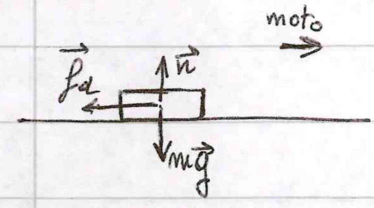
1. PROBLEMA



$v_0 = 20.0\ m/s$

$\Delta x = 115\ m$

$?\ \mu_d$

$$\boxed{f_d = \mu_d n}$$

$$\begin{cases} x:\ n - mg = 0 \Rightarrow n = mg \\ y:\ -f_d = ma \end{cases}$$

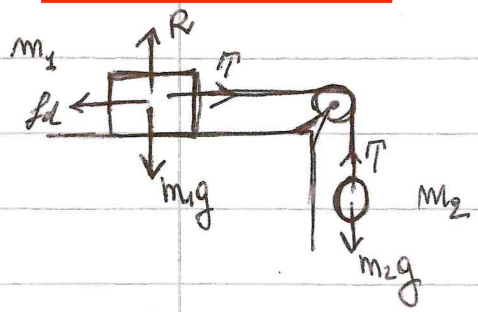
$$\Rightarrow -\mu_d \cancel{m} g = \cancel{m} a \Rightarrow \boxed{\mu_d = -\frac{a}{g}} = \frac{-(-1{,}74\ \cancel{m/s^2})}{9{,}81\ \cancel{m/s^2}} = 0{,}18$$

$$[v(x)]^2 - v_0^2 = 2a(x - \cancel{x_0})$$

h.b. $v(\Delta x) = 0 \Rightarrow$

$$0 - v_0^2 = 2a\Delta x \rightarrow \boxed{a = -\frac{v_0^2}{2\Delta x}} = -\frac{(20{,}0)^2}{2 \cdot 115}\frac{m}{s^2} = -1{,}74\ \frac{m}{s^2}$$

2. PROBLEMA



$\mu_d = 0.30$

$m_1 = 4.0\ kg$

$m_2 = 7.0\ kg$

$?\ a, T$

① $\begin{cases} x:\ T - f_d = m_1 a \\ y:\ R - m_1 g = 0 \end{cases}$ ② $\begin{cases} x:\ -T + m_2 g = m_2 a \\ y:\ — \end{cases}$

Dalla $①_x$ $\left| T - \mu_d(m_1 g) = m_1 a \right.$

Dalla $②_x$ $\left| T - m_2 g = -m_2 a \right.$

$$\Rightarrow +\mu_d m_1 g + m_1 a = m_2 g - m_2 a$$

$$\mu_d m_1 g + m_1 a = m_2 g - m_2 a$$

$$(m_1 + m_2) a = m_2 g - \mu_d m_1 g$$

$$\boxed{a = \frac{(m_2 - \mu_d m_1)}{(m_1 + m_2)} g}$$

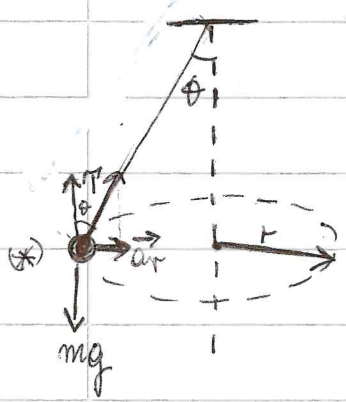
$$-T + m_2 g = m_2 a \Rightarrow T = m_2 (g - a) \Rightarrow$$

$$T = m_2 g \left[1 - \frac{m_2 - \mu_d m_1}{m_1 + m_2} \right] =$$

$$= m_2 g \left[\frac{m_1 + \cancel{m_2} - \cancel{m_2} + \mu_d m_1}{m_1 + m_2} \right] \Rightarrow$$

$$\boxed{T = \frac{m_1 m_2 \mu_d}{m_1 + m_2} g}$$

3. PROBLEMA



$m, L, r, v = \text{cost}$

$? \; v, \; T_p$

$$\boxed{r = L \sin\theta}$$

$$\begin{cases} x: \; T_x = m a \;\Rightarrow\; T \sin\theta = m a_r = m \dfrac{v^2}{r} \\ y: \; T_y - mg = 0 \;\Rightarrow\; T \cos\theta = mg \end{cases}$$

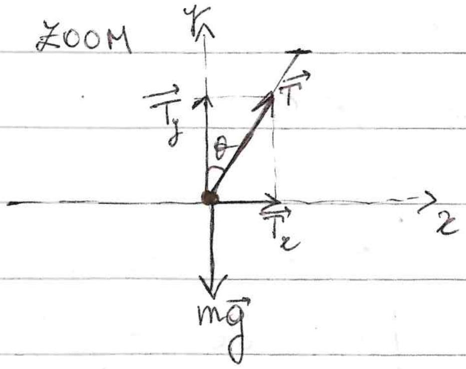
$$\Rightarrow \frac{\cancel{T} \sin\theta}{\cancel{T} \cos\theta} = \cancel{m} \frac{v^2}{r} \frac{1}{\cancel{m} g} \;\Rightarrow\; g \, tg\theta = \frac{v^2}{r}$$

$$\Rightarrow \boxed{v = \sqrt{r g \, tg\theta}}$$

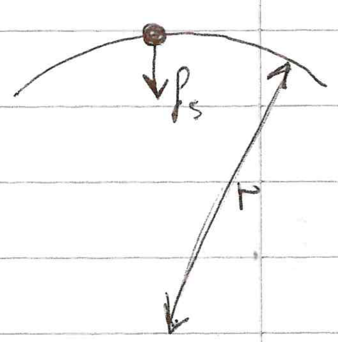
$$\boxed{T_p} = \frac{2\pi r}{v} = \frac{2\pi r}{\sqrt{r g \, tg\theta}} = \frac{2\pi L \sin\theta}{\sqrt{L \sin\theta \, g \, tg\theta}} = \frac{2\pi L \sin\theta}{\sqrt{L g \sin\theta \dfrac{\sin\theta}{\cos\theta}}} =$$

$$= 2\pi \sqrt{\frac{L^{\cancel{2}}}{\cancel{L} g}} \sqrt{\frac{\cancel{\sin^2\theta}}{\dfrac{\cancel{\sin\theta \sin\theta}}{\cos\theta}}} = \boxed{2\pi \sqrt{\frac{L \cos\theta}{g}}}$$

(*) ZOOM



4. PROBLEMA



$m = 1500\ kg$

$r = 35.0\ m$

$\mu_s = 0.500$

? v_{max}

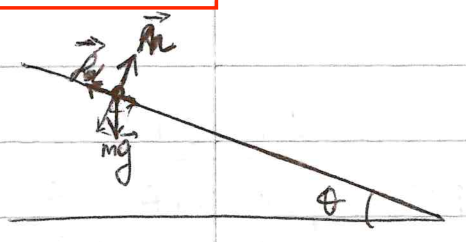
① $f_s = ma = m\frac{v^2}{r}$

② $f_{s,max} = \mu_s n \Rightarrow (mg = n)$

mettendo insieme ① e ② $\Rightarrow$

$$\cancel{m}\frac{v_{max}^2}{r} = \mu_s \cancel{m} g \Rightarrow \boxed{v_{max} = \sqrt{\mu_s g r}}$$

5. PROBLEMA



? $\Delta x_{frenata}$

$v_0 = 20.0\ m/s$

$\mu_d = 0.180$

$\theta = 5.00°$

$$\begin{cases} x: & mg\sin\theta - f_d = ma \\ y: & n - mg\cos\theta = 0 \Rightarrow n = mg\cos\theta \end{cases}$$

Quindi: $mg\sin\theta - \mu_d n = ma$

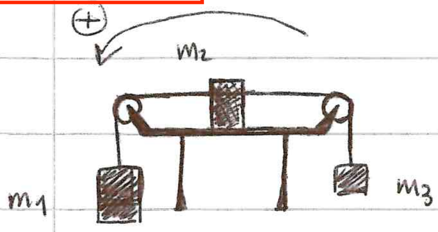
$$\cancel{m}g\sin\theta - \mu_d(\cancel{m}g\cos\theta) = \cancel{m}a$$

$$\Rightarrow \boxed{a = g(\sin\theta - \mu_d\cos\theta)}$$

n.b. $v(\Delta x_{frenata}) = 0 \overset{uso}{\Rightarrow} v^2(x) - v_0^2 = 2a(x - x_0)$

$$\Rightarrow -v_0^2 = 2a\,\Delta x_{frenata} \Rightarrow \boxed{\Delta x_{frenata} = -\frac{v_0^2}{2a}}$$

6. PROBLEMA



$\mu = 0.350$

$m_1 = 4.00\ kg$

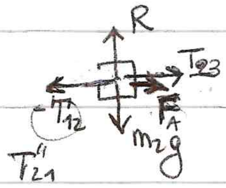
$m_2 = 1.00\ kg$

$m_3 = 2.00\ kg$

? a, T_{12}, T_{23}

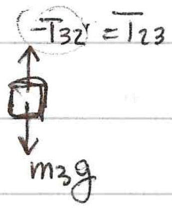
1) 

$$m_1 g - T_{12} = m_1 a$$

2) 

$$\begin{cases} T_{12} - F_A - T_{23} = m_2 a \\ m_2 g = R \end{cases}$$

$F_A = \mu R$

3) 

$$T_{23} - m_3 g = m_3 a$$

$$\begin{cases} m_1 g - m_1 a - T_{12} = 0 \\ T_{12} - \mu m_2 g - T_{23} - m_2 a = 0 \\ T_{23} - m_3 g - m_3 a = 0 \end{cases}$$

sistema 3 equazioni 3 incognite

$$\begin{cases} T_{12} = m_1 (g - a) \\ m_1(g-a) - (\mu g + a) m_2 = T_{23} \\ m_1(g-a) - m_2(\mu g + a) - m_3 g - m_3 a = 0 \end{cases}$$

dalla 3) $\Rightarrow$

$$m_1 g - m_1 a - m_2 \mu g - m_2 a - m_3 g - m_3 a = 0$$

$$a(m_1 + m_2 + m_3) = g(m_1 - \mu m_2 - m_3)$$

$\Rightarrow$

$$\Rightarrow \boxed{a = \frac{m_1 - \mu m_2 - m_3}{m_1 + m_2 + m_3} g}$$

Sostituendo a nella 2) e nella 3) si ottengono T_{12} e T_{23} $\Rightarrow$

$$T_{12} = m_1 g - m_1 \frac{(m_1 - \mu m_2 - m_3)}{m_1 + m_2 + m_3} g =$$

$$= \left[\frac{m_1(m_1 + m_2 + m_3) - m_1^2 + \mu m_1 m_2 + m_1 m_3}{m_1 + m_2 + m_3}\right] g =$$

$$= \frac{\cancel{m_1^2} + m_1 m_2 + m_1 m_3 - \cancel{m_1^2} + \mu m_1 m_2 + m_1 m_3}{m_1 + m_2 + m_3} g \Rightarrow$$

$$\boxed{T_{12} = \frac{m_1 [2 m_3 + m_2(1+\mu)]}{m_1 + m_2 + m_3} g}$$

$$T_{23} = m_1(g-a) - m_2(\mu g + a) =$$

$$= (m_1 - m_2 \mu) g - (m_1 + m_2) a =$$

$$= \left[m_1 - m_2 \mu - \frac{(m_1 + m_2)(m_1 - \mu m_2 - m_3)}{m_1 + m_2 + m_3}\right] g =$$

$$= \left[\cancel{m_1^2} + \cancel{m_1 m_2} + m_1 m_3 - \cancel{m_1 m_2 \mu} - \cancel{m_2^2 \mu} - m_3 m_2 \mu + \right.$$

$$\left. - \cancel{m_1^2} + \cancel{m_1 m_2 \mu} + m_1 m_3 - \cancel{m_1 m_2} + \cancel{\mu m_2^2} + m_2 m_3\right] \times$$

$$\times \frac{g}{m_1 + m_2 + m_3} =$$

$$\Rightarrow$$

$$\boxed{T_{23} = \frac{m_3 [2 m_1 + m_2(1-\mu)]}{m_1 + m_1 + m_3} g}$$

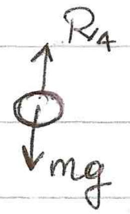
(*) RESISTENZA DOVUTA ALL'ARIA

7. PROBLEMA

$D = 0.5$ (x sfere)

$r = 8.00\ cm$

$\rho = 0.830\ g/cm^3$



? v_{max}

? h_{caduta} (senza resistenza aria)

$$R_A = \frac{1}{2} D \rho_A A v^2 \quad (*)$$

$$-R_A + mg = ma$$

$v_{limite} \Rightarrow a = 0 \Rightarrow$

$$-R_A + mg = 0$$

$$\Rightarrow -\frac{1}{\cancel{2}_4}\cancel{0.5}\,\rho_A \cancel{\pi} r^{\cancel{2}} v_{max}^2 + \frac{4}{3}\cancel{\pi} r^{\cancel{3}} \rho g = 0$$

$$v_{max}^2 = \frac{16 r}{3} \frac{\rho}{\rho_A} g \Rightarrow \boxed{v_{max} = \sqrt{\frac{16 r}{3} \frac{\rho}{\rho_A} g}}$$

$$\rho_A = 1{,}225\ \frac{kg}{m^3} = 1{,}225 \cdot \frac{10^3}{(10^2)^3}\ \frac{g}{cm^3} = 1{,}225\ \frac{10^3}{10^6}\ g/cm^3 = 1{,}225\ 10^{-3}\ g/cm^3$$

$$v_{max} = \sqrt{\frac{16}{3}\ 8.00 \cdot 10^{-2}\ m\ \frac{0.830\ \cancel{g/cm^3}}{1{,}225 \cdot 10^{-3}\ \cancel{g/cm^3}}\ 9{,}81\ \frac{m}{s^2}} =$$

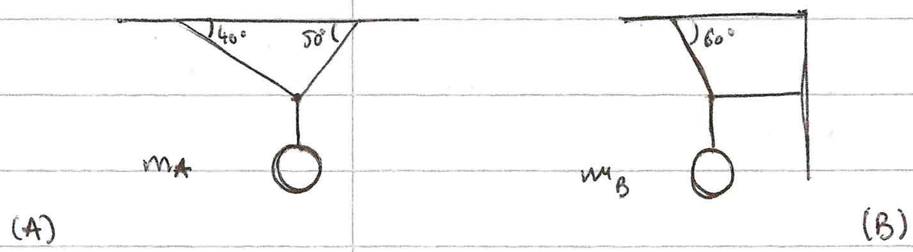
$$= \frac{m}{s} \sqrt{\frac{16}{3} \cdot 8.00 \cdot 9{,}81 \cdot \frac{0{,}830 \cdot 10}{1{,}225}} = 53{,}3\ \frac{m}{s}$$

Supponendo $v_{max} = v_{impatto}$

$$v(x)^2 - \cancel{v_0^2} = 2a(x - \cancel{x_0})$$

$$v_{max}^2 = -2gh \Rightarrow \boxed{h = \left|\frac{v_{max}^2}{2g}\right|} = \frac{(53{,}3)^2\ m^2/\cancel{s^2}}{2 \cdot 9{,}81\ m/\cancel{s^2}} = 145\ m$$

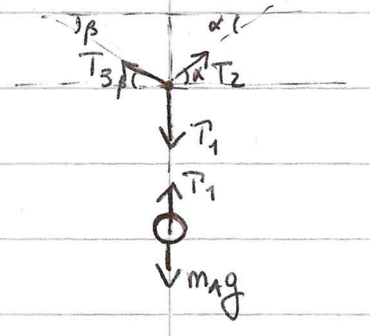
8. PROBLEMA



$m_A = 5\ kg$

$m_B = 10\ kg$

SISTEMA (A)



$$\begin{cases} T_1 = m_A g \\ T_{2x} - T_{3x} = 0 \\ T_1 - T_{2y} - T_3 = 0 \end{cases}$$

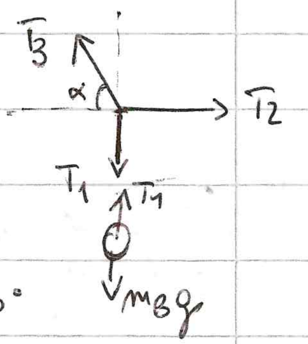
$\alpha = 50°$
$\beta = 40°$

$$\begin{cases} T_1 = m_A g \\ T_2 \cos\alpha - T_3 \cos\beta = 0 \\ T_1 - T_2 \sin\alpha - T_3 \sin\beta = 0 \end{cases}$$

$$\Rightarrow \begin{cases} T_2 \cancel{\cos\alpha} = T_3 \dfrac{\cos\beta}{\cos\alpha} \\ m_A g - T_3 \cos\beta \ \mathrm{tg}\alpha - T_3 \sin\beta = 0 \end{cases}$$

$$\Rightarrow \boxed{T_3 = \frac{m_A g}{(\cos\beta \ \mathrm{tg}\alpha + \sin\beta)} \qquad T_2 = T_3 \frac{\cos\beta}{\cos\alpha} \qquad T_1 = m_A g}$$

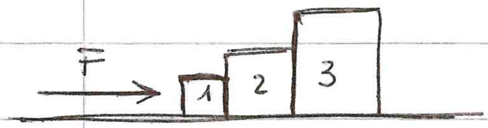
(B)



$\alpha = 60°$

$$\begin{cases} T_1 = m_B g \\ T_3 \cos\alpha = T_2 \\ T_1 = T_3 \sin\alpha \end{cases} \Rightarrow \boxed{\begin{array}{l} T_1 = m_B g \\ T_3 = T_1 / \sin\alpha \\ T_2 = T_3 \cos\alpha \end{array}}$$

9. PROBLEMA



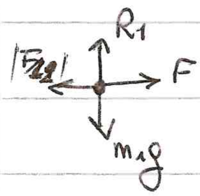
$m_1 = 2.00\,kg$

$m_2 = 3.00\,kg$

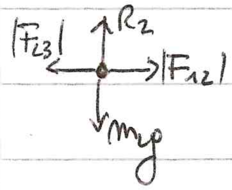
$m_3 = 4.00\,kg$

$F = 18.0\,N$

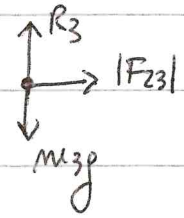
? a $\quad F_{R_{1,2,3}}$, $F_{contatto}$

1) 

$$\begin{cases} m_1 g = R_1 \\ F - F_{12} = m_1 a \end{cases}$$

2) 

$$\begin{cases} m_2 g = R_2 \\ F_{12} - F_{23} = m_2 a \end{cases}$$

3) 

$$\begin{cases} m_3 g = R_3 \\ F_{23} = m_3 a \end{cases}$$

$$\begin{cases} F - F_{12} = m_1 a \\ F_{12} - F_{23} = m_2 a \\ F_{23} = m_3 a \end{cases} \Rightarrow \begin{cases} F = (m_1 + m_2 + m_3) a \\ F_{12} = (m_2 + m_3) a \\ - \end{cases}$$

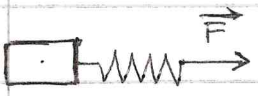
$$\Rightarrow \boxed{a = \frac{F}{m_1 + m_2 + m_3}}$$

1: $F_R = F - F_{12} = m_1 a = \frac{m_1}{m_1 + m_2 + m_3} F$

2: $F_R = F_{12} - F_{23} = m_2 a = \frac{m_2}{m_1 + m_2 + m_3} F$

3: $F_R = F_{23} = m_3 a = \frac{m_3}{m_1 + m_2 + m_3} F$

10. PROBLEMA



$m = 0{,}5\ kg$

$M = 0{,}1\ kg$

$F = 10\ N$

$K = 200\ N/m$

(1) <u>sulla molla</u> $F - F_E = Ma$ (= 0 se M trascurabile)

(2) <u>sul corpo</u> $F_E = ma$ ($F_E = Kx$ FORZA ELASTICA)

(3) <u>sul sistema molla + corpo</u> $F = (M+m)\,a$

Dalla (3) $\Rightarrow$ $a = \dfrac{F}{M+m}$ sostituisco nella (2) $\Rightarrow$

$$F_E = ma = \frac{mF}{M+m} \quad \text{ma} \quad F_E = Kx \Rightarrow$$

$$\frac{m}{M+m}F = Kx \Rightarrow \boxed{x = \frac{m}{m+M}\,\frac{F}{K}}$$

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