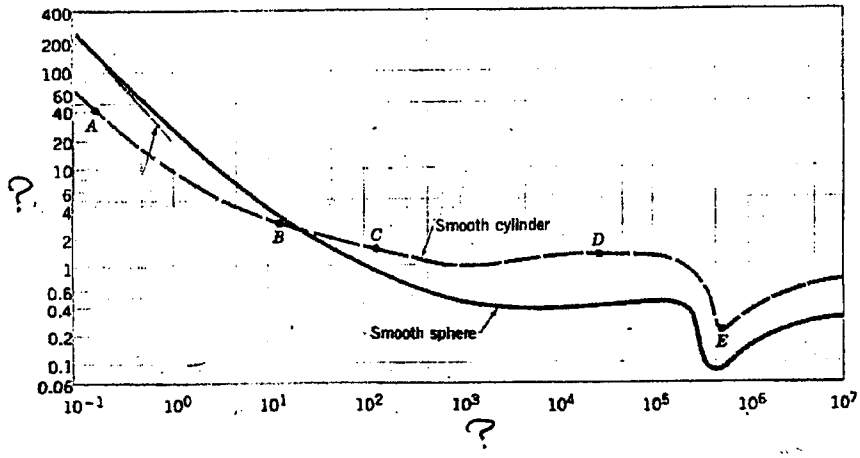
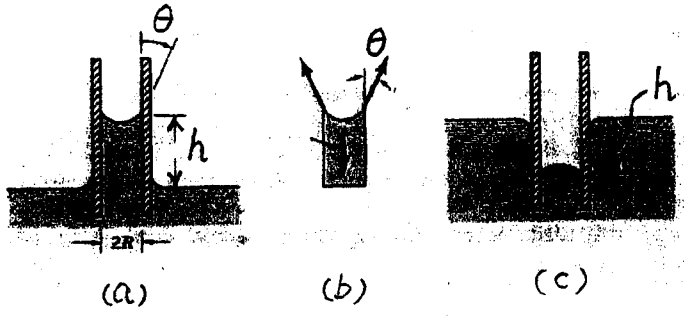
1. (20%) The following figure illustrates two special curves signifying the important flow characteristics for a uniform flow past a smooth circular cylinder and past a smooth sphere, respectively. Please describe what information they give you from the smooth cylinder curve according to different ranges of abscissa (橫座標) or those 5 points marked by the capital letters from A to E. (本題座標故意不標示)



2. (25%) The velocity components of a two-dimensional flow in the Cartesian coordinates (x, y) are given by $u = 2x^2t$ and $v = 4y(t-1) + 2x^2t$ at time t. Please (a) verify that this flow is incompressible and rotational; (b) calculate the local and convective accelerations; and (c) draw the streamline at t=2 passing through the origin and find out the value of stream function on this line.

3. (25%) When a small-diameter tube is inserted into the still water and mercury, respectively, it is seen that, as shown in Figures (a) and (c), there are two different heights inside the tube from the normal liquid surface for these two fluids. Please explain what effects cause these and why they differ from each other. If you can assume such an interface property by a constant σ, please refer to Figure (b) to derive the expression of h as the function of θ, R, γ (specific wight) and σ. Meanwhile, carry out dimensional analysis on this expression.



4. (10%) An open rectangular water tank filled in 80% of volume is fixed in a car. If this car accelerates smoothly from its rest state without disturbing the water surface badly in the tank, which side is the most possible for the water finally splashing out of the tank? Please state your reason mathematically using, e.g., Car's acceleration α, water density ρ, gravitational constant g, etc. (State the meaning for all the variables you use)

5. (10%) What are the meanings of HGL and EL ? Please write down the complete words (spelling in English) for the abbreviations. How are they defined?

6. (10%) Please sketch the boundary layer, wake or viscous influence region of a uniform flow passing by a finitely long flat plate parallel to the flow at Reynolds number $\mathrm{Re} = 0.1, 50$ and 10^6. Discuss the flow separation, flow pattern (laminar or turbulent flow) and any other characters all you know in this flow.