國　立　清　華　大　學　命　題　紙

九十二學年度___生命科學院_____系（所）_____丙_____組碩士班研究生招生考試

科目__輸送現象與單元操作___科號___1004__共____2___頁第___1____頁 *請在試卷【答案卷】內作答

1. Please briefly answer the following questions: (30%)

a) What is the Newton's law of viscosity? Compare with Hooke's law of elasticity.

b) What is the range of applicability of Stokes's law? Would Stokes's law be expected to valid for liquid droplets of *A* falling in an immiscible liquid medium made up of *B*?

c) Explain how an orifice meter works. What are some advantages and disadvantages of orifice meters?

d) What is the physical significance of the Nusselt numbers? Explain in terms of temperature profiles.

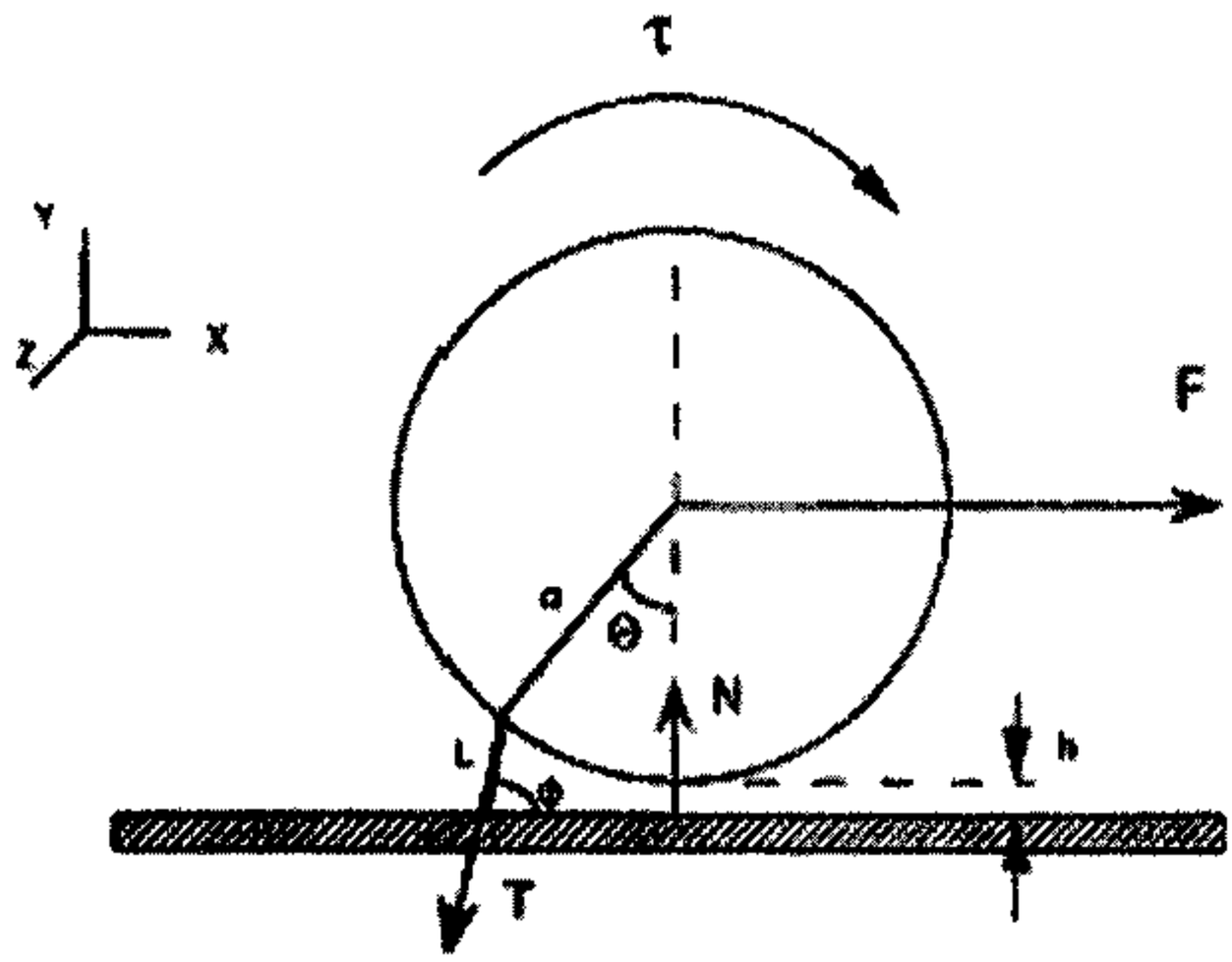
e) What is the physical significance of the Stanton number?

2. When a tangential or shear force is applied to the particle as in the following figure, a tension T is exerted within the bond which can be calculated by a mechanical equilibrium balance of force in the x direction and torque in the z direction. Here a is the radius of the bead and plate, h is the separation distance between the bead and plate, L is the bond length, T is the tension of the bond, N is the normal nonspecific force, and F and τ are the external force and torque exerted on the particle. (30%)

a) Derive the equations by assuming the force balance in the y direction is omitted.

b) If $a/L >> 1$, $\cos\theta = 1-\theta^2/2$, $\sin\theta = \theta$, $\cos\phi = \pi/2-\phi = \alpha$, and $\sin\phi = 1-\alpha^2/2$, further derive the equations.

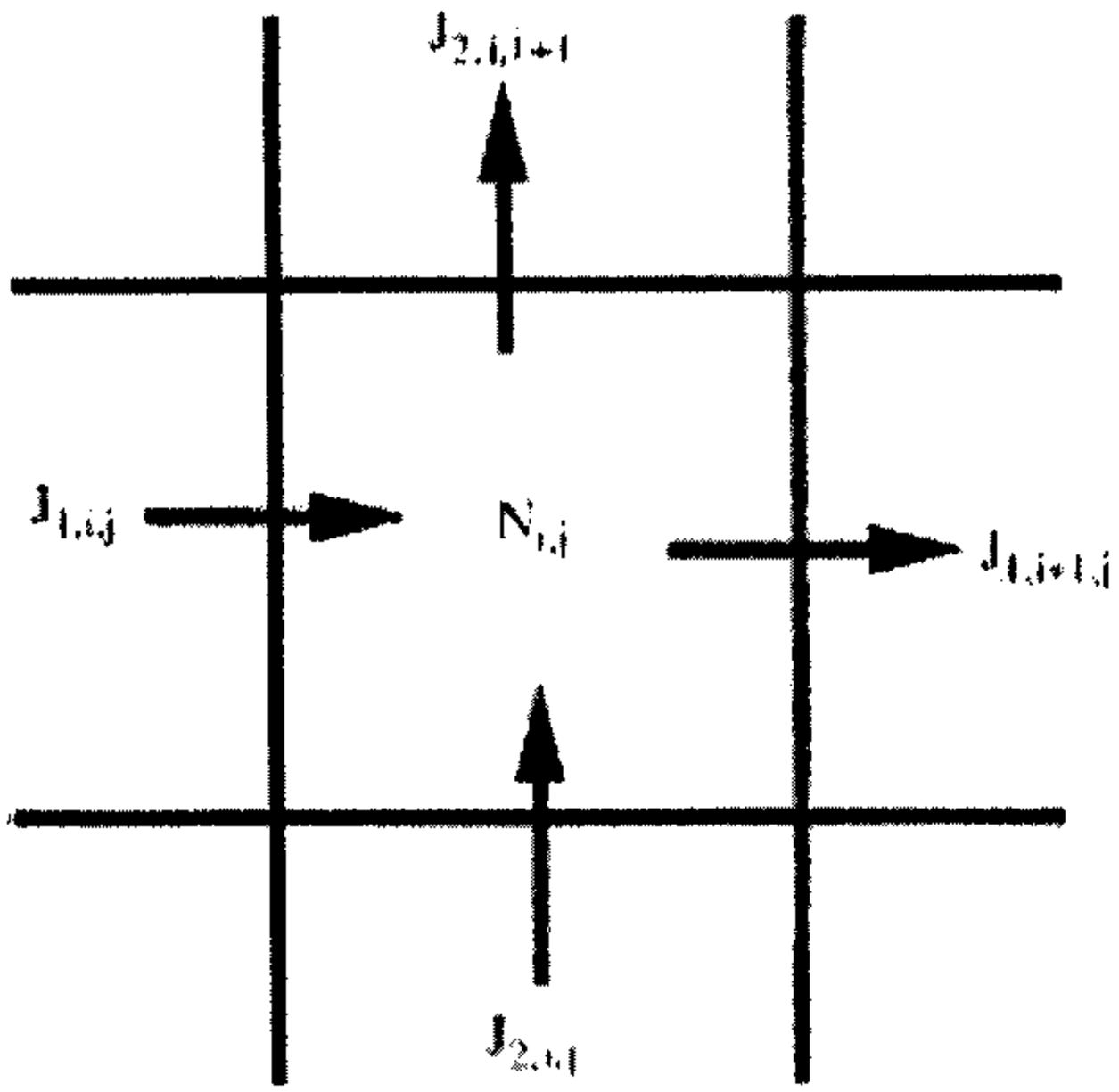
c) What kinds of biological functions can be described by these equations? (hint: cellular physiology)



3. Identify the fluxes affecting particle number in two-dimensional discretization of particle space around region (i , j). (20%)

a) Write down a material balance, equating the change in the number of particles in the bin, N, with the particle flux across the boundaries, J. The flux $J_{1,i,j}$ (t) is determined by the kinetics $x_{2,j}$ to $x_{2,j+1}$ and The flux $J_{2,i,j}$ (t) is determined by the kinetics $x_{1,i}$ to $x_{1,i+1}$

b) The applications envisaged are, for example, in biological systems where one may be interested in the kinetics of internal processes given dynamic experimental measurements. Such measurements are made possible by flow cytometer which is used to sort particles based on their scatter and fluorescence emission at rates of approximately 10,000 per second. Please describe the experimental design with the information obtained from the flux analysis.



4. Most biomolecular events are organized into networks of binding and catalytic processes. As a simple example, many transcriptional factors are synthesized and exist in cells as monomers (M), which form dimmers (D) under activating conditions. Only the dimmer binds to its cognate gene sequence (S) to form a complex (C), which promotes or represses gene expression. The concentration of dimmer required to result in occupation of one-half of the DNA sequence sites is equal to the dissociation constant of the second step, K_{D2}. The concentration of dimmer can be related to the corresponding concentration of monomer via the first step, which has the dissociation constant, K_{D1}. (20%)

a) What is the concentration of monomer resulting in occupying one-half of the DNA sequence sites?

b) In most biological systems, which affinity constant is higher and why?