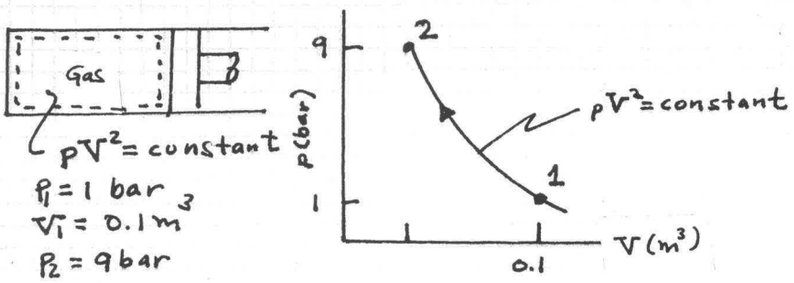
PROBLEM 2.25

KNOWN: A gas in a piston-cylinder assembly undergoes a process during which $pV^2 = \text{constant}$. State data are provided.

FIND: Determine the final volume occupied by the gas, in m^3, and the work for the process, in kJ.

SCHEMATIC & GIVEN DATA:



ENGINEERING MODEL:

1. The gas within the piston-cylinder is the closed system.
2. Volume change is the only work mode.
3. The process of the gas obeys $pV^2 = \text{constant}$.

ANALYSIS:

(a) We have $pV^2 = \text{constant}$. Thus, $p_1V_1^2 = \text{constant}$ and $p_2V_2^2 = \text{constant}$.

$$\rightarrow p_2V_2^2 = p_1V_1^2 \rightarrow V_2 = \left[\frac{p_1}{p_2}\right]^{1/2} V_1 = \underbrace{\left[\frac{0.1}{0.9}\right]^{1/2}}_{1/3} (0.1\ m^3) = 0.033\ m^3 \leftarrow$$

(b) Calling on Eq. 2.17,

$$W = \int_1^2 p\,dV = \frac{p_2V_2 - p_1V_1}{1-n} \quad \text{(See Example 2.1(a) for the integration.)}$$

(from (a))

$$\therefore W = \frac{p_2[V_1/3] - p_1V_1}{1-n} = \frac{V_1[p_2/3 - p_1]}{(-1)} = \frac{0.1\ m^3[3-1] \times 10^5\ N/m^2}{(-1)} \left|\frac{1\ kJ}{10^3\ N \cdot m}\right|$$

(2)

$$= -20\ kJ$$

Energy is transferred to the air by work in the compression process.