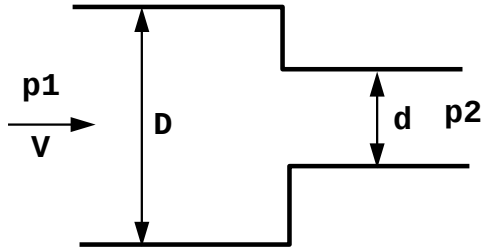
DIMENSIONAL ANALYSIS

3.1) Experiments show that the pressure drop dow to flow through a sudden contraction in a circular duct may be expressed as

$$\Delta p = p_1 - p_2 = f(\rho, \mu, V, d, D)$$

where the geometric variables are defined in the figure. Using ρ, V and D as repeating variables, express the pressure drop in terms of non-dimensional quantities.



3.2) The velocity V of a free surface gravity wave in deep water is a function of wavelength λ, depth D, water density ρ and the acceleration of gravity g. Use dimensional analysis to find the functional dependency of V on the other variables. Choose ρ, D and g as repeating variables. Express V in the simplest form possible.

3.3) The drag on an airfoil at zero angle of attack is a function of the flow density, viscocity and velocity, in addition to a length parameter. A 1:10 scale model of an airfoil was tested in a wind tunnel at a Reynolds number of 5.5×10^6, based on chord length. Test conditions in the wind tunnel air stream were 60F and 140 psi. The prototype airfoil has a chord length of 6 ft and it is to be flown in air at 60F, 14 psi. Determine:
a) The velocity at which the wind tunnel model was tested.
b) The corresponding prototype velocity.

3.4) A disc of radius R rotates with angular velocity ω near a fixed surface separated by a distance h. The space in between is filled with a fluid of viscocity μ. Find the dependence between the torque on the disc τ and the other variables.