Problem 1









Fig. 1 Schematic of an arrangement creating a sub-atmospheric pressure (see Anim. 0.A.*vacuumPressure*).





In the accompanying figure, the area of the piston is 25 cm2, the mass of the hanging weight is 10 kg, the atmospheric pressure is 100 kN/m2, and the acceleration due to gravity is 9.81 m/s2. Determine (a) the pressure inside the cylinder in kN/m2 .***What-if scenario****:* (b) what is the maximum possible mass that this configuration can support?

**Solution** Draw a free-body diagram of the piston and balance the horizontal forces.

**Assumptions** Neglect friction, if any, between the piston and the cylinder.

**Analysis** The free-body diagram of the piston is drawn in Fig. 0.4 by isolating it and marking all the horizontal forces. A horizontal force balance yields:





**What-if Scenario** As  increases, the piston moves to the right and new equilibrium positions are established. With  and remaining constant,  will decrease according to the horizontal force balance equation. Because pressure is always compressive, the minimum value of  is zero. Therefore, the maximum mass that can be supported is:

