Homework 7

Questions: 7.10, 7.14, 7.20, 7.24 and 7.38

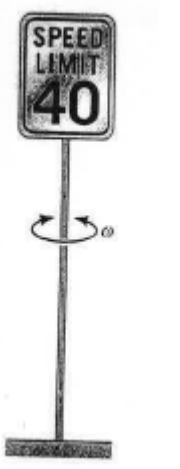
0) Please send your group video to Diogo via email. If you've already done so great!

1) The pressure drop Δp, across a pump can be expressed as

$$\Delta p = f(D, \rho, \omega, Q)$$

Where D is the impeller diameter, ρ the fluid density, ω the rotational speed and Q the volume flowrate. Determine a suitable set of dimensionless parameters.

2) Under certain conditions, wind blowing past a rectangular speed limit sign can cause the sign to oscillate with a frequency ω (see figure below). Assume that ω is a function of the sign width b, sign height h, wind velocity, V, air density ρ, and an elastic constant, k (dimensions of Force x Length). Develop a suitable set of pi terms for this problem.



3) The buoyancy force F_B, acting on a body submerged in a fluid is a function of the specific weight , γ, of the fluid and the volume V, of the body. Show by dimensional analysis that the force must be directly proportional to the specific weight.

4) A liquid flows with a velocity V through a hole in the side of a large tank. Assume that

$$\mathbf{V=f(h,g,\rho,\sigma)}$$

where h is the depth of fluid above the hole, g is acceleration due to gravity, ρ is the fluid density and σ is the surface tension. The following data were obtained by changing h and measuring V, with a fluid density 1000 kg/m^3 and surface tension = 0.074 N/m

V(m/s)	3.13	4.43	5.42	6.25	7.00
h(m)	0.50	1.00	1.50	2.00	2.50

Plot these data by using appropriate dimensionless variable. Could any of the original variables have been omitted?

5) The drag , D, on a sphere located in a pipe through which a fluid is flowing is to be determined experimentally (see figure). Assume that the drag is a function of the sphere diameter, d, the pipe diameter, D, the fluid velocity, V, and the fluid density, ρ.

(a) What dimensionless parameters would you use for this problem?

(b) Some experiments using water indicate that for d=0.2 in, D=0.5 in and V=2 ft/s the drag is 1.5 x 10^{-3} lb. If possible estimate the drag on a sphere located in a 2 ft diameter pipe through which water is flowing with a velocity of 6 ft/s. The sphere diameter is such that geometric similarity is maintained. If it is not possible, explain why not.

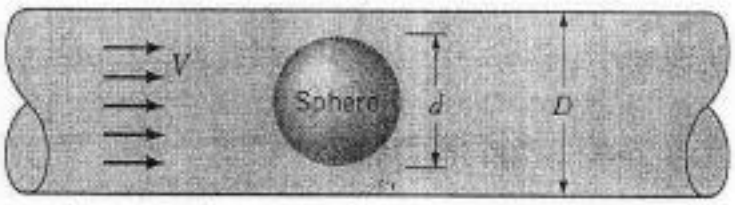


FIGURE P7.38