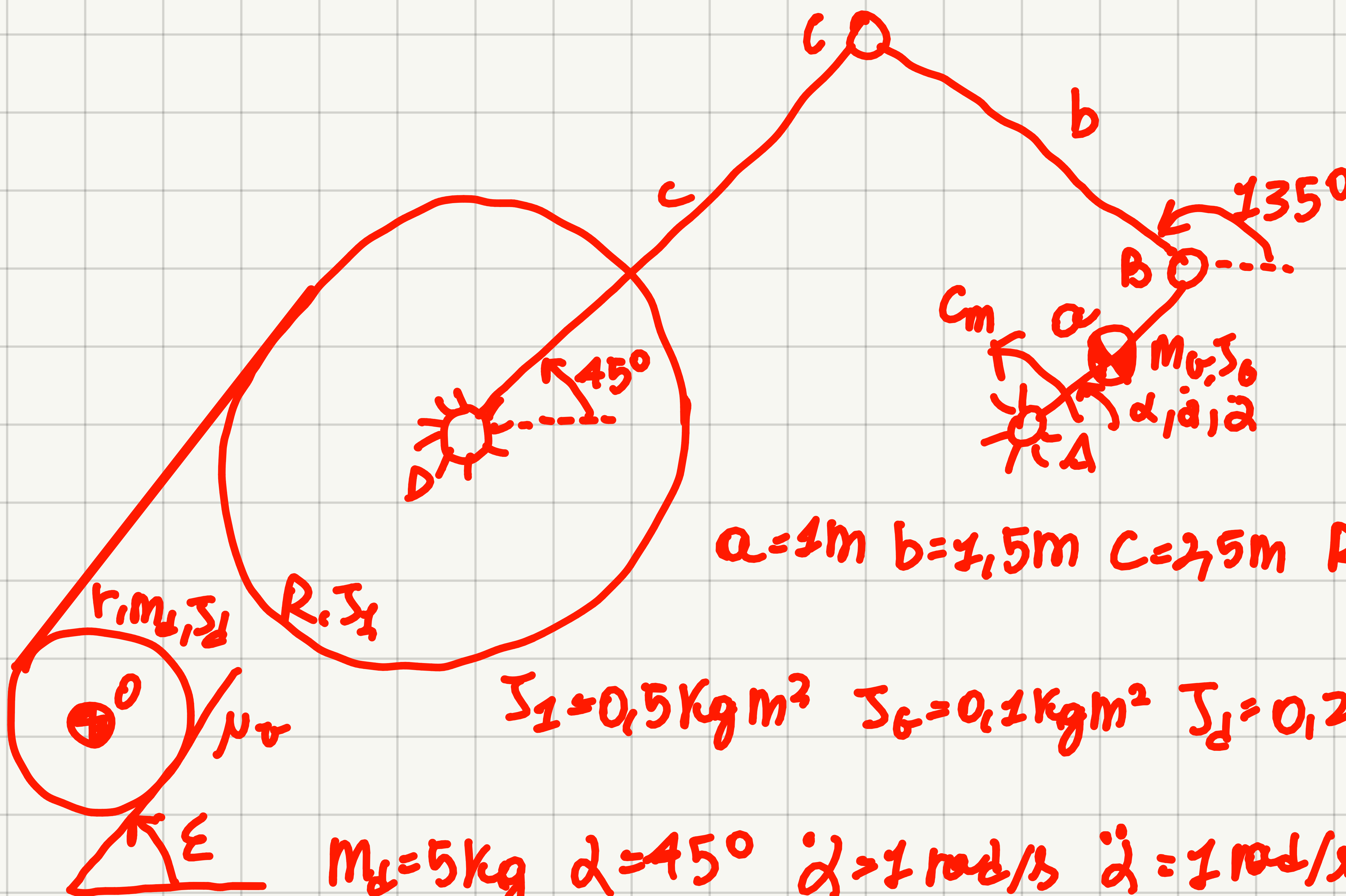
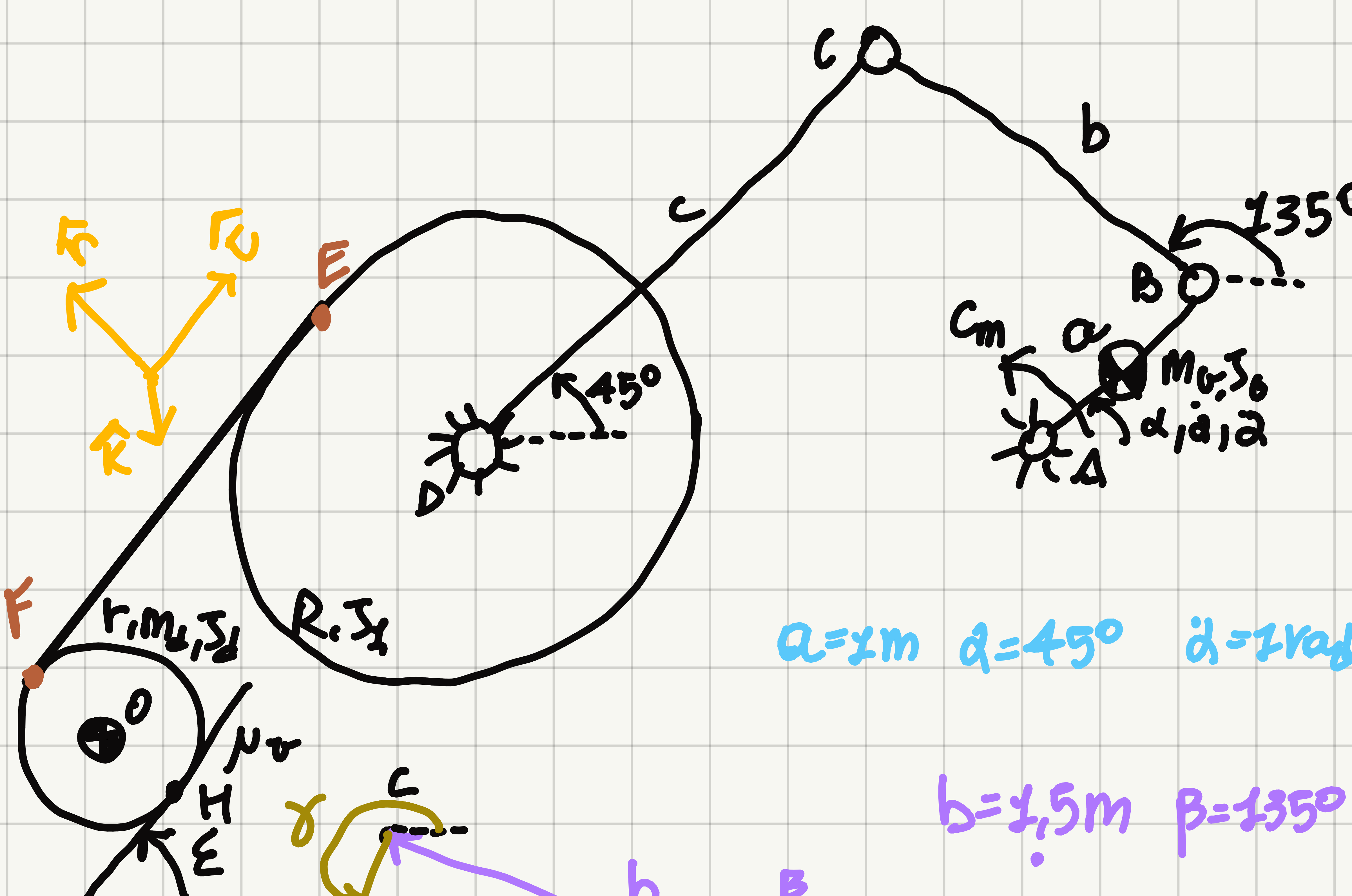


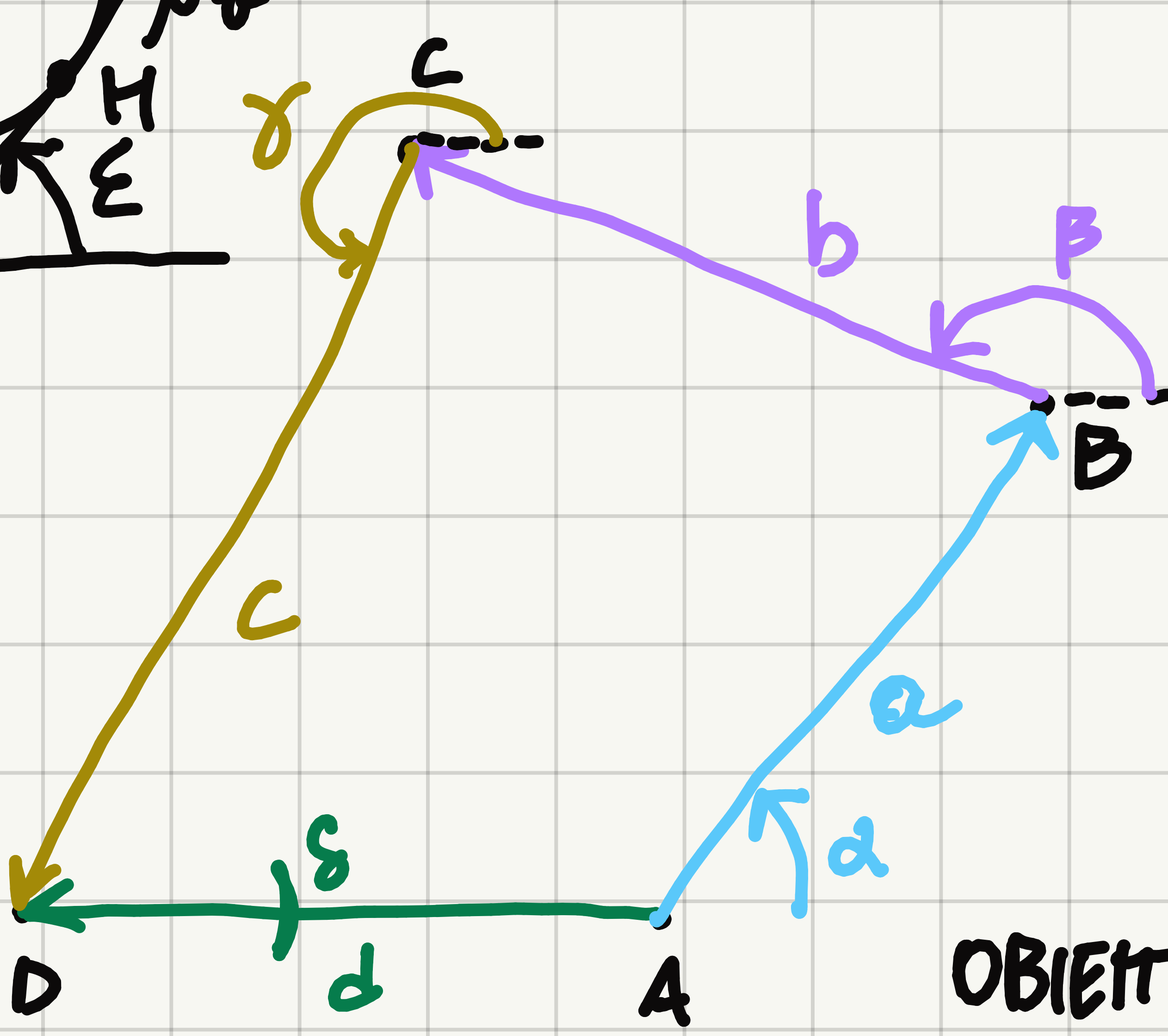
$a = 1m \quad b = 1{,}5m \quad c = 2{,}5m \quad R = 0{,}5m \quad r = 0{,}25m$

$J_1 = 0{,}5\,kg\,m^2 \quad J_G = 0{,}1\,kg\,m^2 \quad J_d = 0{,}2\,kg\,m^2 \quad m_G = 2kg$

$m_d = 5kg \quad \alpha = 45° \quad \dot{\alpha} = 1\,rad/s \quad \ddot{\alpha} = 1\,rad/s^2 \quad \mu_r = 0{,}05$

v_0, a_0? C_m?





$a = 1m \quad \alpha = 45° \quad \dot{\alpha} = 1\,rad/s \quad \ddot{\alpha} = 1\,rad/s^2$

$b = 1{,}5m \quad \beta = 135° \quad \dot{\beta}, \ddot{\beta} \neq 0$

$c = 2{,}5m \quad \gamma = 45 + 180 = 225° \quad \dot{\gamma}, \ddot{\gamma} \neq 0$

$d = \_ \quad \delta = 180°$

OBIETTIVI: $\dot{\gamma}, \ddot{\gamma} \equiv \omega_{DISCO}, \dot{\omega}_{DISCO}$

$$\begin{cases} a\cos\alpha + b\cos\beta + c\cos\gamma = -d \\ a\sin\alpha + b\sin\beta + c\sin\gamma = 0 \end{cases}$$

$a = 1m$ $\alpha = 45°$ $\dot\alpha = 1 rad/s$ $\ddot\alpha = 1 rad/s^2$

$$\begin{cases} -a\dot\alpha\sin\alpha - b\dot\beta\sin\beta - c\dot\gamma\sin\gamma = 0 \\ a\dot\alpha\cos\alpha + b\dot\beta\cos\beta + c\dot\gamma\cos\gamma = 0 \end{cases}$$

$b = 1{,}5m$ $\beta = 135°$ $\dot\beta, \ddot\beta \neq 0$

$$\begin{cases} -b\dot\beta\sin\beta - c\dot\gamma\sin\gamma = a\dot\alpha\sin\alpha \\ b\dot\beta\cos\beta + c\dot\gamma\cos\gamma = -a\dot\alpha\cos\alpha \end{cases}$$

$c = 2{,}5m$ $\gamma = 45 + 180 = 225°$ $\dot\gamma, \ddot\gamma \neq 0$

$d = \_$ $\delta = 180°$

$$\begin{vmatrix} -b\sin\beta & -c\sin\gamma \\ b\cos\beta & c\cos\gamma \end{vmatrix} \cdot \begin{vmatrix} \dot\beta \\ \dot\gamma \end{vmatrix} = \begin{vmatrix} a\dot\alpha\sin\alpha \\ -a\dot\alpha\cos\alpha \end{vmatrix}$$

$$\begin{vmatrix} -1{,}06 & 1{,}77 \\ -1{,}06 & -1{,}77 \end{vmatrix} \cdot \begin{vmatrix} \dot\beta \\ \dot\gamma \end{vmatrix} = \begin{vmatrix} 0{,}707 \\ -0{,}707 \end{vmatrix}$$

$\dot\beta = 0 \ rad/s$

$\dot\gamma = 0{,}4 \ rad/s$

$$\begin{cases} -b\ddot\beta\sin\beta - \cancel{b\dot\beta^2}\cos\beta - c\ddot\gamma\sin\gamma - c\dot\gamma^2\cos\gamma = a\ddot\alpha\sin\alpha + a\dot\alpha^2\cos\alpha \\ b\ddot\beta\cos\beta - \cancel{b\dot\beta^2}\sin\beta + c\ddot\gamma\cos\gamma - c\dot\gamma^2\sin\gamma = -a\ddot\alpha\cos\alpha + a\dot\alpha^2\sin\alpha \end{cases}$$

$$\begin{vmatrix} -1{,}06 & 1{,}77 \\ -1{,}06 & -1{,}77 \end{vmatrix} \cdot \begin{vmatrix} \ddot\beta \\ \ddot\gamma \end{vmatrix} = \begin{vmatrix} 1{,}13 \\ -0{,}283 \end{vmatrix}$$

$\ddot\beta = -0{,}4 \ rad/s^2$

$\ddot\gamma = 0{,}4 \ rad/s^2$

$$\vec{v}_E = \cancel{\vec{v}_D} + \dot{\vec\gamma} \times (E-D) = \dot\gamma\hat{k} \times R\hat{n} = -0{,}2\hat{t} \ m/s$$

$$\vec{a}_E = \cancel{\vec{a}_D} + \ddot\gamma\hat{k} \times (E-D) - \dot\gamma^2(E-D) = -0{,}2\hat{t} + \vec{a}_E^{(n)}$$

$! \ \vec{v}_F = \vec{v}_E \quad \vec{a}_F = \vec{a}_E^{(n)}$

$$\omega_{DISCO}\cdot 2r = \dot\gamma R \Rightarrow \omega_{DISCO} = \frac{R}{2r}\dot\gamma = 0,4\,rad/s \rightarrow \dot\omega_{DISCO} = \frac{R}{2r}\ddot\gamma = 0,4\,rad/s^2$$

↳ PUNTO DI CONTATTO CON PIANO

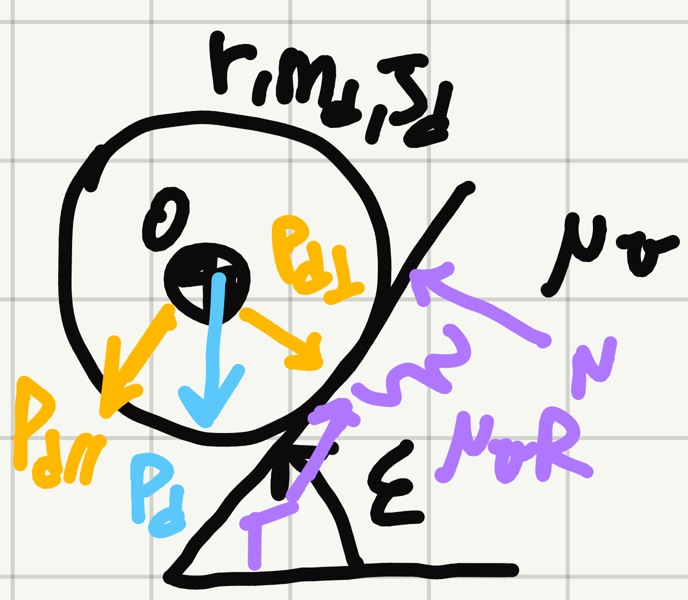
$$\vec v_0 = \cancel{\vec v_H} + \omega_{DISCO}\times(O-H) = 0,1\hat k\times\hat n = -0,1\hat t\ m/s$$

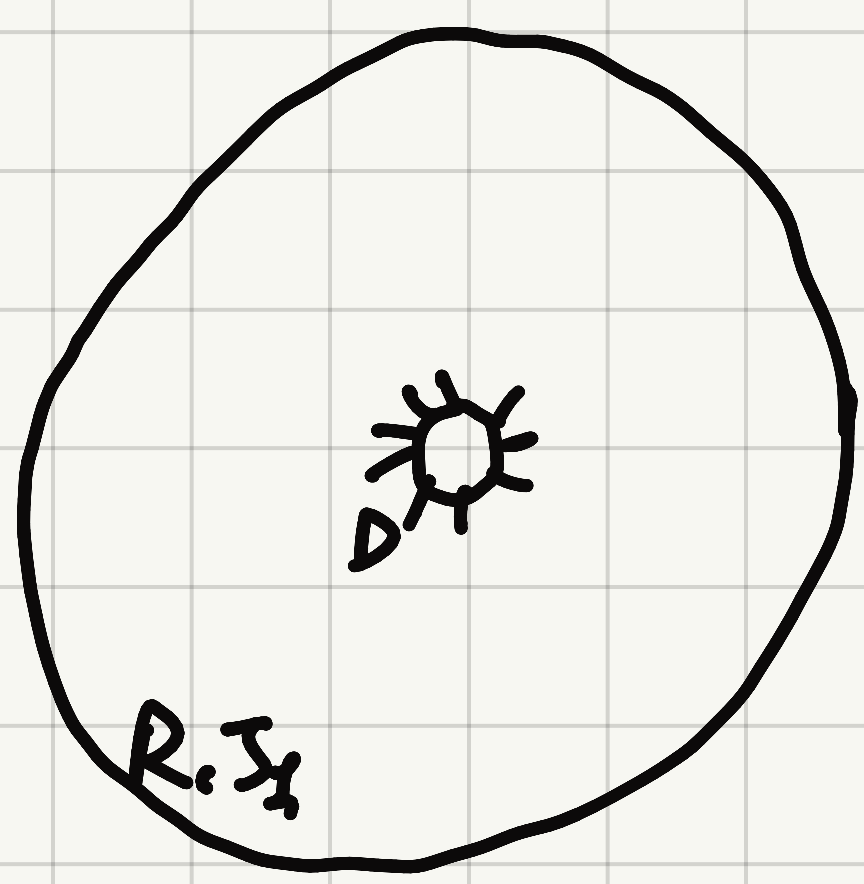
PURO ROTOLAMENTO SUL PIANO

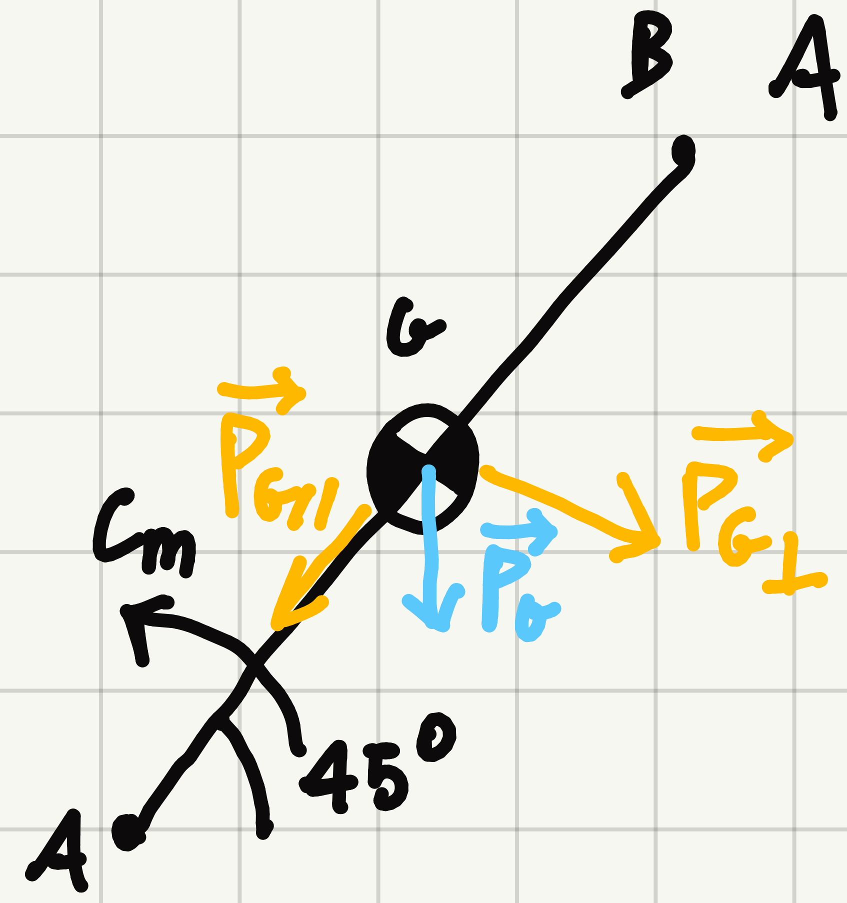
$$\vec a_0 = \vec a_F + \dot{\vec\omega}_{DISCO}\times(O-F) - \cancel{\omega^2_{DISCO}}(O-F) = (-0,2\hat t + 0,4\hat k\times r(-\hat n)) =$$

$$= (-0,1\hat t)\ m/s^2$$

BILANCIO DI POTENZE: $\sum P = \frac{d}{dt}K$







$$\frac{d}{dt}K = (m_d v_0 a_0^{(t)} + J_d\omega_{DISCO}\dot\omega_{DISCO}) + (J_1\dot\gamma\ddot\gamma) + (m_G v_G a_G^{(t)} + J_G\dot\alpha\ddot\alpha)$$

$$\vec v_G = \cancel{\vec v_A} + \dot\alpha\hat k\times(G-A) = \frac{\dot\alpha a}{2}(-\sin(45)\hat\imath + \cos(45)\hat\jmath) = (-0,354\hat\imath + 0,354\hat\jmath)\ m/s$$

$$\vec a_G = \underbrace{\cancel{\vec a_A} + \ddot\alpha\hat k\times(G-A)}_{a_G^{(t)}} - \dot\alpha^2(G-A) \quad |\vec a_G^{(t)}| = 0,5\,m/s^2 \quad |\vec v_G| = 0,5\,m/s$$

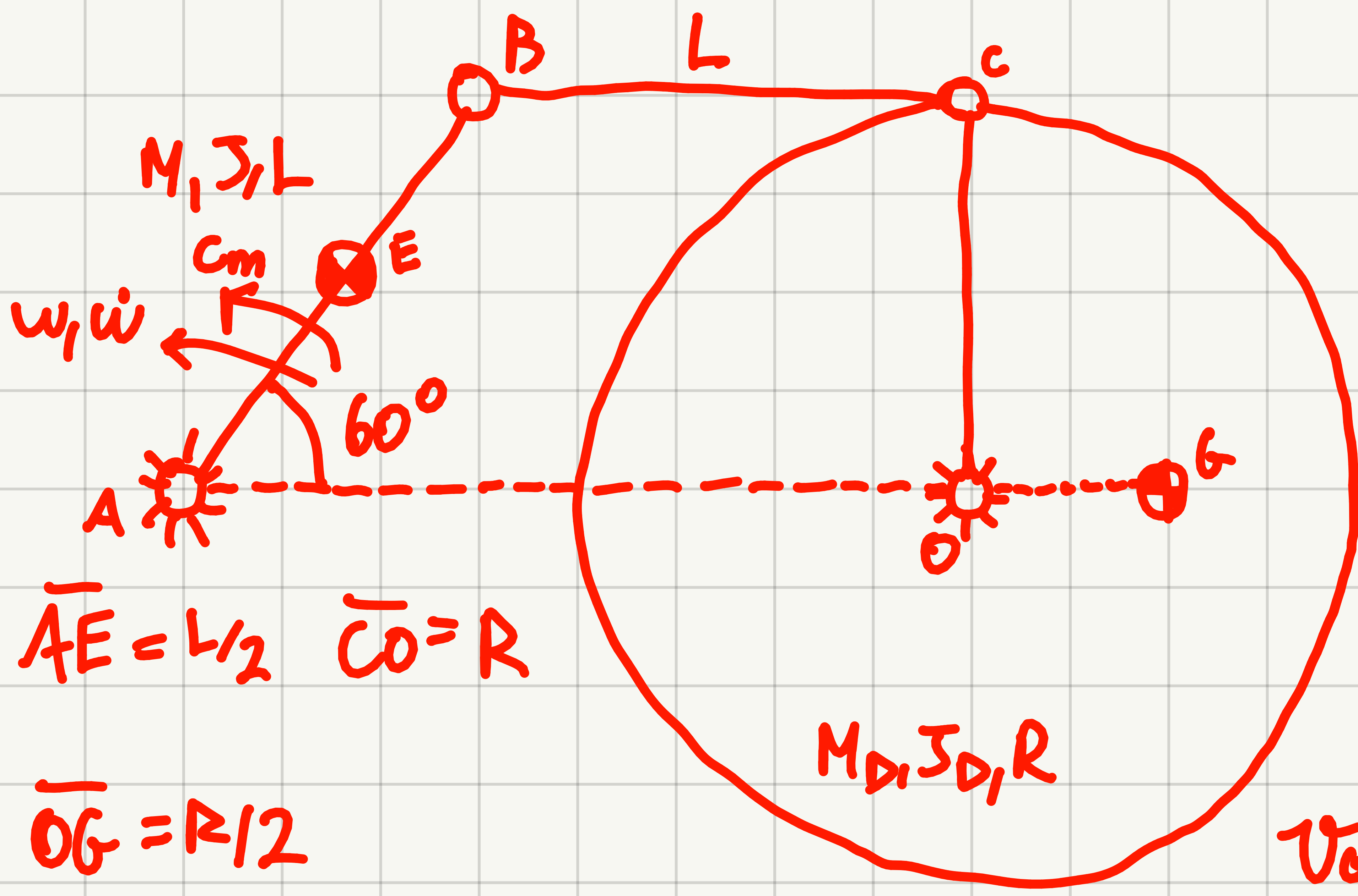
$$\frac{d}{dt}K = 0,762\,W$$

$$\sum P = (-P_{d\parallel}v_0 - P_T) + (0) + (C_m\dot\alpha + P_{G\parallel}v_G)$$

$$P_T = \mu_v\omega_{DISCO}RN = \mu_v\omega_{DISCO}Rm_d g\cos(30)$$

$$-m_d g\sin(30)|v_0| - \mu_v\omega_{DISCO}Rm_d\cos(30) + C_m\dot\alpha - m_G g\sin(45)v_G =$$

$$= 0,762\,W \Rightarrow C_m = 5,28\,Nm$$



$\overline{AE} = L/2 \quad \overline{CO} = R$

$\overline{OG} = R/2$

$L = 1m \quad R = \frac{\sqrt{3}}{2} m$

$J = 0{,}5 \, Kgm^2 \quad M = 0{,}5 Kg$

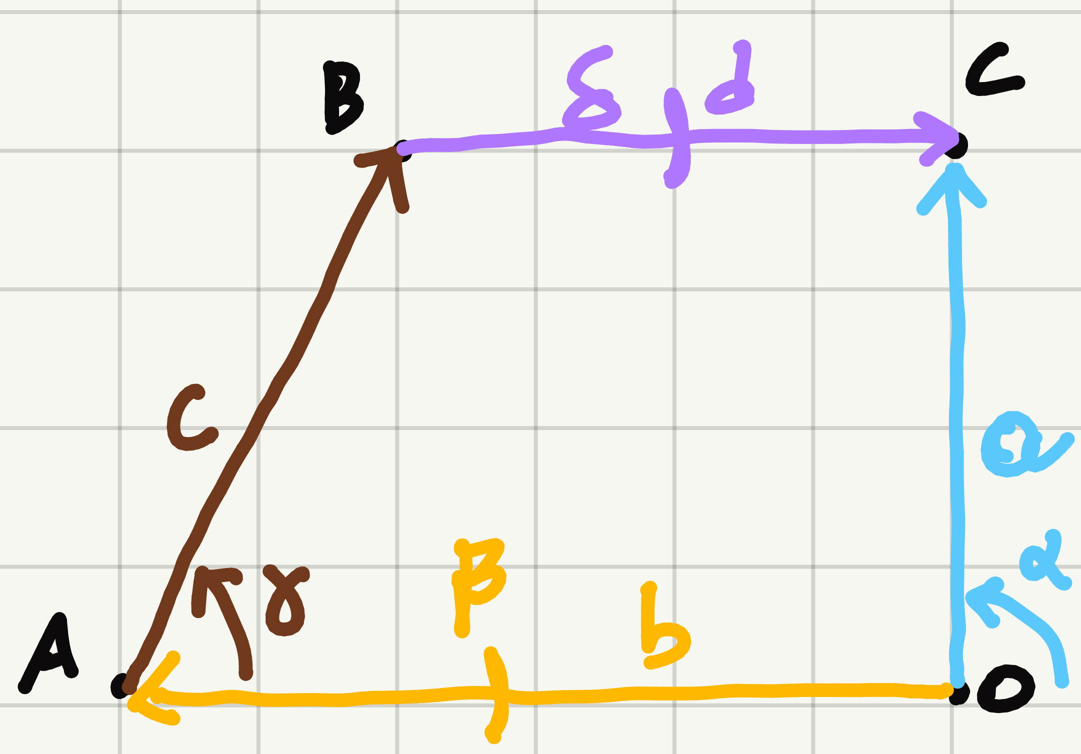
$J_D = 0{,}1 \, Kgm^2 \quad M_D = 2 Kg$

$\omega = 1 \, rad/s \quad \dot{\omega} = 1 \, rad/s^2$

$v_G, a_G, \omega_{DISCO}, \dot{\omega}_{DISCO}, C_m\,?$

$n = 3 \cdot 3 - (2_A + 2_B + 2_C + 2_O) = 1$

$\vec{v}_G = \cancel{\vec{v}_O} + \vec{\omega}_{DISCO} \times (G-O) \qquad (G-O) = \frac{R}{2}\hat{\imath}$



$\vec{a} = \vec{b} + \vec{c} + \vec{d}$

$a = \frac{\sqrt{3}}{2} m \quad \alpha = 90° \quad \dot{\alpha}, \ddot{\alpha} \neq 0$

$b = \_ \quad \beta = 180° \text{ FISSO}$

OBIETTIVI: $\dot{\alpha}, \ddot{\alpha} = \omega_{DISCO}, \dot{\omega}_{DISCO}$

$c = 1m \quad \gamma = 60° \quad \dot{\gamma} = 1 \, rad/s \quad \ddot{\gamma} = 1 \, rad/s^2$

$d = 1m \quad \delta = 0° \quad \dot{\delta}, \ddot{\delta} \neq 0$

$$\begin{cases} a\cos\alpha = -b + c\cos\gamma + d\cos\delta \\ a\sin\alpha = c\sin\gamma + d\sin\delta \end{cases}$$

$$\begin{cases} -a\dot{\alpha}\sin\alpha = -c\dot{\gamma}\sin\gamma - d\dot{\delta}\sin\delta \\ a\dot{\alpha}\cos\alpha = c\dot{\gamma}\cos\gamma + d\dot{\delta}\cos\delta \end{cases}$$

$$\begin{cases} -a\dot{\alpha}\sin\alpha + d\dot{\delta}\sin\delta = -c\dot{\gamma}\sin\gamma \\ a\dot{\alpha}\cos\alpha - d\dot{\delta}\cos\delta = c\dot{\gamma}\cos\gamma \end{cases}$$

$$\begin{vmatrix} -a\sin\alpha & d\sin\delta \\ a\cos\alpha & -d\cos\delta \end{vmatrix} \cdot \begin{vmatrix} \dot{\alpha} \\ \dot{d} \end{vmatrix} = \begin{vmatrix} -c\dot{\gamma}\sin\gamma \\ c\dot{\gamma}\cos\gamma \end{vmatrix}$$

$$\begin{vmatrix} -\sqrt{3}/2 & 0 \\ 0 & -1 \end{vmatrix} \cdot \begin{vmatrix} \dot{\alpha} \\ \dot{d} \end{vmatrix} = \begin{vmatrix} -\sqrt{3}/2 \\ 1/2 \end{vmatrix} \qquad \det A = \sqrt{3}/2$$

$$\dot{\alpha} = \frac{\det\begin{vmatrix} -\sqrt{3}/2 & 0 \\ 1/2 & -1 \end{vmatrix}}{\sqrt{3}/2} = 1 \text{ rad/s} \qquad \dot{\delta} = \frac{\det\begin{vmatrix} -\sqrt{3}/2 & -\sqrt{3}/2 \\ 0 & 1/2 \end{vmatrix}}{\sqrt{3}/2} = -0{,}5 \text{ rad/s}$$

$$\vec{v}_c = \cancel{\vec{v}_0} + \vec{\dot{\alpha}} \times (C-O) = \hat{k} \times R\hat{\jmath} = -\sqrt{3}/2\,\hat{\imath}$$

$$|\vec{v}_c| = R|\vec{\omega}_{DISCO}| \rightarrow \vec{\omega}_{DISCO} = \frac{|\vec{v}_c|}{R} = (1\hat{k})\frac{\text{rad}}{\text{s}} \qquad \vec{v}_G = \hat{k} \times \frac{R}{2}\hat{\imath} = (0{,}433\hat{\jmath})\text{ m/s}$$

$$\vec{a}_G = \vec{a}_0 + \vec{\dot{\omega}}_{DISCO} \times (G-O) - \omega^2_{DISCO}(G-O)$$

$$\begin{cases} -a\ddot{\alpha}\sin\alpha - a\dot{\alpha}^2\cos\alpha + d\ddot{\delta}\sin\delta + d\dot{\delta}^2\cos\delta = -c\ddot{\gamma}\sin\gamma - c\dot{\gamma}^2\cos\gamma \\ a\ddot{\alpha}\cos\alpha - a\dot{\alpha}^2\sin\alpha - d\ddot{\delta}\cos\delta + d\dot{\delta}^2\sin\delta = c\ddot{\gamma}\cos\gamma - c\dot{\gamma}^2\sin\gamma \end{cases}$$

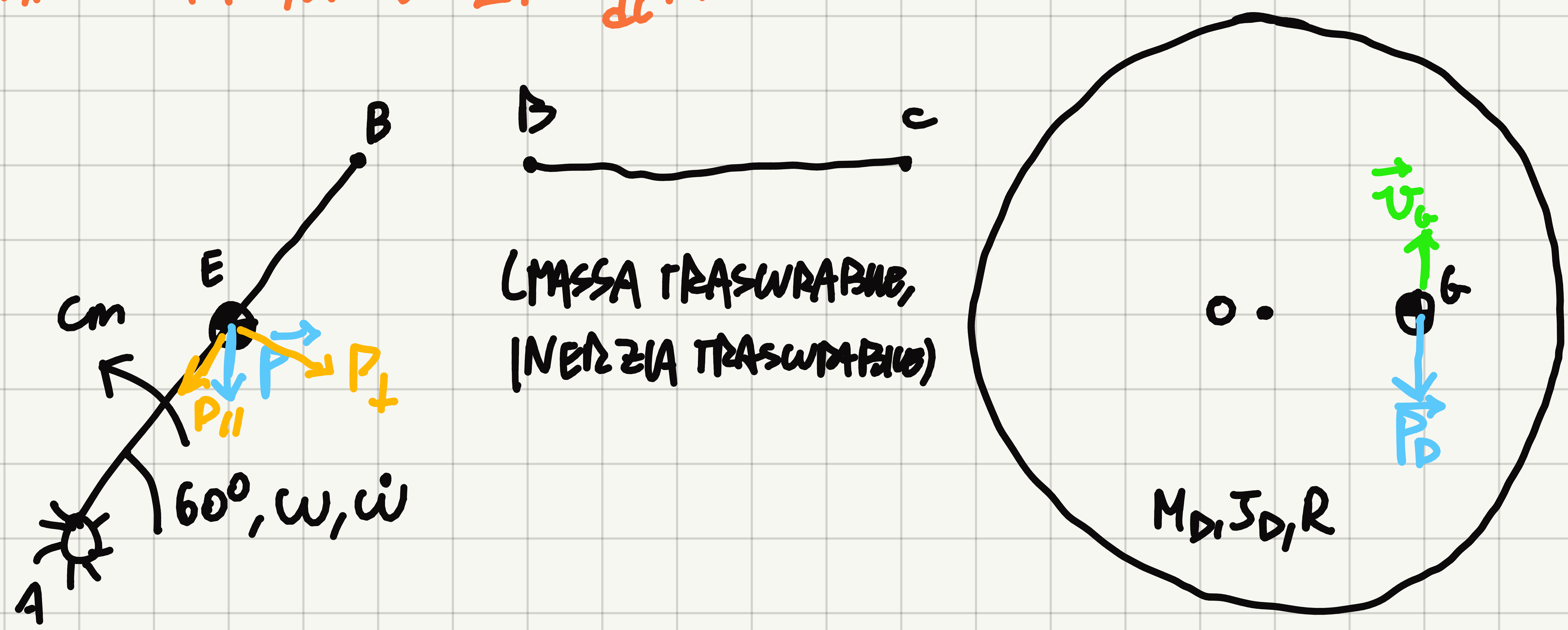
$$\begin{vmatrix} -\sqrt{3}/2 & 0 \\ 0 & -1 \end{vmatrix} \cdot \begin{vmatrix} \ddot{\alpha} \\ \ddot{d} \end{vmatrix} = \begin{vmatrix} -1{,}616 \\ 0{,}5 \end{vmatrix} \qquad \begin{aligned} \ddot{\alpha} &= 1{,}866 \text{ rad/s}^2 \\ \ddot{\delta} &= -0{,}5 \text{ rad/s}^2 \end{aligned}$$

$$\vec{a}_c = \vec{a}_0 + \vec{\ddot{\alpha}} \times (C-O) - \dot{\alpha}^2(C-O) = \underbrace{-1{,}616\hat{\imath}}_{t}\ \underbrace{-0{,}866\hat{\jmath}}_{n}$$

$$\vec{\dot{\omega}}_{DISCO} = \frac{|\vec{a}_c^{\,t}|}{R} = (1{,}866\hat{k})\frac{\text{rad}}{\text{s}^2}$$

$$\vec{a}_G = (\underbrace{(0{,}808\hat{\jmath})}_{t} + \underbrace{(-0{,}433\hat{\imath})}_{n})\text{ m/s}^2$$

BILANCIO DI POTENZE: $\sum P = \frac{d}{dt}K$



$$\frac{d}{dt}K = \left(M v_E a_E^{(t)} + J\omega\dot\omega\right) + (0) + \left(M_D v_G a_G^{(t)} + J_D \omega_{DISCO}\dot\omega_{DISCO}\right)$$

$$\vec{v}_E = \vec{v}_A + \omega \times (E-A) = \hat{k} \times 0{,}5(\cos(60)\hat{\imath} + \sin(60)\hat{\jmath}) =$$

$$= (-0{,}433\hat{\imath} + 0{,}25\hat{\jmath})\,m/s \qquad |\vec{v}_E| = 0{,}499\,m/s$$

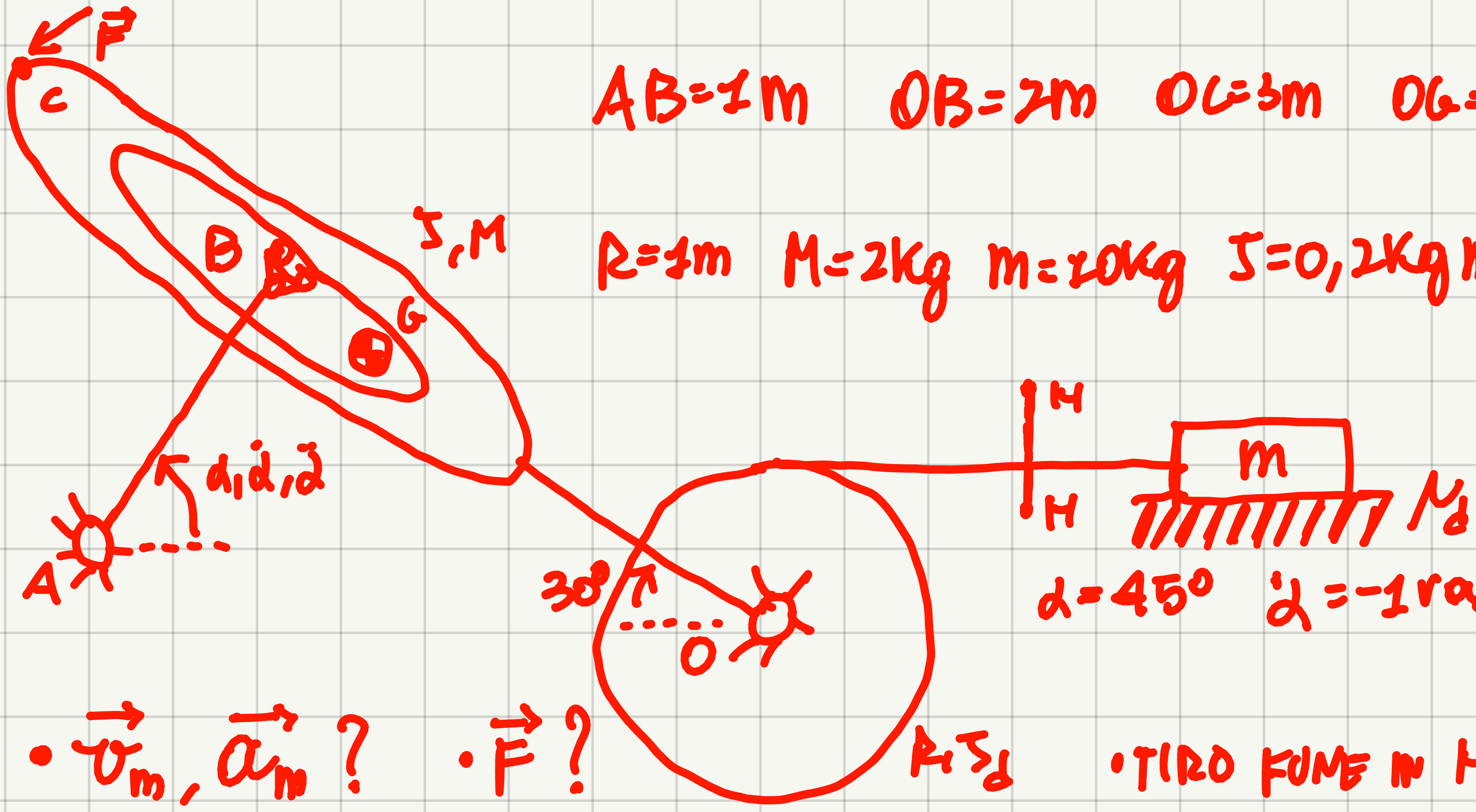
$$\vec{a}_E = \underbrace{a_A + \dot\omega \times (E-A)}_{a^{(t)}} - \omega^2(E-A)$$

$$a_E^{(t)} = (-0{,}433\hat{\imath} + 0{,}25\hat{\jmath})\,m/s^2 \qquad |\vec{a}_E^{(t)}| = 0{,}499\,m/s^2$$

$$\frac{d}{dt}K = 1{,}511\,W$$

$$\sum P = (-P_{\parallel} v_E + C_m \omega) + (0) + (-P_d v_G)$$

$$-Mg\overbrace{\cos(60)\, v_E}^{v_{E_y}} + C_m\omega - M_D g v_G = 1{,}511\,W \Rightarrow C_m = 11{,}23\,NM$$



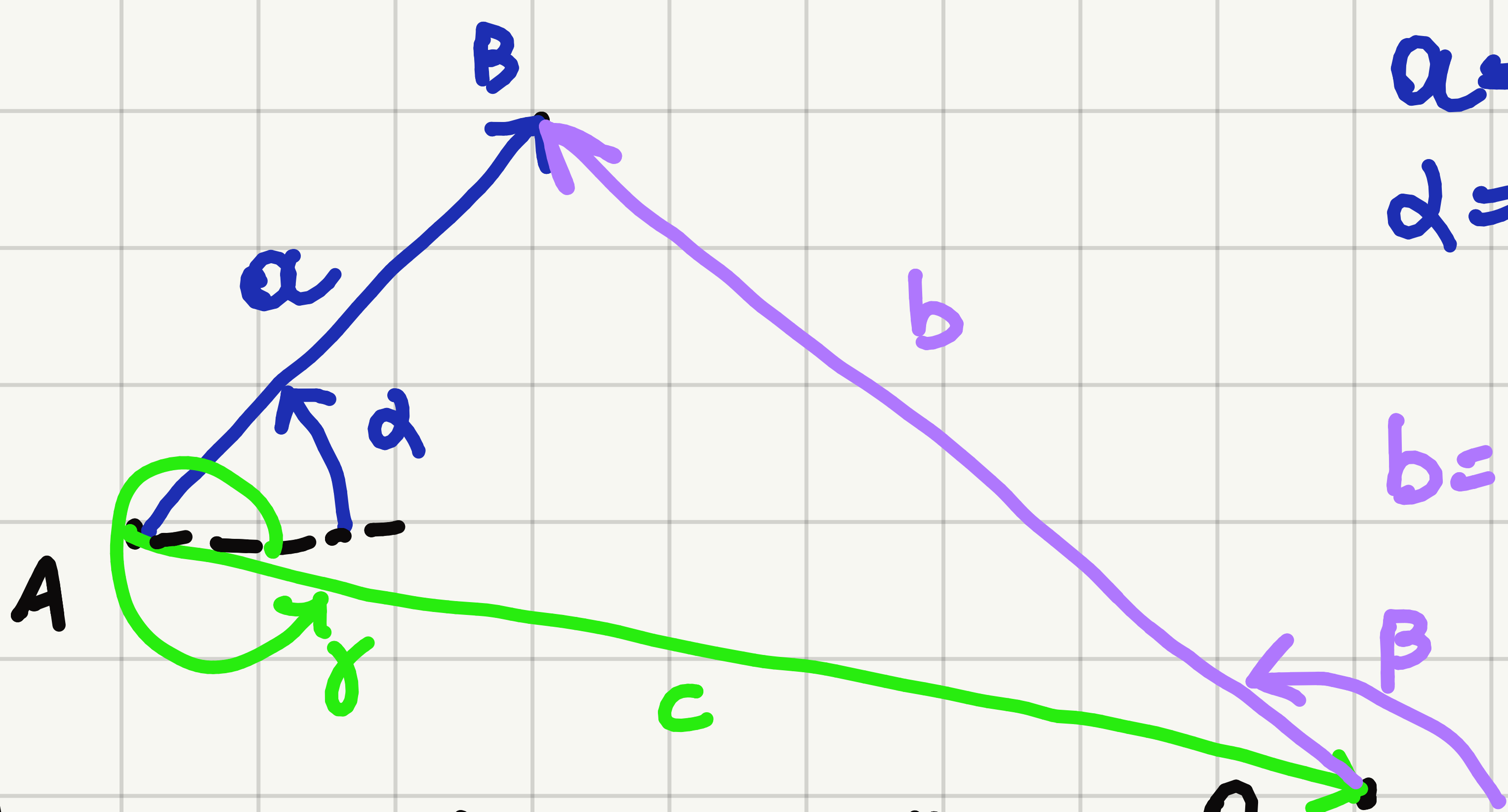
$AB = 1\,m \quad OB = 2\,m \quad OC = 3\,m \quad OG = 1{,}5\,m$

$R = 1\,m \quad M = 2\,kg \quad m = 10\,kg \quad J = 0{,}2\,kg\,m^2 \quad J_d = 0{,}8\,kg\,m^2$

$\mu_d = 0{,}5$

$\alpha = 45° \quad \dot{\alpha} = -1\,rad/s \quad \ddot{\alpha} = -1\,rad/s^2$

• $\vec{v}_m, \vec{a}_m$? • $\vec{F}$? • TIRO FUNE in H-H ?



$a = 1\,m$

$\alpha = 30° \quad \dot{\alpha} = -1\,rad/s \quad \ddot{\alpha} = -1\,rad/s^2$

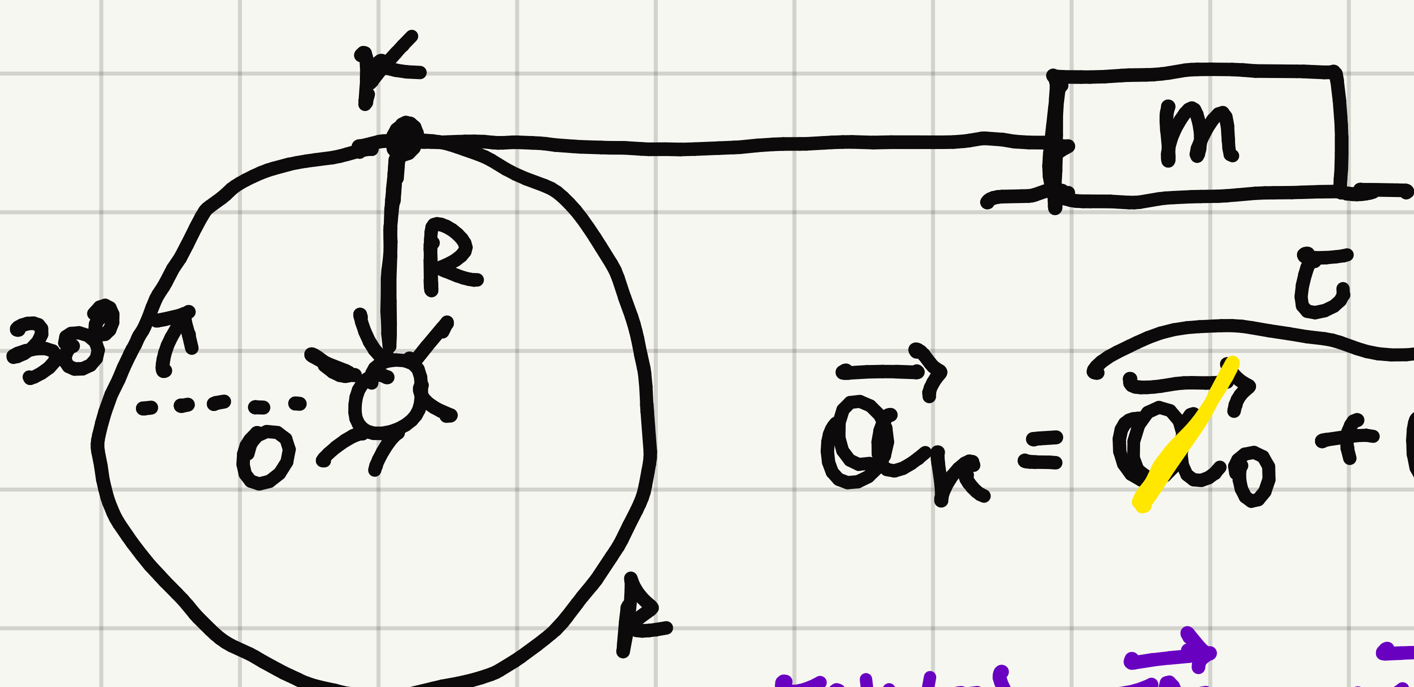
$b = 2\,m \quad \beta = 180 - 30 = 150° \quad \dot{\beta}, \ddot{\beta} \neq 0$

$\dot{b}, \ddot{b} \neq 0$

$c = \_ \quad \gamma = \_$

$\dot{c}, \ddot{c}, \dot{\gamma}, \ddot{\gamma} = 0$

OBIETTIVI: $\dot{\beta} = \omega_{DISCO}, \ \ddot{\beta} = \dot{\omega}_{DISCO}$



$$\vec{v}_K = \cancel{\vec{v}_O} + \vec{\omega}_{DISCO} \times (K - O)$$

$$\vec{a}_K = \cancel{\vec{a}_O} + \overbrace{\dot{\vec{\omega}}_{DISCO} \times (K - O)}^{\tau} \overbrace{- \omega_{DISCO}^2 (K - O)}^{n}$$

FUNE) $\vec{v}_m = \vec{v}_K \qquad \vec{a}_m = \vec{a}_K^{(\tau)}$

$$\begin{cases} a\cos\alpha = b\cos\beta + c\cos\gamma \\ a\sin\alpha = b\sin\beta + c\sin\gamma \end{cases} \Rightarrow \begin{cases} -a\dot{\alpha}\sin\alpha = \dot{b}\cos\beta - b\dot{\beta}\sin\beta \\ a\dot{\alpha}\cos\alpha = \dot{b}\sin\beta + b\dot{\beta}\cos\beta \end{cases}$$

$$\begin{vmatrix} \cos\beta & -b\sin\beta \\ \sin\beta & b\cos\beta \end{vmatrix} \cdot \begin{vmatrix} \dot{b} \\ \dot{\beta} \end{vmatrix} = \begin{vmatrix} -a\dot{\alpha}\sin\alpha \\ a\dot{\alpha}\cos\alpha \end{vmatrix} \qquad \det A = b(\cos^2\beta + \sin^2\beta) = 2$$

$$\begin{vmatrix} -0{,}866 & -1 \\ 0{,}5 & -1{,}732 \end{vmatrix} \cdot \begin{vmatrix} \dot{b} \\ \dot{\beta} \end{vmatrix} = \begin{vmatrix} 0{,}707 \\ -0{,}707 \end{vmatrix}$$

$$\dot{b} = \frac{\det\begin{vmatrix} 0{,}707 & -1 \\ -0{,}707 & -1{,}732 \end{vmatrix}}{2} = -0{,}97\,m/s$$

$$\dot{\beta} = \frac{\det\begin{vmatrix} -0{,}866 & 0{,}707 \\ 0{,}5 & -0{,}707 \end{vmatrix}}{2} = 0{,}129\,rad/s$$

$$\begin{cases} -a\ddot{\alpha}\sin\alpha - a\dot{\alpha}^2\cos\alpha = \ddot{b}\cos\beta - 2\dot{b}\dot{\beta}\sin\beta - b\ddot{\beta}\sin\beta - b\dot{\beta}^2\cos\beta \\ a\ddot{\alpha}\cos\alpha - a\dot{\alpha}^2\sin\alpha = \ddot{b}\sin\beta + 2\dot{b}\dot{\beta}\cos\beta + b\ddot{\beta}\cos\beta - b\dot{\beta}^2\sin\beta \end{cases}$$

$$\begin{vmatrix} \cos\beta & -b\sin\beta \\ \sin\beta & b\cos\beta \end{vmatrix} \cdot \begin{vmatrix} \ddot{b} \\ \ddot{\beta} \end{vmatrix} = \begin{vmatrix} -a\ddot{\alpha}\sin\alpha - a\dot{\alpha}^2\cos\alpha + 2\dot{b}\dot{\beta}\sin\beta + b\dot{\beta}^2\cos\beta \\ a\ddot{\alpha}\cos\alpha - a\dot{\alpha}^2\sin\alpha - 2\dot{b}\dot{\beta}\cos\beta + b\dot{\beta}^2\sin\beta \end{vmatrix}$$

$$\begin{vmatrix} -0{,}866 & -1 \\ 0{,}5 & -1{,}732 \end{vmatrix} \cdot \begin{vmatrix} \ddot{b} \\ \ddot{\beta} \end{vmatrix} = \begin{vmatrix} -0{,}154 \\ -1{,}614 \end{vmatrix} \qquad \begin{aligned} \ddot{b} &= -0{,}67\ m/s^2 \\ \ddot{\beta} &= 0{,}737\ rad/s^2 \end{aligned}$$

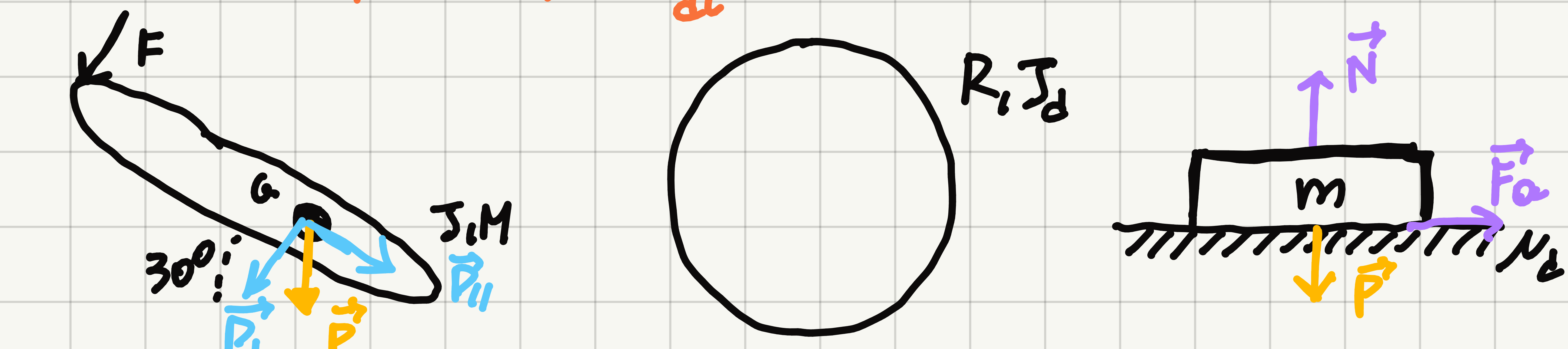
$(K-O) = R\hat{j} = (1\hat{j})m \qquad \omega_{DISCO} = \dot{\beta}\hat{k} \qquad \dot{\omega}_{DISCO} = \ddot{\beta}\hat{k}$

$\vec{v}_K = \dot{\beta}\hat{k} \times (R\hat{j}) = \dot{\beta}R(-\hat{i}) = (-0{,}129\,\hat{i})\ m/s$

$\vec{a}_K = \ddot{\beta}\hat{k} \times (R\hat{j}) + \vec{a}_K^{(n)} = (-0{,}737\,\hat{i} + \vec{a}_K^{(n)})\ m/s^2$

$\Rightarrow \quad \vec{v}_m = (-0{,}129\,\hat{i})\ m/s \qquad \vec{a}_m = (-0{,}737\,\hat{i})\ m/s^2$

BILANCIO DI POTENZE: $\sum P = \frac{d}{dt}K$



$\frac{d}{dt}K = M v_G a_G^{(t)} + J\dot{\beta}\ddot{\beta} + J_d\dot{\beta}\ddot{\beta} + m v_m a_m^{(t)}$

$\vec{v}_G = \cancel{\vec{v}_O} + \dot{\beta}\hat{k} \times (G-O) \qquad (G-O) = 1{,}5\,(\cos(150)\hat{i} + \sin(150)\hat{j})$

$\vec{v}_G = (0{,}194\,\hat{k} \times (\cos(150)\hat{i} + \sin(150)\hat{j}))\ m/s \qquad |\vec{v}_G| = 0{,}194\ m/s^2$

$\vec{a}_G = \cancel{\vec{a}_O} + \ddot{\beta}\hat{k} \times (G-O) - \dot{\beta}^2(G-O)$

$\vec{a}_G^{(c)} = (1{,}11\hat{k}\times(\cos(130)\hat{\imath}+\sin(130)\hat{\jmath}))\,m/s^2 \qquad |\vec{a}_G^{(c)}| = 1{,}11\ m/s^2$

$\frac{d}{dt}K = M v_G a_G^{(c)} + J\dot{\beta}\ddot{\beta} + J_d\dot{\beta}\ddot{\beta} + m v_m a_m^{(c)} = 1{,}48\,W$

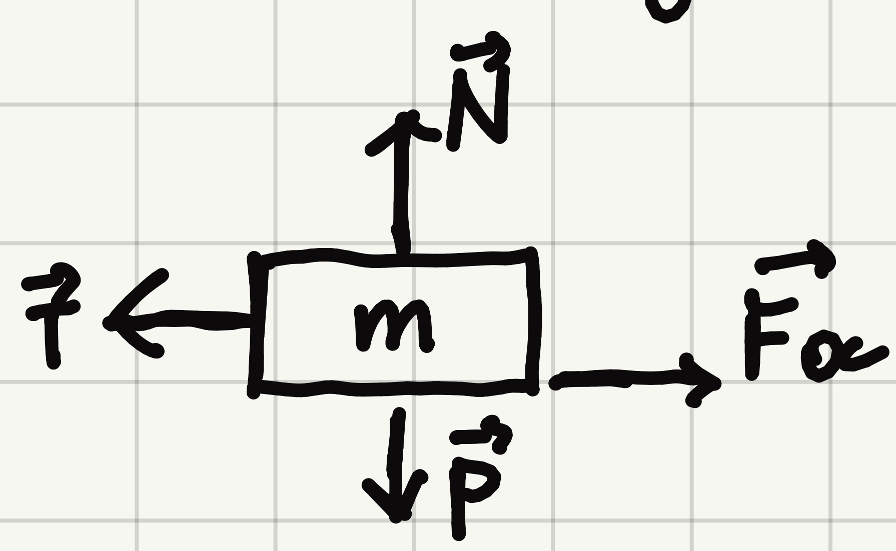
$\sum P = P_{\parallel} v_G + F v_C - F_a v_m$

$F_a = \mu_d N = \mu_d m g$

$\vec{v}_C = \cancel{\vec{v}_O} + \dot{\beta}\hat{k}\times(C-O) = (0{,}387\hat{k}\times(\cos(130)\hat{\imath}+\sin(130)\hat{\jmath}))\,m/s$

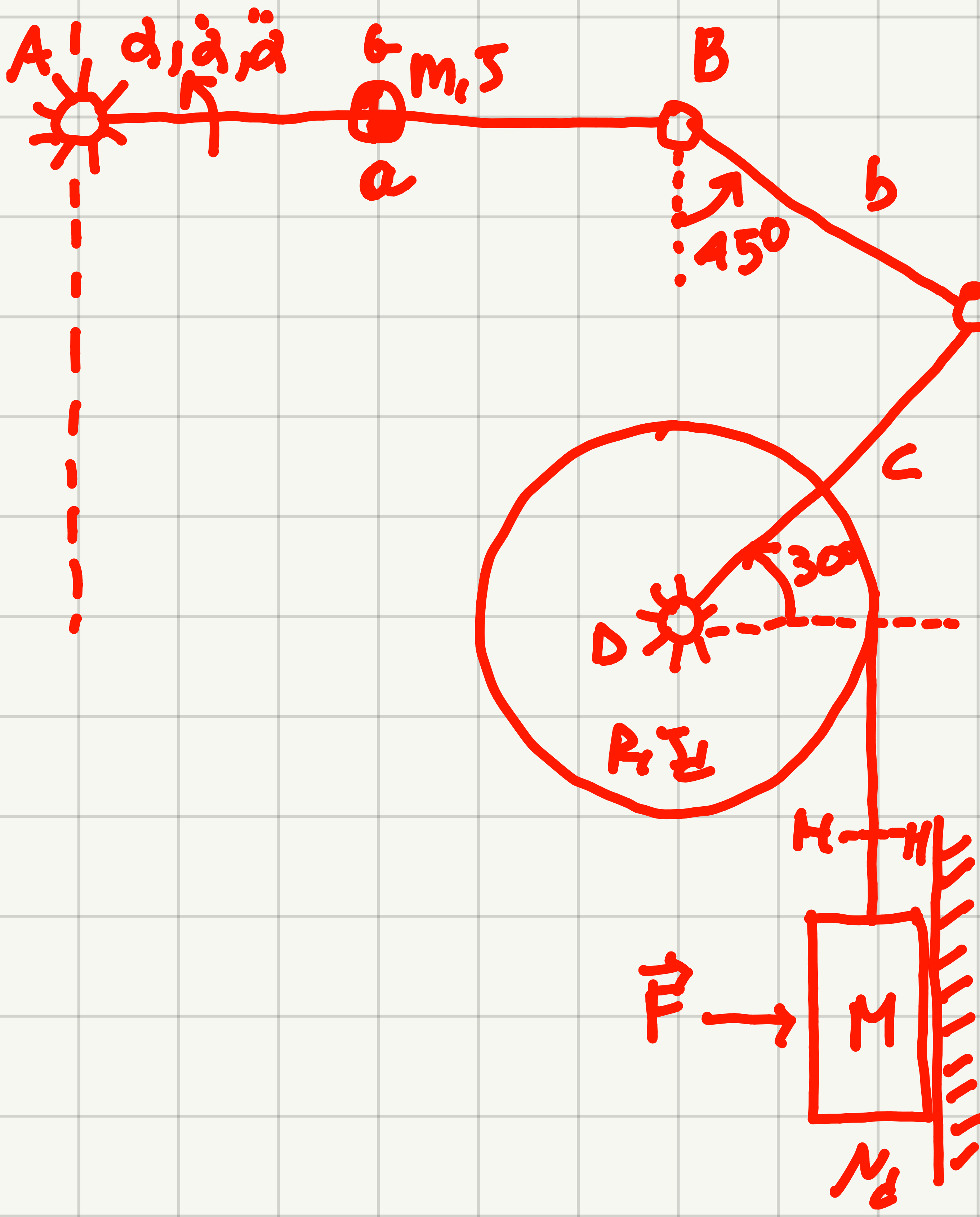
$|\vec{v}_C| = 0{,}387\,m/s$

$Mg\sin(\beta)v_G + F v_C - \mu_d m g = 1{,}48\,W \Rightarrow F = 49{,}6\,N$



$\begin{cases} \sum F_x = m a_m \\ \sum F_y = 0 \end{cases} \qquad \begin{cases} F_a - T = m a_m \\ N = P \end{cases}$

$T = \mu_d m g - m a_m = 56{,}42\,N$



$a = 2\,m \quad b = 1\,m \quad c = 1{,}5\,m \quad \alpha = 0°$

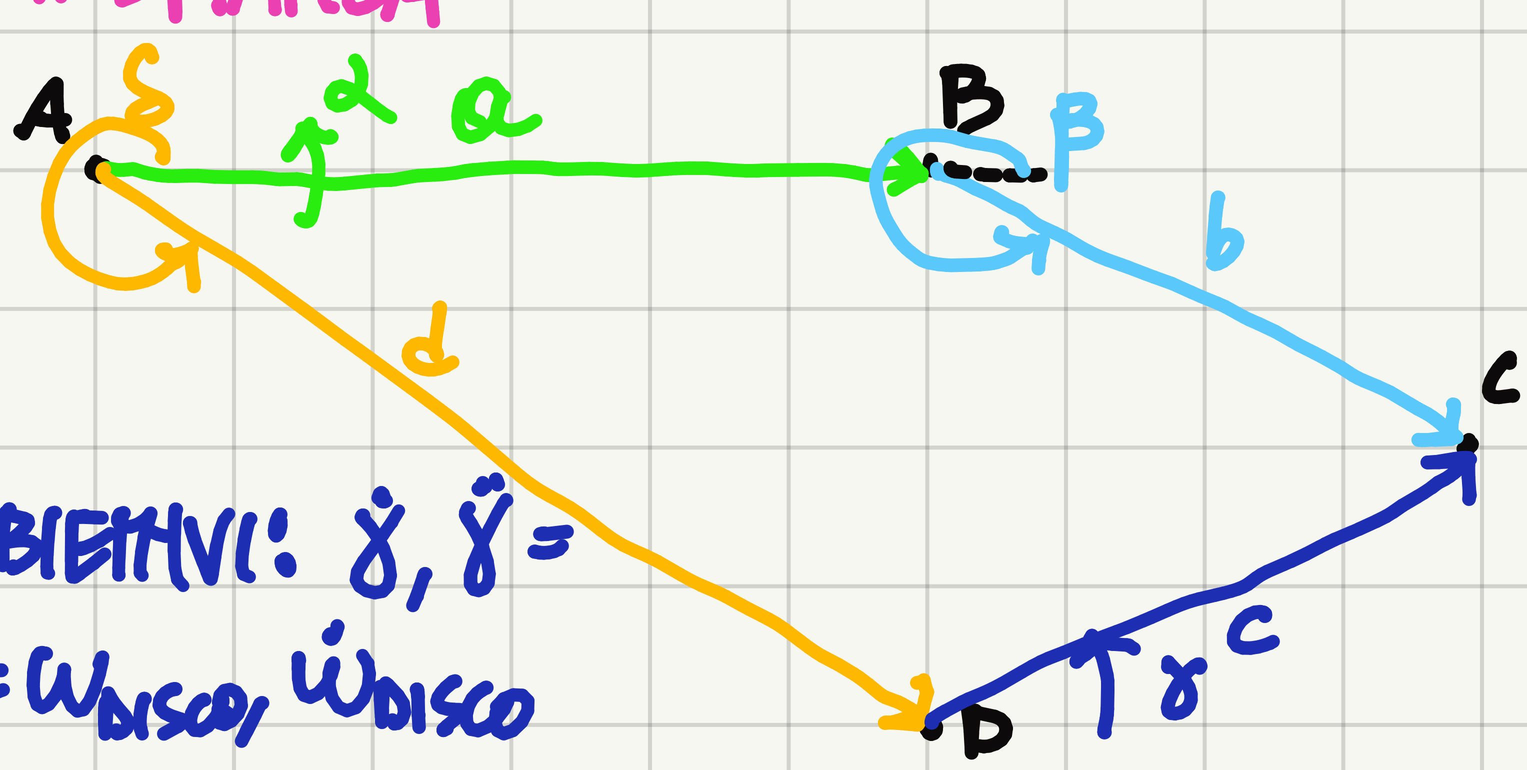
$\dot\alpha = 1\,rad/s \quad \ddot\alpha = 1\,rad/s^2 \quad R = 0{,}4\,m$

$m = 2\,kg \quad M = 1\,kg \quad J = 0{,}2\,kgm^2$

$J_d = 0{,}8\,kgm^2 \quad F = 30\,N \quad \mu_d = 0{,}7$

$\vec v_M, \vec a_M$? C_m ? TIRO FUNE IN H-H ?

CINEMATICA



OBIETTIVI: $\dot\gamma, \ddot\gamma =$
$= \omega_{DISCO}, \dot\omega_{DISCO}$

$a = 2\,m \quad \alpha = 0° \quad \dot\alpha = 1\,rad/s \quad \ddot\alpha = 1\,rad/s^2$

$b = 1\,m \quad \beta = 315° \quad \dot\beta, \ddot\beta \neq 0$

$c = 1{,}5\,m \quad \gamma = 30° \quad \dot\gamma, \ddot\gamma \neq 0$

$d, \delta \quad \dot d = \ddot d = \dot\delta = \ddot\delta = 0$

$\vec a + \vec b = \vec c + \vec d$

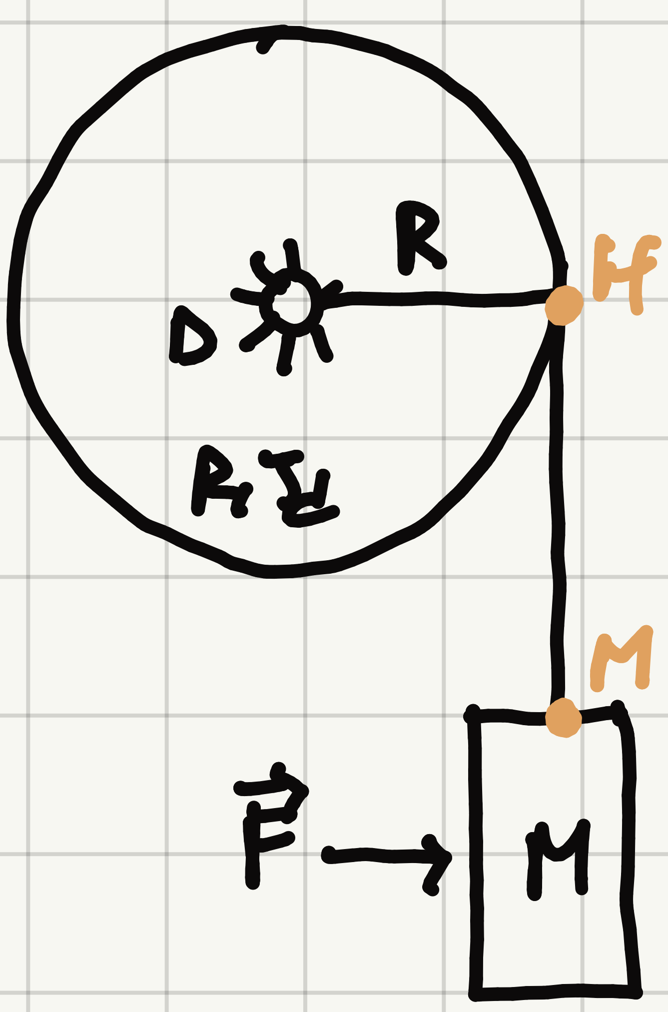
$$\begin{cases} a\cos\alpha + b\cos\beta = c\cos\gamma + d\cos\delta \\ a\sin\alpha + b\sin\beta = c\sin\gamma + d\sin\delta \end{cases}$$

$$\begin{cases} -a\dot\alpha\sin\alpha - b\dot\beta\sin\beta = -c\dot\gamma\sin\gamma \\ a\dot\alpha\cos\alpha + b\dot\beta\cos\beta = c\dot\gamma\cos\gamma \end{cases}$$

$$\begin{cases} -a\dot\alpha\sin\alpha = b\dot\beta\sin\beta - c\dot\gamma\sin\gamma \\ a\dot\alpha\cos\alpha = -b\dot\beta\cos\beta + c\dot\gamma\cos\gamma \end{cases}$$

$$\begin{vmatrix} b\sin\beta & -c\sin\gamma \\ -b\cos\beta & c\cos\gamma \end{vmatrix} \cdot \begin{vmatrix} \dot\beta \\ \dot\gamma \end{vmatrix} = \begin{vmatrix} -a\dot\alpha\sin\alpha \\ a\dot\alpha\cos\alpha \end{vmatrix}$$

$$\begin{vmatrix} -0{,}707 & -0{,}75 \\ -0{,}707 & 1{,}299 \end{vmatrix} \cdot \begin{vmatrix} \dot\beta \\ \dot\gamma \end{vmatrix} = \begin{vmatrix} 0 \\ 2 \end{vmatrix} \Rightarrow \begin{cases} \dot\beta = -1{,}04 \text{ rad/s} \\ \dot\gamma = 0{,}98 \text{ rad/s} \end{cases}$$



$$\Rightarrow \vec{\omega}_{DISCO} = 0{,}98\hat{k} \text{ rad/s}$$

$$\vec{v}_H = \cancel{\vec{v}_D} + \vec{\omega}_{DISCO} \times (H-D) =$$

$$= \dot\gamma R(\hat{k}\times\hat{\imath}) = 0{,}39\hat{\jmath} \text{ m/s}$$

$$\vec{v}_M = \vec{v}_H = (0{,}39\hat{\jmath}) \text{ m/s}$$

$$\begin{cases} -a\ddot\alpha\sin\alpha - a\dot\alpha^2\cos\alpha = b\ddot\beta\sin\beta + b\dot\beta^2\cos\beta - c\ddot\gamma\sin\gamma - c\dot\gamma^2\cos\gamma \\ a\ddot\alpha\cos\alpha - a\dot\alpha^2\sin\alpha = -b\ddot\beta\cos\beta + b\dot\beta^2\sin\beta + c\ddot\gamma\cos\gamma - c\dot\gamma^2\sin\gamma \end{cases}$$

$$\begin{vmatrix} b\sin\beta & -c\sin\gamma \\ -b\cos\beta & c\cos\gamma \end{vmatrix} \cdot \begin{vmatrix} \ddot\beta \\ \ddot\gamma \end{vmatrix} = \begin{vmatrix} -a\ddot\alpha\sin\alpha - a\dot\alpha^2\cos\alpha - b\dot\beta^2\cos\beta + c\dot\gamma^2\cos\gamma \\ a\ddot\alpha\cos\alpha - a\dot\alpha^2\sin\alpha - b\dot\beta^2\sin\beta + c\dot\gamma^2\sin\gamma \end{vmatrix}$$

$$\begin{vmatrix} -0{,}707 & -0{,}75 \\ -0{,}707 & 1{,}299 \end{vmatrix} \cdot \begin{vmatrix} \ddot\beta \\ \ddot\gamma \end{vmatrix} = \begin{vmatrix} -1{,}52 \\ 3{,}48 \end{vmatrix} \Rightarrow \begin{cases} \ddot\beta = -0{,}44 \text{ rad/s}^2 \\ \ddot\gamma = 2{,}44 \text{ rad/s}^2 \end{cases}$$

$$\Rightarrow \dot{\vec{\omega}}_{DISCO} = 2{,}44\hat{k} \text{ rad/s}^2$$

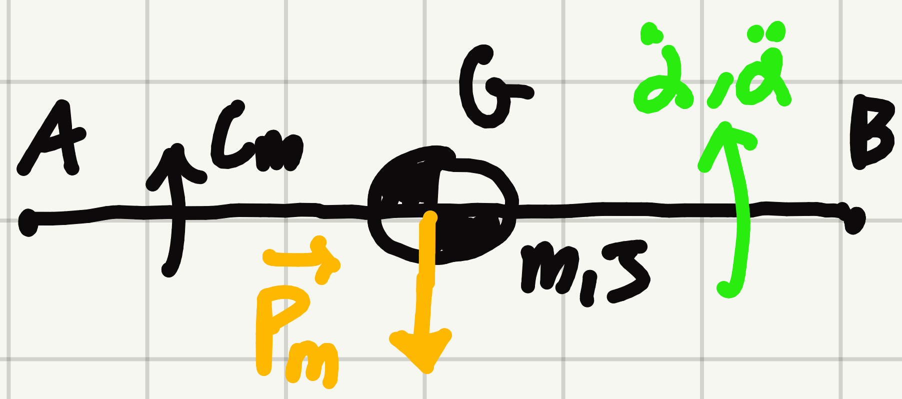
$$\vec{a}_H = \cancel{\vec{a}_D} + \dot{\vec{\omega}}_{DISCO} \times (H-D) - \omega^2_{DISCO}(H-D) = \dot\omega_{DISCO} R(\hat{k}\times\hat{\imath}) + a_H^{(cn)} =$$

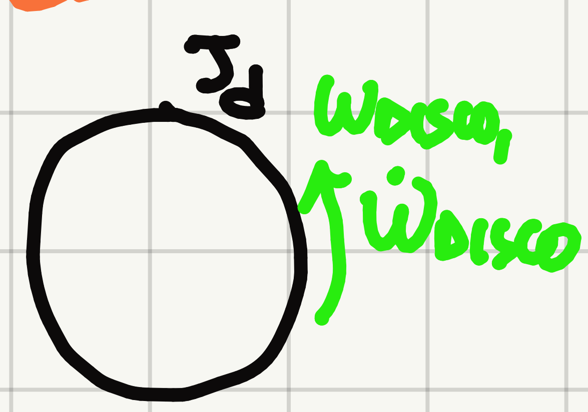
$$= 0{,}98\hat{\jmath} \text{ m/s}^2 + a_H^{(cn)}$$

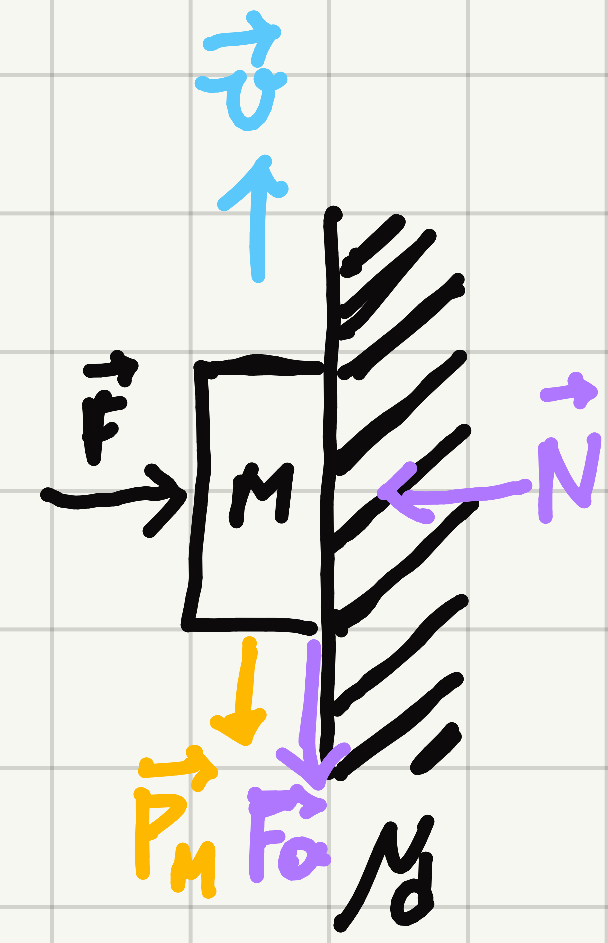
$$\vec{a}_M = \vec{a}_H^{(cn)} = (0{,}98\hat{\jmath}) \text{ m/s}^2$$

DINAMICA

BILANCIO DI POTENZE: $\sum P = \frac{d}{dt}K$







$$\frac{d}{dt}K = (m v_G a_G^{(t)} + J\dot{\alpha}\ddot{\alpha}) + (J_d \omega_{DISCO}\dot{\omega}_{DISCO}) + (M v_M a_M^{(t)})$$

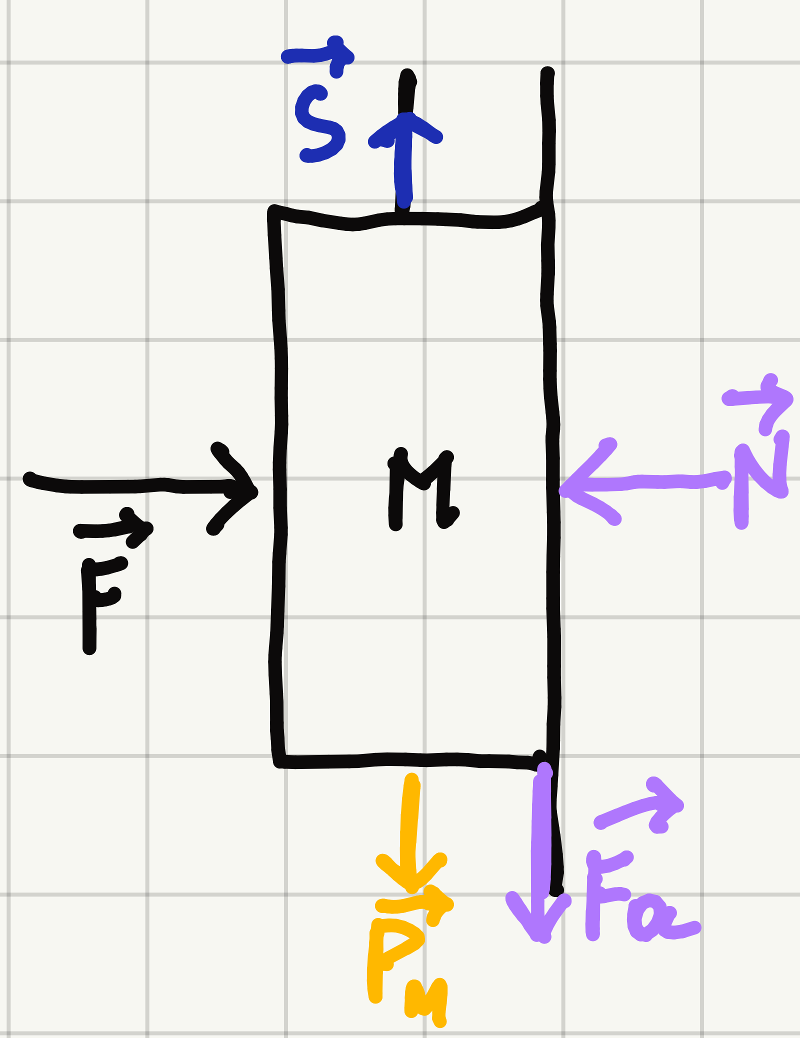
$$\vec{v}_G = \cancel{\vec{v}_A} + \dot{\alpha} \times (G-A) = \hat{k} \times \frac{R}{2}\hat{\imath} = (1\,3)\,m/s$$

$$\vec{a}_G = \cancel{\vec{a}_A} + \ddot{\alpha} \times (G-A) - \dot{\alpha}^2(G-A) = \hat{k} \times \frac{R}{2}\hat{\imath} + \vec{a}_G^{(n)} = (1\,3)\,m/s^2 + \vec{a}_G^{(n)}$$

$$\frac{d}{dt}K = 4{,}50\,W$$

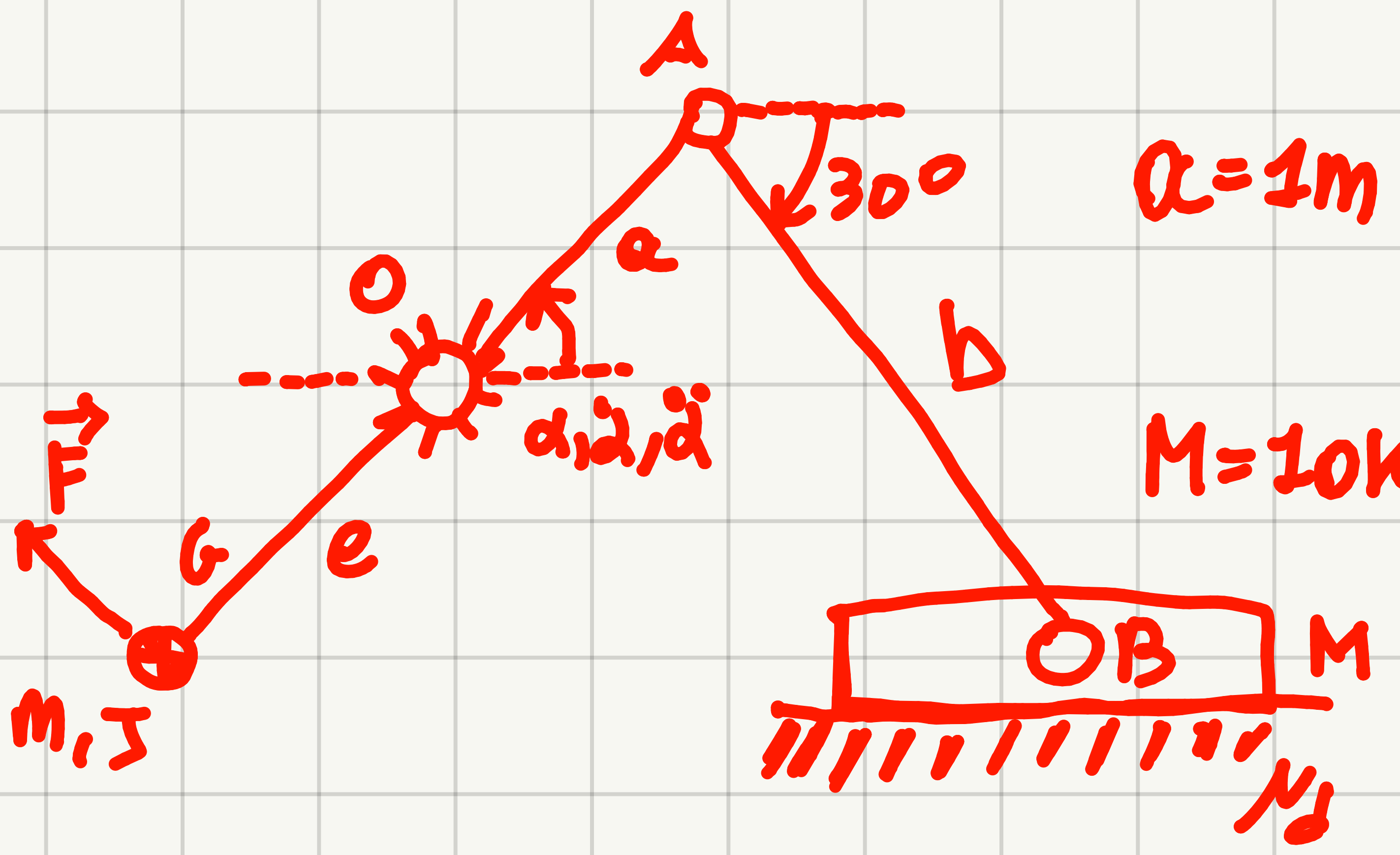
$$\sum P = (-m g v_G + C_m\dot{\alpha}) + (0) + (-M g v_M - F_a v_M) \qquad F_a = \mu_d N = \mu_d F$$

$$C_m\dot{\alpha} - m g v_G - M g v_M - \mu_d F = 4{,}50\,W \Rightarrow C_m = 36{,}14\,N$$



$$\begin{cases} \sum F_x = 0 \\ \sum F_y = Ma \end{cases} \qquad \begin{cases} F - N = 0 \\ S - F_a - Mg = Ma \end{cases}$$

$$S = \mu_d F + M(g+a) = 34{,}8\,N$$

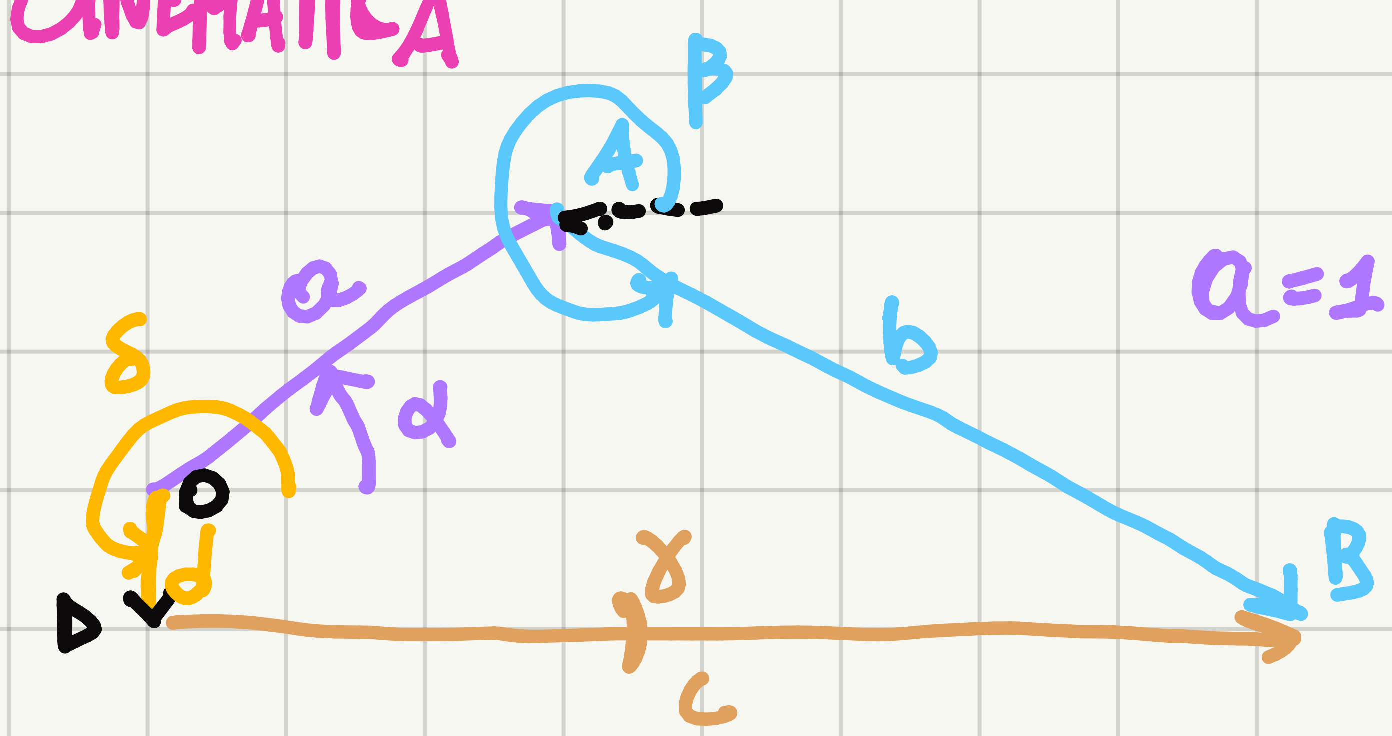


$a = 1m$ $b = 2m$ $e = 0{,}5m$ $\mu_d = 0{,}4$ $m = 2kg$

$M = 10kg$ $\alpha = 60°$ $\dot{\alpha} = 1\,rad/s$ $\ddot{\alpha} = 1\,rad/s^2$

$\vec{v}_B, \vec{a}_B$? $\vec{F}$?

CINEMATICA



$a = 1m$ $\alpha = 60°$ $\dot{\alpha} = 1\,rad/s$ $\ddot{\alpha} = 1\,rad/s^2$

$b = 2m$ $\beta = 360 - 30 = 330°$ $\dot{\beta}, \ddot{\beta} \neq 0$

c $\dot{c}, \ddot{c} \neq 0$ $\gamma = 0°$ FISSO d, δ FISSI

OBIETTIVI: $\dot{c} = v_B$, $\ddot{c} = a_B$

$$\begin{cases} a\cos\alpha + b\cos\beta = c + d\cos\delta \\ a\sin\alpha + b\sin\beta = d\sin\delta \end{cases}$$

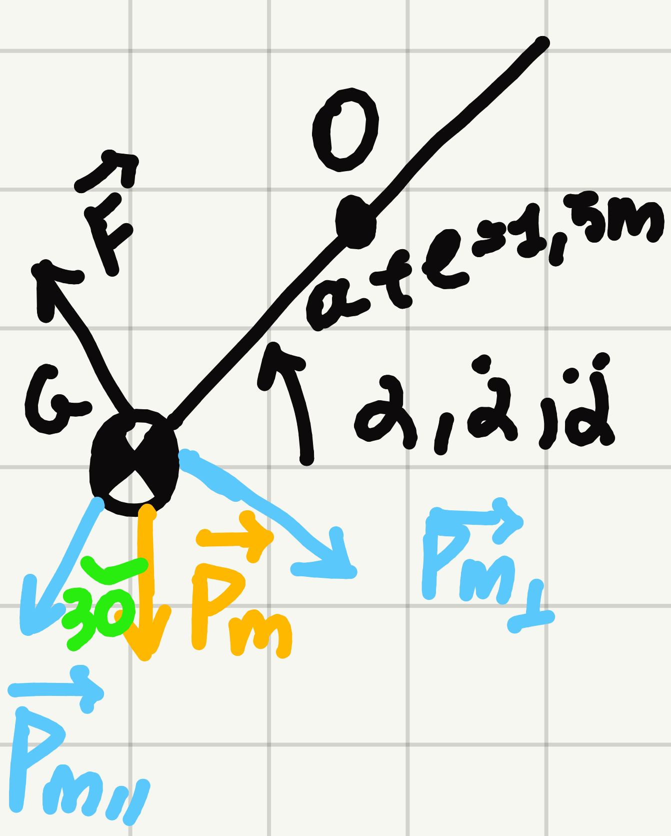
$$\begin{cases} -a\dot{\alpha}\sin\alpha - b\dot{\beta}\sin\beta = \dot{c} \\ a\dot{\alpha}\cos\alpha + b\dot{\beta}\cos\beta = 0 \end{cases} \qquad \begin{cases} \dot{c} = -1{,}16\,m/s \\ \dot{\beta} = -0{,}289\,rad/s \end{cases} \qquad \vec{v}_B = (-1{,}16\,\hat{i})\,m/s$$

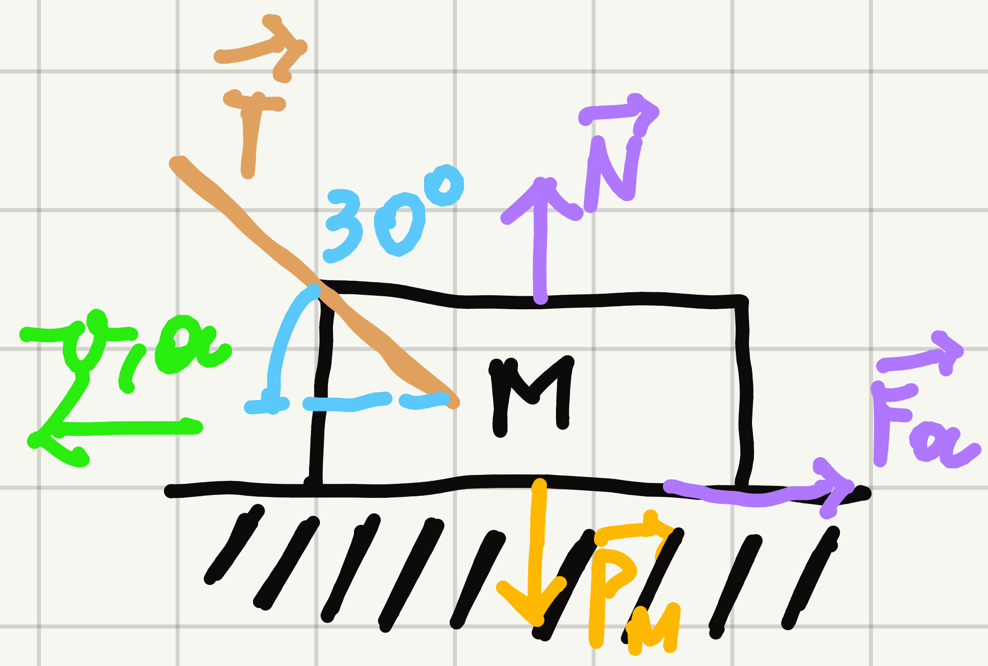
$$\begin{cases} -a\ddot{\alpha}\sin\alpha - a\dot{\alpha}^2\cos\alpha - b\ddot{\beta}\sin\beta - b\dot{\beta}^2\cos\beta = \ddot{c} \\ a\ddot{\alpha}\cos\alpha - a\dot{\alpha}^2\sin\alpha + b\ddot{\beta}\cos\beta - b\dot{\beta}^2\sin\beta = 0 \end{cases}$$

$$\begin{cases} \ddot{c} = -1{,}35\,m/s^2 \\ \ddot{\beta} = 0{,}16\,rad/s^2 \end{cases} \qquad \vec{a}_B = (-1{,}35\,\hat{i})\,m/s^2$$

DINAMICA

BILANCIO DI POTENZE: $\sum P = \frac{d}{dt}K$





$$\frac{d}{dt}K = (m v_G a_G^{(t)} + J\dot{\alpha}\ddot{\alpha}) + (M v_B a_B^{(t)})$$

$$\vec{v}_G = \cancel{\vec{v}_O} + \vec{\dot{\alpha}} \times (G-O) = \dot{\alpha}(G-O)\hat{k} \times (\cos(60)\hat{i} + \sin(60)\hat{j}) = 0{,}5(\sin(60)\hat{i} - \cos(60)\hat{j})$$

$|\vec{v}_G| = 0{,}5\, m/s$

$$\vec{a}_G = \underbrace{\cancel{\vec{a}_O} + \ddot{\alpha}(G-O)}_{(t)} - \dot{\alpha}(G-O)$$

$|\vec{a}_G^{(t)}| = 0{,}5\, m/s^2$ $\quad \frac{d}{dt}K = 16{,}21\, W$

$$\sum P = mg v_G \sin(30) - F v_G - F_a v_B \qquad F_a = \mu_d N$$

$$\begin{cases} \mu_d N - T\cos 30 = -M a_B \\ -Mg + N + T\sin 30 = 0 \end{cases} \qquad \begin{cases} T = \dfrac{-M a_B - \mu_d N}{-\cos 30} \\ N = Mg - (M a_B - \mu_d N)\tan 30 \end{cases}$$

$$N = \frac{Mg - M a_B \tan 30}{1 + \mu_d \tan 30} = 73{,}36\, N$$

$$mg v_G \cos(60) - F v_G - \mu_d N v_B = 16{,}21\, W \Rightarrow F = -90{,}7\, N$$