GABARITO P3 – Física II 01 IO-2013

1-(a) $Q_{ab} = nC_p(T_b - T_a)$

$Q_{bc} = nC_v(T_c - T_b) = nC_v(T_a - T_b) = -nC_v(T_b - T_a)$ ← $T_a = T_c$

$Q_{ca} = nRT_a \ln\left(\frac{V_a}{V_c}\right) = -nR\ln r$

$Q_{ab} > 0 \quad Q_{bc} < 0 \quad Q_{ca} < 0$

$Q_q = Q_{ab} \qquad Q_f = -Q_{bc} - Q_{ca} = nC_v(T_b - T_a) + nRT_a \ln r$

$$\eta = 1 - \frac{Q_f}{Q_q} = 1 - \frac{C_v(T_b - T_a) + RT_a \ln r}{C_p(T_b - T_a)}$$

$P_b = P_a \therefore 2$

$C_v = 3R$

$\frac{V_b}{V_a} = \frac{T_b}{T_a} = r \qquad (V_b = V_c) \qquad C_p = C_v + R = 4R$

$$\eta = 1 - \frac{C_v\left(\frac{T_b}{T_a} - 1\right) + R\ln r}{C_p\left(\frac{T_b}{T_a} - 1\right)} = 1 - \frac{3R(r-1) + R\ln r}{4R(r-1)}$$

$$\eta(r) = 1 - \frac{3}{4} - \frac{\ln r}{(r-1)} = \frac{1}{4} - \frac{\ln r}{4(r-1)}$$

p/ $r = 10 \quad \eta(10) = \frac{1}{4} - \frac{\ln 10}{4 \times 9} = 0{,}186$

(18,6%)

(b) $\eta_c = 1 - \frac{T_f}{T_q} = 0,186$

$$\frac{T_f}{T_q} = 1 - 0,186 = 0,814$$

(c) $\eta = \frac{W}{Q_q} \quad K = \frac{Q_f}{W} \quad W = Q_q - Q_f$

$$\eta K = \frac{Q_f}{Q_q} = 1 - \eta \qquad \eta = 1 - \frac{Q_f}{Q_q}.$$

$$K = \frac{1-\eta}{\eta} = \frac{1 - 0,186}{0,186} = 4,38$$

(d) $Q_{qIrr} = Q_q = n C_p (T_b - T_a)$

$Q_{fIrr} = -Q_{bc} = n C_v (T_b - T_a)$

$$K_{Irr} = \frac{Q_{fIrr}}{Q_{qIrr} - Q_{fIrr}} = \frac{n C_v (T_b - T_a)}{n (C_p - C_v)(T_b - T_a)}$$

$K_{Irr} \cdot \frac{C_v}{R} = 3 \quad < K$

O desempenho é pior

(e) $dS = \frac{dQ}{T}$ $\qquad P = \frac{nRT}{V}$

$$\Delta S_{ac} = \int_a^c \frac{dQ}{T} \qquad dQ = PdV = nRT\frac{dV}{V}$$

$$\Delta S_{ac} = nR\frac{T_a}{T_a}\ln\frac{V_c}{V_a} = nR\ln r = \frac{5}{3}\times 8{,}31\ln 10$$

$$\Delta S_{ac} = 31{,}89\ \text{J/K}$$

$$\Delta S_{cb} = \int_c^b nC_v\frac{dT}{T} \qquad (dQ = nC_v dT)$$

$$\Delta S_{cb} = nC_v\ln\frac{T_b}{T_c} = nC_v\ln r = \frac{5}{3}3R\ln 10$$

$$\Delta S_{cb} = 5\times 8{,}31\times\ln 10 = 95{,}67\ \text{J/K}$$

$$\Delta S_{ba} = \int_b^a nC_p\frac{dT}{T} = nC_p\ln\frac{T_a}{T_b} = -nC_p\ln r$$

$$\Delta S_{ba} = -\frac{5}{3}\times 4\times 8{,}31\times\ln 10 = -127{,}56\ \text{J/K}$$

$$\Delta S_{acba} = 0$$

(f) $\Delta S_U = \Delta S_{ac} = 31{,}89\ \text{J/K}$

(g) $\Delta S_{ac} = k\ln\frac{W_c}{W_a}$ $\qquad \frac{W_c}{W_a} = e^{\frac{\Delta S_{ac}}{k}} = e^{\frac{31{,}89}{8{,}31\times 10^{-23}}}$

$\frac{W_c}{W_a} = e^{23\times 10^{23}}$ $\qquad P_{c\to a} = \frac{W_a}{W_c} = e^{-23\times 10^{23}}$