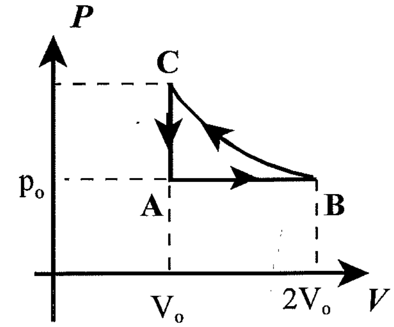
Rec 30

Thermodynamics

A monoatomic ideal gas is taken through the cycle **A→B→C→A** shown in the figure. Find:



1. the heat flowing into the gas during the process A –B

$Q_{AB} = nc_p \Delta T = \frac{5}{2} nR\left(\frac{2p_o V_o}{nR} - \frac{p_o V_o}{nR}\right) = \frac{5}{2} p_o V_o$

2. the work done by the gas during process A –B

$W_{AB} = p\Delta V = p_o(2V_o - V_o) = p_o V_o$

3. the change in internal energy from A to B

$\Delta U_{AB} = Q_{AB} - W_{AB} = \frac{5}{2} p_o V_o - p_o V_o = \frac{3}{2} p_o V_o$

4. If we know that the internal energy of the monoatomic ideal gas remains constant during the process B-C, what must be the pressure at point C?

$U_B = U_C \rightarrow T_B = T_C \quad \frac{p_B \cdot 2V_o}{nR} = \frac{p_C V_o}{nR} \rightarrow p_C = 2p_o$

Find:

5. the work done by the gas during the process B-C

$W_{BC} = \int p\,dV = \int \frac{nRT}{V} dV = nRT_B \ln\frac{V_o}{2V_o} = nR\frac{p_o 2V_o}{nR} \ln\frac{1}{2}$

$W_{BC} = -2p_o V_o \ln 2$

6. the heat flowing into the gas during the process B –C

$\Delta U = Q - W = 0$

$Q_{BC} = W_{BC} = -2p_o V_o \ln 2$

7. the heat flowing into the gas during the process C –A

$Q_{CA} = nc_V \Delta T = \frac{3}{2} nR\left(\frac{p_o V_o}{nR} - \frac{2p_o V_o}{nR}\right) = -\frac{3}{2} p_o V_o$

$-\frac{p_o V_o}{nR}$

8. the work done by the gas during process C –A

$W_{CA} = 0 \quad V = const$

9. the change in internal energy from C to A

$\Delta U_{CA} = Q_{CA} - W_{CA} = -\frac{3}{2} p_o V_o$

10. What is the total work done by the system in the complete cycle?

$W = W_{AB} + W_{BC} + W_{CA} = p_o V_o - 2p_o V_o \ln 2 + 0 = p_o V_o(1 - 2\ln 2)$

negative CCW

11. How much heat flows into the system in a complete cycle?

$\Delta U = Q - W = 0$ for cycle $\rightarrow Q = W = p_o V_o(1 - 2\ln 2)$

negative

CCW