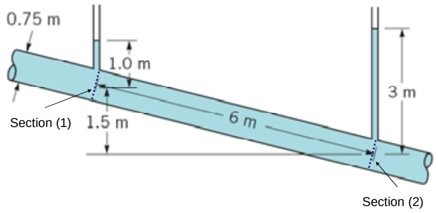
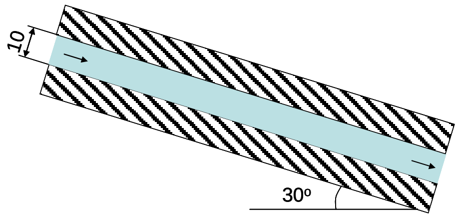
Exam Lab-on-Chip, 6/06/2008.

1. Assume that the drag on a small sphere placed in a rapidly moving stream of fluid depends on the fluid density but not the fluid viscosity. Using dimensional analysis determine how the drag is affected if the velocity of the fluid is doubled.

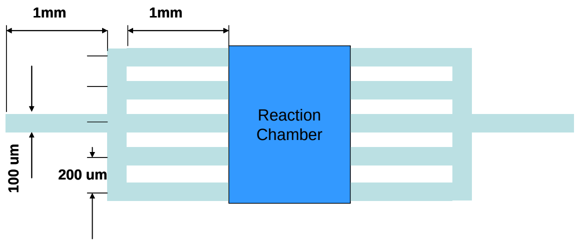
2. Water flows steadily through the inclined pipe as indicated in the Figure. Determine the following:
(a) the difference in pressure p_1-p_2;
(b) water flow direction and velocity;
(c) the axial and normal force exerted by the pipe wall on the flowing water between sections (1) and (2).



3. Two infinite parallel plates spaced 10 mm apart are inclined by 30 deg. Water flows between the plates with the volume rate of 5 m^2/s (per unit width of the plate). Using Navier-Stokes equation determine:
(a) the pressure drop per unit length
(b) shear stress acting on the lower plane
(c) velocity along the centerline of the channel



4. To achieve a more uniform flow distribution across the microfluidic reaction chamber you have introduced an extra circuit shown in the figure. The height of all channels – 50um, the width - 100 um (see the Figure). Estimate the extra flow resistance introduced by the circuit (i.e. neglecting flow resistance of the reaction chamber). Assume that fully developed laminar flow in all channels. What extra pressure drop will it cause at the flow rate of 20ul/min.



5. You want to distribute 30 nm diameter gold nanoparticles equally between two streams A and B using an H-cell (channel height - 50um, channel width - 50um, contact zone length 20 mm). Estimate the maximal volume flow rate you can use. Suggest how you will modify the device to improve the throughput.