I.

1.1. $a = -g$

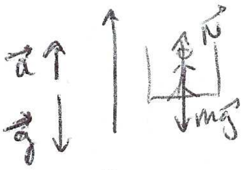
$v = -gt + v_0 \qquad t_s = \frac{v_0}{g}$

il tempo di discesa è uguale a quello di salita.

1.2

$$\vec{r}_{cm} = \frac{\sum_i m_i \vec{r}_i}{\sum_i m_i}$$

1.3 ascensore accelerando verso l'alto: $a > 0$



$\vec{N} + m\vec{g} = m\vec{a}$

$N - mg = ma \qquad N = m(a+g)$

→ peso superiore a quando l'ascensore è in moto uniforme ($a=0$).

1.4. oscillatore armonico:

a) $\overline{E}_p = \overline{E}_c = 25\,J$

b) nel punto di equilibrio: $E_p = 0$, $E_c = 50\,J$

c) accelerazione massima per ampiezza massima
min ($=0$) per punto di equilibrio

1.5. onde acustiche

fondamentale:
$L = \frac{\lambda}{4}$

$\lambda = 4L$

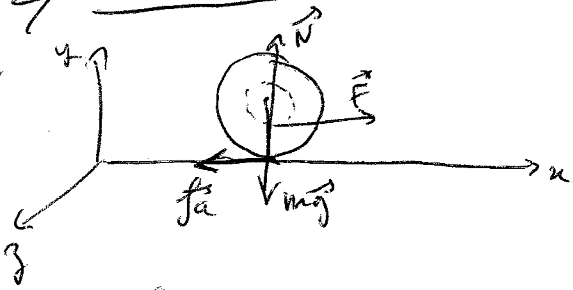
$f = \frac{v}{\lambda} = 1700\,Hz$

1.6 interferenza distruttiva per

$$|L_1 - L_2| = \left(n + \tfrac{1}{2}\right)\lambda$$

2/ Meccanica:

a/



b/ $\boxed{\vec{v}_c = -\omega R \vec{u}_y}$

c/ $\begin{cases} mg = N \\ -f_a + F = m a_x \\ -f_a R + bF = -J\alpha \end{cases}$ e $a_x = R\alpha$ con $\underline{\alpha > 0}$

$\rightarrow f_a = F - mR\alpha$

$-FR + mR^2\alpha + bF = -J\alpha \longrightarrow \boxed{\alpha = F\left(\frac{R-b}{mR^2+J}\right)}$

d/ $\omega = F\left(\frac{R-b}{mR^2+J}\right)t + \cancel{\omega(t=0)}_{0}$

$v_c = \omega R = F\left(\frac{R-b}{mR^2+J}\right)t$

$\boxed{x_c(t) = \frac{1}{2}RF\left(\frac{R-b}{(mR^2+J)}\right)t^2}$

e/ $v_K = (R-b)\omega$

$v_K = v_A$ $\boxed{x_A(t) = (R-b)\omega t + \ell}$

f/ $E_c = \frac{1}{2}mv_c^2 + \frac{1}{2}J\omega^2 = \frac{1}{2}\omega^2(mR^2+J)$

con $\omega = F\left(\frac{R-b}{mR^2+J}\right)t$

$\rightarrow \boxed{E_c = \frac{1}{2}F^2\left(\frac{(R-b)^2}{mR^2+J}\right)t^2}$

g/ F_{max} per non scivolare?

$f_a \leq \mu N$, $f_a \leq \mu mg$

$f_a = F - mR\alpha = F - mRF\frac{(R-b)}{(mR^2+J)}$

$= F\left(\frac{mRb+J}{mR^2+J}\right)$ $\boxed{F \leq \mu mg\left(\frac{mR^2+J}{mRb+J}\right)}$

3) Termodinamica

1) a) $\ell = \frac{T}{n}\left(\frac{\partial P}{\partial T}\right)_V = \frac{T}{n}\left(\frac{nR}{V-nb}\right) = \frac{RT}{(V-nb)}$

b) $dU = \delta Q - PdV$

$= nC_v dT + n\ell\, dV - P dV$

$= nC_v dT + \frac{nRT}{(V-nb)} dV - P dV$

$= nC_v dT + \left(\frac{RT}{V-nb}\right)\underbrace{\cancel{(n-n)}}_{0} dV$ → dipende solo da T.

2) a) reversibile

$dS_1 = \frac{\delta Q}{T} = \underbrace{\frac{nC_v \cancel{dT}}{T}}_{\substack{0 \\ \text{perché isoterma}}} + \frac{n\ell\, dV}{T} = \frac{nR\cancel{T}}{(V-nb)}\frac{dV}{\cancel{T}} = nR\left(\frac{dV}{V-nb}\right)$

$\Delta S_1 = \underset{\substack{\parallel \\ 1}}{n} R \ln\left(\frac{V_2-nb}{V_1-nb}\right)$

$P_1 = P_0 + \frac{Mg}{S} = 2.96\ 10^5\ \text{Pa}$ $\qquad P_1 = \left(\frac{RT_0}{V_2-nb}\right)$, $P_0 = \left(\frac{RT_0}{V_1-nb}\right)$

→ $\left(\frac{V_2-nb}{V_1-nb}\right) = \frac{P_1}{P_2}$ $\qquad \Delta S_1 = R\ln\frac{P_1}{P_2} = -9.0\ \text{J}$

$\delta Q_1 = nC_v \underset{0}{\cancel{dT}} + n\ell\, dV$ → $Q_1 = nRT_0 \ln\left(\frac{V_2-nb}{V_1-nb}\right) = RT_0 \ln\frac{P_0}{P_1}$

$= -2.7\ \text{kJ}$

(anche $\Delta S_1 = \frac{Q_1}{T_0}$)

Q_1 = calore realmente scambiato

→ $\Delta S_1 = S_{e1}$, $\sigma_1 = 0$.

< 0, sistema non isolato!

$dU = 0$ perché isoterma

$\rightarrow \Delta U_2 = W_2 + Q_2 = 0 \qquad Q_2 = -W_2$

$$Q_2 = P_{ext}\, dV = P_1 (V_2 - V_1) = \underbrace{P_1 (V_2 - nb)} - P_1 (V_1 - nb)$$

$$= RT_0 - \frac{P_1}{P_0} \times \underbrace{\frac{P_0 (V_1 - nb)}{RT_0}}$$

$$= RT_0 \left(1 - \frac{P_1}{P_0}\right)$$

$Q_2 = -4.9\,kJ$

$\Delta S_2 = \Delta S_1$ perché entropia funzione di stato, non dipende del percorso

$$S_{e2} = \frac{Q_2}{T_0} \text{ (realmente scambiato)} = -16.3\ J$$

$$\sigma_2 = \Delta S_2 - S_{e2} = 7.3\,J \quad > 0 \rightarrow \text{ok!}$$