LEZIONE 11

6/11/2020

13.4 (MENCUCCINI ESERCIZI)

$T_0 = 0°C$ $\qquad p_0 = 1\ atm$

$V_0 = 1\ L$ $\qquad m = 2g$

$m \longrightarrow m/2$ $\qquad p$ FINALE ?

SISTEMA GAS

$$\Delta U = 0 = Q - L \Rightarrow Q = L$$

$$-Q = \frac{\lambda m}{2}$$

$$\Rightarrow -L = \frac{\lambda m}{2}$$

$$L = \int p\, dV \qquad pV = nRT_0 \rightarrow dV = -\frac{nRT_0}{p^2}\, dp$$

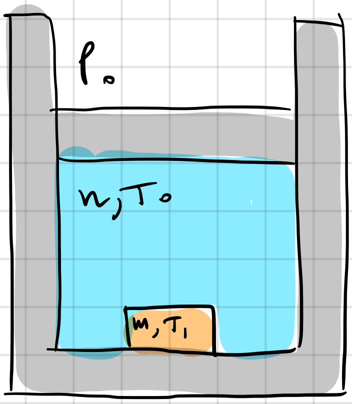
$$L = -\int \frac{p\, nRT_0}{p^2}\, dp = -nRT_0 \ln\frac{p_f}{p_0}$$

$$nRT_0 \ln\frac{p_f}{p_0} = \frac{\lambda m}{2} \qquad \ln p_f/p_0 = \frac{\lambda m}{2nRT_0}$$

$$\frac{p_f}{p_0} = \frac{V_0}{V_f} = e^{\frac{\lambda m}{2nRT_0}} = e^{\frac{\lambda m}{2p_0V_0}} = e^{\frac{3.3\ 10^2\ J\ 2\ g}{2\ 10^5\ Pa\ g\ 10^{-3}\ m^3}} = 27$$

$$V_f = \frac{V_0}{27} \sim 37\ ml$$

13.5 (MENCUCCINI E)



$T_1 > T_0$

DATO ΔV RICAVARE CALORE SPECIFICO

$$n c_p (T^* - T_0) + m c (T^* - T_1) = 0$$

$$\to c = \frac{n c_p}{m} \frac{T^* - T_0}{T_1 - T^*}$$

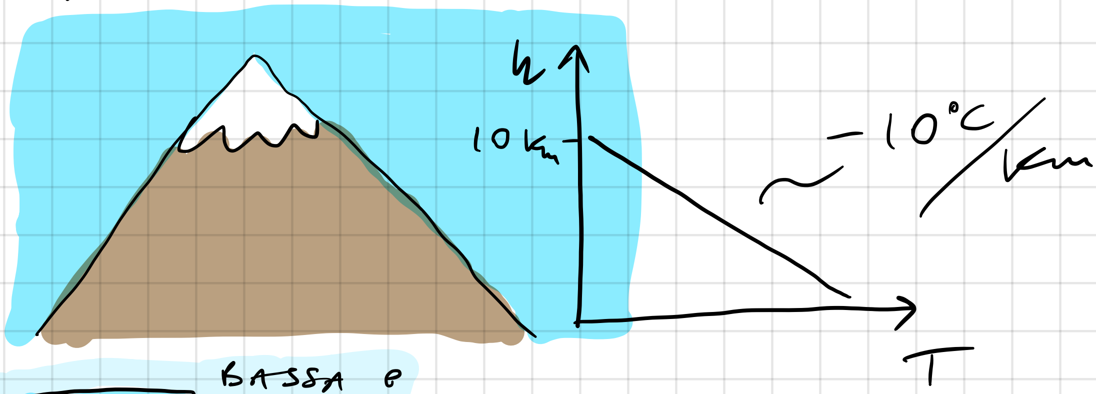
$$p_0 V = nRT \to p_0 \Delta V = nR(T^* - T_0)$$

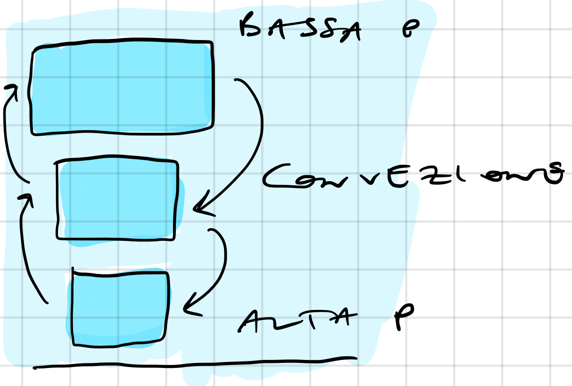
$$T^* - T_0 = \frac{p_0 \Delta V}{nR}$$

$$c = \frac{n c_p}{m} \frac{T^* - T_0}{T_1 - T_0 + T_0 - T^*} = \frac{n c_p}{m} \frac{p_0 \Delta V}{nR(T_1 - T_0) - p_0 \Delta V}$$

ESERCIZIO (DA FERMI "THERMODYNAMICS")

RICAVARE IL PROFILO DI TEMPERATURA IN FUNZIONE DELLA QUOTA





SEGUIAMO UNA MASSA D'ARIA MENTRE SI ALZA

CONDUCIBILITÀ ARIA MOLTO BASSA (SI USA COME ISOLANTE NEI MATERIALI POROSI)

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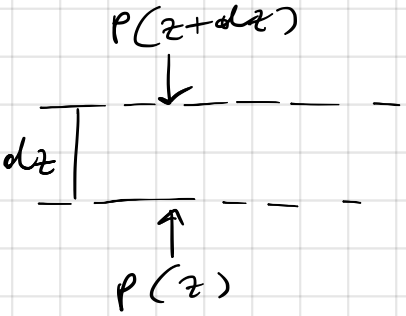
PROCESSO ADIABATICO



EQUILIBRIO IDROSTATICO

$$[p(z) - p(z+dz)]\,S = \rho(z)\, g\, \underbrace{S\,dz}_{\text{volume}}$$

$$\frac{dp}{dz} = -\rho(z)\, g$$

$$pV^\gamma = \text{cost} \xrightarrow{V \propto T/p} p^{1-\gamma}T^\gamma = \text{cost} \qquad p\,T^{\frac{\gamma}{1-\gamma}} = \text{cost}$$

$$\ln p + \frac{\gamma}{1-\gamma}\ln T = \text{cost} \Rightarrow \frac{dp}{p} = \frac{\gamma}{\gamma-1}\frac{dT}{T}$$

$$\frac{dp}{dz} = \frac{\gamma}{\gamma-1}\frac{p\,dT}{T\,dz}$$

$$\frac{dT}{dz} = \frac{\gamma-1}{\gamma}\frac{T}{p}\frac{dp}{dz} = -\frac{\gamma-1}{\gamma}\frac{T}{p}\rho g = -\frac{\gamma-1}{\gamma}\frac{TM}{\underbrace{pV}_{nRT}} g = -\frac{\overbrace{\gamma}^{\to 1.4}-1}{\gamma}\frac{\overbrace{m}^{\sim 29\,g/mol}}{\underbrace{R}_{\to 8.3\,J/mol\,K}} g = -9.4\ °C/km$$

TEOREMI CALCOLO DERIVATE PARZIALI

$$f(x, y, z) = 0$$

$$x = x(y, z) \qquad\qquad y = y(x, z)$$

$$dx = \left(\frac{\partial x}{\partial y}\right)_z dy + \left(\frac{\partial x}{\partial z}\right)_y dz \qquad\Big|\qquad dy = \left(\frac{\partial y}{\partial x}\right)_z dx + \left(\frac{\partial y}{\partial z}\right)_x dz$$

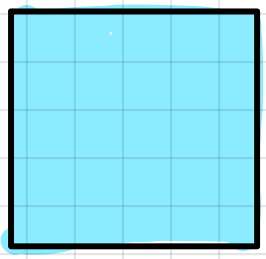
$$dx = \left(\frac{\partial x}{\partial y}\right)_z \left[\left(\frac{\partial y}{\partial x}\right)_z dx + \left(\frac{\partial y}{\partial z}\right)_x dz\right] + \left(\frac{\partial x}{\partial z}\right)_y dz$$

$$dx = \underbrace{\left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial x}\right)_z}_{=1} dx + \underbrace{\left[\left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial z}\right)_x + \left(\frac{\partial x}{\partial z}\right)_y\right]}_{=0} dz$$

1) $$\left(\frac{\partial x}{\partial y}\right)_z = \frac{1}{\left(\frac{\partial y}{\partial x}\right)_z}$$

2) $$\left(\frac{\partial x}{\partial z}\right)_y = -\left(\frac{\partial y}{\partial z}\right)_x \left(\frac{\partial x}{\partial y}\right)_z$$

ES.



QUANTA PRESSIONE DEVE REGGERE SENZA DEFORMARSI UN CONTENITORE IN GRADO DI MANTENERE ACQUA A VOLUME COSTANTE MENTRE LA TEMPERATURA AUMENTA DI 10 K ?

$$\Delta P \sim \left(\frac{\partial P}{\partial T}\right)_V \Delta T$$

$$\left(\frac{\partial P}{\partial T}\right)_V = -\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial V}\right)_T = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P \left[-V\left(\frac{\partial P}{\partial V}\right)_T\right] =$$

$$= \alpha \beta_T = \frac{200 \; 10^{-6}}{K} \; 2 \; 10^9 \; Pa =$$

$$= 4 \; 10^5 \; \frac{Pa}{K} = 4 \; \frac{atm}{K}$$

$$\Delta P = 40 \; atm \rightarrow 40 \; kg_P/cm^2$$