Esercizi

Onde Fluidi Termodinamica

PROVE D'ESAME

SONO PROVE D'ESAME RACCOLTE NEL CORSO DEGLI ANNI.

ANNOTAZIONI

ESERCIZI / PROVE DA CONTROLLARE:

- 20/06/2024
- 18/07/2022
- 14/09/2022

16/09/2011

1 T, ρ_L $\Rightarrow v = \sqrt{\dfrac{T}{\rho_L}} = 12{,}54 \ m/s$

ESTREMI FISSI

$x_1 = 12 \ m$ $\qquad y(t) = -0{,}1073 \cos(4\pi t)$

$\Rightarrow \omega = 4\pi \quad \Rightarrow k = \dfrac{\omega}{v} = 1{,}002 \ \dfrac{rad}{m}$

GENERALMENTE $\qquad y(x,t) = 2A\sin(kx)\cos(\omega t)$

$$\Rightarrow y(x_1, t) = y(t) \Rightarrow 2A\sin(kx_1) = -0{,}1073 \Rightarrow A = \frac{-0{,}1073}{2\sin(kx_1)}$$

$$\Rightarrow A = 0{,}1 \ m$$

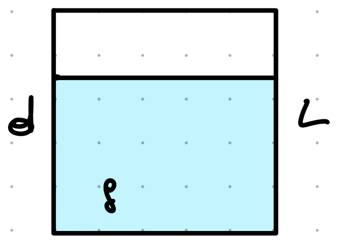
LE ONDE CHE DANNO $y(x,t) = 2A\sin(kx)\cos(\omega t)$ SONO

$$\xi(x,t) = A\sin(kx \pm \omega t)$$

HO $\quad \nu = \dfrac{\omega}{2\pi} = 2 \ Hz \quad \Rightarrow \nu_4 = \nu = 4\dfrac{v}{2L} = \dfrac{2v}{L}$

$$\Rightarrow L = \frac{2v}{\nu} = 12{,}54 \ m$$

2



HO $p(z) = p_0 + \rho g z$

$$\Rightarrow dF(z) = S \cdot p(z) = \ell (p_0 + \rho g z)\, dz$$

$$\Rightarrow F(z) = \int_0^d dF = \ell \left(p_0 d + \frac{1}{2} \rho g d^2\right)$$

$$\Rightarrow F(z) = \ell d \left(p_0 + \frac{1}{2} \rho g d\right) = 30{,}477 \text{ kN}$$

CONOSCO IN GENERALE

$$\vec{\nabla} p = \rho f \qquad \Rightarrow \qquad \vec{\nabla} p = \rho f_g + \rho f_a$$

ESSENDO f_g (GRAVITAZIONALE) E f_a (acc) CONSERVATIVE

$$\vec{f}_a = -\vec{\nabla} U_a \qquad \vec{f}_g = -\vec{\nabla} U_g$$

E QUINDI CON $\vec{f}_a = -a\hat{x}$ $\quad \vec{f}_g = -g\hat{k}$

$$\Rightarrow \rho \vec{f}_g = -\rho g \hat{k} = -\vec{\nabla}(\rho g z) \quad ; \quad \rho \vec{f}_a = -\rho a \hat{x} = -\vec{\nabla}(\rho a x)$$

QUINDI

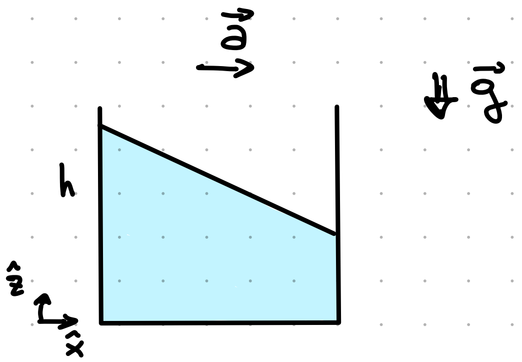
$$\vec{\nabla}(p + \rho g z + \rho a x) = 0$$

CHE VUOL DIRE

$$p(x,z) + \rho g z + \rho a x = \text{cost}$$

POSSO FISSARE LA COSTANTE $p(0,0) = \text{cost}$

$$\Rightarrow \boxed{p(x,z) + \rho g z + \rho a x = p(0,0)}$$



GUARDO IL PUNTO $(0,h)$

$$p(0,h) + \rho g h = p(0,0)$$

MA SO USARE STEVINO, DUNQUE

$$p(0,h) + \rho g h = p(0,0) = p_0 + \rho g h$$

$$\Rightarrow p(0,h) = p_0$$

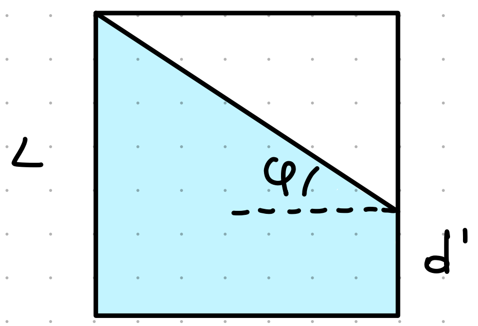
SAPENDO CHE HO SUPERFICI EQUIPOTENZIALI ALLORA SU UN PUNTO GENERICO DELLA SUPERFICIE HO

$$p_0 + \rho g z + \rho a x = \text{cost} = p_0 + \rho g h$$

$$\Rightarrow \rho g z = \rho g h - \rho a x$$

$$\Rightarrow \boxed{z = h - \frac{a}{g} x}$$

VOGLIO $a(x=0, z=L)$.



POSSO TROVARE d':

h È L'ALTEZZA DEL LIQUIDO IN $x=0$. $\Rightarrow h=L$

$$z(x) \Rightarrow z(L) = d' = L - \frac{a}{g} L$$

PER RICAVARE a MI SERVE QUINDI d'.

UTILIZZO LA CONSERVAZIONE DELLA MASSA ($\rho = \text{cost}$)

$$\rho L^2 d = \rho\left(L^2 d' + L^2 \cdot \frac{(L-d')}{2}\right)$$

$$\Rightarrow L^2 d = L^2 d' + \frac{1}{2} L^3 - \frac{L^2 d'}{2}$$

$$\Rightarrow L^2 d - \frac{1}{2} L^3 = \frac{1}{2} L^2 d' \quad \Rightarrow \quad d' = 2d - L = 0{,}6\ m$$

DUNQUE $\Rightarrow d' = L - \frac{a}{g} L \Rightarrow a = \frac{L-d'}{L} g = 2\frac{L-d}{L} g$

SFRUTTANDO IL FATTO DI AVERE SUPERFICI ISOBARE TROVO LA PRESSIONE NELL'ANGOLO INFERIORE DESTRO

$$p(x,z) + \rho g z + \rho a x = p_0 + \rho g L \quad \Rightarrow \quad p(L,0) = p_0 + \rho(g-a)L$$

$$\Rightarrow p(L,0) = 118983\ Pa$$

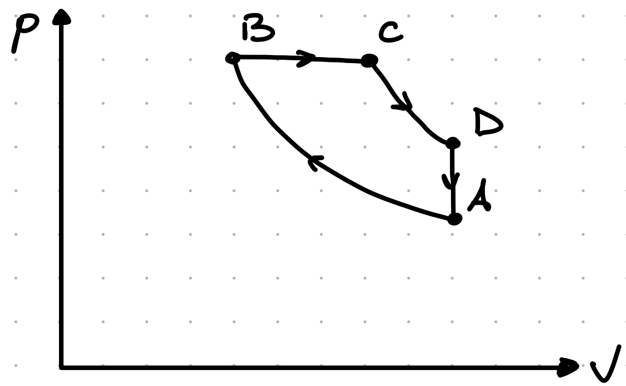
3

14/09/2017

1

$n = 2,5$ mol   MONOATOMICO

AB	COMP.	ADIABATICA	REV.
BC	ESP	ISOBARA	REV.
CD	ESP	ADIABATICA	REV.
DA	ISOCORA		



$\frac{V_A}{V_B} = 5$ $\frac{V_A}{V_C} = 2$

$m = 100\ g$ $T_i = -5.1\ °C$

AB: $Q = 0$ BC $Q = n C_p (T_C - T_B) > 0$

CD: $Q = 0$ DA $Q = n C_V (T_A - T_D) < 0$

CERCO DI SCRIVERE TUTTE LE T IN FUNZIONE DI T_A

AB $T_A V_A^{\gamma-1} = T_B V_B^{\gamma-1} \Rightarrow T_B = \left(\frac{V_A}{V_B}\right)^{\gamma-1} T_A = 5^{\gamma-1}$

BC $\frac{V_B}{T_B} = \frac{V_C}{T_C} \Rightarrow T_C = \frac{V_C}{V_B} T_B = \frac{V_C}{V_B} \cdot \frac{V_A}{V_A} T_B = \frac{V_C}{V_A} \frac{V_A}{V_B} T_B = \frac{5^\gamma}{2} T_A$

CD $T_C V_C^{\gamma-1} = T_D V_D^{\gamma-1} \Rightarrow T_D = \left(\frac{V_C}{V_A}\right)^{\gamma-1} T_C = \left(\frac{V_C}{V_A}\right)^{\gamma-1} \frac{V_C}{V_A} \frac{V_A}{V_B} T_B$

$= \frac{1}{2^{\gamma-1}} \frac{1}{2}\, 5\, 5^{\gamma-1} T_A = \left(\frac{5}{2}\right)^\gamma T_A$

COSÌ HO

$$Q_{TOT} = mC_p\left(\frac{5}{2}(5^{\gamma-1})T_A - (5)^{\gamma-1}T_A\right) + mC_v\left(T_A - \left(\frac{5}{2}\right)^{\gamma}T_A\right)$$

$$= mC_p 5^{\gamma-1} T_A\left(\frac{5}{2} - 1\right) + mC_v T_A\left(1 - \left(\frac{5}{2}\right)^{\gamma}\right)$$

VOGLIO FONDERE $m \Rightarrow Q_{CED} = Q_{DA}$

$$\Rightarrow Q_{DA} = -mc\,(T_F - T_i) - m\lambda$$

$$\Rightarrow mC_v T_A\left(1 - \left(\frac{5}{2}\right)^{\gamma}\right) = -mc\,(T_F - T_i) - m\lambda$$

$$\Rightarrow T_A = -\frac{mc\,(T_F - T_i) - m\lambda}{mC_v\left(1 - \left(\frac{5}{2}\right)^{\gamma}\right)} = 306{,}7\ K$$

$$\Rightarrow Q_{DA} = -34387{,}99$$

$$\Rightarrow Q_{BC} = mC_p\,(T_C - T_B) = mC_p T_A\left(\frac{5^{\gamma}}{2} - 5^{\gamma-1}\right) = 69916{,}5\ J$$

$$\eta = 1 - \frac{|Q_{DA}|}{Q_{BC}} = 0{,}51$$

$$\Delta S_U = \Delta S_{CICLO} + \Delta S_{AMB}$$

$$= \underbrace{\Delta S_{AB}}_{0} + \Delta S_{BC} + \underbrace{\Delta S_{CD}}_{0} + \Delta S_{DA} + \Delta S_{AMB}$$

ΔS_{AMB} È SOLO QUELLA DEL GHIACCIO

$$= mc_p \ln\left(\frac{T_C}{T_B}\right) + mc_v \ln\left(\frac{T_A}{T_D}\right) + \int_{T_i}^{T_0} \frac{mc\,dT}{T} + \frac{m\lambda}{T_0}$$

$$= mc_p \ln\left(\frac{5^\gamma}{2} T_A \frac{1}{5^{\gamma-1} T_A}\right) + mc_v \ln\left(\left(\frac{2}{5}\right)^\gamma\right) + mc \ln\left(\frac{T_0}{T_i}\right) + \frac{m\lambda}{T_0}$$

$$= mc_p \ln\left(\frac{5}{2}\right) + m\underbrace{\gamma c_v}_{c_p} \ln\left(\frac{2}{5}\right) + mc \ln\left(\frac{T_0}{T_i}\right) + \frac{m\lambda}{T_0}$$

$$= 125.9 \ J/K$$

2

$$\frac{dz}{dt} = 0,6 \ \frac{mm}{min} \qquad \ell = 0,7 \ m$$

$$m = 36 \ Kg \qquad \mu_s = 0,53$$

LA FORZA SULLA PARETE SARÀ

$$\frac{dp}{dz} = \rho g \qquad dp = \rho g \, dz \quad , \qquad dF = \ell z \, dp$$

$$\Rightarrow dF = \rho g \ell z \, dz \qquad \Rightarrow F = \frac{1}{2} \rho g \ell z^2$$

$$F_{ATT} = mg\mu \qquad \Rightarrow F = F_{ATT} \qquad \Rightarrow \frac{1}{2} \rho g \ell z^2 = mg\mu$$

$$\Rightarrow z = \sqrt{\frac{2m\mu}{\rho \ell}} = 0,233 \ m$$

HO

$$\frac{dz}{dt} = K = 6 \cdot 10^{-4} \ m/min \qquad \Rightarrow z(t) = Kt$$

$$\Rightarrow z(\tau) = 0,233 \ m = K\tau \qquad \Rightarrow \tau = \frac{0,233 \ m}{6 \cdot 10^{-4} \ m} \ min = 388,3 \ min$$

$$= 6,47 \ h$$

APPLICO BERNOULLI

$$p_0 + \rho g z + \frac{1}{2}\rho V^2 = p_0 + \frac{1}{2}\rho v^2$$

MA $v S_{MIN} = V \ell^2 \Rightarrow V \ll v \quad , S_{MIN} \ll \ell^2$

$$\Rightarrow \frac{1}{2}\rho v^2 = \rho g z \Rightarrow v = \sqrt{2gz}$$

USO L'EQUAZIONE DI CONTINUITÀ

$$v S = \frac{dz}{dt}\ell^2 \Rightarrow \frac{dz}{dt} = \frac{S}{\ell^2} v = \frac{S}{\ell^2}\sqrt{2gz}$$

HO UNA CONDIZIONE IN CUI $\forall t$ NON SI SPOSTA IN SE AL PIÙ HO

$$\frac{dh}{dt} = 0 \Rightarrow \frac{dh}{dt} = k - \frac{S}{\ell^2}\sqrt{2gh} = 0 \Rightarrow S = \frac{k\ell^2}{\sqrt{2gz}} = 2{,}29 \text{ mm}^2$$

$k \rightarrow$ ALTEZZA PIOGGIA

ORA CESSA LA PIOGGIA $\Rightarrow \dfrac{dz}{dt} = -\dfrac{S}{\ell^2}\sqrt{2gz}$

$$\Rightarrow \int_h^{h/2} \frac{dz}{\sqrt{2gz}} = -\frac{S}{\ell^2}t \Rightarrow 2\frac{\sqrt{z}}{\sqrt{2g}}\Bigg|_h^{h/2} = -\frac{S}{\ell^2}t$$

$$\Rightarrow \frac{2}{\sqrt{2g}}\left(\sqrt{\frac{h}{2}} - \sqrt{h}\right) = -\frac{s}{e^2}t$$

$$\Rightarrow t = \frac{2e^2\sqrt{h}}{s\sqrt{2g}}\left(1 - \frac{1}{\sqrt{2}}\right) = 13659,30\ s = 3,79\ h$$

$h = z = 23,3\ cm$

3

$\nu_1 = 500$ Hz

FUNI FISSE

ARIA GAS BIATOMICO , p_0 , $\rho = 1{,}23\ \mathrm{Kg/m^3}$

HO $\nu_1 = \dfrac{v}{2L} = \dfrac{1}{2L}\sqrt{\dfrac{T}{\mu_L}}$

LA SECONDA SARÀ

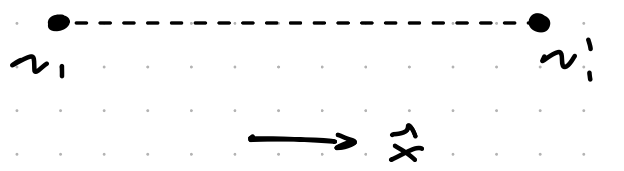
$$\nu_1' = \frac{v'}{2L} = \frac{1}{2L}\sqrt{\frac{T+\Delta T}{\mu_L}}$$

$$\Rightarrow \frac{\nu_1'}{\nu_1} = \sqrt{\frac{T+\Delta T}{T}}$$

MA $\nu_1' = \nu_B + \nu_1 = 501$ Hz

$$\Rightarrow \left(\frac{\nu_1'}{\nu_1}\right)^2 = 1 + \frac{\Delta T}{T} \Rightarrow \frac{\Delta T}{T} = \left(\frac{\nu_1'}{\nu_1}\right)^2 - 1 = 0{,}4\ \%$$

HO



SENTIRÀ DOPPLER

$$\tilde{\nu}' = \frac{c_s \pm v}{c_s}\nu'$$

$$\tilde{\nu} = \frac{c_s \mp v}{c_s}\nu$$

$$\nu_B = \tilde{\nu}' - \tilde{\nu} = \frac{c_s \pm v}{c_s}\nu' - \frac{c_s \mp v}{c_s}\nu = \frac{c_s(\nu'-\nu) \pm v(\nu'+\nu)}{c_s}$$

MA HO $\nu_B = 0$ $\Rightarrow$ SCELGO IL SEGNO SOTTO

$$\tilde{\nu}' = \frac{c_s - v}{c_s}\nu'$$

$$\Rightarrow c_s(\nu'-\nu) - v(\nu'+\nu) = 0$$

$$\tilde{\nu} = \frac{c_s + v}{c_s}\nu$$

$$\Rightarrow v = \frac{\nu'-\nu}{\nu'+\nu}c_s = 0{,}34 \; m/s$$

SI MUOVE DA ν_1 A ν_1'

$$c_s = \sqrt{\frac{\gamma p_0}{\rho}} = 339{,}6 \; m/s$$

$L(10\,m) = 40\,dB$ SULLA CORDA HO

$$\xi(r,t) = \frac{A}{r}\sin(kr - \omega t)$$

$$\Rightarrow \Delta p(r,t) = \frac{\Delta p_{MAX}}{r}\cos(kr - \omega t) \quad \text{DOVE} \quad \Delta p_{MAX} = \sqrt{I 2 \rho v}$$

IN CUI $L = 10\log\left(\frac{I}{I_0}\right) \Rightarrow I = I_0 10^{L/10}$

DUNQUE

$$\Delta p_{MAX} = \sqrt{I \, 2 \rho e_s} = 2,89 \cdot 10^{-3} \ Pa \cdot m$$

$$\omega = 2\pi\nu_1 = 3141,6 \ rad/s$$

$$k = \frac{\omega}{e_s} = 9,25 \ rad/m$$

23/06/2022

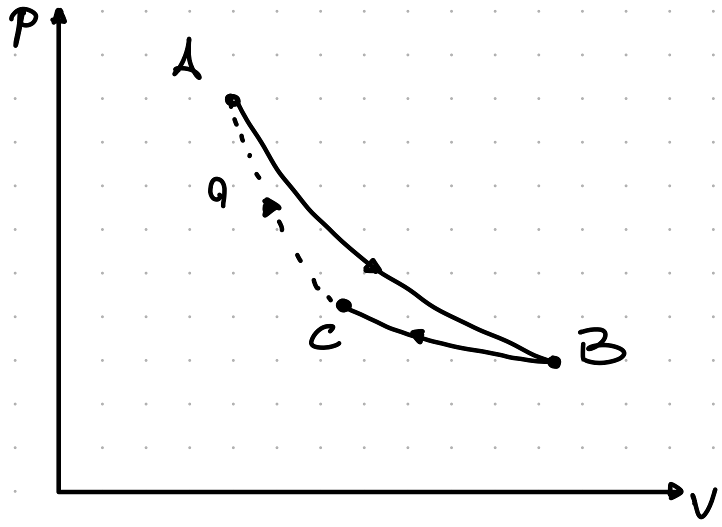
1

$n = 1$ mol BIATOMICO

AB ESP ADIABATICA $V_B > V_A$

BC COMP. ISOTERMA $V_A < V_C < V_B$

CA POLITROPICA $pV^\delta = \text{COST}$



$$\frac{V_B}{V_A} = 32 \qquad \frac{V_C}{V_A} = 2$$

RICAVO DALLE TRASFORMAZIONI

AB: $\quad p_A V_A^\gamma = p_B V_B^\gamma \implies \frac{p_A}{p_B} = \left(\frac{V_B}{V_A}\right)^\gamma = 128$

BC: $\quad p_B V_B = p_C V_C \implies \frac{p_B}{p_C} = \frac{V_C}{V_B} = \frac{V_C}{V_A}\frac{V_A}{V_B} = \frac{2}{32} = \frac{1}{16} = 0{,}0625$

CA: $\quad p_C V_C^\delta = p_A V_A^\delta \implies \frac{p_A}{p_C} = \left(\frac{V_C}{V_A}\right)^\delta$

$$\Rightarrow \frac{p_A}{p_B}\frac{p_B}{p_C} = \left(\frac{V_C}{V_A}\right)^{\delta}$$

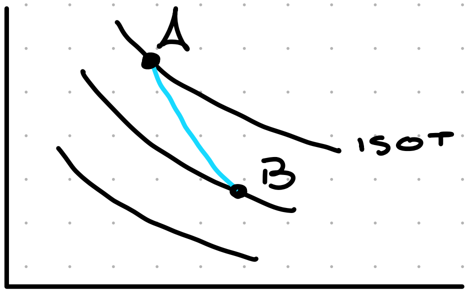
$$\Rightarrow \frac{128}{16} = 2^{\delta}$$

$$\Rightarrow \log(8) = \log(2^{\delta})$$

$$\Rightarrow \delta \log(2) = \log(8)$$

$$\Rightarrow \delta = \frac{\log 8}{\log 2} = 3$$

HO $W_{AB} = -m c_v (T_B - T_A)$ MA ADIAB PENDENZA MAGGIORE DELLE ISOTERME

$\Rightarrow$ 

$\Rightarrow T_A > T_B$

$$T_A V_A^{\gamma-1} = T_B V_B^{\gamma-1} \Rightarrow T_A = \left(\frac{V_B}{V_A}\right)^{\gamma-1} T_B = 4 T_B$$

$Q_{AB} = 0 \qquad W_{AB} = 3 m c_v T_B > 0$

POI $\quad W_{BC} = m R T_B \ln\left(\frac{V_C}{V_B}\right) = m R T_B \ln\left(\underbrace{\frac{V_C}{V_A}\frac{V_A}{V_B}}_{\frac{2}{32} = \frac{1}{16}}\right) = - m R T_B \ln(16)$

$\frac{2}{32} = \frac{1}{16} \Rightarrow \ln < 0$

$\Rightarrow W_{BC} = Q_{BC} < 0$

E $\quad W_{CA} = \int p(V)\,dV = \int \frac{cost}{V^\delta}\,dV = K \frac{1}{V^{\delta+1}} \frac{1}{1-\delta}\Big|_C^A = \frac{K}{1-\delta}\left(\frac{1}{V_A^{\delta-1}} - \frac{1}{V_C^{\delta-1}}\right)$

$\Rightarrow W_{CA} = \frac{K}{1-\delta} \frac{1}{V_C^{\delta-1}}\left(\left(\frac{V_C}{V_A}\right)^{\delta-1} - 1\right)$

FISSO K

$p_A V_A^\delta = K$

$= \frac{K}{1-\delta}\frac{3}{V_C^{\delta-1}} = -\frac{3}{2}\frac{K}{V_C^{\delta-1}} = -\frac{3}{2}\frac{p_A V_A^\delta}{V_C^{\delta-1}} = -\frac{3}{2}\left(\frac{V_A}{V_C}\right)^{\delta-1} p_A V_A$

$\Rightarrow W_{CA} = -\frac{3}{8} m R T_A = -\frac{3}{2} R T_B$

DUNQUE

$W_{TOT} = 3 m c_v T_B - m R T_B \ln(16) - \frac{3}{2} R T_B$

$\Rightarrow W_{TOT} = 6RT_B - RT_B \ln(16) = RT_B(6 - \ln 16) > 0$

$\Rightarrow$ LAVORO CEDUTO $\Rightarrow$ MACCHINA TERMICA

E I CALORI

$$Q_{AB} = 0$$

$$Q_{BC} = W_{BC} = -nRT_B \ln(16) < 0$$

$$Q_{CA} = \Delta U_{CA} + W_{CA} = nc_v(T_A - T_C) - \frac{3}{2}RT_B$$

PERÒ NOTO CHE HO $T_C = T_B$ POICHÈ BC = ISOTERMA

$$\Rightarrow Q_{CA} = nc_v(T_A - T_B) - \frac{3}{2}RT_B = \frac{15}{2}RT_B - \frac{3}{2}RT_B = 6RT_B > 0$$

DUNQUE HO

$$Q_{TOT} = -RT_B \ln(16) + 6RT_B$$

E

$$\eta = \frac{W_{TOT}}{|Q_{ASS}|} = \frac{RT_B(6 - \ln 16)}{6RT_B} = 1 - \frac{1}{6}\ln 16 = 0,537 = 54\%$$

2

$v = 110 \; km/h$ $\qquad c_s^\circ = 343 \; \frac{m}{s}$ $\qquad T_0 = 20°C$

$T = 0°C$

$\nu_{AV} = 582,8 \; Hz$

$\nu_{AL} = 375,8 \; Hz$

HO $c_s = \sqrt{\frac{\gamma R T}{A}} \Rightarrow \frac{c_s}{c_s^\circ} = \sqrt{\frac{T}{T_0}} \Rightarrow c_s = \sqrt{\frac{T}{T_0}}\, c_s^\circ = 331,1 \frac{m}{s} = 1191,96 \frac{km}{h}$

HO EFFETTO DOPPLER IN AVVICINAMENTO ED ALLONTANAMENTO (CHE METTO A SISTEMA)

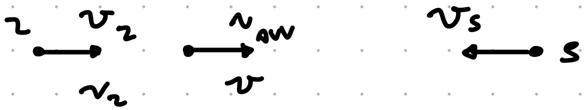
$$\begin{cases} \nu_{AVV} = \nu \dfrac{c_s + v_s}{c_s - v} \\[2ex] \nu_{ALL} = \nu \dfrac{c_s - v_s}{c_s + v} \end{cases} ; \quad \begin{cases} \nu = \dfrac{c_s - v}{c_s + v_s} \nu_{AVV} \\[2ex] \nu_{ALL} = \dfrac{c_s - v}{c_s + v_s} \dfrac{c_s - v_s}{c_s + v} \nu_{AV} = \dfrac{c_s - v}{c_s + v} \dfrac{c_s - v_s}{c_s + v_s} \nu_{AV} \end{cases}$$

$$\begin{cases} \nu = \dfrac{c_s - v}{c_s + v_s} \nu_{AVV} \\[2ex] \nu_{ALL} (c_s + v_s) = \dfrac{c_s - v}{c_s + v} \nu_{AV} (c_s - v_s) \end{cases}$$

$$v_s\left(\nu_{ALL} + \frac{c_s - v}{c_s+v}\nu_{AV}\right) = c_s\left(\frac{c_s-v}{c_s+v}\nu_{AV} - \nu_{ALL}\right)$$

$$\begin{cases} \nu = \dfrac{c_s - v}{c_s + v_s}\,\nu_{AVV} = 469{,}75 \text{ Hz} \\[2ex] v_s = \dfrac{\frac{c_s-v}{c_s+v}\nu_{AVV} - \nu_{ALL}}{\frac{c_s-v}{c_s+v}\nu_{AVV} + \nu_{ALL}}\, c_s = 150{,}37 \ \dfrac{\text{km}}{\text{h}} \end{cases} \qquad , \quad \frac{c_s - v}{c_s + v} = 0{,}831$$

ORA HO



AVRÒ $\quad \nu_2 = \nu\,\dfrac{c_s + v_s}{c_s - v_2}$

$$\Rightarrow \nu_B = |\nu_{AVV} - \nu_2|$$

$$\Rightarrow \pm\nu_B = \nu_{AVV} - \nu_2 = \nu_{AVV} - \nu\,\frac{c_s + v_s}{c_s - v_2}$$

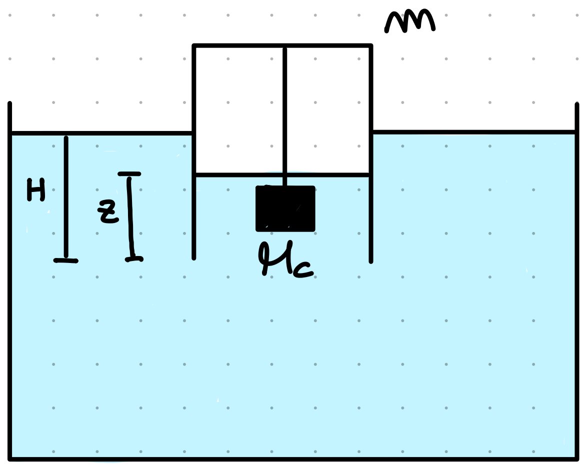
$$\Rightarrow \nu\,\frac{c_s + v_s}{c_s - v_2} = \nu_{AVV} \pm \nu_B \qquad \Rightarrow \frac{\nu_{AVV} \pm \nu_B}{\nu}(c_s - v_2) = c_s + v_s$$

$$\Rightarrow v_2 = c_s - \frac{\nu}{\nu_{AVV} \pm \nu_B}(c_s + v_s) = \begin{cases} 126{,}47 \ \frac{\text{km}}{\text{h}} = 35{,}13 \ \text{m/s} \\ 93{,}04 \ \text{km/h} = 25{,}84 \ \text{m/s} \end{cases}$$

18/07/2022 (ES. 1, 2 ERANO DI MECCANICA) $\to$ VEDI ALTRO FILE

3 $m = 50\ kg$, $h = 0{,}7\ m$

$D = 2m$ $\quad M_c = 500\ kg$



BISOGNA CONSIDERARE CHE QUANDO SI IMMERGE LA CAMPANA L'ARIA AL SUO INTERNO SI COMPRIME ED È PRESENTE LA SPINTA DI ARCHIMEDE.

VOGLIO SIA z CHE H.

UTILIZZO L'APPROSSIMAZIONE ARIA ~ ISOTERMA : $pV = cost.$

FUORI DALL'ACQUA HO p_0 , $V_0 = \pi \frac{D^2}{4} h$

IN ACQUA $p_1 = p_0 + \rho g (H - z)$, $V_1 = \pi \frac{D^2}{4} (h - z)$

$\hookrightarrow$ PRESSIONE SUL PELO LIBERO NEL BICCHIERE $\quad \hookrightarrow$ VOLUME D'ARIA

QUINDI

$$p_0 V_0 = p_1 V_1 \Rightarrow p_0 \pi \frac{D^2}{4} h = (p_0 + \rho g (H - z)) \pi \frac{D^2}{4} (h - z)$$

$$\Rightarrow p_0 h = (p_0 + \rho g (H - z))(h - z)$$

OVVIAMENTE MI SERVE USARE ANCHE IL FATTO DI ESSERE ALL'EQUILIBRIO, OSSIA, RISULTANTE = 0

$$\vec{R}_c + \vec{R} = 0$$

$$\Rightarrow \quad M_c g - A_c + mg - A = 0$$

ASSE $\hat{z}$ RIVOLTO VERSO IL BASSO E CON ORIGINE SUL PELO LIBERO

$$\Rightarrow \quad M_c g - \rho g V_{c,imm} + mg - \rho g V_{imm} = 0$$

$$\Rightarrow \quad M_c g - \frac{\rho}{\rho_c} g M_c + mg - \rho g \pi \frac{D^2}{4}(H-z) = 0$$

$$\Rightarrow \quad M_c \left(1 - \rho/\rho_c\right) + m - \rho \pi \frac{D^2}{4}(H-z) = 0$$

QUINDI HO IL SISTEMA:

$$\begin{cases} M_c \left(1 - \frac{\rho}{\rho_c}\right) + m - \rho \pi \frac{D^2}{4}(H-z) = 0 \\ p_0 h = (p_0 + \rho g (H-z))(h-z) \end{cases}$$

$1^\circ \Rightarrow \rho \pi \frac{D^2}{4}(H - z) = M_c\left(1 - \frac{\rho}{\rho_c}\right) + m$

$$\Rightarrow (H - z) = \frac{4}{\rho \pi D^2}\left(M_c\left(1 - \frac{\rho}{\rho_c}\right) + m\right)$$

$2^\circ \Rightarrow p_0 h = \left(p_0 + \frac{4g}{\pi D^2}\left(M_c\left(1 - \frac{\rho}{\rho_c}\right) + m\right)\right)(h - z)$

$$\Rightarrow h - z = \frac{p_0 h}{p_0 + \frac{4g}{\pi D^2}\left(M_c\left(1 - \frac{\rho}{\rho_c}\right) + m\right)}$$

$$\Rightarrow z = h - \frac{p_0 h}{p_0 + \frac{4g}{\pi D^2}\left(M_c\left(1 - \frac{\rho}{\rho_c}\right) + m\right)} = 7,3 \cdot 10^{-3}\ m = 7,3\ mm$$

L'ACQUA È SALITA DI 7,3 mm NELLA CAMPANA

TROVO H

$$H = \frac{4}{\rho \pi D^2}\left(M_c\left(1 - \frac{\rho}{\rho_c}\right) + m + z\right) = 0,11\ m$$

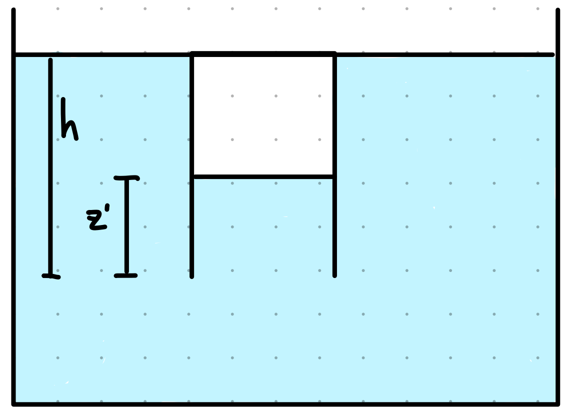
CHE È L'ALTEZZA DI CUI LA CAMPANA È IMMERSA

DUNQUE

$$x = \frac{H}{h} = 0,157 = 15,7\%$$

ORA CHIEDO CHE $H \equiv h$ E SCRIVO $M_c = M$. RIPARTO DAL SISTEMA

$$\begin{cases} M\left(1 - \dfrac{\rho}{\rho_c}\right) + m - \rho\pi\dfrac{D^2}{4}(h - z') = 0 \\ p_0 h = (p_0 + \rho g(h - z'))(h - z') \end{cases}$$



RINOMINO $h - z' \equiv \eta$

$$\overset{2}{\Rightarrow} \quad p_0 h = p_0 \eta + \rho g \eta^2$$

$$\Rightarrow \quad \rho g \eta^2 + p_0 \eta - p_0 h = 0$$

$$\eta_{1,2} = \frac{-p_0 \pm \sqrt{p_0^2 + 4\rho g p_0 h}}{2\rho g} = \begin{cases} 0,65 \text{ m} \\ -11,02 \text{ m} \end{cases}$$

ACCETTABILE SOLO $z = 0,65\ m$

$\Rightarrow h - z' = 0,65\ m \Rightarrow z' = h - 0,65\ m = 0,05\ m$

$\Rightarrow z' = 5\ cm$

LA CAMPANA HA L'ACQUA ALTA $z' = 5\ cm$

$$\overset{1°}{\Rightarrow} M\left(1 - \frac{\rho}{\rho_c}\right) + m - \rho\pi\frac{D^2}{4}(h - z') = 0$$

$$\Rightarrow M\,\frac{\rho_c - \rho}{\rho_c} = \rho\pi\frac{D^2}{4}(h - z') - m$$

$$\Rightarrow M = \frac{\rho_c}{\rho_c - \rho}\left(\rho\pi\frac{D^2}{4}(h - z') - m\right) = 3397,14\ Kg$$

4 F, T $T_1 = 350\ K$ $T_2 = 280\ K$

$W_T^m = 140\ J$

$\Delta S^m = 0{,}35\ J/K$

SO CHE IN UN CICLO $\Delta U = 0$ E $\Delta S = 0$

$$\Delta S^m = \Delta S_u = \Delta S_{AMB}$$

ED È SOLO QUELLA DELLE SORGENTI $\Delta S_{SORG_i} = \dfrac{Q_i}{T_i}$

E POSSO ANCHE DIRE

$$\Delta U_T = 0 \Rightarrow Q_T^m = W_T^m \Rightarrow W_T^m = Q_{ASS}^m - Q_{CED}^m$$

DALLE SORGENTI AVRÒ Q_{ASS} DA T_1 E Q_{CED} A T_2 PER LA MACCHINA TERMICA, MA IL FRIGORIFERO È REVERSIBILE E QUINDI $\Delta S_F^m = 0$.

Posso SCRIVERE

$$\begin{cases} W_T^m = Q_{ASS}^m - |Q_{CED}^m| \\ \Delta S_u = -\dfrac{Q_{ASS}}{T_1} + \dfrac{|Q_{CED}|}{T_2} \end{cases}$$

$$\begin{cases} Q_{ASS}^{M} = W_{T}^{M} + |Q_{CED}^{M}| \\ \Delta S_U = -\frac{W_T^M}{T_1} + |Q_{CED}^{M}|\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \end{cases}$$

$$\begin{cases} Q_{ASS}^{M} = W_{T}^{M} + |Q_{CED}^{M}| \\ |Q_{CED}^{M}|\frac{T_1 - T_2}{T_1 T_2} = \Delta S_U + \frac{W_T^M}{T_1} \end{cases}$$

$$\begin{cases} Q_{ASS}^{M} = W_{T}^{M} + |Q_{CED}^{M}| = 1190 \text{ J} \\ |Q_{CED}^{M}| = \frac{T_1 T_2}{T_1 - T_2}\left(\Delta S_U + \frac{W_T^M}{T_1}\right) = 1050 \text{ J} \end{cases}$$

COSÌ HO $\eta_T = 1 - \frac{|Q_{CED}|}{Q_{ASS}} = 0{,}118 = 11{,}8\,\%$

$$\eta_R = 1 - \frac{T_2}{T_1} = 0{,}2 = 20\%$$

PER F POSSO SCRIVERE (ORA W_T^M È ASSORBITO)

$$\begin{cases} \Delta U = 0 \\ \Delta S = 0 \end{cases} \Rightarrow \begin{cases} -|W_T^M| = Q_{ASS}^{F} - |Q_{CED}^{F}| \\ 0 = -\frac{Q_{ASS}^F}{T_2} + \frac{|Q_{CED}^F|}{T_1} \end{cases}$$

$$\begin{cases} -|W_T^m| = |Q_{CED}^F| \left(\frac{T_2}{T_1} - 1 \right) \\ Q_{ASS}^F = \frac{T_2}{T_1} |Q_{CED}^F| \end{cases}$$

$$\begin{cases} |Q_{CED}^F| = \frac{T_1 |W_T^m|}{T_1 - T_2} = 700 \text{ J} \\ Q_{ASS}^F = \frac{T_2}{T_1} |Q_{CED}^F| = 560 \text{ J} \end{cases}$$

DUNQUE HO

$$Q_1 = -Q_{ASS}^m + |Q_{CED}^F| = -490 \text{ J}$$

$$Q_2 = |Q_{CED}^m| - Q_{ASS}^F = 490 \text{ J}$$

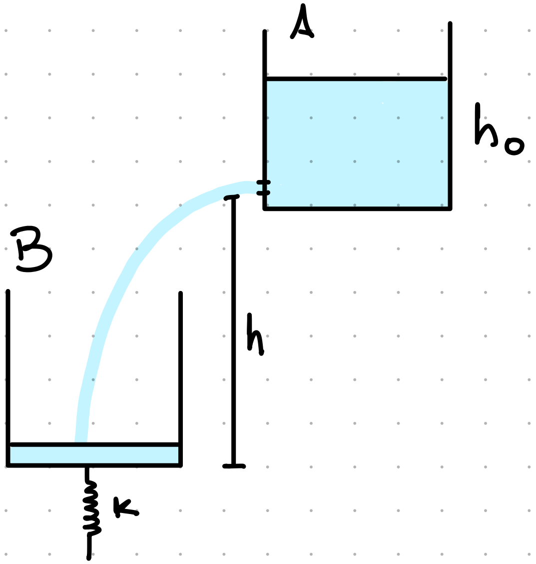
SE FACCIO $T \to R$ ALLORA AVREI $\Delta S^m = 0$ E DUNQUE

$$\begin{cases} Q_{ASS}^R = W_T^m + |Q_{CED}^R| = 700 \\ |Q_{CED}^R| = \frac{W_T^m T_2}{T_1 - T_2} = 560 \end{cases} \Rightarrow \begin{cases} Q_1 = 0 \text{ J} \\ Q_2 = 0 \text{ J} \end{cases}$$

(RELAZIONI DI PRIMA PER T)

14/09/2022 (ES 1, 2 ERANO DI MECCANICA) $\rightarrow$ VEDI ALTRO FILE

3



$h_0 = 0{,}9 \ m$

$h = 1{,}3 \ m$

$K = 120 \ N/m$

$s = 1{,}4 \ cm^2 \ll S$

USO BERNOULLI IN A:

$$p_0 + \frac{1}{2}\rho V^2 = p_0 + \frac{1}{2}\rho v^2 - \rho g h_0$$

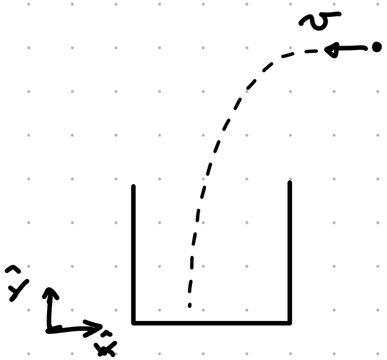
DALLA COSTANZA DELLA PORTATA $vs = VS \Rightarrow s \ll S \Rightarrow V \ll v$

$\Rightarrow v = \sqrt{2 g h_0}$ VELOCITÀ CON CUI ESCE DA s

$\Rightarrow v = 4{,}2 \ m/s$

ORA HO MOTO PARABOLICO FINO A B

$$\begin{cases} x(t) = x_0 - v t \\ y(t) = h - \frac{1}{2} g t^2 \end{cases}$$



$$\Rightarrow \begin{cases} v_x = -v \\ v_y = -gt \end{cases}$$

IL TEMPO DI CADUTA È $y(\tau) = 0 = h - \frac{1}{2} g \tau^2$

$$\Rightarrow \tau = \sqrt{\frac{2h}{g}}$$

DUNQUE HO

$$\boxed{\begin{array}{l} v_x = -v \quad , \quad v_y = -\sqrt{2hg} \quad , \quad v = \sqrt{v_x^2 + v_y^2} \\ v_x = -4{,}2 \ m/s \quad , \quad v_y = -5{,}05 \ m/s \quad , \quad v = 6{,}57 \ m/s \end{array}}$$

LA MASSA CHE ENTRA IN B È LA STESSA CHE ESCE DA A

$$Q_v = vS = 5{,}88 \cdot 10^{-4} \ m^3/s$$

MA SO $Q_m = \frac{dm}{dt}$ E $Q_m = Q_v \rho$

$$\Rightarrow \frac{dm}{dt} = \rho Q_v \Rightarrow \boxed{m(t) = \rho Q_v t = \rho v S t}$$

PER TROVARE LA FORZA ESERCITATA DALL'ACQUA DI B SULLA

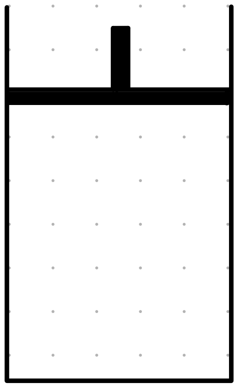
MOLLA USO IL 3° PRINCIPIO DELLA DINAMICA

$$\vec{F}_P = -m(t)g \implies \vec{F}_{EL} = -\vec{F}_P = m(t)g$$

$$\implies k\Delta y = m(t)g \implies \Delta y(t) = \frac{m(t)g}{k}$$

$$\implies \Delta y(t) = \underbrace{\frac{\rho v S g}{k}}_{y_0 = 0,05 \text{ m}} t$$

4 $n = 1$ mol BIATOMICO



XY : T_0 , COMPRES. REVERSIBILE

$V_Y = \frac{1}{3} V_X$

YZ : $T_1 \rightarrow T_0$ ISOCORA

ZX : ESPANSIONE REVERSIBILE

$T_0 = \text{cost}$ $V \rightarrow V_X$

$Q_{TOT} = 8100 \text{ J}$

XY : ADIABATICA

YZ : ISOCORA

ZX : ISOTERMA

HO $Q_{XY} = 0$ $Q_{YZ} = nc_V (T_Z - T_Y)$ $Q_{ZX} = nRT_X \ln\left(\frac{V_X}{V_Z}\right)$

MA HO $V_Z = V_Y$, $T_X = T_Z = T_0$ E $T_Y = T_1$

MA SOPRATTUTTO $T_Z > T_Y \Rightarrow T_0 > T_1$

POICHÈ IN YZ
SI RISCALDA

DUNQUE

$$Q_{YZ} = nc_v(T_0 - T_1) > 0 \quad , \quad Q_{ZX} = nRT_0 \ln(3) > 0$$

$$\Rightarrow Q_{ASS} = Q_{YZ} + Q_{ZX}$$

E CHE $Q_{ASS} = Q_{TOT}$ PERCHÈ IN YZ E IN ZX RESTA A CONTATTO CON LA SORGENTE T_0.

$$Q_{TOT} = n\frac{5}{2}R(T_0 - T_1) + nRT_0 \ln(3)$$

DA XY TROVO

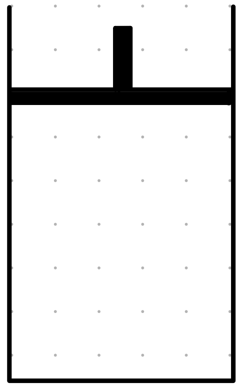
$$T_0 V_x^{\gamma-1} = T_1 V_y^{\gamma-1} \quad \Rightarrow \quad T_1 = \left(\frac{V_x}{V_y}\right)^{\gamma-1} T_0 = 3^{\gamma-1} T_0$$

DUNQUE HO

$$Q_{TOT} = \frac{5}{2}RT_0\left(1 - 3^{\gamma-1}\right) + RT_0 \ln 3$$

$$\Rightarrow T_0 = \frac{Q_{TOT}}{\frac{5}{2}R(1 - 3^{\gamma-1}) + R\ln 3} =$$

4 $m = 1$ mol BIATOMICO



XY : T_0 , COMPRES. REVERSIBILE

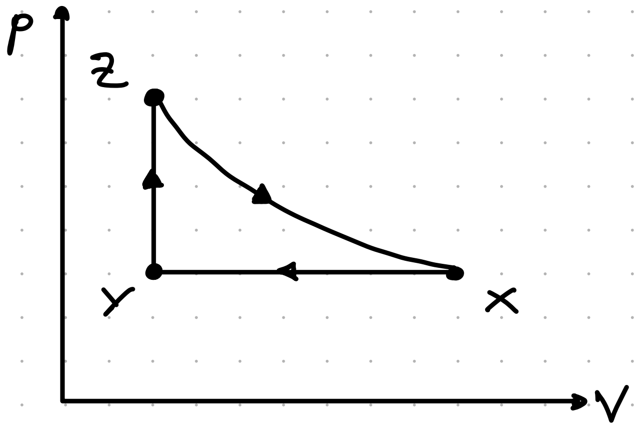
$V_Y = \frac{1}{3} V_X$

YZ : $T_1 \to T_0$ ISOCORA

ZX : ESPANSIONE REVERSIBILE

$T_0 = \text{COST}$ $V \to V_X$

$Q_{TOT} = 8100 \text{ J}$



xy : ISOBARA

yz : ISOCORA

zx : ISOTERMA

HO $Q_{xy} = mc_p (T_y - T_x)$ $Q_{yz} = mc_v (T_z - T_y)$ $Q_{zx} = mRT_x \ln\left(\frac{V_x}{V_z}\right)$

MA HO $V_z = V_y$, $T_x = T_z = T_0$ E $T_y = T_1$

MA SOPRATTUTTO $T_z > T_y \Rightarrow T_0 > T_1$

QUINDI

$$Q_{xy} = nc_p(T_1 - T_0) < 0$$

$$Q_{yz} = nC_v(T_0 - T_1) > 0$$

$$Q_{zx} = nRT_0 \ln \underbrace{\left(\frac{V_x}{V_y}\right)}_{=3} > 0$$

DUNQUE

$$Q_{TOT} = Q_{ASS} = nC_v(T_0 - T_1) + nRT_0 \ln\left(\frac{V_x}{V_y}\right)$$

DA xy HO

$$\frac{V_x}{T_0} = \frac{V_y}{T_1} \Rightarrow T_1 = \frac{V_y}{V_x} T_0 \Rightarrow T_1 = \frac{1}{3} T_0$$

DUNQUE

$$Q_{TOT} = \frac{2}{3} nC_v T_0 + nRT_0 \ln(3)$$

$$\Rightarrow T_0 = \frac{Q_{TOT}}{\frac{2}{3} nC_v + nR \ln 3} = 352,27 \text{ K}$$

PER CUI $$T_1 = \frac{1}{3} T_0 = 117{,}42\ K$$

POSSO TROVARE

$$Q_{xy} = m c_p (T_1 - T_0) = -\frac{2}{3} m c_p T_0 = -6834{,}04\ J$$

IN UN CICLO TD SO $\Delta U = 0$

$$\Rightarrow Q_{CICLO} = W_{CICLO}$$

$$\Rightarrow W_{CICLO} = Q_{xy} + Q_{TOT} = 1265{,}96\ J$$

SO CHE VALE

$$\Delta S_U = \Delta S_{CICLO} + \Delta S_{AMB} \rightarrow \Delta S \text{ DELLA SORGENTE A } T_0$$

$$= \Delta S_{xy} + \Delta S_{yz} + \Delta S_{zx} + \Delta S_{SORG}$$

$$= m c_p \ln\left(\frac{T_1}{T_0}\right) + m c_v \ln\left(\frac{T_0}{T_1}\right) + m \underbrace{R}_{c_p - c_v} \ln\left(\frac{V_x}{V_y}\right) + \Delta S_{SORG}$$

$$= nc_p \ln\left(\frac{1}{3}\right) + nc_v \ln(3) + n(c_p - c_v)\ln(3) + \Delta S_{SORG}$$

$$= \Delta S_{SORG}$$

$$= -\frac{Q_{TOT}}{T_0}$$

$$= -22{,}99 \ J/K$$

20/06/2024

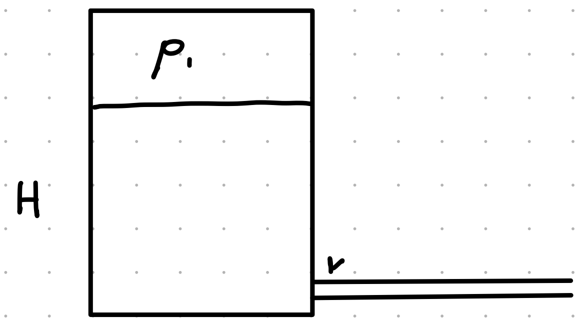
1

$R = 2\,m$ $\qquad r = 10\,cm$

$\rho = \frac{5}{6}\rho_{H_2O}$ $\qquad L = 10\,m$

$H = 20\,m$

$p_1 = 3p_0$



LA FORZA SUL TAPPO LA TROVO DALLA FORZA DI PRESSIONE

$$p_H = p_1 + \rho g H = p_1 + \frac{5}{6}\rho_{H_2O} g H = 466984,5\ Pa$$

SUL TAPPO È ESERCITATA UNA FORZA

$$F_T = p_H \cdot A_T = p_H \pi r^2 = \boxed{14,67\ kN}$$

ORA, CON IL TAPPO APERTO APPLICO BERNOULLI

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g H = p_0 + \frac{1}{2}\rho v_2^2$$

E LA COSTANZA DELLA PORTATA

$$S_1 v_1 = S_2 v_2 \Rightarrow \pi R^2 v_1 = \pi r^2 v_2 \Rightarrow v_2 = \frac{R^2}{r^2} v_1$$

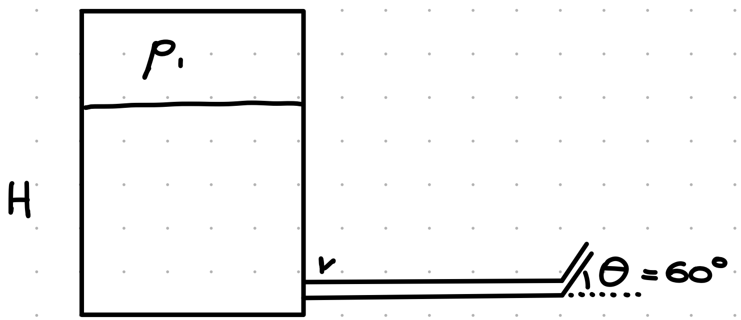
$$\Rightarrow 3p_0 + \frac{1}{2}\rho v_1^2 + \rho g H = p_0 + \frac{1}{2}\rho \left(\frac{R^2}{r^2}\right)^2 v_1^2$$

$$\Rightarrow \frac{\rho}{2}\left(1 - \left(\frac{R^2}{r^2}\right)^2\right) v_1^2 = -2p_0$$

$$\Rightarrow \left(\left(\frac{R^2}{r^2}\right)^2 - 1\right) v_1^2 = \frac{4p_0}{\rho}$$

$$\Rightarrow v_1 = \sqrt{\frac{4p_0}{\rho\left(\left(\frac{R^2}{r^2}\right)^2 - 1\right)}} \Rightarrow Q = S_1 v_1 = \pi R^2 \sqrt{\frac{4p_0}{\rho\left(\left(\frac{R^2}{r^2}\right)^2 - 1\right)}} = \boxed{0{,}7 \ m^3/s}$$

ORA METTO IL GOMITO



CON UN FLUIDO IDEALE HO $Q = \text{COST}$
E ARRIVO ALL'IMBOCCATURA CON v_2

$$v_2 = \frac{R^2}{r^2} v_1 = 22{,}087 \ m/s$$

$$(v_1 = 0{,}055 \ m/s)$$

HO LA v_2 INIZIALE E STUDIO IL MOTO PARABOLICO

$$\begin{cases} v_{0x} = v_2 \cos\theta \\ v_{0y} = v_2 \sin\theta \end{cases} ; \quad \begin{cases} x(t) = L + v_{0x} t \\ y(t) = v_{0y} t - \frac{1}{2} g t^2 \end{cases} \quad \begin{cases} v_x = v_{0x} \\ v_y = v_{0y} - g t \end{cases}$$

ALLA QUOTA MASSIMA $v_y = 0 \Rightarrow \tau = \frac{v_{0y}}{g} = \frac{v_2 \sin\theta}{g}$

$$\Rightarrow h_{MAX} = \frac{v_2^2 \sin^2\theta}{g} - \frac{1}{2} \frac{v_2^2 \sin^2\theta}{g} = \frac{1}{2} \frac{v_2^2 \sin^2\theta}{g} = 18,65 \text{ m}$$

$H \sin^2\theta$

PRENDO UN FLUIDO REALE $(\eta = 10^{-2} \text{ Pa s})$
HO LA PRESSIONE SUL FORO

$$p_H = p_1 + \rho g H$$

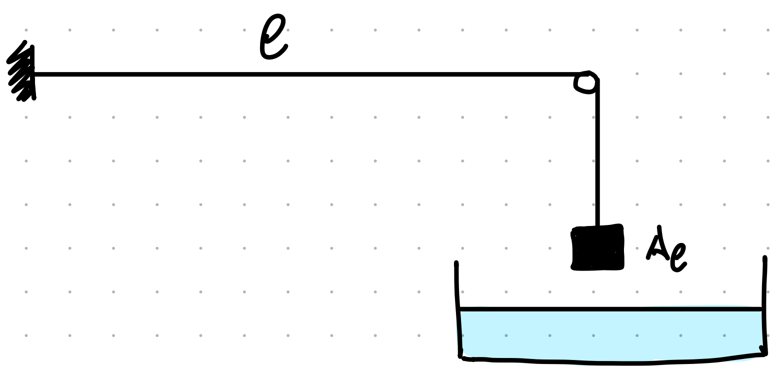
E HAGEN - POISEUILLE

$$Q = \frac{\pi r^4}{8\eta} \frac{\Delta p}{L}$$

IN CUI Δp È LA DIFFERENZA DI PRESSIONE CHE SI HA AI CAPI DEL CONDOTTO

$$\Rightarrow \Delta p = \frac{8\eta Q L}{\pi r^4} = 1782,54 \text{ Pa}$$

2 $\ell = 1,5\ m \qquad d = 0,2\ mm$



$\nu_1 = 200\ Hz$

CONOSCO PER UNA CORDA TESA $v = \sqrt{\dfrac{T}{\rho_L}}$ IN CUI $T = m_{Al}\, g$

CON

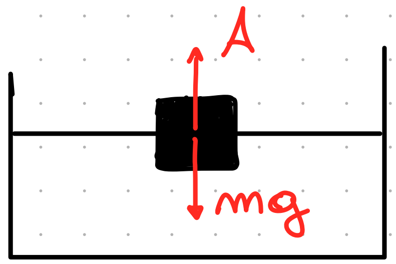
$$\nu_1 = \frac{v}{\lambda_1} \quad , \quad \lambda_1 = \frac{2L}{1} \quad \Rightarrow \quad \nu_1 = \frac{v}{2L}$$

$$\Rightarrow \quad 2\ell\nu_1 = \sqrt{\frac{mg}{\rho_L}} \quad \Rightarrow \quad m = \frac{4\ell^2\nu_1^2\rho_L}{g} = \frac{\ell^2\nu_1^2\pi d^2}{g}$$

$$\rho_L = \rho_{FE}\cdot S = \rho_{FE}\,\pi\,\frac{d^2}{4}$$

$$\Rightarrow \quad m = 9,073\ Kg$$

SUL BLOCCO DI ALLUMINIO IN ACQUA HO



$$\Rightarrow T' = mg - A = mg - \rho_{H_2O} V_{imm}\, g$$

$$\Rightarrow \nu_1' = 180\ Hz = \frac{v'}{2L}$$

$$\Rightarrow 4L^2 \nu_1'^2 = \frac{T'}{\rho_L} \quad \Rightarrow \quad mg - \rho_{H_2O} V_{imm}\, g = 4L^2 \nu_1'^2 \rho_L$$

$$\Rightarrow \rho_{H_2O} V_{imm}\, g = mg - \pi L^2 \nu_1'^2 d^2 \rho_{FE}$$

$$\Rightarrow V_{imm} = \frac{m}{\rho_{H_2O}} - \frac{\pi L^2 \nu_1'^2 d^2 \rho_{FE}}{\rho_{H_2O}\, g}$$

AVEVO

$$m = \rho V_{TOT} \quad \Rightarrow \quad V_{TOT} = \frac{m}{\rho_{AL}} = 3{,}35 \cdot 10^{-3}\ m^3$$

$$\Rightarrow \frac{V_{imm}}{V_{tot}} = \frac{\rho_{AL}}{\rho_{H_2O}} - \frac{\rho_{FE}\,\rho_{AL}}{\rho_{H_2O}} \frac{\pi L^2 \nu_1^2 d^2}{mg} = 0,66 = 66\,\%$$

ORA HO L'ATTENUAZIONE $A = 2\,\mathrm{dB/Km}$ ED $L(16\,m) = 60\,dB$
HO

$$L = \tilde{L} - Ax \quad , \quad x = 16\,m$$

$$\Rightarrow \tilde{L} = L + Ax \qquad \text{EMESSO}$$

$$\Rightarrow \tilde{L} = 10 \log\left(\frac{I}{I_0}\right) \Rightarrow I = I_0\, 10^{\frac{\tilde{L}}{10}}$$

$$\Rightarrow P_m = 4\pi x^2 I = 4\pi x^2 I_0\, 10^{\frac{\tilde{L}}{10}} = 3,24 \cdot 10^{-3}\ W$$

$\Rightarrow P_{m,c}$ DELLA CORDA È TUTTA CONVERTITA IN SUONO

$$\Rightarrow P_{m,c} = P_m \Rightarrow \frac{1}{2} \rho_L \omega^2 A^2 v = P_m$$

$$\Rightarrow A = \sqrt{\frac{2P_m}{\omega^2 v \rho_L}} = \sqrt{\frac{8P_m}{\omega^2 v \pi d^2 \rho_{FE}}}$$

HO

(USO ν_1')

$$\omega = 2\pi\nu_1' = 1130,97 \ rad/s$$

$$v = 2L\nu_1' = 540 \ m/s$$

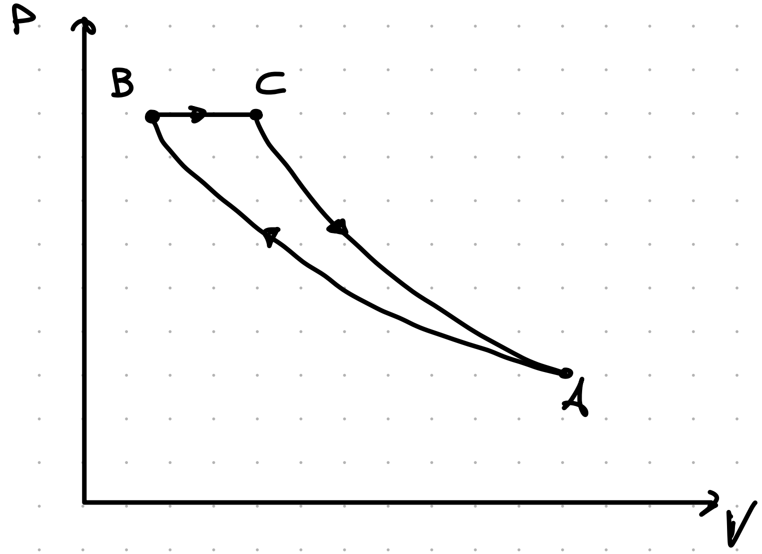
$$\Rightarrow A = 1,948 \cdot 10^{-4} \ m = 0,195 \ mm$$

3

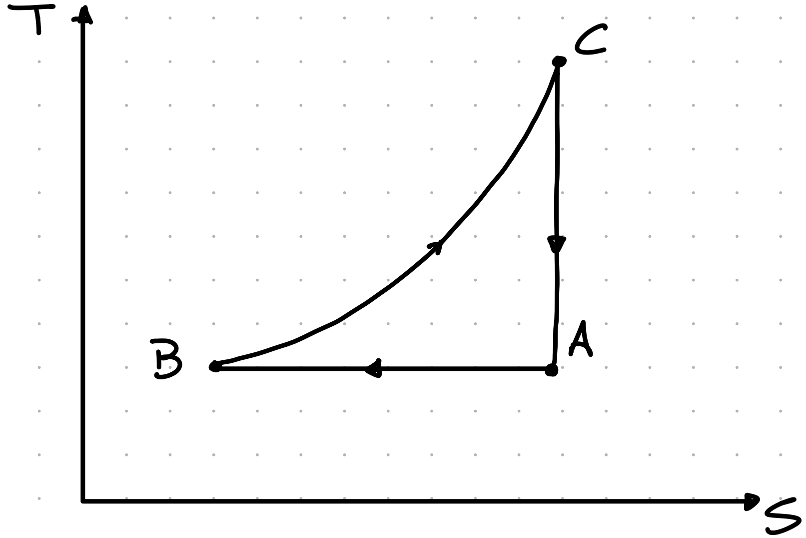
$n = 0,86$ mol   BIATOMICO

$V_A = 20 \cdot 10^{-3}\ m^3$ $T_A = 280\ K$

$V_B = 2 \cdot 10^{-3}\ m^3$



AB ISOTERMA REVERSIBILE
BC ISOBARA REVERSIBILE
CA ADIABATICA REVERSIBILE



TROVO $\quad p_A = \dfrac{nRT_A}{V_A} = 100100,56\ Pa$

AB: $\quad p_A V_A = p_B V_B \Rightarrow p_B = \dfrac{V_A}{V_B} p_A$

$\Rightarrow p_B = 1001005,6\ Pa \quad , \quad T_B = T_A$

BC: $\quad \dfrac{V_B}{T_B} = \dfrac{V_C}{T_C} \quad , \quad p_B = p_C \quad \Rightarrow \quad T_C = \dfrac{V_C}{V_B} T_B$

CA: $\quad p_C V_C^{\gamma} = p_A V_A^{\gamma} \quad \Rightarrow \quad V_C = \left(\dfrac{p_A}{p_C}\right)^{1/\gamma} V_A = 3,86 \cdot 10^{-3}\ m^3$

$\Rightarrow T_C = 540,59 \ K$

i CALORI

$$Q_{AB} = W_{AB} = nRT_A \ln\left(\frac{V_B}{V_A}\right) = -4609,8 \ J$$

$$Q_{BC} = nC_p (T_C - T_B) = 6506,76 \ J$$

$$Q_{CA} = 0$$

$$\Rightarrow \eta = 1 - \frac{Q_{CED}}{Q_{ASS}} = 0,29 = 29\%$$

CALCOLO

$$\Delta S_{BC} = nC_p \ln\left(\frac{T_C}{T_B}\right) = 16,46 \ J/K$$