

Indian Institute of Technology Kanpur

Thermodynamics (ESO201A) Instructor: Jishnu Bhattacharya

Tutorial 1

1-14 A 4-kW resistance heater in a water heater runs for 3 hours to raise the water temperature to the desired level. Determine the amount of electric energy used in both kWh and kJ.

1-22C Is the weight of a system an extensive or intensive property?

1-50 The water in a tank is pressurized by air, and the pressure is measured by a multifluid manometer as shown in Fig. P1-50. Determine the gage pressure of air in the tank if $h_1 = 0.2$ m, $h_2 = 0.3$ m, and $h_3 = 0.4$ m. Take the densities of water, oil, and mercury to be 1000 kg/m^3 , 850 kg/m^3 , and $13,600 \text{ kg/m}^3$, respectively.

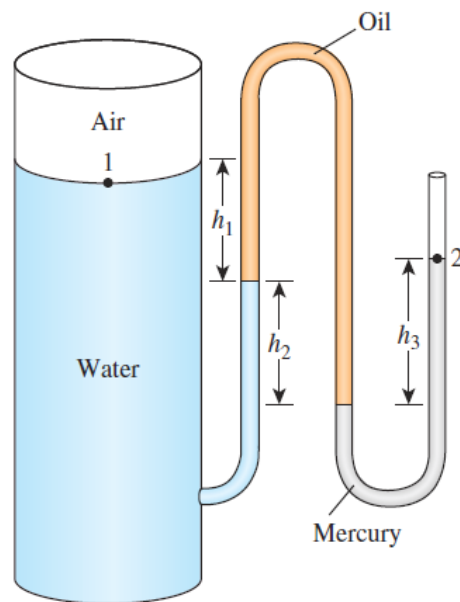


FIGURE P1-50

1-54 The absolute pressure in water at a depth of 9 m is read to be 185 kPa. Determine (a) the local atmospheric pressure, and (b) the absolute pressure at a depth of 9 m in a liquid whose specific gravity is 0.85 at the same location.

1–62 A gas is contained in a vertical, frictionless piston–cylinder device. The piston has a mass of 3.2 kg and a cross-sectional area of 35 cm². A compressed spring above the piston exerts a force of 150 N on the piston. If the atmospheric pressure is 95 kPa, determine the pressure inside the cylinder. *Answer: 147 kPa*

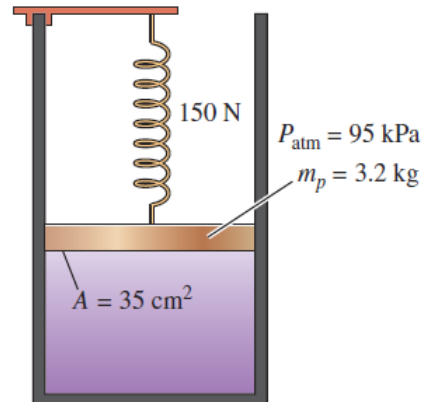


FIGURE P1–62

1–91 A hydraulic lift is to be used to lift a 2500 kg weight by putting a weight of 25 kg on a piston with a diameter of 10 cm. Determine the diameter of the piston on which the weight is to be placed.

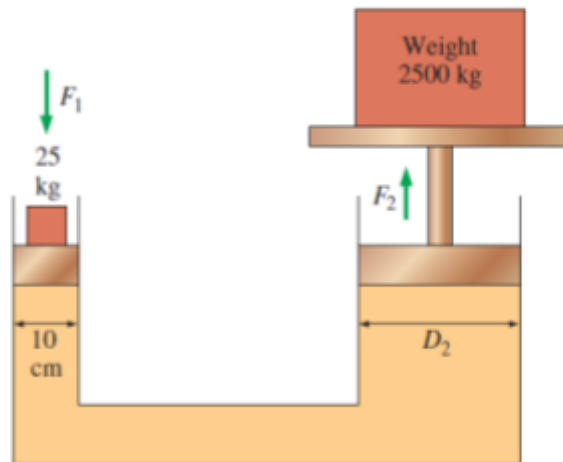


FIGURE P1–91

Additional Homework Problems

1–25C What is a quasi-equilibrium process? What is its importance in engineering?

1–29C What is specific gravity? How is it related to density?

1–34 The deep body temperature of a healthy person is 37°C . What is it in kelvins?

1–64 Both a gage and a manometer are attached to a gas tank to measure its pressure. If the reading on the pressure gage is 80 kPa, determine the distance between the two fluid levels of the manometer if the fluid is (a) mercury ($\rho = 13,600 \text{ kg/m}^3$) or (b) water ($\rho = 1000 \text{ kg/m}^3$).

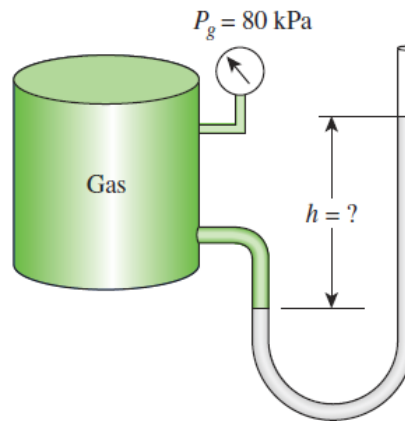


FIGURE P1–64

1–76 Freshwater and seawater flowing in parallel horizontal pipelines are connected to each other by a double U-tube manometer, as shown in Fig. P1–76. Determine the pressure difference between the two pipelines. Take the density of seawater at that location to be $\rho = 1035 \text{ kg/m}^3$. Can the air column be ignored in the analysis?

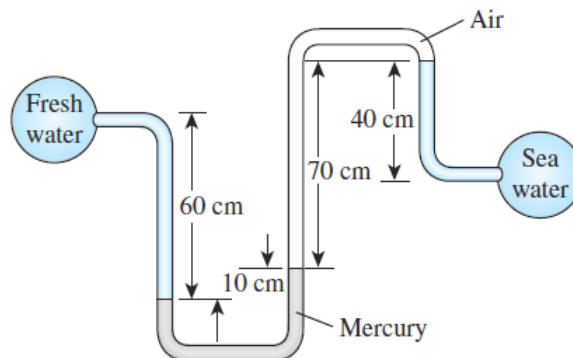


FIGURE P1–76

1–107 A pressure cooker cooks a lot faster than an ordinary pan by maintaining a higher pressure and temperature inside. The lid of a pressure cooker is well sealed, and steam can escape only through an opening in the middle of the lid. A separate metal piece, the petcock, sits on top of this opening and prevents steam from escaping until the pressure force overcomes the weight of the petcock. The periodic escape of the steam in this manner prevents any potentially dangerous pressure buildup and keeps the pressure inside at a constant value. Determine the mass of the petcock of a pressure cooker whose operation pressure is 100 kPa gage and has an opening cross-sectional area of 4 mm^2 . Assume an atmospheric pressure of 101 kPa, and draw the free-body diagram of the petcock. *Answer: 40.8 g*

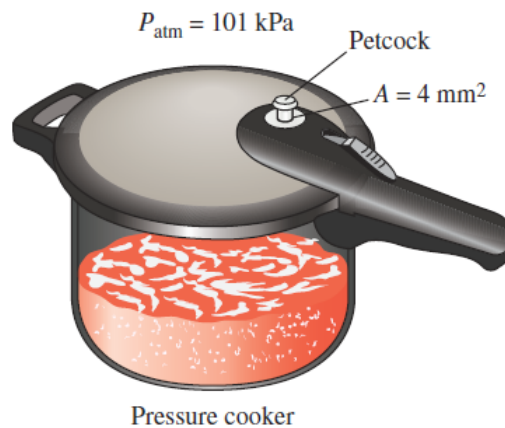


FIGURE P1–107