ASSIGNMENT 6

CHEMISTRY 300

Due: 4:30 pm Friday 3 November 2006

1. Fick's laws describes diffusion from at point source of N_0 molecules:

$$n(r,t) = \frac{N_0 e^{-r^2/4Dt}}{(4\pi Dt)^{3/2}}$$

Bombykol ($C_{16}H_{29}OH$) is a silkworm moth attractant pheromone. As few as 200 bombykol molecules in a cubic centimeter causes the male silkworm to flutter his wings in a characteristic frenzy. If 1.0 mg of bombykol is placed in a small spot 1.0 m from a male moth, when will the male moth go into a frenzy? The diffusion coefficient is $D = 4.1 \times 10^{-7}$ m^2 s^{-1}.

2. If a 1.00 cm^2 $\times$ 10.0 cm bar of Cu (k=400 W m^{-1} K^{-1}) has one end in contact with a 1.0 g sample of ice at 0°C and the other in contact with a hot plate at 140°C, how long does it take to melt the ice? The enthalpy of fusion for water is $\Delta H^\circ_{fus} = 6.008$ kJ mol^{-1}.

3. The Poiseuille equation for an incompressible fluid is related to viscosity:

$$\frac{dV}{dt} = \frac{\pi R^4}{8L\eta}\Delta p$$

where R is the diameter and L is the length of a cylindrical pipe, and p is pressure.

Consider two copper pipes, each 3 m long, the first having 2.6 cm and the second having 1.3 cm inner diameter, are connected in series. A pressure of 5 atm is supplied at the opening of the wider pipe and oil ($\eta = 0.114$ Pa s) exits from the narrow end at a pressure of 1 atm.

(a) Calculate the pressure at the point where the two pipes are joined.

(b) How many litres per minute of oil can be delivered by the combination.

4. Consider problem 3 in assignment 5. Derive an expression for $(\kappa/d)_{eff}$ such that:

$$\Gamma_q = -\left(\frac{\kappa}{d}\right)_{eff}(T_{indoor} - T_{outdoor})$$