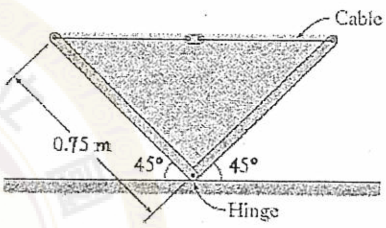
1. Consider the following steady, incompressible, two dimensional velocity field:

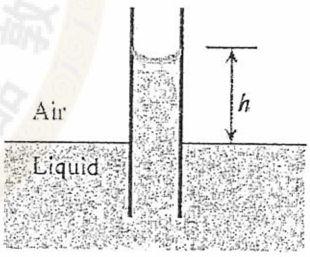
$$\vec{V} = (u, v) = (0.5 + 1.2x)\vec{i} + (-2.0 - 1.2y)\vec{j}$$

(a) Find the path line of this flow field.
(b) If a particle is at the position (x , y)=(1,6), at time t=0, find the position of this particle at time t=1.0.

2. The two sides of a V-shaped water trough are hinged to each other at the bottom where they meet, making an angle of 45° with the ground from both sides. Each side is 0.75 m wide, and the two parts are held together by a cable and turnbuckle placed every 6 m along the length of the trough. Calculate the tension in each cable when the trough is filled to the rim.



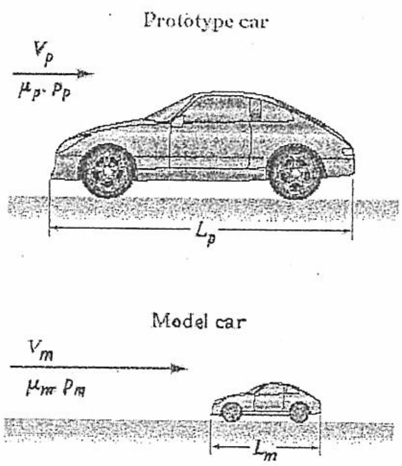
3. A 2.0 mm diameter tube is inserted into an unknown liquid whose density is 960 kg/m^3, and it is observed that the liquid rises 5 mm in the tube, making a contact angle of 15°.Determine the surface tension of the liquid.



4. If the drag force F_D of a sport car moving with constant velocity V in air is a function of air density ρ, viscosity μ and its size,(characteristic length), L, i.e.

$$F_D = f(V, L, \rho, \mu)$$

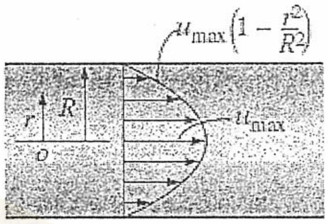
The drag force of a new sport car is to be predicted at a speed of *360 km/hr*. Automotive engineers build a *1/5* scale model of the car to test in a water tunnel, Determine how fast the model car should be run in the water tunnel in order to achieve similarity between the model and the prototype. If the drag force at this water tunnel testing speed is measured to be 2.0 N, and the length of the prototype is L_p=3.8 m. What is the drag force of the prototype?



$\rho_{air} = 1.2\, kg/m^3$; $\mu_{air} = 1.85\times10^{-5} kg/(m\cdot s)$

$\rho_{water} = 1.0\times10^3\, kg/m^3$; $\mu_{water} = 1.0\times10^{-3} kg/(m\cdot s)$

5. In regions far from the entrance, fluid flow through a circular pipe is one-dimensional, and the velocity profile for laminar flow is given by $u = u_{max}(1-\frac{r^2}{R^2})$, where R is the radius of the pipe, r is the radial distance from the center of the pipe, and u_{max} is the maximum flow velocity, which occurs at the center. Determine



(*a*) a relation for the drag force applied by the fluid on a section of the pipe of length L..

(b) the value of the drag force for water flow at 20°C with $R = 0.08\, m$, $L = 15\, m, u_{max} = 3\, m/s$ and $\mu = 0.001 kg/m\cdot s$