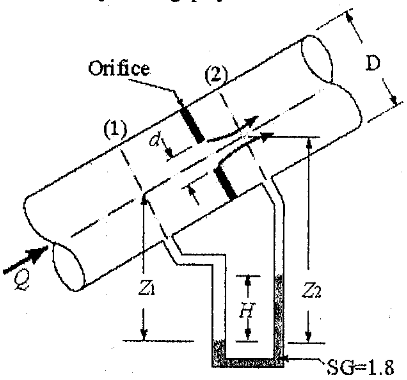
所別：中國文學系碩士班 甲組 科目：國文

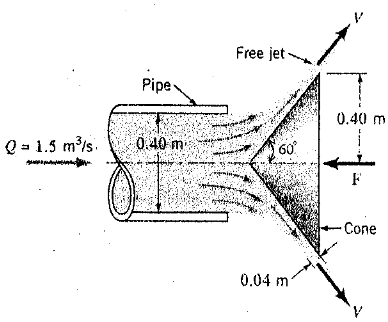
1. Define and explain the following terms:
   (a) hydrodynamic pressure, (b) stagnation pressure, (c) pressure head , (d) head loss, (e) ideal fluid. (10%)

2. Consider an inclined pipe fitted with an orifice. The fluid in the pipe is water and the gage fluid in the U-tube manometer has a specific gravity of 1.8. The corresponding physical values are: the density of water $\rho = 1000\ \mathrm{kg/m^3}$, the local acceleration of gravity $g = 9.8\,\mathrm{m/s^2}$, $D = 0.1$ m, $d = 0.05$ m, $Z_1 = 0.1$ m, $Z_2 = 0.18$ m, and $H = 0.05$ m.
   (a) Write down the Bernoulli equation between position (1) and (2). (3%)
   (b) Explain the vena contracta effect that occurs downstream of the orifice. (4%)
   (c) Compute the pressure difference $p_1 - p_2$ between position (1) and (2). (5%)
   (d) If the contraction coefficient (which is an area ratio) of the orifice is 0.63, determine the volumetric rate Q. (8%)



3. (a) What are the streamline, pathline, and streakline? At what condition where all three lines are coincided? (4 %)
   (b) Please write down the appropriate units for the mass flux (mass flow rate) and the momentum flux. (2 %)
   (c) What is the material derivative (D/Dt) in the flow acceleration field? (2 %)

4. A conical plug is used to regulate the air flow from the pipe shown right. The air leaves the edge of the cone with a uniform thickness of 0.04 m. If viscous effects can be neglected and the flow rate is 1.5 m^3/s, please determine the pressure within the pipe and the magnitude of the force $\vec{F}$ acting on the conical plug, where the density of air $\rho = 1.2$ kg/m^3) (12%)



5. Consider an incompressible, Newtonian fluid in a two-dimensional flow field. (total 15 %)
   (a) The momentum equations are given as follows.

$$x\text{-Mom:}\quad \rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)$$

$$y\text{-Mom:}\quad \rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial y}-\rho g+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)$$

注意：背面有試

Please use the similitude argument to obtain the non-dimensional **continuity** and **momentum** equations.

[Hint: Use the following reference variables to non-dimensionalize u, v, p, x, y and t, for examples, the characteristic velocity (V) for u and v, the characteristic pressure (P_o) for p, the characteristic length (L) for x and y, and the characteristic time (τ) for t.] (6 %)

(b) Please identify each term in the above non-dimensional momentum equations with the appropriate forces using the following terms: inertia (local) force, inertia (convective) force, pressure force, gravitational force, and viscous force, respectively. (5 %)

(c) Please further arrange the above non-dimensional momentum equations in terms of the Strouhal, Euler, Reynolds, and Froude numbers, respectively. (4 %)

6. A perfect gas flows in a constant-area duct, with no heat addition or frictional effects, and a shock takes place at a fixed location in the duct. Assume T_o be the stagnation temperature, γ the specific heat ratio, V_1 and V_2 the velocities ahead and behind the shock, respectively. From mass, momentum and energy equations, prove that

$$V_1 V_2 = \frac{2\gamma R T_0}{\gamma + 1} \qquad (15\%)$$

7. A viscosity pump illustrated below consists of a stationary case inside of which a drum is rotating with angular speed of Ω. The case and the drum are concentric. Fluid enters at A and leaves at B. The length of the annulus from A to B is L and the width of the annulus h is very small compared to the diameter of the drum, so that the flow in the annulus is equivalent to the flow between two flat plates. Assume the flow to be laminar and the fluid to be of density ρ, viscosity μ and volumetric rate Q. Find the pressure rise between A and B in terms of μ, Ω, R, h, Q, L. (20%)