1. (20%)

In two-dimensional incompressible, let (u,v) be velocity.

a) Give the definitions of vorticity and stream function.

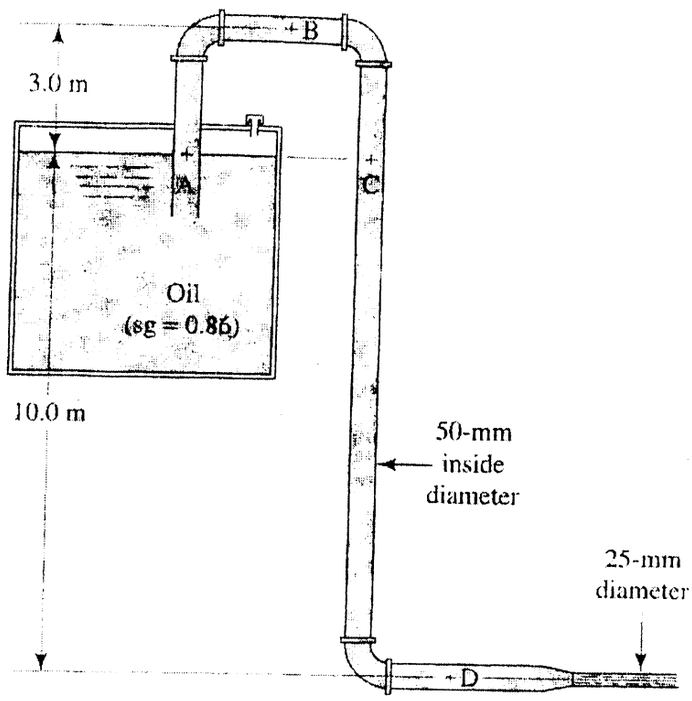
b) Give the definitions of streamline, pathline, and streakline.

c) Give the definition of circulation within a closed curve.

d) Give the definition of Reynolds number.

2. (20%)

For the siphon shown below



The following data are known:

- The fluid is oil (specific gravity sg=0.86).
- Tube inside diameter is 50 mm
- The nozzle diameter is 25 mm
- Neglect all energy losses.
- Density of water is 1000 kg/m^3

Answer the following questions:

(a) Calculate the volume flow rate of oil from the tank.

(b) Calculate the pressure at point A.

(c) Calculate the pressure at point B.

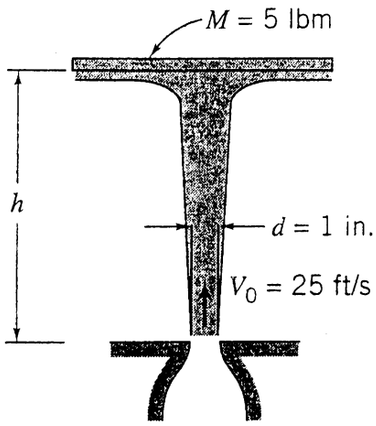
(d) Calculate the pressure at point C.

(e) Calculate the pressure at point D.

（背面仍有題目，請繼續作答）

3. (20%)

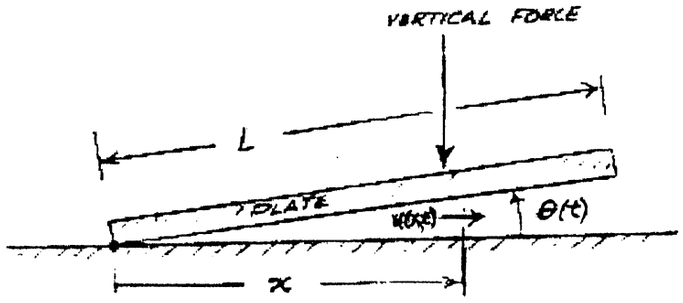
A 5 lbm disk is constrained horizontally but is free to move vertically. The disk is struck from below by a vertical jet of water. The speed and diameter of the water jet are 25 ft/s and 1 in. at the nozzle exit. Obtain a general expression for the speed of the water jet as a function of height, h. Find the height to which the disk will rise and remain stationary.



4. (20%)

Following Aristotle, we may suppose that the time of fall, t, of the dropped stone is in fact influenced by its mass. Specifically, if the falling stone is sufficiently light in weight, we expect the time of fall to be influenced by fluid resistance. Consider a sphere of diameter , d; the mass of the sphere will be contained implicitly in our list of variables by including the density ρ_s and the diameter d. The fluid resistance should depend on the viscosity μ and the fluid density ρ_f. Thus the dimensional variables are expected: height, h, d, ρ_s, ρ_f, μ, t, and acceleration of gravity, g. Determine a set of dimensionless groups that can be used to correlate data.

5. (20%)



A flat plate is hinged at one side to s smooth floor, as shown, and held at a small angle θ_o ($\theta_o << 1$) relative to the floor. The entire system is submerged in a liquid of constant density ρ At $t = 0$, a vertical force is applied and adjusted continually so that the rate of decrease of the plate angle θ remains constant at a value ω:

$$\frac{d\theta}{dt} = -\omega \ .$$

Assuming that the flow is incompressible and inviscid, derive expressions for

(a) the horizontal velocity $u(x,t)$ at point x and time t

(b) the x-direction force $F_H(t)$ exerted by the hinge on the floor. Assume the plate has negligible inertia.