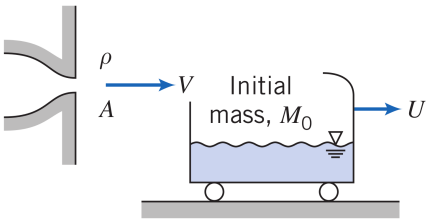
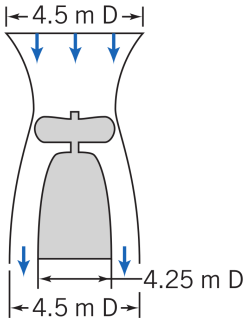
# Evaluated Homework (Due date: 27th Oct in class)
# Late submission incurs 100% penalty (no excuses)
# Plagiarism will be dealt with harshly

*AE 225, Autumn 2017, IITB Aerospace Engineering*

1. (5 points) The tank shown rolls with negligible resistance along a horizontal track. It is to be accelerated from rest by a liquid jet that strikes the vane and is deflected into the tank. The initial mass of the tank is $M_0$. Use the continuity and momentum equations to show that at any instant the mass of the vehicle and liquid contents is $M = M_0V/(V-U)$. Obtain a general expression for $U/V$ as a function of time.




2. (5 points) The total mass of the helicopter-type craft shown is 1000 kg. The pressure of the air is atmospheric at the outlet. Assume the flow is steady and one-dimensional. Treat the air as incompressible at standard conditions and calculate, for a hovering position, the speed of the air leaving the craft and the minimum power that must be delivered to the air by the propeller.




3. (10 points) Write out the incompressible Navier-Stokes equation in cylindrical coordinates. Starting from this, derive the expression for the velocity field and the wall shear stress on both walls in the cylindrical Couette flow. The inner cylinder (of radius $R_1$) is rotating with speed $\omega_1$, and the outer cylinder (of radius $R_2$) is rotating with speed $\omega_2$. Assume that axis is vertical in the graviational field of the earth, and there is no flow in axial direction.

4. (30 points) Write a computer code to compute and plot the streamlines and equipotential lines for the potential flow over a cylinder with circulation. The code can be in any computer language of your choice. Recreate the figures in your textbooks for circulation values resulting in (a) two stagnation points, (b) one stagnation point and (c) no stagnation points on the cylinder surface. Also generate the figure with no circulation. You must not have any streamlines/equipotentials within the cylinder.

   Notes:

   - YOU SHOULD NOT USE THE CONTOUR FUNCTION OF MATLAB, OR ITS EQUIVALENT IN OTHER PROGRAMMING LANGUAGES
   - Instead, you should calculate the appropriate points on the streamlines/equipotential lines by solving the applicable equations. The solution can be done by `fzero`/`fsolve` in MATLAB, or its equivalent in your chosen programming language. You may also write your own Newton-Raphson routine.
   - You must submit your code listing, including the code used to generate all the 4 figures, in hard copy.
   - No marks will be given if final figures are not supplied.
   - Try to make your code efficient – in particular, it shouldn't take more than a minute to run on a standard computer.
   - An example MATLAB code is provided for the case of a source and a sink of equal strength placed some distance apart.