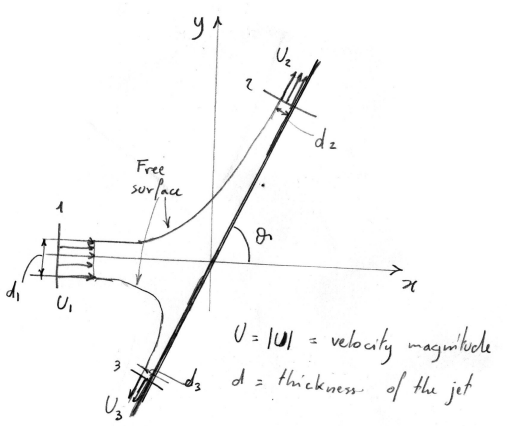
February 2nd 2014

Fluid dynamics

Problem

Let us consider the jet shown in the figure, which hits an inclined, flat, rigid wall.

Using the assumptions listed below compute the force per unit length (x and y components) that the jet exerts on the wall.



Assumptions:

- The flow is two-dimensional in the (x, y) plane.
- The flow is steady.
- Neglect the role of gravity.
- Neglect the effect of viscosity (no friction between the fluid and the wall and no dissipation of mechanical energy).
- Assume that the velocity is uniformly distributed in the inflow (1) and outflow (2 and 3) cross-sections.

Hints for the solution:

- Use the momentum equation in integral form.
- Use the Bernoulli equation to determine the relationship between U_1, U_2 and U_3.
- Use the continuity equation to determine the thickness of the two outflow jets d_2 and d_3.

Theoretical question

Derive the Reynolds transport theorem and show an example of its application in fluid mechanics.