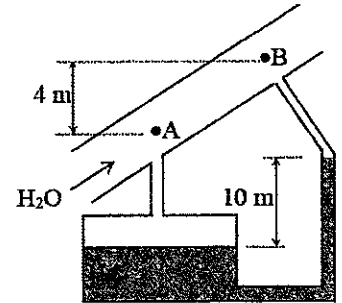


※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A differential manometer is used to measure the pressure change caused by a flow constriction in a piping system as shown below. Determine the pressure difference between points A and B in mmH₂O. The ρ_{H_2O} and ρ_{Hg} are 1000 and 13600 kg/m³, respectively. (20%)



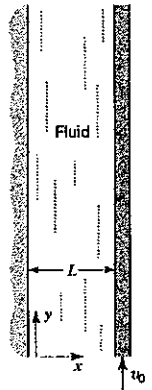
2. The power output P of a hydraulic turbine depends on the diameter D of the turbine, the density ρ of water, the height H of water surface above the turbine, the gravitational acceleration g , the angular velocity ω of the turbine wheel, the discharge Q of water through the turbine, and the efficiency η of the turbine. By dimensionless analysis, generate a set of appropriate dimensionless groups (20%)

3. Navier-Stokes equation can be shown below.

(1) Please describe the physical meaning of each term in the equation (10%)

$$\rho \frac{D\mathbf{v}}{Dt} = \rho\mathbf{g} - \nabla P + \mu \nabla^2 \mathbf{v}$$

(2) As shown in the figure (right), an incompressible fluid confined between two parallel, vertical surfaces. The left surface is stationary, whereas the other is moving upward at a constant velocity (v_0). If we consider the fluid Newtonian and the flow laminar, the governing equation of motion is the Navier-Stokes equation. Please illustrate the velocity profile. (10%)



4. A fluid flows through a pipe (radius = R) in a turbulent flow and its velocity distribution is shown as follow,

$$u = u_{\max} \left(1 - \frac{r}{R}\right)^{1/7}$$

Please calculate

(1) Average velocity (u_{ave}) (10%)

(2) Energy correction factor (α) (10%)

5. In the sudden enlargement shown in the figure (the control volume selected is indicated by the dashed line), the pressure acting at section (1) is considered uniform with value P_1 . Please derive the friction loss (20%)

$$h_f = \frac{V_1^2}{2g} \left(1 - \frac{A_1}{A_2}\right)^2$$

