Prob. 1 (25%)

An object A connects with a plate through one rope. Water is flowing into the tank. The plate is hinged at the bottom.

(a) The plate is about to rotate clockwise, and water level in the tank is at 40cm. What is the mass of the object A in Kg?

(b) The plate is about to rotate clockwise, and water level in the tank is at 60cm. The object A is submerged fully in water. What is the mass of the object A in Kg?

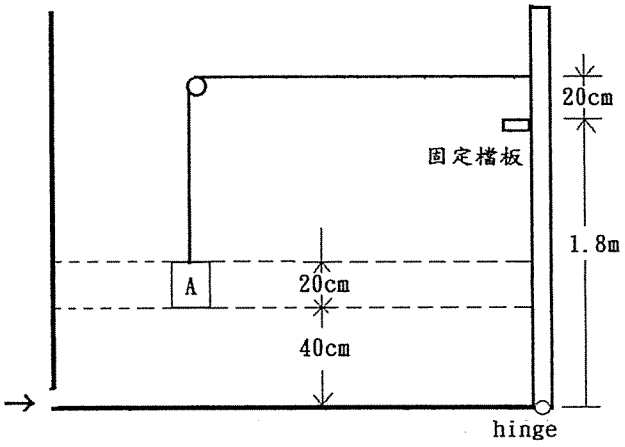

Fig. 1

Prob. 2 (25%)

A plate is pulling away from the fluid free surface. If the flow condition of the thin film on top of the plate has reached steady uniform flow and the net flow rate cross any cross section is Q upward, find the depth of the film h as a function of V, ρ and μ.

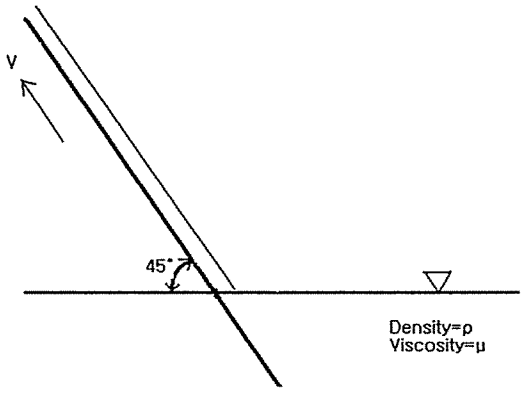

Fig 2

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Prob. 3 (25%) In order to study the force on a large water pipe by strong wind when this pipe is hanging in air, we want to do a laboratory test with small pipe. Thus, theory of models has to be used. The real pipe has a diameter of 3m and the strong wind has a speed of 60Km/hr. If the lab pipe has a diameter of 30cm and consider the pipe is infinitely long, answering

(a) (3%)What is the theory of models

(b) (3%)What is the Buckingham Pi theorem

(c) (5%)For the present pipe problem, list at least 5 variables involved in the problem

(d) (5%) Form all pi terms

(e) (6%) What is the wind speed we should use in the lab? If we measure the force on pipe is 1Nt in lab, how much is it in the real pipe.

(f) (3%) Explain why you can use the pi terms to ensure the modeling result is correct. If there is conflict, state what is your choice and why.

(Note: The fluid used is mercury ($\rho_{air}/\rho_{water}=0.0012$, and $\nu_{air}/\nu_{water}=0.018$).

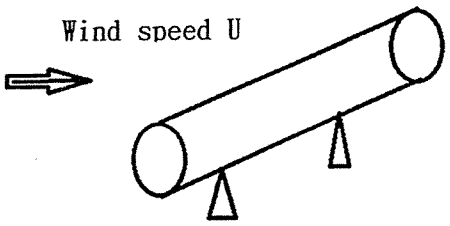

Fig. 3

Prob. 4 (25%) Water jet impact on the vertical wall of a car and car starts to move. The jet cross sectional area $A_j=20cm^2$, the flow rate is 0.2cms. Assume the car will move horizontally. Draw the control volumes for all the questions below when you answer questions. For this problem, draw your control volume moving with the car. Make sure you indicate all forces.

(a) (10%) If there is no bottom friction between car and ground, at the steady state, what is the speed of the car and what is the force exerted to the car by water jet?

(b) (15%) If the friction is 20NT, what is the speed of the car at steady state?

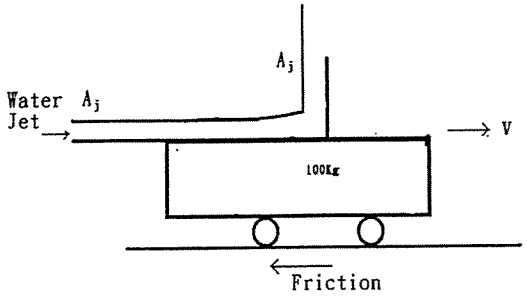

Fig. 4

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