Problema 1

a) Bernoulli entre la superficie del tanque y la salida a la atmósfera

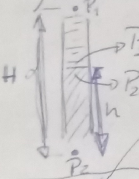
$$v_{f1} = \sqrt{2gH_1}$$
$$v_{f2} = \sqrt{2gH_2}$$

Continuidad entre el punto 1 y la salida

$$a v_1 = \frac{a}{5} v_{1f} \longrightarrow \boxed{v_1 = \frac{\sqrt{2gH_1}}{5}}$$
$$a v_2 = \frac{a}{2} v_{2f} \longrightarrow \boxed{v_2 = \frac{\sqrt{2gH_2}}{2}}$$

(a)

b) Analizando la presión en la interfaz



$$P_1' = P_2'$$

$$P_1 = P_0 + \frac{1}{2}\rho_1 v_{f1}^2 - \frac{1}{2}\rho_1 v_1^2$$ y el fine

Bernoulli entre el punto 1 y el fine

$$P_2 = P_0 + \frac{1}{2}\rho_2 v_{f2}^2 - \frac{1}{2}\rho_2 v_2^2$$ y el fine

Bernoulli entre el punto 2 y el fine

$$P_1' = P_1 + \rho_1 g (H-h)$$
$$P_2' = P_2 - \rho_2 g h$$
$\longrightarrow P_1' = P_2'$ y sustituyendo v_1 y v_2 hallados en a

$$h = \frac{1}{(\rho_2 - \rho_1)}\left[\frac{3}{4}\rho_2 H_2 - \frac{24}{25}\rho_1 H_1 - \rho_1 H\right]$$

usando $\rho_2 = 12\rho_1$

(b) $$\boxed{h = \frac{1}{11}\left(9H_2 - H - \frac{24}{25}H_1\right)}$$

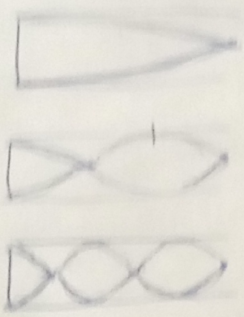
(c) Cuando $h = \frac{H}{2}$ → sustituyendo en (b)

$$\frac{13}{2}H = 9H_2 - \frac{24}{25}H_1 \longrightarrow H = \frac{2}{13}\left(9H_2 - \frac{24}{25}H_1\right)$$

$$H = \frac{2}{13}\left(9\times 65 - \frac{24}{25}50\right)$$

(c) $$\boxed{H = 82{,}6 \text{ cm}}$$

Problema 2

1)  $L_T = \frac{\lambda_T}{4}$

2) $L_T = \frac{3}{4}\lambda_T$

3) $L_T = \frac{5}{4}\lambda_T$

$$L_T = \frac{(2n-1)}{4}\lambda_T \quad n = 1, 2, 3, \ldots$$

$$\lambda_T = \frac{4}{(2n-1)} L_T$$

$$v_S = \lambda_T \nu_T$$

$$\boxed{\nu_T = \frac{v_S}{\lambda_T} = \frac{v_S}{4L_T}(2n-1)}$$

$n = 3$

$$\nu_{T3} = \frac{5}{4}\,\frac{343}{0,7}$$

$$\boxed{\nu_{T3} = 612,5\ Hz}$$

$$\Delta p_x = \Delta p_{max}\,\mathrm{sen}(kx+\varphi)\cos\omega t$$

$$k = \frac{2\pi}{\lambda_T} = \frac{2\pi}{4L_T}(2n-1)$$

$x = L_T$

$$\mathrm{sen}(L_T k + \varphi) = 0 = \mathrm{sen}\left(\frac{2\pi(2n-1)}{4} + \varphi\right)$$

$$= \mathrm{sen}\left((2n-1)\frac{\pi}{2} + \varphi\right) = 0$$

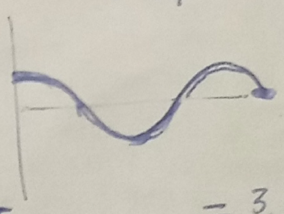
$$\boxed{\varphi = \frac{\pi}{2}}$$

$$\mathrm{sen}\left(kx + \frac{\pi}{2}\right) = \mathrm{sen}\,kx\cos\frac{\pi}{2} + \cos kx\,\mathrm{sen}\frac{\pi}{2} = \cos kx$$

a)
$$\boxed{\Delta p_x = \Delta p_{max}\cos(kx)\cos\omega t}$$

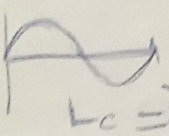
$$\boxed{k = \frac{2\pi}{4L_T}(2n-1) \qquad \omega = v_S k}$$

$$\omega = 2\pi\nu = 2\pi\frac{v_S}{\lambda_T} = k v_S$$

b) 

c) $$v_C = \sqrt{\frac{T}{\mu}} \rightarrow \mu = \frac{T}{v_C^2} = \frac{T}{(\nu L_C)^2} = \frac{T}{\left(\frac{v_S}{L_T}\left(\frac{5}{4}\right)L_C\right)^2} = 3,33\times 10^{-3}\ \frac{Kg}{m}$$

$$v_C = \nu\lambda_C = \nu L_C$$



$L_C = \lambda_C$

0,4

c) $$\boxed{m = \mu L_C = 1,33\ g}$$

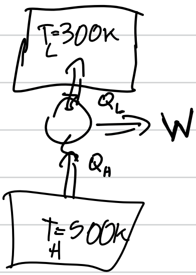
d) $$\nu_{T3} = \frac{5}{4}\,\frac{v_S'}{L_T'} \longrightarrow L_T' = \frac{5}{4}\,\frac{v_S'}{\nu_{T3}} = \ldots$$

$$v_S' = \sqrt{\frac{B'}{\rho_0}} = 1029,7\ m/s$$

d) $$\boxed{L_T' = \frac{5}{4}\,\frac{1029,7}{612,5} = 2,1\ m}$$

Datos

- $Q_H = 10\ kJ$
- $Q_L = 8\ kJ$
- $T_H = 500K$
- $T_L = 300K$
- $P_i = 101\ kPa = P_0$
- $V_i = 0{,}05\ m^3$
- Diatómico $\Rightarrow \gamma = 1{,}4 = \frac{7}{5}$
- $n = 2\ mol$
- $A = 0{,}5\ m^2$



a) $W = 2\ kJ \Rightarrow e = \frac{W}{Q_H} = \boxed{0{,}2}$

b) $\Delta U = n\frac{5}{2}R(T_f - T_i) = W + Q = W \Rightarrow \boxed{T_f = T_i + \frac{W}{n\frac{5}{2}R} = 351{,}1\ K}$

$$T_i = \frac{P_i V_i}{nR} = \frac{101\times10^3\ 0{,}05 m^3}{2\ mol\ 8{,}31\ J/mol\,K} = 303\ K$$

$$P_f V_f^{\gamma} = P_i V_i^{\gamma} = nRT_f V_f^{\gamma-1} = P_i V_i^{\gamma} \Rightarrow \boxed{V_f = \left(\frac{P_i V_i^{\gamma}}{nRT_f}\right)^{\frac{1}{\gamma-1}} = \left(\frac{101\times10^3\ (0{,}05)^{1{,}4}}{2\times8{,}31\times351}\right)^{\frac{1}{0{,}4}} = 0{,}034\ m^3}$$

$$P_f V_f = nRT_f \Rightarrow \boxed{P_f = \frac{nRT_f}{V_f} = \frac{2\times8{,}31\times351}{0{,}034} = 171\ kPa}$$

$$x = \frac{V_f - V_i}{A} = \frac{0{,}05 - 0{,}034 m^3}{0{,}5\ m^2} = 0{,}032\ m = \boxed{3{,}2\ cm}$$

c)

$$e_{Carnot} = 1 - \frac{T_L}{T_H} = 1 - \frac{300K}{500K} = 0,4 = \frac{W_{car}}{10kJ} \Rightarrow W_{car} = \boxed{4kJ}$$

$$T_f = T_i + \frac{W}{n\frac{5}{2}R} = 303K + \frac{4kJ}{5\times 8,31} = 400K$$

$$V_f = \left(\frac{P_i V_i^\gamma}{nRT_f}\right)^{\frac{1}{\gamma-1}} = \left(\frac{101\times10^3 \times (0,05)^{1,4}}{2\times 8,31\times 400}\right)^{\frac{1}{0,4}} = 0,025\ m^3$$

$$\Rightarrow x_{car} = \frac{0,025\ m^3}{0,5\ m^2} = 0,05\ m = \boxed{5\ cm}$$

d)

$$\Delta S_{I} = \frac{8kJ}{300K} - \frac{10kJ}{500K} = \boxed{6,6\ J/K}$$

$$\Delta S_{II} = \boxed{0}$$