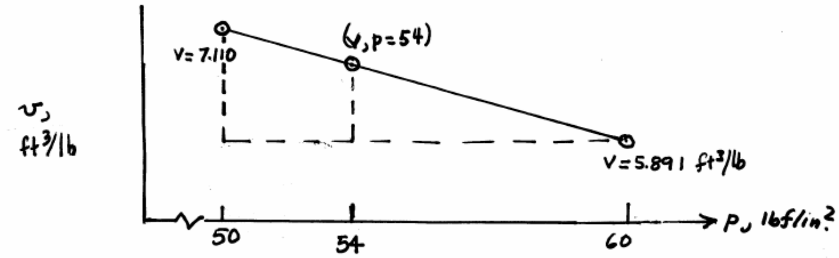
PROBLEM 1.30

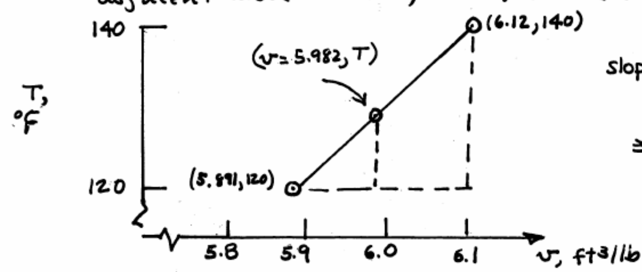
(a) At a temperature of 120°C, the specified pressure of 54 lbf/in.² falls between the table values of 50 and 60 lbf/in.² To determine the specific volume corresponding to 54 lbf/in.², we think of the slope of a straight line joining the adjacent table states, as follows:



similar triangles:

$$|\text{slope}| = \frac{v-5.891}{60-54} = \frac{7.110-5.891}{60-50} \Rightarrow v = 5.891 + \frac{6}{10}(7.110-5.891) = 6.622\ \frac{ft^3}{lb}$$ (a)

(b) At a pressure of 60 lbf/in.², the given specific volume of 5.982 ft³/lb falls between the table values of 120 and 140°F. To determine the temperature corresponding to the given specific volume, we think of the slope of a straight line joining the adjacent table states, as follows:



$$\text{slope} = \frac{T-120}{5.982-5.891} = \frac{140-120}{6.12-5.891}$$

$$\Rightarrow \quad T = 120 + \left[\frac{5.982-5.891}{6.12-5.891}\right](20)$$

$$= 127.9\,°F$$ (b)

(c) In this case, the specified pressure falls between the table values of 50 and 60 lbf/in² and the specified temperature falls between the table values of 100 and 120°F. Thus, double interpolation is required.

- At 110°F, the specific volume at each pressure is simply the average over the interval:

  at $50\frac{lbf}{in^2}$, 110°F; $v = \frac{7.110+6.836}{2} = 6.973\ ft^3/lb$

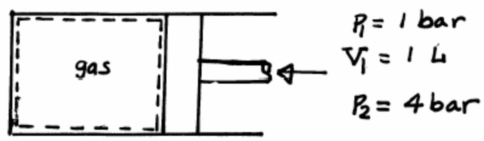
  at $60\frac{lbf}{in^2}$, 110°F; $v = \frac{5.891+5.659}{2} = 5.775\ ft^3/lb$

- Then, with the same approach as in (a)

$$\frac{v-5.775}{60-58} = \frac{6.973-5.775}{60-50} \Rightarrow v = 5.775 + \frac{2}{10}[6.973-5.775]$$

$$= 6.015\ ft^3/lb$$ (c)

PROBLEM 1.34



(a) The process is described by pV = constant. The constant can be evaluated using data at state 1:

$$pV = \text{constant}$$
$$= p_1 V_1$$
$$= (1\,\text{bar})(1\,\text{L}) = 1\ \text{bar}\cdot\text{L}$$

So, for every state during the process, we have the relation

$$pV = 1\ \text{bar}\cdot\text{L}$$

When $p = 3$ bar,

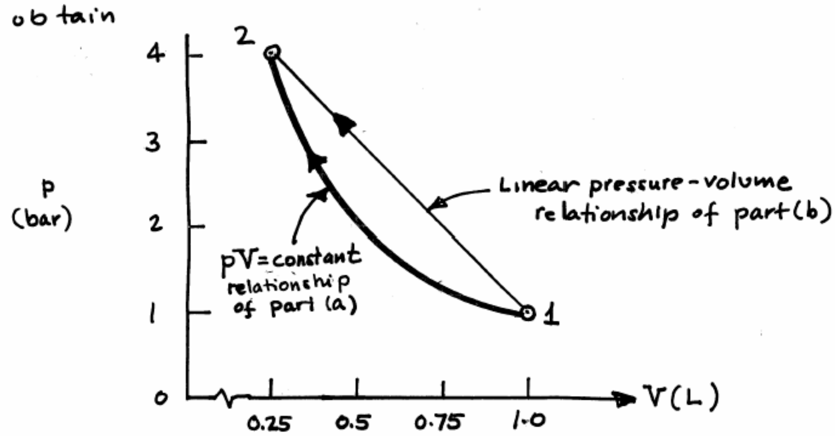
$$V = \frac{1\ \text{bar}\cdot\text{L}}{3\ \text{bar}} = 0.33\ \text{L}$$

when $p = 4$ bar, $V_2 = \dfrac{1\ \text{bar}\cdot\text{L}}{4\ \text{bar}} = 0.25\ \text{L}$

Plotting the relation on pressure-volume coordinates we use

$$p = \frac{1\ \text{bar}\cdot\text{L}}{V}$$

to obtain



(b) For comparison, the linear pressure-volume relationship is shown on the plot above. The volume corresponding to $p = 3$ bar can be obtained simply using the slope of the straight line between 1 and 2:

$$|\text{slope}| = \frac{(4-1)\,\text{bar}}{(1.0-0.25)\,\text{L}} = \frac{(3-1)}{(1.0-V)} \Rightarrow V = 0.5\ \text{L}$$

This value also can be read from the plot.