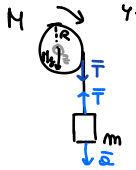
ESERCITAZIONE CORPO RIGIDO

N°1

SCHEMATIZZAZIONE: cerco $\bar{a}, \bar{T}$



$\rightarrow$ su m: $\bar{a} = \bar{a}_{CM} \rightarrow \bar{T} - mg = ma_{CM} \rightarrow \bar{T} = m(\alpha R + g)$

$\rightarrow$ cerco $\bar{a}_{ci}$: $a_{CM} = \alpha R$, scelgo centro di rotazione nel centro carrucola

$\sum_i \bar{\tau}_{P_i} = I_{z_P} \bar{\alpha}$

$\rightarrow \bar{R} \times \bar{T} = I_{z_P} \bar{\alpha} \rightarrow -RT\bar{u}_z = \frac{1}{2} MR^2 \cdot \bar{\alpha} \rightarrow$ sost. T $\quad -Rm(\alpha R + g) = \frac{1}{2} MR^2 \bar{\alpha}$

$\rightarrow mR^2\alpha + mRg = \frac{1}{2} MR^2 \alpha \rightarrow \alpha\left(\frac{2m+M}{2}\right)R^2 = mRg \rightarrow \alpha = \frac{2mRg}{R^2(M+2m)}$

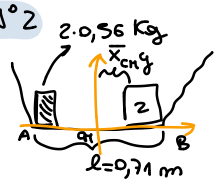
$\rightarrow |a| = a_{CM} = \frac{2mR^{\cancel{2}}g}{\cancel{R^2}(M+2m)} = \frac{2mg}{M+2m}$

$\rightarrow$ cerco $\bar{T}$: $\bar{T} = m(a+g) = m\left(\frac{2mRg}{M+2m} + g\right) = mg\left(\frac{2mR+M+2m}{M+2m}\right)$

$\rightarrow$ cerco V_M dopo h_m: $\begin{cases} V_M = V_0 + at \\ S = S_0 + V_0 t + \frac{1}{2} a t^2 \end{cases} \rightarrow h = \frac{1}{2} a t^2 \rightarrow t = \sqrt{\frac{\cancel{2}h(M+2m)}{\cancel{2}mg}} = \sqrt{\frac{h(M+2m)}{mg}}$

$\rightarrow V_m = \frac{2mg}{M+2m}\sqrt{\frac{h(M+2m)}{mg}}$

N°2



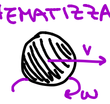
$A\bar{X}_{CM} = B\bar{X}_{CM}$ $\quad$ cerco dist $m_1 - m_2$.

$\rightarrow \underbrace{-A\bar{X}_{CM}(m_1)g + \bar{X}_{CM}y\, m_2 g = 0}_{\text{Momento cercali}} \rightarrow \bar{X}_{CM}y = 0,22\,m$

$\rightarrow \bar{Ay} = d = A\bar{x}_{CM} + \bar{X}_{CM}y = 0,58\,m$

N°3

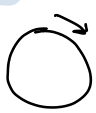
SCHEMATIZZAZIONE: E_{ROT}? E_{TRAS}?



$\rightarrow E_{TRAS} = \frac{1}{2} m v^2 = 1,7 \cdot 10^3$ J $\quad \rightarrow E_{ROT} = \frac{1}{2} I \omega^2 = \frac{1}{5} M r^2 \omega^2$

$\frac{2}{5} M r^2$ (conosco r)

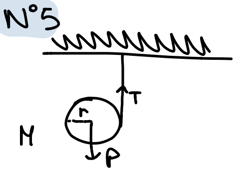
N°4



conosco m, R, ω. E_{CIN}?

$I = \frac{1}{2} mR^2 \rightarrow E_{CIN} = E_{ROT} = \frac{1}{2} I \omega^2 = \frac{1}{4} mR^2 \omega^2$

N°5



a_{CM}? T?

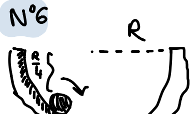
$\rightarrow$ per CM: $\begin{cases} mg - T = ma_{CM} \rightarrow a_{CM} = \frac{2}{3} g \\ Tr = I\alpha = \frac{1}{2} m r^2 \frac{a_{CM}}{r} \rightarrow T = \frac{1}{2} mg \end{cases}$

$V_{CM} = \frac{2}{3} g t \rightarrow \omega = \frac{V_{CM}}{r}$

$\rightarrow$ con conservazione em: $\underbrace{\frac{1}{2} m V_{CM}^2}_{E_{TR}} + \underbrace{\frac{1}{2} I \omega^2}_{E_{RT}} + \underbrace{mg y_{CM}}_{U} = K$

$\rightarrow \frac{3}{2} m V_{CM} a_{CM} - mg V_{CM} = 0 \rightarrow a_{CM} = \frac{2}{3} g$

N°6



Det h_P, ω_P. $V_i = 0$. $X_{CMi} = \frac{R}{2}$

$\rightarrow \Delta E = 0 \rightarrow mg\frac{R}{4} = \frac{1}{2} I \omega^2 + \frac{1}{2} m V_{CM}^2 \rightarrow \omega$

$\omega \frac{R}{4}$

quando X_{CM_i} è a metà

$\rightarrow E_{CM} = \text{cost}$ perché ω cost : $\Delta E = 0 \rightarrow \frac{1}{2} m v_{CM}^2 = \frac{1}{6} m g R = \frac{2}{3} m g \left(\frac{R}{4}\right) = m g \Delta h \rightarrow$ trovo Δh (cm scende di $\frac{R}{4}$ e sale di $\frac{2}{3}\frac{R}{4}$)

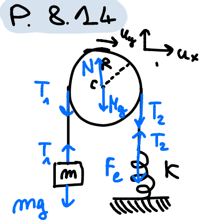
P. 8.1

L, $\rho(x) = \rho_1 + (\rho_2 - \rho_1) x / L$ con ρ_1, ρ_2 cost e $0 < x < L$. X_{cm}

$$X_{cm} = \frac{1}{m} \int_0^L x \rho(x)\, dx =$$

↳ dove $m = \int dm = \int \rho(x) dx = \int x \rho_1 + (\rho_2 - \rho_1) x^2/2 \, dx = \rho_1 + (\rho_2 - \rho_1)$

P. 8.14



$m = 1$ Kg, $K = 30$ N/m, $M = 10$ Kg, $R = 0{,}5$ m.

i. Δx della molla quando in eq:

$$\begin{cases} \sum \vec{\mathcal{C}}_i = 0 \rightarrow \text{centro in } c: -T_1 R + T_2 R = I_c \alpha \\ T_1 - mg = m R \alpha \\ T_2 - K \Delta x = m R \alpha \\ N - Mg = 0 \end{cases}$$

se eq.: $\left.\begin{matrix} T_1 = mg \\ T_2 = K\Delta x \end{matrix}\right\} -mgR + K\Delta x R = 0 \rightarrow \Delta x_{eq} = \frac{mg}{K}$

ii. se $\alpha \neq 0 \rightarrow$ $\left.\begin{matrix} T_1 = m \frac{d^2 x}{dt} + mg \\ T_2 = m \frac{d^2 x}{dt^2} + Kx \end{matrix}\right\} -m_1 R \frac{d^2 x}{dt} - m_1 R g + m_2 R \frac{d^2 x}{dt^2} + RK\Delta x = \frac{1}{2} M R \frac{d^2 x}{dt^2}$

$$\rightarrow \frac{1}{2}(M + 2m) R \frac{d^2 x}{dt^2} = R(mg + K\Delta x) \rightarrow \frac{d^2 x}{dt^2} = \frac{2(mg + K\Delta x)}{M + 2m}$$

$$\omega = \sqrt{\Omega} = \sqrt{\frac{2K}{M+2m}} \rightarrow \omega = \frac{2\pi}{T} \rightarrow T = 2\pi \sqrt{\frac{M+2m}{2K}}$$

iii. $\omega_{max}(t)$ con $\Delta x = 0{,}4$ m

$x(t) = x_{eq} + A\cos(\Omega t + \phi) \rightarrow x(t) = \Delta x \cos\left(\frac{2K}{M+2m} t\right) + \overset{\text{cost}}{x_{eq}}$

$x(0) = x_{eq} + \Delta x \rightarrow A = \Delta x$ derivo ↳ $v(t) = -\frac{\Delta x\, 2K}{M+2m} \operatorname{sen}\left(\frac{2K}{M+2m} t\right)$

$\phi = 0$

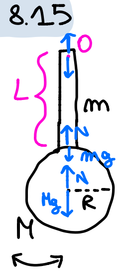
$$\omega(t) = \frac{v(t)}{R} = \underbrace{-\frac{\Delta x\, 2K}{R(M+2m)}}_{\gamma} \operatorname{sen}\left(\frac{2K}{M+2m} t\right)$$

$\rightarrow$ cerco pto max: $\omega'(t) = \gamma \frac{2K}{M+2m} \cos\left(\frac{2K}{M+2m} t\right) = 0$

se $\frac{2Kt}{M+2m} = \frac{\pi}{2} \rightarrow t = \frac{\pi(M+2m)}{4K}$ pto max per andamento cos

$$\omega(t) = \gamma \operatorname{sen}\left(\frac{\cancel{2K}}{\cancel{M+2m}} \cdot \frac{\pi \cancel{(M+2m)}}{2\,\cancel{4K}}\right) = \gamma$$

P. 8.15



L, m, M, R.

$\rightarrow T$ oscillazioni.

$\rightarrow F_p = (M+m) g$

so che: $(M+m)\alpha R = (M+m) g \operatorname{sen}\theta$

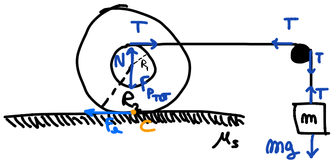
↳ $\alpha R = g \operatorname{sen}\theta \rightarrow \frac{d^2\theta}{dt^2} = \frac{g \operatorname{sen}\theta}{R}$ → $\operatorname{sen}\theta \cong \theta$ a ∞ piccolo

$$\rightarrow \frac{d^2\theta}{dt^2} - \frac{g}{R}\theta = 0 \rightarrow x(t) = A\cos\left(\sqrt{\frac{g}{L}}\, t\right)$$

P 8.23

↳ i. momento d'inerzia (asse ⊥ a c)

↳ $I_c = I_{c_1} + I_{c_2} = \frac{1}{2}M_1R_1^2 + M_1R_2^2 + \frac{1}{2}M_2R_2^2 + M_2R_2^2$



ii. $a = ?$

$$\begin{cases} T - mg = ma \longrightarrow T - mg = m\alpha(R_1+R_2) \\ N - (M_1+M_2)g = 0 \longrightarrow N = (M_1+M_2)g \\ T - F_a = (M_1+M_2)a_G = (M_1+M_2)\alpha R_2 \\ T(R_1+R_2) = I\alpha \rightsquigarrow T = \frac{I\alpha}{R_1+R_2} \end{cases}$$

centro polo in C →

da (1) → $\frac{I\alpha}{R_1+R_2} - mg = m\alpha(R_1+R_2) \rightarrow \frac{I - m(R_1+R_2)^2}{R_1+R_2}\alpha = mg \rightsquigarrow \alpha = \frac{mg(R_1+R_2)}{I - m(R_1+R_2)^2}$

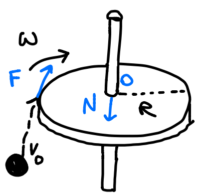
iii. μ_s min.

→ $F_a = \mu_s N = \mu_s(M_1+M_2)g \longrightarrow \frac{I\,mg}{I - m(R_1+R_2)^2} - \mu_s(M_1+M_2)g = (M_1+M_2)\alpha R_2 \rightarrow \mu_s(M_1+M_2)g = \} - (M_1$

sost in (3)

$\mu_s = \sim \frac{1}{(M_1+M_2)g}$

P. 8.20



$m = 0{,}05$ Kg, $v_0 = 100$ m/s, $M = 10$ Kg, $R = 0{,}5$ m. Det ω_p

→ URTO ANAELASTICO: si può conservare solo L_o, Δp

↳ vincolo asse impulsivo: metto centro in O

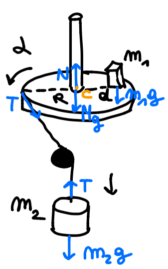
↳ $\sum \vec{\tau} = I\alpha \rightarrow FR = I_c\alpha$

↳ $\Delta \vec{L}_o = 0 \longrightarrow \vec{L}_p = \vec{L}_i \longrightarrow I_c\vec{\omega} = m\vec{v}_0 \times \vec{R}$

↳ $\omega = \frac{m v_0 R}{I_c}$ con $I_c = \frac{1}{2}MR^2 + mR^2$

P. 8.16

↳ $R, M, m_1, d\,(<R), m_2$



i. α? $\longrightarrow T - m_2 g = m_2\alpha R \rightarrow T = m_2(\alpha R + g)$

$\sum \vec{\tau}_i = I\alpha \xrightarrow[\text{centro in c}]{} -TR + \cancel{d\,m_1 g} = I\alpha \rightarrow -m_2(\alpha R + g)R + \cancel{d\,m_1} g = I\alpha$

so che $I = \frac{1}{2}MR^2 + m_1 d^2$ ↳ $\left(\frac{1}{2}MR^2 - m_1 d^2 + m_2 R^2\right)\alpha = \cancel{d\,m_1} g - m_2 g R$

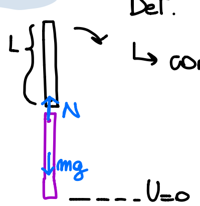
↳ $\alpha = g\,\frac{\cancel{d\,m_1} - m_2 R}{I - m_2 R^2}$

ii. t quando m_1 si stacca → si ribalta ($\omega(t) = \alpha t$)

→ cerco $\omega|_{m_1 \text{ si ribalta}}$: $d m \omega d^2 = I_m \alpha \rightarrow \omega = \frac{\cancel{m} d^{\cancel{2}} \alpha}{\cancel{m} d^3} = \frac{\alpha}{d}$

→ $\frac{\alpha}{d} = \alpha t \rightarrow t = \frac{1}{d}$ → devo introdurre attrito

P. 18

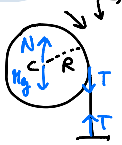


Det. $\omega(t)|_{\text{eq. stabile}}$

↳ com en. → $\Delta E = 0 \rightarrow mgh = \frac{1}{2}M\underbrace{V_{cm}^2}_{0} + \frac{1}{2}\underbrace{I_z}_{=\frac{1}{3}ML^2}\omega^2$, $h \to L$

$E_i = E_f \rightarrow \cancel{M}g\frac{\cancel{L}3}{2} = \frac{1}{6}\cancel{M}L^{\cancel{2}}\omega^2 + \frac{\cancel{L}}{2}\cancel{M}g \longrightarrow g = \frac{L}{6}\omega^2 \rightarrow \omega = \sqrt{\frac{6g}{L}}$

P. 8.13

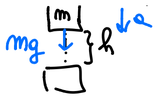


$h = 2$ m, $R = 0{,}5$ m, $m = 2$ Kg, $M = 10$ Kg

→ ω a h : $\omega(t) = \alpha t$

→ $mg - T = m\alpha R \rightarrow T = m(g - \alpha R)$

polo in $TR = I\alpha \rightsquigarrow mRg - \alpha(I + mR^2) \rightarrow \alpha = \frac{mRg}{}$

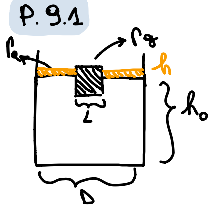


trovo t: $2=\frac{1}{2}\alpha R t^2 \rightarrow t=\sqrt{\frac{4}{\alpha R}}$

$\omega(t)=\sqrt{\frac{\alpha^2 t}{\alpha R}}=\sqrt{\frac{4mg}{I+mR^2}}$

STATICA E DINAMICA DEI FLUIDI

P. 9.1



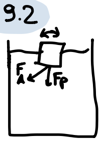
Det h.

$\rightarrow$ spinta archimede: $F_A=-\rho_l V_0 \vec{g}$ V_0 volume immerso

$F_A-F_p=0 \rightarrow \rho_l V_0 g-\underbrace{mg}_{\rho_g L^3}=0 \rightarrow V_0=\frac{\rho_g L^3}{\rho_a}$ volume spostato

$\rightarrow V_0=\frac{D^2}{4}\pi(h-h_0) \rightarrow h-h_0=\overbrace{\frac{\rho_g L^3 4}{\rho_A \pi D^2}}^{\gamma} \rightarrow h=\gamma+h_0$

P. 9.2



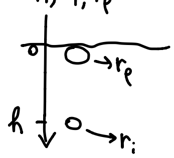
$\rightarrow$ da archimede $V_0=\frac{\rho_g}{\rho_a}L^3$

↳ $F_a=ma=m\frac{d^2z}{dt^2} \rightarrow \rho_A \overbrace{V_0}^{L^2 z} g=m\frac{d^2z}{dt^2} \rightarrow \frac{d^2z}{dt^2}-\frac{\rho_A L^2 g}{m}z=0$

$T=\frac{2\pi}{\omega}=2\pi\sqrt{\frac{m}{\rho_A L^2 g}}=2\pi\sqrt{\frac{\rho_g L}{\rho_A g}}$ $\quad m=\rho_g L^3$

P. 9.3

$h, r_i, r_p \longrightarrow$ T cost. Det h

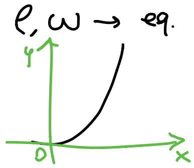


$pV=nRT=cost \rightarrow p_0V_0=p_hV_h \rightarrow p_h=\frac{p_0V_0}{V_h}=p_0\frac{\cancel{4}}{\cancel{3}}\cancel{\pi}r_p^3\cdot\frac{\cancel{3}}{\cancel{4\pi}r_i^3}=p_0\left(\frac{r_p}{r_i}\right)^3$

$\rightarrow p(z)=p_0+\rho_A g h \rightarrow p_0\left(\frac{r_p}{r_i}\right)^3=p_0+\rho_A g h \rightarrow h=\frac{p_0}{\rho_A g}\left(\left(\frac{r_p}{r_i}\right)^3-1\right)$

P. 9.4

$\rho, \omega \rightarrow$ eq. superficie



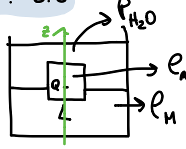
u_x: $F=ma=m\omega^2R$

u_y: $F=\rho_v V_0 g=m\rho_v^2 g$

$|a|=\sqrt{(\omega^2R)^2+(\rho_v^2 g)^2}$

$y=\frac{x}{\omega^2R}\rho_v^2 g$ NON PROPRIO

P. 9.6



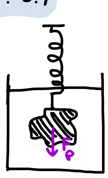
Det dist(Q,CM)

$\rightarrow \rho_M V_{IMM}\cancel{g}=\rho_{AL}V_{CUB}\cancel{g}-\rho_{H_2O}(V_{CUB}-V_{IMM})\cancel{g} \rightarrow (\rho_M-\rho_{H_2O})V_{IMM}=(\rho_{AL}-\rho_{H_2O})V_{CUB}$

↳ $V_{IMM}=\frac{(\rho_{AL}-\rho_{H_2O})}{\rho_M-\rho_{H_2O}}L^3$

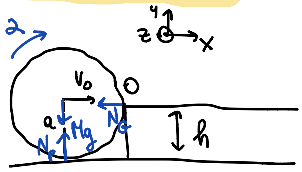
$\rightarrow V_{IMM}=L^2Q \rightarrow Q=\frac{\rho_{AL}-\rho_{H_2O}}{\rho_M-\rho_{H_2O}}L \rightarrow dist(Q,CM)=\frac{L}{2}-Q=5-\frac{2,7-1}{13,6-1}10=5-1,39=3,65$ cm

P. 9.7



$F_p=5N$

ES. CORPO RIGIDO



V_0 / salga. $h<a$

$N=0$ perché si stacca $\xrightarrow[\text{centro in O}]{}$ $\Sigma \tau = 0 \rightarrow F(a-h) = Mg\sqrt{a^2-(a-h)^2} = Mg\sqrt{2ah-h^2}$ → min che deve avere M

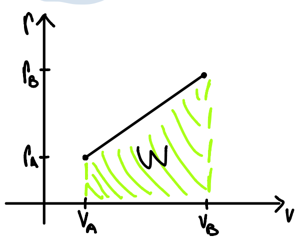
$F = Ma \rightarrow \frac{g\sqrt{2ah-h^2}}{a(a-h)} = \alpha \rightarrow \omega R = V_0$

$\downarrow$

$\omega = \alpha t$

ES. TERMODINAMICA

ES. 1



$A(p_A, V_A) \longrightarrow B(p_B, V_B)$. Det W e Q

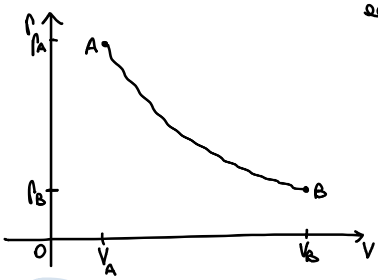
$\rightarrow W = \frac{(p_A+p_B)(V_B-V_A)}{2}$

$\rightarrow Q = \Delta U + W$

$\Delta U = m c_v \Delta T = \frac{\Delta p \Delta V c_v}{R} = \frac{c_v}{R}(p_B V_B - p_A V_A)$; $\Delta T = \frac{\Delta p \Delta V}{mR}$

$\rightarrow Q = \frac{c_v}{R}(p_B V_B - p_A V_A) + \frac{(p_B+p_A)(V_B-V_A)}{2}$

ES. 2

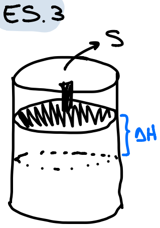


adiab $\rightarrow Q=0 \rightarrow \Delta U = -W$

$\hookrightarrow \Delta U = m c_v \Delta T = m c_v \left(\frac{p_B V_B}{mR} - \frac{p_A V_A}{mR}\right) = -W$

$\rightarrow T_A \gtreqless T_B$? : siccome $\underbrace{W>0}_{\text{espansione}} \rightarrow \Delta T < 0 \rightarrow T_B < T_A$

ES. 3



$\rightarrow Q>0$ e moto. Det Δh

$\hookrightarrow p$ cost $\rightarrow \Delta V = \frac{mR\Delta T}{p}$ cerco ΔT: $\Delta U = m c_v \Delta T = Q - W$ → $p\Delta V$

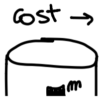
$\rightarrow \Delta T = \frac{Q - p\Delta V}{m c_v}$

$\rightarrow \Delta V = \frac{\cancel{m}R}{p}\left(\frac{Q-p\Delta V}{\cancel{m}c_v}\right) \rightarrow \left(1+\frac{R}{c_v}\right)\Delta V = \frac{QR}{p c_v} \rightarrow \Delta V = \frac{QR}{p(c_v+R)} = \frac{QR}{p c_p}$

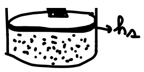
$\Delta V = S \cdot \Delta H \longrightarrow \Delta H = \frac{QR}{p c_p S}$

ES. 4

T_S cost $\rightarrow$ isoterma. Δp quando posiziono m . Det Q



$\rightarrow W = \int_{V_i}^{V_f} p_E \, dV = p_E \Delta V = \left(p_{ATM} + \frac{mg}{S}\right)\Delta V = \left(p_{ATM} + \frac{mg}{S}\right) S(h_2 - h_1) < 0$ coer. con comp.



$$p_f = p_i + \underbrace{\rho g h}_{\text{varia ma } \propto V} = \rho \frac{V}{S} g + p_i = p_i + \frac{mg}{S}$$

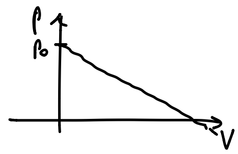
$$\to \underbrace{\Delta U}_{0} = Q - W \to Q = W = \left(p_{ATM} + \frac{mg}{S}\right)\left(\frac{p_{ATM} S h_1}{p_{ATM} + \frac{mg}{S}} - h_1 S\right) = -mgh_1$$

$$p_1 V_1 = p_2 V_2 \to V_2 = \frac{p_1 V_1}{p_2}$$

ES. 5

$p = p_0 - KV$. a) temp max

$\to$



a) $pV = nRT \to T = \frac{pV}{nR} = \frac{(p_0 - KV)V}{nR}$

$$\to T\ max: \frac{dT}{dt} = \frac{p_0}{nR} - \frac{2KV}{nR} = 0 \to V = \frac{p_0}{2K} \to p = p_0 - \frac{p_0}{2} = \frac{p_0}{2}$$

$$\hookrightarrow T = \frac{p_0}{2nR} \cdot \frac{p_0}{2K} = \frac{p_0^2}{4nKR}$$

b) $V_1 = \frac{p_0}{3K}$. Det calore molare $\to p = p_0 - \frac{p_0}{3} = \frac{2p_0}{3}$

$$\hookrightarrow C_\gamma = \frac{1}{n}\frac{\delta Q}{dT} = \frac{1}{n}\left(\frac{nC_v dT}{dT} + \frac{p_0 V_1}{dT} - \frac{KV_1^2}{2dT}\right) = C_v + \frac{p_0 \cancel{V_1}}{\cancel{n} p \cancel{V_1}} \cancel{n} R - \frac{K V_1^{\cancel{2}}}{\cancel{n} 2p \cancel{V_1}} \cancel{n} R = C_v + \frac{3}{2} - \frac{KR}{2} \cdot \frac{3}{2\cancel{p_0}} \cdot \frac{\cancel{p_0}}{3\cancel{K}} = C_v + \frac{3}{2} - \frac{R}{4}$$

$$\hookrightarrow T = \frac{pV_1}{nR} \to \delta Q = dU + \delta W = nC_v dT + p_0 V - \frac{KV^2}{2}$$

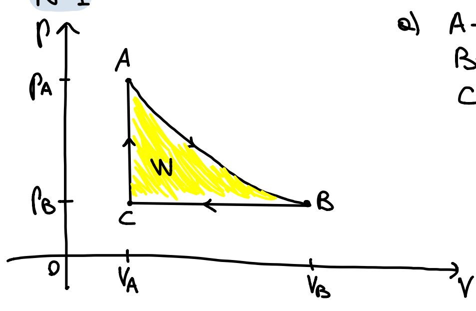
ES. 6

$m_1 = 0{,}5\ Kg$, $T_1 = 20°C \to T_f = 0°C$, m_2 ?

$$Q_f = m_1 c_1 \Delta T = m_1 c_1 (0-20) \to Q_c = \lambda m_2 \to m_1 c_1 (0-20) = -\lambda m_2 \to m_2 = \frac{20 m_1 c_1}{\lambda} = \frac{20 \cdot 0{,}5 \cdot 1}{80} = \frac{10}{80} = 0{,}125\ Kg$$

ESERCITAZIONE 13

N°1



a) $A \to B$: adiabatica
$B \to C$: isobara
$C \to A$: isocora

$V_B = 2V_A$ $\quad T_A, T_B$
$V_C = V_A$

b) $W = \int p_E dV \qquad p_A = \frac{nRT_A}{V_A} \qquad p_B = \frac{nRT_B}{V_B} = \frac{nRT_B}{2V_A}$

$W_{AB} = nc_v \Delta T = -nc_v(T_B - T_A)$ $\quad (Q=0)$

$W_{CA} = 0$ perché $\Delta V = 0$

$$W_{BC} = \int_{V_i}^{V_f} p_B dV = \frac{nRT_B}{2V_A}(2V_A - V_A) = \frac{nRT_B}{2}$$

$$\to W_{TOT} = -n\underbrace{c_v}_{\frac{1}{2}3R}(T_B - T_A) + \frac{nRT_B}{2} = \frac{3}{2}RT_A - 2RT_B$$

c) se $V_B \neq 2V_A \to W_{TOT} = -nc_v(T_B - T_A) + \frac{nRT_B}{V_B}(V_B - V_A)$

so che: $\begin{cases} p_A V_A^\gamma = p_B V_B^\gamma \to \frac{p_A}{p_B} = \left(\frac{V_B}{V_A}\right)^\gamma \\ \end{cases}$

N°2

$$\eta = \frac{W}{Q_{ASS}}$$

$\hookrightarrow W = A_{\hat{ABC}} = \frac{(2p_c - p_c)(2V_c - V_c)}{2} = \frac{p_cV_c}{2}$ $\qquad Q_{ass}?$

$\to AB:\ \Delta U = Q - W$, $\quad W = A_{TRAP} = \frac{(2p_c + p_c)V_c}{2} = \frac{3p_cV_c}{2}$ $\to Q = \frac{3p_cV_c}{2} \geq 0$ assorbito

$\Delta U = mc_v\Delta T = mc_v\left(\frac{p_c 2V_c}{mR} - \frac{2p_cV_c}{mR}\right) = 0$

$\to BC:\ \Delta U = Q + p_cV_c \to Q = mc_v\Delta T - p_cV_c = \frac{c_v p_c V_c}{R} - p_cV_c \leq 0$ non assorbe Q

$\Delta T = \frac{p_cV_c}{mR} - \frac{2p_cV_c}{mR}$ $\qquad c_v = \frac{1}{2}gR \to 5$

$\to AC:\ \Delta U = Q \to Q = mc_v\Delta T = \cancel{m}\frac{5}{2}\cancel{R}V_c\left(\frac{2p_c}{\cancel{mR}} - \frac{p_c}{\cancel{mR}}\right) = \frac{5}{2}V_cp_c$ assorbito

$\hookrightarrow Q_{ASS} = \frac{5}{2}V_cp_c + \frac{3p_cV_c}{2} = 4V_cp_c$ $\qquad \to \eta = \frac{p_cV_c}{2\cdot 4p_cV_c} = \frac{1}{8} = 0{,}125$

N°3

$v = \frac{V_{MAX}}{V_{MIN}}$ $\qquad t = \frac{T_{MAX}}{T_{MIN}}$ $\qquad$ • Det $\eta\ \left(= 1 - \frac{|Q_{CED}|}{Q_{ASS}}\right)$

$\to V_{MAX} = V_B\ ;\ V_{MIN} = V_c\ ;$

$\to$ A-B: adiab $\to Q = 0$

$\to$ B-C: isobara $\to \Delta U = Q - W$, $\quad W = p_c(V_c - V_B) \to \frac{mRT_B}{V_B} = \frac{mRT_c}{V_c} \to \frac{V_B}{V_c} = \frac{T_B}{T_c}$

$\cancel{m}\frac{3}{2}\frac{\cancel{R}p_c}{\cancel{mR}}(V_c - V_B) = mc_v\Delta T$

$\hookrightarrow Q = \frac{3}{2}p_c(V_c - V_B) + p_c(V_c - V_B) = \frac{5}{2}p_c(V_c - V_B) \leq 0$ ceduto

$\to$ C-A: isocora $\to W = 0 \to Q = \Delta U = mc_v\Delta T = \cancel{m}\frac{3}{2}\frac{\cancel{R}V_c}{\cancel{mR}}(p_A - p_c) = \frac{3}{2}V_c(p_A - p_c) \geq 0$ ass.

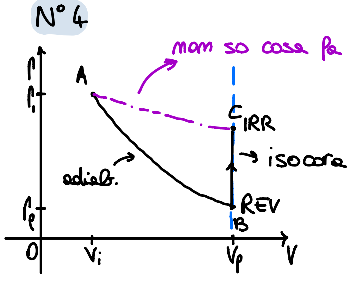
$V_B = vV_c$

$$\eta = 1 - \frac{\frac{5}{\cancel{2}}p_c(V_c - V_B)}{\frac{3}{\cancel{2}}V_c(p_A - p_c)} = 1 - \frac{5p_c\cancel{V_c}(1-v)}{3\cancel{V_c}(p_A - p_c)} = 1 - \frac{5\cancel{p_c}(1-v)}{3\cancel{p_c}(t-1)} = 1 - \frac{5(1-v)}{3(t-1)}$$

$p_A = \frac{mRT_{MAX}}{V_c} = \frac{T_{MAX}}{T_{MIN}}p_c = tp_c$

$V_c = \frac{mRT_{MIN}}{p_c}$

N°4



$\to \begin{cases} pV = mRT \\ \Delta U = Q - W \end{cases}$

$\to \frac{p_f}{T_f} = \frac{mR}{V} = \text{cost} \to$ rev. $\qquad \frac{p_B}{T_B} = \frac{p_c}{T_c}$

$$\Delta S_G = mc_v\ln\left(\frac{T_F}{T_i}\right) + \underbrace{mR\ln\left(\frac{V_f}{V_i}\right)}_{\text{cost}}$$

$\to \Delta S_{G_{ISOC}} = mc_v\ln\left(\frac{T_F}{T_i}\right) + mR\ln\left(\frac{V_F}{V_i}\right) \to mc_v\ln\left(\frac{T_c}{T_B}\right) \geq 0 \to \frac{T_c}{T_B} \geq 1 \to \overset{IRR}{T_c} \geq \underset{REV}{T_B}$

$\to T_c \geq T_B \to \frac{p_c\cancel{V}}{\cancel{mR}} \geq \frac{p_B\cancel{V}}{\cancel{mR}} \to p_c \geq p_B$

$\to \Delta U = mc_v\Delta T \to mc_v(T_c - T_A) \geq mc_v(T_B - T_A) \to U_{IRR} \geq U_{REV}$