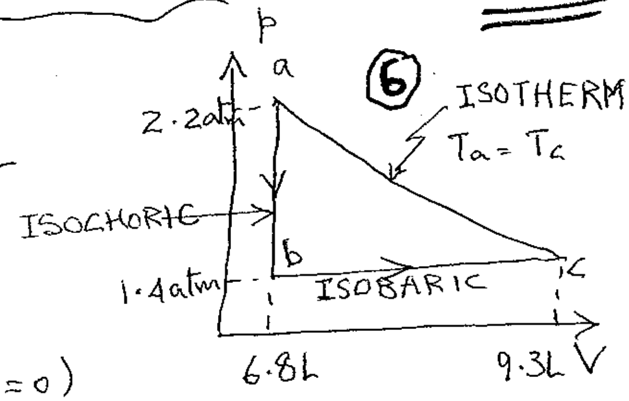
(15-10) 16

P-151/002 Random Graded HWK

Total Pts = 30



$p_1 = 2.2$ atm, $p_2 = 1.4$ atm, $V_1 = 6.8$ L

$V_2 = 9.3$ L

From 1st Law of Thermodynamics,

$Q = W + \Delta U$ —— (1)

(a) $W_{a\to b} = 0$, because ab represents ISOCHORIC process ($\Delta V = 0$)

$W_{b\to c} = p\Delta V = 1.4\text{ atm}(9.3 - 6.8)\text{L} = 1.4\text{ atm}(2.5\text{L})$

$= 1.4\text{ atm}\left(\frac{1.013\times10^5 N/m^2}{1\text{ atm}}\right)(2.5\text{ L})\frac{1\text{ m}^3}{10^6\text{ cm}^3}\left(\frac{10^3\text{ cm}^3}{1\text{ L}}\right)$

$= 1.4\times1.013\times2.5\times10^2$ Joules

(3) $= 3.55\times10^2$ J ⟵ Total Work done by ideal gas via ISOBARIC process.

(b) Since states 'a' and 'c' are at the same temperature ($T_a = T_c$)

$\Delta U = 0$, since $U = \frac{3}{2}NRT$ (3)

(c) From (1) above,

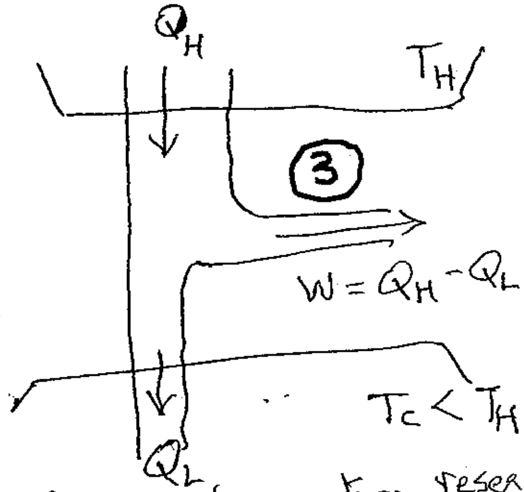
$Q = W + \Delta U$ (ΔU → 0, from (b))

$= 3.55\times10^2$ J (4)

(15-51) $W = 1.5 \times 10^6 \frac{J}{s}$, $Q_H = 3 \times 10^6 \frac{J}{s}$

14 $Q_L = 1.5 \times 10^6 \frac{J}{s}$, $T_H = 425\,K$

$T_L = 215\,K$



$\eta_e \equiv$ efficiency of the proposed engine

$$\eta_e = \frac{W}{Q_H} = \frac{1.5 \times 10^6\ J/s}{3 \times 10^6\ J/s} = \underline{\underline{0.500}} \quad (3)$$

$\eta_c \equiv$ efficiency of Carnot cycle operating between two reservoir

$$\eta_c = 1 - \frac{T_L}{T_H} = 1 - \frac{215}{425} = 1 - 0.506$$

$$= \underline{\underline{0.494}} \quad (3)$$

(5)

Since $\eta_e > \eta_c$, there is something fishy about his claim! No practical engine can be more efficient than the (ideal) Carnot engine.