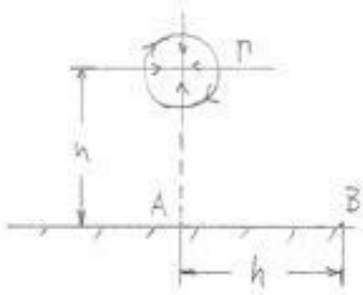
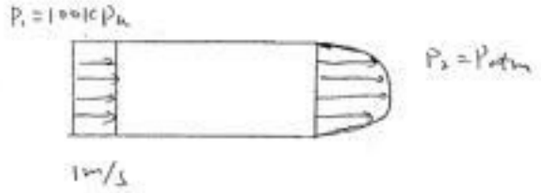
1. A free vortex with a circulation Γ and a sink with a flow rate m are place at a height h above a solid plane. Assuming inviscid flow, determine a) the flow velocity at points A and B; b) the difference between the pressures at the points. (25 points).



2. Water flows through a circular pipe of 0.2m in diameter. The velocity at the inlet is uniform at 1m/s. The velocity at the outlet is parabolic: $u(r)=2(m/s)(1-(r/R)^2)$. The pressure at the inlet is 100kPa. The outlet is at atmospheric pressure. Determine the force needed to hole the pipe in place. (25 points)



3. The lift force F of a flying missile depends on its length, L, diameter, D, velocity, U, angle of attack, α, air density, ρ, viscosity, μ, and the speed of sound, a. Find a non-dimensional form of the relationship (with the Pi term containing F as the dependent variable). (25 points).

4. Fluid with a viscosity μ and density ρ flows between two vertical parallel planes moving at velocities U_1 and U_2, respectively. A pressure gradient (dp/dz) is applied in the direction of the flow. Starting from the Navier-Stokes equation, determine the velocity profile. (25 points)