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1. A cube, 4 ft on a side, weights 3,000 lb and floats half-submerged in an open tank as shown in Fig. 1. For a liquid depth of 10 ft, determine (a) the specific weight of the liquid, $\gamma$, (b) the force of the liquid on the inclined section *AB* of the tank wall, $F_R$, and (c) the location of the pressure center from the free surface, $y_R$, along the inclined wall. The width of the wall is 8 ft. (Note: $I_{xc} = ab^3/12$ for a rectangle with base $a$ and height $b$)

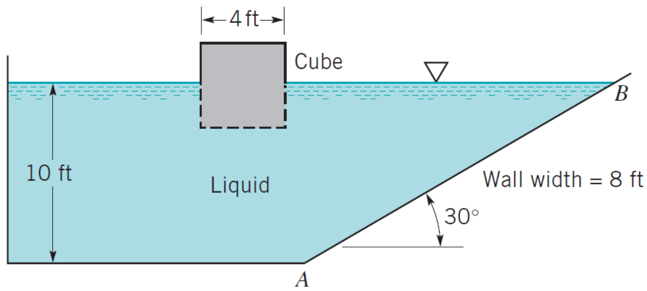


Fig 1

2. In Fig. 2, water ($\gamma = 9{,}790\ \mathrm{N/m^3}$) exits from a nozzle into atmospheric pressure, $p_{atm}$. The manometer fluid has a specific gravity of *SG* = 13.56 and the reading is $h$ = 58 cm. With *friction neglected*, what is (a) the upstream pressure at section 1, $p_1$, (b) the average velocity at sections 1 and 2, $V_1$ and $V_2$, respectively, and (c) the axial flange force, $F_x$, required to keep the nozzle attached to pipe (1)?

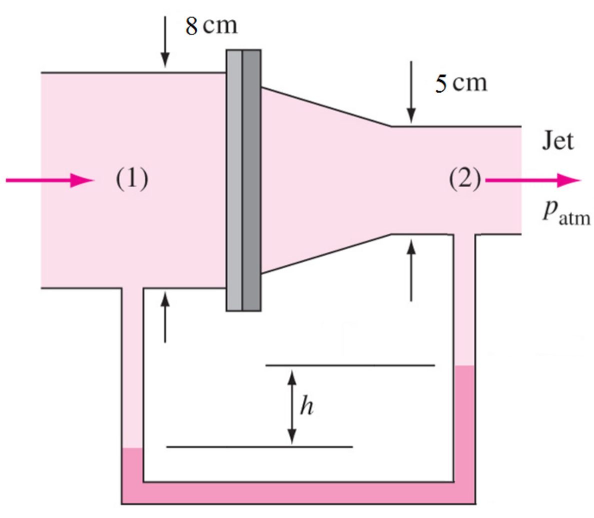


Fig 2

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3. The drag on a 30-ft long, vertical, 1.25-ft-diameter pole subjected to a 30-mph (44 ft/s) wind ($\rho = 2.38 \times 10^{-3}$slugs/ft$^3$ and $\mu = 3.74 \times 10^{-7}$ lb $\cdot$ s/ft$^2$) is to be determined with a model study. It is expected that the drag, $D$, is a function of the pole length, $l$, and diameter, $d$, the fluid density, $\rho$, and viscosity, $\mu$, and the fluid velocity, $V$; in a dimensionless functional form

$$\frac{D}{\rho V^2 d^2} = \phi\left(\frac{d}{l}, \frac{\rho V d}{\mu}\right)$$

Laboratory model tests were performed in a high-speed water ($\rho = 1.94$ slugs/ft$^3$ and $\mu = 2.34 \times 10^{-5}$ lb $\cdot$ s/ft$^2$) tunnel using a model pole having a length of 2 ft and a diameter of 1in. Some model drag data are shown in Fig. 3. Based on these data, predict the drag on the full-sized pole.

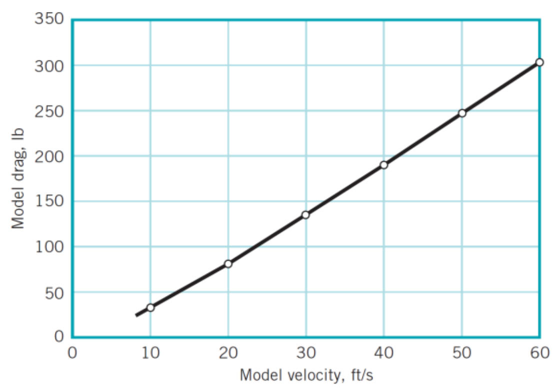


Fig 3

4. Water ($\rho = 999$ kg/m$^3$ and $\mu = 1.12 \times 10^{-3}$ N $\cdot$ s/m$^2$) drains from a large tank through a pipe system as shown in Fig. 4. The head of the turbine is equal to 116 m. If entrance effects are negligible, determine the flow rate, $Q$. Use the following equation for friction factor.

$$\frac{1}{\sqrt{f}} = -1.8 \log\left[\left(\frac{\varepsilon/D}{3.7}\right)^{1.1} + \frac{6.9}{Re}\right]$$

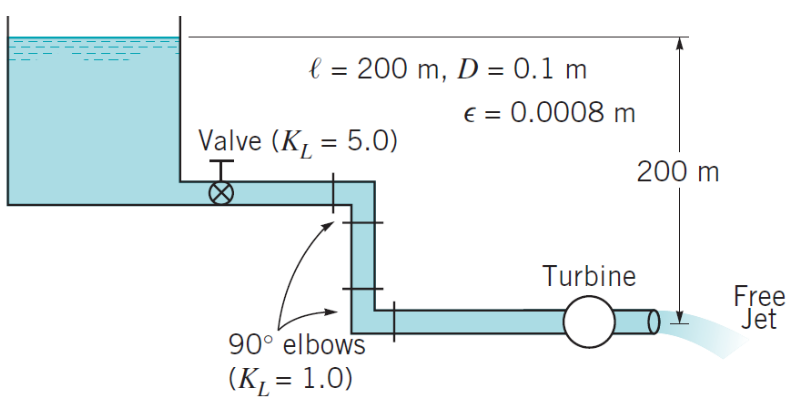


Fig 4

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5. A pizza store has a delivery car with a sign attached. The sign (a flat plate) has a height $H$ = 1.5 ft and a length $L$ = 5 ft. Calculate the drag $D$ (in lbf) on the sign *alone* at a speed $V$ = 40 mph (58.7 ft/s) when the sign is placed (a) parallel to the wind (Fig. 5 left) and (b) facing (or normal to) the wind (Fig. 5 right). For the parallel orientation case assume the flow is initially laminar and for the blunt (normal orientation) case use a drag coefficient of $C_D = 1.2$. (Note: $\rho = 2.38 \times 10^{-3}$ slugs/ft$^3$ and $\mu = 3.74 \times 10^{-7}$ lb $\cdot$ s/ft$^2$ for air and $Re_{trans} = 5 \times 10^5$)

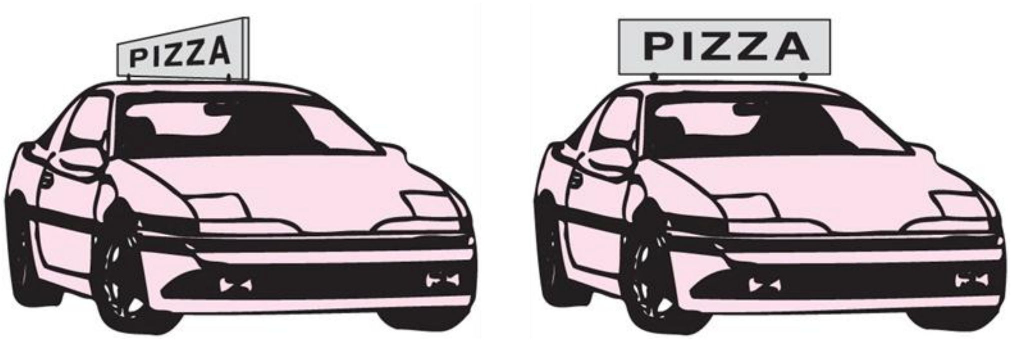


Fig 5

6. A buoyant ball of specific gravity $SG$ = 0.5 is released free from the bottom of a calm water as shown in Fig. 6. How long time will it take for the ball to reach to the water surface if the ball diameter $D$ = 10 cm and the water depth $h$ = 10 m? Assume a constant drag coefficient $C_D = 0.5$ and neglect the initial transient state such that the ball rises up at a constant velocity (the terminal velocity), $V$, from the beginning. (Note: $\rho = 999$ kg/m$^3$ and $\mu = 1.12 \times 10^{-3}$ N $\cdot$ s/m$^2$ for water; Volume of a sphere $\forall = \pi D^3/6$)

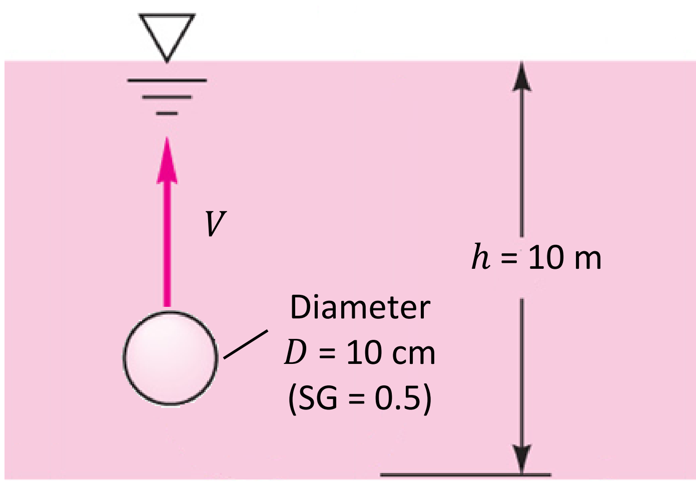


Fig 6