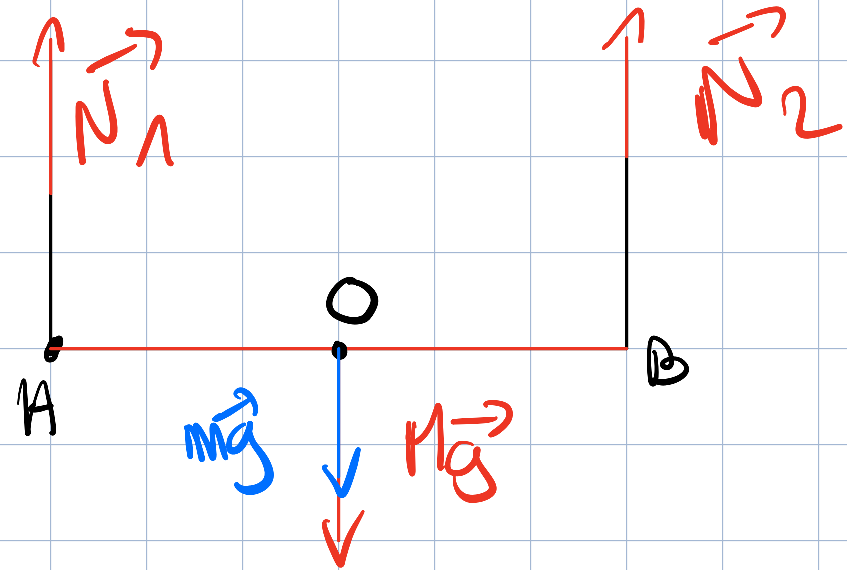
600 euros 1200 euro



$$\vec{L}_O = \vec{r} \wedge m\vec{v} = \vec{0} \Rightarrow \vec{M}_O = \vec{0}$$

① Ça tournerait

② ça tomberait

$$\sum \vec{F} = \vec{0} = m\vec{a}$$

$$\vec{M}_O(m\vec{g}) = \vec{OO} \wedge m\vec{g} = \vec{0}$$

$$\vec{M}_O(M\vec{g}) = \vec{OO} \wedge M\vec{g} = \vec{0}$$

$$\vec{M}_O(\vec{N}_1) = \vec{OA} \wedge \vec{N}_1 = -OA \cdot N_1 \cdot \vec{e}_z$$

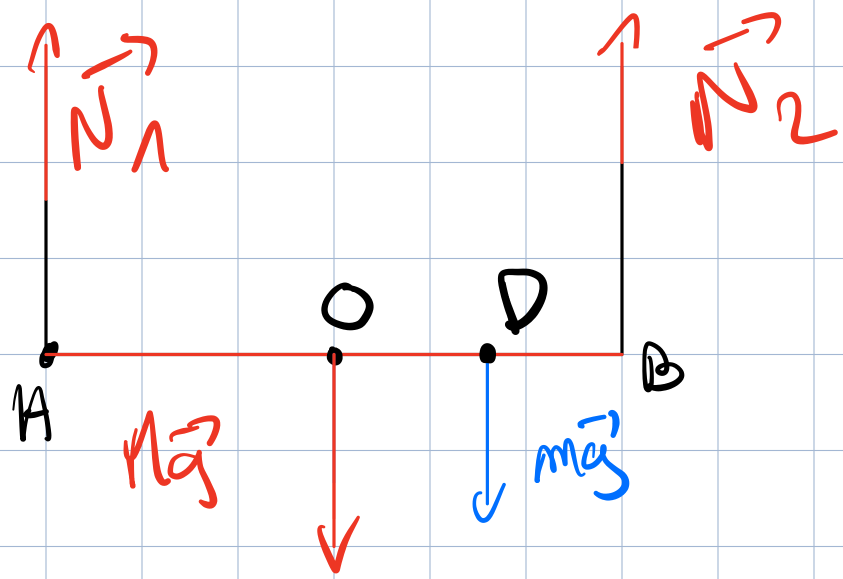
$$\vec{M}_O(\vec{N}_2) = \vec{OB} \wedge \vec{N}_2 = OB \cdot N_2 \cdot \vec{e}_z$$

$$\tilde{OA} \wedge \tilde{N_1} + \tilde{OB} \wedge \tilde{N_2} = \tilde{0}$$

$$\overline{OB} = -\overline{OA}$$

$$OA \wedge N_1 - OB \wedge N_2 = 0$$

$$\cancel{OA}\, N_1 = \cancel{OB}\, N_2 \qquad \underline{N_1 = N_2}$$

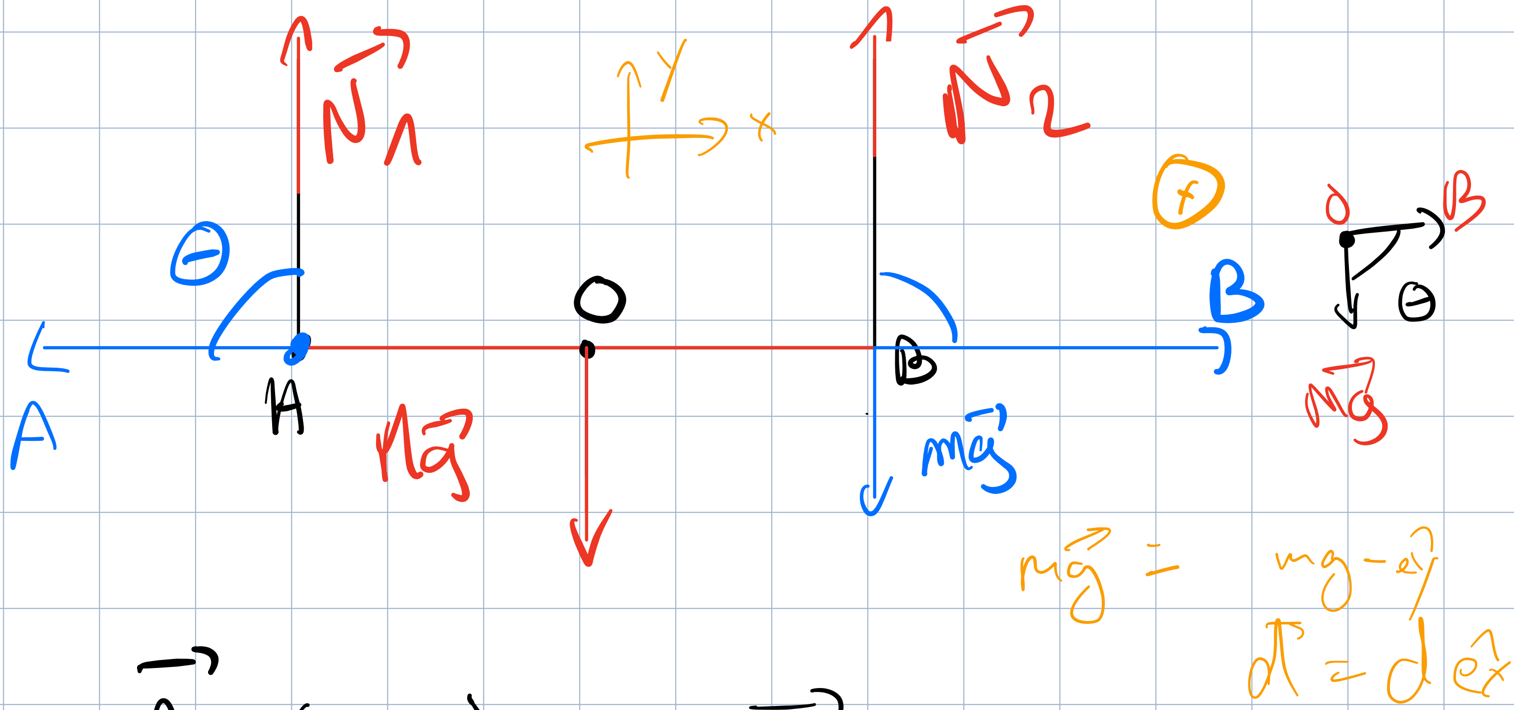


$$M_O(M\vec{g}) = \vec{0}$$

$$M_O(m\vec{g}) = \vec{OD} \wedge m\vec{g}$$

$$= OD \cdot mg$$

$$\underbrace{N_1 + N_2}_{800} = Mg + mg = 1200N$$



$$\vec{M}_O(m\vec{g}) = \vec{OB} \wedge m\vec{g}$$

$$= OB \cdot mg \cdot \hat{e}_z$$

$$\vec{M}_O(M\vec{g}) = \vec{0}$$

$$\vec{M}_O(\vec{N_1}) = \vec{OB} \wedge \vec{N_2}$$

$$= OB \cdot N_2 \cdot \hat{e}_z$$

$$\vec{M}_O(\vec{N_2}) = -OA \cdot N_1 \cdot \hat{e}_z$$

$$OB \cdot mg + OB \cdot N_2 - OA \cdot N_1$$

$$= 0$$

$$\Leftrightarrow (OA)(mg + N_2 - N_1) = 0.$$

$$\Leftrightarrow \quad mg = N_1 - N_2.$$

① Voyage vers Mars

ⓐ $$k = \frac{T_M^2}{(2R_M)^3} = \frac{T_T^2}{(2R_T)^3}$$

$$\Leftrightarrow \quad T_M = \sqrt{\frac{(2R_M)^3}{(2R_T)^3} \cdot T_T^2}$$

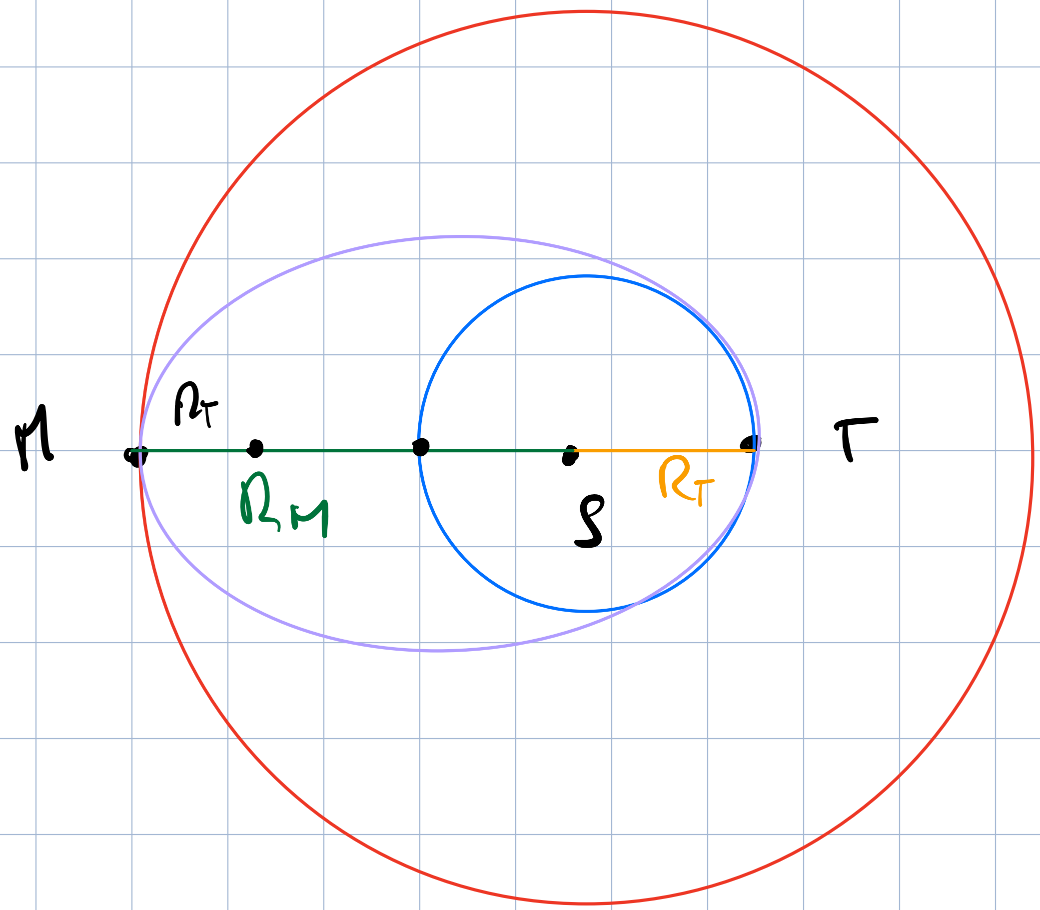
$$\simeq 684 \text{ jours}$$

ⓑ $$S_M = 2\pi \cdot R_M$$

$$V_M = \frac{2\pi \cdot R_M}{T_M}$$

ⓒ $$\vec{M}_{SM} = \vec{r}_M \wedge \vec{F} = \vec{0}.$$

$$\vec{L}_{SM} = \vec{0}.$$



$$\boxed{\frac{R_T + R_M}{2} = a.}$$

$$\frac{T_V^2}{(2a)^3} = \frac{T_M^2}{(2R_M)^3}$$

$$\Leftrightarrow \quad T_V^{\cancel{2}} = \sqrt{\frac{T_M^2}{(2R_M)^3} \cdot (2a)^3}$$

(d) $E_m = k + V(r)$

$$\sum \vec{F} = \vec{F_G} = -G \cdot \frac{M_S \cdot m}{R^2} \cdot \frac{\vec{r}}{r}$$

Comme $\vec{F_G}$ est conservatrice $\Rightarrow$ E_m conservée.

$$E_{m_0} = \frac{1}{2} m (V_{départ})^2 - G \frac{M_S \cdot m}{(R_T)}$$

$$E_{mf} = \frac{1}{2} m (V_{arrivée})^2 - G \frac{M_S \cdot m}{(R_M)}$$

$$\frac{1}{\cancel{2}} \cancel{m} (V_{départ})^2 - 2G \frac{M_S \cdot \cancel{m}}{R_T} = \frac{1}{\cancel{2}} \cancel{m} (V_{arrivée})^2 - 2G \frac{M_S \cdot \cancel{m}}{R_M}$$

$$V_{départ}^2 - 2G \frac{M_S}{R_T} = V_{arrivée}^2 - 2G \frac{M_S}{R_M}$$

$L_0 = cst$ car force centrale

$$\vec{L_{O_i}} = R_T \frac{\vec{r}}{r} \wedge m \vec{v}_{depart} = R_T \cdot m \cdot v_{depart}$$

$$\vec{L_{O_f}} = R_M \frac{\vec{r}}{r} \wedge m \vec{v}_{arrivée} = R_M \cdot m \cdot v_{arrivée}$$

$$\frac{T^2}{a^3} =$$

$$R_T \cdot \cancel{m} \cdot V_{depart} = R_M \cdot \cancel{m} \cdot V_{arrivée}$$

$$\Leftrightarrow V_{depart} = \frac{R_M}{R_T} \cdot V_{arrivée}$$

$$\left(\frac{R_M}{R_T}\cdot V_A\right)^2 - 2G\frac{M_S}{R_T} = V_A^2 - 2G\frac{M_S}{R_M}$$

$$\Leftrightarrow \left(\frac{R_M}{R_T}\right)^2 \cdot V_A^2 - V_A^2 = -2G\frac{M_S}{R_M} + 2G\frac{M_S}{R_T}$$

$$\Leftrightarrow \left(\left(\frac{R_M}{R_T}\right)^2 - 1\right) V_A^2 = 2G\left(\frac{M_S}{R_T} - \frac{M_S}{R_M}\right)$$

$$\Leftrightarrow \left(\frac{R_M^2 - R_T^2}{R_T^2}\right) V_A^2 = 2G\left(\frac{M_S R_M - M_S R_T}{R_T R_M}\right)$$

$$\Leftrightarrow \quad // \quad = 2G M_S\left(\frac{R_M - R_T}{R_T R_M}\right)$$

$$V_A^2\left(\frac{R_M^2 - R_T^2}{R_T^2}\right) = 2GM_S\left(\frac{R_M - R_T}{R_T R_M}\right)$$

$R_M = x \quad R_T = y$

$$\frac{x^2 - y^2}{y^2} = k\left(\frac{x-y}{xy}\right)$$

$$\Leftrightarrow \quad \cancel{(x-y)}(x+y)(xy) = k\cancel{(x-y)}\cdot y^2$$

$$\Leftrightarrow \quad (x+y)(xy) = ky^2$$

$$\Leftrightarrow \quad (x+y)x = ky$$

$$k = \frac{2GM_S}{V_A^2}$$

$$(R_M + R_T)R_M = \frac{2GM_S}{V_A^2} R_T$$

$2R_T$

$$\Leftrightarrow \frac{(R_M+R_T)R_M \cdot V_A^2}{2R_T} = \boxed{GM_S}$$

Cette équat° est valable pour le vaisseau mais aussi pour la Terre de vitesse

$$\frac{(R_M+R_T)R_M \cdot V_A^2}{2R_T} = R_T \cdot (V_T)^2$$

$$V_A^2 = (V_T)^2 \cdot 2(R_T)^2 \cdot \frac{1}{(R_M+R_T)R_M}$$

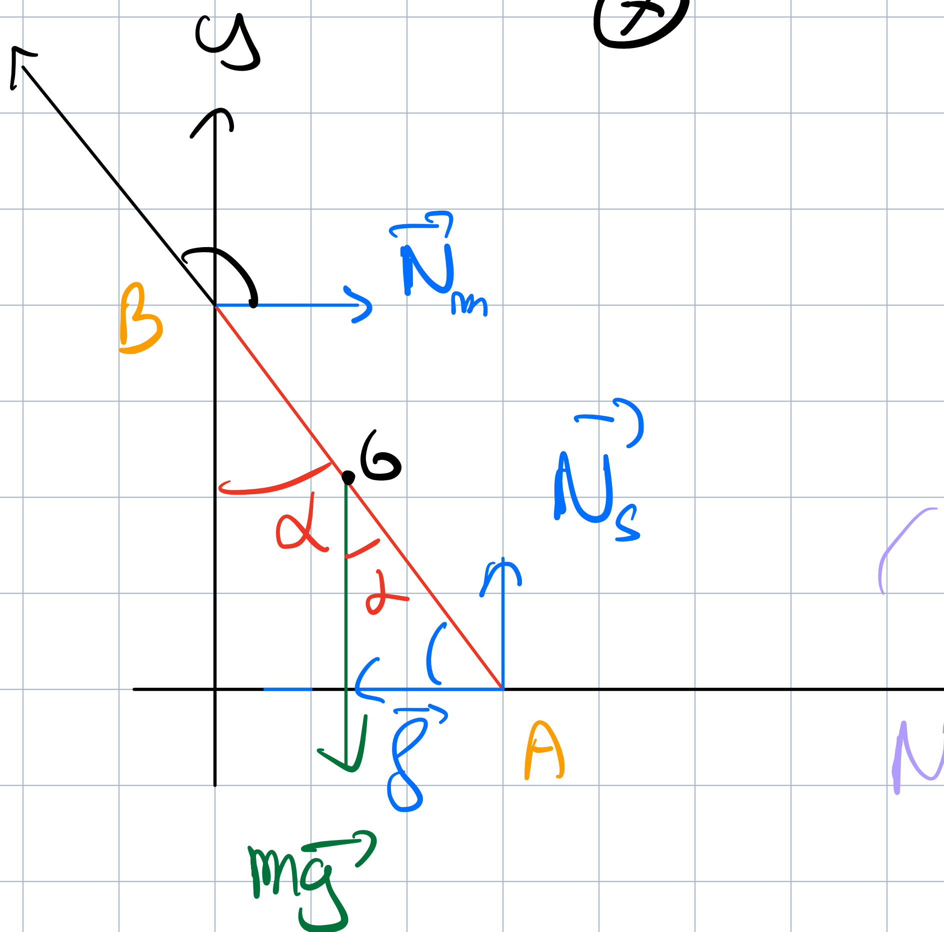
$$\Leftrightarrow V_A^2 = 2(V_T)^2 \cdot \frac{(R_T)^2}{R_M^2 + R_T R_M}$$

$$=$$

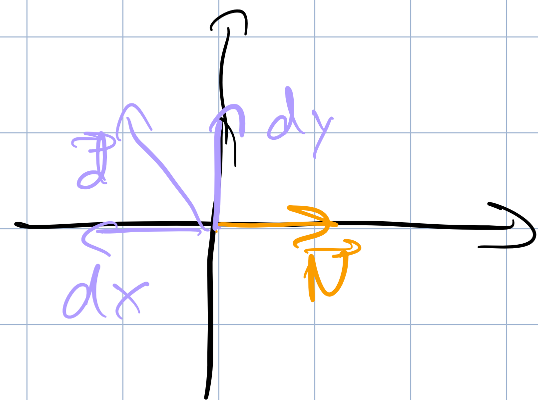
$$V_A^2 = 2V_T^2 \frac{R_T^{\cancel{2}}}{\cancel{R_T}\left(\frac{1}{R_M^2} + R_M\right)}$$

$$\Leftrightarrow (v_A)^2 = 2(v_T)^2 \cdot \frac{(R_T)^2}{R_M^2 + R_T R_M}$$

② L'échelle



⑦



$\vec{d} \wedge \vec{N} =$

$(d_y \, \vec{e_y} + d_x \vec{e_x}) \times (N \, \vec{e_x}) =$

$N d_y (\vec{e_y} \times \vec{e_x} + \cancel{\vec{e_x} \times \vec{e_x}})$

on cherche les conditions pour rester en équilibre (moment nul)

on choisit comme origine A

$$\vec{AA} \wedge \vec{g} = 0$$

$$+ \vec{AA} \wedge \vec{N_s} = 0$$
$$+ \vec{AG} \wedge m\vec{g}$$
$$+ \vec{AB} \wedge \vec{N_m}$$

$$= \vec{0}$$

$$\Leftrightarrow \left(\frac{l}{2} \cdot mg \cdot \sin\alpha - l \cdot \sin\left(\alpha + \frac{\pi}{2}\right) \cdot N_m\right)\hat{e_3} = \vec{0}$$

$$N_m = \frac{-l}{2} \cdot mg \cdot \sin\alpha \cdot \frac{1}{\cos\alpha} \cdot \frac{-1}{l}$$

$$= \frac{1}{2} \cdot mg \cdot \tan\alpha$$

$$\sum \vec{F} = \vec{N_m} + \vec{f} + \vec{N_s} + m\vec{g}$$

$$\begin{cases} (\hat{e}_y) & m\vec{a} = \vec{N_s} + m\vec{g} = \vec{0} \\ (\hat{e}_x) & m\vec{a} = \vec{f} + \vec{N_m} = \vec{0} \end{cases}$$

$$F_{max}^{frot\ st.} + N_m = 0$$

$$\Leftrightarrow -\mu_{max} N_s + \frac{1}{2} \cdot mg \cdot \tan\alpha = 0$$

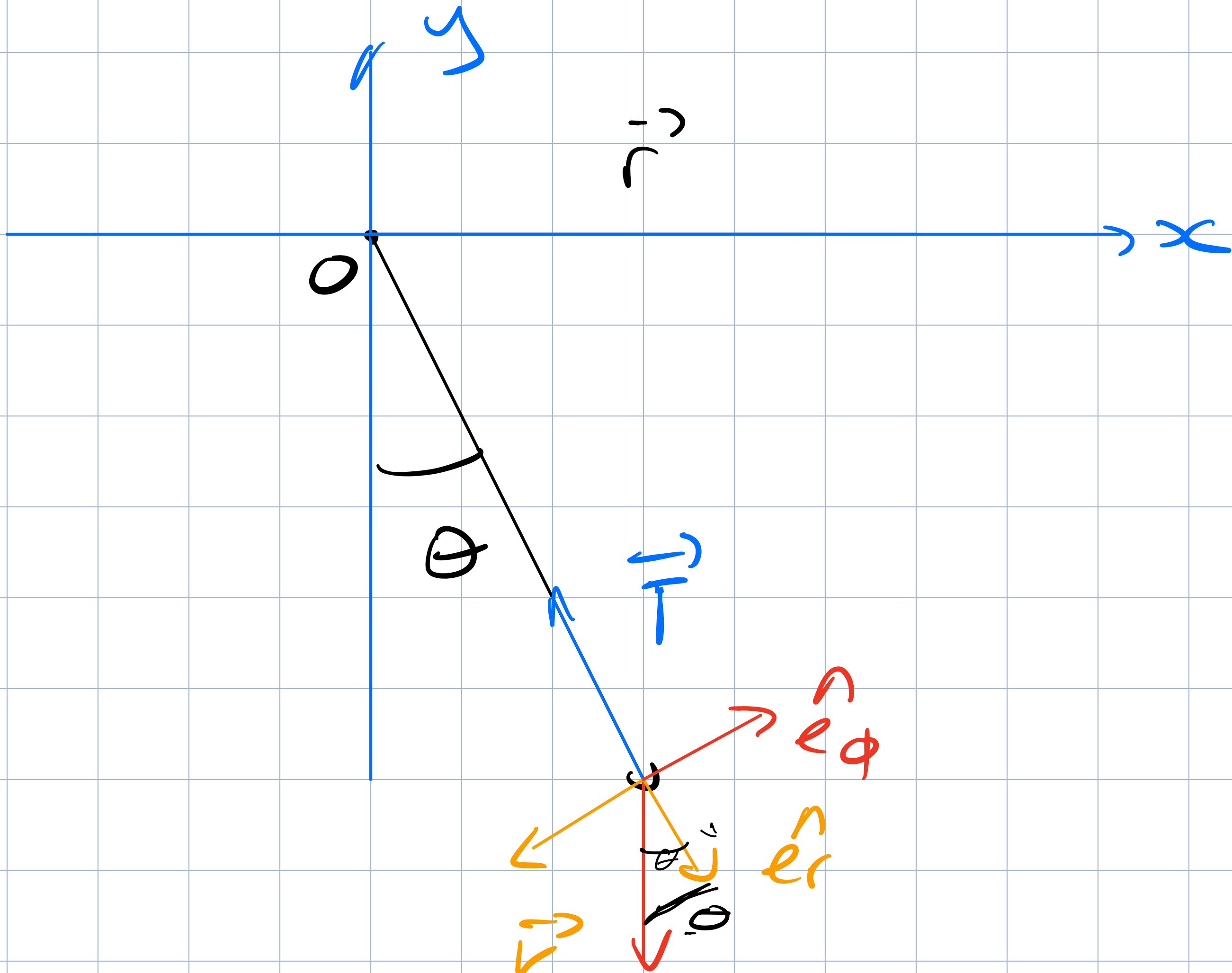
$$\Leftrightarrow -\mu_s (mg) + \frac{1}{2} mg \cdot \tan\alpha = 0$$

$$\Leftrightarrow \frac{1}{2} \cancel{mg} \tan\alpha = \mu \cancel{mg}$$

$$\Leftrightarrow \tan\alpha = 2\mu$$

③ $$\frac{d\vec{L}_O}{dt} = \vec{M}_O$$

$\otimes$



$$\vec{v} = \dot{\rho}\,\cancel{\hat{e}_\rho} + \rho\,\dot{\phi}\,\hat{e}_\phi$$

$$\vec{L_O} = \vec{r} \wedge m\vec{v}$$

$$\Leftrightarrow \vec{L_O} = \ell \hat{e_\rho} \wedge m \ell \dot{\phi} \hat{e_\phi}$$

(coord. cylind.)

$$\Leftrightarrow \vec{L_O} = (\ell \cdot m \ell \dot{\phi}) \hat{e_3}$$

$$= \ell^2 m \dot{\phi} \hat{e_3}$$

$$\Rightarrow \frac{d\vec{L_O}}{dt} = \ell^2 m \ddot{\phi} \hat{e_3}$$

$$= \vec{M_O}$$

$$\vec{M_O} = \hat{r} \wedge \vec{F}$$

$$= \ell \hat{e_r} \wedge ($$

$$mg \cdot \cancel{\cos\theta\, \hat{e_r}} - mg \cdot \sin\theta\, \hat{e_\phi})$$

$$= l\,\hat{e}_r \wedge \left(-mg \sin\theta\, \hat{e}_\phi\right)$$

$$= -l\,mg \sin\theta\, \hat{e}_3$$

$$= \vec{M}_O$$

$$-\cancel{l}\,\cancel{m}g \sin\theta = l^{\cancel{2}}\,\cancel{m}\,\ddot{\phi}$$

$$\Leftrightarrow \frac{-g}{l} \sin\theta = \ddot{\phi}$$