Soluciones Cuestiones

1./

$v = 134.0 \text{ km/h} = 134.0 \frac{\text{km}}{\text{h}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 37.22 \text{ m/s}$

$\sigma = 321.4 \frac{\text{din}}{\text{cm}} = 321.4 \frac{\text{din}}{\text{cm}} \cdot \frac{1 \text{ N}}{10^5 \text{ din}} \cdot \frac{1 \text{ cm}}{0.01 \text{ m}} = 0.3124 \frac{\text{N}}{\text{m}}$

$\eta = 0.12 \mu\text{P} = 0.12 \cdot 10^{-6} \frac{\text{din s}}{\text{cm}^2} \cdot \frac{1 \text{ N}}{10^5 \text{ din}} \cdot \frac{1 \text{ cm}^2}{10^{-4} \text{ m}^2} = 0.12 \cdot 10^{-7} \frac{\text{N}}{\text{m}^2} \text{s}$

$\rho = 13.1 \frac{\text{g}}{\text{cm}^3} = 13.1 \frac{\text{g}}{\text{cm}^3} \cdot \frac{1 \text{ kg}}{10^3 \text{ g}} \cdot \frac{10^6 \text{ cm}^3}{1 \text{ m}^3} = 13.1 \cdot 10^3 \text{ kg/m}^3$

$P = 1012 \text{ mbar} = 1012 \cdot 10^{-3} \text{ bar} \frac{10^2 \text{ Pa}}{10^{-3} \text{ bar}} = 1.012 \cdot 10^5 \text{ Pa}$

2/

$\rho_M = 1.030 \text{ g/cc} \longrightarrow \rho_A = 1.025 \text{ g/cc}$

$V_S = 100 \text{ m}^3$

$\rho_M > \rho_A \Rightarrow \bar{E}_M > \bar{E}_A \Rightarrow$ Debe descargar peso.

$\Delta E = E_M - E_A = (\rho_M - \rho_A) g V_S = (500 \text{ kg}) N = (\Delta m \, g) N$

$\Delta m = 500 \text{ kg}$

3/

$m = 150.0 \text{ g } H_2O \quad T_0 = 20^\circ\text{C}$

Foco térmico $T_F = -20^\circ\text{C}$

$T_{final} = -20^\circ\text{C} = T_F$

$\Delta S_a = \Delta S_{1a} + \Delta S_{2a} + \Delta S_{3a}$

$\Delta S_{1a} = \int_{20^\circ\text{C}}^{0^\circ\text{C}} \frac{\delta Q}{T} = \int_{293\text{K}}^{273\text{K}} \frac{mc_a dT}{T} = mc_a \ln \frac{273}{293}$

$\Delta S_{1a} = -44.40 \frac{\text{J}}{\text{K}}$

Agua $+20^\circ\text{C}$ → 1a → Agua 0°C → 2a → Hielo 0°C → 3a → Hielo -20°C

$$\Delta S_{2a} = \int \frac{L_f \, dm}{T} = \frac{m L_f}{T_{fusion}} = -184.06 \ J/K$$

$$\Delta S_{3a} = m c_h \ln \frac{273}{273} = -23.97 \ J/K$$

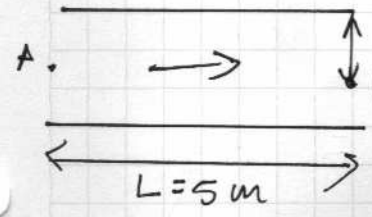
$$\Delta S_a = -252.4 \ J/K$$

$$\Delta S_f = \frac{m C_a (293-273) K}{253 K} + \frac{m L_f}{253 K} + \frac{m C_h (273-253) K}{253 K}$$

$$\Delta S_f = 273.2 \ J/K$$

$$\Delta S_T = \Delta S_a + \Delta S_f = 20.73 \ J/K$$

4/



$\Phi = 50.0 \ l/s$

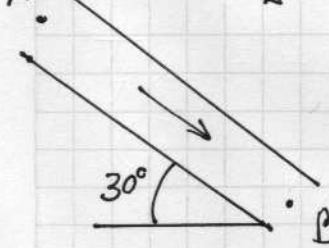
$\rho_r = 0.95$

$$\Phi = v_A S = v_B S \Rightarrow v_A = v_B = \frac{\Phi}{S} = 1.6 \ m/s$$

$S = \pi R^2$

$$\Delta P_{AB} = 0$$

5/



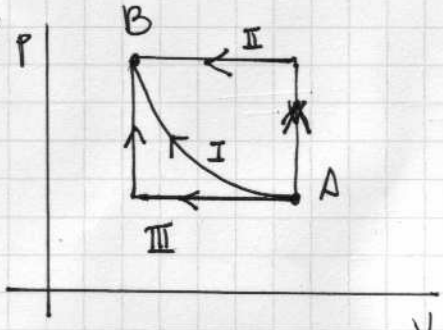
$v_A = v_B = 1.6 \ m/s$

$$P_A + \tfrac{1}{2}\rho v_A^2 + \rho g h_A = P_B + \tfrac{1}{2}\rho v_B^2 + \rho g h_B$$

$h_B = 0$

$$\Delta P_{AB} = \rho g h_A = \rho g L \sin 30° = 23275 \ Pa$$

6/

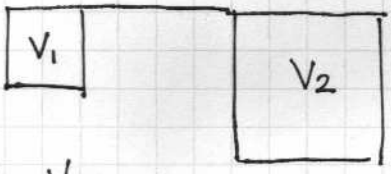


U función de estado

$\Delta U_I = \Delta U_{II} = \Delta U_{III} = \Delta U$

$T_A = T_B \Rightarrow \Delta U = 0$

7/



$V_1 = V_0$

$V_2 = 4V_0$

Expansión libre

$W = 0$

$\Delta U = 0$

$Q = 0$

$$\Delta S = nR \ln \frac{V_{final}}{V_{inicial}} = R \ln \frac{5V_0}{V_0} = R \ln 5 = 13.4 \ \frac{J}{K}$$

8/ $\rho = aT^4 + bT^2$ $\quad a, b$ cte

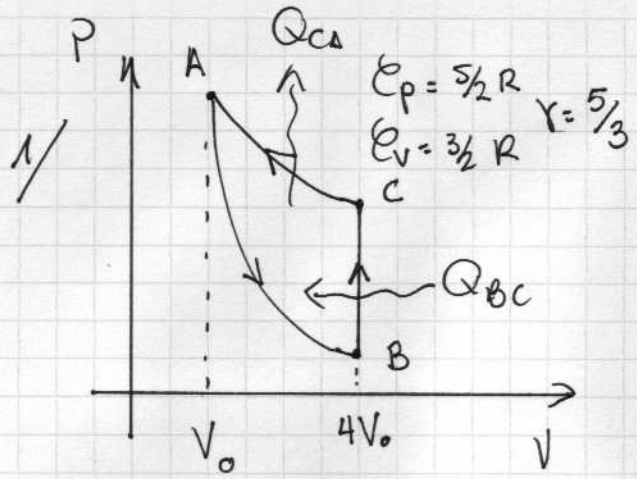
$$\beta = \frac{1}{V}\frac{dV}{dT} = -\frac{1}{\rho}\frac{d\rho}{dT} \quad (*)$$

$$\beta = -\frac{1}{aT^4+bT^2}\left(4aT^3+2bT\right) = -\frac{4aT^2+2b}{aT^3+bT}$$

(*) $\rho = m/V \qquad V = m/\rho$

$$dV = -m/\rho^2 d\rho$$

Soluciones Problemas



A	B	C
P_0	$4^{-\gamma}P_0$	$P_0/4$
V_0	$4V_0$	$4V_0$
T_0	$4^{1-\gamma}T_0$	T_0

(a)

$$P_0 V_0^\gamma = P_B V_B^\gamma \Rightarrow P_0 V_0^\gamma = P_B (4V_0)^\gamma \Rightarrow P_B = 4^{-\gamma} P_0 = 0.0992\, P_0$$

$$P_B V_B = nRT_B \Rightarrow T_B = \frac{P_B V_B}{nR} = \frac{4^{-\gamma} P_0 4V_0}{nR} = 4^{1-\gamma} T_0 = 0.397\, T_0$$

$$P_C V_C = nRT_C \Rightarrow P_C 4V_0 = nRT_0 \Rightarrow P_C = P_0/4$$

(b)

$$Q_{AB} = 0$$

$$\Delta U_{AB} = n C_v \Delta T = -\frac{3}{2} nR \left(1 - 4^{1-\gamma}\right) T_0 \qquad \Delta S_{AB} = 0$$

$$W_{AB} = -\Delta U_{AB} = \frac{3}{2} nR (1 - 4^{1-\gamma}) T_0$$

$$Q_{BC} = n C_v \Delta T = \frac{3}{2} nR \left(1 - 4^{1-\gamma}\right) T_0$$

$$\Delta U_{BC} = Q_{BC} = \frac{3}{2} nR (1 - 4^{1-\gamma}) T_0 \qquad \Delta S_{BC} = n C_v \ln \frac{T_C}{T_B} = -\frac{3}{2} nR \ln 4^{1-\gamma}$$

$$W_{BC} = 0$$

$$Q_{CA} = nRT_0 \ln \frac{V_A}{V_C} = -nRT_0 \ln 4 \qquad \Delta S_{CA} = -nR \ln 4$$

$$\Delta U_{CA} = 0 \quad W_{CA} = Q_{CA} = -nRT_0 \ln 4$$

$$\Delta U_T = \frac{3}{2} nR (1 - 4^{1-\gamma}) T_0 - \frac{3}{2} nR (1 - 4^{1-\gamma}) T_0 = 0$$

$$\Delta S_T = -nR \ln 4 - \frac{3}{2} nR \ln 4^{1-\gamma} = -nR \ln 4 - \frac{3}{2} nR \left(1 - \frac{5}{3}\right) \ln 4$$

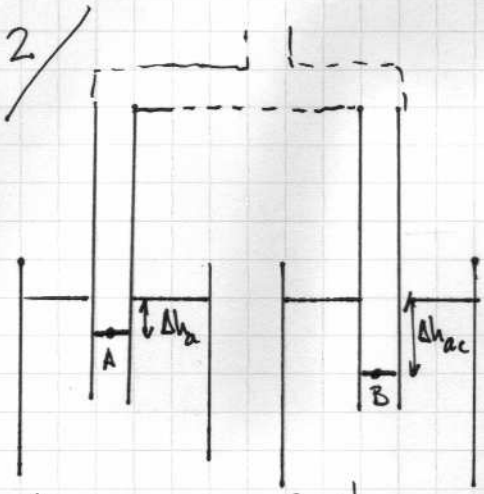
$$= -nR \ln 4 + nR \ln 4 = 0$$

$$W_T = Q_T = -nRT_0 \left(\ln 4 + \frac{3}{2}\left(4^{1-\gamma} - 1\right)\right)$$

c) Máquina frigorífica ($W_T < 0$)

$$K = \frac{Q_{BC}}{|W_T|} = \frac{1 - 4^{1-\gamma}}{1 - 4^{1-\gamma} - \frac{2}{3}\ln 4} \sim 0.75$$

2/



$V_0 \rightarrow V_f = V_0/2$ Proc. adiabático

$P_0 = P_{atm} \rightarrow P_f = P_{atm} + \Delta P$

No hace falta calcular ΔP.
Problema hidrostática

$$P_A = P_B = P_{atm} + \Delta P$$

$$P_A = P_{atm} + \rho_a g \Delta h_a$$

$$P_B = P_{atm} + \rho_{ac} g \Delta h_{ac}$$

$$\left.\begin{aligned} \Delta P &= \rho_a g \Delta h_a \\ \Delta P &= \rho_{ac} g \Delta h_{ac} \end{aligned}\right\} \quad 1 = \frac{\rho_a}{\rho_{ac}} \frac{\Delta h_a}{\Delta h_{ac}} \Rightarrow \underline{\rho_r = \frac{\Delta h_a}{\Delta h_{ac}}}$$

- La relación es idéntica si el proceso es adiabático o isotermo.

- Si $\theta_a < 90° \Rightarrow$ Moja las paredes $\Rightarrow h_a$ disminuye
  Si $\theta_{ac} > 90° \Rightarrow$ No moja " " $\Rightarrow h_{ac}$ crece

ρ_r disminuye respecto al valor obtenido sin tener en cuenta capilaridad

3/ (CGS) $\rightsquigarrow$ g, cm, s

$y(x,t) = 6 \sin(3\pi x - 2\pi t + \pi) = A \sin(kx - \omega t + \varphi)$

(a) $A = 6\,cm$

$\omega = 2\pi \Rightarrow \frac{2\pi}{T} = 2\pi \Rightarrow T = 1\,s$

$k = \frac{2\pi}{\lambda} \Rightarrow 3\pi = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2}{3}\,cm$

$v_{fase} = \lambda / T = \frac{2}{3}\,cm/s$

(b) $v_y(x,t) = -12\pi \cos(3\pi x - 2\pi t + \pi)$

$a_y(x,t) = -24\pi^2 \sin(3\pi x - 2\pi t + \pi)$

Para $x = 5.0\,cm \Rightarrow v_y(t) = -12\pi \cos(16\pi - 2\pi t)$

$a_y(t) = -24\pi^2 \sin(16\pi - 2\pi t)$

(c) $v_y(Máx) = \pm 12\pi\,cm/s$

(d) Si $x = 100\,cm \Rightarrow v_y(t) = -12\pi \cos(301\pi - 2\pi t)$

$v_y(Máx)$ si $301\pi - 2\pi t = n\pi \Rightarrow$

$\Rightarrow 301 - 2t = n \Rightarrow t = \frac{301 - n}{2}$

$t = 0.0\,s$

$0.5\,s$

$1.0\,s$

$\vdots$