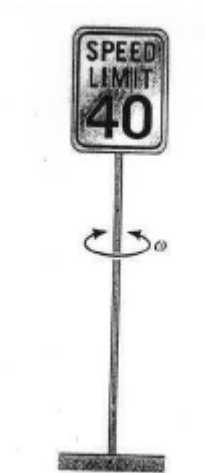


Homework 8 – Due April 24

Questions: 7.12, 7.14, 7.20, 7.24 and 7.38

1) At a sudden contraction in a pipe the diameter changes from D_1 to D_2 . The pressure drop Δp , which develops across the contraction is a function of D_1 and D_2 as well as velocity, V , in the larger pipe, and the fluid density, ρ , and viscosity, μ . Use D_1 , V and μ as repeating variable to determine a suitable set of dimensionless parameters. Why would it be incorrect to include the velocity in the smaller pipe as an additional variable?

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

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

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 $= 0.074 \text{ N/m}$

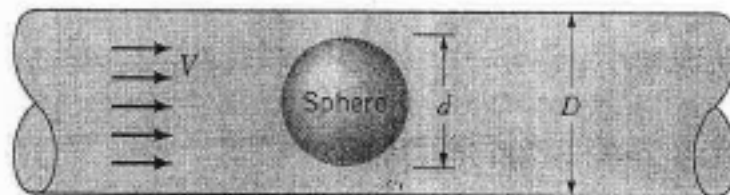
$V(\text{m/s})$	3.13	4.43	5.42	6.25	7.00
$h(\text{m})$	0.50	1.00	1.50	2.00	2.50

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

5) The drag, \mathcal{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 $d=0.2 \text{ in}$, $D=0.5 \text{ in}$ and $V=2 \text{ ft/s}$ the drag is $1.5 \times 10^{-3} \text{ lb}$. 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