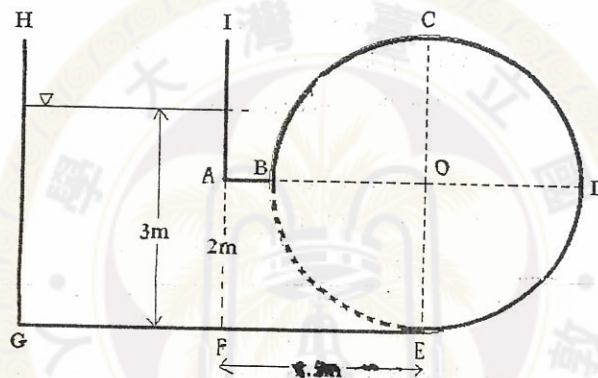


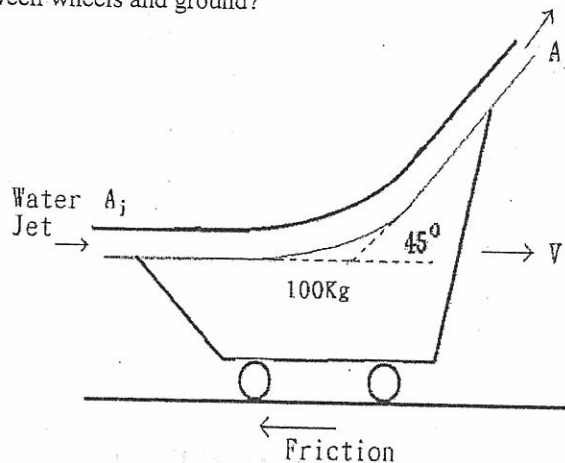
**Problem 1.** (25%) A container ABCDEFGHI is full of liquid as in figure. BCDE forms a circle with radius 2m. AB=0.5m. The density of the fluid is  $1\text{g/cm}^3$ . We only consider unit width vertical to this paper.

- (a) (5%) What is the pressure at point C? Give your answers in Head (m)
- (b) (10%) Calculate the total net force on wall EF. Give the **magnitude, direction and position** of the static force. (force in Newton)
- (c) (10%) Calculate the total net force on wall ABCDEF. Give the **magnitude, direction and position** of the total static force (force in Newton).



**Problem 2** (25%) As in figure. Water jet impact on the cart, cart starts to move. The cross section of the jet is  $A_j=0.01\text{ m}^2$ , the jet length along the cart surface is 5m, and the flow rate is 0.1cms.

- (a) (5%) Draw the control volumes for all the questions below and list equations that you shall use for this problem.
- (b) (5%) If there is no bottom friction, at the steady state, what is the speed of the cart and what is the force exerted to the cart by water jet?
- (c) (6%) If the friction is 10 Nt, what is the speed of the cart at steady state
- (d) (9%) If the cart does not move under the jet impact, what is minimum friction factor required between wheels and ground?



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**Problem 3. (25%) Dimensional Analysis**

We want to know what is the force exerted to building 101 by a strong wind. The wind speed is 100Km/hr. For this problem, let us simplify 101 building as a cylinder with radius 25m and height 500m. Now

- (a) (6%) List all variables that you think are related to this problem. List these variables under three different groups: Material characteristic, shape, force. You should list at least 6 variables and explain why they are relevant. (Note: No explanation, no point)
- (b) (4%) Find the number of  $\pi$  terms and list the repeating variables.
- (c) (6%) Find the dimensionless variables
- (d) (3%) Explain how you would do a lab experiment with a model 100 times smaller in each side.
- (e) (6%) Give the formula we can use relate the force measured in lab to the real force on building 101. Explain if there will be any difficulty in completing the task.

**Problem. 4 (25%) Potential Flow**

For a sink of strength  $M$  located close to a wall as shown in the figure.

- (a) (8%) Write down the stream function  $\psi$  and velocity potential  $\phi$  for this flow field
- (b) (10%) Draw a few (at least 2) stream lines to show the flow field
- (c) (7%) What is the pressure along the wall if  $P=P_0$  at  $y=0$  and  $x = \infty$

