PROBLEM 3.128

KNOWN: Data are provided for air on one side of a rigid container. The other side of the container is initially evacuated.

FIND: For the air, determine the final temperature and Q.

SCHEMATIC & GIVEN DATA:

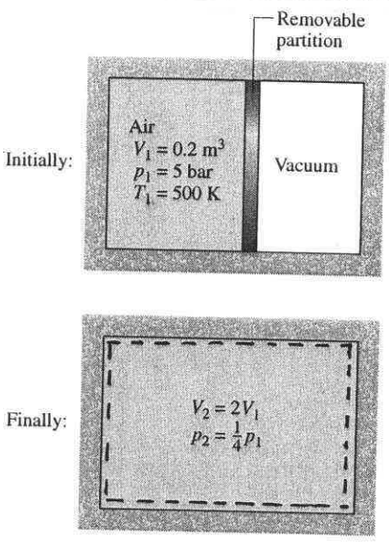

Fig. P3.128

ENGR. MODEL:

1. The closed system is the region within the container, ignoring the partition.
2. The air is modeled as an ideal gas.
3. There are no overall changes in kinetic or potential energy.
4. $W = 0$.

ANALYSIS:

(a) Using the ideal gas model equation of state, $P_1V_1 = mRT_1$, $P_2V_2 = mRT_2$. Thus,

$$T_2 = T_1\left[\frac{P_2V_2}{P_1V_1}\right] = 500K\left[\frac{1}{4}\right][2] = 250K \qquad \leftarrow T_2$$

(b) An energy balance reduces to $\Delta U + \cancel{\Delta KE} + \cancel{\Delta PE} = Q - \cancel{W}$, or

$$Q = m(u(T_2) - u(T_1))$$

where

$$m = \frac{P_1V_1}{RT_1} = \frac{(5\times10^5 N/m^2)(0.2m^3)}{\left(\frac{8314}{28.97}\frac{N\cdot m}{kg\cdot K}\right)(500K)} = 0.7\,kg$$

So, with data from Table A-22

$$Q = 0.7\,kg(178.28 - 359.49)\frac{kJ}{kg}$$

$$= -126.8\ kJ \qquad \leftarrow Q$$