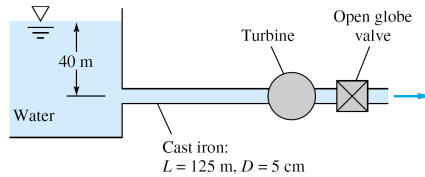


Name: \_\_\_\_\_

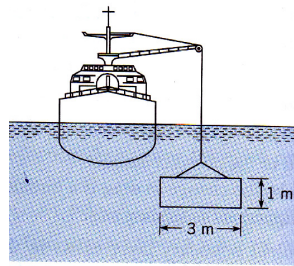
Fluid I.D. : \_\_\_\_\_

(Each problem has 20 points)

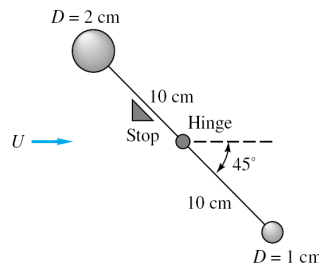
- 1) Water at  $20^{\circ}\text{C}$  flows in a 9 cm diameter pipe under fully developed turbulent flow conditions. The wall shear stress is 122Pa. (a) By using Log Law, find the centerline velocity  $V_c$ , (b) flow rate  $Q$ , (c)  $\Delta p$  for a 100 m pipe length.
- 2) In the figure below, the pipe entrance is sharp-edged. If the flow rate is  $0.004\text{m}^3/\text{s}$ , what power, in W, is extracted by turbine to exhaust flow to the air?



- 3) A thin plastic panel (3 mm thick) is lowered from a ship to a construction site on the ocean floor. The plastic panel weighs 500 N in air and is lowered at a constant rate of 6m/s. Assuming that the panel remains vertically oriented, calculate the tension in the cable. ( Note: Buoyancy is not negligible)



- 4) Two steel balls (SG=7.86) are connected by a thin hinged rod of negligible weight and drag in vertical plane. A stop prevents counter clockwise rotation. Estimate the air velocity  $U$  for which the rod will first begin to rotate clockwise.



- 5) It is desired to simulate flow past a bump by using streamline above the flow over a cylinder. The bump is to be  $a/3$  high, as shown in the figure. What is the proper elevation  $h$  of this streamline? What is  $U_{\max}$  on the bump compared to  $U_{\infty}$ ?

