國立中正大學
111學年度碩士班招生考試
試 題

[第2節]

科目名稱	流體力學
系所組別	機械工程學系-丙組

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始40分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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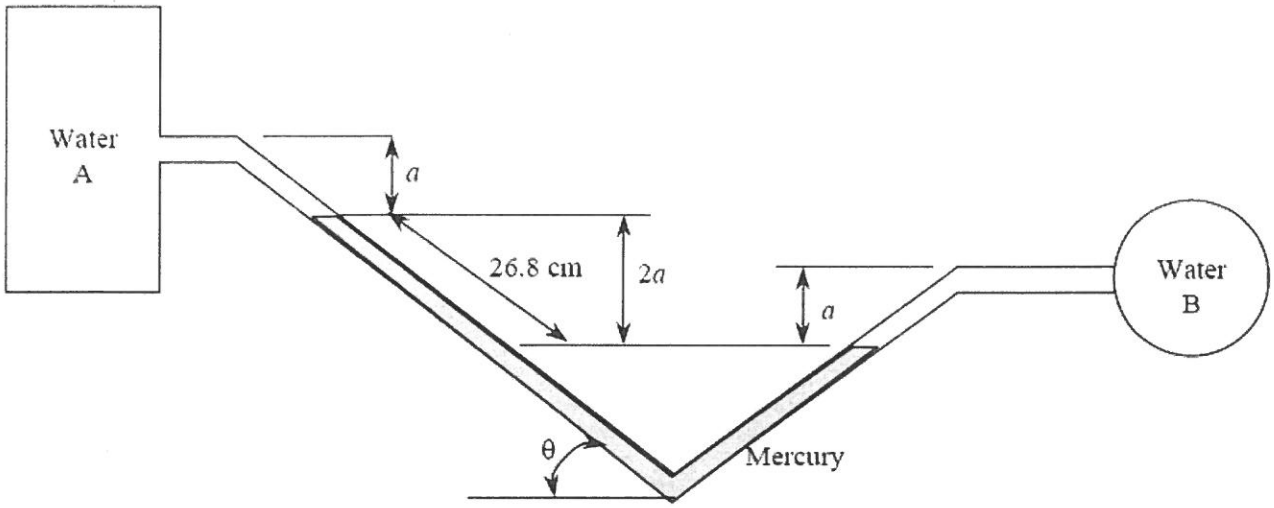
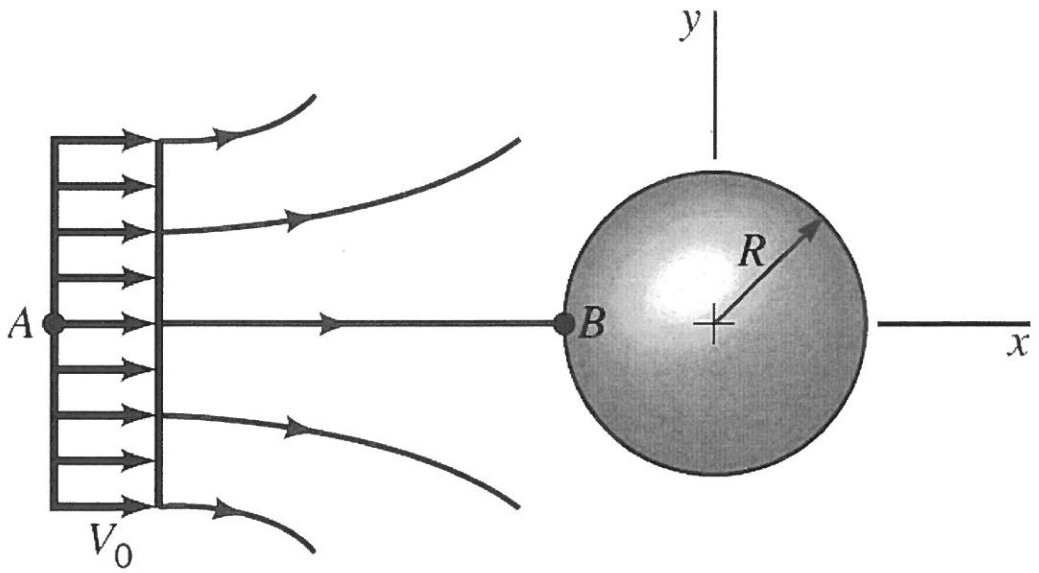
科目名稱：流體力學　　本科目共 3 頁　第 1 頁

系所組別：機械工程學系-丙組

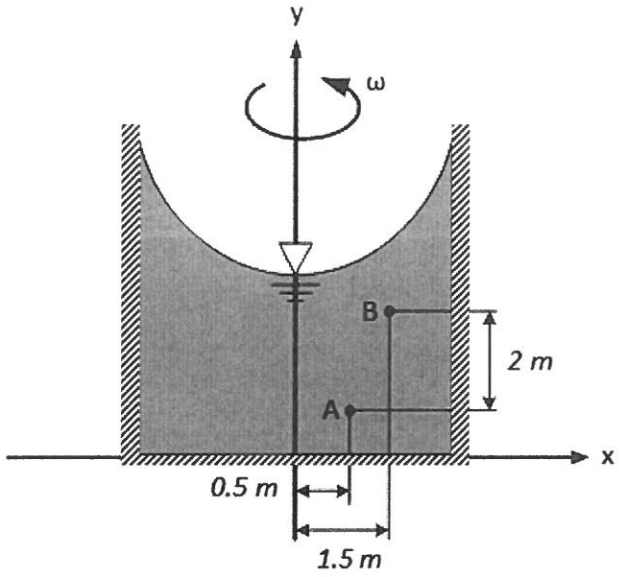
1. (15%)Two water tanks are connected to each other through a mercury manometer with inclined tubes, as shown in this figure. If the pressure difference between the two tanks is 20 kPa, calculate a and θ. Assume the density of water to be ρ=1000 kg/m^3 and the SG of Mercury is 13.6.



2. (15%)An incompressible, inviscid fluid flows steadily past a sphere of radius R as shown in the figure. According to a more advanced analysis of the flow, the fluid velocity along streamline A-B is given by $V = u(x)\hat{i} = V_0\left(1+\frac{a^3}{x^3}\right)\hat{i}$ where V_0 is the upstream velocity far ahead of the sphere. Determine the acceleration experienced by fluid particles as they flow along the streamline in terms of V_0 and a.

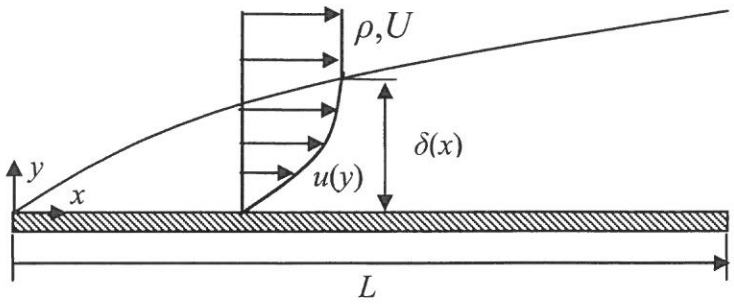


3. (20%)A cylindrical container, as shown in this figure, filled with water ($\gamma_w = 9.81\ \text{kN/m}^3$) rotates at a constant angular speed of ω. If the pressures at points A and B are equal, find the required ω of the rotation.



4. (25%)Consider the air flow past a flat plate of length L and width W with a velocity of U. Suppose that the boundary layer velocity profile is approximated as a sinusoidal function.

(Hint: Momentum integral equation: $\frac{d}{dx}(U^2\Theta)+\delta^* U\frac{dU}{dx}=\frac{\tau_w}{\rho}$)



(a) Find the velocity profile $u(y)$. (5 %)

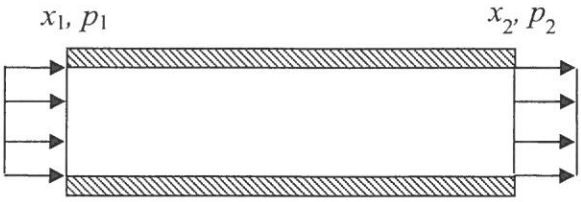
(b) Find the boundary layer displacement thickness δ^*. (5 %)

(c) Find the boundary layer momentum thickness Θ. (5 %)

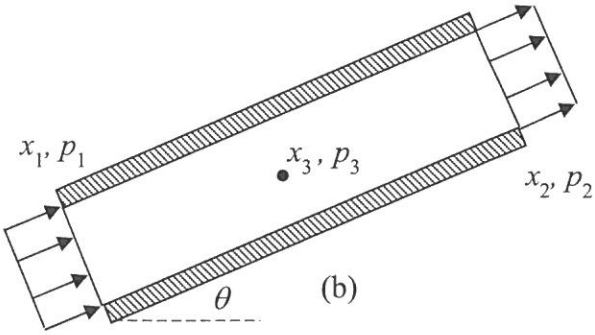
(d) Find the boundary layer momentum thickness δ. (5 %)

(e) Find the friction drag coefficient C_{Df}. (5 %)

5. (25%)An oil with a viscosity of $\mu = 0.4\ \text{N} \cdot \text{s/m}^2$ and density $\rho = 900\ \text{kg/m}^3$ flows in a pipe of diameter $D = 0.02$ m.



(a)



(b)

(a) What pressure drop, $p_1 - p_2$, is needed to produce a flowrate of $Q = 3.0\times10^{-5}\ \text{m}^3/\text{s}$ if the pipe is horizontal with $x_1 = 0$ and $x_2 = 15$ m? (10 %)

(b) How steep a hill, θ, must the pipe be on if the oil is to flow through the pipe at the same rate as in part (a), but with $p_1 = p_2$? (10 %)

(c) For the conditions of part (b), if $p_1 = 200$ kPa, what is the pressure at section x_3 =5 m, where x_3 is measured along the pipe? (5 %)