Facultad de Ingeniería **Universidad de la República**

Segundo parcial de Física 2 – Solución

1/12/2017

1) **Pregunta:** Ver teórico

2) **Ejercicio:** $Q = Q_1 + Q_2 + Q_3 + Q_4$

Donde:

- Q_1 es la energía necesaria para llevar la temperatura del hielo a 0 ºC
- Q_2 la que se necesita para derretir el hielo
- Q_3 para elevar la temperatura del agua de 0 ºC a 100 º C
- Q_4 para evaporarla.

$Q_1 = m \cdot c_H \cdot \left(0\ ºC - (-10\ ºC)\right) = 845{,}6\ J$

$Q_2 = m \cdot L_f = 13388{,}8\ J$

$Q_3 = m \cdot c_A \cdot (100\ ºC - 0\ ºC) = 16724\ J$

$Q_4 = m \cdot L_v = 90374{,}4\ J$

Resultando:

$Q = 121{,}3\ kJ$

3) **Ejercicio:**

a)

$$\begin{cases} TV = cte \\ T = \dfrac{pV}{nR} \end{cases} \Rightarrow pV^2 = cte \Rightarrow \boxed{p(V) = \frac{p_a {V_a}^2}{V^2}}$$

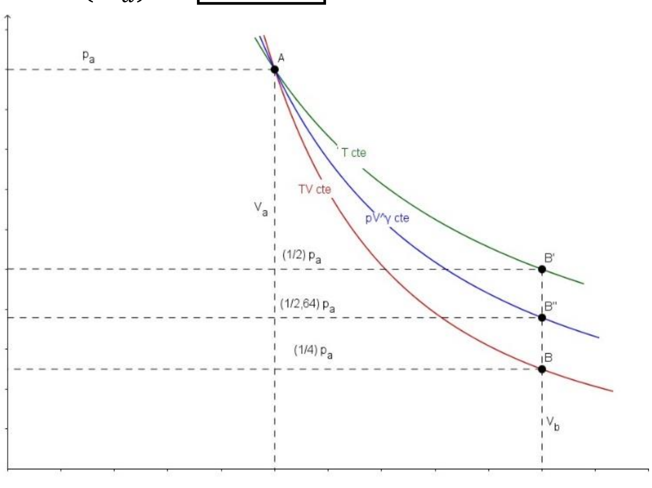
Estado b:

$$V_b = 2V_a \Rightarrow p_b = \frac{p_a {V_a}^2}{(2V_a)^2} \Rightarrow \boxed{p_b = \frac{p_a}{4}}$$

Proceso del gas: $pV^2 = cte$

Proceso isotermo: $pV = cte$

Proceso adiabático: $pV^{1,4} = cte$



b)

$$W_{GAS\rightarrow ENT} = \int p(V)dV = \int_{V_a}^{2V_a} \frac{p_a {V_a}^2}{V^2} dV = p_a {V_a}^2 \int_{V_a}^{2V_a} V^{-2} dV = -p_a {V_a}^2 \left(\frac{1}{2V_a} - \frac{1}{V_a}\right) = \frac{p_a V_a}{2}$$

c)

$$\Delta U = \frac{5}{2} nR\Delta T = \frac{5}{2}(p_b V_b - p_a V_a) = \frac{5}{2}\left(\frac{p_a V_a}{2} - p_a V_a\right) = -\frac{5}{4} p_a V_a$$

$$Q = \Delta U - W_{ENT\rightarrow GAS} = -\frac{5}{4} p_a V_a - \left(-\frac{p_a V_a}{2}\right) = -\frac{3}{4} p_a V_a$$

d)

$$\delta Q = dU - \delta W = \frac{5}{2} nRdT + pdV$$

$$\Delta S = \int_i^f \frac{\delta Q_{rev}}{T} = \int_{T_a}^{T_b} \frac{5}{2} nR \frac{dT}{T} + \int_{V_a}^{V_b} p \frac{dV}{T} = \frac{5}{2} nR \ln \frac{T_b}{T_a} + nR \ln \frac{V_b}{V_a}$$

Como $\frac{T_b}{T_a} = \frac{P_b V_b}{P_a V_a} = \frac{1}{2}$

$$\Delta S = \left(nR - \frac{5}{2} nR\right) \ln 2 = -\frac{3}{2} nR \ln 2 = -8{,}64\ {}^{J}/_{K}$$

4) Ejercicio:

a)

Proceso AB Isotérmico ⇒

$$p_A V_A = p_B V_B \Rightarrow V_B = \frac{p_A}{p_B} V_A = 0{,}0025\ m^3$$

Proceso BC Adiabático ⇒

$$TV^{\gamma-1} = cte \Rightarrow V_C = V_B \left({}^{T_B}/_{T_C}\right)^{\frac{1}{\gamma-1}} = 0{,}0311\ m^3$$

$$PV^{\gamma} = cte \Rightarrow P_C = P_B \left({}^{V_B}/_{V_C}\right)^{\gamma} = 23{,}77\ kPa$$

Proceso DA Adiabático⇒

$$TV^{\gamma-1} = cte \Rightarrow V_D = V_A \left({}^{T_A}/_{T_D}\right)^{\frac{1}{\gamma-1}} = 0{,}0249\ m^3$$

$$PV^{\gamma} = cte \Rightarrow P_D = P_A \left({}^{V_A}/_{V_D}\right)^{\gamma} = 29{,}68\ kPa$$

b)

$$W_{AB} = nRT_A . L\left({}^{V_B}/_{V_A}\right) = P_A V_A . L\left({}^{V_B}/_{V_A}\right) = -0{,}452\ kJ$$

$$W_{BC} = {}^{(P_C V_C - P_B V_B)}\Big/_{(\gamma - 1)} = -3{,}218\ kJ$$

$$W_{CD} = nRT_C . L\left(V_D/V_C\right) = P_C V_C . L\left(V_D/V_C\right) = 0{,}164\ kJ$$

$$W_{DA} = (P_A V_A - P_D V_D)/(\gamma - 1) = 3{,}218\ kJ$$

$$Q_{AB} = -W_{AB} = 0{,}452\ kJ \qquad \Delta U_{AB} = 0$$

$$Q_{BC} = 0\ kJ \qquad \Delta U_{BC} = \mathrm{Q}_{BC} + \mathrm{W}_{BC} = -3{,}218\ kJ$$

$$Q_{CD} = -W_{CD} = -0{,}164\ kJ \qquad \Delta U_{CD} = 0$$

$$Q_{DA} = 0\ kJ \qquad \Delta U_{DA} = \mathrm{Q}_{DA} + \mathrm{W}_{DA} = 3{,}218\ kJ$$

d)

$$\eta = |W|/|Q_{ENT}| = |W_{AB} + W_{BC} + W_{CD} + W_{DA}|/|Q_{AB}| = 63{,}5\%$$

$$\eta_C = 1 - T_L/T_H = 63{,}5\%$$