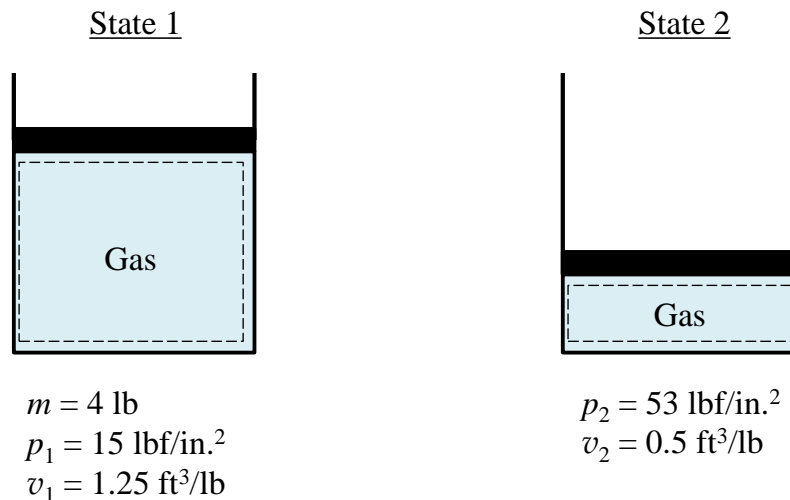


**1.28** A closed system consisting of 4 lb of a gas undergoes a process during which the relation between pressure and volume is  $pV^n = \text{constant}$ . The process begins with  $p_1 = 15 \text{ lbf/in.}^2$ ,  $v_1 = 1.25 \text{ ft}^3/\text{lb}$  and ends with  $p_2 = 53 \text{ lbf/in.}^2$ ,  $v_2 = 0.5 \text{ ft}^3/\text{lb}$ . Determine (a) the volume, in  $\text{ft}^3$ , occupied by the gas at states 1 and 2 and (b) the value of  $n$ . (c) Sketch Process 1-2 on pressure-volume coordinates.

**KNOWN:** Gas undergoes a process from a known initial pressure and specific volume to a known final pressure and specific volume.

**FIND:** Determine (a) the volume, in  $\text{ft}^3$ , occupied by the gas at states 1 and 2 and (b) the value of  $n$ . (c) Sketch Process 1-2 on pressure-volume coordinates.

**SCHEMATIC AND GIVEN DATA:**



**ENGINEERING MODEL:**

1. The gas is a closed system.
2. The relation between pressure and volume is  $pV^n = \text{constant}$  during process 1-2.

**ANALYSIS:**

(a) The specific volume is volume per unit mass. Thus, the volume occupied by the gas can be determined by multiplying its mass by its specific volume.

$$V = mv$$

For state 1

$$V_1 = mv_1 = (4 \text{ lb}) \left( 1.25 \frac{\text{ft}^3}{\text{lb}} \right) = \underline{5 \text{ ft}^3}$$

For state 2

$$V_2 = mv_2 = (4 \text{ lb}) \left( 0.5 \frac{\text{ft}^3}{\text{lb}} \right) = \underline{2 \text{ ft}^3}$$

(b) The value of  $n$  can be determined by substituting values into the relationship:

$$p_1(V_1)^n = \text{constant} = p_2(V_2)^n$$

Solving for  $n$

$$\frac{p_1}{p_2} = \left( \frac{V_2}{V_1} \right)^n$$

$$\ln \left( \frac{p_1}{p_2} \right) = n \ln \left( \frac{V_2}{V_1} \right)$$

$$n = \frac{\ln \left( \frac{p_1}{p_2} \right)}{\ln \left( \frac{V_2}{V_1} \right)} = \frac{\ln \left( \frac{15 \text{ lbf/in.}^2}{53 \text{ lbf/in.}^2} \right)}{\ln \left( \frac{2 \text{ ft}^3}{5 \text{ ft}^3} \right)} = \underline{\underline{1.38}}$$

(c) Process 1-2 is shown on pressure-volume coordinates below:

