Solución 2ndo Parcial Física 2 - 08/07/2017

Ejercicio 1

m_p — $n = 1\,mol$ — $T_{R.T.} = 500°C = 773\,K$

$A = 0{,}1\,m^2$ — gas ideal diatómico

$k = 50\,kN/m$

a) 1er proceso:

- <u>Estado inicial ①</u>
  $V_1 = 0{,}02\,m^3 = 2\,l$
  $P_1 = 120\,kPa$
  $T_1 = \frac{P_1 V_1}{nR} = 288{,}8\,K$

- Newton al pistón: $P_{gas} = \frac{k\Delta h}{A} + \frac{m_p g}{A} + P_0$

  Inicialmente, resorte con longitud natural: $P_{gas} = P_1 = \frac{m_p g}{A} + P_0$

  $\Rightarrow m_p = (P_1 - P_0)\frac{A}{g} = 190{,}6\,kg$

- <u>Estado final ②</u>
  $V_2 = 0{,}03\,m^3 = 3\,l$ ($\Rightarrow \Delta h = (V_2 - V_1)/A = 0{,}1\,m$)
  $P_2 = \frac{k}{A}(0{,}1\,m) + m_p\frac{g}{A} + P_0 = 170\,kPa$
  $T_2 = \frac{P_2 V_2}{nR} = 613{,}7\,K$

- <u>trabajo realizado por el sistema</u>:

$$W = \int P_{gas}\,dV = \int P_{gas}\,A\,dh = AP_0\Delta h + m_p g\Delta h + k\frac{\Delta h^2}{2}$$

$W_{x\,gas} = 1450\,J$

- <u>calor</u>:

1era ley: $\Delta U = Q + W_{\text{sobre gas}} = Q - W_{x\,gas}$

$\Rightarrow Q = \Delta U + W_{x\,gas}$

gas ideal: $\Delta U = n c_v (T_2 - T_1) = n\left(\frac{5}{2}R\right)(T_2 - T_1) = 6749{,}8\,J$

$\Rightarrow$ **$Q_{gas} = 8199{,}8\,J$**

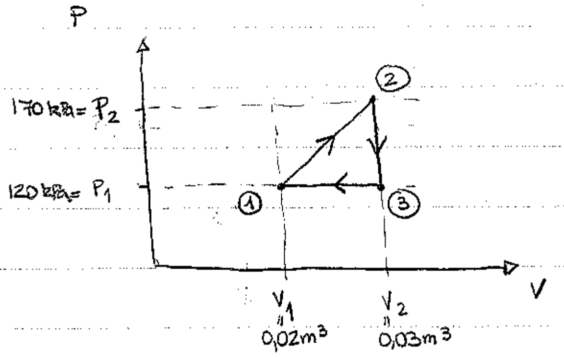
b) $\Delta S_{univ} = \Delta S_{gas} + \Delta S_{R.T}$

$$\Delta S_{gas} = n c_V \ln\left(\frac{T_2}{T_1}\right) + nR\ln\left(\frac{V_2}{V_1}\right) = 19{,}0 \ J/K$$

$$\Delta S_{R.T.} = -\frac{|Q_{gas}|}{T_{R.T.}} = -\frac{8199{,}8J}{773\ K} = -10{,}6 \ J/K$$

$\Rightarrow$ $\boxed{\Delta S_{univ} = 8{,}4 \ J/K} > 0$

c) 2ndo proceso:



Estado ③ :
$$\begin{cases} P_3 = P_1 = 120 \ kPa \\ V_3 = V_2 = 0{,}03 \, m^3 \\ T_3 = \dfrac{V_3 P_3}{nR} = 433{,}2 \ K \end{cases}$$

d) calor entregado por el gas en el proceso 2-3-1:

$$Q_{gas_{231}} = \underset{\substack{\uparrow \\ q\ \text{cte}}}{Q_{23}} + \underset{\substack{\uparrow \\ a\ \text{cte}}}{Q_{31}} = n c_V (T_3 - T_2) + n c_p (T_1 - T_3) = -3749{,}9 J - 4199{,}9 J$$

$\Rightarrow$ $Q_{gas_{231}} = -7949{,}8 J$

El calor que pierde el gas es el que gana el hielo:

$$Q_{Hielo} = -Q_{gas} = m_{fund} \cdot L_{fus} = 7949{,}8 J$$

$$\Rightarrow m_{fund} = \frac{7949{,}8 J}{L_{fus}}$$

$\boxed{m_{fund} = 0{,}024 \ kg}$

e) $\Delta S_{univ} = \underset{\substack{\| \\ 0 \\ (\text{ciclo})}}{\Delta S_{gas}} + \Delta S_{R.T.} + \Delta S_{Hielo} = -10{,}6 \frac{J}{K} + \frac{Q_{Hielo}}{273 \ K} = -10{,}6 \ J/K + 29{,}1 \ J/K$

$\Rightarrow$ $\boxed{\Delta S_{univ} = 18{,}5 \ J/K} > 0$ proceso irreversible

EJERCICIO 2

$n = 2$ mol

gas ideal monoatómico

a) Estado ①: $\begin{cases} V_1 = 50\ \ell = 0{,}05\ m^3 \\ T_1 = 300\ K \\ P_1 = \dfrac{nRT_1}{V_1} = 99{,}72\ kPa \end{cases}$

Estado ②: $\begin{cases} V_2 = V_3 = \dfrac{V_4}{8} = 3{,}125 \times 10^{-2}\ m^3 \\ T_2 = T_1 = 300\ K \\ P_2 = \dfrac{nRT_2}{V_2} = 159{,}6\ kPa \end{cases}$

Estado ③: $\begin{cases} V_3 = \dfrac{V_4}{8} = 3{,}125 \times 10^{-2}\ m^3 \\ T_3 = T_4 = 1503{,}4\ K \\ P_3 = \dfrac{nRT_3}{V_3} = 799{,}6\ kPa \end{cases}$

Estado ④: $\begin{cases} T_4 = 1503{,}4\ K \\ Q_{41} = -50\ kJ = nC_p\,(T_1 - T_4) \\ \Rightarrow T_4 = T_1 + \dfrac{50\ kJ}{nC_p} \\ P_4 = P_1 = 99{,}72\ kPa \\ V_4 = \dfrac{nRT_4}{P_4} = 0{,}25\ m^3 \end{cases}$

- ciclo recorrido en sentido horario $W_{x\,sist.} > 0$

se trata de una máquina térmica

b) $e = \dfrac{|W|}{|Q_{in}|}$

$Q_{in} = Q_{34} + Q_{23}$

- Proceso $3 \to 4$ a T cte: $\Delta U_{34} = 0$

1era ley: $Q_{34} = -W_{x\,gas,34} = nRT_3 \ln\left(\dfrac{V_4}{V_3}\right) = 51{,}96\ kJ$

- Proceso $2 \to 3$ a V cte: $Q_{23} = nC_v\,(T_3 - T_2) = 30{,}00\ kJ$

$\Rightarrow Q_{in} = 81{,}96\ kJ$

- ciclo: $\Delta U = 0 \Rightarrow |W_{ciclo}| = |Q_{ciclo}| = |Q_{12} + Q_{23} + Q_{34} + Q_{41}| =$

$= |\underbrace{nRT_1 \ln(V_2/V_1)}_{-2343\ J} - 50000\ J + 30000\ J + 51960\ J| = 29617\ J$

$\Rightarrow e = \dfrac{29{,}62\ kJ}{81{,}96\ kJ} = \boxed{0{,}361 = e}$

c) $\begin{cases} T_a = 1800\,K \\ T_b = 250\,K \end{cases}$

En un ciclo $\quad \Delta S_{univ} = \underbrace{\Delta S_{gas}}_{0\,(ciclo)} + \Delta S_{R.T.1} + \Delta S_{R.T.2} = -\frac{|Q_{in}|}{T_a} + \frac{|Q_{out}|}{T_b} =$

$$= -\frac{|Q_{23} + Q_{34}|}{T_a} + \frac{|Q_{12} + Q_{41}|}{T_b} = \frac{-81960\,J}{1800\,K} + \frac{52343\,J}{250\,K}$$

$$\Rightarrow \boxed{\Delta S_{univ} = 163,8\ J/K}$$

d) $T_a = T_3$
$T_b = T_1$

$$\Delta S_{univ} = \frac{-81960\,J}{1503,4\,K} + \frac{52343\,J}{300\,K} = 120,0\ J/K$$