

- [1] (10 points) Can μ in the general expression of stress tensor be named as shear viscosity and dynamic viscosity? Why? Why the dilatational viscosity can often be ignored from the general expression of stress tensor?
- [2] (10 points) What are the normal stresses? Why can't the normal stresses be ignored in a convergent channel?
- [3] (10 points) Contrast the radial dependence of the shear stress for laminar flow of a Newtonian fluid in a tube and in an annulus. In the latter, why does the function of shear stress change sign?
- [4] (10 points) Is Stokes' law valid for tiny spherical hailstones (ice crystals) falling in air? Is Stokes' law valid for tiny water drops falling in oil? Why?
- [5] (10 points) How can you balance the force including gravity, buoyancy and kinetic force to formulate the terminal velocity of a falling particle? What is the restriction on the Reynolds number in this formula?
- [6] (10 points) A sphere is falling in creeping flow with a terminal velocity v_∞ through a quiescent fluid. When the fluid velocity on the horizontal plane falls to 1% of v_∞ , what is the magnitude of v_0 relative to the sphere?
- [7] (10 points) Explain the following equation physically, when a semi-infinite body of liquid bounded by a horizontal surface (the xz -plane) is set in motion in the positive x direction.

$$\frac{d}{dt} \int_0^\infty \rho v_x dy = \tau_{yx} \Big|_{y=0}$$

- [8] (10 points) Describe the relation among inviscid fluid, irrotational flow and the Bernoulli equation. What is the physical meaning of the Bernoulli equation?
- [9] (10 points) In rectangular system, what are the two correlations describing the relation between the velocity components and the stream function in two dimensional flows? What equation is automatically satisfied by defining the

stream function?

[10] (10 points) In the case of laminar entrance flow in a slit, boundary-layer and potential-flow regions may be applied. Is the velocity in the potential-flow region a constant? Why?