Question #81525, Physics / Molecular Physics | Thermodynamics

3. n moles of an ideal gas undergo an isobaric process 1->2 and then the isochoric process 2->3 shown in Fig. 1 in such was that the gas performs work A. The ratio of P2 and P3 is known: P2/P3=k. The temperature T1 in the state 1 equals to the temperature T3 In state 3. Calculate temperature T3.

Solution

1) $W = p_2(V_2 - V_1) = A$

2) $nRT_1 = p_1V_1 = p_2V_1$

3) $\frac{p_3}{p_2} = \frac{T_3}{T_2} = \frac{1}{k} \rightarrow T_3 = \frac{T_2}{k}$

4) $nRT_2 = p_2V_2$

Thus,

$$A = nR(T_2 - T_1)$$

$$T_2 = T_1 + \frac{A}{nR}.$$

So,

$$T_3 = \frac{1}{k}\left(T_1 + \frac{A}{nR}\right).$$

4. A monoatomic gas takes up a volume of V=4m3 and is at a pressure of 8x105 Pa. The gas undergoes an isothermal expansion reaching the final pressure of 1 atm. Calculate a) the work done to the gas in such a process b) the amount of heat absorbed by the gas c) change in the internal energy of the gas.

Solution

a) the work done to the gas:

$$W = nRT\ln\frac{V_2}{V_1}$$

$$T = const \rightarrow p_1V_1 = p_2V_2 \rightarrow \frac{V_2}{V_1} = \frac{p_1}{p_2}$$

$$nRT = pV = p_1V_1$$

Thus,

$$W = p_1V_1\ln\frac{p_1}{p_2} = (800000)(4)\ln\frac{8}{1.01325} = 6.6\ MJ.$$

b) the amount of heat absorbed by the gas:

$$Q = W = 6.6\ MJ.$$

c) change in the internal energy of the gas:

$$\Delta U = Q - W = 0\ J.$$