※ 考生請注意：本試題不可使用計算機

**1** (20 %) When the velocity of a flow in an open rectangular channel of width $w$ is relatively large, it is possible for the flow to "jump" from a depth $h_1$ to a depth $h_2$ over a relatively short distance, as shown in Fig. 1. Let $g$ indicate the gravitational acceleration and assume that it is a horizontal uniform flow. Neglecting the drag present on the walls, please express $h_2$ in terms of $h_1$, $V_1$ and $g$.

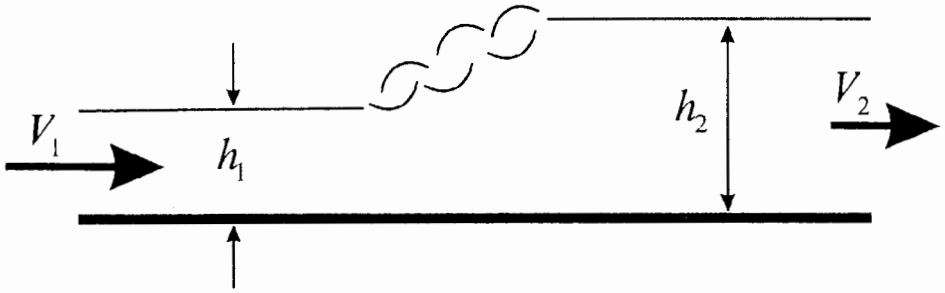


Figure 1

**2** (22%) A nonviscous, incompressible fluid flows between wedge-shaped walls into a small opening as shown in Fig. 2. The velocity potential (in $\mathrm{m^2/s}$) of the flow is given by $\phi(r) = -4 \ln r$. Please determine the volume rate of flow into the opening.

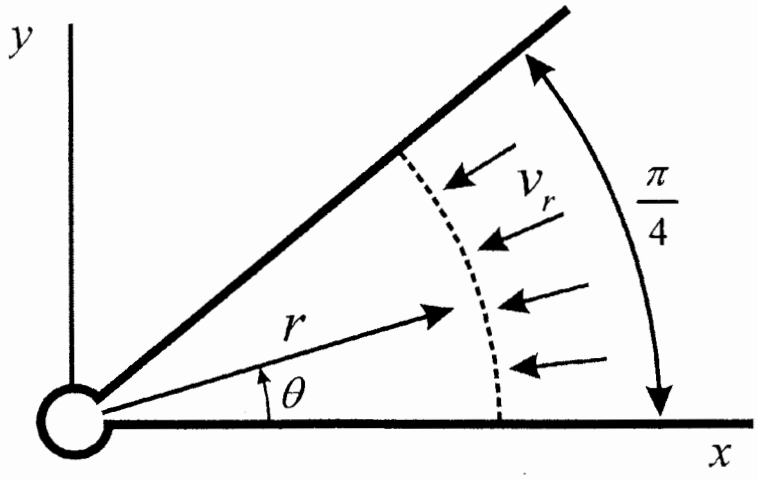


Figure 2

(背面仍有題目,請繼續作答)

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**3** (30%) Consider the viscous fluids.

(a) Letting the fluid density be denoted by $\rho$, and the dynamic viscosity by $\mu$, please write down the incompressible Navier-Stokes equations in the Cartesian coordinate system $O_{xyz}$, where the gravity points downwards along the $z$-direction. (10%)

(b) Consider a two-dimensional flow of constant density between the two horizontal, infinite parallel plates as shown in Fig. 3. For this geometry the fluid particles move in the $x$-direction parallel to the plates, and there is no velocity in the $z$-direction. Once the pressure gradient in $x$-direction is given by $A = \partial p/\partial x$ and $u = 0$ at $z = \pm h$, please determine the velocity distribution $u(z)$ in terms of $A$, $\mu$ and $h$ at steady state. (20%)

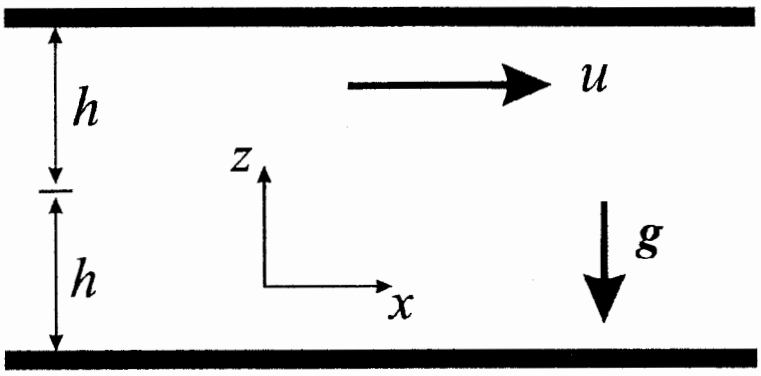


Figure 3

**4** (28%) Consider a fluid flow problem whose characteristic length is $L$, velocity $V$, density $\rho$, dynamic viscosity $\mu$, kinematic viscosity $\nu$. Let $g$ denote the gravitational acceleration.

(a) Please express the Reynolds number (5%)

(b) Please express the Froude number (5%)

(c) What is the physical meaning of Reynolds number? (5%)

(d) What is the physical meaning of Froude number? (5%)

(e) By what kind of flows you have to take into account the Froude number? Why?(8%)