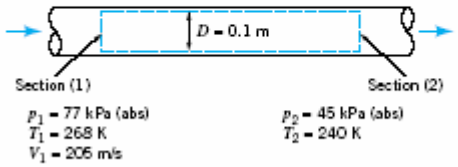
Franklin W. Olin College of Engineering
ENGR 3310: Transport Phenomena

Problem Set 2

Assigned: 9/16/04 Fall 2004
Due: 9/23/04 by 5:00 pm

Problem 1:

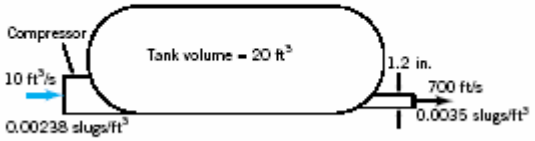
5.4 Air flows steadily between two cross sections in a long, straight section of 0.1-m inside-diameter pipe. The static temperature and pressure at each section are indicated in Fig. P5.4. If the average air velocity at section (1) is 205 m/s, determine the average air velocity at section (2).



■ FIGURE P5.4

Problem 2:

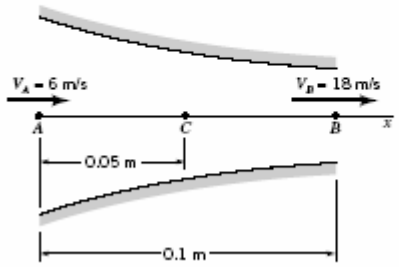
5.15 Air at standard conditions enters the compressor shown in Fig. P5.15 at a rate of 10 ft^3/s. It leaves the tank through a 1.2-in.-diameter pipe with a density of 0.0035 $slugs/ft^3$ and a uniform speed of 700 ft/s. (a) Determine the rate (slugs/s) at which the mass of air in the tank is increasing or decreasing. (b) Determine the average time rate of change of air density within the tank.



■ FIGURE P5.15

Problem 3:

4.21 The fluid velocity along the x axis shown in Fig. P4.21 changes from 6 m/s at point A to 18 m/s at point B. It is also known that the velocity is a linear function of distance along the streamline. Determine the acceleration at points A, B, and C. Assume steady flow.



■ FIGURE P4.21

Problem 4:

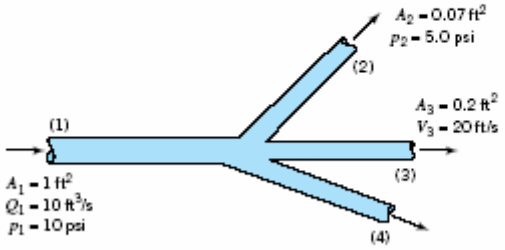
3.22 A person holds her hand out of an open car window while the car drives through still air at 65 mph. Under standard atmospheric conditions, what is the maximum pressure on her hand? What would be the maximum pressure if the "car" were an Indy 500 racer traveling 220 mph?

Problem 5:

3.24 A 40-mph wind blowing past your house speeds up as it flows up and over the roof. If elevation effects are negligible, determine (a) the pressure at the point on the roof where the speed is 60 mph if the pressure in the free stream blowing toward your house is 14.7 psia. Would this effect tend to push the roof down against the house, or would it tend to lift the roof? (b) Determine the pressure on a window facing the wind if the window is assumed to be a stagnation point.

Problem 6:

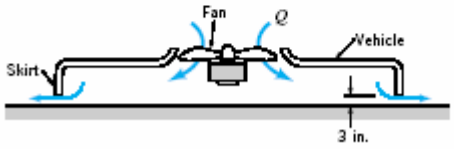
3.82 Water flows through the horizontal branching pipe shown in Fig. P3.82 at a rate of 10 ft^3/s. If viscous effects are negligible, determine the water speed at section (2), the pressure at section (3), and the flowrate at section (4).



■ FIGURE P3.82

Problem 7:

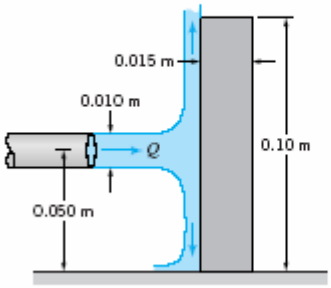
3.88 An air cushion vehicle is supported by forcing air into the chamber created by a skirt around the periphery of the vehicle as shown in Fig. P3.88. The air escapes through the 3-in. clearance between the lower end of the skirt and the ground (or water). Assume the vehicle weighs 10,000 lb and is essentially rectangular in shape, 30 by 50 ft. The volume of the chamber is large enough so that the kinetic energy of the air within the chamber is negligible. Determine the flowrate, Q, needed to support the vehicle. If the ground clearance were reduced to 2 in., what flowrate would be needed? If the vehicle weight were reduced to 5000 lb and the ground clearance maintained at 3 in., what flowrate would be needed?



■ FIGURE P3.88

Problem 8:

5.29 A 10-mm diameter jet of water is deflected by a homogeneous rectangular block (15 mm by 200 mm by 100 mm) that weighs 6 N as shown in Video V5.4 and Fig. P5.29. Determine the minimum volume flowrate needed to tip the block.



■ FIGURE P5.29