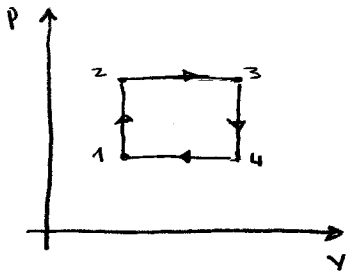
EXAMEN 14/12/2019 F2 (1152) (SOLUCIONES)

① 

	P(Pa)	V(m³)	T(K)
1	101 K	0,05	300 K
2	199 K	0,05	591 K
3	199 K	0,1	1182 K
4	101 K	0,1	600 K

$P_2 = P_1 + \frac{mg}{A} = 199\ kPa \longrightarrow T_2 = \frac{P_2 V_2}{nR} = \frac{P_2 V_2}{P_1 V_1} T_1 = 591\ K.$

$T_3 = \frac{P_3 V_3}{P_2 V_2} T_2 = 2T_2 = 1182\ K.$

$nR = \frac{P_1 V_1}{T_1} = 0,016893\ K$

$T_4 = \frac{P_4 V_4}{P_3 V_3} T_3 = 600\ K.$

b) $\eta_c = 1 - \frac{T_L}{T_H} = 76\%.$ $(T_L = 17°C = 290\ K,\ T_H = 1200\ K)$

c) $1 \to 2$ $W_{12} = 0$ $Q_{12} = nC_v (T_2 - T_1) = 12\ kJ$ $(C_v = \frac{5}{2}R)$ $(C_p = \frac{7}{2}R)$

$2 \to 3$ $W_{23} = -P_2 (V_3 - V_1) = -10\ kJ$ $Q_{23} = nC_p (T_3 - T_2) = 35\ kJ$

$3 \to 4$ $W_{34} = 0$ $Q_{34} = nC_v (T_4 - T_3) = -24,5\ kJ$

$4 \to 1$ $W_{41} = P_1 (V_3 - V_1) = +5\ kJ$ $Q_{41} = -17,5\ kJ$

d) $\eta = \frac{W_N}{Q_{in}} = \frac{|W_{23} + W_{41}|}{|Q_{12} + Q_{23}|} = 0,10 \Rightarrow 10\%$

e) $\Delta S_u = -\frac{|Q_{in}|}{T_H} + \frac{|Q_{out}|}{T_L} = 106\ J/K.$

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③ $\delta W = \vec{F}_N \cdot d\vec{r}$ $\frac{\delta W}{dt} = A \Delta P \frac{dr}{2} \longrightarrow \dot{W} = \dot{V} \Delta P$

DEMOSTRACIÓN EJ ③

$\dot{V} = A \frac{dr}{dt}$

② a) $\Delta p_{He}(x,t) = \Delta p_{M_1} \operatorname{sen}(k_1 x + \varphi_1) \cos \omega t$

$\Delta p_{He}(x=0,t) = 0 \longrightarrow \operatorname{sen}\varphi_1 = 0 \longrightarrow \varphi_1 = 0$

$\Delta p_{He}(x=L_1,t) = 0 \longrightarrow \operatorname{sen}(k_1 L) = 0 \longrightarrow k_1 = \frac{n\pi}{L_1}$

$\Delta p_{Aire}(x,t) = \Delta p_{M_2} \operatorname{sen}(k_2 x + \varphi_2) \cos \omega t$

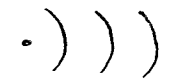
$\Delta p_{Aire}(x=0,t) = 0 \longrightarrow \varphi_2 = 0$

$\Delta p_{Aire}(x=L_2,t) = \Delta p_{M_2} \cos \omega t \longrightarrow \operatorname{sen}(k_2 L_2) = 1 \longrightarrow k_2 = \frac{m\pi}{2L_2}$

$n, m = 1 \longrightarrow k_1 = \frac{\omega}{v_{He}} = \frac{\pi}{L_1} \longrightarrow L_1 = 0{,}98\ m \quad (\omega = 2\pi\nu)$

$k_2 = \frac{\omega}{v_{Ai}} = \frac{\pi}{2L_2} \longrightarrow L_2 = 0{,}16\ m$

b) i)



$v'_s = v_s - v_o \longrightarrow f' = \frac{v'_s}{\lambda} = f\left(\frac{v_s - v_o}{v_s}\right)$

ii) $f' = f\left(1 + \frac{v_o}{v_s}\right)$

$f'' = f\left(1 - \frac{v_o}{v_s}\right)$

$\Big\rangle \quad f' - f'' = 2f\frac{v_o}{v_s} = 20\ Hz \longrightarrow v_o = 6{,}6\ m/s$

③ $D = 0{,}02\ m$
$H = 12\ m$
$h = 3\ m$

Continuidad: $A_2 v_2 = A_3 v_3 \longrightarrow v_3 = 4 v_2 \qquad A = \frac{\pi D^2}{4}$

Bernoulli 2-3 / $P_3 = P_0 \qquad P_2 + \frac{1}{2}\rho v_2^2 = P_0 + \rho g h + \frac{1}{2}\rho v_3^2$

Energía 3-4 $\qquad \frac{1}{2}\rho v_3^2 = \rho g H \longrightarrow v_2 = \frac{v_3}{4} = \sqrt{\frac{gH}{8}} = 3{,}83\ m/s$

$P_2 = P_0 + \rho g\left(h + \frac{15H}{16}\right) = 241\ kPa$

$P_1 = P_0 + \rho g h = 131\ kPa$

$\dot{W} = \dot{v}\,\Delta P = A v_2 (P_2 - P_1) = \frac{D^2\pi}{4} v_2 (P_2 - P_1) = 132\ W$