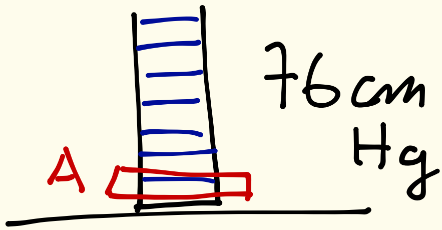
17/6/2020

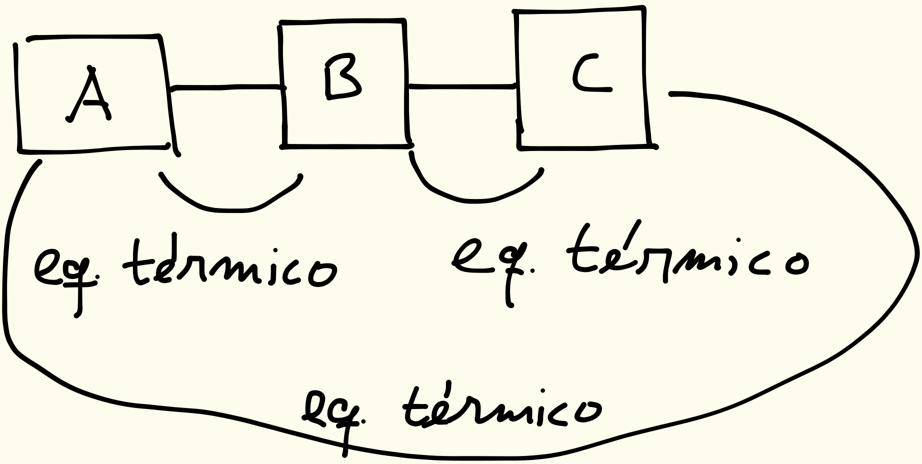
$$P = \frac{F}{A}, \quad 1\,atm$$



$$F = mg = \rho V g = \rho A h g$$

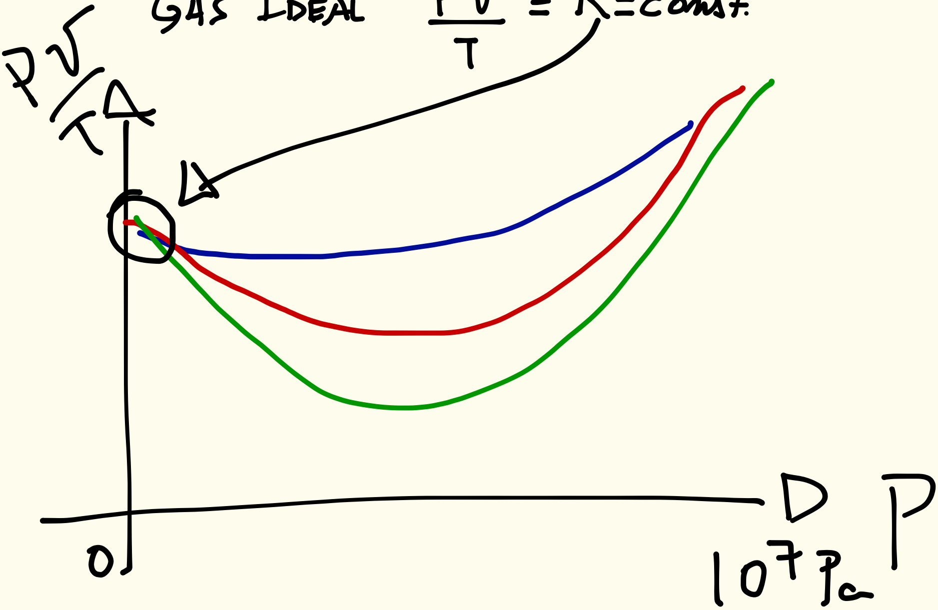
$$P_{atm} = \frac{\rho \cancel{A} h g}{\cancel{A}} = \rho h g \simeq 10^5 \frac{N}{m^2}$$

Lei Zero

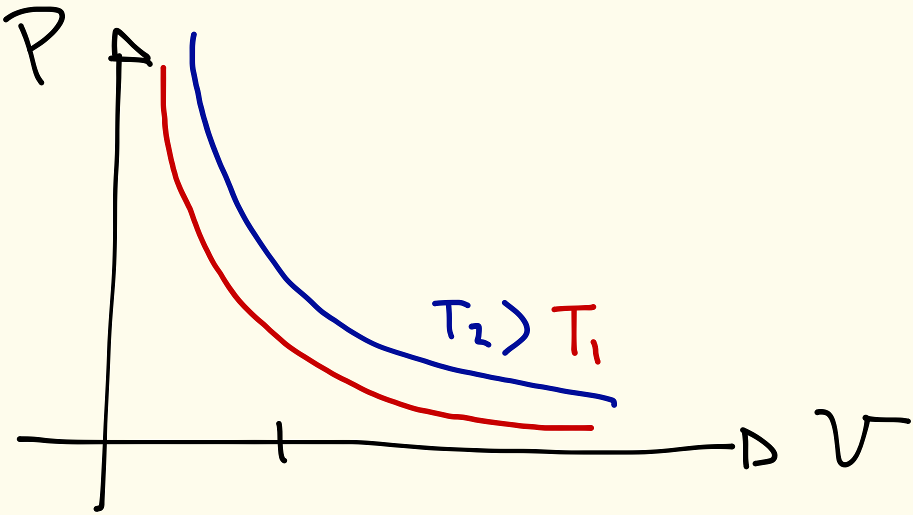


19/6/2020

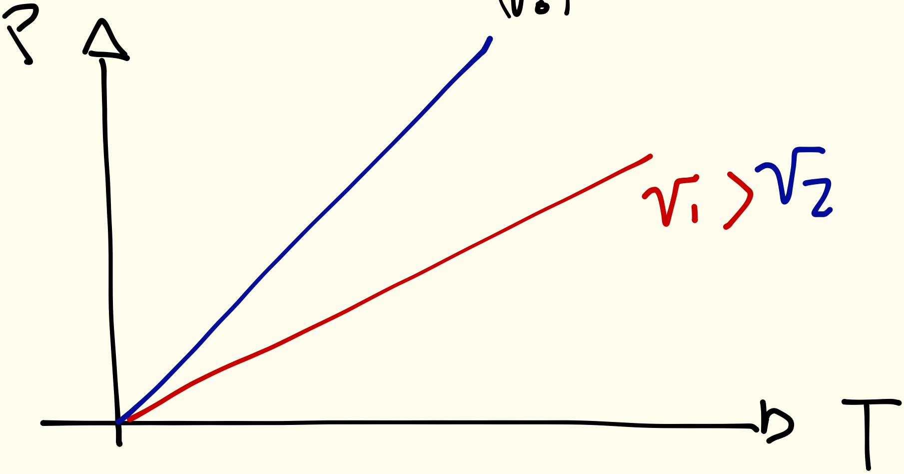
Gás Ideal $\frac{PV}{T} = R = \text{const.}$



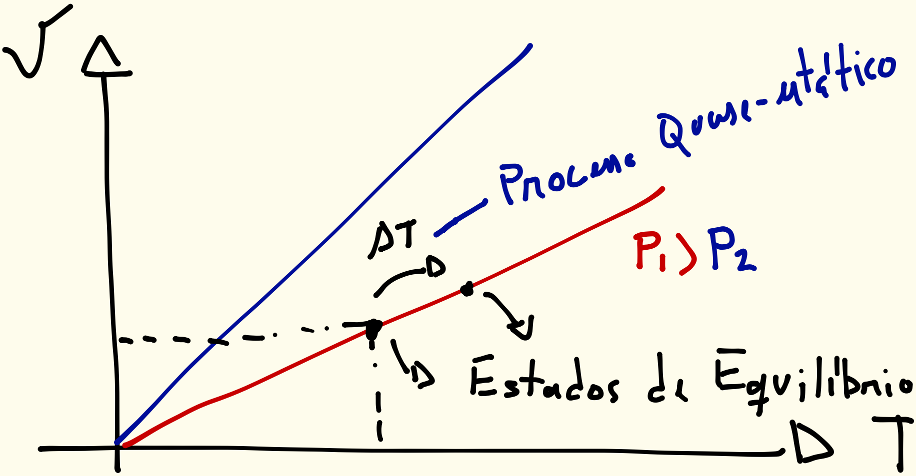
P. Isotérmico $T = T_0 \Rightarrow P = \frac{(RT_0)}{V}$



P. Isovolumétrico: $P = \left(\frac{R}{V_0}\right) T$



P. Isobárico : $V = \left(\frac{R}{P_0}\right) T$



24/6/20

Ponto crítico: $\left(\frac{\partial P}{\partial v}\right)_T = 0$ $\left(\frac{\partial^2 P}{\partial v^2}\right)_T = 0$

GÁS IDEAL: $Pv = RT$

$$P(v,T) = \frac{RT}{v} = (RT)v^{-1}$$

$$\frac{\partial P}{\partial v} = RT(-1)v^{-2} = -\frac{RT}{v^2}$$ $-\frac{RT}{v^2} = 0$ $\nexists$ sol.

$$\frac{\partial^2 P}{\partial v^2} = RT(-1)(-2)v^{-3} = \frac{2RT}{v^3}$$ $\frac{2RT}{v^3} = 0$ $\nexists$ sol.

O gás ideal não tem Ponto Crítico.

GÁS REAL: $\left(P + \frac{a}{v^2}\right)(v-b) = RT$

$$P + \frac{a}{v^2} = \frac{RT}{(v-b)} \Rightarrow P(v,T) = \frac{RT}{(v-b)} - \frac{a}{v^2}$$

$$P(v,T) = \frac{RT}{(v-b)} - \frac{a}{v^2}$$

$$\frac{\partial}{\partial v}\underbrace{(v-b)}_{y}^{-1} = \frac{\partial y^{-1}}{\partial y}\frac{\partial y}{\partial v}$$

$$= -1\, y^{-2}\,(1)$$

$$\frac{\partial P}{\partial v} = -\frac{RT}{(v-b)^2} + \frac{2a}{v^3}$$

$$\frac{\partial^2 P}{\partial v^2} = (\dots)$$

$$\frac{\partial P}{\partial v} = 0 \Rightarrow \frac{2a}{v^3} = \frac{RT}{(v-b)^2}$$

$$\frac{\partial^2 P}{\partial v^2} = 0 \Rightarrow (\dots) = (\dots)$$

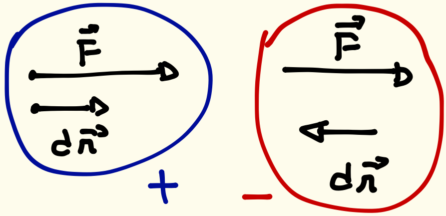
$$\Downarrow$$

$$T_c, v_c, \; P_c(v_c, T_c)$$

$$P(v_c, T_c) = P_c$$

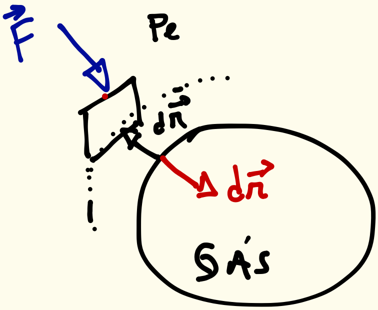
TRABALHO

$$\vec{F}\cdot d\vec{r} = \pm F\,dr$$



Na mecânica

Trabalho numa expansão



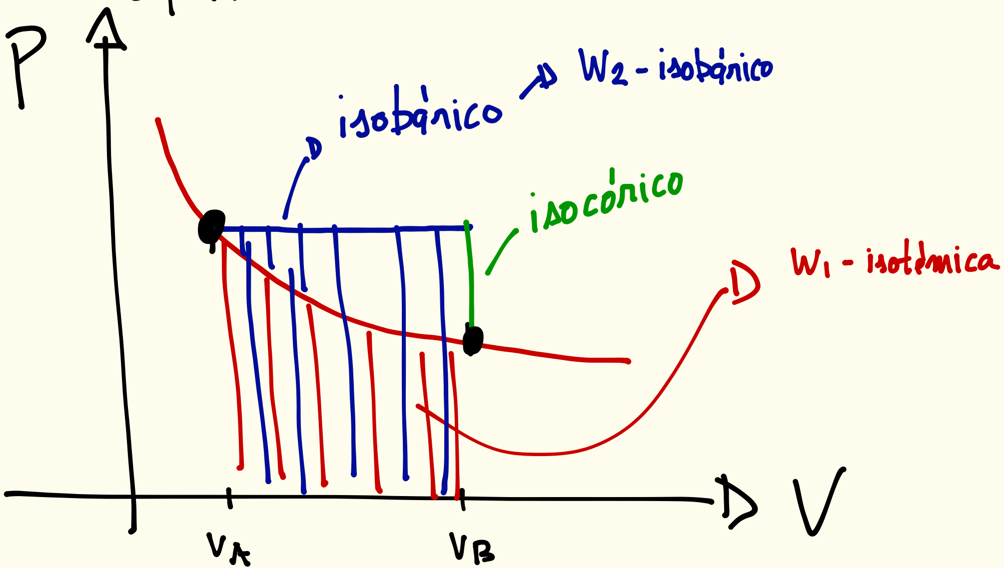
$dW = + P_e\,dV$

↳ trabalho sendo realizado pelo gás.

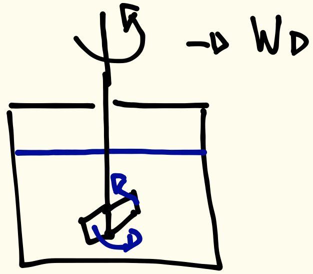
$dw = - P_e\,dV$

↳ trabalho sendo realizado no gás.

Trabalho depende do caminho.



Trabalho Dissipativo:



Exercícios

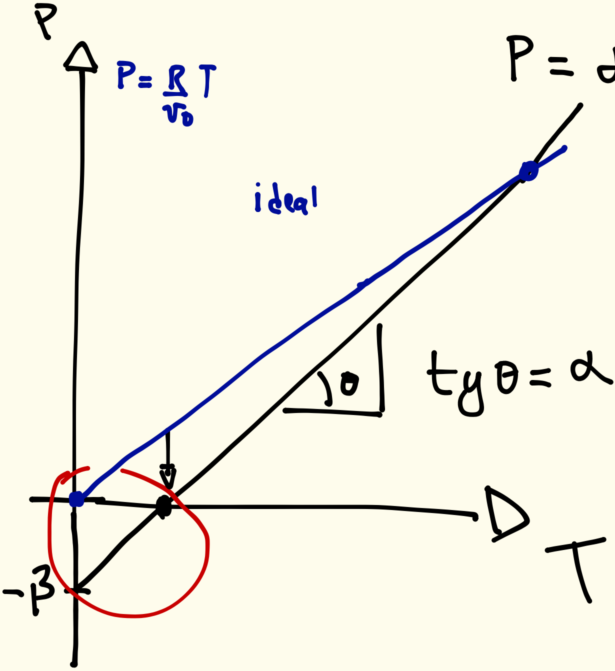
2.5 $\left(P + \frac{a}{v^2}\right)(v - b) = RT$, $v = v_0 = \text{const.}$

$$P + \frac{a}{v_0^2} = \frac{RT}{v_0 - b} \Rightarrow P = P(T) = \left(\frac{R}{v_0 - b}\right)T - \frac{a}{v_0^2}$$

$$P = \alpha T - \beta > 0$$

$$\Rightarrow T > \beta/\alpha = \frac{a}{v_0^2}\,\frac{v_0 - b}{R}$$

$$T_P > \frac{a}{v_0^2}\,\frac{v_0 - b}{R} > 0$$



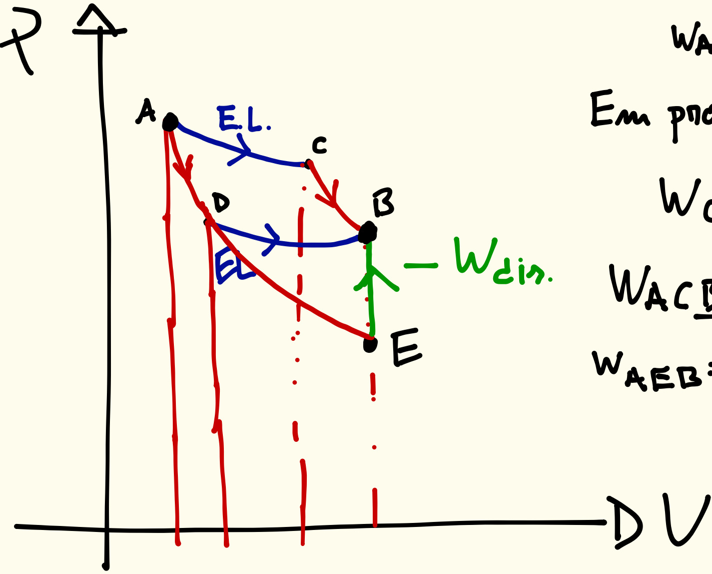
2.1 $v_m = \frac{V}{M}$, $v_m = \frac{1}{\rho_m}$; $v = \frac{V}{m}$, $\rho = \frac{1}{v} = \frac{m}{V}$

$$Pv = RT \Rightarrow P = RT\rho \rightarrow \rho = \frac{P}{RT} = \frac{1\,atm}{R(298{,}16K)}$$

$$P_1 = RT_1\rho \,,\; P_2 = RT_2\rho \Rightarrow P_1 = \cancel{R}T_1\left(\frac{P_2}{\cancel{R}T_2}\right)$$

$$\Rightarrow \boxed{T_2 = \frac{P_2}{P_1}T_1} \qquad T_2 = C_2 + K_2$$

1/7/20 1ª Lei da Termodinâmica



$W_{AC} = 0 = W_{DB}$

Em processos adiabáticos

$W_{CB} = W_{AD}$

$W_{ACB} = W_{ADB} = W_{AEB}$

$W_{AEB} = W_{AE} - W_{dis}$

3/7/20 Exercícios Sec. 3

① $\left(P+\frac{a}{v^2}\right)(v-b)=RT$, $W_{AB}=\int_{V_A}^{V_B} P\,dV$, $v=\frac{V}{n}$

$$P=\frac{RT}{\frac{V}{n}-b}-\frac{a}{\frac{V^2}{n^2}}=\frac{nRT}{V-nb}-\frac{n^2a}{V^2}$$

(a) isocórico, $dV=0$, $W=0$

(b) $P=$ fixo, $W=P(V_B-V_A)$

(c) isotérmica: $T=$ fixo, $W=\int_{V_A}^{V_B}\left[\frac{nRT_0}{V-nb}-\frac{n^2a}{V^2}\right]dV$

$$\begin{matrix} u=V-nb \\ du=dV \end{matrix} \Rightarrow W=nRT_0\int_{u(V_A)}^{u(V_B)}\frac{du}{u}-n^2a\left.\frac{V^{-1}}{(-1)}\right|_{V_A}^{V_B}$$

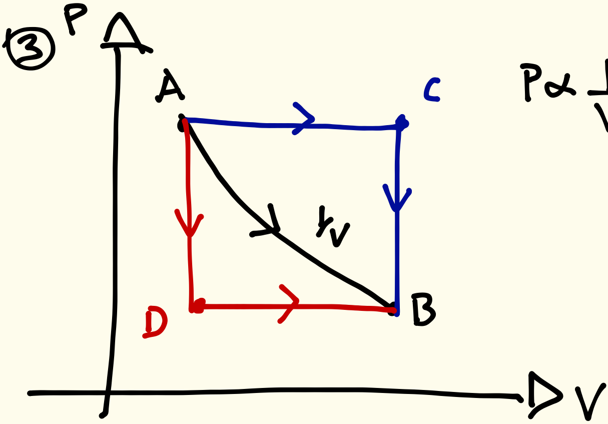
$$\Rightarrow W=nRT_0\ln|V-nb|\Big|_{V_A}^{V_B}+n^2a\left(\frac{1}{V_B}-\frac{1}{V_A}\right)$$

$$\Rightarrow W=nRT_0\ln\left|\frac{V_B-nb}{V_A-nb}\right|+n^2a\left(\frac{1}{V_B}-\frac{1}{V_A}\right)$$

② $P = \dfrac{A}{V^{\gamma}}$, $W = \displaystyle\int_{V_A}^{V_B} \frac{A}{V^{\gamma}}\, dV = A \left. \frac{V^{1-\gamma}}{1-\gamma} \right|_{V_A}^{V_B}$

$W = \dfrac{A}{1-\gamma}\left(V_B^{1-\gamma} - V_A^{1-\gamma}\right)$, $P_A = A V_A^{-\gamma} \Rightarrow W = \dfrac{1}{1-\gamma}\left(P_B V_B - P_A V_A\right)$

③



$P \propto \dfrac{1}{V}$ (isoterm)

④ $p = w\rho$, $\rho = c^2 \rho_M$, $E^2 = M^2 c^4 + |\vec{p}|^2 c^2$

$V = \frac{4}{3}\pi a^3(t)$, $dU = \cancel{dQ}^{\,0} - dW$, $U = \rho V$, $dW = p\, dV$

$\Rightarrow dU = d(\rho V) = V d\rho + \rho\, dV \Rightarrow \boxed{V d\rho + \rho dV = -p dV = -w\rho\, dV}$

$dV = \frac{4}{3}\pi\, d(a^3) = \frac{4\pi}{3} 3a^2 da = 4\pi a^2 da$

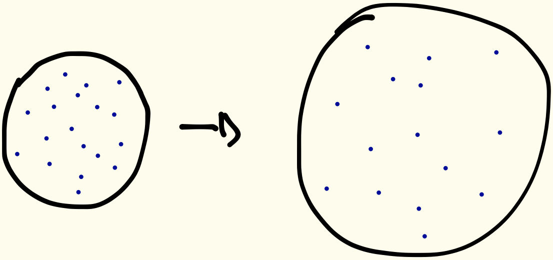
$\Rightarrow \frac{4\pi}{3} a^3 d\rho + \rho (4\pi) a^2 da = -w\rho (4\pi) a^2 da$ $\times \frac{3}{a^3}$

$\Rightarrow d\rho + \frac{\rho}{a} da + w\rho \frac{da}{a} = 0 \Rightarrow d\rho + \rho(1+w)\frac{da}{a} = 0$

$\Rightarrow \displaystyle\int_{\rho_i}^{\rho} \frac{d\tilde{\rho}}{\tilde{\rho}} = -(1+w)\int_{a_i}^{a} \frac{d\tilde{a}}{\tilde{a}} \Rightarrow \ln(\rho/\rho_i) = -(1+w)\ln(a/a_i) \Rightarrow \rho = \rho_i \left(\frac{a}{a_i}\right)^{-3(1+w)}$

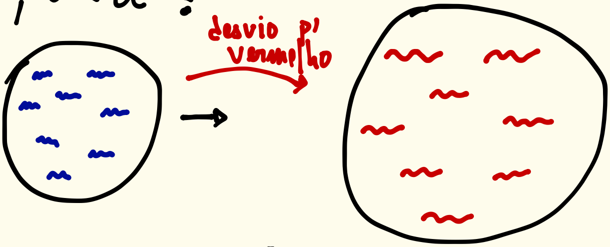
$$\rho = \rho_i \left(\frac{a}{a_i}\right)^{-3(1+w)} \Rightarrow \rho \propto a^{-3(1+w)}$$

<u>$w=0$</u> $\Rightarrow \rho \propto a^{-3}$



$U = \rho V = \text{const.}$

<u>$w=1/3$</u> $\Rightarrow \rho \propto a^{-4}, \; U \propto a^{-1}$?



$T_{RCF} = 2{,}7XXX \text{ K}$