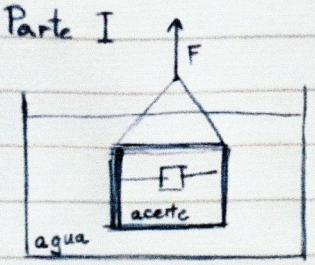
1. Parte I



eq. mecánico (caja de hierro):

$$F + E - m_{Total}\, g = 0 \longrightarrow F = m_{Total}\, g - E$$

- $E = \rho_{agua} L^3 g$
- $m_{Total}\, g = (m_{Fe} + m_{aceite} + m_{madera})g$

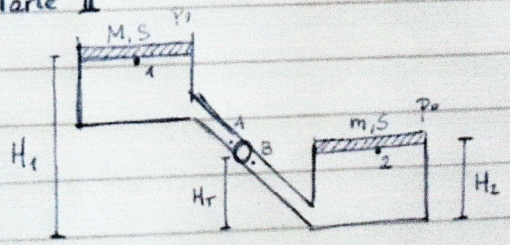
$\rightarrow m_{Fe} = 6\varepsilon L^2 \rho_{Fe}$; La forma exacta: $m_{Fe} = \rho_{Fe}\left(L^3 - (L-2\varepsilon)^3\right)$

$\rightarrow m_{aceite} = \rho_{aceite} V_{aceite} = 0.7 L^3 \rho_{aceite}$

$\rightarrow$ eq. mecánico (madera): $E = m_{madera}\, g \longrightarrow m_{madera} = 0.85\, V_m \rho_{aceite}$

$$\rightarrow \boxed{F = 6\varepsilon L^2 \rho_{Fe} g + 0.7 L^3 \rho_{aceite} g + 0.85 V_m \rho_{aceite} g - L^3 \rho_{agua} g}$$

Parte II



a) Bernoulli 1-A: (~ 0 ($v_1 \ll v_A$))

$$p_1 + \rho g H_1 + \tfrac{1}{2}\rho v_1^2 = p_A + \rho g H_T + \tfrac{1}{2}\rho v_A^2$$

$$\rightarrow p_A = p_1 + \rho g (H_1 - H_T) - \tfrac{1}{2}\rho v_A^2$$

Bernoulli 2-B: (~ 0)

$$p_2 + \rho g H_2 + \tfrac{1}{2}\rho v_2^2 = p_B + \rho g H_T + \tfrac{1}{2}\rho v_B^2$$

eq. mecánico (tapas): $p_1 S = Mg + p_0 S$

$p_2 S = mg + p_0 S$

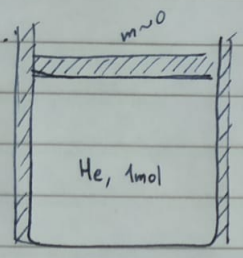
además $v_A = v_B$ (continuidad)

$$\rightarrow \boxed{p_A - p_B = \frac{(M-m)g}{S} + \rho g (H_1 - H_2)}$$

b) potencia: $\dfrac{dW_T}{dt} = F_T v = (p_A - p_B) A v = A v \left[\dfrac{(M-m)g}{S} + \rho g (H_1 - H_2)\right]$

$$\boxed{\frac{dW_T}{dt} \text{ es máxima para } m = 0}$$

2.



$n = 1\,mol$, monoatómico

a)

Estado 1: $T_1 = 300K$, $p_1 = 200kPa$, $V_1 = 0.01247m^3$

$V_1 = \frac{nRT_1}{p_1} = 0.01247m^3$

1 → 2 : expansión isotérmica, $V_2 = 3V_1$

Estado 2 : $T_2 = 300K$, $p_2 = 66.7kPa$, $V_2 = 0.03742m^3$

$p_2 = \frac{nRT_2}{V_2} = 66.67kPa$

2 → 3 : compresión adiabática $V_3 = 2V_1$

Estado 3 : $T_3 = 393.3K$ $p_3 = 131.1kPa$, $V_3 = 0.02494m^3$

$p_2 V_2^{\gamma} = p_3 V_3^{\gamma} \rightarrow p_3 = p_2 \left(\frac{V_2}{V_3}\right)^{\gamma} = p_2 \left(\frac{3}{2}\right)^{\gamma} = 131.1kPa$

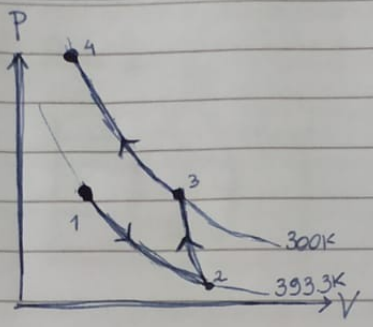
$\gamma = \frac{GL+2}{GL} = \frac{5}{3}$

$\frac{T_3}{T_2} = \frac{p_3 V_3}{p_2 V_2} \rightarrow T_3 = 393.3K$

3 → 4 compesión isotérmica $V_4 = \frac{2}{3} V_1$

Estado 4 : $T_4 = 393.3K$, $p_4 = 393.4kPa$, $V_4 = 0.008313m^3$

$p_4 = \frac{nRT_4}{V_4} = 393.4kPa$



b) $\boxed{\Delta U = \frac{3}{2} nR\Delta T = 1.164\,kJ}$

c) $1 \to 2$: $Q_{12} = \Delta U_{12}^{\,0\ (\Delta T=0)} - W_{12} = \int_{V_1}^{V_2} p\,dV = nRT_1 \int_{V_1}^{V_2} \frac{dV}{V} = nRT_1 \ln\left(\frac{V_2}{V_1}\right)$

$\to \boxed{Q_{12} = 2.740\,kJ}$

$2 \to 3$: $\boxed{Q_{23} = 0}$ (adiabático)

$3 \to 4$: $Q_{34} = nRT_3 \ln\left(\frac{V_4}{V_3}\right) \to \boxed{Q_{34} = -3.593\,kJ}$

d) $W_{12}^{gas} = -W_{12} = Q_{12} \to \boxed{W_{12}^{gas} = 2.740\,kJ}$

$W_{23}^{gas} = -W_{23} = -\Delta U_{23} = \frac{3}{2} nR\Delta T_{23} \to \boxed{W_{23}^{gas} = -1.164\,kJ}$

$W_{34}^{gas} = Q_{34} \to \boxed{W_{34}^{gas} = -3.593\,kJ}$

e) $\boxed{\Delta S_{12} = \Delta S_{12}^{gas} + \Delta S_{12}^{fuente} = 0}$ ($\Delta S_{12}^{gas} = \frac{Q_{12}}{T_1}$, $\Delta S_{12}^{fuente} = \frac{-Q_{12}}{T_1}$)

$\boxed{\Delta S_{23} = 0}$ (adiabático)

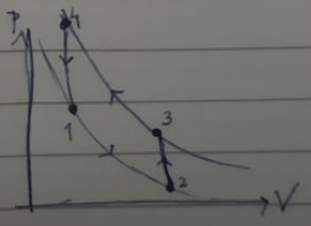
$\boxed{\Delta S_{34} = \Delta S_{34}^{gas} + \Delta S_{34}^{fuente} = 0}$ ($\Delta S_{34}^{gas} = \frac{Q_{34}}{T_3}$, $\Delta S_{34}^{fuente} = \frac{-Q_{34}}{T_3}$)

f) existe proceso adiabático $4 \to 1$:

$p_4 = \frac{T_4}{T_1}\frac{p_1 V_1}{V_4} = p_1 \left(\frac{V_1}{V_4}\right)\frac{T_4}{T_1} = \frac{3}{2} p_1 \frac{T_3}{T_2} = \left(\frac{3}{2}\right)^{\gamma} p_1$ ($\frac{V_1}{V_4} = \frac{3}{2}$)

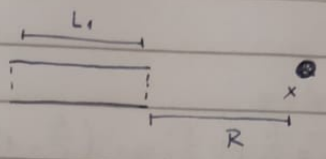
$\hookrightarrow T_2 V_2^{\gamma-1} = T_3 V_3^{\gamma-1} \to \frac{T_3}{T_2} = \left(\frac{V_2}{V_3}\right)^{\gamma-1} = \left(\frac{3}{2}\right)^{\gamma-1}$

$\to \boxed{p_4 V_4^{\gamma}} = \left(\frac{3}{2}\right)^{\gamma} p_1 \left(\frac{2}{3}\right)^{\gamma} V_1^{\gamma} = \boxed{p_1 V_1^{\gamma}}$



→ el ciclo completo es ciclo de Carnot, $\Delta S = 0$

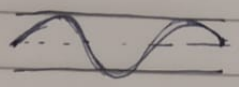
3. Parte I



R = 40cm

$L_1 = 60\,cm$

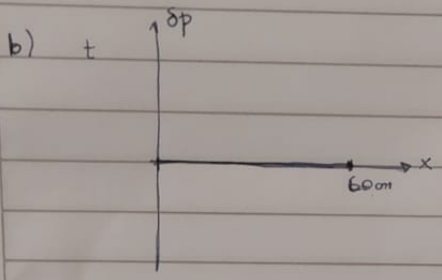
a) 3er armónico



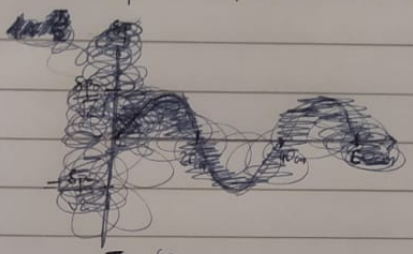
$L_1 = \frac{3}{2}\lambda \rightarrow \boxed{\lambda = \frac{2L_1}{3} = 40cm}$

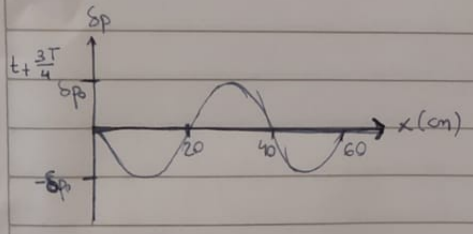
$v = \lambda f \rightarrow \boxed{f = \frac{v}{\lambda} = 857.5Hz}$

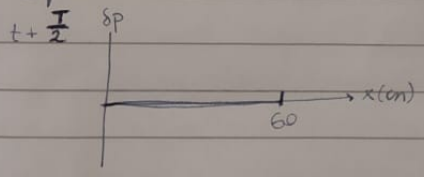
b)



$\delta p(x,t) = \delta p_0 \sin(kx)\sin(\omega t)$





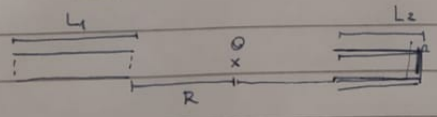


c) $NI = 80dB = 10\log_{10}\frac{I}{I_0} \rightarrow 10^8 \cdot I_0 = I$

$I = \frac{\bar{P}}{A} = \frac{\bar{P}}{4\pi r^2}$

$\bar{P} = (4\pi r^2) \times 10^{-4}\frac{W}{m^2} = \boxed{201.1\mu W}$

Parte II



$L_2 = 30cm$

a) segundo armónico:

$L_2 = \frac{3}{4}\lambda \rightarrow \lambda_2 = \frac{4L_2}{3} = 40cm$

$\rightarrow f_2 = 857.5Hz = f_1$

no hay pulsaciones, frecuencia de batido es 0

d) $f_1 - f_2' = 5\,Hz$

$\rightarrow f_2' = 852.5\,Hz$

$$f_2' = f_2 \frac{v_s}{v_s + v_f} \rightarrow \frac{f_2'}{f_2}(v_s + v_f) = v_s$$

$$\rightarrow \boxed{v_f = \frac{f_2}{f_2'}\left(1 - \frac{f_2'}{f_2}\right) v_s = \left(\frac{f_2}{f_2'} - 1\right) v_s = 2.01\,m/s}$$