QUIZ4- CHAPTER 19
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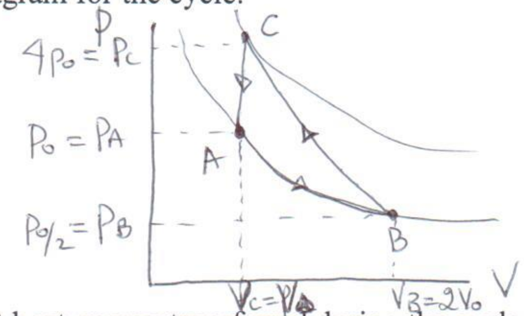
A 2.0 moles of a monatomic ideal gas with a volume $V_o = 1$ L and a pressure $p_o = 1$ atm undergoes an isothermal expansion to volume $V_1 = 2\,V_o$ and pressure $p_1 = p_o/2$. The gas is then compressed adiabatically to the original volume V_o and pressure $4p_o$. The gas is then cooled at constant volume until it reach its initial state.

(a) Draw the pV diagram for the cycle.



(b) Calculate the net heat energy transferred during the cycle.

$$Q_{AB} = nRT_A \ln\left(\frac{V_B}{V_A}\right) = P_A V_A \ln\left(\frac{V_B}{V_A}\right) = 1\times 101\times 10^{3}\times 10^{-3}\ln(2) = \boxed{70\text{ J}}$$

$$Q_{BC} = 0 \quad (\text{adiabatic process})$$

$$Q_{CA} = nC_v\Delta T = n\,\frac{3}{2}R\,\frac{V\Delta p}{nR} = \frac{3}{2}V_c\,(P_A - P_c)$$

$$= \frac{3}{2}V_o\,(P_o - 4P_o) = -\frac{9}{2}V_o P_o = -\frac{9}{2}\,1\times 10^{-3}\times 101\times 10^{3}$$

$$= \boxed{-455\text{ J}} \qquad Q_{net} = 70 - 455 = \boxed{-385\text{ J}}$$

(c) Calculate the net change in internal energy of the gas.

$$\Delta E_{int} = 0 \quad (\text{cycle})$$

(d) Calculate the net work done during the cycle.

$$W = Q_{net} - \Delta E_{net} = Q_{net} = \boxed{-385\text{ J}}$$

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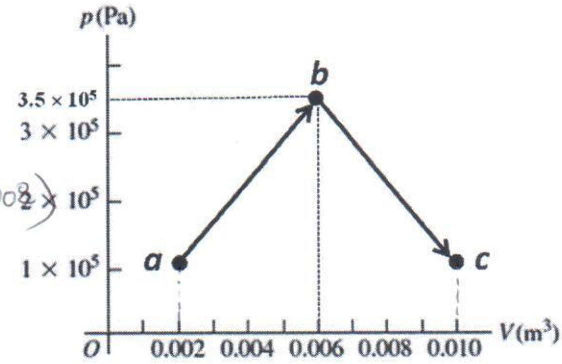
Two moles of a diatomic ideal gas is taken along the path *abc* shown in the figure. Calculate:

(a) The work done by the gas in the process abc.



W_{abc} = area under the curve

$$= \frac{1}{2}(3.5-1)\times10^5 \times (0.01-0.002) + 1\times10^5 \times (0.01-0.002)$$

$$= 1000 + 800 = \boxed{1800\ J}$$

(b) The change in internal energy of the gas in the process abc.

$$\Delta E_{int} = n\, C_v\, \Delta T = n\, C_v (T_c - T_a) = n\,\frac{5}{2} R \left(\frac{P_c V_c}{nR} - \frac{P_a V_a}{nR}\right)$$

$$= \frac{5}{2}(P_c V_c - P_a V_a)$$

$$= \frac{5}{2}(1\times10^5 \times 0.01 - 1\times10^5 \times 0.002)$$

$$= \boxed{2000\ J}$$

(c) The heat energy transferred in the process abc.

$$\Delta E_{int} = Q - W \Rightarrow Q = \Delta E_{int} + W$$

$$Q = 2000 + 1800 = \boxed{3800\ J}$$

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1. During a thermal expansion process at constant pressure, 970 J of heat are added to 1.8 moles of an ideal gas to heat it from 10.0 °C to 25.0 °C. The gas does 223 J of work during the expansion. Calculate γ for the gas.

$$Q = n C_p \Delta T$$
$$\Delta E_{int} = n C_v \Delta T \Rightarrow \frac{Q}{\Delta E_{int}} = \frac{\not{n} C_p \not{\Delta T}}{\not{n} C_v \not{\Delta T}} = \frac{C_p}{C_v} = \gamma$$

$$\Delta E_{int} = Q - W = 970 - 223 = 747 J$$

$$\Rightarrow \gamma = \frac{Q}{\Delta E_{int}} = \frac{970}{747} = \boxed{1.3}$$

2. How much work is required to compress 2.0 moles of diatomic ideal gas at 20 °C and 1.0 atm to one-third of the original volume in an adiabatic process?

Adiabatic process $\Rightarrow Q = 0 \Rightarrow W = -\Delta E_{int}$

$$W = -n C_v \Delta T = -n C_v (T_f - T_i)$$
$$= -n \frac{5}{2} R (T_f - T_i)$$

$$T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}$$
$$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1}$$
$$= 293 \left(\frac{V_i}{\frac{V_i}{3}}\right)^{1.4-1}$$
$$= 293 (3)^{0.4} = 455 K$$

$$W = -2 \times \frac{5}{2} \times 8.31 (455 - 293)$$
$$= \boxed{-6731 J}$$

Work required is 6731 J