|  |  |  |
| --- | --- | --- |
| **Prob #** | **Points** | **Max** |
| **1a** |  | **20** |
| **1b** |  | **20** |
| **2** |  | **30** |
| **3** |  | **15** |
| **4** |  | **15** |
| **Total** | **0** | **100** |

**Note:** In many cases, you will find it easiest to use “snip” to cut and paste your work from MathCad.

1. A drug has a molecular weight of 240 gm/mole. Estimate the diffusion coefficient (in ) for glucose in at 25 fluid with viscosity 0.012 gm/(cm-s) and a density of 1.7 g/cm3, according to
2. The Stokes-Einstein equation
3. The empirical equation of Renkin and Curry. (Recall that this equation is for solutes in water at 37 and gm/(cm-s). (Pay attention to Eq. 5.42).
4. A 0.5 cm diameter sphere is coated with glucose and immersed in 37 pure water flowing at a velocity of 1.5 cm/s. The dynamic viscosity of the water is 0.0069 gm/(cm-s) and the density of water is 1 g/cm3. Assume that the diffusion coefficient for glucose is cm2/s and the equilibrium solubility is 0.91 gm/ml. Find the rate of mass flux from the sphere in gm/s.

1 cm/s

1. The solution for concentration from a given mass transfer problem is
2. Find a formula for flux per unit area in the direction, based on this expression.
3. A spherical shell of radius is evenly coated on the inside with a drug whose saturation concentration is . Diffusion is in the radial () direction only and no reactions are present within the shell. The fluid inside the sphere is not in motion. Find the partial **differential equation** **and boundary equations** that describe the change in concentration with radial position and time, (Do not attempt to solve the equations.) (Hint: Information on boundary conditions was covered in the PowerPoint lecture on Chapter 5a.)

**Potentially Useful Formulas**

Let be a characteristic velocity, be a characteristic length, be kinematic viscosity,

Further, let be diffusion coefficient.

Finally, let be the mass transfer coefficient.

**General mass transport equation**

In Cardesian coordinates

In cylindrical coordinates

In spherical coordinages

**Boundary layer development**

Pipe flow, fully developed momentum boundary layer .

Pipe flow, fully developed concentration boundary layer .

Flat plate, laminar boundary layer .

Cylinder, laminar flow .

**Constants**

Avagadro’s Number:

Faraday’s Constant:

Universal Gas Constant:

Centigrade to Kelvin: Degrees Kelvin 273.15 Degrees Centigrade

**Sherwood Numbers**

|  |  |
| --- | --- |
| Condition | Sh |
| Sphere in a stagnant fluid | 2 |
| Forced convection over a sphere |  |
| Laminar flow over a flat plate |  |
| Laminar flow in a cylindrical tube, short contact time |  |
| Laminar flow in a cylindrical tube, fully developed flow and concentration profiles | 3.66 |
| Turbulent flow through a circular tube |  |
| Spinning Disk |  |
| Falling Film, Average |  |