Sag Curve". The ultimate BOD of a river just below a sewage outfall is 50 mg/L and the DO is at saturation value of 10 mg/L. The deoxygenation rate coefficient  $k_1$  is 0.2 d<sup>-1</sup> and the reaeration rate coefficient  $k_2$  is 0.8 d<sup>-1</sup>. The river is flowing at the speed of 48 miles/d. The only source of BOD on this river is this single outfall. (20 points)  
Mathematics that may be needed for calculation:  $\ln 2=0.69$ ,  $\ln 3=1.10$ ,  $\ln 4=1.39$ ,  $\ln 5=1.61$ ,  $\ln 6=1.79$ ;  
 $\exp(-0.23)=0.79$ ,  $\exp(-0.46)=0.63$ ,  $\exp(-0.69)=0.50$ ,  $\exp(-0.92)=0.40$ ,  $\exp(-1.84)=0.16$   
(a) Find the critical distance downstream where DO is a minimum.  
(b) Find the minimum DO.
- CO<sub>2</sub> equilibrium in closed air-water system. At 25°C, a closed vessel of 10 L that is half filled with water and the CO<sub>2</sub> concentration at equilibrium in the headspace of the vessel is 1000 ppm and the headspace pressure is 1 atm.  $K_{H,CO_2} = 0.034$  (M atm<sup>-1</sup>),  $k_m = [H_2CO_3]/[CO_2]_{aq} = 0.00158$ ,  $K_{a1} = 4.47 \times 10^{-7}$ ,  $K_{a2} = 4.68 \times 10^{-11}$ . What is the total inorganic carbon concentration in the aqueous phase at pH = 7 (as mg C/L)? (15 points)
- Describe in detail the four major components in "Risk Assessment". (10 points)
- A bottle of expensive perfume is accidentally left open after its last use. It remains open, unnoticed, as the perfume volatilizes and escapes into the air. How much time before the perfume has completely escaped from the bottle? Assume that perfume concentration in the air is close to zero, perfume within the bottle (below the neck) is at saturation vapor pressure, and that perfume is diffusing through the neck. Hint: Fick's Law. (15 points)



#### System information

$d = 0.3$  cm, diameter of bottle neck

$L = 1$  cm, length of bottle neck

$M = 0.004$  mol, perfume in bottle at  $t = 0$

$D = 0.2$  cm<sup>2</sup>/s, diffusivity of perfume in air

$P_s = 0.02$  atm, Saturation vapor pressure of perfume

$T = 293$  K, air temperature

- Sketch a typical secondary wastewater treatment plant. Please label the major components and flow sequence, and include a brief description of the function for each component. (10 points)
- Plot the cross section of a typical hazardous waste landfill. Label each component and describe its function. (10 points)