

國立臺灣科技大學

九十二學年度博士班招生考試試題

系所組別：化學工程系博士班甲組

科目：輸送現象

Ph.D. Entrance Examination 2003
Transport Phenomena
(總分 100 分)

- Consider an incompressible, steady, planar flow in two dimensions, $\mathbf{v} = u \mathbf{i} + v \mathbf{j}$ where u and v depend only on (x, y)
 - If $u(x, y)$ is known, how would you calculate $v(x, y)$? (5 points)
 - How would one calculate the total pressure, $P(x, y)$? (5 points)
 - If $\Psi(x, y)$ is the stream function of the flow, define the u and v in terms of Ψ . (5 points) What equation of fluid dynamics does satisfy automatically by its definition? (5 points)
- Consider a solid cylinder of radius R and length L , initially at temperature T_0 . At time zero, it is suddenly immersed in a well-stirred solution that is of such enormous volume that its temperature is constant at $T=0$. The heat transfer of the solid cylinder is symmetry, and the both ends of the cylinder are insulated. Set up the equation describing the unsteady-state radial temperature distribution of the solid cylinder by energy balance (15 points) and the appropriate initial and boundary conditions. (5 points) (You DO NOT need to solve the equation.)
- Define the Schmidt number and Sherwood number, and the physical interpretations of these two terms. (10 points)
- A liquid with a density of 1000 kg/m^3 flows through a tube of 1 m in length and 10 mm in diameter. If a pressure drop of 200 Pa and a flow rate of $60 \text{ mm}^3/\text{s}$ are measured. Assume the entrance effect can be neglected, determine the viscosity of the liquid. (15 points)
- Estimate the terminal velocity of spherical particle falling in water. Assume the drag coefficient is 7.9, the density and the diameter of the particle are 2800 kg/m^3 and 0.15 mm, the density of the water is 996 kg/m^3 . (10 points)
- A heated sphere of radius R is suspended in a large, motionless body of fluid. If the temperature profile in the fluid is $T = T_\infty + (T_R - T_\infty)(R/r)$, where r is the distance from the center of the sphere, T_R and T_∞ are the temperatures at the surface of the sphere and at $r = \infty$ in the fluid. From the temperature profile, show that $hD/k=2$, where h is the heat transfer coefficient, D is the diameter of the sphere, and k is the conductivity of the fluid. (10 points)
- Calculate the rate of diffusion (in $\text{kg-mol/m}^2\text{-s}$) of water vapor from a pool of water at the bottom of 6 m well to dry air flowing over the top of the well. Assume the air in the well is stagnant and that the entire system is at 25°C and 1 atm. The diffusivity of water vapor in air is $2.55 \times 10^{-5} \text{ m}^2/\text{s}$. The vapor pressure of water at 25°C is 0.031 atm. (15 points)

