Frank M. White

# Fluid Mechanics

THIRD EDITION

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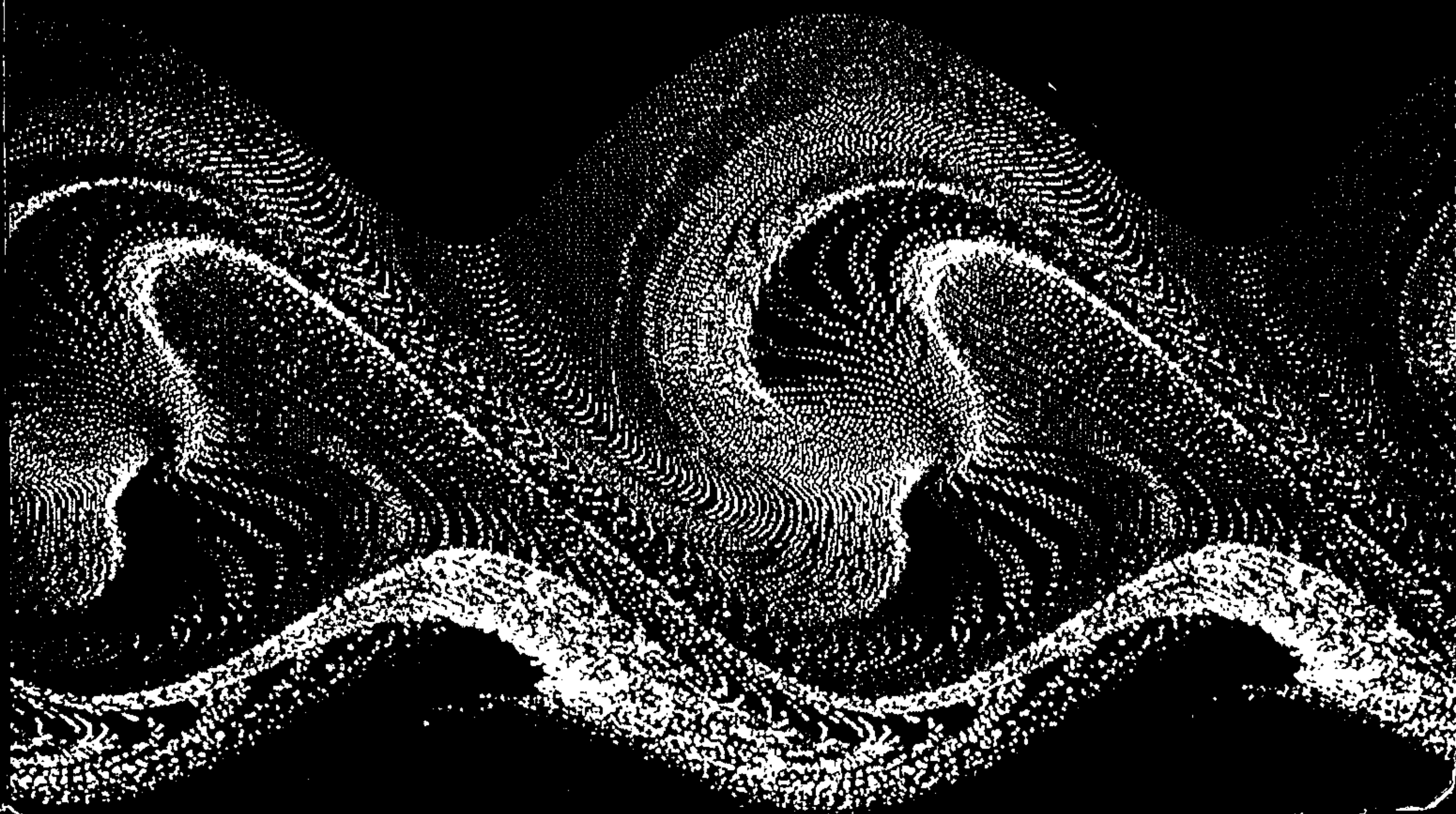

**FLUID MECHANICS**



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be adjusted to any small exit area. Assuming no losses, if the hose jet is to reach the garden, what minimum gage pressure is required at the faucet?

**3.160** The air-cushion vehicle in Fig. P3.160 brings in sea-level standard air through a fan and discharges it at high velocity through an annular skirt of 3-cm clearance. If the vehicle weighs 50 kN, estimate (*a*) the required airflow rate and (*b*) the fan power in kW.

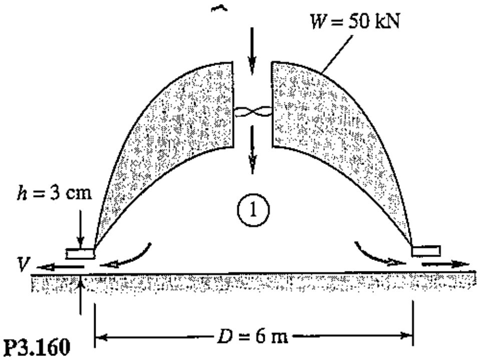


**Fig. P3.160**

**3.161** A necked-down section in a pipe flow, called a *venturi*, develops a low throat pressure which can aspirate fluid upward from a reservoir, as in Fig. P3.161. Using Bernoulli's equation with no losses, derive an expression for the velocity $V_1$ which is just sufficient to bring reservoir fluid into the throat.

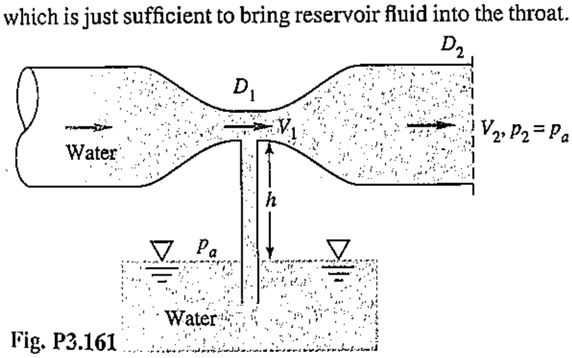


**Fig. P3.161**

**3.162** The solution to Prob. 3.102 is

$$h_2 = \frac{1}{2} h_1 \left[ \left( 1 + \frac{8V_1^2}{gh_1} \right)^{1/2} - 1 \right]$$

Show that Bernoulli's equation, when applied between sections 1 and 2, does *not* give this result. Then derive an expression for the head loss $h_f$ for a hydraulic jump.

**3.163** The liquid in Fig. P3.163 is kerosine at 20°C. Estimate the flow flow rate from the tank for (*a*) no losses and (*b*) pipe losses $h_f \approx 4.5V^2/(2g)$.

**3.164** In Fig. P3.164 all fluids are at 20°C. Compute the exit mass flow of water in lbm/s for (*a*) no losses and (*b*) pipe losses $h_f \approx 2.5V^2/(2g)$.

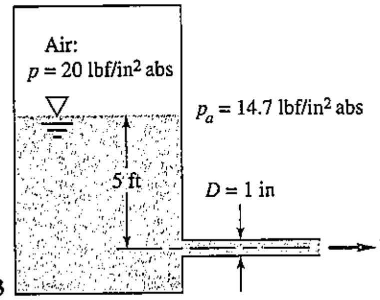


**Fig. P3.163**

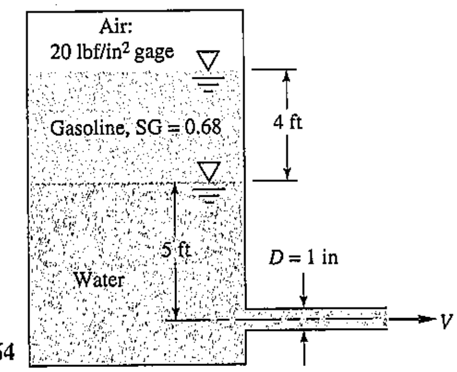


**Fig. P3.164**

**3.165** A *venturi meter*, shown in Fig. P3.165, is a carefully designed constriction whose pressure difference is a measure of the flow rate in a pipe. Using Bernoulli's equation for steady incompressible flow with no losses, show that the flow rate $Q$ is related to the manometer reading $h$ by

$$Q = \frac{A_2}{\sqrt{1 - (D_2/D_1)^4}} \sqrt{\frac{2gh(\rho_M - \rho)}{\rho}}$$

where $\rho_M$ is the density of the manometer fluid.

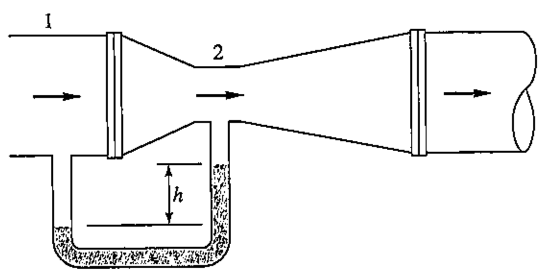


**Fig. P3.165**

**3.166** An open-circuit wind tunnel draws in sea-level standard air and accelerates it through a contraction into a 1-m by 1-m test section. A differential transducer mounted in the test section wall measures a pressure difference of 45 mm of water between the inside and outside. Estimate (*a*) the test section velocity in mi/h and (*b*) the absolute pressure on the