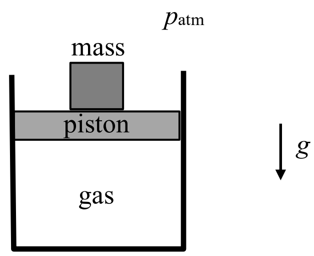
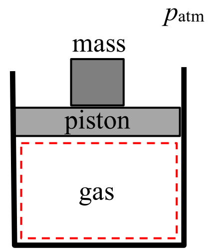
Determine the work done by the gas on the piston shown below as it expands quasi-statically from a volume of 0.02 m^3 to 0.04 m^3 given that the piston area is 0.01 m^2 and the mass resting on the piston is 100 kg (neglect the weight of the piston). Assume that atmospheric pressure is 101 kPa (abs).



SOLUTION:



The work done by the gas on the surroundings is,

$$W_{\text{by gas}} = \int_{V_1}^{V_2} p\,dV \,, \tag{1}$$

where,

$p = p_{\text{atm}} + mg/A = 101$ kPa (abs) + (100 kg)(9.81 m/s^2)/(0.01 m^2) = 1.99*10^5 Pa (2)

The pressure in the gas balances the atmospheric pressure plus the weight of the mass divided by the piston area. Note that this pressure is a constant throughout the process since we're always balancing the same mass and atmospheric pressure.

$V_1 = 0.02$ m^3

$V_2 = 0.04$ m^3

Since the pressure remains constant throughout the process, Eq. (1) may be written as,

$$W_{\text{by gas}} = \int_{V_1}^{V_2} p\,dV = p\int_{V_1}^{V_2} dV = p\left(V_2 - V_1\right). \tag{3}$$

Substituting the numbers given above,

$\boxed{W_{\text{by gas}} = 3.9 \text{ kJ}}$.