Problem Set II – December 2019

Some of the problems given out in this problem set were compiled from the following book:

Fluid Mechanics – Fundamentals and Applications

3rd Ed. Yunus A. Çengel and John M. Cimbala

1.

**5–118** A wind tunnel draws atmospheric air at 20°C and 101.3 kPa by a large fan located near the exit of the tunnel. If the air velocity in the tunnel is 80 m/s, determine the pressure in the tunnel.

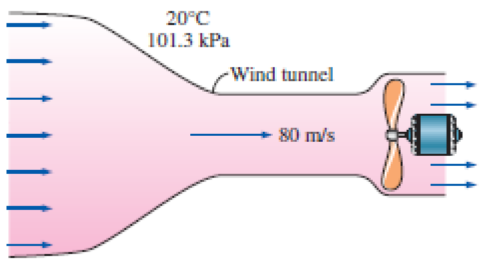



**FIGURE P5–118**

2.

**5–106** A very large tank contains air at 102 kPa at a location where the atmospheric air is at 100 kPa and 20°C. Now a 2-cm-diameter tap is opened. Determine the maximum flow rate of air through the hole. What would your response be if air is discharged through a 2-m-long, 4-cm-diameter tube with a 2-cm-diameter nozzle? Would you solve the problem the same way if the pressure in the storage tank were 300 kPa?

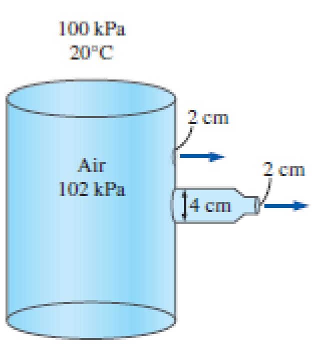



**FIGURE P5–106**

3.

**5–104** Air flows through a pipe at a rate of 120 L/s. The pipe consists of two sections of diameters 22 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height of water between the two pipe sections. Take the air density to be 1.20 kg/m$^3$. *Answer:* 1.37 cm

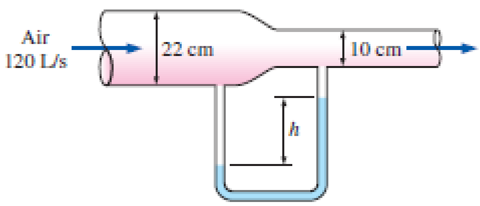



**FIGURE P5–104**

4.

**5–56** Air at 105 kPa and 37°C flows upward through a 6-cm-diameter inclined duct at a rate of 65 L/s. The duct diameter is then reduced to 4 cm through a reducer. The pressure change across the reducer is measured by a water manometer. The elevation difference between the two points on the pipe where the two arms of the manometer are attached is 0.20 m. Determine the differential height between the fluid levels of the two arms of the manometer.

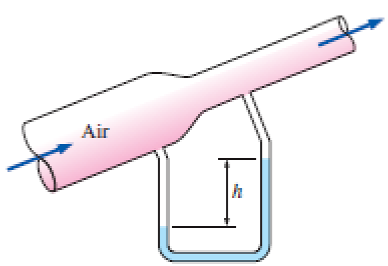
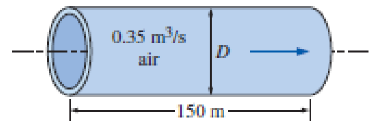



**FIGURE P5–56**

5.

**EXAMPLE 8–4** **Determining the Diameter of an Air Duct**

Heated air at 1 atm and 35°C is to be transported in a 150-m-long circular plastic duct at a rate of 0.35 $m^3/s$ (Fig. 8–33). If the head loss in the pipe is not to exceed 20 m, determine the minimum diameter of the duct.




6.

Consider a steady, incompressible laminar flow of a Newtonian fluid in a pipe ignoring the effects of gravity. When a constant pressure gradient is applied in the x-direction, demonstrate that the maximum velocity of the fluid is given by 2 times of its average velocity.

7.

In most process engineering books, the friction factor under laminar incompressible flow conditions is given by 16/Re. Using the mathematical relationships, prove that the given relationship is not exactly correct.

8.

Considering the Bernouilli equation, prove that it would be possible to walk on water!