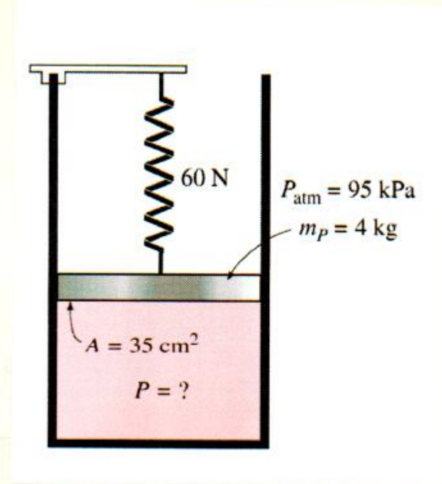
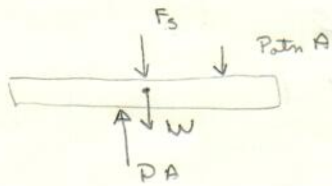
(3-24) A gas is contained in a vertical frictionless piston-cylinder device as shown. The piston has a mass of 4 kg and a cross sectional area of 35 cm². A compressed spring above the piston exerts a force of 60 N on the piston. If the atmospheric pressure is 95 kPa, determine the pressure inside the cylinder.



FBD



$$\therefore \quad F_s + P_{atm}A + W = PA$$

$$\text{or} \quad P = \frac{1}{A}\left[F_s + P_{atm}A + W\right]$$

$$= \frac{60\,N + 95\times10^3\,\frac{N}{m^2}\left(3.5\times10^{-3}\,m^2\right) + 39.24\,N}{3.5\times10^{-3}\,m^2}$$

$$A = 35\,cm^2 \times \left(\frac{1\,m}{100\,cm}\right)^2$$
$$= 0.0035\,m^2$$
$$= 3.5\times10^{-3}\,m^2$$

$$\text{or} \quad P = \frac{431.7\,N}{3.5\times10^{-3}\,m^2} = \boxed{123.4\,kPa}$$ ans

$$W = mg$$
$$= (4\,kg)(9.81\,m/s^2)$$
$$= 39.24\,N$$

→ If the gas in the container is air at 40°C, what is the air density for the conditions shown?

$$P = \rho R T \qquad R_{air} = 286.9\,J/kg\cdot K$$
$$\rho = \frac{P}{RT} \qquad T = 273 + 40 = 313\,K$$

$$= \frac{123.4\times10^3\,N/m^2}{\left(286.9\,\frac{N\text{-}m}{kg\text{-}K}\right)(313\,K)} = \boxed{1.374\,kg/m^3}$$ ans