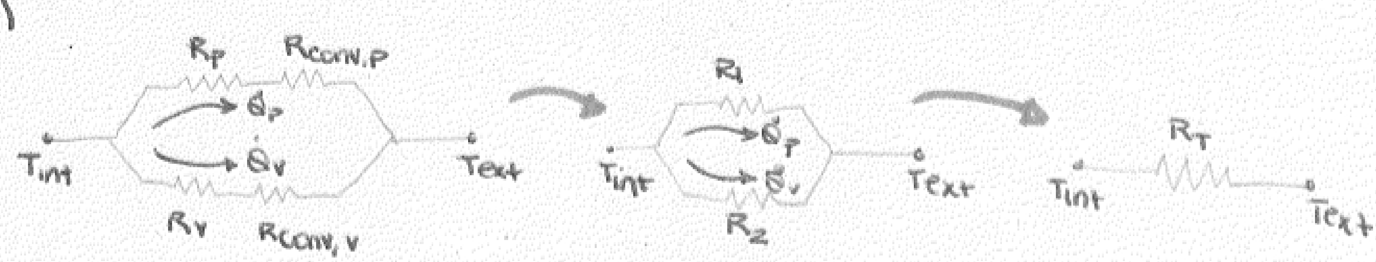
Ejercicio 1

a)



$$R_p = \frac{e_L}{k_L A_p} = \frac{0{,}2\,m}{0{,}7\,\frac{W}{mK}\;70\,m^2} = 4{,}08 \times 10^{-3}\,\frac{K}{W}$$

$$R_v = \frac{e_v}{k_v A_v} = \frac{5\times10^{-3}\,m}{10\,\frac{W}{mK}\cdot 5m^2} = 1{,}0\times10^{-3}\,K/W$$

$$R_{conv,v} = \frac{1}{h_c A_v} = \frac{1}{20\,\frac{W}{m^2K}\cdot 5m^2} = 1{,}0\times10^{-2}\,\frac{K}{W}$$

$$R_{conv,p} = \frac{1}{h_c A_p} = \frac{1}{20\,\frac{W}{m^2K}\cdot 70m^2} = 7{,}14\times10^{-4}\,\frac{K}{W}$$

$$\dot{Q}_T = \dot{Q}_p + \dot{Q}_v = \frac{1}{R_T}\,(T_{int} - T_{ext})$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4{,}8\times10^{-3}\,\frac{K}{W}} + \frac{1}{1{,}1\times10^{-2}\,\frac{K}{W}}$$

$$\Downarrow$$

$$\boxed{R_T = 3{,}34\times10^{-3}\,K/W}$$

$$\begin{cases} R_1 = R_p + R_{conv,p} = 4{,}8\times10^{-3}\,K/W \\ R_2 = R_v + R_{conv,v} = 1{,}1\times10^{-2}\,K/W \end{cases}$$

b)

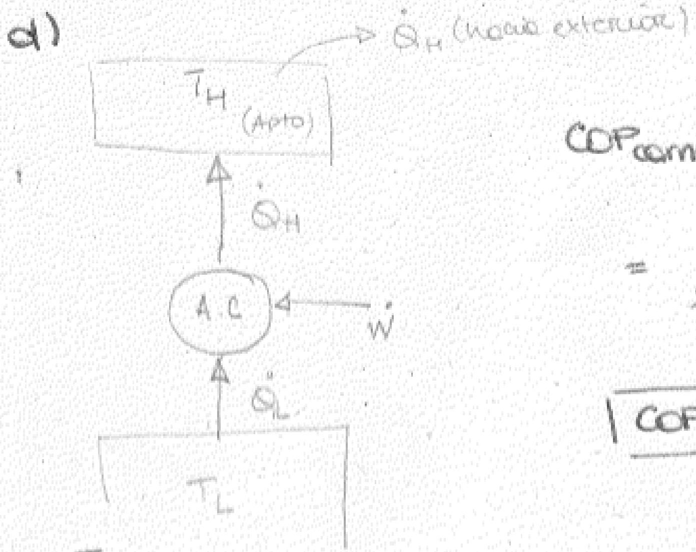
$$\dot{Q}_T = \frac{1}{3{,}34\times10^{-3}\,\frac{K}{W}}\,(\overbrace{294{,}15\,K - 282{,}15\,K}^{=12\,K})$$

$$\boxed{\dot{Q}_T = 3{,}59\times10^{3}\,W}$$

c) El apartamento se mantiene a T constante.

Al estar en régimen estacionario $\Rightarrow \Delta \dot{S} = 0$

d)



$T_L = 282,15\,K$

$T_H = 294,15\,K$

$$COP_{carnot} = \frac{Q_H}{W} = \frac{Q_H}{Q_H - Q_L} = \frac{T_H}{T_H - T_L} =$$

$$= \frac{1}{1 - \frac{T_L}{T_H}} = \frac{1}{1 - 0{,}96}$$

$$\boxed{COP_{carnot} = 24{,}5}$$

e) $COP_{aire\,ac.} = 0{,}2\, COP_{carnot} = 4{,}9$

$\quad \parallel$

$\quad \frac{Q_H}{W}$

$$\text{nuevo consumo} = \dot{W}_{del\,aire} = \frac{\dot{Q}_H}{COP_{aire}} = \frac{2700\,W}{4{,}9} = 551\,W$$

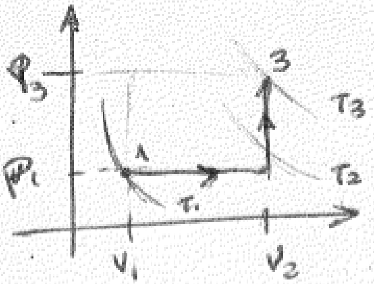
$$\Rightarrow \boxed{\dot{W}_{aire} = 551\,W}$$

f) $\Delta S_{ciclo} = 0$

La entropía es una variable de estado $\Rightarrow$ cambio S en un proceso sólo depende de estado inicial y final.

En un ciclo $S_i = S_f \Rightarrow \Delta S_{ciclo} = S_f - S_i = 0$

2)



$T_1 = 293,15K$

$T_2 = 322,465$

$T_f = 340K \rightarrow V_f = V_2$

a) $\Delta S_{gas} = n c_v \ln\left(\frac{T_f}{T_i}\right) + nR \ln\left(\frac{V_f}{V_i}\right)$

$\Delta S_{gas} = 7,22 \text{ mol} \left[30 \frac{J}{mol K} \cdot \ln\left(\frac{351,78K}{293,15K}\right) + 8,314 \frac{J}{mol K} \ln\left(\frac{0,176 m^3}{0,16 m^3}\right) \right]$

$= 7,22 \text{ mol} \left[30 \frac{J}{mol K} \cdot \ln(1,2) + 8,314 \ln(1,1) \right]$

$\boxed{\Delta S_{gas} = 45,21 \frac{J}{K}}$

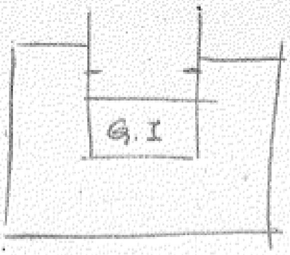
b) $\Delta S_{agua} = \int_i^f \frac{\delta Q_{agua}}{T}$ $\qquad \delta Q_{agua} = mc\,dT$

$= \int_{T_i}^{T_f} mc \frac{dT}{T} = mc \ln\left(\frac{T_f}{T_i}\right) = 200 kg \cdot 4,190 \times 10^3 \frac{J}{kg K} \ln\left(\frac{351,78}{293,15}\right)$

$\boxed{\Delta S_{agua} = 152,78 \times 10^3 \frac{J}{K}}$

c) No se puede debido a que no sabemos cómo se calienta el agua.

d)



Gas ideal: $c_V = 30\,J/mol\,K$

- Estado inicial: $P_1 = 110\,kPa$, $V_1 = 0{,}16\,m^3$, $T_1 = 293{,}15\,K$
- Estado intermedio: $P_2 = P_1$, $V_2 = 0{,}176\,m^3$, $T_2 = 322{,}465\,K$
- Estado final (3) $P_3 = 120\,kPa$, $V_3 = V_2$, $T_3 = 351{,}78\,K$

} Antes de agregar el hielo.

- $n = 7{,}22\,mol$.

Cuando el sistema esté en el estado 3, se le agrega $m_{hielo} = 15{,}55\,kg$ de hielo a $T_H = -10°C = 263{,}15\,K$ (a los 200kg de agua)
La temperatura final del sistema es $T_F = 340\,K$

- Como $T_F = 340 > T_2$ $\rightarrow$ el pistón sigue en los topes ~~kg~~ $(V_f = V_2 = 0{,}176\,m^3)$

- $\Delta S_U = \Delta S_{gas} + \Delta S_{hielo} + \Delta S_{agua}$

- Agua: $dS = \frac{\delta Q}{T} \rightarrow \Delta S_a = \int_{T_3}^{T_F} m_{agua}\cdot c_{agua}\frac{dT}{T} = m_{agua}\, c_{agua} \ln\left(\frac{340}{351{,}78}\right)$

$\Delta S_a = 200kg \cdot 4{,}19 \frac{kJ}{kg\,K}(-0{,}034)$

$\boxed{\Delta S_a = -28{,}54\, kJ/K}$

- Hielo: $-10°C$ a $0°C$ sólido; funde; $0°C$ a T_F $\rightarrow$ líquido

$\Delta S_H = m_H \cdot c_{V\,hielo} \cdot \ln\left(\frac{273{,}15K}{263{,}15K}\right) + \frac{m_H \cdot l_{hielo}}{273{,}15K} + m_H\, c_{agua} \ln\left(\frac{340K}{273{,}15K}\right)$

$\Delta S_H = 15{,}55kg\left[2{,}2\frac{kJ}{kg\,K}\cdot 0{,}037 + 333\frac{kJ}{kg}\cdot\frac{1}{273{,}15K} + 4{,}19\frac{kJ}{kg\,K}\cdot 0{,}219\right]$

$\boxed{\Delta S_H = 34.49\,\frac{kJ}{K}}$

- Gas: Como $V = cte$ $\quad \Delta U = Q + \cancel{W}^{0} \rightarrow dQ = n c_V\, dT$

$\Delta S_{gas} = n c_V \ln\left(\frac{340K}{351{,}78}\right)$

$\Delta S_{gas} = 7{,}22\,mol \cdot 30\frac{J}{mol\,K}(-0{,}0341) = -7{,}377\,J/K = -7{,}38\times10^{-3}\,\frac{kJ}{K}$ $\quad \boxed{\Delta S_g = -7{,}38\times10^{-3}\,\frac{kJ}{K}}$

$\Delta S_U = (-28{,}54 + 34.49 - 7{,}38\times10^{-3})\frac{kJ}{K}$ $\quad \boxed{\Delta S_U = 5.94\, kJ/K}$

$\boxed{\text{Ejercicio 3}}$

a) $Y_1(x,t) = 5\times10^{-2}m \text{ sen}(k_1x - \omega_1 t + \phi_1)$

$$k_1 = \frac{2\pi}{\lambda_1} = \frac{2\pi}{Tv_1} = \frac{2\pi}{0{,}22s \cdot 25m/s} = \boxed{1{,}14 m^{-1} = k_1}$$

$$\lambda_1 = v_1 T$$

$$\boxed{\omega_1 = \frac{2\pi}{T} = 28{,}56 \text{ Hz}}$$

$$Y_1(0,0) = 0 = 5\times10^{-2}m \text{ sen}(\phi_1)$$

$$\Rightarrow \phi_1 = 0, \pi$$

$$\dot{Y}_1(0,0) = 5\times10^{-2}m(-\omega_1)\cos(\phi_1) < 0 \Rightarrow \boxed{\phi_1 = 0}$$

$$\Rightarrow \boxed{Y_1(x,t) = 5\times10^{-2}m \text{ sen}(1{,}14x - 28{,}56t)}$$

b)

$$y_2(x,t) \begin{cases} \omega_1 = \omega_2 \\ A_1 = A_2 \\ k_1 \neq k_2 \end{cases}$$

$$\uparrow$$

$$k_2 = \frac{2\pi}{\lambda_2} = \frac{2\pi}{v_2 T} = \frac{2\pi}{0{,}22s \cdot 20m/s} = 1{,}43 m^{-1}$$

$$Y_2(0,0) = Y_1(0,0)$$

$$Y_2(x,t) = 5\times10^{-2}m \text{ sen}(1{,}43x - 28{,}56t + \phi_2)$$

$$Y_2(x=11m, t=0) = 5\times10^{-2}m \text{ sen}(1{,}43 \cdot 11 + \phi_2) =$$

$$= Y_1(x=11m, t=0) = 5\times10^{-2}m \text{ sen}(1{,}14 \cdot 11)$$

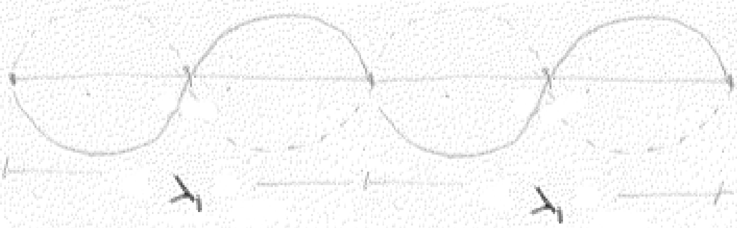
• Igualando las fases:

$$1{,}43 \cdot 11 + \phi_2 = 1{,}14 \cdot 11$$

$$\Rightarrow \phi_2 = (1{,}14 - 1{,}43) \times 11 = -3{,}19$$ (no es exactamente π por el redondeo)

$$Y_2(x,t) = 5\times10^{-2}m\,(1{,}43x - 28{,}56t - 3{,}19)$$

c). $\lambda_1 = 25\ m/s \cdot 0{,}22\ s = 5{,}5\ m$



existen 4 antinodos en la cuerda 1

d) $L_2 = m\frac{\lambda_2}{2}$ $\lambda_2 = 20\frac{m}{s} \cdot 0{,}22\ s = 4{,}4\ m$

$m=1 \Rightarrow \boxed{L_2 = 2{,}2\ m}$ menor longitud posible

para tener L_2 lo menor posible

e) Función de onda estacionaria en la cuerda 1:

$$Y_{est,1}(x,t) = \underbrace{2{,}5\times10^{-2}\ m}_{=2A_1}\ sen(k_1 x)\cos(\omega_1 t)$$

$$\boxed{Y_{est,1}(x,t) = 0{,}1\ m\ sen(1{,}14\,x)\cos(28{,}56\,t)}$$